Efficiency and Formation of Expectations: Evidence from the European Investment Survey

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1. Introduction

Business fixed investment in manufacturing constitutes a sizeable component of total demand and therefore exerts a significant impact on economic activity. In addition, apart from its contemporaneous effect on the level of income, it also exerts a longer-lasting effect, since it directly impacts on the future production capabilities of manufacturing. Thus, studying various aspects of the underlying investment decision making process is of paramount importance both for academics and policy makers.

For these reasons the Directorate General of Economic and Financial Affairs of the Commission of the European Communities conducts a survey where managers state their plans about future investment, which the European Commission then uses for multiple purposes such as forecasting output growth and employment in Euroland. In other words, managers state their expectations regarding future investment and essentially provide a quantitative forecast. It is apparent that the quality of the survey responses will ultimately affect their usefulness for policy making decisions. Although planned investment will probably differ from actual investment, one expects that differences will be random. This forecast would be valuable to the extent that it contains significant predictive power over future investment. Moreover, having obtained direct observations on investment plans, it is possible to investigate empirically the nature of expectations formation.

Thus, in this study we mainly focus on two issues. First, test whether the particular survey-based expectations are compatible with rationality. Second, in the event rationality is rejected, explore the properties of the expectations formation mechanism.

The remainder of the paper is structured as follows. Section 2 provides a brief review of the literature on testing Rational Expectations. Section 3 describes the dataset used in our analysis. Section 4 discusses the empirical methodology adopted. Section 5 presents the empirical results. Finally, major findings are summarised in Section 6.

2. Testing Rational Expectations: A Brief Literature Review

The introduction of the notion of Rational Expectations Hypothesis (REH, hereafter) by Muth (1961) and its further development by Lucas (1972), and Sargent and Wallace (1976) has produced a so-called revolution in economics as a science, which has dramatically altered the way economic modelling is done as well as policy is conducted (Goodwin and Sheffrin, 1982; Pesaran, 1987; Keane and Runkle, 1990, 1993; Dominitz and Manski, 1997). Early studies investigated whether forecast errors possessed properties that were compatible with rationality, as an indirect way of testing the validity of REH (Mullineux, 1978).

A major drawback of testing the REH is that it is very often based on *ex post* observed data, which are then used to form forecast (expectation) errors. For this reason, there is a growing literature that tests the REH using survey data, which by definition correspond to agents' stated expectations. Thus, directly observing market participants expectations allows the econometrician to assess their rationality, and in cases the expectations are quantitative rather than qualitative, to also study the evolution of expectations. The forecasting accuracy, predictive content and rationality of survey-based expectations are of paramount importance in various markets.

A number of studies have found expectations to contain useful information and in general conclude that macroeconomic models perform better when survey-based expectations are utilised instead of model-constructed rational expectations (Batchelor, 1986; Lee, 1994; Holden and Thompson, 1997; Lee and Shields, 2000; Smith and McAleer, 1995; Roberts, 1995, 1997; Mankiw and Reis, 2001). Madsen (1996), Thomas (1999), and Mehra (2002) consider the issue of formation of inflation expectations and its implications for the efficiency of macroeconomic policy. The rationality of participants in the foreign exchange market, and its implications for exchange rate behaviour and management has also been a prominent application (Tagaki, 1991; Ito, 1994; Sobiechowski, 1996; Dutt and Ghosh, 1997; Suk-Joong, 1997; Moosa and Shamsuddin, 2004). Finally, the rationality of participants in financial markets has also attracted considerable attention (Fraser and MacDonald, 1993; Pieroni and Ricciarelli, 2005). Considerable amount of research effort has also been committed on testing whether income expectations predict future income, in the context of micro-level data studies (Flavin, 1991; Dominitz, 1993; Alessie and Lusardi, 1997; Das and Van Soest, 1999; Delorme *et al*, 2001). Finally, an extensive literature focuses on the efficiency of betting markets by testing the rationality of market participants' in forecasting (Gray and Gray, 1997; Boulier, *et al*, 2006).

3. Data Description and Definitions of Variables

We utilise data from the **Investment Survey** (part of **Business Surveys**) conducted twice a year by the **European Commission Directorate General for Economic and Financial Affairs.** The survey covers a wide range of industrial sectors and firms of various sizes (in terms of number of employees). Our sample covers the 1985-2003 periods and includes **Austria, Belgium, Denmark, Finland, France,**

Germany, Greece, Ireland, Italy, Netherlands, Portugal, Spain, **Sweden** and the **United Kingdom**.

