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Confidence About Inflation Forecasts: Evidence from Surveys of Swedish Consumers

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INTRODUCTION

This study utilises the results of two surveys of inflation expectations in Sweden to test whether consumers' subjective ratings of the confidence they have in their inflation forecasts can be considered rational expectations of the objective error variances surrounding these forecasts.

The rationality of perceptions of forecast variances is an important issue because the economic behaviour of risk-averse individuals will be influenced not only by their predictions of the mean values of variables such as inflation,but also by their assessments of the uncertainty surrounding the mean forecast. If changes in uncertainty are not rationally assessed,individuals will not react appropriately,and some avoidable loss in economic welfare will occur.

Our study is innovative in several respects. Almost all earlier investigations of rationality in expectations formation have focussed exclusively on the mean forecast,and have used time series data on the average of mean expectations over a number of individuals to conduct tests for bias and systematic error in these forecasts. The studies of Brown and Maital(1981) on the Livingston survey of expert forecasts,de Leeuw and McKelvey(1981) on the Bureau of Economic Analysis business forecasts,and Noble and Fields(1982) on the Michigan SRC consumer forecasts are typical of recent empirical studies of what we might call "mean rationality". In contrast,we focus on the rationality of consumers' estimates of the variance surrounding their mean forecasts,and use cross-sectional data on individual variance estimates as the basis for our tests of "variance

rationality". To our knowledge,only Cukierman and Wachtel(1982) have previously investigated variance rationality,using the dispersion of mean expectations across (expert) individuals as a proxy for the subjective uncertainty of a typical individual. As discussed in Batchelor(1986),this proxy is valid only under rather restrictive conditions,and we use more direct measures of subjective uncertainty below. Similarly,we are aware of only one study,by Maital and Maital(1981),which exploits cross-sectional data on individuals,and this is exclusively concerned with testing for mean rationality.

A simple theory of information collection and processing is developed in the first section of our paper,as a basis for thinking about how individual differences in subjective probability distributions for inflation might arise,and what properties should be observed in the mean and variance of these distributions if expectations have been formed rationally. We then introduce our survey data,and conduct two sets of tests for variance rationality. In one,we compare ex post absolute forecast errors with ex ante measures of confidence in the forecasts,as expressed on a five-point scale. In the other,the sizes of the ranges used by consumers in making their inflation forecasts are used as proxies for the degree of subjective uncertainty. Where possible,we follow Maital and Maital in testing whether socio-economic characteristics of the individuals involved impart systematic biases to their judgments.

Our conclusions are mixed. There is only a weak correlation between actual forecast accuracy and the degree of confidence expressed by individuals in the first survey. In addition,systematic differences in forecast accuracy across individuals associated with differences in age and income are not reflected in differences in self-rated confidence between, say, the young and the middle aged, or the rich and the poor. Most people claimed to be more certain than uncertain about their inflation forecast. These findings are consistent with the weight of evidence from experimental psychology, which suggest that in non-economic contexts individuals are rather poor judges of risk, and tend toward overconfidence; see, for example, the now classic studies collected in Kahnemann, Slovic and Tversky (1982).

However, the second survey reveals that, for those individuals who chose to express their inflation forecast in terms of a range, forecast accuracy is significantly negatively correlated with the size of the range. This result is not inconsistent with the hypothesis of economic rationality, which postulates that individuals can make reasoned judgments about risk. We can at present only guess at why our two surveys have produced inconsistent results. One problem is that the confidence scale used in the first survey may be a rather crude filter for measuring subjective forecast variance, and the correlation between forecast accuracy and confidence from that survey may be understated because of this measurement error. On the other hand, the option of expressing forecasts as a range in the second survey may have been exercised by the more sophisticated survey respondents, so that the correlation between accuracy and confidence in that survey may overstate the correlation in the population as a whole. On balance, we interpret our results as showing that consumers are bad but not entirely irrational judges of the uncertainty surrounding their inflation forecasts.

THEORY

The work of Stigler (1961) and Muth (1961) has given a very precise meaning to the principle of rationality as applied to information collection and information processing in economics.

