Reply to the comment on the paper "Information Stickiness in General Equilibrium and Endogenous Cycles", under discussion in *E-conomics, the Open-Access, Open-Assessment E-Journal.*

I appreciate the extremely insightful comments made by this reader. They are important and will certainly help in exploring further the issues that the paper raises. Below, I reply to each one of the eight remarks that are presented. I hope this helps in clarifying the arguments that this work intends to offer.

Relatively to the first point, concerning equation (4), I believe that the equation is correct at the light of the main assumptions of the Mankiw-Reis framework. The procedure to reach it is developed in Reis (2006, 2009). I present a brief explanation below.

The solution of the optimal control problem of a household j, when her behavior evidences inattentiveness to the arrival of new information is

$$C_{t,j} = \beta^{-\theta} E_{t-j}\left[E_t\left(\widetilde{R}_{t+1}^{-\theta} C_{t+1,0}\right)\right] \tag{1}$$

with $C_{t,j}$ the consumption at date t by household j, β the discount factor, θ the intertemporal elasticity of consumption utility and $\widetilde{R}_t$ the real return on bonds. This is a dynamic equation on consumption, that indicates that consumption at time t of an agent that last updated her information j periods ago corresponds to the expectation formed j periods ago about today's consumption level $C_{t,0}$.

The log-linearization of the equation in the steady-state vicinity transforms the expression in the following one,

$$c_{t,j} = E_{t-j}\left(c_{t+1,0} - \theta r_t\right) \tag{2}$$

with $c_{t,j}$ the log-linear deviation of consumption relatively to its steady-state level and r_t the log-linear deviation of $E_t\left(\widetilde{R}_{t+1}\right)$.

To proceed, one needs to iterate forward equation (2) in order to obtain

$$c_{t,j} = \lim_{T\to\infty} E_{t-j}\left(c_{t+T+1,0}\right) - \theta\sum_{i=0}^{\infty} E_{t-j}\left(r_{t+i}\right) \tag{3}$$

The first term in the r.h.s. of (3) is the steady-state level of consumption c^n. Under market clearing, total consumption equals total output and therefore c^n can be replaced by y^n, which represents the steady-state or potential level of output (because this has to be measured also as a log-linear deviation, one can consider it equal to zero). The second term in the r.h.s. of equation (3) is a convergent sum that can be expressed as $\theta E_{t-j}\left(R_t\right)$, with $R_t = E_t\left(\sum_{i=0}^{\infty} r_{t+1}\right)$ being the long real interest rate.

Thus, one may rewrite equation (3) as

$$c_{t,j} = -\theta E_{t-j}\left(R_t\right) \tag{4}$$

which is equation (4) in the paper. The dynamics continue to be present in the equation but they are transferred from consumption to the interest rate, since (4) assumes all the expected future interest rates from now to an undefined future.

The second issue concerns the constraint on the policy parameter. Parameter ϕ is included in the Taylor rule and can be interpreted as the degree of sensitivity of monetary policy (of changes in the value of the nominal interest rate) relatively to changes on the inflation rate (more specifically, in this case, to the deviation of expected inflation relatively to the corresponding target value). Note that one has ignored real stabilization concerns in the design of the monetary policy rule and, therefore, the interest rate is not related to the output gap (it is as if the policy parameter associated to the output gap in the expression is assumed equal to zero); this signifies that price stability is the only objective around which monetary policy is conducted.

Such kind of specification implies a well known monetary policy result: with $\phi > 1$ the rational expectations equilibrium paths of inflation and of the nominal interest rate are determinate. If instead $0 < \phi < 1$, the rational expectations equilibrium is indeterminate (this result can be found in proposition 2.6 of Woodford (2003), page 91).

Since the rational expectations equilibrium is the benchmark relatively to which one wants to compare results with, it makes sense to exclude, from the beginning, the indeterminacy case because it implies an infinity of solutions with no relevant economic meaning. As mentioned in the comment, Bullard and Mitra (2002) do not impose this constraint from the beginning, but they also arrive to a no indeterminacy condition (which is not exactly the one mentioned here, because their Taylor rule includes a real stabilization concern alongside with the price stability policy goal).