Basically, a questionnaire is sent to managers twice a year in order to provide information regarding their current and planned (fixed) investment decisions. In particular, the first survey is conducted on March/April, while the second on October/November and respondents answer the following questions:

March/April Investment Survey

- March/April Q1: *State percentage change in investment last year* $(t-1)$ *on investment two years ago* $(t-2)$.
- March/April Q2: *State percentage change in investment this year* (t) *on investment last year* $(t-1)$.

October/November Investment Survey

- October/November Q1: *State percentage change in investment this year* (t) *on investment last year* $(t-1)$.
- October/November Q2: *State percentage change in investment next year* $(t+1)$ *on investment this year* (t).

The timing of responses is crucial in this context since it affects the time horizon (span) of responses as well as their nature (backward or forward looking). The October/November Q1 is clearly backward-looking since respondents, at about the end of the fiscal year, state the percentage change of investment relative to last year. Responses on this question are used in our analysis as the (reported) realised change in investment, and are denoted as: $\Delta\left(I_t^i\right)$, where Δ and i stand for the first-difference operator and country index respectively. More formally, $\Delta\left(I_t^i\right)=I_t^i-I_{t-1}^i$, evaluated on October/November of year (t).

Given the structure of the survey, one may device two alternative conditional forecasts for $\Delta\left(I_t^i\right)$ based on information available prior to (t). The first is based on responses to the October/November Q2, where respondents are asked to state their investment plans for the coming year. Let us call this forecast $F_{t-1,t}^{i,1}$, which utilises responses on this question from the year prior to (t). The second forecast, call it $F_{\tilde{t},t}^{i,2}$ for symmetry, is based on responses to the March/April Q2, where respondents are asked to state their planned investment the year (t) relative to year $(t-1)$. Notice that we denote conditioning on $\tilde{t}$ in order to emphasize that although responses are given in year (t), this is done when only three months of this year have elapsed.

The two alternative forecasts, $F_{t-1,t}^{i,1}$ and $F_{\tilde{t},t}^{i,2}$, differ in terms of timing. The first is an expectation for investment growth (change) in year (t), which is formed 3 months before year $(t-1)$ has ended. The second is an expectation for investment growth in year (t), which is formed 3 months into year (t). Thus, $F_{\tilde{t},t}^{i,2}$ should be a more accurate forecast in comparison to $F_{t-1,t}^{i,1}$ since the former is based on a superior information set.

Graphs 1 and 2 offer a pictorial representation of the direction of movements between expectations and actual (as reported) investment changes.

[Graphs 1 & 2]

Both expectations measures exhibit a strong positive relationship with actual investment change, providing informal evidence that each one of them contains some explanatory power over actual investment growth. Note that $F_{\tilde{t},t}^{i,2}$ tends to be more accurate as indicated by (i) the steepness of the scatter diagram, and (ii) the smaller dispersion.

We also constructed the scatter diagram between the two forecast measures, provided below.

[Graph 3]

The two conditional expectations are very closely linked, as expected, and their scatter diagram almost coincides with the 45^0 line. Any deviations from the unit-slope curve may primarily be attributed to the asynchronous timing in forming these expectations and therefore, reflect differences in the information sets.

4. Empirical Methodology and Testable Hypotheses

4.1 Efficiency of Expectations

One interpretation of rationality of expectations is that survey measures are unbiased forecasts of actual future outcomes. Under rational expectations, the unbiasedness hypotheses are given by:

$$F_{t-1,t}^{i,1} = E_{t-1}\left[\Delta\left(I_t^i\right)\right] \quad \textbf{(1)}$$

and

$$F_{\tilde{t},t}^{i,2} = E_{\tilde{t}}\left[\Delta\left(I_t^i\right)\right] \quad \textbf{(2)}$$

Where $E(\bullet)$ is the conditional expectations operator. These relationships state that the expectations' formation mechanism at any point in time produces forecasts equal to the expected value of the underlying variable of interest. Linking now *ex ante* formed expectations with ex post observed outcomes produces the following relationships:

$$\Delta\left(I_t^i\right) = F_{t-1,t}^{i,1} + \xi_t^{i,1} \quad \textbf{(3)}$$

and

$$\Delta\left(I_t^i\right) = F_{\tilde{t},t}^{i,2} + \xi_t^{i,2} \quad \textbf{(4)}$$

where $\xi's$ are the expectations' forecast errors and under rational expectations should, at least, satisfy the following properties (Sheffrin, 1983): $E_{t-1}\left(\xi^{i,j}\right) = 0$ and $E_{t-1}\left(\xi_{t+k}^{i,j}\xi_t^{i,j}\right) = 0 \;\; \forall \; k \neq 0$.