Faced with a situation of uncertainty about, say, the future rate of inflation, Stigler argues that rational individuals will aim to reduce that uncertainty by collecting progressively more costly information, up to the point at which the costs of collecting further information just match the benefits from having that extra information. Irrespective of the amount of information collected, Muth argues that rational individuals will use the information to construct a probability distribution for inflation by implicitly parameterising the true model linking inflation to its measureable determinants. The two acts of information collection and processing are interdependent, since the expected benefits from obtaining particular pieces of information can be gauged only by reference to their role in the model of inflation.

Under rationality, differences in the probability distributions across individuals in a cross-section can arise between otherwise identical individuals as a result of sampling error, or as a result of their holding different but observationally equivalent models of inflation; and between different types of individual, as a result of their facing different costs and benefits from obtaining information about inflation.

The following highly stylised model illustrates these points, and suggests how tests of mean and variance rationality might be conducted on cross-sectional data.

Rational Expectations and Individual Differences

Suppose that individuals i have utility functions U_i defined in terms of expected wealth EW_i. For simplicity suppose that these utility functions exhibit constant absolute risk aversion $R_i = -U_i''/U_i'$, and that nominal wealth W_i is known with certainty, so that $EW_i = W_i(1+\hat{\mu}_i)$ where $\hat{\mu}_i$ is individual i's estimate of the expected value of the unknown future rate of inflation. Finally suppose that information on inflation p is available from a number of equally informative "markets" j, where market j yields estimate $p_j = p + u_j$, $u_j \sim N(0,\sigma^2)$, at a cost c_i to individual i. If the p_j are literally the market inflation rates of particular goods within the aggregate price index, σ^2 would be a measure of relative price variability. However, the information sources j could equally be observations on past inflation rates, the current forecasts of experts, or the stated policy objectives of government. In these cases, σ^2 would reflect the variability of inflation over time, the error in expert forecasts, or the credibility of official policy statements.

A rational individual i who chooses to visit m_i markets will frame an estimate $\mu_i = E(p|p_1,p_2,\ldots,p_{m_i}) = \sum_j p_{ij}/m_i$ of the mean rate of inflation, and an estimate $\sigma_i^2 = E(\sigma^2|p_1,p_2,\ldots,p_{m_i}) = \sum_j (p_{ij}-p_i^e)^2/m_i$ of the variance of

market inflation rates around the mean. The mean estimate μ_i is of course distributed as $N(p,\tau_i^2)$, where $\tau_i^2=\sigma^2/m_i$, and the rational individual will frame an estimate $\tau_i^2=\sigma_i^2/m_i$ of τ^2. In this paper we interpret the subjective variance τ_i^2 of the individual's mean estimate of inflation as an appropriate measure of inflation risk. As shown by Rothschild and Stiglitz (1971), this is valid under several plausible assumptions about the shape of the individual's utility function, including the form assumed here.

For two rational individuals who choose to visit the same number of markets, the subjective pdfs for inflation will be identical except for sampling error in μ_i and τ_i^2. This error may arise by accident, as when the two individuals both decide to sample purely from cross-sectional market data, but wind up visiting different markets. Or the error may arise by design, as when one individual has a theory which leads him to use only cross-sectional data, while the other has a theory which leads to his sampling time series data. By construction, in our example both sets of data are equally informative, and in that sense the two theories can be considered observationally equivalent.

The pdf described above is obtained only at the cost of reducing wealth by $c_i m_i$. The optimum number of markets m_i for a rational individual to visit is that which maximises his expected utility, taking into account both the value of reduced uncertainty and the costs of obtaining information. Since under constant absolute risk aversion,

$$EU_i = \alpha - \beta\exp\{EW_i - \tfrac{1}{2}R_i VW_i\} \qquad (1)$$

where VW_i is the subjective variance of future real wealth, m_i should be chosen so as to minimise $EW_i - \frac{1}{2}R_i VW_i$. Substituting from the pdf for inflation, m_i must satisfy

$$\frac{\partial}{\partial m_i}\{W_i(1-p)-c_i m_i-\frac{1}{2}R_i W_i^2\sigma^2/m_i\} = 0 \qquad (2)$$

$$=> \quad c_i + \frac{1}{2}R_i W_i^2\sigma^2/m_i^2 = 0 \qquad (3)$$

$$=> \quad m_i = \sqrt{(R_i/2c_i)}.W_i\sigma \qquad (4)$$

$$=> \quad \tau_i^2 = \sigma/\{\sqrt{(R_i/2c_i)}W_i\} \qquad (5)$$

This shows that the amount of information collected will be greater, and hence the subjective uncertainty τ_i^2 smaller, for

- individuals with a high degree of risk aversion R_i
- individuals for whom the cost c_i of gathering information is low
- individuals with a high nominal wealth W_i, who have a lot to gain or lose from changes in inflation.

