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The Role of Money in New-Keynesian Models

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1. Introduction

This is an interesting topic and can possibly be discussed in a way that may be understandable widely and yet be of interest to central bank monetary economists. For the non-economists, I should mention that New Keynesian (NK) models typically do not even refer to money!

Before 1993 academic economists modeled and thought of monetary policy in terms of growth rates of money supply—quantity of money. There were different measures used for different purposes but most academic studies focused on some measure of money (M), and viewed monetary policy as control of M_t. The policy effects were often described in this way: if the central bank increases the amount of money in the economy it spurs spending: people need only so much money to carry out their spending activities conveniently. So if more is supplied they will want to lend some of it and these offers will push interest rates down, inducing others to borrow and spend more than otherwise.

Economists from the central bank thought of monetary policy in terms of interest rates. For them, easy money was not a rapid growth rate of some M but instead a low value of some key interest rate—which would push other rates lower and induce more spending.

Thus there was not much fruitful interaction between the economists from the central bank and academics. One could look at a research paper and tell which type of economist had written it. Today that is not the case; research papers by the economists from the central bank and academic economists are indistinguishable. Both assume interest-rate control.

This change came about during 1990s and was catalyzed by Taylor (1993). Taylor proposed a very simple formula to be used to determine quarterly settings of the US Federal Funds (FF) rate:

$$r = p + 0.5y + 0.5(p - 2) + 2$$

where r is the FF rate in annual percentage points, p is the inflation rate in annual percentage points, and y is the output gap, in percentage deviation of real GDP from "natural" levels. In this equation, the "inflation target" is 2 and the estimated average real rate is 2.

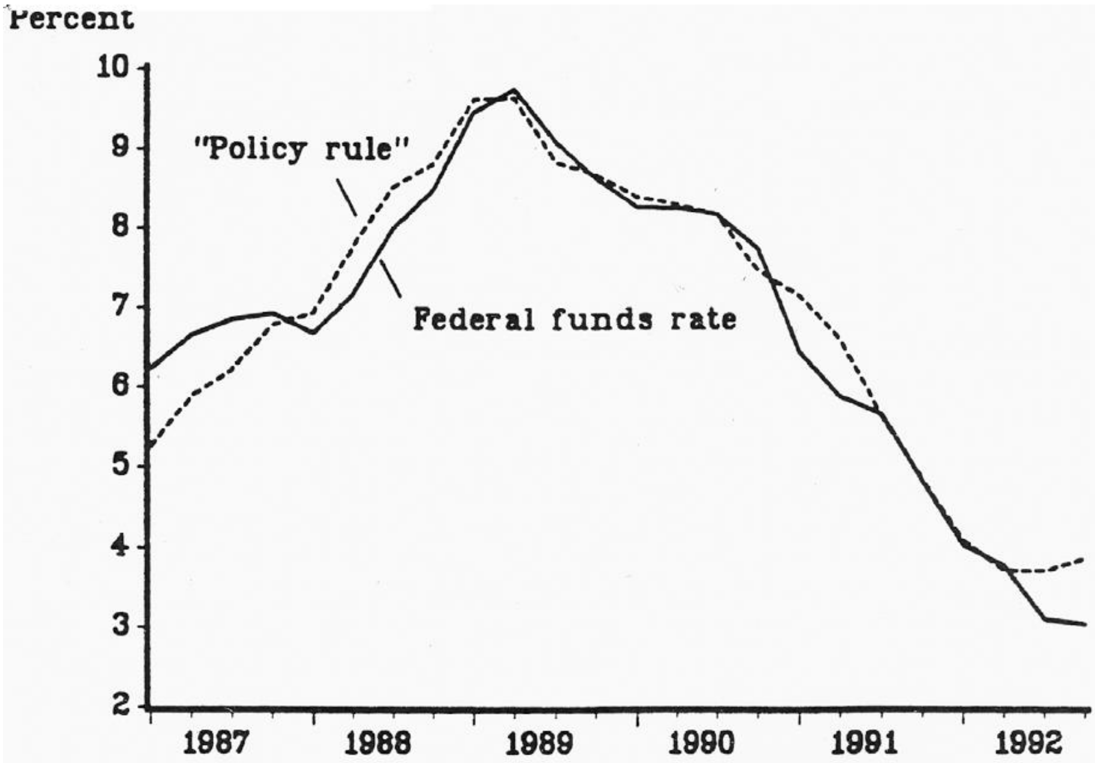
So if the actual inflation rate was 4 and output was 3% above natural, then the rule-proposed setting for r would be 8.5, for a real rate of 4.5. If instead, $y = 0$ and $p = 2$, would have $r = 4$ and $r - p = 2$.

