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Quantification of Ordinal Surveys and Rational Testing: An Application to the Colombian Monthly Survey of Economic Expectations

Cuantificación de encuestas ordinales y pruebas de racionalidad: una aplicación con la encuesta mensual de expectativas económicas

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Abstract

Expectations and perceptions obtained in surveys play an important role in designing the monetary policy. In this paper we construct continuous variables from the qualitative responses of the Colombian Economic Expectation Survey (EES). This survey examines the perceptions and expectations on different economic variables. We use the methods of quantification known as balance statistics, the Carlson-Parkin method, and a proposal developed by the Analysis Quantitative Regional (AQR) group of the University of Barcelona. Then, we later prove the predictive ability of these methods and reveal that the best method to use is the AQR. Once the quantification is made, we confirm the rationality of the expectations by testing four key hypotheses: unbiasedness, no autocorrelation, efficiency and orthogonality.

***Key words*:** Rational Expectations, Survey, Quantification.

Resumen

En este artículo se cuantifican las respuestas cualitativas de la "Encuesta Mensual de Expectativas Económicas (EMEE)" a través de métodos de conversión tradicionales como la estadística del balance de Batchelor, el método probabilístico propuesto por Carlson-Parkin (CP) y la propuesta del grupo de Análisis Cuantitativo Regional (ACR) de la Universidad de Barcelona. Para las respuestas analizadas de esta encuesta se encontró que el método ACR registra el mejor desempeño teniendo en cuenta su mejor capacidad predictiva. Estas cuantificaciones son posteriormente utilizadas en pruebas de racionalidad de expectativas que requieren la verificación de cuatro hipótesis fundamentales: insesgamiento, correlación serial, eficiencia y ortogonalidad.

***Palabras clave*:** cuantificación, encuestas, expectativas racionales.

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1. Introduction

Economic decisions are usually made under a scenario of uncertainty about economic conditions. Thus, expectations on key variables and how private agents form their expectations play a crucial role in macroeconomic analysis. The direct way in the measurement of expectations comes from the application of qualitative surveys[1] of firms, which try to gauge respondent's perceptions regarding current economic conditions and expected future activity. According to Pesaran (1997), the "Business Surveys" provide the only opportunity to explore one of the big black boxes in the economy that inquire about the expectations and which allows to obtain leading indicators of current changes in economic variables over the business cycle.

The main characteristic of this kind of surveys is that questions provide ordinal answers that reveal the direction of change for the variable under consideration[2]. In other words it increases, remains constant or declines. The information extracted with ordinal data is used to anticipate the behavior of economic variables of continuous type and to build indicators of economic activity[3]. However, the analysis requires a cardinal unit of measurement and therefore a conversion method from nominal to quantitative figures is a topic in business analysis.

In this paper we study the properties of several methodologies to quantify the qualitative answers and present an application from the monthly Economic Expectation Survey (EES) realized by the central bank of Colombia during the period October 2005 to January 2010. The article is organized into six sections including this introduction. In Section 2, briefly we describe traditional methods to convert variables from qualitative to continuous type. Later, in Section 3 we present the application of these methods with some of the questions contained in the EES. The models for expectations and the econometric strategy for testing are summarized in the Section 4. Section 5 shows the empirical results. Finally, in Section 6 we summarize the conclusions.

2. Quantification Methods of Expectations

In order to measure the attitudes of the respondents for variables such as prices, the central bank distributes monthly a questionnaire that can be classified into four broad categories: past business conditions, outlook of the business activity, pressures on firm's production capacity, outlook of wages and prices.

The EES survey answers contains three options classified as follows: "increases", "decreases" or "remains the same". In Table 1 is described the notation of the answers of the public-opinion poll in terms of judgments (perception in the period t

[1]The impact of the expectations of the agents on the economic variables is difficult to observe due to the fact that these are evaluated by quantitative measurements that present problems of sensitivity: Sampling errors, sampling plan and measurement errors.

[2]Berk (1999), Visco (1984) among others, analyzed opinion surveys with more than three categories of response.

[3]The evolution of cyclical movements is called the Business Climate indicator.

of the evolution of variable respect of the period $t-1$) and expectations (perception in t of the evolution expected from the variable for $t+1$)[4]. In this case, $JUP_t + JDO_t + JEQ_t = 1$ if they are judgments, or $EUP_t + EDO_t + EEQ_t = 1$ if they are expectations.

Table 1: Clasification of answers.

Notation	Description
JUP_t	Proportion of enterprises that at time t perceive that the observed variable is going 'Up' between period $t-1$ and period t.
JDO_t	Proportion of enterprises that at time t perceive that the observed variable is going 'Down' between period $t-1$ and period t.
JEQ_t	Proportion of enterprises that at time t perceive that the observed variable has 'A normal level' between period $t-1$ and period t.
EUP_t	Proportion of enterprises that at time t expect an 'Increase' of the variable from period t to period $t+1$.
EDO_t	Proportion of enterprises that at time t expect a 'Decrease' of the variable from period t to period $t+1$.
EEQ_t	Proportion of enterprises that at time t 'Don't expect any change' in the variable from period t to period $t+1$.

In this article, the expectations for growth in sales volume, the variation of the total raw material prices (national and imported) and the variation in price of products that will be sold; are quantified. The quantification techniques are based on two concepts. The first concerns with the distribution of expectations in which it is assumed that in the period t every individual i forms a distribution of subjective probability distribution $f_{it}(\mu_{it}, \tau_{it}^2)$ with mean μ_{it} and variance τ_{it}^2. The mean of this can be distributed through individuals as: $\mu_{it} g_t(\mu_t, \sigma_t^2)$ (where the expected value μ_t measures the average expectations in the survey population at time t and σ_t measures the dispersion of average expectations in that population); the second assumes that an individual with probability distribution f_{it} answers "increases" or "decreases" to the questions of the survey, according to whether the average subjective μ_{it} exceeds some rate limit δ_{it} or it is less to another rate limit $-\epsilon_{it}$ respectively, so that $\delta_{it} > 0$ and $\epsilon_{it} > 0$.

2.1. The Balance Statistics

Originally, this kind of statistics was introduced by Anderson (1952) in his work for the IFO survey. This statistic is obtained by:

$$S_t^{t+1} = EUP_t - EDO_t \tag{1}$$

The advantage of this statistic is that it can be used both for questions that investigate on judgments (S_t^{t-1}), and for making reference on expectations (S_t^{t+1}). Batchelor (1986) takes into account the key concepts of the general theory of quantification based on the following assumptions:

[4]See `www.banrep.gov.co/economia/encuesta_expeco/Cuestionario_CNC.pdf`

•The distribution of expectations follows a sign function (Pfanzagl 1952, Theil 1958), with a time-invariant parameter θ. It is to say $g_t(\mu_t, \sigma_t^2) = g(\mu_t, \sigma_t^2)$, where:

$$EDO_t \quad \text{si} \quad \mu_{it} = -\theta; \qquad EEQ_t \quad \text{si} \quad \mu_{it} = 0; \qquad EUP_t \quad \text{si} \quad \mu_{it} = \theta \tag{2}$$

•The distribution of the expectation is characterized by long terms unbiased, which means that in a period of time with T surveys, the average expectation μ_t is equal to the current average rate variable:

$$\sum_{t=1}^{T} \mu_t = \sum_{t=1}^{T} x_t \tag{3}$$

•The function of the response limits δ_{it} and ϵ_{it}; may be asymmetric and vary over the individuals and time, but must be strictly less than θ; it is to say:

$$\delta_{it} < \theta, \quad \epsilon_{it} < \theta \tag{4}$$

Therefore, the expected value and the variance of the distribution are:

$$\mu_{it} = \theta(EUP_t - EDO_t), \quad \sigma_t^2 = \theta^2[(EUP_t + EDO_t) - (EUP_t - EDO_t)^2] \tag{5}$$

By assuming the response function, the proportions of the sample:EUP_t, EDO_t and EEQ_t behave like maximum likelihood estimators, making it possible to estimate the parameter θ. With this estimate, it is obtained that

$$\begin{aligned} \sum_{t=1}^{T} \theta(EUP_t - EDO_t) &= \sum_{t=1}^{T} x_t, \\ \theta \sum_{t=1}^{T} (EUP_t - EDO_t) &= \sum_{t=1}^{T} x_t, \end{aligned} \qquad \widehat{\theta} = \frac{\sum_{t=1}^{T} x_t}{\sum_{t=1}^{T}(EUP_t - EDO_t} \tag{6}$$

Fluri & Spoerndli (1987) estimate the expectation of the variable as:

$$(E(X))_t = \widehat{\theta}(EUP_t - EDO_t) \tag{7}$$

Where $E(X)$ denotes the expectation of the random studied variable, x_t is the realization of the variable under study and $(\widehat{\theta})$ is the scaling factor determined by the unbiasedness of the equation . Thus, the Modified Balance Statistical (MBS) provides a measure of the expected average in the variable, taking into account the trend and the points of inflection.

2.1.1. Recent Proposals

Loffler (1999) estimates the measurement error introduced by the probabilistic and proposes a linear correction method[5]. On his part, Mitchell (2002) finds

[5]Claveria & Suriñach (2006).

evidence that the normal distribution, as well as any other stable distribution, provides accurate expectations[6]. Claveria & Suriñach (2006) posed different statistical expectations for the quantifications, including a method that proposes the use of random walks and another one that use Markov processes of first order.

Claveria (2010) proposes a statistical balance with nonlinear variation, called Weighted Balance, such that $WB_t = \frac{R_t - F_t}{R_t + F_t} = \frac{B_t}{1 - C_t}$. This statistic takes into account the percentage of respondents expecting no change in the evolution of an economic variable.

2.2. Probabilistic Method

This method was proposed originally for Theil (1952), initially applied by Knobl (1974), and identified by Carlson & Parkin (1975) as CP "Probabilistic Method". For these authors, x_{it} represents the percentage of change of a random variable X_i of period $t-1$ for the period t (with $t = 2, 3, \ldots, T$); the respondent is indexed by i and x^e_{it} symbolizes the expectation having i on the change in X_i from the period t to the period $t+1$ (with $t = 1, 2, \ldots, T-1$). Also, they assume intuitively that respondents have a range of indifference $(a_{it},\ b_{it})$, with $a_{it} < 0$ and $b_{it} > 0$, so that each one of the respondent answers "Decrease" if $x^e_{it} < a_{it}$ or "Increase" if $x^e_{it} > b_{it}$. If there is not change, $x^e_{it} \in (a_{it}, b_{it})$.

Thus, in the period t each respondent based his answers on a subjective probability distribution $f_i(x_{it}/I_{t-1})$ defined as from future change in X_i conditioned by information available at the time $t-1$ (represented by I_{t-1}). These subjective probability distributions $f_i(\cdot)$ are such that they can be used to obtain a probability distribution of added $g(x_i/\Omega_{t-1})$, where $\Omega_{t-1} = \bigcup_{i=1}^{N-1} I_{t-1}$ is the union of individual information groups (where N_t is the total number of respondents in the period t)[7]. For the estimation of x^e_t, ("Average expectation of respondents"), the equation $x^e_t = \sum_{i=1}^{N} w_i x^e_{it}$, is used where w_i represents the weight of the respondent i and x^e_{it} represents the individual expectations.

Carlson and Parkin make two additional assumptions: First, that the indifference interval is equal for all respondents ($a_{it} = a_t$ y $b_{it} = b_t$). Second $f_i(x_{it}/I_{t-1})$ has the same form for all players and the first and second moment are finite. Thus, x^e_{it} may be considered as independent samples of an aggregate distribution $g(\cdot)$ with mean $E(x_t/\Omega_{t-1}) = x^e_t$ and variance σ^2_t, that can be written as[8]:

$$EDO_t = prob\{x_t \leq a_t/\Omega_{t-1}\}, \quad EUP_t = prob\{x_t \geq b_t/\Omega_{t-1}\} \tag{8}$$

where each agent has the same subjective distribution of expectations based on the information available. In most applications the use of the normal distribution that is statistically appropriate, is completely specified by two parameters. Thus, if G is defined as the cumulative distribution of the aggregate distribution $g(\cdot)$;

[6] Ibíd.

[7] Which is constant for each period.