In addition, changes in σ^2 (relative price variability, variability in inflation over time, policy credibility) will impact on the subjective confidence of all individuals, but to a lesser degree on individuals with high risk aversion, low information costs, and high nominal wealth. Such individuals will respond to the increased noisiness of the inflation environment by seeking more information.

In Batchelor and Jonung (1986), we have suggested that the critical differences in risk aversion and information costs might be associated with identifiable socio-economic

characteristics of the individuals under scrutiny. For example, groups with high economic participation rates (men, the middle aged, the employed, those with high incomes) have both ready access to information about some nominal magnitudes in the economy (their own wages) and a strong incentive to remain informed about price inflation (to monitor their real wages). Similarly, women, who tend to spend more time shopping than men, collect more cross-sectional information on relative prices. The old. involuntarily collect more data on the time series properties of inflation. And so on.

Denoting the vector of socio-economic characteristics of individual i by x_i, this interpretation of the rational expectations hypothesis implies that

$$\tau_i = \tau(x_i) \qquad (6)$$

This relationship forms the basis for the empirical tests of rationality in individual perceptions of forecast accuracy described below. In Batchelor and Jonung (1986), we test whether this prediction of our theory, that individual differences in forecast accuracy should be correlated with differences in socioeconomic characteristics, using data from a survey of consumers in Sweden in the years 1978-85. Groups which are unambiguously expected to produce superior forecasts of inflation -the middle-aged, the rich -do indeed prove to be more accurate.

Cross-sectional Tests of Rationality

Let us write the actual mean inflation rate expected by individual i as $\hat{\mu}_i$ and the standard error surrounding this estimate, as perceived by individual i, as $\hat{\tau}_i$. Then $\hat{\mu}_i$ and $\hat{\tau}_i$ are rational expectations only if

$$\hat{\mu}_i = \mu_i = E(p \mid P_1, P_2, \ldots; x_i) \qquad (7)$$

$$\hat{\tau}_i^2 = \tau_i^2 = E\{(p-\mu_i)^2 \mid P_1, P_2, \ldots; x_i\} \qquad (8)$$

Hence in the relationships

$$p = a + b\hat{\mu}_i + v_i \qquad (9)$$

$$|p-\mu_i| = a' + b'\hat{\tau}_i + v_i' \qquad (9')$$

we should observe

$$(a,b) = (a',b') = (0,1) \qquad (10)$$

$$Cov(v_i, x_i) = Cov(v_i', x_i) = 0 \qquad (11)$$

Expression (10) summarises the unbiasedness conditions for mean and variance rationality. Expression (11) summarises the orthogonality conditions for mean and variance rationality. Under unbiasedness, v_i is the error in the forecast of mean inflation, and v_i' is the error in the individual's perception of the standard error surrounding that mean forecast. The orthogonality conditions require that these errors be uncorrelated with any information freely available to the forecaster. Since individuals certainly know their own socioeconomic characteristics, v_i and v_i' should be uncorrelated with elements of the vector x_i.

Equation (9) is implicitly the basis for the cross-sectional test of mean rationality conducted by Maital and Maital (1981). They regress individual inflation forecasts, from a survey carried out in Israel in 1975, on socioeconomic characteristics of the individuals surveyed. That is, they postulate

$$v_i = cx_i + w_i \qquad (12)$$

and test for the condition c=0 in the regression

$$\hat{\mu}_i = a'' + c''x_i + w_i'' \qquad (13)$$

In terms of our model $a''=(p-a)/b$, $c''=c/b$ and $w_i''=w_i/b$. Maital and Maital find that mean inflation expectations are significantly correlated with age, income, and a dummy reflecting the degree of interpersonal trust (credulity with respect to political promises?) of the survey respondent.