That proposed rule is simple and would not alone have been enough to make his proposal persuasive, but he attached the following figure (see Figure 1):

From Figure 1 we see that the actual path of the Fed Funds rate closely matched the rule-designated values over the years 1987-1992. This is relevant because it was generally believed (ex post) that monetary policy had been just about right over these years, even in the face of the stock market collapse of October, 1987. Therefore central bankers, who had been militantly opposed to any idea of conducting policy in accordance with a rule, were led to see that the idea might not be crazy.

At the same time, Taylor's paper argued that it might be useful to discuss rules for setting interest rates, rather than money growth rates, since central bankers did in fact behave in that manner—and this rule would make sense since it called for adjustments in the *real* rate of interest to fight against high inflation and below-capacity production: $(r - p) - 2 = 0.5y + 0.5(p - 2)$.

Figure 1



Note: Federal funds rate and example policy rule.

Source: Taylor (1993).

I believe that Taylor's paper (and offshoots of it) had a major sociological effect of bringing central bank and academic economists together.

2. New Keynesian Models

What does this have to do with "New Keynesian"? Well, that term had come to be used to refer to models (for monetary policy) that have:

(i) Sticky prices (so monetary policy has major temporary effects on output)

(ii) Optimizing behavior by agents (so the model is "structural")

(iii) Policy implemented by interest-rate rule (to be realistic).

There were several influential papers using this terminology. I recall especially Clarida, Gali, and Gertler (1999) partly because I tried to convince Gertler that this label was misleading—that these models were more like monetarist models of the 1970s than Keynesian models! But they are Keynesian in that there is a short run "Phillips Curve"

(PC) tradeoff implied by (i). And they are "New" because the PC specification is such that there is no "long run" tradeoff (not quite true).

Optimizing behavior in (ii) above refers to Calvo sticky price specification but also to the demand side—i.e., the savings vs. consumption decisions of households (and firms in larger versions). A small but useful version is a three-equation model such as:

(IS) $y_t = b_0 + E_t y_{t+1} + b_1(R_t - E_t \Delta p_{t+1}) + v_t$

(PC) $\Delta p_t = \beta E_t \Delta p_{t+1} + \kappa(y_t - \bar{y}_t) + u_t$

(MP) $R_t = (1 - \mu_3)\left[(1 + \mu_1)\Delta p_t + \frac{\mu_2}{4}(y_t - \bar{y}_t)\right] + \mu_3 R_{t-1} + e_t$

This type of model was used frequently to study the general properties of larger models that would be needed for actual quantitative analysis by the economists from the central bank, with the work of Woodford (2003) and Clarida, Gali, and Gertler (1999) being very influential. [Here y_t and p_t are fractional deviations from steady state.]

To use such a model for policy analysis the idea is to make empirical studies to get a good idea of the magnitude of the parameters b_0, b_1, β, κ and the properties of the random disturbance terms v_t, u_t, and e_t to be used for experimentation (or optimization analysis) to find what values of the policy parameters μ_1, μ_2, μ_3 would yield outcomes for y_t and Δp_t that are perhaps close to optimal or at least desirable in terms of the central banks and the society's preferences. This might be done by optimization or by simulation studies.

3. Is Neglect of Money OK?

Now we come to the issue in the paper's title. Is it adequate to use this type of model for monetary policy analysis, when the model being discussed does not even include, as one of its variables, any measure of the quantity of money? Several economists with "monetarist" leanings have suggested that by omitting any role for money—the economy's medium of exchange—these models are inadequate for study of this basic problem (for which they were designed!).