The unbiasedness of survey measures can be tested in a simple regression framework, where the observed outcome is the dependent variable and the conditional forecast measure is the explanatory variable:

$$\Delta\left(I_t^i\right) = \alpha_1^i + \beta_1\left(F_{t-1,t}^{i,1}\right) + u_t^{i,1} \quad \textbf{(5)}$$

and

$$\Delta\left(I_t^i\right) = \alpha_2^i + \beta_2\left(F_{\tilde{t},t}^{i,2}\right) + u_t^{i,2} \quad \textbf{(6)}$$

Where $u's$ are white noise disturbance terms.

Under the null hypothesis of unbiasedness a set of restrictions are imposed on the parameters of the above regressions as follows (Lovell, 1986; Bernheim, 1990):

$H_0 : \alpha_1 = 0 \;\wedge \beta_1 = 1$, and $H_0 : \alpha_2 = 0 \;\wedge \beta_2 = 1$.

Rejection of these hypotheses would provide *prima facie* evidence against the unbiasedness hypothesis and consequently against rationality.

4.2 Evolution and Formation of Expectations

By exploiting the different timing of forming the two forecasts, one may test some further fruitful hypotheses regarding the evolution of expectations. In particular, using the law of iterated expectations, the two expectations formed should differ by the amount of any information that became available between $\left(t-1,\, \tilde{t}\right)$:

$$F_{\tilde{t},t}^{i,2} = \left(F_{t-1,t}^{i,1}\right) + \eta_{t-1,\tilde{t}} \quad \textbf{(7)}$$

Any differences between the two forecasts may only be attributed to the 'arrival of news'. Hence, if expectations were rational, then any revisions or changes in them should be uncorrelated with all previously available information. The difference between expectations is essentially a revision of expectations, and should reflect the arrival of new information and by default should be non-autocorrelated and furthermore should be orthogonal to any member of the information set Ω_{t-1}. Let us denote the revision process as follows:

$$REV_{\tilde{t},t-1}^{i} = F_{\tilde{t},t}^{i,2} - F_{t-1,t}^{i,1} \quad \textbf{(8)}$$

Rationality of expectations can also be tested using the properties of the revision process. In particular, current revision should be unrelated to past revisions. Thus, the slope parameters of the following model should be jointly equal to zero:

$$REV_{\tilde{t},t-1}^{i} = \delta_i + \phi_1\left(REV_{\tilde{t}-1,t-2}^{i}\right) + \phi_2\left(REV_{\tilde{t}-2,t-2}^{i}\right) + \varepsilon_t^i \quad \textbf{(9)}$$

While the above analysis allows us to comment on the nature and the efficiency of expectations it is not informative about how the expectations are formed. In order to find the type of expectation formation mechanism that underlies the evolution of expectations, assume first that expected changes in investment are a weighted average of the current change in investment and some other element, x_t:

$$\left(F_{\tilde{t},t}^{i,2}\right) = w_1 x_t + \left(1 - w_1\right)\Delta\left(I_t^i\right) \quad \textbf{(10)}$$

Where w_1 is a weighting factor.

If $w_1 = 0$ then (10) would describe static expectations. Having (10) as a starting point we may consider two alternative expectation mechanisms.

First, Regressive Expectations, where $x_t = \overline{g}$, and $\overline{g}$ denotes the sample mean of $\Delta\left(I_t^i\right)$. Regressive Expectations imply that agents adjust their expectations a certain fraction of last year's deviation from the distribution mean of the underlying variable. In other words, agents believe that the variable of interest will tend to move towards its mean. Then one may reparameterise (10) as:

$$\left(F_{\tilde{t},t}^{i,2} - F_{\tilde{t}-1,t-1}^{i,2}\right) \equiv \Delta F_{\tilde{t},t}^{i,2} = \lambda\left[\overline{g} - \Delta\left(I_{t-1}^i\right)\right] + u_{\tilde{t}}^* \quad \textbf{(11)}$$

Where $u_{\tilde{t}}^*$ is a white noise error term and λ is an estimable parameter that measures the rate of adjustment to deviations from the mean, which is expected to lie in the $(0,1)$ interval.