A similar cross-sectional test of variance rationality can be designed by writing (12) in terms of v', as

$$v_i' = c'x_i + w_i' \qquad (12')$$

Substituting this in (9') yields

$$|p-\mu_i| = a' + b'\hat{\tau}_i + c'x_i + w_i' \qquad (14)$$

The orthogonality condition for variance rationality is that c'=0. The only outstanding problem is how to obtain empirical counterparts to the variables appearing in the test equation.

EVIDENCE

The dependent variable in (14) is easily proxied. As pointed out by Cukierman and Wachtel(1982), the observable ex post forecast error $|p-\hat{\mu}_i|$ is a maximum likelihood estimator for the ex ante forecast standard error $|p-\mu_i|$. So in a cross-sectional regression, the dependent variable can be taken as the absolute forecast error made by each individual. Survey data on mean inflation expectations are, of course, available for many types of agent in many countries.

It is more difficult to obtain estimates for the subjective standard error $\hat{\tau}_i$. One possibility is to proxy this by the dispersion of mean expectations across individuals in the survey, a device used by Levi and Makin(1980) and Mullineaux(1980) among others. Cukierman and Wachtel test for variance rationality by computing the time series correlation between the variance of forecasts within the Livingston survey and the squared error in the average survey forecast. This turns out to be modest, but significantly positive (0.29), and so the hypothesis of variance rationality is not rejected. However, as discussed in Batchelor(1986), the variance of forecasts across individuals is not guaranteed to be a good proxy for subjective uncertainty. For example, even if in our simple model of optimal information processing all individuals visit the same number of markets m, the variance of mean forecasts across individuals in any survey will be an estimator of the sampling variance of the mean τ^2/m, and this will be correlated with uncertainty τ^2 only if m is stable over time.

In this paper, we utilise data from two surveys of consumers in Sweden which provide more direct proxies for subjective uncertainty about inflation.

The Statistika Centralbyran (SCB) Survey

The first survey was specially commissioned as part of the regular consumer omnibus surveys conducted by the Stockholm-based Statistika Centralbyran (SCB) in April 1984. The survey covered around 1200 individuals.

With regard to perceptions of past inflation, respondents were asked:

- Q1 How have prices in general changed during the past 12 months?
  (Increased/decreased/remained unchanged/don't know)

- Q2 By how many per cent have prices increased/decreased?
  (per cent/don't know)

- Q3 How certain are you about your reply concerning price movements during the past 12 months?
  (very certain, rather certain, as certain as uncertain, rather uncertain, very uncertain)

A similar set of three questions was asked about price movements over the coming 12 months. Satisfactory answers to all these questions were obtained from 342 of the individuals surveyed.

In addition to these and other questions about the economic environment, survey repondents were asked a number of questions about their socioeconomic status – about sex, age, education and so on. A preliminary discussion of the relationships between inflation uncertainty, as measrued by responses to Q3, and these individual factors is contained in Jonung (1986). Here, we look at the sources of inflation uncertainty more formally.

We have proxied $\hat{\tau}_i$ by defining a set of dummy variables $CONF_{i1}, CONF_{i2}, CONF_{i3}, CONF_{i4}$ and $CONF_{i5}$ representing successively higher degrees of self-rated confidence in the respondents inflation forecast. If respondent i answers "very uncertain" to Q3 then $CONF_{i1}=1$ and the other confidence dummies are set to 0; an answer of "rather uncertain" sets $CONF_{i2}=1$ and the others to zero; and so on. This assumes that responses to Q3 are triggered by a response function of the form

$$\text{Prob}(CONF_{ik}=1) = f(\hat{\tau}_i) \quad k=1,2,3,4,5 \qquad (15)$$

where f is a monotonically decreasing function in τ. That is, the higher is individual i's estimate of the standard error surrounding his mean inflation forecast, the more likely it is that he will choose a lower confidence class in answering Q3.

