New Monetarist Economics

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Abstract

1 Introduction

The purpose of this paper is to articulate the principles and the approach of a school of thought, *New Monetarist Economics*. This label was chosen for two reasons. First, New Monetarists find much that is appealing in the Old Monetarist ideas of Milton Friedman, but also disagree with Friedman in important ways. Second, New Monetarist Economics has little in common with New Keynesian Economics, though this has more to do with how New Keynesians approach monetary economics than with the idea that sticky wages and prices may be important for monetary policy and business cycles.

New Monetarism is taken to encompass a body of research on monetary theory and policy, as well as the economics of banking, financial intermediation, and payments, that has taken place over the last 36 years (give or take a few years). In monetary theory and policy, this includes the seminal work of Lucas (1972) and the *Models of Monetary Economies* volume (Kareken and Wallace 1980), as well as the monetary search and matching literature, including Kiyotaki and Wright (1989), Trejos and Wright (1995), and Lagos and Wright (2005). In the economics of banking, financial intermediation and payments, which built on advances in information economics that occurred mainly in the 1970s, some key work is Diamond and Dybvig (1983), Diamond (1984), Williamson (1986, 1987), Bernanke and Gertler (1989), and Freeman (1995). Much of this work is theoretical in nature, but the literature has turned more recently to empirical issues and practical policy questions.

In this paper, the first step is to explain what New Monetarism is not, by laying out the key principles of Keynesianism (new and old), and Old Monetarism. Next, we lay out a set of New Monetarist principles. New monetarists argue that: (i) to analyze monetary phenomena and monetary policy requires that we use models that are explicit about the frictions that give rise to a role for monetary exchange; (ii) no one model should be an all-purpose vehicle for all issues in monetary economics, but some models are more simple and tractable than others; (iii) financial intermediation is important - for example, while bank liabilities and currency may perform similar roles as media of exchange, treating them as identical objects can lead us astray.

After stating basic principles, a benchmark New Monetarist model is constructed, and then put to work. First, we illustrate some of the key standard properties of the benchmark New Monetarist model, including the neutrality of money and optimality of the Friedman rule for monetary policy. Next, it is shown that the benchmark model can be used to exposit both Old Monetarist ideas and New Keynesian ideas. Old Monetarism is captured in the model in the form of a Lucas (1972) signal extraction problem, which leads to conclusions analogous to Friedman (1968) and Lucas (1972), with some important differences. Then, it is shown that we can capture some of the key New Keynesian policy conclusions arising from a sticky price friction (e.g. as in Clarida, Gali and Gertler 1999 or Woodford 2003), again with some important differences from the standard New Keynesian literature, that stem from our New Monetarist approach.

Finally, we give two examples which are extensions of the benchmark New Monetarist model and are also new in the literature. The first incorporates some ideas from payments economics (Freeman 1995), while the second integrates a Diamond-Dybig (1983) approach to banking into the basic model. These examples illustrate the power of the approach, and its flexibility in intergrating banking, credit, and payments arrangements into the analysis.

The paper is organized as follows. In the first three sections, Keynesianism, Old Monetarism, and the principles of New Monetarism are discussed. Then, in Section 4, a benchmark New Monetarist model is constructed, and this model is then used to exposit and evaluate Old Monetarist and New Keynesian ideas in Sections 5 and 6. Next, in Sections 7 and 8, the New Monetarist model is modified to permit payments arrangements and banking, respectively. Finally, Section 9 is a conclusion.

2 Old and New Perspectives on Monetary Policy

To understand the basic principles of New Monetarism, we first need to summarize some popular alternative schools of thought. This will allow us to highlight what is different about New Monetarism, and how it allows us to better explain monetary phenomena and provide guidance for monetary policy.

2.1 Keynesianism

Keynesianism of course originated with Keynes's *General Theory* in 1936. Keynes's ideas were popularized in the form of Hicks's (1937) IS-LM model, which became enshrined in the undergraduate macroeconomics curriculum, and was integrated into the so-called Neoclassical Synthesis of the 1960s. New Keynesians, for example Clarida, Gali, and Gertler (1999) or Woodford (2003), make use of more sophisticated tools than did the Old Keynesians (Hicks, Samuelson, Solow, and Tobin, for example), but the language and ideas are essentially the same. New Keynesianism is typically marketed as a synthesis which can be boiled down to an IS relationship, a Phillips curve, and a policy rue, determining the nominal interest rate, the "output gap," and the inflation rate. It is argued that this framework is consistent with some key revolutionary ideas in macroeconomics during the last 40 years, such as the Lucas Critique and real business cycle analysis. If we take Woodford (2003) as representing the state of the art in New Keynesian thinking, the key New Keynesian ideas are the following:

1. The key friction that gives rise to short-run nonneutralities of money, and the primary concern of monetary policy, is sticky prices. Because some prices are not fully flexible, inflation or deflation induces relative price distortions and welfare losses.

