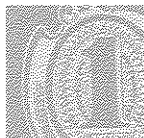


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Commentary

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Glenn Hubbard's paper considers what is perhaps the most basic question in monetary economics: How does monetary policy "work"? It suggests that informational frictions affecting capital markets create additional mechanisms—beyond those of conventional textbook models—through which monetary policy operates. In particular, Hubbard suggests that "realistic models of financial constraints on firms' decisions imply potentially significant effects of monetary policy beyond those working through conventional interest rate channels." Now I personally feel that there are a number of serious issues about what these "conventional interest rate channels" are,¹ but that takes us beyond the scope of the present paper. So, for the purpose of discussion, let's imagine that we accept that there are such channels,² and consider how the presence of financial constraints impacts the scope for monetary policy to have other effects.

As the previous quotation suggests, there ought to exist models in which there are informational (or other) frictions affecting firm investment decisions, and in which there is scope for monetary policy to operate. This requires a model with—at a minimum—money, capital and a credit market friction. Moreover, I would argue that an interesting model for analyzing the role of monetary (or other) policies in an economy with a financial market friction should be a general-equilibrium model, since we would like to know the answers to at least two questions: not only

- (1) What *can* monetary policy do? but also,
- (2) What *should* monetary policy do? (That is, what are the welfare implications of alternative methods of conducting monetary policy?)

While the Hubbard paper cites any number of references on financial market imperfections and their effects on firm investment behavior, to my knowledge *none* of the papers he cites presents a general-equilibrium model of an economy with money, capital and a credit market friction. So, at this point, I have the following questions:

- What are the models of financial constraints implying these magnified effects of monetary policy (presuming, of course, the need for general-equilibrium models)?
- What are the implications of these models for the effects (and welfare consequences) of various methods for conducting monetary policy?

The Hubbard paper comes in two parts: Its appendix contains a suggestive model of a single firm undertaking credit-financed investment, subject to a moral hazard problem, along with a proposed list of empirical implications derived from the literature that the model represents. The text of the paper presents a discussion of the empirical literature on how monetary policy does (or can) affect the investment behavior of individual firms. To a large extent, I very much like both the model of the paper and the discussion of the empirical evidence. I do think, however, there is a serious question about how these two parts of the paper fit together. Let me therefore add to my list of questions:

- If we do have general-equilibrium models of capital accumulation in the presence of money and financial market frictions, what do these models imply about the consequences of various monetary policy actions?
- What is (or could be) the empirical evidence on these implications?
- How does the empirical evidence discussed in the Hubbard paper bear on them?

Before proceeding to a discussion of these issues, let me say that I intend to focus my discussion most where the Hubbard discussion focuses least—on the theoretical aspects of monetary growth models with

¹ For example, some monetary models give rise to Modigliani and Miller's theorems for open market operations. These theorems state conditions under which open market activity has *no* implications for interest rates, or anything else. For a discussion of such theorems, and their empirical relevance, see Wallace (1981), Chomley and Polemarchakis (1984), Sargent (1982, 1987), Sargent and Smith (1987) or Smith (1994).

² The issue in the literature discussed in footnote 1 is: Under what conditions would there be such channels? That literature suggests that these channels exist only if policy is conducted in a way which is intentionally redistributive.

informational frictions. In large part, this is because Glenn is a pioneer in, and a major continuing contributor to, the empirical literature on these topics, and his discussion of this literature is thoughtful and easy to follow. Thus, while admitting Glenn may have absolute advantage along both dimensions, considerations of comparative advantage suggest that I should primarily concentrate on theoretical issues.

The Hubbard paper identifies three common implications of the models he has in mind, and which he identifies with the credit view:

1. "Uncollateralized external finance is more costly than internal finance.
2. "The spread between the cost of external and internal funds varies negatively with the level of the borrower's internal funds.
3. "A reduction in internal funds reduces the borrower's spending, holding underlying investment opportunities constant."

While the discussion on these points is somewhat vague, from my knowledge of the literature I take these to be partial equilibrium results that apply to a particular borrower, holding aggregate conditions fixed. What monetary growth models exist, then, that would deliver these as implications at the level of an individual firm?

To my knowledge, there is exactly one such model—that of Boyd and Smith (1994). Let me sketch the main features of this model and then describe its implications for the kinds of issues that come up in the Hubbard discussion.

The Boyd and Smith model uses as its basic framework the neoclassical growth model of Diamond (1965), which allows for outside assets in a general-equilibrium model of capital accumulation. The Diamond model is a two-period, overlapping-generations model in which all agents supply one unit of labor inelastically when young, earning the prevailing real wage rate. These agents are retired when old. They save for old-age retirement by accumulating either capital or money (or, more generally, outside assets).