The vector x_i of the socioeconomic characteristics of the respondents has also been expressed in terms of a set of dummy variables X_{il}. The variables are

- sex :MALE or FEMALE

- age :YOUNG, MIDAGE (35-54 years), OLD
- location :METROPOLITAN, URBAN, RURAL
- education :ELEMENTARY, HIGH SCHOOL, COLLEGE
- employment :FULL TIME, PART TIME, UNEMPLOYED
- income :LOW, MID INCOME (SEK 70-150 thousand), HIGH INCOME

All of these are 0-1 dummies, with obvious interpretations.

Our empirical counterpart to (14) is therefore

$$|p-\hat{\mu}_i| = a' + \sum_{k=2}^{5} b_k' CONF_{ik} + \sum_{l} c_l' X_{il} + w_i \qquad (16)$$

It is evident that, because we do not have a quantitative measure of $\hat{\tau}_i$ we cannot conduct a strict test of unbiasedness. However, since the b_k are the differences between the forecast standard errors of individuals with confidence $CONF_k$ and individuals with the lowest self-rated confidence $CONF_1$, a necessary condition for unbiasedness is that

$$0 > b_2 > b_3 > b_4 > b_5 \qquad (17)$$

The orthogonality condition for rationality is $c_l'=0 \ \forall \ l$.

Separate regressions of the form (15) have been conducted using data on perceptions of past inflation, and expectations of future inflation. The results are shown on Table 1.

Table 1 Variance Rationality Tests on SCB Data

Independent Variable	Dependent Variable: Absolute Error in Perceptions	Absolute Error in Expectations
Constant	4.19 (4.03)	4.77 (6.49)
$CONF_2$	-1.02 (1.52)	-0.88 (1.68)
$CONF_3$	-0.81 (0.82)	-0.80 (1.40)
$CONF_4$	0.15 (1.06)	-0.84 (1.24)
$CONF_5$	-0.54 (2.62)	-1.11 (0.77)
FEMALE	-0.13 (0.23)	0.15 (0.44)
MIDAGE	0.35 (0.58)	-0.77 (2.09)
OLD	1.15 (1.61)	-0.78 (1.81)
URBAN	-0.78 (1.36)	-0.14 (0.41)
RURAL	-0.93 (1.51)	-0.04 (0.13)
HIGH SCHOOL	0.66 (1.08)	0.28 (0.76)
COLLEGE	0.82 (1.31)	0.00 (0.00)
PART TIME	0.62 (0.84)	0.43 (0.97)
UNEMPLOYED	-0.46 (0.67)	0.49 (1.19)
MID INCOME	0.01 (0.02)	-0.75 (1.87)
HIGH INCOME	-1.31 (1.66)	-0.99 (2.10)
Statistics		
$\bar{R}^2$	0.001	0.022
$F_{11,326}$	0.21	1.68

Estimates of parameters of text equation (15). Figures in parentheses are t-statistics.

The unbiasedness condition for variance rationality is rejected by the data. Although most of the b_{ik} coefficients are correctly signed, only one is significantly nonzero. The necessary condition (16) for unbiasedness can therefore be rejected relative to a null hypothesis that there are no significant differences in the ex post forecasting performance of individuals expressing different degrees of confidence ex ante. The only support for variance rationality comes from the observation that perceptions of past inflation by the "very certain" group have a significantly lower absolute error than the forecasts of the "very uncertain" group.

The orthogonality condition for variance rationality is accepted for perceptions of past inflation, but not for expectations of future inflation. A joint F-test on the coefficients on the socioeconomic dummies does not rejectthe hypothesis in either regression. However, three of the individual c_{li} coefficients - on MID AGE, MID INCOME and HIGH INCOME - are significantly nonzero in the expectations regression. As shown in Batchelor and Jonung (1986), middle-aged, high-income groups produce consistently more accurate forecasts than others in the sample. The significant c_{li} coefficients now show that this is not reflected in a consistently higher confidence rating among members of these groups.

The Konjunkturinstitutet (KI) Survey

The second survey we utilise is that conducted on a quarterly basis since 1978 by the Swedish

Konjunkturinstitutet (National Institute of Economic Research), also based in Stockholm. The particular survey with which we are concerned, taken in January 1985, covered around 5000 individuals, but contained rather less detail on expectations and respondent characteristics than the SCB survey. With respect to inflation expectations, the KI survey simply asks

- Q4 By what percentage have prices risen over the past 12 months?
  (per cent or range)

with a similar question regarding future inflation.