The specification that both monetarists and New Keynesians would have taken as a reasonable depiction of money demand (MD) was of the form:

(MD) $m_t - p_t = \gamma_0 + \gamma_1 y_t + \gamma_2 R_t + e_t$

with $\gamma_1 > 0$ and $\gamma_2 < 0$, and the type of policy rule that monetarists would favor could (for example) be of the form:

(MS) $\Delta m_t = \theta_0 + \theta_1 m_{t-1} + \theta_2 (y_t - \bar{y}_t) + \theta_3 \Delta \mathrm{p}_t + e_t$

so that the growth rate of the money supply is related to the inflation rate and the output gap, with θ_2 and θ_3 both presumably negative. Thus the traditional approach would have been to use a system including a money supply (MS), a MD, an IS, and a PC to choose parameters of MS so as to obtain desirable behavior of m_t, p_t, y_t, and R_t. Instead, the NK approach used only MP, IS, and PC to manage the behavior of R_t, p_t, and y_t. So, the issue is whether anything is lost by the latter.

The argument of the NK proponents is as follows. In fact, almost all central banks do in fact conduct policy by deciding upon and setting interest rates as in the IS, PC, MP scheme, i.e., without explicit reference to the behavior of Δm_t. In that case, there is nothing lost by using only the three equations, for then adding MD to the system would do nothing except specify how much money would be supplied in the process of setting the interest rates already decided upon.

A potential flaw in that argument concerns the specification of the model's IS relationship. For the intellectual basis for the money demand function MD is that money held by households and firms, even when it pays no interest to its holders (who could instead be holding interest-bearing bonds) because it provides transaction-facilitating services to its holders (for example, they can pay with the means of exchange, MOE, without having to make arrangements for a credit transaction.) Thus the models at hand involve some specification of the transaction costs that money-holding helps to reduce. There will be some cost function such as $\psi(c_t, m_t)$ with $\psi_1 > 0$ and $\psi_2 < 0$ where c_t is consumption spending and m_t is real money balance at the start of t. This cost will appear in the budget constraint of private agents. This being the case, the extent of these costs will be relevant in the household's spending decisions that lead to the equation denoted IS. So why doesn't the IS include some dependence on m_t? The answer is that the IS will include a term involving m_t unless the function ψ is *additively separable*, and there is no good reason for believing that it would be.

Therefore, this crucial feature of NK models—that the quantity of money plays no role in the three-equation system (IS) - (PC) - (MP) is in principle incorrect. In principle, one needs to include m_t in the policy analysis.

Why is this not widely recognized? Well, it probably is realized by those who do research in the area—but is ignored because the quantitative significance of including m_t (and another equation) in the model would be very small. I published a paper in 2001 showing that this was the case—to my disappointment—according to my study. Similar results were obtained by Ireland and especially in Woodford (2003).

