Optimal monetary policy in a New Keynesian model with endogenous growth ☆

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A R T I C L E   I N F O

A B S T R A C T

We study optimal monetary policy in a New Keynesian (NK) model with endogenous growth and knowledge spillovers external to each firm. We find that, in contrast with the standard NK model, the Ramsey dynamics implies deviation from full inflation targeting in response to technology and government spending shocks, while the optimal operational rule is backward looking and responds to inflation and output deviations from their long-run levels.

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1. Introduction

The traditional NK literature features exogenous growth or no growth at all. Yet, business cycle fluctuations affect growth-enhancing activities and modify the growth trend of the entire economy. However, very few papers analyze the interaction between growth and uncertainty in the context of monetary models (e.g. Dotsey and Sarte, 2000; Varvarigos, 2008). An even smaller subset introduce nominal rigidities, but in the form of one-period nominal wage contracts.[2] An exception are Annicchiarico et al. (2011b), who consider an NK model and study the interplay between nominal rigidities, nominal uncertainty and growth under different Taylor rules, but do not study optimal monetary policy. Those papers studying optimal monetary policy in NK frameworks, instead, (e.g. Khan et al., 2003; Schmitt-Grohé and Uribe, 2007a,b; Faia, 2008b, 2009), usually abstract from growth, so disregarding the interaction between short-run dynamics and growth which is, instead, of interest for the optimal monetary policy analysis.[3] The paper most related to ours is Faia (2008b), which studies Ramsey monetary policy in a basic NK model with capital accumulation and sticky prices à la Rotemberg (1982), but no growth.

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[2] Blackburn and Pelloni (2004, 2005) and Annicchiarico et al. (2011a).
[3] See also Schmitt-Grohé and Uribe, 2004a,b. An exception is given by Mattesini and Nisticò (2010) who explore the optimal behavior of the monetary authorities in an NK model with trend (exogenous) growth.

In this paper we fill this gap and consider an NK model with endogenous growth *à la* Romer (1986) and nominal rigidities due to staggered prices *à la* Calvo (1983) to study optimal monetary policy. Since in this paper we want to deviate from the mainstream NK model only for the inclusion of an endogenous growth mechanism, we opt for the Calvo setting which among the various models of price rigidities is the most widely used in the derivation of New Keynesian Phillips Curves and represents a key ingredient of the standard NK textbook model (see e.g. Galí, 2008; Walsh, 2010). Moreover, Ascari et al. (2011) provide evidence in favor of the statistical superiority of the Calvo setting with respect to the Rotemberg one.[4]

In particular, we study the Ramsey optimal monetary policy and characterize the monetary policy rules that are optimal within a family of implementable and simple rules in a calibrated model of the business cycle under a positive steady-state inflation rate. In this respect we depart from the standard NK literature which studies optimal monetary policy in economies where long-run inflation is nil or there is some form of wide-spread indexation.[5] From an empirical point of view, neither of these two assumptions is realistic for economies like the United States or the Euro Area. Thus, it is of interest to investigate the characteristics of optimal policy in their absence and their relationship with growth.

The economy we consider in this paper features three sources of inefficiency which provide a rationale for the conduct of monetary policy. The first two distortions are the ones which characterize the basic NK model, namely: (i) monopolistic competition, which generates an average markup, which lowers output with respect to the efficient economy; (ii) nominal rigidities due to staggered prices, which generate price dispersion. The third source of inefficiency is the one that differentiates the present model from the standard NK model, i.e. the presence of *knowledge spillovers* which are external to each firm. In other words, a sort of serendipitous learning mechanism characterizes the production activity. In this context, the decentralized equilibrium is Pareto suboptimal and the economy grows at a lower rate than under the allocation that would maximize the representative household's lifetime utility. The following main results characterize our model economy.

First, even in the presence of the additional distortion due to knowledge spillovers, we find that the Ramsey steady-state inflation rate is zero.[6] The reason is the following. In the long run, a higher inflation rate, by increasing the average markup and by introducing price dispersion, would imply a lower return on capital and a reduced level of economic activity, thus lowering savings and growth. The increase in consumption and in growth rate more than compensates the increase in hours worked and thus households' welfare increases as trend inflation decreases.

Second, despite the long-run value of inflation is zero, the Ramsey dynamics requires deviation from full inflation targeting in response to technology and government spending shocks. However, the intensity of the reaction crucially depends on the nature of the shock. Following a positive technology shock the central bank tolerates moderate deviations of the inflation rate from its optimal steady state in order to push the short-run economy growth rate toward the efficient one. In this case optimality calls for an increase in the real interest rate so as to moderate consumption, foster capital accumulation and so growth.[7] Also in response to a government spending shock, the optimal monetary requires an increase in the real rate, so as to generate a fall in consumption and mitigate the expansionary effects of the demand shock.

Finally, the optimal operational monetary rule is backward-looking, features a strong positive reaction to output movements and a mild response to inflation, contrary to the previous findings in the literature.[8] As will be clear in the paper, all these results strongly depend on the role played by the endogenous growth mechanism and the implied inefficiency due to the presence of external knowledge spillovers.

Summing up, while the NK literature assumes that growth is an exogenous and independent process with respect to the business cycle, the literature that studies the interplay between growth and business cycle concentrates on the relationship between volatility and growth and disregards the implied optimal monetary policy prescriptions. Thus, to the best of our knowledge we are the first to study the monetary policy implication of this setup.[9]

The paper proceeds as follows. Section 2 describes the model. Section 3 analyzes the Ramsey optimal policy. Section 4 shows results from the search of an optimal operational interest rate rule. Section 5 concludes.

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[4] We are aware that the Calvo and Rotemberg price-setting mechanisms, despite the strong similarities to a first order of approximation (provided that there is no trend inflation, as shown by Ascari and Rossi, 2012), may have very different welfare implications at higher order of approximation, even if almost negligible, when the steady state is distorted (see e.g. Lombardo and Vestin, 2008). Hence, for robustness check and to make our findings more comparable to those of Faia (2008b), in a separate appendix, available on the authors' webpages, we also consider an NK model with AK technology and Rotemberg pricing.

[5] An exception are Schmitt-Grohé and Uribe (2007a). The authors show that, by assuming zero steady-state inflation or full price indexation, nominal rigidities have no real consequences for economic activity and thus welfare in the long run. Thus, the assumptions of zero long-run inflation or indexation should not be expected to be inconsequential for the form that optimal monetary policy takes.

[6] It is well known in the literature that in a model with Calvo pricing the first two distortions require a zero steady-state inflation (see King and Wolman, 1999).

[7] We will see that this result stands in sharp contrast with that obtained by Faia (2008b) in the context of a NK model with capital accumulation. In this sense we argue that the explicit introduction of an endogenous growth mechanism itself may be source of non-trivial implications for the optimal monetary policy analysis. As already anticipated, for robustness check, we have also solved the Ramsey problem under Rotemberg pricing and found that the optimal steady-state inflation is zero (as in Faia, 2008b), while the optimal response to productivity and public consumption shock is always counter-cyclical.

[8] See for example Schmitt-Grohé and Uribe (2004a, 2007a,b)) who, in different models, find that the optimal interest-rate rule features a muted response to output.

[9] In a similar framework Vaona (2012) explores the relationship between inflation and growth.