[8] Note that if individual distributions are independent through respondents, they have a common and finite first and second time, then by the Central Limit Theorem $g(\cdot)$, they have normal distribution.

it is obtained by standardizing f_t and r_t as the abscissa of the inverse of the G corresponding to EDO_t and $(1 - EUP_t)$. That is:

$$f_t = G^{-1}(EDO_t) = (a_t - x_t^e)/\sigma_t, \quad r_t = G^{-1}(1 - EUP_t) = (b_t - x_t^e)/\sigma_t \tag{9}$$

Solving the system of Equation 9 to find the average expectations x_t^e and the dispersion σ_t, we obtain:

$$x_t^e = \frac{b_t f_t - a_t r_t}{f_t - r_t}, \quad \sigma_t = -\frac{b_t - a_t}{f_t - r_t} \tag{10}$$

Carlson and Parkin assume that the indifference interval does not vary over time, remaining fixed between business, and is symmetric around zero; that is, $-a_t = b_t = c$. Given this, we obtain an expression for calculating operational x_t^e by the method of Carlson and Parkin (CP), defined as:

$$x_{t,cp}^e = c\frac{f_t + r_t}{f_t - r_t} \tag{11}$$

with $c = \frac{\sum_t x_t}{\sum_t d_t}$ and $d_t = \frac{f_t + r_t}{f_t - r_t}$, where x_t includes the annual variation of the observed variable. In this case, the role of c is scaled x_t^e, so that the average value of x_t equals x_t^e, which means that expectations are assumed to be average unbiased. Assuming that the random variable observed X has normal distribution, then f_t and r_t are found using the inverse of the cumulative distribution standard normal distribution, in the Equation 9. It is important to note that the imposition of expectations makes them unsuitable to apply rationality contrasts a posteriori. Moreover, it is assumed that $f_i(\cdot)$ has normal distribution. However, the uniform distribution also can be used. Assuming that X is distributed uniformly over the interval [0, 1], then f_t and r_t are calculated as:

$$f_t = \sqrt{12}(EDO_t - \frac{1}{2}), \quad r_t = \sqrt{12}(\frac{1}{2} - EUP_t) \tag{12}$$

2.2.1. Disadvantages and Extensions of the Carlson-Parkin Method

There are several shortcomings related to the Carlson-Parkin method. The same answers for all the respondents cause that the statistic goes to infinity, which, in turn, impedes the computation of expectations. Moreover, the assumption of constant and symmetric limits through time means that respondents are equally sensitive to an expected rise or an expected fall, of the variable under study. Seitz (1988) relaxes the assumptions of the Carlson-Parkin method allowing time variant boundaries of the indifference interval[9].

2.3. Regional Quantitative Analysis (RQA) Method

This method was implemented by Pons and Claveria at the Regional Quantitative Analysis Group (RQA); Department of Econometrics; Statistics and Economics at the University of Barcelona (Claveria, Pons & Suriñach 2003). The

[9]See Nardo (2003).

estimation is performed in two stages. The first stage gives a first set of expectations of the variation of the variable referred to as input, which can be defined as:

$$x^e_{input,t} = \widehat{c} * d_t \tag{13}$$

where $\widehat{c} = |x_{t-1}|$, $d_t = \frac{f_t + r_t}{f_t - r_t}$ and x_{t-1} shows the growth rate of the reference quantitative indicator of the previous period. The parameter estimation of indifference has a dual function: Firstly, it avoids the imposition of unbiasedness that occurs when estimating the range of indifference by the CP method, thus, the estimation allows movement in the indifference interval boundaries to incorporate changes in response time, and secondly, it relaxes the assumption of constancy over time of the scaling parameter because the parameter c will correspond to the rate of variation of quantitative indicator in the reference period $t - 1$.

The re-scaling of the series Input obtained from Equation 13 is necessary, because the function of c is the scalar statistic d_t and, therefore, would be distorting the interpretation given by the over-dimension of the class EEQ_t, that requires less commitment from the respondent, and just distorting the interpretation that is the parameter c as the limit of visibility. This justifies the need for scaling in two stages.

In the second stage the model is re-scaled with parameters changing over time. This regression equation estimated by ordinary least squares (OLS) and the parameters obtained are used to estimate the new set of expectations, where the series Input acts as an exogenous variable:

$$x_t = \alpha + \beta x^e_{input,t} + u_t \tag{14}$$

where α y β are the parameters of the estimation and u_t is the error. On the OLS, estimation of the regression parameters is constructed following conversion equation:

$$x^e_t = \widehat{\alpha} + \widehat{\beta} x^e_{input,t} \quad \text{donde} \quad x^e_{input,t} = \widehat{c} * d_t \quad \text{y} \quad \widehat{c} = |x_{t-1}| \tag{15}$$

where $\widehat{\alpha}$ and $\widehat{\beta}$ parameters are estimated and x^e_t represents the number of estimated expectations of the rate of variation of the observed variable. Obtaining these set of directly observed expectations allows us to contrast some of the hypotheses usually assumed in economic models, such as the rationality of the agents.

3. Application to the EES

In this section we apply the methods of quantification submitted to the observed variables (EES); therefore expectations obtained are evaluated in terms of their predictive ability. This is evaluated under four statistics known as Mean Absolute Error (MAE), Median Absolute of the Percentage Error (MAPE), Root

Error Square Mean (RESM) and the coefficient U of Theil (TU1):

$$\begin{aligned} MAE &= \sum_{t=1}^{T} \frac{|x_t - x_t^e|}{T} \\ MAPE &= \frac{\sum_{t=1}^{T} \frac{|x_t - x_t^e|}{x_t}}{T} * 100 \\ RESM &= \sqrt{\sum_{t=1}^{T} \frac{(x_t - x_t^e)^2}{T}} \\ TU1 &= [\frac{\sum_{t=1}^{T}(x_t - x_t^e)^2}{\sum_{t=1}^{T}(x_t)^2}]^{\frac{1}{2}} \end{aligned} \tag{16}$$

3.1. Quantification of Question 2 for EES

The growth of sales volume (quantity) in the next 12 months, compared with growth in sales volume (quantity) in the past 12 months, is expected to be: a) Increased, b) Decreased, c) The same (See Figure 1).

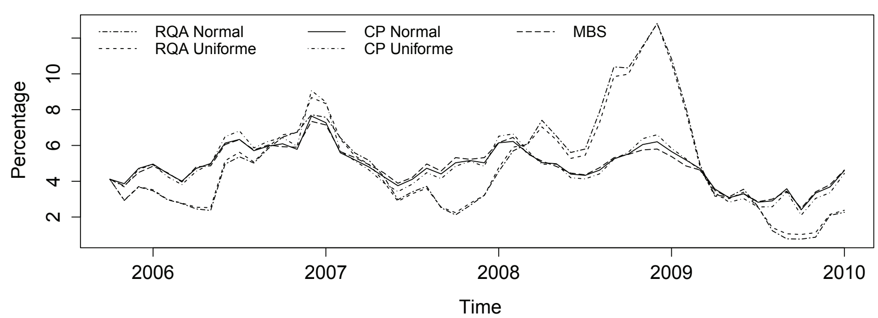

Figure 1: Expectations question 2.

For the quantification of this question the indicator of annual variation Total Index Sales[10], obtained from DANE is used as a reference. The methods applied were: RQA with normal and uniform distribution, method of CP with normal and uniform distribution and MBS.

It is noted that the expectations generated by normal RQA and the uniform method have very similar behaviors, and the patterns tend to have more movement when compared with other methods. Similarly, one can see that the series of expectations with the CP method with standard normal and uniform distribution, have similar behavior.

The results of the evaluation of the predictive power are presented in Table 2, and they suggest that the most appropriate method to carry out this quantification is the RQA with normal distribution, followed by the uniform distribution. In third

[10]In this case, the variable is nominal.

place is the CP method with uniform distribution, statistically below the MBS and finally by the normal CP method.

Table 2: Predictability Evaluation Question 2.

	MBS	Normal CP	Uniform CP	Normal RQA	Uniform RQA
MAE	0.046	0.047	0.042	0.029	0.032
MAPE	1.826	1.947	1.579	0.731	0.866
RESM	0.055	0.057	0.051	0.036	0.039
TU1	0.454	0.463	0.416	0.295	0.319

3.2. Quantification of Question 9 for EES

The increase in total prices of raw materials (domestic or imported) to buy in the next 12 months, compared with the total prices of raw materials purchased in the past 12 months is expected to be: a) Higher, b) Lower, c) The same (See Figure 2).

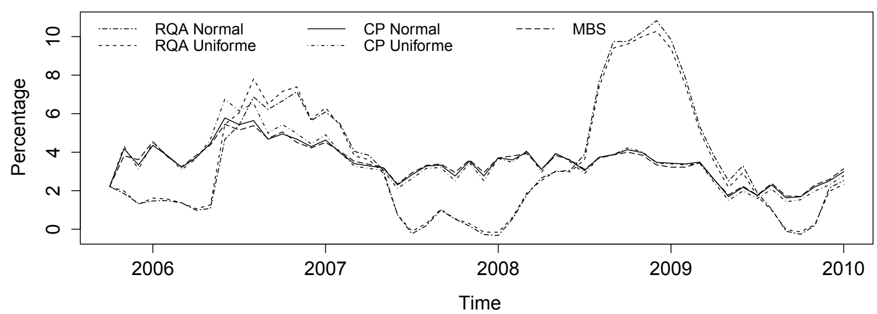

Figure 2: Expectations question 9.

The indicator used as reference is the annual variation Producer Price Index, obtained from the natinal statistical office in Colombia DANE. The series of expectations are estimated with the method of RQA with normal and uniform distributions and they exhibit similar behaviors on oscillations recorded over time. Moreover, the estimated normal uniform and CP and MBS fluctuate less than the other series.

The evaluation of the predictive ability (Table 3) indicates that the most appropriate method is RQA with normal distribution, followed by the uniform distribution. The third and fourth place corresponds to the CP method with uniform and normal distribution, respectively. The least predictive method presented is the MBS.

Table 3: Predictability Evaluation Question 9.

	MBS	Normal CP	Uniform CP	Normal RQA	Uniform RQA
MAE	2.648	2.623	2.616	1.648	1.704
MAPE	1.324	1.295	1.247	0.689	0.678
RESM	3.359	3.317	3.289	2.123	2.158
TU1	0.667	0.657	0.652	0.421	0.428

3.3. Quantification of Question 11 for EES

The increase in prices of products that will sell in the next 12 months, compared with the increase of prices of products sold in the past 12 months,are expected to be: a) Higher, b) Lower, c) The same (See Figure 3).

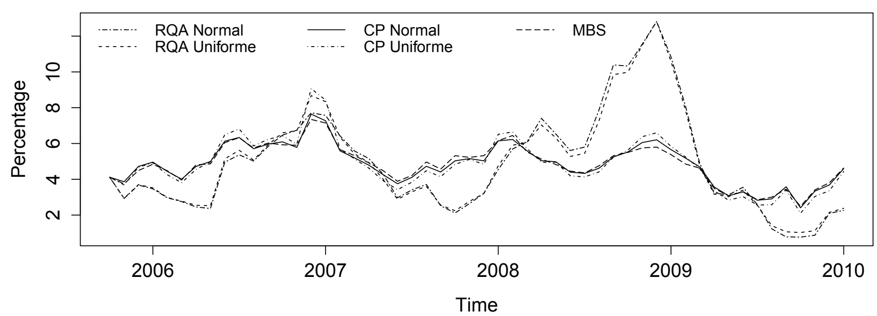

Figure 3: Expectations question 11.

The quantification is used as a reference indicator of annual variation rate of the Producer Price Index Produced and Consumed (PPIP&C).

It is noted that the expectations generated by the application of the method of MBS have a pattern that turns smoothly around the mean. The expectations series obtained with the CP method with normal and uniform distribution are similar but with a greater degree of variability. The expectations series obtained with the CP method with normal and uniform distribution are similar but with a greater degree of variability.

According to the statistics for the evaluation of the predictive ability (Table 4), the method with the best performance is the RQA with normal distribution, followed by the uniform distribution. The third and fourth place corresponds to the CP method uniform and the normal distributions respectively. Finally, the MBS method is the least predictive.

In general, there is evidence that the RQA methodology with standard normal distribution, followed by the uniform distribution; they present the best results in terms of evaluation of the predictive and their methods are attractive because the indifference parameter is asymmetric, changing over time and staying unbiased (which makes it optimal for the contrast of hypothesis about formation of expectations).

Nevertheless, due to the restriction of information on this method (both judgments and expectations), it is suggested to consider the CP method and the method of MBS in the quantification of the variables if you do not have all the information available.

Table 4: Predictability evaluation question 11.

	MBS	Normal CP	Uniform CP	Normal RQA	Uniform RQA
MAE	2.034	2.026	2.035	1.484	1.549
MAPE	0.697	0.691	0.660	0.446	0.461
RESM	2.792	2.772	2.753	1.980	2.058
TU1	0.477	0.474	0.470	0.339	0.351

4. Modeling the Expectations

4.1. Extrapolative and Adaptative Expectations

The pure model of extrapolative expectations is based on the assumption that the expectations depend only on the observed values of the variable that wil be predicted[11], of the variable to predict (Ece 2001), so this model can be represented as (Pesaran 1985):

$$ {}_t x^e_{t+1} = \alpha + \sum_{i=1}^{\infty} w_j x_{t-j} + u_{t+1} \tag{17} $$

where ${}_t x^e_{t+1}$ is the expectation of the variable formed in the period t, for the period $t+1$; x_{t-j}(with $j = 0, 1, 2, \ldots$) are the known data of the variable in the period t; w_j are the weights (fixed) given to each of the known values of the variable, and u_{t+1} is the random error term that attempts to capture the unobserved effects on the expectation.