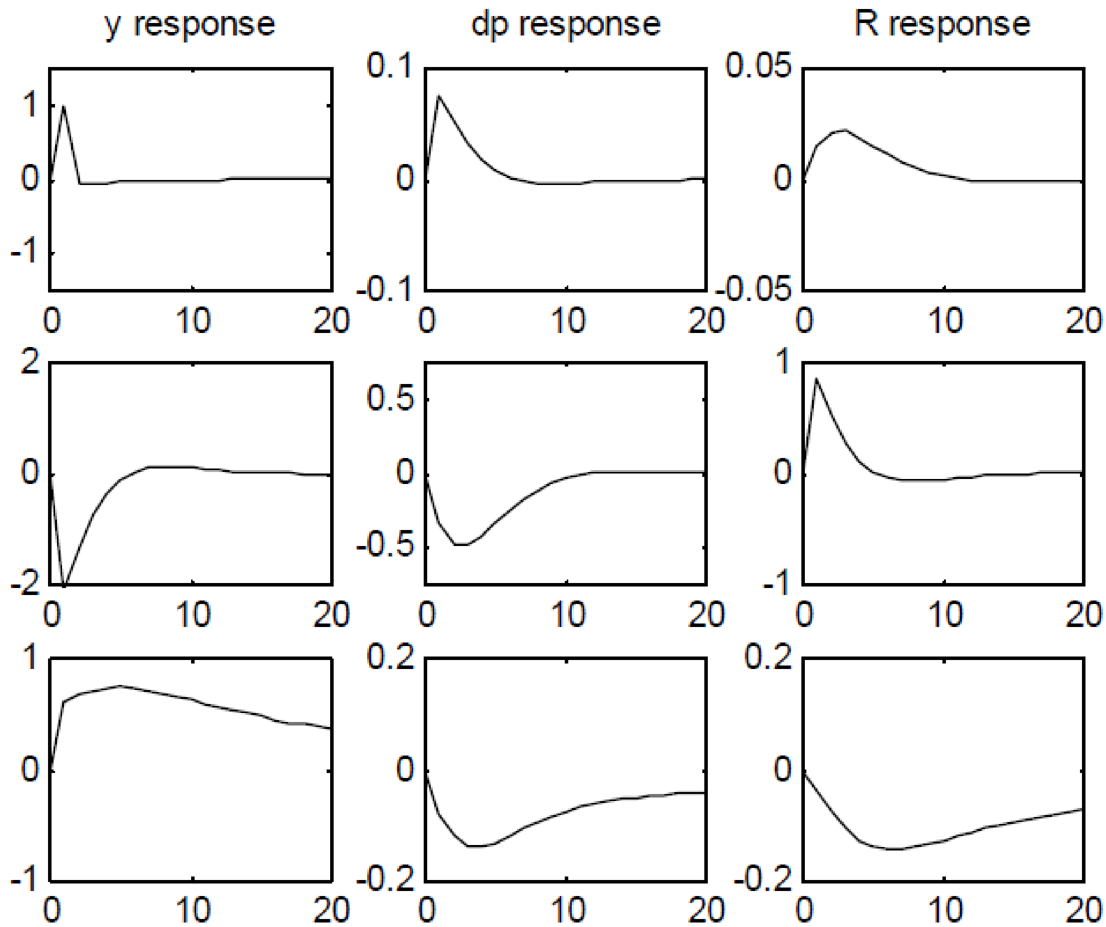
Thus we reconsider the model but with $\psi(c_t, m_t)$ in the budget constraint. Term such as $\log m_t - E_t(\log m_{t+1})$ appears in the IS unless $\psi(c_t, m_t)$ is separable (unlikely). In McCallum (2001) we specify $\psi(c_t, m_t) = c_t a_1 (c_t/m_t)^{a_2}$ and derive system but now including a function for money demand, as well as having the different property of the expectational IS function. Calibrate, get 0.017 for coefficient on $[\log m_t - E_t(\log m_{t+1})]$.[1] To determine whether this magnitude is large enough to be of importance, we can compare the model's impulse response functions, in cases with the

[1] In McCallum (2001), this parameter is denoted b_3.

coefficient set at 0.017 and at zero. Doing so results in the impulse – responses reported in Figures 2 and 3. They are clearly almost identical.