About one third of the respondents chose to give range ("5–10 per cent", say) rather than point answers, and it is on these range answers that our interest is focussed. It seems reasonable to postulate that both the choice of a range rather than a point answer, and the choice of the size of the range for inflation, is dependent on the size of the subjective forecast standard error $\hat{\tau}_i$. If we define a dummy variable $POINT_i$ to be 1 or 0 according to whether or not respondent i uses a point answer, and denote the size of the range by $RANGE_i$ (=0 if $POINT_i$=1), then the implied response function is

$$Prob\{POINT_i=0\} = g(\hat{\tau}_i) \quad (18)$$

$$RANGE_i = h(\hat{\tau}_i) \quad (19)$$

where g and h are monotonically increasing functions.

We have not conducted a test of the orthogonality condition for variance rationality using this data. But we have conducted a test for bias. Conditional on the above response function, a necessary condition for unbiasedness in subjective estimates of the accuracy of the mean inflation forecast is that in

$$|p-\hat{\mu}_i| = a' + b'POINT_i + c'RANGE_i + w_i \quad (20)$$

we should find

$$b' \leq 0 \ , \ c' > 0 \quad (21)$$

That is, the ex post absolute forecast errors made by those who choose to make a point forecast should be smaller than the errors of those who make a range forecast. And the larger the range chosen, the larger the ex post forecast error should be.

Table 2 carries the results from conducting regression (20) on the KI cross-sectional data for both perceptions and expectations. In cases where the forecast is made in range form, we have put $\hat{\mu}_i$ at the mid-point of the range.

The figures show that one of our unbiasedness conditions in (21) is satisfied, and the other is not. The coefficient on $RANGE_i$ is significantly positive, indicating that individuals who express their inflation expectation in terms of a large range do prove less accurate than those who use a smaller range. Roughly, a 1 per cent increase in range is associated with a 3/4 per cent increase in the absolute forecast error. However, the coefficient on the $POINT_i$ dummy is not negative.

Table 2 Variance Rationality Tests on KI Data

Independent Variable	Dependent Variable	
	Absolute Error in Perceptions	Absolute Error in Expectations
Constant	0.45 (4.10)	0.79 (9.47)
POINT	3.74 (16.96)	2.61 (15.23)
RANGE	0.75 (15.70)	0.68 (17.00)
Statistics		
$\bar{R}^2$	0.079	0.077

Estimates of parameters of text equation (19). Figures in parentheses are t-statistics.

On the contrary, it is significantly positive. That is, individuals giving a point forecast of inflation are not significantly more accurate than those giving a range forecast. The coefficient of 3.74 on the POINT dummy for perceptions indicates that on average individuals giving a point response are more accurate than individuals using ranges only if the range is greater than $3.74/0.75 \simeq 5$ per cent. Similarly for expectations the critical range size is $2.61/0.68 \simeq 4$ per cent. The average range size is around 4-5 per cent in both cases, so there is no significant difference in the accuracy of the point and range answers.

However, the fact that a correlation exists between range size and forecast accuracy means that our results from the KI survey are less critical of the hypothesis of variance rationality than our results from the SCB survey.

CONCLUSIONS

This study represents a first attempt at formally testing whether individuals form rational expectations of the uncertainty surrounding their inflation forecasts. Our findings have been contradictory, and depend crucially on what proxy is used to measure uncertainty. We have been forced to rely on such proxies because of the difficulty of extracting, from a lay sample, quantitative estimates of forecast standard errors or confidence intervals. However, the result is that our tests effectively maintain the joint hypothesis of variance rationality and a particular response function (equations (15), or (18) and (19)) linking the uncertainty proxy to the subjective forecast variance. Failure in our tests could therefore indicate either irrationality on the part of respondents or an incorrect assumption on our part about the response function.

This type of problem in isolating the hypothesis of interest is common in econometric studies of mean rationality, particularly those based on the observation of market prices. Use of direct survey data on mean expectations has helped resolve this problem, and we are hopeful that better techniques of uncertainty measurement will similarly in time help resolve the question of variance rationality.

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