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### Bounded rationality and heterogeneous expectations in macroeconomics

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# Chapter 6

## Summary

This thesis studies the effect of individual bounded rationality on aggregate macroeconomic dynamics. Boundedly rational agents are specified as using simple heuristics in their decision making. An important aspect of the type of bounded rationality described in this thesis is that the population of agents is heterogeneous, that is, actors can choose from different rules to solve the same economic problem. The set of rules is disciplined by an evolutionary selection mechanism where the best performing rule, measured according to some fitness metric, attracts the higher number of agents. An important role in triggering switching between rules is played by the dynamic feedback between individual expectations of macroeconomic variables and their aggregate realizations. This expectational feedback mechanism translates agents' interaction into a mutual dependence between the individual choices of economic actors and the macro environment against which these choices are evaluated.

The contributions of the thesis are threefold. First, we develop theoretical New Keynesian models with monopolistic competition, nominal rigidities, heterogeneous expectations and evolutionary selection among forecasting strategies and study aggregate macro behavior under heterogeneous expectations among boundedly rational agents. Second, in departing from the traditional assumption of a representative rational agent, we investigate the validity of a frequently used argument in support of rationality, namely that rationality is the outcome of the repeated interaction of heterogeneous boundedly rational agents. In particular, we test the valid-

ity of standard monetary policy advices such as the Taylor principle, derived to ensure a unique stable equilibrium under the assumption of RE, in the presence of heterogeneous agents whose beliefs are updated based on past performance. Third, the thesis contributes to the empirical validation of heterogeneous agents models. In particular, the heuristics switching model is used to explain aggregate time series data as well as experimental data on individual expectations and aggregate macro behavior.

Chapter 2 presents a simple frictionless DSGE model to study the role of heterogeneous expectations about future inflation with evolutionary selection of strategies and the potential (de-)stabilizing effect of different interest rate rules. Macroeconomic stability and inflation dynamics depend in interesting ways on the set of forecasting strategies and the reaction coefficient to inflation of a Taylor-type interest rate rule. In particular, the standard policy recommendation, i.e., to adjust the interest rate more than point for point in reaction to inflation (Taylor principle), is sufficient to guarantee convergence to the RE equilibrium in the case of a *continuum* of beliefs. However, the Taylor principle is no longer sufficient to guarantee uniqueness and global stability of the RE equilibrium in the (more realistic) case of finitely many belief types. Non-rational beliefs and multiple equilibria may then survive evolutionary competition.

Chapter 3 derives a general New Keynesian framework consistent with heterogeneous expectations by explicitly solving the *micro-foundations* underpinning the model. We design an economy where agents can decide whether to pay some information gathering and processing costs for rationality or use simple heuristics to forecast macroeconomic variables. In such an environment, we address determinacy issues, i.e., uniqueness and stability of the RE equilibrium, related to the use of different interest rate rules. The central finding is that in a world with heterogeneous agents, standard policy advices do not necessarily guarantee uniqueness and stability of the RE equilibrium. In fact, policy attempts to achieve determinacy under RE, may destabilize the economy even when only a small fraction of boundedly rational agents is present in the economic environment.

Chapter 4 estimates a behavioral model of inflation dynamics with monopolistic price set-

ting, nominal rigidities and endogenous evolutionary switching between different forecasting strategies according to some fitness measure. In the stylized framework presented in the chapter there are two groups of price setters, fundamentalists and naive. Fundamentalists are forward-looking and believe in a present value relationship between inflation and marginal costs, while naive are backward-looking, using the simplest rule of thumb, naive expectations, to forecast future inflation. The estimation results show statistically significant behavioral heterogeneity and substantial time variation in the weights of forward-looking and backward-looking agents.

Chapter 5 reports the results of laboratory experiments with human subjects, designed to study individual expectations, their interactions and the aggregate behavior they co-create within a New Keynesian setup. Experimental data show that individuals tend to base their predictions on past observations, following simple forecasting heuristics, and individual learning takes the form of switching from one heuristic to another. We then use a simple model of individual learning with a performance-based evolutionary selection among different forecasting rules to explain coordination of individual expectations and aggregate macro behavior observed in the laboratory experiments. The analysis shows the simple heterogeneous expectations switching model fits individual learning as well as aggregate outcomes and outperforms homogeneous expectations benchmarks.

A general conclusion following from the theoretical and empirical results of this thesis is that non-rational beliefs may survive evolutionary competition among heterogeneous forecasting strategies. Therefore, policy makers should seriously take into account bounded rationality when designing monetary policy, since policies constructed under the assumption of homogeneous RE maybe destabilizing when expectations are heterogeneous.