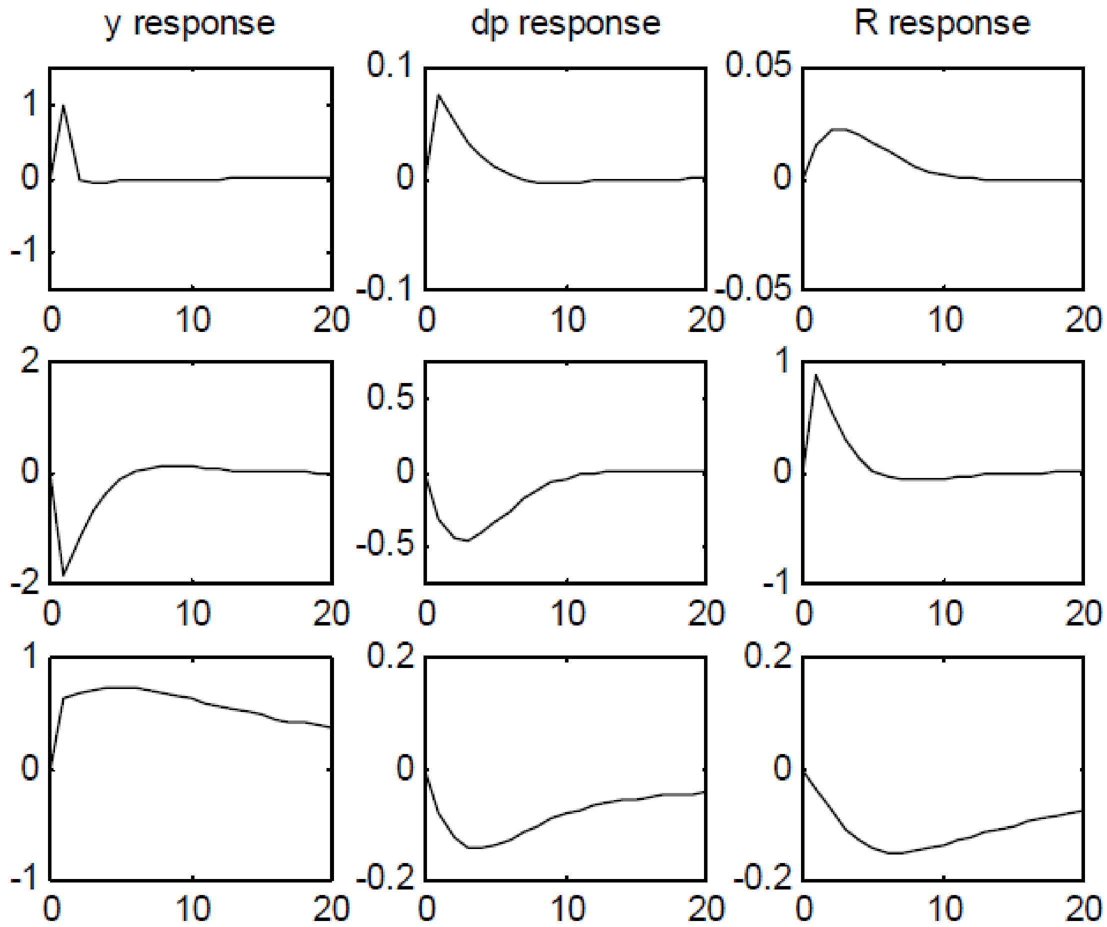
Thus it seems that neglect of this term is probably justified. More significantly, Woodford's hugely influential book of 2003 showed in several ways that the effect of including money would probably be negligible. This position has been dominant since 1999.

Figure 2



Note: Unit shock to IS (top raw), policy rule (middle raw), and technology with money ($b_3 = 0.017$).

Figure 3



Note: Unit shock to IS (top raw), policy rule (middle raw), and technology with money ($b_3 = 0.0$).

4. Richer Model

It has been argued, however, that this conclusion results from the bare-bones simplicity of the models described above and, in particular, by their neglect of banking or other financial institutions. That position was taken by Goodfriend (2005), who suggested that inclusion of a banking sector that provides broad money financed by bank loans might alter the conclusion. Goodfriend's analysis was entirely qualitative, however, as observed by Hess (2005). Accordingly, Goodfriend and McCallum (2007) developed a version that could be simulated quantitatively in order to determine whether inclusion of a banking sector would significantly affect major policy conclusions. A feature of the analysis is the essential role of several distinct types of one-period interest rates.

The model includes households and banks. Households consume, supply labor (for goods production and also to the banking sector), and own production facilities that use labor and capital to produce goods. Their consumption choices are subject to a cash-in-advance constraint where the relevant MOE cash is bank deposits. These deposits (which are subject to reserve requirements) are the banks' liabilities; their assets are base money (supplied by the central bank) and loans to households. These loans are managed so as to avoid default according to a "production function" with inputs of *monitoring* (labor services) and *collateral* (government bonds and capital). We assumed (i) that these inputs are effective enough to avoid default and (ii) that bonds are more effective as collateral than capital.

