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Trend growth and learning about monetary policy rules

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ABSTRACT

The paper examines the effect of trend productivity growth on the determinacy and learnability of equilibria under alternative monetary policy rules. Under zero trend inflation we show that the economic structure is isomorphic to that of Bullard and Mitra (2002) and show that under a policy rule that responds to current period inflation and output a higher trend growth rate relaxes the conditions for determinacy and learnability. Results are mixed for other policy rules. Under the expectations-based rule, trend growth tightens the conditions for determinacy but it relaxes the conditions for learnability. Under the lagged-data-based rule, trend growth tightens the conditions for determinacy and learnability. Our analysis shows that lower (higher) trend growth has similar effects as higher (lower) trend inflation in the sense of making inflation more (less) forward-looking. Thus, our results complement previous studies on the role of high trend inflation as a cause of macroeconomic volatility in the U.S. in the 1970s, as this period was also characterized by productivity growth slowdown.

1. Introduction

Business cycle models with forward-looking expectations may be prone to two types of problems. The first is real indeterminacy—the possibility that multiple stationary rational expectations equilibria exist. The second is expectational instability or E-instability under private sector learning (see, e.g., Evans and Honkapohja, 2001).[1] In sticky price models in which monetary policy constitutes one of the building blocks that determine macroeconomic outcomes one may wonder what sorts of policy rules may lead the economy into indeterminacy and/or E-instability, so that policymakers can avoid using such undesirable policy rules. Bullard and Mitra (2002) were among the first to analyze determinacy and learnability of rational expectations equilibria in the standard New Keynesian model of inflation and output. They evaluate the performance of various forms of Taylor-type rules for setting the nominal interest rate. One of the key results of their analysis is that following the so-called Taylor principle, where the central bank adjusts the nominal interest rate more than one-for-one with changes in inflation, is desirable both from determinacy and learnability point of view. Another is that, in general determinacy does not imply learnability of rational expectations equilibria.[2]

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[1] In what follows we use the words learnability and E-stablility interchangeably.

[2] See McCallum (2007) for a detailed analysis of the connections between the determinacy and learnability criteria and Evans and Honkapohja (2008) for a survey of the learning literature.

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In this paper we extend the Bullard and Mitra (2002) framework to allow for trend productivity growth (in short, trend growth).[3] The aim is to analyze how the presence of positive trend growth affects the performance of Taylor-type policy rules in terms of model determinacy and learnability. We consider Taylor rules that prescribe adjusting the nominal interest rate in response to deviations of inflation and output (current, lagged or expected) from their respective target levels. In what follows these three alternative policy rules are called, respectively, current-data-based rule, lagged-data-based rule and expectations-data-based rule.

The analysis follows in two stages. In the first stage, in line with Bullard and Mitra (2002), we assume zero trend inflation. This allows us to derive partial analytical results, as our model is then isomorphic to that of Bullard and Mitra (2002). Here, we show that trend productivity growth changes the slope and position of the short-run Phillips curve, one of the key structural equations of the New Keynesian model. In particular, the sensitivity of actual inflation to expected inflation is lower while its sensitivity to output is higher the higher is trend growth. We then show that the effect of trend growth on determinacy and learnability of rational expectations equilibria depends on the policy rule under consideration. Under a current-data-based rule higher trend growth relaxes the conditions for determinacy and learnability of rational expectations equilibria. Under the expectations-data-based rule, higher trend growth tightens the conditions for determinacy but relaxes the conditions for learnability. Under the lagged-data-based rule, trend growth tightens the conditions for determinacy and learnability.

In the second stage, we allow for the presence of positive trend inflation, as in Ascari and Ropele (2009). This allows us to relate our results to those of Ascari and Ropele (2009) and the interaction between trend inflation and trend productivity growth. It turns out that the presence of positive trend inflation makes our model analytically intractable, even under the simplifying assumption of indivisible labor that Ascari and Ropele (2009) impose to derive analytical results. Nevertheless, as we show below, our model reveals that unlike Ascari and Ropele (2009) the assumption of indivisible labor is not innocuous in the presence of trend productivity growth and nonseparability between consumption and leisure in the utility function (see, e.g., King et al., 1988a; Basu and Kimball, 2002; Guerron-Quintana, 2008).

This paper makes a contribution to the expanding literature, which builds on the important contribution of Bullard and Mitra (2002) and extends their analysis in several directions. For instance, Evans and Honkapohja (2003) consider the design of optimal monetary policy rules and show the importance of conditioning policy directly on observed private sector expectations while Honkapohja and Mitra (2005) examine the implications of heterogeneity in forecasting by the central bank and private agents for determinacy and learnability. In a model with money in the utility function Kurozumi (2006) analyzes how the timing of money balances matters for determinacy and learnability of Taylor type rules. Bullard and Schaling (2009) show how an open economy framework modifies the conditions for determinacy and learnability of equilibria depending on the exchange rate regime. Ascari and Ropele (2009) and Coiboin and Gorodnichenko (2011) study the implications of non-zero trend inflation for the determinacy properties of the New-Keynesian model while Kabayashi and Muto (2013) examine E-stability in the New-Keynesian model with non-zero trend inflation.

The paper is organized as follows. In Section 2 we discuss the key behavioral equations that are affected by the presence of trend productivity growth, while in Section 3 we compare the linearized model under zero trend inflation (Bullard and Mitra, 2002) to that under positive trend inflation (Ascari and Ropele, 2009). Then, in Section 4 we show the results of the paper pertaining to effect of trend productivity growth on the determinacy and learnability properties of the model. Finally, Section 5 gives concluding remarks.

2. The model

We introduce exogenous technological progress in labor productivity into the standard New Keynesian model in a way that is consistent with balanced growth (see, e.g., King et al., 1988a; Basu and Kimball, 2002).[4] In particular, the economy has a continuum of monopolistically competitive firms, each producing and setting the price of a differentiated consumption good. A typical firm's production function is of the form $Y_t = A_t N_t$, where A_t denotes aggregate labor productivity representing technological progress. Let $\Gamma_t \equiv A_t/A_{t-1}$ denote gross productivity growth rate and $\gamma_t \equiv \Gamma_t - 1$ the net growth rate of productivity. Following King et al. (1988b) and subsequent research we assume that log productivity follows a random walk with drift, which implies that the net growth rate is $\gamma_t = \gamma + \alpha_t$, where γ is the long-run growth rate and α_t is a productivity shock.[5]

The derivation of the key structural equations of the model is standard. We solve the households' consumption and labor supply decisions and firms' pricing decisions under Calvo-type nominal price rigidity and make use of market clearing conditions and aggregation constraints. In the presence of productivity growth and in a balanced growth path output, consumption, and real wages grow at the same rate as labor productivity, while aggregate hours is constant. Thus as in King et al. (1988a) we transform the growing economy into a stationary one by dividing all by the labor productivity. Below we present the key behavioral equations (see Appendix A for a detailed derivation).

[3] While we follow Bullard and Mitra (2002) and most of the literature in making the standard assumption of *Euler equation learning* (where agents make only one-step ahead forecasts) there is an alternative approach (sometimes termed *infinite horizon learning*) where agents are assumed to have infinite horizon behavioral rules (see, e.g., Preston, 2006).

[4] For a detailed discussion of the standard New Keynesian model see, e.g., Woodford (2003).

[5] For a more recent treatment of productivity growth see Muto (2013) and the references therein.