

Introduction: Monetary Policy and Capital Accumulation

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Abstract

The papers in this symposium address the issue of multiple equilibria that can be induced by monetary policy in models with capital accumulation. In particular they examine how the “Taylor Principle,” under which interest rates respond more than proportionately to increases in inflation, can generate multiple equilibria. They also explore the design of policies to avoid the problem of multiple equilibria and indeterminacy.

Keywords: Taylor rules, multiple equilibria, indeterminacy, capital accumulation.

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The last 10 years have witnessed an explosion in the theoretical analysis of monetary models in which the central bank uses the short term interest rate as the policy instrument. One branch of this literature is concerned with the issue of equilibrium determinacy. The logic of this concern is that a necessary condition for a good policy rule is that it not introduce the possibility of non-fundamental or sunspot fluctuations. These analyses have typically been done in models without capital or investment. A familiar result of these papers is that if monetary policy satisfies the “Taylor Principle,” that is interest rates respond by more than one for one with increases in inflation, then equilibrium multiplicities are not likely to arise.

Dupor (2001) was the first to incorporate capital and endogenous investment into the above models and analyze the conditions necessary for determinacy. In sharp contrast to a labor-only economy, Dupor demonstrated that a necessary condition for determinacy is that the monetary policy rule be *passive*, that is, interest rates must respond by *less* than one for one. In Dupor's analysis, monetary policy rules that satisfy the Taylor Principle may lead to either indeterminacy, or to over-determinacy, i.e., no stationary equilibrium.

Dupor's analysis was done in a continuous-time model. This, however, was not thought to be important since the earlier models that ignored investment spending were done in both continuous and discrete time with comparable determinacy results. The first paper in this symposium revisits Dupor's analysis in a discrete time framework. In sharp contrast to Dupor, Carlstrom and Fuerst show that in a model with endogenous investment, a necessary condition for determinacy is that the Taylor Principle must be

satisfied. As long as prices are not extremely sticky, they show that current-looking rules that satisfy the Taylor Principle generate equilibrium determinacy. Unlike both Dupor and the corresponding labor-only model, Carlstrom and Fuerst show that responding to expected rather than current inflation creates indeterminacy.

Carlstrom and Fuerst go on to show why Dupor's continuous time framework and their discrete time model yield diametrically different results. The key lies in the different Euler equations for investment in the two models. In continuous time, the marginal productivity of capital *today* must equal the instantaneous interest rate. With discrete time, the marginal productivity of capital *next period* must equal the interest rate. Since capital is predetermined, there is an extra predetermined variable in the continuous time model that does not appear in the discrete time model. Carlstrom and Fuerst argue for the discrete time modeling approach since there are several important implicit assumptions that are unwittingly being made when working in continuous time.

Both Dupor and Carlstrom and Fuerst assumed an economy wide rental market for capital so that capital can flow across firms leading to a common capital-labor ratio across firms. This assumption is not innocuous. With a fixed aggregate capital stock, Woodford (2003) shows that if capital is firm-specific, the economy behaves as if prices are much more sticky than if capital were mobile as in the rental market assumption. The logic is straightforward. In a model with sticky prices, a monetary expansion forces those who cannot adjust their prices to produce more. If there is a common rental market, this increased production drives up the marginal cost of all firms, leading those who can adjust prices to raise their prices in response to this higher marginal cost. In a model with

firm-specific capital, this marginal cost channel is absent so that the firms who can move their prices are less inclined to do so.

In this symposium, Sveen and Weinke overcome some important technical difficulties and extend the assumption of firm-specific capital to a model with endogenous investment. The basic intuition of Woodford survives the addition of investment, i.e., the implicit degree of price stickiness is higher in a model with firm-specific capital. This effect is quantitatively important. For example, a model with firm-specific capital and an average price rigidity of 4 quarters has the same degree of price stickiness as a model with a rental market and 10 quarters of average price rigidity. Sveen and Weinke demonstrate that with firm-specific capital, the implied stickiness is enough to eliminate the possibility of equilibrium indeterminacy for these policy rules. This then overturns Carlstrom and Fuerst's conclusion on the efficacy of current-based Taylor rules.

While Sveen and Weinke indicated that the regions for indeterminacy are greater than Carlstrom and Fuerst appreciated, the paper by Benhabib and Eusepi show that even if you cross into the region of local uniqueness you have multiple equilibria globally. The possibility for multiplicities is much greater than these other papers appreciated because these papers only considered local determinacy conditions. If you look at the global rather than the local picture, the model of Carlstrom and Fuerst could still exhibit multiple equilibria. As you decrease the amount of price stickiness and switch into the locally determinate region, other non-stationary equilibria are bifurcating, very much like they are in models without capital. Benhabib and Eusepi also generalized the model to

include bonds, and the potential for distortionary taxes. Either bonds and/or capital are sufficient to produce the possibility of these global bifurcations.

In summary, the papers in this symposium all show that monetary policy rules that satisfy the Taylor Principle may not be sufficient to guarantee uniqueness. Carlstrom and Fuerst demonstrate the danger of forward-looking rules. Sveen and Weinke conclude that even current-looking rules can be dangerous because firm specific capital makes the economy behave as if prices are extremely sticky. Finally Benhabib and Eusepi show that local determinacy is far from sufficient for global determinacy. Sveen and Weinke and Benhabib and Eusepi, however, suggest one possibility of solving this problem. Both papers demonstrate that an interest rate rule that responds to inflation and output can dramatically reduce the possibility of these multiplicities, both locally and globally. Whether this result is robust remains to be seen. But all of three papers in this symposium cast doubt on the hypothesis that the Taylor Principle is sufficient for equilibrium determinacy.