Money Growth Rules as Stabilization Policies in Open Economies

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Abstract

High degrees of relative risk aversion induces indeterminacy in cash-in-advance economies. This paper finds that endogenous money growth rules can pre-empt such sunspot equilibria. Moreover, aggressively backward-looking inflation targeting produces determinacy for every admissable value of relative risk aversion.

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1 Introduction

Cash-in-advance economies bear the potential of being subject to sunspot equilibria. Such real indeterminacy arises for weak degrees of intertemporal substitution (see for example Farmer, 1999) and implies that macroeconomic instability can arise in the form of self-fulfilling beliefs: people's non-fundamental expectations – i.e. beliefs that are unrelated to the economy's fundamentals – can affect allocations. These endogenous reallocations are welfare reducing. The present paper addresses the role of monetary policy in keeping these unwelcomed fluctuations at bay.

Low values of intertemporal substitution are empirically plausible. For example, Hansen and Singleton (1983) suggest that the coefficient of relative risk is between zero and two. Kocherlakota (1996, p. 52) states that values of the coefficient "above ten (or for that matter, above five) imply highly implausible behavior on the part of individuals".

The current paper develops a small open general equilibrium economy with flexible prices and endogenous monetary growth rules. It finds that monetary policy can be exploited to stabilize the economy. In particular, it demonstrates that self-fulfilling cycles can be pre-emptied by a backward-looking money-targeting in which the central bank aggressively represses inflation movements.

2 Artificial open economy

The economy is populated by atomistic and infinitely-lived households of measure one.[1] Money is introduced by imposing a cash-in-advance constraint on consumption purchases. All markets are perfectly competitive and prices are perfectly flexible.

The representative agent derives utility from the function

$$E_0 \sum_{t=0}^{\infty} \beta^t u(c_t, 1-h_t) \qquad u(.) \equiv \frac{c_t^{1-\sigma}}{1-\sigma} - h_t \qquad 0 < \beta < 1,\ \sigma > 0$$

where β denotes the subjective discount factor, c_t stands for the imported consumption good and h_t is labor supply. The coefficient σ measures the relative risk-aversion – the inverse of the elasticity of substitution between

[1] The model builds on Carlstrom and Fuerst (2002).

consumption at different dates. E_0 is the rational expectations operator. The budget constraint is given by

$$m_{t+1} + P_t b_{t+1} = m_t + W_t h_t + P_t(1+r)b_t - P_t c_t + n_t(R_t - 1) + \Pi_t$$

where P_t is the price level and W_t is the nominal wage. People hold wealth in three forms. They can arrange cash-holdings, m_{t+1}, which they carry into period $t+1$. They can also decide on buying foreign assets, b_t, which pay the constant real world-interest rate, $r = (1-\beta)/\beta$. Finally, they can loan cash, n_t, to financial intermediaries at the beginning of the period. These deposits earn the nominal interest R_t. I denote by Π_t the profit flow from (domestic) firms and intermediaries. A positive value is assigned to the inconvertible currency by assuming that during the shopping session the household is subject to the cash-in-advance-restriction

$$m_t + W_t h_t - n_t \geq P_t c_t.$$

Output is manufactured by firms with identical technologies:

$$y_t = e_t A h_t \qquad A > 0.$$

Domestically produced goods are sold abroad at the given real exchange rate e_t. I assume that the real exchange rate is taken as given: the economy is small relative to the rest of the world. Before hiring workers, firms must borrow cash at the short-term rate, R_t,from the financial intermediaries.

Intermediaries accept cash from the households, N_t,and receive injections from the central bank. Intermediaries use these resources to lend to firms. The loans must be repaid at the end of the period.