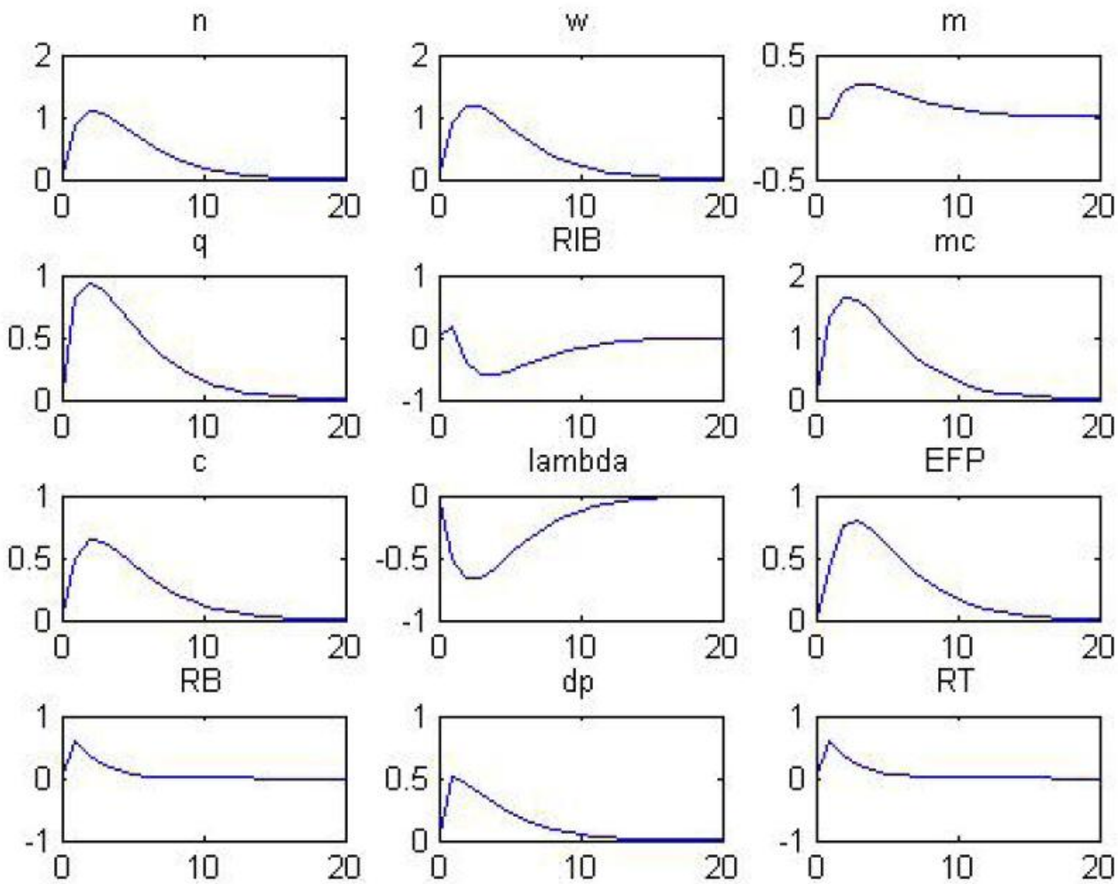
As in much of the NK literature, the aggregate stock of capital is held constant, with individual household-producers nevertheless choosing each period how much of their wealth to hold in the form of capital, taking account of its role of serving as collateral for their loans from banks.

