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Inflation targeting in a learning economy: An ABM perspective

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ABSTRACT

This paper investigates the performances of an inflation targeting regime in a learning economy framed as an Agent-Based Model (ABM). We keep our ABM as close as possible to the original New Keynesian (NK) model, but we model the individual behaviour of the agents under procedural rationality à la Simon. Accordingly, we assume that their behaviour is guided by simple rules of thumb – or heuristics – while a continuous learning process governs the evolution of those rules. Under these assumptions that also allow the emergence of agents heterogeneity, we analyze the dynamics of the economy without assuming rational expectations, and study the role that a central bank, implementing an inflation targeting regime via a monetary policy rule, can play in the orientation of these dynamics. Consequently, our main goal is to analyse the interplay between the learning mechanisms operating at the individual level and the features and performances of the inflation targeting regime. Our results point to the prime importance of the credibility of central bank's inflation target regarding macroeconomic stabilisation, as well as the beneficial role played by that target as an anchoring device for private inflation expectations. We also establish the potential welfare cost of imperfect public information and contribute to the current debate on optimal monetary policy rules under imperfect common knowledge and uncertainty.

1. Introduction

Ever since the Reserve Bank of New Zealand Act of 1989 introduced inflation targeting (IT) as an official framework for the conduct of monetary policy, IT has been adopted by increasing numbers of countries throughout the world. That development has raised a great deal of interest in that particular monetary regime, both from an empirical and a theoretical point of view.

The present paper aims at contributing to the existing theoretical literature that has, so far, mainly emphasized two kinds of issues concerning IT properties and functioning. First, several studies have investigated how the design of IT could be formulated in terms of a specific policy rule that the monetary authorities would follow (and/or commit to). That strand of the literature has emphasized two families of rules (explicit instrumental rules vs. optimal targeting rules) which have been perceived as two polar ways of implementing IT strategies. In that respect, several contributions have notably assessed the properties of inflation forecast targeting rules (Svensson, 1999; Svensson and Woodford, 2004). Second, another strand of the literature has tried to identify the channels through which the IT regime could affect the course of the economy and which features of the economic environment can be key in promoting that impact. The role played by the degree of transparency of the central bank (CB) concerning the conduct of monetary policy has been particularly highlighted in that respect (Walsh, 2006, 2008).

Although those two lines of research pursue different objectives, they both insist on the role of expectations in the functioning of an IT regime and the importance of a declared commitment by the monetary authorities as to the course of their future policy decisions which might anchor those expectations. As such, both lines of research perfectly fit into the new paradigm for monetary policy conduct that has emerged over the past fifteen years. At the heart of that paradigm lies the idea that expectations are the prime concern of CBs, and a key channel of the transmission mechanism. Policy decisions should be transparent, so as to make them predictable and to allow for a more effective monetary policy. In such a context, the CB is viewed as a manager of private expectations (Woodford, 2005).

The New Keynesian canonical macroeconomic model (NK model) has become the reference framework for analysing the design of monetary policy rules under IT and the macroeconomic properties of that monetary regime (see (Giannoni and Woodford, 2005) for a standard reference). Effectively, the role of agents' expectations is at the core of that dynamic stochastic general equilibrium (DSGE) model, whose main features include forward-looking optimizing behaviour on the part of the private sector and rational expectations (RE), (see Woodford, 2003 for the reference masterpiece in that respect).

However, that theoretical framework does not appear to be totally adequate for addressing transparency and/or communication issues in the analysis of IT regimes. As underlined by Svensson (2009, p. 11), "*in a hypothetical world of a fully informed and rational private sector in*

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a stationary environment with a stationary monetary policy, symmetric information between the CB and the rest of the economy, and rational expectations, there is no specific role for CB communication".[1] As a consequence, and to address those issues, deviations from the full RE setting (i.e. rational expectation formation based on a complete information set) have been contemplated in the literature, while keeping unchanged, in most of cases, the other underlying ingredients of the NK model. Two modelling routes have been followed in that respect.

The first line of research has reconsidered the common knowledge hypothesis that underlies the computation of the RE equilibrium in the standard canonical NK model. This line, which is inspired by the work of Morris and Shin (2002), has been applied to the analysis of monetary policy transparency in the context of global games and high order beliefs. Acknowledging an imperfect knowledge of monetary policy actions by and within the private sector provides a natural way to analyse the features of the communication policy of the CB and the optimal degree of transparency in a context of public and private noisy signals. For example, Cornand and Heinemann (2008) perform such an analysis by means of a coordination game, while Demertzis and Viegi (2009) address the role of the inflation target as a focal point. Moreover, Baeriswyl and Cornand (2010) and Walsh (2006, 2008) adapt the NK model to an imperfect knowledge environment.

