Journal of Macroeconomics 40 (2014) 114–131

Contents lists available at ScienceDirect

Journal of Macroeconomics

journal homepage: www.elsevier.com/locate/jmacro

# Signals and learning in a new Keynesian economy

Stefano Marzioni *

*LUISS Guido Carli and CASMEF (Arcelli Center for Monetary and Financial Studies), Viale Romania 32, Rome 00197, Italy*

ARTICLE INFO

*Article history:*
Received 21 November 2012
Accepted 3 March 2014
Available online 25 March 2014

*JEL Classification:*
E37
E43
E52
E58

*Keywords:*
Gaussian signals
Adaptive learning
DSGE models
Monetary policy

ABSTRACT

This paper aims at assessing whether, and how, communication of central bank's forecast might affect economic dynamics. In a simple new Keynesian environment it is assumed that private sector conditions its own expectations to central bank's forecasts. Private sector's prior expectations are estimated in each period in accordance with the adaptive learning scheme, and successively updated with a signal based on central bank's forecasts. Using both analytical and numerical calculations it is shown that the economy's dynamics is affected by central bank's ability to correctly assess the effect of the signal. In particular, if the central bank takes into account the impact of signals on private agents' expectations the economic dynamics is less volatile. Moreover, if a fundamentals based signal includes a stochastic component unrelated to the economy, the strategy of communicating expectations to the private sector may perform worst than in the case of a totally uninformative signal.



## 1. Introduction

In the recent decades monetary policy strategies have increasingly hinged on expectations management. In order to persuade rational (or near rational) agents about economic perspectives, major central banks often communicate policy intentions (including targets), increase operational transparency or try to convey information from a supposedly more advanced economic model. For instance, communication of forecasts about output and inflation may be interpreted as a channel to improve agents' own forecasts and the overall economic awareness.

The purpose of this paper is to assess the role of macroeconomic forecasts, as communicated by central bank to the private sector, in a general equilibrium model. In the model proposed below the private sector extracts information from signals issued by the policy maker. Such signals are then weighted in accordance with the signal's past performance in terms of prediction, and become part of their expectations about the economy's state variables. The mechanism used by agents to generate expectations consists of two steps. In the first step agents determine their prior about expectations. In the second step agents update their prior with a new piece of information (i.e. the signal by central bank). The final expected value of the vector of states variable is hence a combination of new and old information. The weight assigned to new information changes in each period and is determined by the degree of comovement between the signal and the variables and the signals variance.

Agents are adaptive learners, in accordance with the framework analyzed in Evans and Honkapohja (2001). Agents learn adaptively the parameters of the rational expectation equilibrium by estimating it period by period in order to compute their prior expectation. Next, agents update the prior accordingly with the signal from central bank. Agents' expectations are computed on the basis of a guessed solution, of observable data and of signals from the central bank, which together

* Tel.: +39 0685225980.
*E-mail address:* smarzioni@luiss.it

http://dx.doi.org/10.1016/j.jmacro.2014.03.002
0164-0704/

constitute the private sector's information set. By assumption, the policy maker is endowed with a deeper knowledge of the economy than the private sector. Indeed, it is assumed that the central bank knows the structural equations of the economy, and therefore computes expectations according to the rational expectations (RE) solution of the model.

The framework defined by the structural assumptions implies the existence of asymmetric information between agents and policy maker. This is a situation that can arise in a number of context. Though it may seem unreasonable to assume that the policy maker knows exactly the structure of the economy, this assumption has the advantages of analyzing the effect of information spreading throughout the economy from the largest possible information set. Thus, the signal sender is artificially put in a privileged position with respect to agents.