2. New Keynesians view the frictions that we typically encounter in deep (e.g. Lagos and Wright 2005) and not-so-deep (e.g. Lucas and Stokey 1987) monetary economics as of second-order importance. These frictions are absence-of-double-coincidence problems and information frictions which give rise to a fundamental role for monetary exchange, and which typically lead to intertemporal distortions that can be corrected by monetary policy.

3. There is a short run Phillips curve tradeoff. Monetary policy can induce a short run increase in aggregate output coupled with an increase in the inflation rate.

4. The central bank is viewed as being able to set a short term nominal interest rate, and the monetary policy problem is presented as the choice over alternative rules for how this nominal interest rate should be set in response to endogenous and exogenous variables.

New Keynesians tend to be supportive of current central banking practice. For example, in Woodford (2003), elements of the modeling approach are specifically chosen to match standard central bank operating procedures, and Woodford appears to find little in the behavior of central banks that he does not like. Interest in New Keynesian economics has become intense recently, particularly in central banks. Among some macroeconomists (e.g. Goodfriend 2007) there is a view that New Keynesianism has become the default approach to analyzing and evaluating monetary policy.

2.2 Old Monetarism

Old Monetarist ideas are best-represented in the writings of Milton Friedman (1960, 1968, 1969) and Friedman and Schwartz (1963). In the 1960s and 1970s, monetarism was viewed as an alternative to Keynesian economics, with very different implications for how monetary policy should be conducted. Friedman's approach was grounded mainly in informal theory, with a great deal of weight on empirical analysis. Old Monetarism left a lasting impression in macroeconomics and the practice of central banking, yet there are few professed monetarists remaining in the economics profession. The central tenets of Old Monetarism are the following:

1. Sticky prices, while possibly important in generating short-run nonneutralities of money, are an unimportant friction for monetary policy.

2. Inflation, and inflation uncertainty, generate significant welfare losses.

3. The quantity theory of money is an essential building block. There exists a demand function for money which is an empirically stable function of a few variables.

4. There may exist a short-run Phillips curve tradeoff, but the central bank should not attempt to exploit it. There is no long-run Phillips curve tradeoff.

5. Monetary policy is viewed as a process of determining the supply of money in circulation, and an optimal monetary policy involves minimizing the variability in the growth rate of some monetary aggregate.

6. Money is any object that is used as a medium of exchange. Whether these objects are private liabilities or government liabilities is irrelevant for the way they should be treated in the analysis of monetary phenomena and monetary policy.

Friedman tended to be critical of contemporary central banking practice, and this tradition was carried on through such institutions as the Federal Reserve Bank of St. Louis, and the Shadow Open Market Committee. The lasting influence of monetarism is the notion that low inflation should be a primary goal for monetary policy. For example, this is a principle stressed by New Keynesian economists. However, Friedman's monetary policy prescription that central banks should adhere to strict targets for the growth of monetary aggregates is typically regarded as a practical failure.

3 New Monetarism

The foundations for New Monetarism can be traced to a conference at the Federal Reserve Bank of Minneapolis in the late 1970s, with the conference proceedings (and some other post-conference contributions) published in Kareken and Wallace (1980). Two important antecedents for the conference were Samuelson's (1956) overlapping generations model of money and Lucas (1972), which sparked the rational expectations revolution and a move toward incorporating serious theory in macroeconomics.

Kareken and Wallace (1980) contains a diverse body of monetary theory, with the common goal of moving the profession toward a deeper understanding of the role of money in the economy and the proper conduct of monetary policy. This conference volume spurred a body of research, using the overlapping generations model of money, conducted mainly by Neil Wallace and his students and coauthors at the University of Minnesota during the 1980s. Some important findings from that body of research were the following:

1. Because monetarist doctrine neglects economic theory, monetarist prescriptions for policy could go dramatically wrong (Sargent and Wallace 1982).

2. The fiscal policy regime in place is critical for the effects of monetary policy (Sargent and Wallace 1981, Wallace 1981).

3. Monetary theory can make good use of received theory in other branches of economics, for example public finance (Bryant and Wallace 1984) and financial economics (Bryant and Wallace 1979).

A key principle, laid out first in the introduction to Kareken and Wallace (1980), and elaborated later in Wallace (1998) is that progress can be made in monetary economics and the science of monetary policy only by modeling monetary arrangements explicitly. That is, in line with the arguments of Lucas (1976), to conduct a policy experiment in an economic model, that model should be structurally invariant to the policy experiment under consideration. Thus, if we are considering experiments involving the operating characteristics of the economy under different monetary policy rules, we necessarily must have a model in which economic agents hold money not because it enters preferences or the production technology, but because it overcomes some fundamental friction or frictions.