A second line of research replaces the RE setting by an adaptive learning environment: the agents try to learn about the RE (reduced form) equilibrium relationships through a recursive updating of their expectations on the basis of the observations they collect on inflation and output gap variables over time. Based on the new impetus given to the inclusion of learning dynamics in macroeconomics by Evans and Honkapohja (2001), that line of research has notably been applied to the case of IT by Orphanides and Williams (2005, 2007). Those authors use a NK framework in a context in which the private agents must learn about the model that drives the economy. The announcement of the inflation target affects the learning dynamics and in turn the reaction of the monetary authorities to the economic environment, which favours the convergence to the RE equilibrium. In the same perspective, Eusepi and Preston (2010) consider an adaptive learning process by private agents that is based on a VAR forecasting model which interplays with the other specified relationships stemming from a microfounded NK model. In such a setting, they demonstrate the need for communication on the part of the CB – including the announcement of an explicit inflation target – to prevent the occurrence of self-fulfilling expectational dynamics.

The objective of our paper is to go one – more – radical step forward in the investigation of IT properties under learning, by adopting an alternative approach to model that learning environment. We more particularly address the case of a learning economy, by which we mean not only that the individual agents depart from the RE benchmark when forming their expectations but also, and more fundamentally, that their decisions themselves rest upon a learning mechanism and thus deviate from the optimizing behavioural framework assumption. In other words, we place ourselves in a context in which individual agents are endowed with bounded rationality and are, as a consequence, engaged in a perpetual learning process, using regularly updated heuristics (or rules of thumb) rather than optimally derived rules to take decisions.

Admittedly, bounded rationality and its modelling have had a long history in economics (see the pioneering work by Simon, 1971) but that concept has been recently brought to the fore by authors who point out the limitations of the NK framework (and, more generally, DSGE methodology) to address macroeconomic issues and, particularly, those regarding the impact of monetary policy (Colander et al., 2008; De Grauwe, 2011; Delli Gatti et al., 2010).

One of the most challenging features concerns the cognitive abilities that the agents are assumed to be endowed with (De Grauwe, 2011). In the NK model, agents know and perfectly understand the underlying model of the economy — its structure as well as the values of its parameters. That, coupled with the RE assumption, allows them to use the model structure to make economic decisions and to forecast the evolution of the relevant variables for these decisions.[2] Those information assumptions are, to say the least, very restrictive and implausible. In general, individuals do not have the ability to process the complexity of the information they receive and to compute optimal action (see Simon, 1971). Rather, they use simple rules, namely "heuristics" to guide their behaviour, in an adaptive way, towards the achievement of their objectives.

Those aspects have been explicitly introduced by Brazier et al. (2008), Canzian (2009) and De Grauwe (2011) using simple evolutionary forecasting heuristics rules within different macroeconomic frameworks: one overlapping-generation model (Brazier et al., 2008), a simple aggregate model without any microfundations (Canzian, 2009) and a DSGE model (De Grauwe, 2011). All those contributions provide interesting insights about the way an explicit inflation target can overcome the additional macroeconomic volatility caused by a strong departure from the RE setting. Bounded rationality is however modelled only at the level of the expectation formation process while, in most cases, the decision rules are left consistent with the substantive rationality approach.

In the present paper, we aim at overcoming that methodological hiatus by explicitly modelling the learning economy as a complex adaptive system whose functioning and dynamics are primarily based on the adoption by boundedly rational households and firms of *individual, learning-based, "heuristic" rules of behaviour*. Given those modelling assumptions, the DSGE framework and tools have to be replaced by an alternative theoretical apparatus that could deal both with the interaction of individual decisions and the aggregation of the ensuing forms of heterogeneous behaviour in a flexible way. Effectively, we cannot suppose that those aspects would be (implicitly or explicitly) solved in a market clearing, equilibrium situation with RE as we cannot assume beforehand that such a situation would emerge from the functioning of the economy as has been specified here.

In our case, the change in the analytical framework is achieved through the building of an agent-based model (ABM).[3] Basically, an ABM consists of a simulated artificial economy, in which heterogeneous agents repeatedly interact according to heuristic, i.e. non-optimized, rules of behaviour (Tesfatsion, 2006). Those rules can be updated through specified learning process.[4] In addition, due to the bottom-up approach that underlies their construction, ABMs constitute a flexible tool to deal with heterogeneity and allows, on that basis, for the emergence of macroeconomic dynamics or features departing from the RE equilibrium paths that are usually envisioned in the NK model. However, as stressed by De Grauwe (2011), in order to avoid the "everything becomes possible" criticism, that heuristics modelling has to be framed

[1] See also Blinder et al. (2008).

[2] In that respect, the introduction of adaptive learning to substitute for the RE assumption may be considered as a first step in modelling bounded rationality. However, its introduction, at least in the macroeconomic literature, comes over as a relatively small deviation from the RE hypothesis, as the agents are supposed to know the features of the model of the economy even if they have to learn about the parameters of the equations that make up that model, under the restriction that the economy stays in the neighbourhood of the RE equilibrium. For a learning process based on a misspecified representation of that model, see Evans (2005). Furthermore, in that case, learning usually operates at the aggregate level of the reduced forms of the model.

[3] See the contributions collected in Tesfatsion and Judd (2006). ABM are widespread in several scientific fields other than ones that pertain to social sciences (such as biology or climate change studies). The use of ABM to analyse macroeconomic issues is rather recent. Contributions include Raberto et al. (2008), Oeffner (2008), Canzian (2009) or Lengnick (2011). To our knowledge, none of those contributions are explicitly related to the analysis of IT.

[4] See Brenner (2006) and Kirman (2011) for a statement of learning in agent-based models.