Expectations of the adaptive model imply that if the variable value and expectations differ from the period of studies, then a correction to the expectation for the next period is made. However, if there is not difference, the expectation for the next period will stay unchanged (Ece 2001). On the imposition of certain restrictions to w_j in equation 17 it is possible to find the models used to testing adaptative expectations (this would support the hypothesis that such expectations are a special case of extrapolative expectations; (Pesaran 1985)). Thus, the four models used to represent the adaptive expectations are (Pesaran 1985, Ece 2001):

$$ x^e_{t+1} - x^e_t = w(x_t - x^e_t) + u_{t+1} \tag{18} $$

$$ x^e_{t+1} - x^e_t = \alpha_0(x_t - x^e_t) + \alpha_0(x_{t-1} - x^e_{t-1}) + u_{t+1} \tag{19} $$

$$ x^e_{t+1} - x^e_t = \beta_0(x_t - x^e_t) + \beta_1(x_{t-1} - x_{t-1}) + \beta_2(x_{t-1} - x^e_{t-1}) + u_{t+1} \tag{20} $$

$$ x^e_{t+1} = \lambda_0 + \lambda_1 x^e_t + \lambda_2 x^e_{t-1} + \lambda_3 x_t + \lambda_4 x_{t-1} + u_{t+1} \tag{21} $$

[11] See sections 2 and 3 of this paper.

Finally, to see if expectations are adaptive or extrapolative, it is necessary to perform an analysis on the coefficient of determination and the individual and joint significance level of the parameters. If all these indicators are significant, then it confirms the presence of these expectations. These models may have problems of serial correlation of errors and endogeneity, so it is necessary to apply appropriate econometric corrections to obtain estimators on which statistical inference can be made.

4.2. Rational Expectations

The rational expectations model was originally proposed by Muth (1961) and is based on the assumption that individuals (at least on average) use all available and relevant information when they make their predictions on the future behavior of the variable studied (Ece 2001). This can be expressed by:

$$x_t^e = E(x_t/I_{t-1}) \tag{22}$$

where x_t represents the value of the variable in the period t; x_t^e stands for the expected value of the variable for the period t reported in $(t-1)$ and I_{t-1} symbolizes the available and relevant information in $(t-1)$. The rational expectations must satisfy four tests (Ece 2001) and (Da Silva 1998):

1. *Unbiasedness*: For the regression $x_t = \alpha + \beta x_t^e + u_t$ the hypothesis $H_0 : \alpha = 0; \beta = 1$ cannot be rejected.

2. *Lack of serial correlations*: $E(u_t u_{t-i}) = 0, \forall_i \neq 0$

3. *Efficiency*: In the equation $u_t = \beta_1 x_{t-1} + \beta_2 x_{t-2} + \cdots + \beta_i x_{t-i}$, $i > 0$; the coefficients should not be significant.

4. *Orthogonality*: For the regression $x_t = \alpha + \beta x_t^e + \gamma I_{t-1} + u_t$ where, γ represent the effect of the information on the variable, the hypothesis $H_0 : \alpha = 0; \beta = 1, \gamma = 0$ cannot be rejected.

Some authors argue that orthogonality hyphotesis contains the rest. Therefore, is sufficient to prove the existence of this to demonstrate the rationality of expectations (Da Silva 1998).

4.3. Endogeneity Problem and a Correction

Quantitative data for the expectations were calculated from the variable observed, which was also used for the tests of rationality. This may generate endogeneity problems that lead to inconsistent estimators. Then, to the covariance matrix, Hansen & Hodrick (1980) propose, that, given an equation:

$$y_{t+k} = \beta x_t + u_{t,k} \tag{23}$$

where y_{t+k} is a variable k steps-ahead; x_t is a row vector of $T \times p$ dimension (where p is the number of parameters that may or may not include the intercept[12] and T is the number of observations) containing all the relevant information in the period t and at least one of the variables is endogenous; β is a column vector of $p \times 1$ dimension and $u_{t,k}$ is the vector of residues, calculated by Ordinary Least Squares (OLS). It is possible to make a correction to the covariance matrix Θ such that:

$$\widehat{\boldsymbol{\Theta}}_T = T(\boldsymbol{X}'_T\boldsymbol{X}_T)^{-1}\boldsymbol{X}'_T\widehat{\boldsymbol{\Omega}}_T\boldsymbol{X}_T(\boldsymbol{X}'_T\boldsymbol{X}_T)^{-1} \tag{24}$$

with

$$\boldsymbol{X}_T = \begin{bmatrix} x_1 \\ \vdots \\ x_T \end{bmatrix}$$

And the symmetric $\widehat{\boldsymbol{\Omega}}_T$ matrix of $T \times T$ dimension, whose lower triangular representation is:

$$\begin{bmatrix} \overline{R}_u^T(0) & & & & & & \\ \overline{R}_u^T(1) & \overline{R}_u^T(0) & & & & & \\ \vdots & & \ddots & & & & \\ \overline{R}_u^T(k-1) & & & \ddots & & & \\ 0 & & & & \ddots & & \\ \vdots & & & & & \ddots & \\ 0 & \cdots & 0 & \overline{R}_u^T(k-1) & \cdots & \overline{R}_u^T(1) & \overline{R}_u^T(0) \end{bmatrix}$$

where

$$\overline{R}_u^T(j) = \frac{1}{T}\sum_{t=j+1}^{T}\widehat{u}_{t,k}\widehat{u}_{t-j,k}$$

for

$$j \geq 0, R_u(j) = R_u(-j)^{13}$$

5. Empirical Results

We checked the four fundamental hypotheses of the rational expectations model using estimates by OLS and the correction of the covariance matrix. The results of these tests are found in the tables at the end.

The variable in the question 2, corresponde to the year-on-year variation rate of the total sales index (denoted by S_t). In questions 9 and 11, we employ the year-on-year variation of the Producer Price Index (PPI) and the year-on-year variation

[12]As was shown in the previous section, the unbiasedness and orthogonality tests include the intercept. However, the efficiency test does not.

[13]See Hansen (1979)

of the Producer Price Index – Producer and Consumer (PPI_P&C), nominated in both cases as P_t. We denoted the lags of this variable as S_{t-i} (question 2) and P_{t-i} (questions 9 and 11). The variable x_t^e represents in the question 2 the sales expectations, S_t^e, and in the questions 9 and 11 ask for the inflation expectations in raw materials and in products to be sold (in both cases P_t^e). For the efficiency test we use as dependent variable the error term u_t, which is equal to $S_t - S_t^e$ (question 2) and $P_t - P_t^e$ (questions 9 and 11). We generated these errors from the regression used in the unbiasedness test.

In the orthogonality test we use the one period lagged dependent variable[14] in all the questions. For the question 2, we use as information variables the monthly variation of two periods lagged Market Exchange Rate (MER_{t-2}), the year-on-year variation of one period lagged PPI (PPI_{t-1})[15], and year-on-year variation of the two periods lagged Manufacturing Industry Real Production Index (IPI_{t-2}). In the questions 9 and 11 we employ as information variables the MER_{t-2} and the one period lagged Aggregated Monetary ($M3_{t-1}$)[16].

In the Hansen and Hodrick correction, we use as the y_{t+k} variables P_t, S_t and u_t. As x_t we use: for the unbiasedness test, S_t^e (question 2) and P_t^e (questions 9 y 11); for the efficiency test, S_{t-i} (question 2) and P_{t-i} (questions 9 and 11) and for the orthogonality tests S_{t-1}, PPI_{t-1}, IPI_{t-2}, MER_{t-2} (question 2) and P_{t-1}, MER_{t-2} and $M3_{t-1}$ (question 9 y 11). As $u_{t,k}$ variable we use the errors generated for each of the OLS regressions of the rational test. Finally, k is equal to 12, because in all the questions of the survey we ask about the behavior of the variables in 12 months[17].

5.1. Results of the Rational Test for the question 2

5.1.1. Results by OLS

Table 5 presents the results of the unbiasedness and serial correlation tests. Only by methods MBS and uniform and normal CP we can reject the null hypothesis of unbiasedness. In the hypothesis of serial correlation, the LM[18] statistic reveals that only in MBS there is evidence of serial correlation. Table 6 shows the

[14]For example see Ece (2001), Gramlich (1983), Keane & Runkle (1990), Mankiw & Wolfers (2003), Pesaran (1985).

[15]This variables were used because they are indicators of domestic and foreign prices of the products, which can affect sales expectations

[16]As reported by the Central Bank in its Inflation Report of September 2010 (Banco de la República de Colombia 2010), these variables have shown a greater influence on the country's inflation level.

[17]To view the full survey format see
http://www.banrep.gov.co/economia/encuesta_expeco/Cuestionario_CNC.pdf

[18]Which tests the null hypothesis of existence of correlation between the errors of the regression using a regression between the errors, as the dependent variable, and the variables of the equation and the p times lagged errors, as independent variables. From this, the statistic LM = nR2 is calculated, where n is the number of data in the regression of errors and R2 is the coefficient of determination. This statistic approximates the Chi-square distribution with p degrees of freedom. If this statistic is greater than the critical Chi-square, then it is possible to reject the null hypothesis of no autocorrelation among the errors.

results of the efficiency test. In all cases there is a relationship between the error term and S_{t-3}. Additionally the errors in the uniform RQA show relations with S_{t-1} and the errors in normal RQA present relation with S_{t-1} and S_{t-2}.

The results of the orthogonality tests using S_{t-1} (Table 7), MER_{t-2} (Table 8), PPI_{t-1} (Table 9), IPI_{t-2} (Table 10), and all the variables (Table 11), indicates that in the case of S_{t-1}, for all of the data set is possible reject the null hypothesis. For MER_{t-2} is possible reject the null hypothesis by MBS and uniform and normal CP. In the case of PPI_{t-1} we cannot reject the orthogonality for uniform and normal RQA. For IPI_{t-2} is possible reject the null hypothesis by MBS and uniform and normal CP. Finally, with all the variables we can reject the orthogonality for all the data sets.

5.1.2. Results by OLS with the Hansen and Hodrick Correction

Table 12 presents the results of the unbiasedness test with the correction of Hansen and Hodrick. It is not possible to reject the existence of unbiasedness for any of the data sets. The results of the efficiency tests (Table 13) show that there is no evidence to reject this hypothesis in either case. The orthogonality test using S_{t-1} (Table 14), MER_{t-2} (Table 15), PPI_{t-1} (Table 16), IPI_{t-2} (Table 17) and all the variables (Table 18) shows that we cannot reject the null hypothesis, for any of the variables and data sets.

We did not test for serial correlation, since this cannot be corrected by the Hansen and Hodrick method. However, we can say that this test is also satisfied, because it is a corollary of the orthogonality, which is fulfilled for all methods. Therefore, by extension, the serial correlation must be satisfied[19].

5.2. Results of the Rational Test for the question 9

5.2.1. Results by OLS

Table 19 presents the results of the unbiasedness test and serial correlation. For none of the cases it is possible to reject the null hypothesis of unbiasedness. The LM statistic shows that there is serial correlation for all data sets. Table 20 reports the results of the efficiency test. In all the cases there is a relation between the errors and P_{t-1}. For uniform and normal RQA there are also relation with P_{t-2}Finally, MB and uniform and normal CP present relation with P_{t-8}.

The results of the orthogonality test using P_{t-1} (Table 21), MER_{t-2} (Table 22), $M3_{t-1}$ (Table 23), and all the variables (Table 24) show that for P_{t-1} we cannot accept the hypothesis of orthogonality, for any of the data sets. For MER_{t-2}, it is possible to reject the null hypothesis for MBS and normal and uniform CP. In the case of $M3_{t-1}$ we can not reject the null hypothesis, for all the data sets. Finally, with all the variables, it is possible to reject the orthogonality for all the methods.

[19]This reason is used to justify the non-existence of serial correlation for the other two questions.

5.2.2. Results by OLS with the Hansen and Hodrick Correction

In Table 25, we present the results of the unbiasedness test with the Hansen and Hodrick correction. There is not evidence to reject this null hypothesis for any model. The efficiency test (Table 26) shows that we can not reject this hypothesis. The results of the orthogonality test with P_{t-1} (Table 27), MER_{t-2} (Table 28), $M3_{t-1}$ (Table 29), and all the variables (Table 30) show that we cannot reject the null hypothesis, for any of the data sets and variables.

5.3. Results of the Rational Test for the question 11

5.3.1. Results by OLS

The Table 31 shows the results of the unbiasedness and serial correlation test. Only for the case of MBS, we can reject the null hypothesis of unbiasedness. The LM statistic shows that there is serial correlation for all data sets. Table 32 presents the results of the efficiency test. For all methods there is a relationship between errors and P_{t-1}. For normal and uniform RQA there is also a relationship with P_{t-2}.