There is no government consumption. Nominal money supply, M_t^s, grows at the gross rate G_t:

$$M_{t+1}^s = G_t M_t^s$$

I assume that monetary policy targets inflation-movements, $\pi_t \equiv P_t/P_{t-1}$.[2] Policy is described by the time-invariant function

$$G_t = G(E_t \pi_{t+\tau}/\pi) \qquad G_t > \beta \nabla t.$$

Here π denotes the economy's steady state inflation rate. Policies that set $\tau = 0$ are coined current-looking. If $\tau = 1$ ($\tau = -1$), the policy is forward-looking (backward-looking).

[2]If I would assume GDP targeting, the results are the same as in Weder's (2004) closed economy.

3 Equilibrium dynamics

In the symmetric equilibrium, $M_t^s = m_t$ and $N_t = n_t$ must hold for ∇t. Then, the first-order conditions entail

$$E_t c_{t+1}^{-\sigma} \pi_{t+2} = \beta(1+r) E_t c_{t+2}^{-\sigma} \pi_{t+1}$$

$$c_t^{\sigma} = \frac{e_t A}{R_t}$$

and

$$E_t c_t^{-\sigma} \pi_{t+1} = \beta E_t R_t c_{t+1}^{-\sigma}.$$

Furthermore, the binding-versions of the cash-in-advance condition and the intermediaries' loan constraint

$$N_t + M_t^s (G_t - 1) = W_t h_t$$

yield the equilibrium version of the cash-constraint

$$E_t c_{t+1} E_t \pi_{t+1} = c_t E_t G_{t+1}.$$

After Taylor-approximating, the model reduces to equations that are set out below:[3]

$$E_t \widehat{R}_{t+1} = E_t \widehat{\pi}_{t+1}$$

$$\widehat{R}_t = -\sigma \widehat{c}_t$$

$$E_t \widehat{\pi}_{t+1} = \widehat{c}_t - E_t \widehat{c}_{t+1} + E_t \widehat{G}_{t+1} \tag{1}$$

and

$$\widehat{G}_t = \eta_\pi E_t \widehat{\pi}_{t+\tau}. \tag{2}$$

In equation (2), the policy's elasticity with respect to the inflation target is defined by

$$\eta_\pi \equiv \frac{G'(1)}{G(1)}.$$

[3]Of course, I assume that money growth does not approach its lower bound, thus the (potential) effects of nonlinearities are not the subject of the present paper. The first-order conditions are laid out in the Appendix.

3.1 Backward-looking targeting

If the central bank follows a backward-looking policy, i.e. $G_t = G(\pi_{t-1}/\pi)$, the artificial economy boils down to the linear difference equation

$$E_t\widehat{\pi}_{t+1} = \frac{1-\sigma\eta_\pi}{1-\sigma}\widehat{\pi}_t.$$

Real indeterminacy arises if

$$\left|\frac{1-\sigma\eta_\pi}{1-\sigma}\right| < 1.$$

Then, deterministic dynamics are no longer unique and it becomes possible to construct equilibria which are driven by i.i.d. sunspot shocks ω_{t+1}:

$$\widehat{\pi}_{t+1} = \frac{1-\sigma\eta_\pi}{1-\sigma}\widehat{\pi}_t + \omega_{t+1} \qquad \omega_{t+1} \equiv \widehat{\pi}_t - E_t\widehat{\pi}_{t+1}. \tag{3}$$

Equation (3) defines a Markov process associated with a sequence of probability distributions from which random variables, $\widehat{\pi}_t$, are drawn. Multiple rational expectations solutions imply that self-fulfilling changes in people's expectations matter. But hang on. Does monetary policy have the potential to repulse the influence of non-fundamental expectations?