In this system, there are five distinct one-period interest rates:

- R^T= pure inter-temporal rate (satisfies $1 + R_t = E_t \frac{\lambda_t P_{t+1}}{\beta \lambda_{t+1} P_t}$, where λ_t is the lagrange multiplier that equals the current marginal utility of consumption).
- R^L= rate on (collateralized) loans.
- R^B= rate on bonds.
- R^{IB}= interbank rate (the central bank's policy rate).
- R^D= deposit rate on bank loans to households [$R^D = (1 - rr)R^{IB}$]

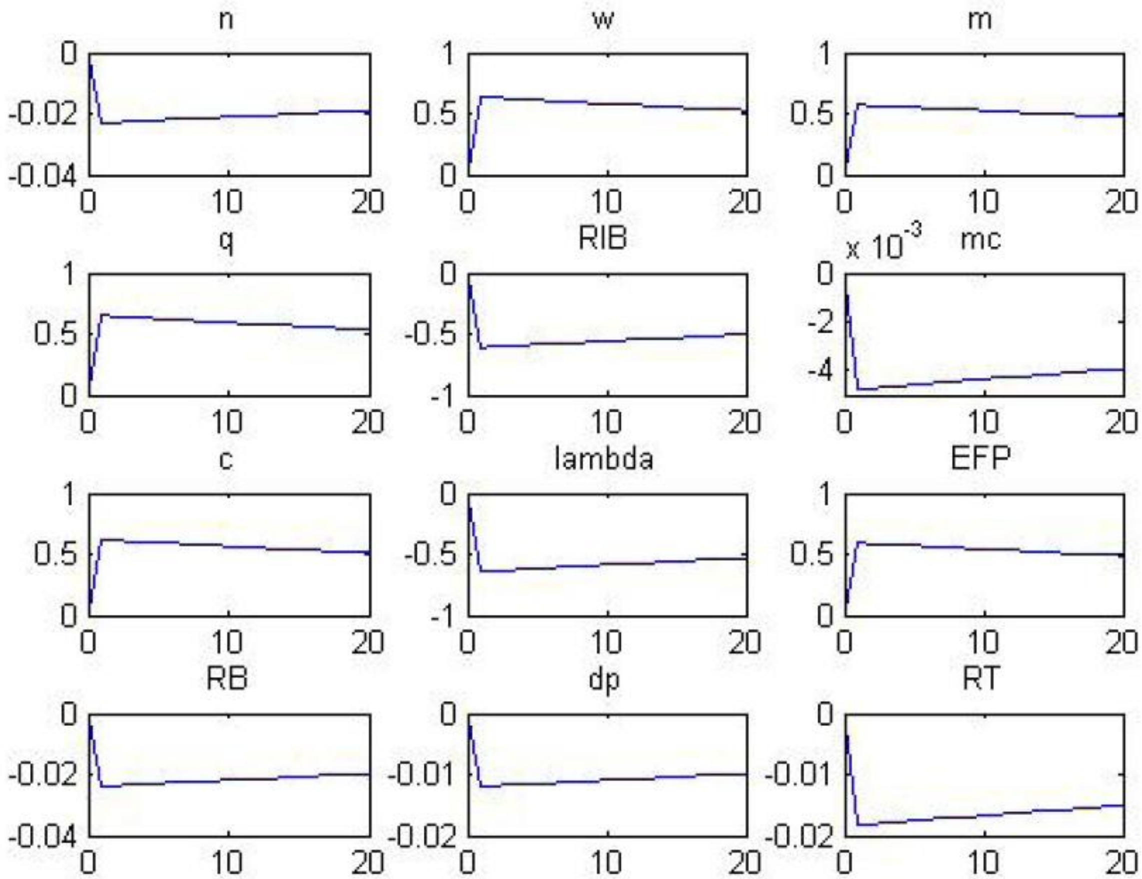
It is clear that in this model the way that the economy responds to different policy rules for management of R_t^{IB} could be very different than its responses in an analysis in which all of these rates are equated. And policy that controlled the growth rate of the monetary base would be different from all of them. To study these differences requires a dynamic model. We first calibrated the model based mostly on steady-state properties and various actual interest rates. This was not easy because the model is highly nonlinear. Then to study its dynamics we linearized the model about its steady state, using quarterly time periods, and then produced impulse response functions for the main endogenous variables in response to various policy rules. For these we used Taylor-style and other rules for setting R_t^{IB} and also rules for adjusting the rate of growth of the monetary base in an AR(1) fashion.