The results of the orthogonality test using P_{t-1} (Table 33), MER_{t-2} (Table 34), $M3_{t-1}$ (Table 35), and all the variables (Table 36) show that for the case of P_{t-1} we can reject the null hypothesis for all the data sets. In the case of MER_{t-2} is possible to reject the null hypothesis for MBS and normal and uniform CP. In the case of $M3_{t-1}$ we can not reject the null hypothesis for all the data sets. Finally, with all the variables, it is possible to reject the orthogonality for all the methods.

5.3.2. Results by OLS with the Hansen and Hodrick Correction

In Table 37 we present the results of the unbiasedness test with the Hansen and Hodrick correction. There is not evidence to reject this null hypothesis for any model. The efficiency test (Table 38) shows that we cannot reject this hypothesis. The results of the orthogonality test with P_{t-1} (Table 39), MER_{t-2} (Table 40), $M3_{t-1}$ (Table 41), and all the variables (Table 42) show that we cannot reject the null hypothesis, for any of the variables and data sets.

6. Conclusions and Recommendations

In order to identify the employers expectation formation process, we quantified the qualitative responses to questions on economic activity and prices in the Economic Expectation Survey (EES), applied by the division of Economic Studies of the central bank of Colombia, from October 2005 to January 2010. We used the conversion methods of Modified Balance Statistical, Carlson-Parkin with standard normal distribution and uniform distribution [0, 1] and the method proposed by the Regional Quantitative Analysis Group (RQA) at the University of Barcelona with standard normal distribution and uniform distribution [0, 1].

The evaluation of the quantification methods was performed using four statistics to analyze their predictability: mean absolute error (MAE), absolute percentage error of the median (MAPE), Root Mean Square Error (RESM) and Theil U coefficient (TU1). According to the criteria above, for the four analyzed variables, it was found that the method with the best predictability was the one proposed by the RQA group with standard normal distribution, followed by the uniform distribution [0, 1]. However, due to the restriction of information on this method, it is suggested to take into account the methods of the MBS and CP, in the quantification of the variables that do not have all available information.

Subsequently, we confirmed the existence of rational expectations for three questions of the EES. By applying the correction proposed by Hansen and Hodrick for the endogeneity problem, it was found that the unbiasedness, efficiency, orthogonality and serial correlation tests were fulfilled for the three questions, considering the five methods of quantification. With these results we can conclude that the business expectations of the variation in sales, prices of raw materials and prices of domestic production in Colombia are compatible with the hypothesis of rational expectations.

However, this document was an initial approach to the quantification and verification of the rational expectations. Futher studies on the topic should explore other methodologies Kalman filter or considering parameters that change over time. Additionally, other papers can implement other econometric methods for testing rationality hypotheses, such as maximum likelihood estimators or restricted cointegration tests.

Table 5: Unbiasedness and Serial Correlation tests by OLS question 2.

$S_t = \alpha + \beta S_t^e + u_t$					
Method	RQA Normal	RQA Uniform	CP Normal	CP Uniform	MBS
α	-0.3752	-0.3016	-13.3096***‡	-6.7867***	-1.3211***
	(0.9048)†	(0.9985)	(2.4780)	(1.8139)	(2.3076)
β	1.0168	1.0101***	2.359***	1.6852***	2.3574***
	(0.0766)	(0.0851)	(0.2464)	(0.1747)	(0.2299)
R^2	0.7789	0.738	0.647	0.6506	0.6777
adjusted R^2	0.7745	0.7328	0.6399	0.6436	0.6712
F-statistic	176.2***	140.8***	91.64***	93.09***	105.1***
Wald test‖					
χ^2	0.2238	0.1513	30.439***	15.422***	34.864***
F	0.1119	0.0756	15.219***	7.711***	17.432***
LM.OSC 12 ††	18.4087	17.2794	17.7599	16.1119	21.5569**
N	52	52	52	52	52

‖ Wald Test verifies the unbiasedness by H_0:$\alpha = 0, \beta = 1$. If H_0 it is rejected (statistically significant) then the rational hypothesis is rejected.

† Standard errors in parentheses

‡ The * denotes if the the estimator is significant at 10% (*), 5% (**) or 1% (***)

†† OSC = Order ... Serial Correlation; testing the H_0 : no correlation among the errors. If H_0 is rejected then the rational hypothesis is rejected.

Table 6: Efficiency tests by OLS question 2.

$u_t = \beta_1 S_{t-1} + \beta_2 S_{t-2} + \beta_3 S_{t-3} + \beta_4 S_{t-4} + \beta_5 S_{t-5} + \beta_6 S_{t-6} + \beta_7 S_{t-7} + \beta_8 S_{t-8} + v_t$					
Method	RQA Normal	RQA Uniform	CP Normal	CP Uniform	MBS
β_1	0.2939*‡	0.3057*	0.0419	0.0705	-0.0521
	(0.1720)†	(0.1891)	(0.2091)	(0.2075)	(0.2053)
β_2	-0.3094*	-0.2471	0.3332	0.3166	0.2743
	(0.1730)	(0.1903)	(0.2104)	(0.2088)	(0.2065)
β_3	0.3450*	0.3838*	0.3542*	0.4126*	0.4494*
	(0.1874)	(0.2061)	(0.2279)	(0.2261)	(0.2237)
β_4	-0.0397	-0.0413	0.1501	0.1015	0.1359
	(0.1937)	(0.2130)	(0.2355)	(0.2337)	(0.2312)
β_5	-0.0384	-0.1114	-0.1049	-0.2137	-0.1689
	(0.2022)	(0.2224)	(0.2459)	(0.2440)	(0.2414)
β_6	0.0103	-0.0398	-0.3004	-0.2462	-0.1979
	(0.1686)	(0.1854)	(0.2050)	(0.2034)	(0.2012)
β_7	-0.2527	-0.2531	-0.2627	-0.2658	-0.2633
	(0.1588)	(0.1746)	(0.1931)	(0.1916)	(0.1895)
β_8	0.0243	0.0526	-0.1140	-0.0833	-0.0990
	(0.1554)	(0.1709)	(0.1889)	(0.1875)	(0.1855)
R^2	0.2466	0.2311	0.3024	0.306	0.266
adjusted R^2	0.1096	0.09124	0.1756	0.1799	0.1326
F -statistic	1.8	1.653	2.384**	2.425**	1.994
N	52	52	52	52	52

† Standard errors in parentheses

‡ The * denotes if the the estimator is significant at 10% (*), 5% (**) or 1% (***)

Table 7: Orthogonality test with S_{t-1} as information variable, for question 2.

$S_t = \alpha + \beta S_t^e + \gamma S_{t-1} + u_t$					
Method	RQA Normal	RQA Uniform	CP Normal	CP Uniform	MBS
α	-0.1833	-0.09118	-4.4334*‡	-2.0916	-4.1608*
	(0.8064)†	(0.84366)	(2.3257)	(1.5738)	(2.4478)
β	0.5371***	0.44677**	0.7877**	0.5415**	0.7722**
	(0.1444)	(0.14174)	(0.3092)	(0.2283)	(0.3385)
γ	0.4652***	0.54731***	0.6577***	0.6621***	0.6476***
	(0.1235)	(0.11872)	(0.1038)	(0.1076)	(0.1166)
R^2	0.8286	0.8173	0.8059	0.8028	0.8022
adjusted R^2	0.8216	0.8098	0.798	0.7948	0.7941
F-statistic	118.4***	109.6***	101.7***	99.76***	99.34***
Wald test‖					
χ^2	14.479***	21.466***	94.375***	64.633***	86.501***
F	4.8265***	7.1554**	31.458***	21.544***	28.834***
N	52	52	52	52	52

‖ Wald Test verifies the unbiasedness by H_0: $\alpha = 0, \beta = 1, \gamma = 0$. If H_0 it is rejected (statistically significant) then the rational hypothesis is rejected.

† Standard errors in parentheses

‡ The * denotes if the the estimator is significant at 10% (*), 5% (**) or 1% (***)

Table 8: Orthogonality test with MER_{t-2} as information variable, for question 2.

$S_t = \alpha + \beta S_t^e + \gamma MER_{t-2} + u_t$					
Method	RQA Normal	RQA Uniform	CP Normal	CP Uniform	MBS
α	-0.3810	-0.3105	-13.3414***‡	-6.8124***	-13.3343***
	(0.9138)†	(1.0085)	(2.5070)	(1.8343)	(2.3334)
β	1.0180***	1.0119***	2.3631***	1.6888***	2.3722***
	(0.07754)	(0.08618)	(0.24963)	(0.1769)	(0.23296)
γ	0.02916	0.03622	0.03219	0.0379	0.08637
	(0.12527)	(0.13642)	(0.15844)	(0.1577)	(0.15167)
R^2	0.7792	0.7384	0.6473	0.651	0.6798
adjusted R^2	0.7702	0.7277	0.6329	0.6367	0.6667
F-statistic	86.45***	69.15***	44.96***	45.69***	52.01***
Wald test‖					
χ^2	0.2738	0.2189	29.896***	15.189***	34.717***
F	0.0913	0.073	9.9654***	5.0631***	11.572***
N	52	52	52	52	52

‖ Wald Test verifies the unbiasedness by H_0: $\alpha = 0, \beta = 1, \gamma = 0$. If H_0 it is rejected (statistically significant) then the rational hypothesis is rejected.

† Standard errors in parentheses

‡ The * denotes if the the estimator is significant at 10% (*), 5% (**) or 1% (***)

Table 9: Orthogonality test with PPI_{t-1} as information variable, for question 2.

$S_t = \alpha + \beta S_t^e + \gamma PPI_{t-1} + u_t$					
Method	RQA Normal	RQA Uniform	CP Normal	CP Uniform	MBS
α	-0.4232	-0.3362	-14.6134***‡	-8.0029***	-15.7273***
	(1.0643)†	(1,1712)	(2.6991)	(2.0440)	(2.5210)
β	1.0173***	1.0105***	2.4171***	1.7301***	2.4879***
	(0.0775)	(0.0862)	(0.2502)	(0.1772)	(0.2304)
γ	0.0122	0.0088	0.2107	0.2221	0.3569**
	(0.1395)	(0.1519)	(0.1767)	(0.1758)	(0.1669)
R^2	0.779	0.738	0.6569	0.6616	0.7052
adjusted R^2	0.7699	0.7273	0.6429	0.6478	0.6931
F -statistic	86.34	69.02***	46.92***	47.9***	58.6***
Wald test‖					
χ^2	0.2271	0.1516	32.116***	17.202***	41.925***
F	0.0757	0.0505	10.705***	5.7341***	13.975***
N	52	52	52	52	52

‖ Wald Test verifies the unbiasedness by H_0:$\alpha = 0, \beta = 1, \gamma = 0$. If H_0 it is rejected (statistically significant) then the rational hypothesis is rejected.

† Standard errors in parentheses

‡ The * denotes if the the estimator is significant at 10% (*), 5% (**) or 1% (***)

Table 10: Orthogonality test with IPI_{t-2} as information variable, for question 2.

$S_t = \alpha + \beta S_t^e + \gamma IPI_{t-2} + u_t$					
Method	RQA Normal	RQA Uniform	CP Normal	CP Uniform	MBS
α	0.7586	1.4121	-5.1226	-1.2549	-5.9224*‡
	(1.2175)†	(1.3030)	(3.0658)	(2.2896)	(3.3640)
β	0.8496***	0.7583***	1.3824***	0.9870***	1.4906***
	(0.1432)	(0.1522)	(0.3358)	(0.2560)	(0.3746)
γ	0.1434	0.2138*	0.3671***	0.3559***	0.3103***
	(0.1041)	(0.1084)	(0.0959)	(0.1027)	(0.1098)
R^2	0.7872	0.7573	0.7282	0.7194	0.7229
adjusted R^2	0.7785	0.7474	0.7171	0.7079	0.7116
F -statistic	90.61***	76.44***	65.65***	62.81***	63.91***
Wald test‖					
χ^2	2.1241	4.05	53.397***	30.839***	47.736***
F	0.708	1.35	17.799***	10.280***	15.912***
N	52	52	52	52	52

‖ Wald Test verifies the unbiasedness by H_0:$\alpha = 0, \beta = 1, \gamma = 0$. If H_0 it is rejected (statistically significant) then the rational hypothesis is rejected.

† Standard errors in parentheses

‡ The * denotes if the the estimator is significant at 10% (*), 5% (**) or 1% (***)

Table 11: Orthogonality test with S_{t-1}, MER_{t-2}, PPI_{t-1} and IPI_{t-2} as information variables, for question 2.