Second, Adaptive Expectations, according to which agents adjust their expectations a certain fraction of last year's expectation error. Hence, $x_t = F_{\tilde{t}-1,t-1}^{i,2}$, which when substituted into (10) produces:

$$\left(F_{\tilde{t},t}^{i,2} - F_{\tilde{t}-1,t-1}^{i,2}\right) \equiv \Delta F_{\tilde{t},t}^{i,2} = \delta\left[F_{\tilde{t}-1,t-1}^{i,2} - \Delta\left(I_{t-1}^i\right)\right] + u_{\tilde{t}}^{**} \quad \textbf{(12)}$$

Where $u_{\tilde{t}}^{**}$ is a white noise error term and δ is an estimable parameter that measures the rate of adjustment to last period's expectation error, which is expected to lie in the $(-1,0)$ interval.

5. Empirical Results

We estimate the parameters of equations (5) and (6) in a panel framework, which will allow us to exploit variation both cross-sectionally (across countries) as well as time. Estimation is conducted applying Fixed and Random Effects, and including a set of year dummies in order to allow for time heterogeneity. The choice between Fixed and

Random Effects is based on the Hausman test (Hausman, 1978). In particular, significant values of the test qualify the Fixed Effects estimator. The relevant estimation results are reported in Table 2.

[Table 2]

For both cases the preferred specification is given by Fixed Effects. Both forecast measures explain a statistically significant portion of the variation in actual investment growth. Furthermore, both slope parameters are positive suggesting that both forecast measures correctly predict the direction of movement. In addition, the second forecast measure accounts for 60 percent of actual investment growth's variation while the first forecast measure explains 49 percent. The difference, as discussed earlier, is attributed to the fact that the second forecast measure is based on a superior information set and consequently constitutes a more accurate forecast. Notice that the slope parameter associated with the second forecast measure is larger and closer to unity (0.58) than that obtained from the first forecast measure (0.48), although both are statistically different from unity, which enables the rejection of efficiency (unbiasedness) of expectations.

Overall, our findings indicate that expectations, on average, predict accurately the direction of movement in investment growth and furthermore contain significant explanatory power over its variation. However, strictly speaking efficiency (rationality) is rejected since expectations do not represent unbiased predictors of investment growth.

We now turn our attention to the evolution of expectations and in particular focus on the orthogonality conditions regarding expectation revisions. As discussed earlier, revisions of expectations should be uncorrelated with any member of the information set that was know at the time of expectation formation. The simplest orthogonality test one may perform is to investigate whether expectations revisions' behaviour exhibits any autoregressiveness. This is one by employing equation (9) whose estimated parameters are reported in Table 3.

[Table 3]

Again the Fixed Effects estimator is in order. The AR(2) model explains an insignificant 5 % of the variation in revisions and furthermore we were able to reject that revisions show any first-order autocorrelation. In contrast, highly significant second-order dependence is uncovered, with the relevant coefficient carrying a negative sign. In other words, the orthogonality condition fails providing us with further evidence against rationality of expectations.

We proceed by exploring the process that more adequately describes the expectation formation mechanism. In particular, we consider two competing specifications; Regressive Expectations and Adaptive Expectations whose performance is assessed by the means of estimating equations (11) and (12) respectively. The relevant results are summarised in Table 4.

[Table 4]

Based on the Fixed Effects estimation results, we observe that both estimated slope parameters are consistent with their *a priori* expected signs. In particular, the slope parameter associated with the Regressive Expectations is positive, suggesting that when last period's actual investment growth was above (below) its average, agents expect that in the current period it will move downwards (upwards), showing a tendency to approach its mean value. Similarly, the parameter of the Adaptive Expectations is negative, indicating that if in the last period agents had overestimated (underestimated) the actual investment growth they will adjust downwards (upwards) their expectations for the current period. As far as the speeds of adjustment (*i.e.* the slope parameters) are concerned, under the validity of Regressive Expectations agents are found to 'clear' about 90 percent of the observed 'disequilibrium', while under Adaptive Expectations only 53 percent is 'cleared'. In addition, we also tested whether the speed of adjustment parameters, as estimated, (i) are indeed different from zero and therefore non-trivial, and (ii) are significantly different from their maximum theoretical values (+1 for Regressive Expectations and -1 for Adaptive Expectations). The null of zero (trivial) speed of adjustment was emphatically rejected for both cases, while we were not able to reject the hypothesis that the coefficient associated with Regressive Expectations is equal to unity, and therefore represents full adjustment within a single period. Finally, both equations explain a significant part of expectations' formation, although the Regressive Expectations mechanism exhibits almost double explanatory power when compared to the Adaptive Expectations. All in all, our results qualify the Regressive Expectations as the mechanism that more adequately describes the behaviour of expectations' formation.

