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Uncertainty in forecasting inflation and monetary policy design: Evidence from the laboratory

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ABSTRACT

This paper designs a laboratory experiment for studying subjects' uncertainty regarding inflation in different monetary policy environments. We find that the contemporaneous Taylor rule produces a lower uncertainty and higher accuracy of interval forecasts than the forward-looking Taylor rule. The latter also produces a lower uncertainty when the reaction coefficient is high, 4, than rules with lower reaction coefficients, 1.5 and 1.35. Subjects perceive the underlying inflation uncertainty correctly in only 60% of cases, and tend to report asymmetric confidence intervals, perceiving a higher level of uncertainty with respect to inflation increases.

1. Introduction

This paper discusses an experimental study of the expectations formation process and the associated uncertainty within a macroeconomic framework. The importance of inflation uncertainty has been recognized at least since Friedman's Nobel Lecture (Friedman, 1977). Friedman argued that higher rates of inflation are associated with higher levels of inflation variability, which in turn causes a reduction in the efficiency of the price system, leading to a reduction in output, due to institutional rigidities. Indeed, Levi and Makin (1980) and Mullineaux (1980) found empirical support for Friedman's conjecture. Moreover, inflation-targeting central banks, in particular, trust that the inflation expectations of economic agents can be shaped importantly by their communication strategies. Inflation uncertainty can be viewed as one measure of the effectiveness of their communication strategies. In his speech about Federal Reserve communications, Mishkin (2008) stressed that the cost of inflation should be viewed in terms of both its level and its uncertainty. As Giordani and Söderlind (2003) demonstrate, this is particularly relevant when there is a regime switch (see also Evans & Wachtel, 1993). More generally, this is consistent with the standard New Keynesian dynamic stochastic general equilibrium (DSGE) model, in which a central bank should minimize the variation of inflation in order to maximize consumer welfare (see e.g. Woodford, 2003).

In our experiment, the subjects (undergraduate students) participate in a fictitious economy described by inflation, interest rates, and the output gap. They are asked to forecast inflation and to provide 95% confidence intervals around their point forecasts. These forecasts are then fed into a simplified version of the New Keynesian model, which is used to generate realizations for inflation, the output gap, and interest rates. After the values have been presented to subjects, the process is iterated, and the subjects are asked to provide forecasts for the next period. This paper studies the relationship between the individual uncertainty and monetary policy.

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In many respects, it would be more desirable to study the responses of professional forecasters, who make economic decisions based on their forecasts that then affect financial markets and the economy. However, there are also clear advantages of using experimental data, namely that they allow us to (i) observe how the forecasts interact with the economy and different monetary policy regimes, as we know the underlying model and the information set of survey respondents; (ii) analyze different policy regimes and different risk attitudes; and (iii) have independent responses that are not affected by a consensus opinion.

We focus on the relationship between monetary policy and inflation uncertainty, and examine whether some environments are better than others at stabilizing inflation and minimizing the uncertainty. Two different monetary policy rules are evaluated: a contemporaneous rule and a forward-looking rule. For the latter, we use three different specifications of the coefficient of the reaction to deviations of inflation forecasts from the inflation target. We find that the monetary policy design has a significant effect on both the width and the accuracy of forecast intervals. In particular, the instrumental rule that reacts to current inflation reduces the uncertainty and increases subjects' forecast accuracy relative to rules that react to the expected inflation. Most of these differences can be attributed to the fact that certain monetary policy regimes result in lower levels of the variability of inflation than others. The contemporaneous rule produces a lower variability in realized inflation than forward-looking rules. Also, the higher the reaction coefficient to deviations in inflation expectations from the target, the lower the variability in inflation. However, there are some treatment effects that go beyond this channel.

When looking at individual responses, we also find that, in general, forecasters tend to underestimate the underlying uncertainty when forecasting inflation, as only 60% of the results fall within the specified 95% intervals. It is well-known that subjects tend to report confidence intervals that are narrower than those asked for, and this is labelled the "overconfidence effect". We study the determinants of the individual confidence intervals using dynamic panel data regressions. The results suggest that the width of the confidence interval is highly inertial, and, interestingly, increases only when inflation is below the target level. However, our results show little evidence of different degrees of uncertainty in different phases of the business cycle.

There are several reasons why it may be preferable to ask subjects for symmetric intervals rather than potentially asymmetric intervals. Symmetric intervals are easier to handle in empirical analyses for constructing the aggregate distribution of expectations, because it can simply be assumed that an individual's distribution follows a normal distribution. Furthermore, there are no model-based reasons why confidence intervals should not be symmetric, as neither the underlying model nor the distribution of shocks exhibit any asymmetries. We have decided to perform both treatments with a restriction to symmetric confidence intervals (referred to as *Sym*), and treatments where we allow the subjects to have potentially asymmetric intervals (*Asym*). For the latter case, we find that only 12.5% of reported confidence intervals are symmetric. Subjects in the *Asym* treatments tend to report narrower intervals, which are therefore less accurate. In particular, the lower part of the interval is very inertial, while the upper interval responds more to current economic conditions.

Most of the research so far has focused on survey data from professional forecasters, see e.g. Giordani and Söderlind (2003) and Zarnowitz and Lambros (1987). Engelberg, Manski, and Williams (2009) review some of the methodological issues involved. Individual uncertainty has not been studied extensively in economics using experimental data.[1] Forecasting uncertainty has attracted a lot of attention among psychologists; however, their focus differs substantially from ours: the psychology literature has usually limited its attention to independent event forecasts, while the present study concentrates on a series of (dependent) forecasts. For surveys, see Hoffrage (2004) and Lichtenstein, Fischhoff, and Phillips (1982).

This paper is organized as follows. Section 2 describes the model and the experimental design; Section 3 introduces our hypotheses; Section 4 analyzes individual uncertainty and the relationship between such uncertainty and monetary policy; and Section 5 concludes.

2. Experimental design

We design an experiment in which the subjects participate in a fictitious economy and are asked to provide inflation forecasts and a measure of uncertainty about their forecasts. The mean of the point forecasts is then used by the data generating process to calculate inflation, the interest rate, and the output gap, and these variables are made available to the subjects before the next period forecast. Such "learning-to-forecast" experiments have been conducted before both within a simple macroeconomic setup (e.g., Arifovic & Sargent, 2003; Evans, Honkapohja, & Marimon, 2001; Marimon, Spear, & Sunder, 1993; Williams, 1987) and within the asset pricing framework (see Anufriev & Hommes, 2012; Hommes, Sonnemans, Tuinstra, & van de Velden, 2005). The closest to our framework, but with different focuses, are experiments by Adam (2007), Assenza, Heemeijer, Hommes, and Massaro (2013), Kryvtsov and Petersen (2013) and Pfajfar and Žakelj (2014, 2015).

2.1. Model economy

The data generating process is a forward-looking sticky price NK monetary model with different monetary policy

[1] Fehr and Tyran (2008) ask subjects to provide descriptive measures of their confidence level (but do not analyze them), while we ask subjects to provide numerical responses. Similarly, Bottazzi and Devetag (2005) ask subjects to provide 95% confidence intervals in an asset pricing experiment, but with the aim (almost exclusively) of defining the average forecast, rather than studying the behaviors of uncertainty or disagreement. Bottazzi, Devetag, and Pancotto (2011) argue that asking for confidence intervals instead of point predictions in an asset pricing framework reduces price fluctuations and increases subjects' coordination on a common prediction strategy. The difference between our experiment and that of Bottazzi et al. (2011) is that the confidence interval input in their setup has a direct effect on the realization of the endogenous variable.