$S_t = \alpha + \beta S_t^e + \gamma_1 S_{t-1} + \gamma_2 MER_{t-2} + \gamma_3 PPI_{t-1} + \gamma_4 IPI_{t-2} + u_t$					
Method	RQA Normal	RQA Uniform	CP Normal	CP Uniform	MBS
α	0.3742	0.6892	-2.8770	-0.7323	-2.7849
	(1.1816)†	(1.2228)	(2.8390)	(2.0988)	(3.3901)
β	0.49085***‡	0.38402**	0.66780*	0.43262*	0.65278
	(0.1693)	(0.1646)	(0.3378)	(0.2560)	(0.4120)
γ_1	0.4511***	0.5179***	0.5445***	0.5638***	0.5445***
	(0.1353)	(0.1327)	(0.1337)	(0.1350)	(0.1465)
γ_2	0.0326	0.0389	0.0241	0.0248	0.0259
	(0.1235)	(0.1269)	(0.1292)	(0.1306)	(0.1312)
γ_3	-0.0409	-0.0428	0.0488	0.0393	0.0776
	(0.1454)	(0.1497)	(0.1563)	(0.1581)	(0.1674)
γ_4	0.0517	0.0790	0.1529	0.1472	0.1447
	(0.1079)	(0.1105)	(0.1023)	(0.1051)	(0.1061)
R^2	0.8302	0.8205	0.8149	0.8109	0.8101
adjusted R^2	0.8118	0.8009	0.7948	0.7904	0.7894
F -statistic	44.99***	42.04**	40.51***	39.46***	39.24***
Wald test‖					
χ^2	14.168**	21.325***	95.162***	65.25***	86.506***
F	2.3613**	3.5542***	15.860***	10.875***	14.418***
N	52	52	52	52	52

‖ Wald Test verifies the unbiasedness by H_0:$\alpha = 0, \beta = 1, \gamma = 0$. If H_0 it is rejected (statistically significant) then the rational hypothesis is rejected.

† Standard errors in parentheses

‡ The * denotes if the the estimator is significant at 10% (*), 5% (**) or 1% (***)

Table 12: Unbiasedness tests with Hansen and Hodrick correction question 2.

$S_t = \alpha + \beta S_t^e + u_t$					
Method	RQA Normal	RQA Uniform	CP Normal	CP Uniform	MBS
α	-0.3752	-0.3016	-13.3096	-6.7867	-13.2109
	(7.2319)†	(8.5205)	(31.1082)	(20.4776)	(29.2455)
β	1.0168*‡	1.0101	2.3591	1.6852	2.3574
	(0,5966)	(0.6957)	(2.9707)	(1.8725)	(2,7932)
R^2	0.7789	0.738	0.647	0.6506	0.6777
adjusted R^2	0.7745	0.7328	0.6399	0.6436	0.6712
Wald test‖					
χ^2	0.003486278	0.001466486	0.392368	0.2437437	0.4402235
N	52	52	52	52	52

‖ Wald Test verifies the unbiasedness by H_0:$\alpha = 0, \beta = 1$. If H_0 it is rejected (statistically significant) then the rational hypothesis is rejected.
† Standard errors in parentheses
‡ The * denotes if the the estimator is significant at 10% (*), 5% (**) or 1% (***)
The correction of Hansen and Hodrick (1980) was applied to the covariance matrix

Table 13: Efficiency tests with Hansen and Hodrick correction question 2.

$u_t = \beta_1 S_{t-1} + \beta_2 S_{t-2} + \beta_3 S_{t-3} + \beta_4 S_{t-4} + \beta_5 S_{t-5} + \beta_6 S_{t-6} + \beta_7 S_{t-7} + \beta_8 S_{t-8} + v_t$					
Method	RQA Normal	RQA Uniform	CP Normal	CP Uniform	MBS
β_1	0.2939	0.3057	0.0419	0.0705	-0.0521
	(1.1371)†	(1.2570)	(1.3959)	(1.3692)	(1.3897)
β_2	-0.3094	-0.2471	0.3332	0.3166	0.2743
	(1.1487)	(1.2589)	(1.3909)	(1.3777)	(1.3560)
β_3	0.3450	0.3838	0.3542	0.4125	0.4494
	(1.2488)	(1.3636)	(1.5038)	(1.4907)	(1.4568)
β_4	-0.0397	-0.0413	0.1501	0.1015	0.1359
	(1.2757)	(1.3972)	(1.5686)	(1.5418)	(1.5316)
β_5	-0.0384	-0.1114	-0.1049	-0.2137	-0.1689
	(1.3369)	(1.4661)	(1.6424)	(1.6283)	(1.5956)
β_6	0.0102	-0.0398	-0.3004	-0.2462	-0.1979
	(1.1377)	(1.2423)	(1.3559)	(1.3502)	(1.3021)
β_7	-0.2527	-0.2531	-0.2627	-0.2658	-0.2633
	(1.0567)	(1.1501)	(1.2481)	(1.2397)	(1.2079)
β_8	0.0242	0.0526	-0.1140	-0.0833	-0.0990
	(1.0405)	(1.1430)	(1,2523)	(1.2431)	(1.2147)
R^2	0.2466	0.2311	0.3024	0.306	0.266
adjusted R^2	0.1096	0.09124	0.1756	0.1799	0.1326
N	52	52	52	52	52

† Standard errors in parentheses
The correction of Hansen and Hodrick (1980) was applied to the covariance matrix

Table 14: Orthogonality test with S_{t-1} as information variable and Hansen Hodrick correction question 2.

$S_t = \alpha + \beta S_t^e + \gamma S_{t-1} + u_t$					
Method	RQA Normal	RQA Uniform	CP Normal	CP Uniform	MBS
α	-0.1832	-0.0911	-4.4331	-2.0916	-4.1608
	(5.5455)†	(5.8321)	(16.2375)	(10.9572)	(17.0546)
β	0.5370	0.4467	0.7876	0.5414	0.7721
	(1.0447)	(1.0154)	(2.0544)	(1.5138)	(2.2452)
γ	0.4651	0.5473	0.6577	0.6620	0.6475
	(0.8946)	(0.8517)	(0.702)	(0.7315)	(0.7776)
R^2	0.8286	0.8173	0.8059	0.8028	0.8022
adjusted R^2	0.8216	0.8098	0.798	0.7948	0.7941
Wald test‖					
χ^2	0.4678	0.7101	0.9642	0.9474	0.7634
N	52	52	52	52	52

‖ Wald Test verifies the unbiasedness by H_0:$\alpha = 0, \beta = 1, \gamma = 0$. If H_0 it is rejected (statistically significant) then the rational hypothesis is rejected.
† Standard errors in parentheses
The correction of Hansen and Hodrick (1980) was applied to the covariance matrix

Table 15: Orthogonality test with MER_{t-2} as information variable and Hansen Hodrick correction question 2.

$S_t = \alpha + \beta S_t^e + \gamma MER_{t-2} + u_t$					
Method	RQA Normal	RQA Uniform	CP Normal	CP Uniform	MBS
α	-0.3810	-0.3105	-13.3414	-6.8123	-13.3343
	(7.2155)†	(8.5095)	(31.4805)	(20.6374)	(29.6241)
β	1.0180**‡	1.0119*	2.3631	1.6887	2.3722
	(0.5987)	(0.7001)	(3.0209)	(1.8999)	(2.8478)
γ	0.0291	0.0362	0.0321	0.0379	0.0863
	(0,8810)	(0.9671)	(1.1653)	(1.1535)	(1.1263)
R^2	0.7792	0.7384	0.6473	0.651	0.6798
adjusted R^2	0.7702	0.7277	0.6329	0.6367	0.6667
Wald test‖					
χ^2	0.0047	0.0030	0.3839	0.2414	0.4406
N	52	52	52	52	52

‖ Wald Test verifies the unbiasedness by H_0:$\alpha = 0, \beta = 1, \gamma = 0$. If H_0 it is rejected (statistically significant) then the rational hypothesis is rejected.
† Standard errors in parentheses
‡ The * denotes if the the estimator is significant at 10% (*), 5% (**) or 1% (***)
The correction of Hansen and Hodrick (1980) was applied to the covariance matrix

Table 16: Orthogonality test with PPI_{t-1} as information variable and Hansen Hodrick correction question 2.

$S_t = \alpha + \beta S_t^e + \gamma PPI_{t-1} + u_t$					
Method	RQA Normal	RQA Uniform	CP Normal	CP Uniform	MBS
α	-0.4232	-0.3362	-14.6134	-8.0028	-15.7273
	(8.4651)†	(10.0479)	(35.1934)	(23.6066)	(33.1838)
β	1.0173**‡	1.0105*	2.4171	1.7300	2.4878
	(0.5996)	(0.7006)	(3.0898)	(1.9161)	(2.8738)
γ	0.0122	0.0088	0.2107	0.2220	0.3569
	(1.0047)	(1.1431)	(1.5247)	(1.4676)	(1.4876)
R^2	0.779	0.738	0.6569	0.6616	0.7052
adjusted R^2	0.7699	0.7273	0.6429	0.6478	0.6931
Wald test‖					
χ^2	0.0034	0.0014	0.4018	0.2830	0.5502
N	52	52	52	52	52

‖ Wald Test verifies the unbiasedness by H_0:$\alpha = 0, \beta = 1, \gamma = 0$. If H_0 it is rejected (statistically significant) then the rational hypothesis is rejected.
† Standard errors in parentheses
‡ The * denotes if the the estimator is significant at 10% (*), 5% (**) or 1% (***)
The correction of Hansen and Hodrick (1980) was applied to the covariance matrix

Table 17: Orthogonality test with IPI_{t-2} as information variable and Hansen Hodrick correction question 2.

$S_t = \alpha + \beta S_t^e + \gamma IPI_{t-2} + u_t$					
Method	RQA Normal	RQA Uniform	CP Normal	CP Uniform	MBS
α	0.7585	1.4121	-5.1226	-1.2548	-5.9224
	(9.6215)†	(10.4423)	(31.4487)	(21.7297)	(35.5760)
β	0.8495	0.7582	1.3824	0.9870	1.4906
	(1.1024)	(1.1700)	(3.2767)	(2.2757)	(3.8010)
γ	0.1433	0.2138	0.3671	0.3558	0.3103
	(0.7542)	(0.7857)	(0.6786)	(0.7180)	(0.8198)
R^2	0.7872	0.7573	0.7282	0.7194	0.7229
adjusted R^2	0.7785	0.7474	0.7171	0.7079	0.7116
Wald test‖					
χ^2	0.0609	0.1350	0.3329	0.2490	0.1876
N	52	52	52	52	52

‖ Wald Test verifies the unbiasedness by H_0:$\alpha = 0, \beta = 1, \gamma = 0$. If H_0 it is rejected (statistically significant) then the rational hypothesis is rejected.
† Standard errors in parentheses
The correction of Hansen and Hodrick (1980) was applied to the covariance matrix

Table 18: Orthogonality test with S_{t-1}, MER_{t-2}, PPI_{t-1}, IPI_{t-2} as information variable and Hansen Hodrick correction question 2.

$S_t = \alpha + \beta S_t^e + \gamma_1 S_{t-1} + \gamma_2 MER_{t-2} + \gamma_3 PPI_{t-1} + \gamma_4 IPI_{t-2} + u_t$					
Method	RQA Normal	RQA Uniform	CP Normal	CP Uniform	MBS
α	0.3742	0.6892	-2.8770	-0.7323	-2.7849
	(8.1915)†	(8.5302)	(20.4118)	(14.6932)	(24.8905)
β	0.4908	0.3840	0.6677	0.4326	0.6527
	(1.1798)	(1.1340)	(2.2492)	(1.6495)	(2.8157)
γ_1	0.4511	0.5179	0.5445	0.5638	0.5445
	(0.9669)	(0.9530)	(0.9798)	(0.9846)	(1.0352)
γ_2	0.0326	0.0389	0.0241	0.0248	0.0259
	(0.8280)	(0.8467)	(0.8421)	(0.8521)	(0.8569)
γ_3	-0.0409	-0.0428	0.0488	0.0393	0.0776
	(0.9562)	(0.9895)	(1.0622)	(1.0583)	(1.1453)
γ_4	0.0517	0.0790	0.1529	0.1471	0.1447
	(0.7599)	(0.7846)	(0.7518)	(0.7635)	(0.7811)
R^2	0.8302	0.8205	0.8149	0.8109	0.8101
adjusted R^2	0.8118	0.8009	0.7948	0.7904	0.7894
Wald test‖					
χ^2	0.4140	0.6111	0.3948	0.4882	0.3443
N	52	52	52	52	52

‖ Wald Test verifies the unbiasedness by H_0:$\alpha = 0, \beta = 1, \gamma = 0$. If H_0 it is rejected (statistically significant) then the rational hypothesis is rejected.
† Standard errors in parentheses
The correction of Hansen and Hodrick (1980) was applied to the covariance matrix

Table 19: Unbiasedness and Serial Correlation tests by OLS question 9.