Figure 4



Note: Responses to unit shock to the "banking attenuator" (money growth rule)

Figure 5



Note: Responses to unit shock to a productivity shock.

From these response functions (see Figures 4 and 5) we drew several conclusions supportive of the idea that a central bank that ignores money and banking will seriously misjudge the proper interest rate policy action to stabilize inflation in response to a productivity shock in the production function for output. Unfortunately, some readers discovered an error; we made a mistake in linearization that, when corrected, greatly diminished the magnitude of some of the effects of including the banking sector.

There seems now to be some interest in developing improved models of this type. Marvin Goodfriend (MG) is working with a PhD student in this topic. At this point I have not been able to give a convincing argument that one needs to include M.

5. One More Argument

There is one respect in which it is nevertheless the case that a rule for the monetary base is superior to a rule for the interbank interest rate. In this context we are clearly discussing the choice of a controllable instrument variable—not one of the "target rules" favored by Svensson and Woodford, which are more correctly called "targets." Suppose that the central bank desires for its rule to be verifiable by the public. Then it will arguably need to be a non-activist rule, one that normally keeps the instrument setting unchanged over long spans of time. In that case we know that in the context of a standard NK model, an interest rate instrument will not be viable. That is, the rule will not satisfy the Taylor Principle, which is necessary for "determinacy." The latter condition is not, I argue, what is crucial for well-designed monetary policy, but *LS learnability* is, and it is not present when the TP is not satisfied. This is well known from, e.g., Evans and Honkapohja (2001), Bullard and Mitra (2002), McCallum (2003, 2009).

By contrast, consider a rule for the growth rate of (base) money that keeps the rate constant:

(MG) $$m_t = m_{t-1} + \mu$$

For simplicity, consider the special case of an (IS) - (PC) model in which prices are fully flexible. Also abstract from growth and normalize so that $\bar{y}_t = 0$ so that $y_t = E_t y_{t+1}$ and the combination of (IS) and (PC) yields

(IS - PC) $$0 = b_0 + b_1(R_t - E_t \Delta p_{t+1}) + v_t$$

Then using (MD) to substitute for R_t in the latter gives:

(1) $$0 = b_0 + b_1 \left[\left(\frac{1}{\gamma_2} \right) (m_t - p_t - \gamma_0 - e_t) - E_t \Delta p_{t+1} \right] + v_t$$

But this amounts to a relationship of the form:

(2) $p_t = \frac{\gamma_2}{\gamma_2 - 1} E_t p_{t+1} +$ additional terms

where the additional terms are all exogenous with respect to p_t. Then, since $\gamma_2/(\gamma_2 - 1)$ is positive and smaller than 1.0, the process generating p_t is least-squares learnable—as shown by Bullard and Mitra (2002) or Evans and Honkapohja (2001, pp. 201-204 or 236-238), among others.

The foregoing example, with not only full price flexibility but also a simplified setup, is a special case that does not permit any general conclusion. I have done a bit of numerical analysis with Calvo price adjustments and typical parameter values, however, and obtained similar results in some more appropriate formulations. Specifically, money growth rules, but not interest rate rules, lead to single-stable-solution findings in all cases. That LS learnability is implied in these cases is demonstrated in McCallum (2007). Thus non-activist interest rate rules do not lead to learnable solutions but money growth rules do. I argue that learnability is a necessary condition for a model to be plausible.

I do not want to give the impression that the foregoing argument, plus recognition that monetary policy in the US and elsewhere has been conducted via interest rate rules, is a major factor leading to the unsatisfactory monetary policy of recent years. The problem with Federal Reserve policy has been, in my opinion, that it has not been rule-oriented and has not respected the distinction between monetary and fiscal policy. More fundamentally, perhaps, the Fed has not been given a coherent set of objectives by Congress. (Current version of monetary policy act says Fed is required "to promote effectively the goals of maximum employment, stable prices, and moderate long-term interest rates," a rather incoherent assignment.)

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