The following results emerge. Figure 1 shows parametric indeterminacy (I) and determinacy (D) regions when monetary policy is backward-looking. Endogenous sunspot fluctuations arise for $\sigma > 1$. These fluctuations can be pre-emptied by setting $\eta_\pi > 1$ or $\eta_\pi < (2-\sigma)/\sigma$. That is, sunspot situations that have been identified by Farmer (1999) arise in small open economies as well, however, monetary policy can remove their existence. Yet, there exists another indeterminacy region at large values of intertemporal substitution, i.e. $\sigma < 1$. This region is given by

$$1 < \eta_\pi < \frac{2-\sigma}{\sigma}.$$

This sunspot zone involves supportive accommodations of inflation rates which brands them somewhat implausible. One can identify one monetary strategy, however, for which endogenous fluctuations can successfully be set upon for every possible degree of risk aversion. Note that

$$\lim_{\sigma\to\infty}\frac{2-\sigma}{\sigma} = -1,$$

thus, self-fulfilling cycles can be pre-emptied by a backward-looking money-targeting in which the central bank stands up aggressively against inflation movements, i.e. $\eta_\pi < -1$.

What are the economics behind a successful policy? The real indeterminacy in the case-in-advance model comes about as follows. Suppose that people increase current consumption without any cause other than believing that it is correct to do so. The consumption binge implies an increase in the expected inflation rate which decreases future consumption (see Equation 1). Unless the intertemporal elasticity of substitution is high – i.e. risk aversion is low – the fall in future consumption does not spawn a meaningful enough force on today's consumption to overthrow the initial beliefs. However, once the central bank targets inflation, the supply of money (and the nominal interest rate distortions) adjusts to the incipient sunspot belief. The initial sunspot-caused movement in consumption is coupled with a reaction of inflation that eliminates sunspot equilibria by destabilizing the economy (see again Equation 1). Quite interestingly, my analysis does not pin down the direction of monetary policy: all that matters for uniqueness is that the central bank's reaction to changes in the economy is considerably forceful. However, a caveat to this finding does exist: the policy's success crucially depends on the central bank's ability to control money aggregates. Otherwise the monetary authority may run into trouble similar to that experienced by the *Federal Reserve* in the early 1980s; even the otherwise celebrated record of the *Bundesbank* shows 11 misses out of the 24 targets for monetary growth the central bankers announced.

3.2 Current-looking targeting

Current-looking policies imply the following dynamics of the artificial economy

$$E_t\widehat{\pi}_{t+1} = \frac{1}{1-\sigma+\sigma\eta_\pi}\widehat{\pi}_t.$$

Determinacy requires that

$$\frac{\sigma-2}{\sigma} < \eta_\pi < 1.$$

As will become clear from Figure 2, current-looking rules are not attractive when it comes to taming endogenous fluctuations. In contrast to the

backward-looking case, exact knowledge of the degree of intertemporal substitution is compulsory for policy advice. Moreover, for large values of σ, the admissable set for the policy parameter is very small and inexact estimations of σ may lead to unwanted consequences, i.e. policy-induced cycles.

3.3 Forward-looking targeting

Forward-looking rules transform the economy into

$$E_t\widehat{\pi}_{t+2} = \frac{\sigma - 1}{\sigma\eta_\pi} E_t\widehat{\pi}_{t+1} + \frac{1}{\sigma\eta_\pi}\widehat{\pi}_t. \tag{4}$$

Since the functional difference equation (4) contains two non-predetermined variables, indeterminacy requires that both roots are inside the unit circle. Figure 3 summarizes the stability-space.[4] In a sense, forward-looking policies share the negative implications of current-looking rules: no secure policy advice that pre-empts sunspots for every possible value of σ exists.

4 Summary

Nominal money growth rules that react endogenously to macroeconomic activity are able to eliminate sunspot equilibria. This is shown within a cash-in-advance model in which the source of indeterminacy are preferences, i.e. certain degrees of relative risk aversion. I find that the best pre-emptive strategy comprises an aggressive money supply policy that inversely targets past inflation movements: sunspot equilibria can be curbed effectively whatever the size of the source of the original instability.

References

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[4] There exists a discontinuity at $\eta_\pi = 0$ since at this point (4) reduces to

$$E_t\widehat{\pi}_{t+1} = \frac{1}{1-\sigma}\widehat{\pi}_t$$

which replicates the Farmer (1999) indeterminacy-conditions.

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