$P_t = \alpha + \beta P_t^e + u_t$					
Method	RQA Normal	RQA Uniform	CP Normal	CP Uniform	MBS
α	0.1300	0.1069	-2.7941	-1.4007	-2.8873
	(0.4499)†	(0.4619)	(1.6719)	(1.3892)	(1.8107)
β	0.9566***‡	0.9632***	1.8114***	1.4075***	1.8393***
	(0.09604)	(0.09929)	(0.4649)	(0.3785)	(0.5061)
R^2	0.665	0.6531	0.2329	0.2166	0.2089
adjusted R^2	0.6583	0.6461	0.2176	0.201	0.1931
F-statistic	99.24***	94.12***	15.18***	13.83***	13.21***
Wald test‖					
χ^2	0.2085	0.1421	3.0477	1.1596	2.7509
F	0.1043	0.071	1.5238	0.5798	1.3755
LM OSC 12††	38.8449***	37.7988***	43.0731***	43.241***	44.9366***
N	52	52	52	52	52

‖ Wald Test verifies the unbiasedness by H_0:$\alpha = 0, \beta = 1$. If H_0 it is rejected (statistically significant) then the rational hypothesis is rejected.
† Standard errors in parentheses
‡ The * denotes if the the estimator is significant at 10% (*), 5% (**) or 1% (***)
†† OSC = Order ... Serial Correlation; testing the H_0 : no correlation among the errors. If H_0 is rejected then the rational hypothesis is rejected.

Table 20: Efficiency tests by OLS question 9.

$u_t = \beta_1 P_{t-1} + \beta_2 P_{t-2} + \beta_3 P_{t-3} + \beta_4 P_{t-4} + \beta_5 P_{t-5} + \beta_6 P_{t-6} + \beta_7 P_{t-7} + \beta_8 P_{t-8} + v_t$					
Method	RQA Normal	RQA Uniform	CP Normal	CP Uniform	MBS
β_1	1.0853***‡	1.0675***	0.6612*	0.7173*	0.6594*
	(0.2527)†	(0.2676)	(0.3649)	(0.3622)	(0.3598)
β_2	-1.1349**	-1.13470**	-0.4884	-0.5771	-0.4770
	(0.4847)	(0.5133)	(0.6998)	(0.6945)	(0.6901)
β_3	0.5139	0.5418	0.4260	0.4874	0.4125
	(0.5198)	(0.5505)	(0.7504)	(0.7448)	(0.7400)
β_4	-0.5755	-0.6271	-0.3916	-0.4130	-0.3199
	(0.5345)	(0.5659)	(0.7715)	(0.7657)	(0.7608)
β_5	0.6086	0.6961	0.8154	0.8519	0.7431
	(0.5357)	(0.5673)	(0.7734)	(0.7676)	(0.7627)
β_6	-0.5728	-0.6346	-0.8417	-0.8800	-0.8253
	(0.5378)	(0.5695)	(0.7763)	(0.7705)	(0.7656)
β_7	0.1490	0.2260	0.7968	0.7824	0.8490
	(0.5166)	(0.5470)	(0.7457)	(0.7401)	(0.7353)
β_8	-0.0091	-0.0600	-0.7338*	-0.7278*	-0.7923*
	(0.2804)	(0.2969)	(0.4048)	(0.4018)	(0.3992)
R^2	0.5088	0.4681	0.553	0.5689	0.5785
adjusted R^2	0.4195	0.3714	0.4718	0.4905	0.5019
F -statistic	5.698***	4.841***	6.805***	7.257***	7.549***
N	52	52	52	52	52

† Standard errors in parentheses

‡ The * denotes if the the estimator is significant at 10% (*), 5% (**) or 1% (***)

Table 21: Orthogonality test with P_{t-1} as information variable question 9.

$P_t = \alpha + \beta P_t^e + \gamma P_{t-1} + u_t$					
Method	RQA Normal	RQA Uniform	CP Normal	CP Uniform	MBS
α	0.1104	0.0875	-1.679***†	-1.1334**	-1.9572***
	(0.2730)‡	(0.2748)	(0.613)	(0.5122)	(0.6422)
β	0.0638	0.0814	0.5937***	0.4288***	0.6706***
	(0.1121)	(0.1091)	(0.1825)	(0.1498)	(0.1895)
γ	0.8954***	0.8844***	0.8835***	0.8901***	0.8870***
	(0.0961)	(0.0920)	(0.0489)	(0.0498)	(0.0473)
R^2	0.8791	0.8797	0.8999	0.8957	0.9031
adjusted R^2	0.8742	0.8747	0.8958	0.8915	0.8991
F -statistic	178.1***	179.1***	220.3***	210.4***	228.2***
Wald test‖					
χ^2	87.34***	92.66***	349.38***	327.59***	372.84***
F	29.113***	30.886***	116.46***	109.20***	124.28***
N	52	52	52	52	52

‖ Wald Test verifies the unbiasedness by H_0:$\alpha = 0, \beta = 1, \gamma = 0$. If H_0 it is rejected (statistically significant) then the rational hypothesis is rejected.

† Standard errors in parentheses

‡ The * denotes if the the estimator is significant at 10% (*), 5% (**) or 1% (***)

Table 22: Orthogonality test with MER_{t-2} as information variable question 9.

$P_t = \alpha + \beta P_t^e + \gamma MER_{t-2} + u_t$					
Method	RQA Normal	RQA Uniform	CP Normal	CP Uniform	MBS
α	0.2502	0.2348	-1.7089	-0.5015	-1.7879
	(0.4872)†	(0.5006)	(1.6635)	(1.3797)	(1.7769)
β	0.9260***‡	0.9305***	1.5157***	1.1661***	1.5404***
	(0.1070)	(0.1107)	(0.4618)	(0.3755)	(0.4959)
γ	0.0547	0.05736	0.2638**	0.2687**	0.2790**
	(0.0824)	(0.0838)	(0.1111)	(0.1122)	(0.1113)
R^2	0.668	0.6563	0.312	0.2988	0.2989
adjusted R^2	0.6544	0.6423	0.2839	0.2702	0.2702
F -statistic	49.29***	46.79***	11.11***	10.44***	10.44***
Wald test‖					
χ^2	0.6483	0.6082	8.9621**	7.0104*	9.3267**
F	0.2161	0.2027	2.9874**	2.3368*	3.1089**
N	52	52	52	52	52

‖ Wald Test verifies the unbiasedness by H_0:$\alpha = 0, \beta = 1, \gamma = 0$. If H_0 it is rejected (statistically significant) then the rational hypothesis is rejected.

† Standard errors in parentheses

‡ The * denotes if the the estimator is significant at 10% (*), 5% (**) or 1% (***)

TABLE 23: Orthogonality test with $M3_{t-1}$ as information variable question 9.

$P_t = \alpha + \beta P_t^e + \gamma M3_{t-1} + u_t$					
Method	RQA Normal	RQA Uniform	CP Normal	CP Uniform	MBS
α	0.2493	0.2256	-2.8228	-1.4501	-2.9258
	(0.4828) †	(0.4947)	(1.6926)	(1.4140)	(1.8322)
β	0.9695*** ‡	0.9765***	1.7966***	1.3939***	1.8203***
	(0.0982)	(0.1016)	(0.4738)	(0.3852)	(0.5149)
γ	-0.1315	-0.1321	0.0638	0.0772	0.0832
	(0.1865)	(0.1899)	(0.2812)	(0.2838)	(0.2851)
R^2	0.6683	0.6565	0.2337	0.2178	0.2103
adjusted R^2	0.6548	0.6424	0.2025	0.1859	0.1781
F -statistic	49.37***	46.82***	7.473***	6.823***	6.525***
Wald test‖					
χ^2	0.7038	0.6247	3.0414	1.2123	2.7859
F	0.2346	0.2082	1.0138	0.4041	0.9286
N	52	52	52	52	52

‖ Wald Test verifies the unbiasedness by H_0:$\alpha = 0, \beta = 1, \gamma = 0$. If H_0 it is rejected (statistically significant) then the rational hypothesis is rejected.

† Standard errors in parentheses

‡ The * denotes if the the estimator is significant at 10% (*), 5% (**) or 1% (***)

TABLE 24: Orthogonality test with P_{t-1}, MER_{t-2}, $M3_{t-1}$ as information variable question 9.

$P_t = \alpha + \beta P_t^e + \gamma_1 P_{t-1} + \gamma_2 MER_{t-2} + \gamma_3 M3_{t-1} + u_t$					
Method	RQA Normal	RQA Uniform	CP Normal	CP Uniform	MBS
α	0.1691	0.1473	-1.6066***‡	-1.0665*	-1.8822***
	(0.3251)†	(0.3270)	(0.6523)	(0.5528)	(0.6785)
β	0.0422	0.0617	0.5815***	0.4173***	0.6586***
	(0.1186)	(0.1155)	(0.1887)	(0.154822)	(0.1953)
γ_1	0.8955***	0.8835***	0.8760***	0.8819***	0.8789***
	(0.0990)	(0.0948)	(0.0526)	(0.0536)	(0.0512)
γ_2	0.0350	0.0333	0.0200	0.0217	0.0212
	(0.0514)	(0.0514)	(0.0467)	(0.0476)	(0.0458)
γ_3	0.0199	0.0162	-0.0001	0.0053	0.0001
	(0.1179)	(0.1176)	(0.1061)	(0.1082)	(0.1043)
R^2	0.8805	0.8809	0.9003	0.8962	0.9035
adjusted R^2	0.8703	0.8708	0.8918	0.8874	0.8953
F -statistic	86.58***	86.91***	106.1***	101.5***	110***
Wald test‖					
χ^2	85.322***	90.3***	336.69***	316***	359.56***
F	17.064***	18.06***	67.337***	63.2***	71.912***
N	52	52	52	52	52

‖ Wald Test verifies the unbiasedness by H_0:$\alpha = 0, \beta = 1, \gamma = 0$. If H_0 it is rejected (statistically significant) then the rational hypothesis is rejected.

† Standard errors in parentheses

‡ The * denotes if the the estimator is significant at 10% (*), 5% (**) or 1% (***)

TABLE 25: Unbiasedness tests with Hansen and Hodrick correction question 9.

$P_t = \alpha + \beta P_t^e + u_t$					
Method	RQA Normal	RQA Uniform	CP Normal	CP Uniform	MBS
α	0.1300	0.1069	-2.7941	-1.4006	-2.8872
	(4.6061)†	(4.7575)	(23.8860)	(19.3813)	(26.4556)
β	0.9566	0.9632	1.8114	1.4074	1.8392
	(0.8196)	(0.8544)	(6.4540)	(5,1573)	(7,1860)
R^2	0.665	0.6531	0.2329	0.2166	0.2089
adjusted R^2	0.6583	0.6461	0.2176	0.201	0.1931
Wald test‖					
χ^2	0.0035	0.0023	0.0294	0.0114	0.0255
N	52	52	52	52	52

‖ Wald Test verifies the unbiasedness by H_0:$\alpha = 0, \beta = 1$. If H_0 it is rejected (statistically significant) then the rational hypothesis is rejected.

† Standard errors in parentheses

The correction of Hansen and Hodrick (1980) was applied to the covariance matrix

Table 26: Efficiency tests with Hansen and Hodrick correction question 9.

$u_t = \beta_1 P_{t-1} + \beta_2 P_{t-2} + \beta_3 P_{t-3} + \beta_4 P_{t-4} + \beta_5 P_{t-5} + \beta_6 P_{t-6} + \beta_7 P_{t-7} + \beta_8 P_{t-8} + v_t$					
Method	RQA Normal	RQA Uniform	CP Normal	CP Uniform	MBS
β_1	1.0853	1.0674	0.6611	0.7173	0.6593
	(1.6476)†	(1.7389)	(2.2721)	(2,2610)	(2,2282)
β_2	-1.1349	-1.1347	-0.4884	-0.5770	-0.4770
	(2.8641)	(3.0105)	(3.8336)	(3,8159)	(3,7332)
β_3	0.5139	0.5418	0.4260	0.4874	0.4125
	(2.7332)	(2.8858)	(3.9358)	(3,9090)	(3,8289)
β_4	-0.5755	-0.6271	-0.3916	-0.4129	-0.3199
	(2.7601)	(2.9172)	(3.9647)	(3,9462)	(3,8422)
β_5	0.6086	0.6961	0.8153	0.8518	0.7430
	(2.8105)	(2.9667)	(3.9029)	(3,8920)	(3,7725)
β_6	-0.5728	-0.6346	-0.8417	-0.8799	-0.8252
	(3.0761)	(3.2309)	(4.0643)	(4,0547)	(3,9467)
β_7	0.1490	0.2260	0.7967	0.7824	0.8490
	(3.1474)	(3.2958)	(3.9544)	(3,9540)	(3,8434)
β_8	-0.0091	-0.0600	-0.7338	-0.7278	-0.7923
	(1.8502)	(1.9480)	(2.4722)	(2,4648)	(2,4242)
R^2	0.5088	0.4681	0.553	0.5689	0.5785
adjusted R^2	0.4195	0.3714	0.4718	0.4905	0.5019
N	52	52	52	52	52

† Standard errors in parentheses
The correction of Hansen and Hodrick (1980) was applied to the covariance matrix

Table 27: Orthogonality test with P_{t-1} as information variable and Hansen Hodrick correction question 9.