6. Conclusion

According to our findings expectations predict accurately the direction of movement in investment growth and furthermore, contain significant explanatory power over its variation. However, strictly speaking efficiency (rationality) is rejected since expectations do not represent unbiased predictors of investment growth. As far as the evolution of expectations is concerned, we report highly significant second-order dependence which provides further evidence against rationality of expectations. Finally, our results qualify Regressive Expectations as the mechanism that more adequately describes the formation of expectations.

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Tables

Table 1 Descriptive Statistics and Sample Correlations

	Mean	Std. Deviation	Min	Max
Actual	4.53	12.82	-30	51
Forecast-1	8.24	13.65	-17	94
Forecast-2	10.00	14.36	-31	77
Revision	1.20	8.99	-28	26
		Sample Correlations		
	Actual	**Forecast-1**	**Forecast-2**	
Actual	1.00			
Forecast-1	0.56	1.00		
Forecast-2	0.69	0.79	1.00	

Table 2 Testing Efficiency of Expectations (Panel estimation, with time dummies)

	Forecast-1		***Forecast-2***	
Coefficient (standard error)	**Fixed Effects**	**Random Effects**	**Fixed Effects**	***Random Effects***
α	15.89 (3.10)***	0.67 (3.19)	-0.60 (2.45)	*-0.266 (2.58)*
β	0.485*** (0.056)	0.398*** (0.052)	0.580*** (0.046)	*0.537*** (0.044)*
Diagnostics				
R^2	49 %	50 %	60 %	*61 %*
Wald test	13.51***	231.30***	21.97***	*375.01****
Hausman test	15.79***		*32.77****	
Hypotheses testing				
$H_0 : \beta = 1$	*81.96****	*130.54****	*81.76****	*107.78****

Notes: Numbers in parenthesis denote heteroscedasticity-adjusted standard errors. The hypothesis is tested using applying a chi-square test. One, two or three asterisks denote significance at the 10, 5 or 1 percent level respectively. R^2 stands for the coefficient of determination. Hausman denotes the Hausman (1978) test and its significance qualifies the Fixed Effects estimator as the appropriate model.

Table 3 AR(2) model for Expectations Revisions (Panel estimation, with time dummies)

Coefficient (standard error)	**Fixed Effects**	***Random Effects***
ϕ_1	0.029 (0.075)	*0.265**** *(0.075)*
ϕ_2	-0.251*** (0.079)	*-0.031* *(0.08)*
Diagnostics		
R^2	5 %	*15 %*
Wald test	1.83	*29.80****
Hausman test	*66.14****	
Hypothesis testing		
$H_0 : \phi_1 = 0$	0.15	*12.31****
$H_0 : \phi_2 = 0$	*10.00****	*0.16*

Notes: Numbers in parenthesis denote heteroscedasticity-adjusted standard errors. The hypothesis is tested using applying a chi-square test. One, two or three asterisks denote significance at the 10, 5 or 1 percent level respectively. R^2 stands for the coefficient of determination. Hausman denotes the Hausman (1978) test and its significance qualifies the Fixed Effects estimator as the appropriate model.

Table 4 Expectation Formation Mechanisms (Panel estimation, with time dummies)

	Regressive expectations		***Adaptive expectations***	
Coefficient (standard error)	**Fixed Effects**	**Random Effects**	**Fixed Effects**	***Random Effects***
λ	0.908*** (0.097)	0.808*** (0.092)	-	-
δ	-	-	-0.530*** (0.132)	*-0.381*** (0.105)*
Diagnostics				
R^2	44 %	44 %	26 %	*26 %*
Wald test	9.29***	148.20***	4.01***	*67.49****
Hausman test	3.88**		*5.94***	
Hypothesis testing				
$H_0 : \lambda = 0$	86.55***		-	
$H_0 : \delta = 0$	-		*16.14****	
$H_0 : \lambda = +1$	0.88		-	
$H_0 : \delta = -1$	-		*12.60****	

Notes: Numbers in parenthesis denote heteroscedasticity-adjusted standard errors. The hypothesis is tested using applying a chi-square test. One, two or three asterisks denote significance at the 10, 5 or 1 percent level respectively. R^2 stands for the coefficient of determination. Hausman denotes the Hausman (1978) test and its significance qualifies the Fixed Effects estimator as the appropriate model.

Graphs

Graph 1 Reported Investment Change (Actual) vs. Forecasted (Measure 1), Scatter Diagram

Graph 2 Reported Investment Change (Actual) vs. Forecasted (Measure 2), Scatter Diagram

Graph 3 Forecasted Investment Change (Measure 1) vs. Forecasted Investment Change (Measure 1) Scatter Diagram