Capital accumulation in the Diamond model—as in most traditional monetary growth models³—is a "black box"; one unit

of consumption foregone today becomes one unit of capital after one period. And, again as in traditional monetary growth models, there is no role for banks or other financial market institutions.

Boyd and Smith modify the Diamond model to allow for two classes of agents in each generation. One class of agent has access to a stochastic linear technology for converting current goods into future capital, the other type does not. In all other respects, the two types are identical.

The capital production technology considered by Boyd and Smith is subject to a standard costly state verification (CSV) problem of the type considered by Townsend (1979) and, more specifically, Gale and Hellwig (1985), Williamson (1986, 1987) and Bernanke and Gertler (1989). As is conventional in such models, each operator of the capital production technology must produce at some fixed, indivisible scale. Thus, to finance capital investments, young investors must combine their own young period income, along with funds obtained externally.

Under the assumption of risk-neutral firms and fixed verification costs, this setup yields an optimal capital structure and financing arrangement for firms producing capital goods. Such firms should be (completely) debt-financed, and it is efficient for them to borrow from financial intermediaries. Presumably this captures the notion of "bank-dependent borrowers" discussed by Hubbard. Moreover, this model would produce, at the individual firm level, the three key results of models that Hubbard associates with the credit view.

In this model, the amount of internal finance provided by investors is endogenous, depending on the young period wage income of borrowers. Internal finance is valuable because it helps to mitigate the CSV problem. In addition, as in Gale and Hellwig (1985) and Williamson (1986, 1987), the presence of the CSV problem permits credit rationing to be observed for exactly the reasons discussed by Stiglitz and Weiss (1981): Because of the costs of verifying project returns when borrowers default, raising the interest rate charged on loans affects a lender's expected return in a non-monotonic fashion. Thus,

³ See, for instance, the models of Sidrauski (1967 a,b), Brock (1974) or Tirole (1985).

the interest rate charged on loans can be “bid up” to a level that maximizes the expected return to a lender; thereafter, increases in the interest rate reduce a lender’s expected return and are counterproductive. As a result, if the demand for credit exceeds its supply and interest rates are raised to their expected return maximizing level, there is no action that an unfunded (or rationed) borrower can take to obtain a loan. This presumably maximizes the scope for monetary factors to “matter,” since availability of credit becomes an issue of central concern.

Boyd and Smith consider the situation where credit is rationed, and examine the following policy regime. The monetary authority fixes, once and for all, a rate of money growth. In the Diamond model, the fixed rate of money growth determines the steady-state real rate of interest. This formulation gives the Hubbard analysis its best case scenario, parenthetically, since it allows the monetary authority—at least potentially—the power to control real interest rates directly.⁴

The Boyd and Smith modification of the Diamond model is, superficially, very minor. But it has dramatic implications for the properties of monetary equilibria in the Diamond model. Most of these implications are, I think, bad news from the standpoint of the kind of analysis conducted in the Hubbard paper, although there is one piece of good news. I will now review some of the relevant implications.

THE BAD NEWS

Traditional monetary growth models have the property that there is a unique monetary steady-state equilibrium, which is a saddle. Thus, one can unambiguously identify *the* monetary equilibrium of such a model, and can unambiguously discuss the effects of monetary policy actions on the equilibrium. The kind of model that Hubbard apparently has in mind may, however, have multiple equilibria, and multiple possible effects of a monetary policy action.

The Boyd and Smith model has (typically) two monetary steady state equilibria. It can easily transpire that one is a sink and one is a saddle, so both can be approached. Thus, there is a continuum of monetary equilibria.

The effects of a monetary policy action depend—very strongly, as it turns out—on which equilibrium path the economy is following. Moreover, for some parameter configurations there exist equilibria which approach no steady state; that is, limit cycles can be observed. Changes in monetary policy can change the entire set of equilibria, creating scope for equilibria that did not exist under other configurations of policy.

These possibilities are of some interest from a theoretical perspective. They imply that the interaction of policy choices with the operation of financial markets subject to frictions creates a scope for the indeterminacy of equilibrium and for “excessive fluctuations,” a point emphasized by Simons (1948) and Friedman (1960). However, they also imply that there is no unique answer to the question: How do credit channels affect the consequences of monetary policy?