$P_t = \alpha + \beta P^e_t + \gamma P_{t-1} + u_t$					
Method	RQA Normal	RQA Uniform	CP Normal	CP Uniform	MBS
α	0.1104	0.0875	-1.6796	-1.1334	-1.9572
	(2.5251)†	(2.5428)	(5.8454)	(4.8321)	(6.2624)
β	0.0638	0.0814	0.5937	0.4288	0.6706
	(0.9506)	(0.9352)	(1.7178)	(1.4046)	(1.8168)
γ	0.8954	0.8844	0.8834**‡	0.8900**	0.8870**
	(0.8640)	(0.8284)	(0.3876)	(0.3987)	(0,3726)
R^2	0.8791	0.8797	0.8999	0.8957	0.9031
adjusted R^2	0.8742	0.8747	0.8958	0.8915	0.8991
Wald test‖					
χ^2	2.0460	2.1057	5.3352	5.2044	5.7971
N	52	52	52	52	52

‖ Wald Test verifies the unbiasedness by H_0:$\alpha = 0, \beta = 1, \gamma = 0$. If H_0 it is rejected (statistically significant) then the rational hypothesis is rejected.
† Standard errors in parentheses
‡ The * denotes if the the estimator is significant at 10% (*), 5% (**) or 1% (***)
The correction of Hansen and Hodrick (1980) was applied to the covariance matrix

Table 28: Orthogonality test with MER_{t-2} as information variable and Hansen Hodrick correction question 9.

$P_t = \alpha + \beta P^e_t + \gamma MER_{t-2} + u_t$					
Method	RQA Normal	RQA Uniform	CP Normal	CP Uniform	MBS
α	0.2502	0.2348	-1.7088	-0.5014	-1.7879
	(4.7485)†	(4.8909)	(21.6063)	(17.4986)	(23.5648)
β	0.9260	0.9305	1.5157	1.1661	1.5404
	(0.8620)	(0.8935)	(5.8503)	(4.6708)	(6,4124)
γ	0.0547	0.0573	0.2637	0.2687	0.2790
	(0.5724)	(0.5757)	(0.6934)	(0.7026)	(0.6979)
R^2	0.668	0.6563	0.312	0.2988	0.2989
adjusted R^2	0.6544	0.6423	0.2839	0.2702	0.2702
Wald test‖					
χ^2	0.0193	0.0182	0.1587	0.1483	0.1727
N	52	52	52	52	52

‖ Wald Test verifies the unbiasedness by H_0:$\alpha = 0, \beta = 1 \gamma = 0$. If H_0 it is rejected (statistically significant) then the rational hypothesis is rejected.
† Standard errors in parentheses
The correction of Hansen and Hodrick (1980) was applied to the covariance matrix

Table 29: Orthogonality test with $M3_{t-2}$ as information variable and Hansen Hodrick correction question 9.

$P_t = \alpha + \beta P_t^e + \gamma M3_{t-1} + u_t$					
Method	RQA Normal	RQA Uniform	CP Normal	CP Uniform	MBS
α	0.2493	0.2255	-2.8228	-1.4501	-2.9258
	(4.7699)†	(4.9244)	(23.9604)	(19.5093)	(26.5471)
β	0.9695	0.9764	1.7966	1.3939	1.8203
	(0.8256)	(0.8582)	(6.4563)	(5.1604)	(7.1712)
γ	-0.1315	-0.1321	0.0638	0.0772	0.0832
	(1.2956)	(1.3116)	(1.8766)	(1.9078)	(1,8920)
R^2	0.6683	0.6565	0.2337	0.2178	0.2103
adjusted R^2	0.6548	0.6424	0.2025	0.1859	0.1781
Wald test‖					
χ^2	0.0144	0.0129	0.0302	0.0129	0.0271
N	52	52	52	52	52

‖ Wald Test verifies the unbiasedness by H_0:$\alpha = 0, \beta = 1, \gamma = 0$. If H$_0$ it is rejected (statistically significant) then the rational hypothesis is rejected.
† Standard errors in parentheses
The correction of Hansen and Hodrick (1980) was applied to the covariance matrix

Table 30: Orthogonality test with P_{t-1}, MER_{t-2} and $M3_{t-2}$ as information variable and Hansen Hodrick correction question 9.

$P_t = \alpha + \beta P_t^e + \gamma_1 P_{t-1} + \gamma_2 MER_{t-2} + \gamma_3 M3_{t-1} + u_t$					
Method	RQA Normal	RQA Uniform	CP Normal	CP Uniform	MBS
α	0.1691	0.1473	-1.6066	-1.0665	-1.8822
	(2.8078)†	(2.8263)	(5.9434)	(4.9616)	(6.3311)
β	0.0422	0.0617	0.5815	0.4173	0.6586
	(0.9755)	(0.9569)	(1.7114)	(1.3978)	(1.8047)
γ_1	0.8955	0.8835	0.8760**‡	0.8819**	0.8789***
	(0.8647)	(0.8306)	(0.4103)	(0.4215)	(0.3968)
γ_2	0.03502	0.0333	0.0200	0.0217	0.0212
	(0.3667)	(0.3645)	(0.3289)	(0.3358)	(0.3232)
γ_3	0.0199	0.0162	-0.0001	0.0053	0.0001
	(0.8168)	(0.8152)	(0.7400)	(0.7560)	(0.7276)
R^2	0.8805	0.8809	0.9003	0.8962	0.9035
adjusted R^2	0.8703	0.8708	0.8918	0.8874	0.8953
Wald test‖					
χ^2	2.0500	2.1045	4.6949	4.6013	5.0347
N	52	52	52	52	52

‖ Wald Test verifies the unbiasedness by H_0:$\alpha = 0, \beta = 1, \gamma = 0$. If H$_0$ it is rejected (statistically significant) then the rational hypothesis is rejected.
† Standard errors in parentheses
‡ The * denotes if the the estimator is significant at 10% (*), 5% (**) or 1% (***)
The correction of Hansen and Hodrick (1980) was applied to the covariance matrix

Table 31: Unbiasedness and Serial Correlation tests by OLS question 11.

$P_t = \alpha + \beta P_t^e + u_t$					
Method	RQA Normal	RQA Uniform	CP Normal	CP Uniform	MBS
α	0.3335	0.3467	-3.4767**‡	-1.3048	-3.673**
	(0.561)†	(0.5935)	(1.6759)	(1.3689)	(1.747)
β	0.921***	0.9192***	1.7199***	1.2712***	1.760***
	(0.0992)	(0.1056)	(0.3372)	(0.2711)	(0.352)
R^2	0.6329	0.6024	0.3422	0.3054	0.3333
adjusted R^2	0.6255	0.5944	0.3291	0.2915	0.32
F -statistic	86.2***	75.75***	26.01***	21.98***	25***
Wald test‖					
χ^2	0.6721	0.6147	4.5589	1.0014	4.6611*
F	0.336	0.3074	2.2795	0.5007	2.3305
LM OSC 12††	41,1284***	40.5504***	42.492***	42.7165***	44.1127***
N	52	52	52	52	52

‖ Wald Test verifies the unbiasedness by H_0:$\alpha = 0, \beta = 1$. If H$_0$ it is rejected (statistically significant) then the rational hypothesis is rejected.
† Standard errors in parentheses
‡ The * denotes if the the estimator is significant at 10% (*), 5% (**) or 1% (***)
†† OSC = Order ... Serial Correlation; testing the H$_0$: no correlation among the errors. If H$_0$ is rejected then the rational hypothesis is rejected.

Table 32: Efficiency tests by OLS question 11.

$u_t = \beta_1 P_{t-1} + \beta_2 P_{t-2} + \beta_3 P_{t-3} + \beta_4 P_{t-4} + \beta_5 P_{t-5} + \beta_6 P_{t-6} + \beta_7 P_{t-7} + \beta_8 P_{t-8} + v_t$					
Method	RQA Normal	RQA Uniform	CP Normal	CP Uniform	MBS
β_1	1.3276***‡	1.3014***	0.7293**	0.7698**	0.6903**
	(0.2202)†	(0.2395)	(0.3389)	(0.3379)	(0.3378)
β_2	-1.4680***	-1.4017***	-0.5923	-0.6023	-0.5849
	(0.3962)	(0.4308)	(0.6097)	(0.6079)	(0.6078)
β_3	0.4327	0.4003	0.2593	0.2663	0.2716
	(0.4230)	(0.4599)	(0.6509)	(0.6489)	(0.6488)
β_4	-0.2804	-0.2568	-0.0817	-0.0723	-0.0543
	(0.4381)	(0.4763)	(0.6741)	(0.6721)	(0.6720)
β_5	0.2264	0.2022	0.2568	0.2457	0.2982
	(0.4396)	(0.4780)	(0.6765)	(0.6745)	(0.6744)
β_6	-0.3410	-0.3364	-0.3445	-0.3552	-0.3332
	(0.4347)	(0.4726)	(0.6689)	(0.6669)	(0.6668)
β_7	0.2913	0.3381	0.4574	0.4536	0.4148
	(0.4127)	(0.4487)	(0.6351)	(0.6332)	(0.6331)
β_8	-0.1389	-0.1898	-0.5509	-0.5687	-0.5644
	(0.2320)	(0.2522)	(0.3569)	(0.3559)	(0.3558)
R^2	0.5354	0.4929	0.3858	0.422	0.3978
adjusted R^2	0.4509	0.4007	0.2742	0.3169	0.2883
F -statistic	6.337***	5.345***	3.455***	4.016***	3.633***
N	52	52	52	52	52

† Standard errors in parentheses

‡ The * denotes if the the estimator is significant at 10% (*), 5% (**) or 1% (***)

Table 33: Orthogonality test with P_{t-1} as information variable question 11.

$P_t = \alpha + \beta P_t^e + \gamma P_{t-1} + u_t$					
Method	RQA Normal	RQA Uniform	CP Normal	CP Uniform	MBS
α	0.3853	0.3823	-1.2100	-0.6584	-1,5631**‡
	(0.3421)†	(0.3482)	(0.7500)	(0.5919)	(0.7577)
β	-0.0918	-0.0781	0.3756**	0.2486*	0.4558**
	(0.1251)	(0.1190)	(0.1741)	(0.1357)	(0.1732)
γ	1.0060***	0.9928***	0.8679***	0.8808***	0.8606***
	(0.1088)	(0.1011)	(0.0596)	(0.0594)	(0.0572)
R^2	0.8662	0.8659	0.8765	0.8734	0.8813
adjusted R^2	0.8607	0.8604	0.8714	0.8682	0.8765
F -statistic	158.6***	158.2***	173.8***	169***	181.9***
Wald test‖					
χ^2	87.243***	98.079***	235.67***	225.21***	251.88***
F	29.081***	32.693***	78.556***	75.07***	83.96***
N	52	52	52	52	52

‖ Wald Test verifies the unbiasedness by H_0: $\alpha = 0, \beta = 1, \gamma = 0$. If H_0 it is rejected (statistically significant) then the rational hypothesis is rejected.

† Standard errors in parentheses

‡ The * denotes if the the estimator is significant at 10% (*), 5% (**) or 1% (***)

Table 34: Orthogonality test with MER_{t-2} as information variable question 11.

$P_t = \alpha + \beta P_t^e + \gamma MER_{t-2} + u_t$					
Method	RQA Normal	RQA Uniform	CP Normal	CP Uniform	MBS
α	0.4864	0.5076	-2.6471	-0.6182	-2.8272
	(0.5995)†	(0.6368)	(1.7360)	(1.4056)	(1.7783)
β	0.8925***‡	0.8890***	1.5559***	1.1374***	1.5934***
	(0.1067)	(0.1140)	(0.3487)	(0.2780)	(0.3577)
γ	0.0551	0.0556	0.1481	0.1624*	0.1648*
	(0.0738)	(0.0771)	(0.0950)	(0.0968)	(0.0939)
R^2	0.637	0.6066	0.3733	0.3431	0.3727
adjusted R^2	0.6222	0.5905	0.3477	0.3163	0.3471
F -statistic	43***	37.77***	14.59***	12.8***	14.56***
Wald test‖					
χ^2	1.2237	1.1289	7.1196*	3.8525	7.9321**
F	0.4079	0.3763	2.3732*	0.2902	2.644*
N	52	52	52	52	52

‖ Wald Test verifies the unbiasedness by H_0: $\alpha = 0, \beta = 1, \gamma = 0$. If H_0 it is rejected (statistically significant) then the rational hypothesis is rejected.

