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Experimental evidence on inflation expectation formation

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ABSTRACT

Using laboratory experiments within a New Keynesian sticky price framework, we study the process of inflation expectation formation. We focus on adaptive learning and rational expectations contrary to the previous literature that mostly studied simple heuristics. Using a test for rational expectations that allows heterogeneity of expectations we find that we cannot reject rationality for about 40% of subjects. More than 20% of subjects are also best described by adaptive learning models, where they behave like econometricians and update their model estimates every period. However, rather than using a single forecasting model, switching between models describes their behavior better. Switching is more likely to occur when experimental economy is in a recession.

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1. Introduction

This paper discusses an experimental study on the expectations formation process within a macroeconomic framework. Recently, with the development of explicit microfounded models, expectations have become pivotal in modern macroeconomic theory. Central banks increasingly attribute more importance to the developments of households' inflation expectations as they signal future inflationary risks. In line with this development, several theoretical models concerning expectations formation process have been proposed.¹ They postulate informational frictions and heterogeneity of expectations as the main features of the expectation formation process. A thorough empirical assessment of these theories must rely on micro-level data and the associated distribution of forecasts.² Moreover, to evaluate some new theories of

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¹ See e.g., Evans and Honkapohja (2001), Mankiw and Reis (2002), Carroll (2003), or Hommes (2013).

² Recently, there have been some studies based on micro survey data, e.g., Branch (2004, 2007), Dräger and Lamla (2012), and Pfajfar and Santoro (2010, 2013). These studies have confirmed that agents only infrequently update their information sets and that they use different theoretical models to forecast inflation.

expectation formation, e.g., adaptive learning,³ we need to assure that agents' current information sets encompass all the information from the previous periods. Controlled laboratory environments avoid these methodological issues that are present in the survey data of households. In this paper we analyze individual data on inflation expectations gathered from an experimental economy and test them for different theoretical models. Insights into agents' expectation formation provide useful guidance to central banks on how to anchor inflation expectations.

We focus on the analysis of adaptive learning and rational expectations (RE). The existing experimental literature has devoted more attention to simple heuristics for forecasting and/or adaptive expectations (for a survey see [Hommes, 2011](#)). Our goal is to assess whether any subjects behave according to these more sophisticated forecasting techniques. Tests for RE that have been applied in the existent literature have followed two approaches, a statistical perspective where RE are defined as those that use the correct distribution in predicting the variables relevant to their decisions, and a modeling perspective where expectations are rational when the model is in the rational expectations equilibrium. Existing tests following both perspectives have various disadvantages: tests in the former group assess only implications of (weaker form) RE while tests in the latter group are too restrictive as they implicitly assume homogeneous expectations (i.e., knowing that also other agents are rational). In this paper we develop a new test for RE that checks the consistency of expectation formation rules with the actual laws of motion, where we explicitly allow for a possibility of heterogeneous expectations. We demonstrate that the results regarding RE are indeed quite different using this approach compared to tests that assume homogeneous expectations. When analyzing individual responses from students of the Universitat Pompeu Fabra and Tilburg University, we find that for about 30–45% of subjects we cannot reject that they are rational using both the test we develop and the statistical test for efficient use of information. In addition, 20–25% of subjects mostly behave in line with adaptive learning where they update coefficient estimates of their models with respect to past forecast errors. From the remaining subjects, around 25–35% of them are best described by the trend extrapolating rule, and about 10–15% of subjects by adaptive expectations, where forecasts are updated with respect to the last observed error, or by a sticky information type model. Overall, our results suggest that for a significant proportion of subjects we cannot reject rationality and that also the share of subjects behaving in line with adaptive learning is quite high. We also confirm previous results of heterogeneity of expectations (see e.g., [Hommes, 2011](#)).

Furthermore, we also investigate whether switching between different forecasting rules better explains subjects' decisions than relying on a single rule for the whole duration of the experiment. We design our analysis to be complementary to the existing literature on switching between different forecasting rules ([Anufriev and Hommes, 2012a, b](#)), where a switching mechanism based on a version of [Brock and Hommes \(1997\)](#) predictor is commonly assumed. Specifically, [Anufriev and Hommes \(2012a,b\)](#) employ a version of the predictor dynamics analyzed in [Hommes et al. \(2005a\)](#) and show that it can replicate the main results of the [Hommes et al. \(2005\)](#) experiment in terms of individual behavior and aggregate dynamics. In this paper we study switching by re-estimating all alternative models in each period and for every individual selecting the best performing model in each period. Thus, we do not impose a particular structure of switching. Switching between alternative models seems to describe subjects' behavior better in our setup. We observe that the average duration of the best performing model is 4 periods. Furthermore, we also show that subjects' behave according to different models as on average in each period 4.5 different models are selected in groups of 9 subjects. This suggests that observed heterogeneity is pervasive. Our results from this exercise suggest that for almost half of all forecasts we cannot reject rationality according to both tests. Also the share of adaptive learning models slightly increases as more than 30% of all inflation forecasts in our experiment are best described with this class of models: therefore confirming their importance for forecasting.

The first experiments investigating the expectation formation process were performed in a no-feedback environment (e.g., [Schmalensee, 1976](#)) and lately some studies have also incorporated a feedback effect in their framework. However, these tend to analyze the expectation processes in an asset pricing setup. Some tests of the rational expectation hypothesis have been conducted within a simple macroeconomic setup (e.g., [Williams, 1987](#); [Marimon et al., 1993](#); [Evans et al., 2001](#); [Adam, 2007](#); [Assenza et al., 2013](#)).⁴ These studies mainly focus on the aggregate expectations formation and tend to reject the RE assumption in favor of adaptive ways of forming beliefs. On the contrary, we focus on the analysis of the behavior of individuals. Our framework allows us to ask the same agents to provide their forecasts over the whole time span. Some analysis of the micro expectations data is conducted by [Marimon and Sunder \(1995\)](#) and [Bernasconi and Kirchkamp \(2000\)](#) in an overlapping generations framework. These authors estimate several different regressions in order to study inflation expectation formation and find that most subjects behave adaptively, although [Bernasconi and Kirchkamp \(2000\)](#) provide evidence that adaptive expectations are not of first order degree as argued in [Marimon and Sunder \(1995\)](#). [Arifovic and Sargent \(2003\)](#),⁵ also address the issue of inflation expectations formation and study the adaptive hypothesis on individual responses. They also find support of adaptiveness and some evidence of heterogeneity of forecasts.⁶ Similar “learning to

³ Adaptive learning assumes that subjects are acting as econometricians when forecasting, i.e., re-estimating their models each time new data becomes available. See [Evans and Honkapohja \(2001\)](#).

⁴ See [Duffy \(2012\)](#) and [Hommes \(2011\)](#) for a survey on experimental macroeconomics.

⁵ [Arifovic and Sargent \(2003\)](#) focus on the time inconsistency problem, asserting that in many cases policy makers achieve a time-inconsistent optimal inflation rate, although in some treatments the economy moves towards sub-optimal (Nash) time consistent outcomes.

⁶ Also [Fehr and Tyran \(2008\)](#) suggest that expectations of individuals are heterogeneous. They study the adjustments of nominal prices after an anticipated monetary shock.

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