Why do credit market frictions create indeterminacies and render questions about their effects on policy actions problematic? The answer has to do with exactly the feature most emphasized by Hubbard: the importance of internal finance, and the fact that the ability to provide internal finance is going to be (at least partly) endogenous in a general equilibrium model. In the Boyd-Smith model, the monetary authority controls the real rate of interest (at least in steady-state equilibria). Borrowers are then forced to deliver this policy-determined real rate of return on funds they obtain. In a steady-state equilibrium, there are typically two ways to do this. One is to have a low capital stock, a correspondingly high marginal product of capital, and low incomes (low levels of internal finance). The other is to have a high capital stock, a correspondingly low marginal product of capital, and high incomes enabling borrowers to provide a lot of internal finance. Since internal finance mitigates the CSV problem, it offsets the low marginal product of capital and permits borrowers to offer lenders the necessary expected return.

The key element in this analysis, of course, is the endogeneity of the amount of internal finance. Once this is endogenous, models representing what Hubbard calls the credit view cannot generally be expected to deliver

⁴ Notice that this does not require the existence of any nominal rigidities, as Hubbard asserts.

unique equilibria, and questions about “the effects” of monetary policy will not be well-posed.

To underscore this point, a monetary expansion in the Boyd and Smith model (a higher rate of money growth) increases the capital stock, output, and credit extension in the low-capital-stock steady state. All of these effects are reversed in the high-capital-stock steady state.

SOME GOOD NEWS AND SOME BAD NEWS

The good news is that—in the low-capital-stock steady state, where expansionary monetary policy actions are actually expansionary—the Boyd and Smith model predicts that capital market imperfections will enhance the effects of a given change in monetary policy. In particular, a given change in the rate of money growth has a larger effect on output in the presence of the credit market friction than is the case under full information. In this sense, one prediction of the credit view is borne out.

However, even this effect does not occur for the reasons discussed by Hubbard. According to his analysis,

“...the crux of models of information-related financial frictions is a gap between the cost of external and internal finance for many borrowers. In this context, the credit view offers channels through which monetary policy can affect this gap.”

In the Boyd and Smith model, monetary policy can have heightened effects, but not because it affects the differential between the cost of internal and external funds in this way. Indeed, it is possible to show that, in the steady state equilibria they examine, monetary policy cannot affect this differential (appropriately defined). Nonetheless, in one of their steady state equilibria, credit market frictions do magnify the impact of monetary policy.

EMPIRICAL IMPLICATIONS

Since the credit view applied to monetary models seems prone to delivering multiple

equilibria, any discussion of its empirical implications must confront the difficulties associated with the empirical analysis of models displaying multiple equilibria. This is a difficult issue, and one that I am not currently prepared to take on. However, Hubbard argues that the money and the credit views have the following implications:

“When informational imperfections are ignored, an increase in real interest rates following a monetary contraction should affect investment (broadly defined) similarly for borrowers of a given type (for example, with similar technology and risk characteristics).⁵

“If informational imperfections are significant only on the borrower side, all else equal, spending by borrowers with lower levels of internal net worth should fall relative to spending by borrowers with higher levels of net worth.⁶

“The model’s intuition can apply to banks as well as non-financial borrowers. A decline in banks’ net worth raises banks’ opportunity cost of external funds (say in the CD market). As a result, the cost of funds to bank-dependent borrowers rises.”

I am not sure what the practical empirical content of the first implication is likely to be, since we do not typically observe the technological characteristics or demand conditions of individual firms directly. I am also unclear as to why borrowers with similar net worth cannot be affected differentially by monetary policy under the credit view. (This is, in fact, what happens in the Boyd and Smith model.) And, indeed, it is easy to produce certain kinds of counter-examples to the second claim in models that seem perfectly consistent with the credit view.⁷ Finally, credit-view models, like Williamson’s (1987), tell us that the effects of increases in the costs of external funds can depend very heavily on the nature of how interest rates are determined. In particular, the “incidence” of higher costs depends heavily on whether credit is rationed, on the interest elasticity of the supply and the demand for funds, and so on. It is therefore not clear to me why it follows that an

⁵ This implication applies, of course, to the money view.

⁶ This implication applies under the credit view.

⁷ For example, the Boyd and Smith model can easily be modified to allow for borrowers with different levels of net worth. In that model, increases in interest rates will affect only the spending of marginal borrowers (who, in many data sets, would then disappear from the sample). Changes in interest rates would not affect infra-marginal borrowers. This point is illustrated, for example, in the model of Ma and Smith (1993).

increase in the costs of external funds for banks must be borne by borrowers.

In short, it is not transparent that there exist any sharp empirical hypotheses distinguishing the money view from the credit view at the firm level. Perhaps we are best advised to take seriously the notion that the credit view predicts the possibility of multiple equilibria, with some equilibria displaying endogenously enhanced volatility and to pursue the empirical implications of that idea.

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