† Standard errors in parentheses

‡ The * denotes if the the estimator is significant at 10% (*), 5% (**) or 1% (***)

Table 35: Orthogonality test with $M3_{t-1}$ as information variable question 11.

$P_t = \alpha + \beta P_t^e + \gamma M3_{t-1} + u_t$					
Method	RQA Normal	RQA Uniform	CP Normal	CP Uniform	MBS
α	0.3540	0.3542	-3.5557***‡	-1.4424	-3.7411**
	(0.5830)†	(0.6168)	(1.6941)	(1.3927)	(1.7649)
β	0.9233***	0.9200***	1.7042***	1.2600***	1.7433***
	(0.1014)	(0.1079)	(0.3408)	(0.2732)	(0.3561)
γ	-0.0257	-0.0093	0.1243	0.1538	0.1194
	(0.17312)	(0.1800)	(0.2290)	(0.2347)	(0.2307)
R^2	0.633	0.6024	0.3462	0.3114	0.3369
adjusted R^2	0.6181	0.5862	0.3195	0.2833	0.3099
F -statistic	42.27***	37.12***	12.97***	11.08***	12.45***
Wald test‖					
χ^2	0.681	0.6052	4.7894	1.4198	4.8607
F	0.227	0.2017	1.5965	0.4733	1.6202
N	52	52	52	52	52

‖ Wald Test verifies the unbiasedness by H_0:$\alpha = 0, \beta = 1, \gamma = 0$. If H_0 it is rejected (statistically significant) then the rational hypothesis is rejected.
† Standard errors in parentheses
‡ The * denotes if the the estimator is significant at 10% (*), 5% (**) or 1% (***)

Table 36: Orthogonality test with P_{t-1}, MER_{t-2} and $M3_{t-1}$ as information variable question 11.

$P_t = \alpha + \beta P_t^e + \gamma_1 P_{t-1} + \gamma_2 MER_{t-2} + \gamma_3 M3_{t-1} + u_t$					
Method	RQA Normal	RQA Uniform	CP Normal	CP Uniform	MBS
α	0.5093	0.5158	-1.0763	-0.5428	-1.4357**‡
	(0.3833)†	(0.3916)	(0.8014)	(0.6417)	(0.7995)
β	-0.1179	-0.1051	0.3561*	0.2335	0.4400**
	(0.1286)	(0.1225)	(0.1794)	(0.1395)	(0.1775)
γ_1	1.0055***	0.9920***	0.8598***	0.8713***	0.8514***
	(0.1099)	(0.1020)	(0.0618)	(0.0617)	(0.0596)
γ_2	0.0488	0.0494	0.0282	0.0308	0.0293
	(0.0461)	(0.0463)	(0.0448)	(0.0452)	(0.0436)
γ_3	0.0144	0.0117	0.0051	0.0089	0.0007
	(0.1078)	(0.1077)	(0.1039)	(0.1051)	(0.1018)
R^2	0.8697	0.8694	0.8776	0.8748	0.8825
adjusted R^2	0.8586	0.8583	0.8672	0.8641	0.8725
F -statistic	78.39***	78.2***	84.23***	82.09***	88.24***
Wald test‖					
χ^2	87.152***	97.82***	228.57***	218.95***	244.52***
F	17.430***	19.564***	45.714***	43.791***	48.904***
N	52	52	52	52	52

‖ Wald Test verifies the unbiasedness by H_0:$\alpha = 0, \beta = 1, \gamma = 0$. If H_0 it is rejected (statistically significant) then the rational hypothesis is rejected.
† Standard errors in parentheses
‡ The * denotes if the the estimator is significant at 10% (*), 5% (**) or 1% (***)

Table 37: Unbiasedness tests with Hansen and Hodrick correction question 11.

$P_t = \alpha + \beta P_t^e + u_t$					
Method	RQA Normal	RQA Uniform	CP Normal	CP Uniform	MBS
α	0.3335	0.3466	-3.4766	-1.3047	-3.6727
	(5.7962)†	(6.2000)	(21.3691)	(17.0799)	(23.3012)
β	0.9210	0.9192	1.7199	1.2712	1.7599
	(0.8650)	(0.926)	(3.9649)	(3.0456)	(4.331)
R^2	0.6329	0.6024	0.3422	0.3054	0.3333
adjusted R^2	0.6255	0.5944	0.3291	0.2915	0.32
Wald test‖					
χ^2	0.0116	0.0107	0.0594	0.0137	0.0556
N	52	52	52	52	52

‖ Wald Test verifies the unbiasedness by H_0:$\alpha = 0, \beta = 1$. If H_0 it is rejected (statistically significant) then the rational hypothesis is rejected.
† Standard errors in parentheses
The correction of Hansen and Hodrick (1980) was applied to the covariance matrix

Table 38: Efficiency tests with Hansen and Hodrick correction question 11.

$u_t = \beta_1 P_{t-1} + \beta_2 P_{t-2} + \beta_3 P_{t-3} + \beta_4 P_{t-4} + \beta_5 P_{t-5} + \beta_6 P_{t-6} + \beta_7 P_{t-7} + \beta_8 P_{t-8} + v_t$					
Method	RQA Normal	RQA Uniform	CP Normal	CP Uniform	MBS
β_1	1.3276	1.3013	0.7293	0.7697	0.6903
	(1.4474)†	(1.5688)	(2.1654)	(2.1639)	(2.1503)
β_2	-1.4679	-1.4017	-0.5923	-0.6022	-0.5849
	(2.5093)	(2.7035)	(3.5178)	(3.5227)	(3.4562)
β_3	0.4327	0.4002	0.2593	0.2662	0.2716
	(2,5421)	(2.7276)	(3.6347)	(3.6334)	(3.5887)
β_4	-0.2803	-0.2567	-0.0817	-0.0723	-0.0543
	(2.6373)	(2.8332)	(3.7724)	(3.7728)	(3.7207)
β_5	0.2264	0.2021	0.2568	0.2456	0.2982
	(2.7005)	(2.9065)	(3.8625)	(3.8619)	(3.8077)
β_6	-0.3409	-0.3364	-0.3445	-0.3551	-0.3332
	(2.7524)	(2.9764)	(4.0017)	(3.9987)	(3.9545)
β_7	0.2913	0.3381	0.4574	0.4536	0.4148
	(2.7136)	(2.9419)	(3.9136)	(3.9129)	(3.8567)
β_8	-0.1388	-0.1897	-0.5509	-0.5687	-0.5644
	(1.6054)	(1.7531)	(2.4628)	(2.4591)	(2,4512)
R^2	0.5354	0.4929	0.3858	0.422	0.3978
adjusted R^2	0.4509	0.4007	0.2742	0.3169	0.2883
N	52	52	52	52	52

† Standard errors in parentheses
The correction of Hansen and Hodrick (1980) was applied to the covariance matrix

Table 39: Orthogonality test with P_{t-1} as information variable and Hansen Hodrick correction question 11.

$P_t = \alpha + \beta P^e_t + \gamma P_{t-1} + u_t$					
Method	RQA Normal	RQA Uniform	CP Normal	CP Uniform	MBS
α	0.3853	0.3823	-1.2100	-0.6584	-1.5631
	(2.9489)†	(2.9989)	(6.1028)	(4.8656)	(6.1776)
β	-0.0918	-0.0781	0.3756	0.2486	0.4558
	(0.9689)	(0,9102)	(1.3596)	(1.0453)	(1.3582)
γ	1.0060	0.9928	0.8679**‡	0.8808**	0.8606**
	(0.8816)	(0.8142)	(0.4627)	(0.4627)	(0.4425)
R^2	0.8662	0.8659	0.8765	0.8734	0.8813
adjusted R^2	0.8607	0.8604	0.8714	0.8682	0.8765
Wald test‖					
χ^2	2.5890	2.9060	3.7690	4.1586	4.0065
N	52	52	52	52	52

‖ Wald Test verifies the unbiasedness by H_0:$\alpha = 0, \beta = 1, \gamma = 0$. If H_0 it is rejected (statistically significant) then the rational hypothesis is rejected.
† Standard errors in parentheses
‡ The * denotes if the the estimator is significant at 10% (*), 5% (**) or 1% (***)
The correction of Hansen and Hodrick (1980) was applied to the covariance matrix

Table 40: Orthogonality test with MER_{t-2} as information variable and Hansen Hodrick correction question 11.

$P_t = \alpha + \beta P^e_t + \gamma MER_{t-2} + u_t$					
Method	RQA Normal	RQA Uniform	CP Normal	CP Uniform	MBS
α	0.4864	0.5076	-2.6471	-0.6181	-2.8272
	(6.1306)†	(6.5513)	(20.7389)	(16.4281)	(22.1554)
β	0.8925	0.8890	1.5558	1.1374	1.5934
	(0.9111)	(0.9745)	(3.8422)	(2.9227)	(4,1180)
γ	0.0551	0.0556	0.1481	0.1624	0.1648
	(0.5348)	(0.5554)	(0.6179)	(0.6320)	(0.6143)
R^2	0.637	0.6066	0.3733	0.3431	0.3727
adjusted R^2	0.6222	0.5905	0.3477	0.3163	0.3471
Wald test‖					
χ^2	0.0308	0.0289	0.0946	0.0696	0.1090
N	52	52	52	52	52

‖ Wald Test verifies the unbiasedness by H_0:$\alpha = 0, \beta = 1, \gamma = 0$. If H_0 it is rejected (statistically significant) then the rational hypothesis is rejected.
† Standard errors in parentheses
The correction of Hansen and Hodrick (1980) was applied to the covariance matrix

Table 41: Orthogonality test with $M3_{t-2}$ as information variable and Hansen Hodrick correction question 11.

$P_t = \alpha + \beta P_t^e + \gamma M3_{t-1} + u_t$					
Method	RQA Normal	RQA Uniform	CP Normal	CP Uniform	MBS
α	0.3540	0.3542	-3.5557	-1.4424	-3.7411
	(5.9232)†	(6.3404)	(21.5437)	(17.3899)	(23.4422)
β	0.9233	0.9200	1.7042	1.2600	1.7432
	(0.8674)	(0.9277)	(3.9278)	(3.0139)	(4.2931)
γ	-0.0257	-0.0093	0.1243	0.1538	0.1194
	(1.2101)	(1.2516)	(1.5350)	(1.5888)	(1.5401)
R^2	0.633	0.6024	0.3462	0.3114	0.3369
adjusted R^2	0.6181	0.5862	0.3195	0.2833	0.3099
Wald test‖					
χ^2	0.0118	0.0106	0.0659	0.0236	0.0614
N	52	52	52	52	52

‖ Wald Test verifies the unbiasedness by H_0:α= 0,β= 1, γ= 0 . If H_0 it is rejected (statistically significant) then the rational hypothesis is rejected.
† Standard errors in parentheses
The correction of Hansen and Hodrick (1980) was applied to the covariance matrix

Table 42: Orthogonality test with P_{t-1}, MER_{t-2} and $M3_{t-2}$ as information variable and Hansen Hodrick correction question 11.

$P_t = \alpha + \beta P_t^e + \gamma_1 P_{t-1} + \gamma_2 MER_{t-2} + \gamma_3 M3_{t-1} + u_t$					
Method	RQA Normal	RQA Uniform	CP Normal	CP Uniform	MBS
α	0.5093	0.5158	-1.0763	-0.5428	-1.4357
	(3.2973)†	(3.3678)	(6.4512)	(5.2262)	(6.4411)
β	-0.1179	-0.1051	0.3561	0.2335	0.4400
	(0.9772)	(0.9209)	(1.3809)	(1.0581)	(1.3750)
γ_1	1.0055	0.9920	0.8598**	0.8713**‡	0.8514**
	(0.8690)	(0.8037)	(0.4772)	(0.4784)	(0.4593)
γ_2	0.0488	0.0494	0.0282	0.0308	0.0293
	(0.3336)	(0.3352)	(0.3220)	(0.3248)	(0.3147)
γ_3	0.0144	0.0117	0.0051	0.0089	0.0007
	(0.7570)	(0.7575)	(0.7349)	(0.7435)	(0.7205)
R^2	0.8697	0.8694	0.8776	0.8748	0.8825
adjusted R^2	0.8586	0.8583	0.8672	0.8641	0.8725
Wald test‖					
χ^2	2.6931	3.0092	3.4991	3.8624	3.6605
N	52	52	52	52	52

‖ Wald Test verifies the unbiasedness by H_0:α= 0,β= 1 . If H_0 it is rejected (statistically significant) then the rational hypothesis is rejected.
† Standard errors in parentheses
‡ The * denotes if the the estimator is significant at 10% (*), 5% (**) or 1% (***)
The correction of Hansen and Hodrick (1980) was applied to the covariance matrix

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