The adaptive learning (AL) approach in macroeconomics has been extensively explored in the literature. In this paper it constitutes the mechanism through which agents determine their prior expectation in each period. Behind the mathematical framework which allows to determine the convergence conditions of a given system of differential equations, lies the simple economic intuition of relaxing the strongest axiom of the rational expectations (RE) theory, i.e. the full knowledge of the model underlying the economy. As Orphanides and Williams (2005) argue, one of the most relevant criticism to the RE approach is that it assumes that agents have far more information about the structure of the economy than could reasonably be expected by any real economic agent in the real world. Moreover, in the RE approach it is assumed that agents believe (or know) that the model economy is an accurate representation of the economy they operate in, with no endogenous verification within the model. According to the adaptive learning approach, instead, private agents may or may not be aware of the structure of the economy they operate in, but they act at best of their possibilities. Economic decisions are therefore supported by econometric estimations that are based on all the available information that is perceived as relevant. Expectations are "adaptive" because they are adjusted in each period in the measure of the forecast error. Nevertheless, the expectations' adaptive form arises from the recursive form that the econometric estimations may assume in certain cases. In particular, if estimates in each period are computed by ordinary least squares, then this method can be expressed in a recursive form. The recursive least squares (RLS) method allows to adjust the estimated coefficients proportionally to the error that arises by comparing the actual new data with the projection of the coefficients on the old information set.

This paper departs from the existing literature on learning by assuming that agents' final expectations (i.e. expectations that actually determine the economy's dynamics) result from the combination of standard adaptive learning expectations and information from external sources. In the vast existing literature focusing on new Keynesian models with adaptive learning agents there are examples of different information sets co-existing in the same economy. Berardi (2009) focuses on the econometric evidence of expectation shocks affecting real variables. Ferrero and Secchi (2010) analyze the impact of interest rate path communication as well as expected inflation and output gap under a Taylor type rule monetary policy regime. In this paper it is assumed that monetary policy is optimal under RE and that the weight that private sector gives to the signal from central bank is endogenous. This approach is different because in Ferrero and Secchi (2010) the weights assigned to the signals from central bank are fixed exogenously. Moreover, in the present paper it is also considered the case of disturbed signals. Muto (2011) introduces a framework, where private agents refer to the central bank forecasts, by assuming that the central bank has only imperfect knowledge of the economy' structure and responds to the bank's own expectations. In the current paper the central bank has perfect structural knowledge of the economy and responds to private agents' expectations (rather than the bank's own expectations) in the monetary policy rule. The main finding in Muto's paper is that the central bank, by following a Taylor type rule, should respond more aggressively to expected inflation than the extent suggested by the Taylor principle. This result arises because of the interaction between central bank's and private sector's expectations and is different from the findings in the present paper. Most of that difference is accounted for by the different information contained in central bank's signal. Since in Muto's framework central bank has no privileged information with respect to the private sector, it introduces a further shock propagation mechanism. Since the weight agents assign to central bank's signal is always equal to one monetary policy should offset this kind of shocks by reacting more strongly to private sector's expectations. This may alter E-stability, as well as determinacy, conditions.

The main difference between the current paper and Muto (2011) lies in the interaction mechanism between central bank's and private agents' expectations, as well as in the assumption of central bank having perfect structural knowledge of the economy. Actually, in this paper the interaction mechanism between expectations from different sources is based on a two-step approach, which combines adaptive learning and updating with signals. Instead, in Muto (2011) a one-step approach of adaptive learning is adopted, which is more in line with traditional adaptive learning framework. Just like in Muto (2011), in this paper private agents utilize central bank's forecasts as sources of information. Nevertheless, in this paper central bank has perfect structural knowledge of the economy. The two-steps approach is motivated by the observation of current major central bank's practices, which often publish forecasts on a regular basis in order to increase the degree of transparency and accountability of policy making. However, since agents are bounded in their information set, they don't have the theoretical instruments to rationally believe communications from the policy maker, even though central bank perfectly knows the true model of the economy. Hence, agents are not able to recognize whether or not using signals would improve their ability to make decisions. Thus, they have to learn the reliability of all the signals from an external source. This is exactly done by adjusting the weight which is assigned to the signal. It follows that information flowing from one side of the economy (central bank) to another (private sector) has to be treated as a signal and, as a such, it has to be processed before being included into agents' information set.