The third remark relates to the computational skills of agents. It is true that agents are modeled as if they were endowed with optimization skills: firms maximize profits intertemporally and households do the same concerning consumption utility. However, this capacity to optimize is constrained by the available information and by the ability to form consistent expectations. Economic agents can adopt an optimization procedure but this does not necessarily imply that they have collected the correct information to make the decision or that they are supporting their decision in relevant information.

It may be relatively easy to access optimization algorithms that endow agents with the ability to solve 'extremely difficult optimization problems'. This can be done, for instance, by repeating previous procedures or by imitating the behavior of others. What is, in fact, hard is to gain the right perception about the data that is required to serve as the input for the problem under evaluation.

The fourth and fifth points are of primary importance. It is a fact that the assumption on expectations is imposed to the linearized aggregate economy and not on the level of the optimizing individual agent. It needs to be emphasized, then, that agents solve their problems without a perception of how they form their own expectations. There is initial uncertainty about the mechanism of generation of expectations and only after optimization problems are solved agents will understand what perception they can create about future events: if they are sufficiently near the point in time relatively to which they estimate the future, the perfect foresight component will prevail; if the relevant period is distant in time, they will be unable to gather all the relevant information and, therefore, they avoid departing significantly from the steady-state in which the system rests unless it is disturbed by some policy shock.

Relatively to point 6, the sentence in the abstract of the paper by Doms and Morin (2004), is in fact the conclusion withdrawn from an empirical study. This is stated in the beginning of the sentence, but I agree it can be underlined with a few statements describing the nature of their study. Basically, these authors collect information from 30 large US newspapers and construct indexes reflecting the number of articles that mention the terms recession, layoffs and economic

recovery. An econometric analysis using the collected data and the constructed indexes allows to conclude that periods of recession are periods of high news coverage about economic events, making these to be also periods of a stronger reaction of economic agents in terms of their sentiment about aggregate economic performance.

Remark 7 also touches a central point of the paper. In fact, it is the precise shape of function (11) that triggers the nonlinearities that are subsequently characterized. This specific function is chosen because it fits well the intended features of the relation between the output growth rate and the degree of attentiveness, namely the existence of a relation of opposite sign between these variables, with the values of the attentiveness variable remaining inside a bounded interval for every possible growth rate.

The need to consider a specific functional form, instead of proceeding the study with a general function with the required properties, resides on the necessity to compute global dynamics and to illustrate the existence of endogenous fluctuations in the long-term paths followed by the variables in this macroeconomic system. Evidently, it is possible to conceive other functions with similar features, and if these contain some kind of nonlinearity, results of a same nature should be expected. The peculiar function that one considers has the advantage of presenting in a single continuous function the set of properties that are required to translate the intended relation (the same kind of relation could be explored, e.g., under a non continuous piecewise function, something that would introduce, without any visible advantage, additional analytical complexity to the model).

Finally, concerning point 8, one could explore further the intuition about the stability result. The main idea is that, as already referred in this text, one is comparing a departure from rationality and attentiveness with the benchmark case of rational expectations and full attentiveness. Under this benchmark scenario, monetary policy needs to be active in order to guarantee a fixed-point steady-state outcome. Departures from this reference turn the requirement more demanding in the sense that the reaction of the central bank to changes in the expected inflation rate need to be even more aggressive. A failure in taking such an aggressive behavior in terms of the choice of the nominal interest rate path may imply endogenous fluctuations that constitute a source of uncertainty for the choices of the private economy and, therefore, should be avoided.

References

[1] Bullard, J.B. and K. Mitra (2002). "Learning about Monetary Policy Rules." *Journal of Monetary Economics*, vol. 49, pp. 1105-1129.

[2] Doms, M. and N. Morin (2004). "Consumer Sentiment, the Economy,and the News Media." *FRBSF working paper* 2004-09.

[3] Reis, R. (2006). "Inattentive Consumers." *Journal of Monetary Economics*, vol. 53, pp. 1761-1800.

[4] Reis, R. (2009). "A Sticky-Information General-Equilibrium Model for Policy Analysis." *NBER working paper* n^o 14732.

[5] Woodford, M. (2003). *Interest and Prices: Foundations of a Theory of Monetary Policy.* Princeton, New Jersey: Princeton University Press.