New monetarists are not wedded to a particular monetary framework, viewing the relevant model as being the simplest one available for addressing the problem at hand. However, much research in monetary theory in the last 20 years has been conducted using models of search and matching. Early key work in this area was Kiyotaki and Wright (1989), which built on the ideas of Jones (1976), and some later important contributions are Shi (1995), Trejos and Wright (1995), and Lagos and Wright (2005).

Models of search and matching are particularly tractable for addressing questions in monetary economics, though a key insight from this literature is that the spatial separation which exists in a typical search and matching framework is not the friction that makes money essential. Rather, as emphasized by Kocherlakota (1998) (with some credit due to earlier work by Townsend (1987, 1989), money is essential because it overcomes a double coincidence of wants problem in the context of imperfect record-keeping. Perfect record-keeping would imply that efficient allocations could be supported through a complete set of insurance markets and credit markets in the absence of monetary exchange.

4 New Monetarism, Banking, and Payments Arrangements

An important point of departure from Old Monetarism is that New Monetarists take seriously the role of financial intermediaries and their interaction with the central bank. Developments in intermediation theory and payments economics over the last 25 years are critical to our understanding of money, credit markets, and central banking arrangements.

The differences in how New Monetarists and Old Monetarists view the role of financial intermediation is reflected in their respective evaluations of Milton Friedman's proposal for a 100% reserve requirement on transactions deposits in Friedman (1960). Friedman's argument was based on the premise that tight control of the total money stock by the central bank was critical to control of the price level. However, since transactions deposits at banks are part of the money stock and the money multiplier is subject to random shocks, even if the central bank could perfectly control the stock of outside money, inside money would be difficult to control. But, if a 100% reserve requirement were imposed on inside money, then the total stock of money would move one-for-one with the quantity of outside money. Friedman and other Old Monetarists viewed this is a good thing. However, what Friedman ignored was that banks are performing a socially useful function in transforming illiquid bank assets into liquid bank liabilities (transactions deposits), and that this activity would be eliminated with the imposition of a 100% reserve requirement, yielding an inefficiency, as would be obvious to most modern intermediation theorists and New Monetarists.

The 1980s saw some important progress in the theory of banking and financial intermediation, spurred by earlier developments in information theory. A particularly influential contribution was the banking model of Diamond and Dybvig (1983), which we now understand to be a useful model of banking as liquidity transformation and insurance, requiring some auxiliary assumptions to produce anything resembling a banking panic or run (see for example Ennis and Keister 2008). Other work involved intermediation models where well-diversified intermediaries economize on monitoring costs, for example Diamond (1984) and Williamson (1986). In all of these banking and intermediation models, financial intermediation is an endogenous phenomenon, and the resulting intermediaries are well-diversified, process information in some manner, and transform assets in terms of liquidity, maturity or other characteristics. The theory of financial intermediation has been useful in helping us understand the potential for instability in banking and the financial system (see Ennis and Keister 2008 for a helpful summary), and how the structure of intermediation and financial contracts can propagate aggregate shocks (Williamson 1987, Bernanke and Gertler 1989).

A branch of banking and financial intermediation theory is payments economics, which involves the study of payments arrangements, particularly among financial institutions, where central banks can play an important role, for example through the Fedwire system in the United States. See for example Freeman (1995) or the survey by Nosal and Rocheteau (2006). The key insights from this literature are related to the role played by outside money and central bank credit in the clearing and settlement of debt, and the potential for systemic financial risk as a result of the extension of intraday credit.

5 A Benchmark New Monetarist Model

As an illustrative baseline model, we use a framework close to Rocheteau and Wright (2005), which is in turn derived from Lagos and Wright (2005). Periods are indexed by $t = 0, 1, 2, ...$, and each period is divided into two subperiods, denoted day and night. The population consists of a continuum of infinite-lived agents, half of whom are *buyers*, with the other half being *sellers*.

A buyer has preferences given by

$$\sum_{t=0}^{\infty} \beta^t [-n_t + u(q_t)] \tag{1}$$

where n_t is labor supply in the day and q_t is consumption at night, with $\beta \in (0, 1)$ the discount factor between night and day. Assume $u(\cdot)$ is strictly concave, strictly increasing, and twice continuously differentiable with $u(0) = 0$, $u'(0) = \infty$, and define q^* to be the solution to $u'(q^*) = 1$. A seller has preferences given by

$$\sum_{t=0}^{\infty} \beta^t (x_t - l_t) \tag{2}$$

where x_t is consumption in the day and l_t is labor supply at night. Sellers and buyers discount at the same rate. When an agent can produce, one unit of labor time produces one unit of the consumption good, which is perishable between day and night, and between night and the next day.

During the day, all agents meet together in a Walrasian market, where they can observe only the competitive price at which money trades for goods. At night, there is random matching of buyers and sellers, with each match consisting of one buyer and one seller. Every buyer is matched with a seller. In each random match, the seller can only observe the quantity of money balances held by the buyer in the match. As well, what occurs during the meeting between a buyer and seller during the night is private information to them. These informational assumptions assure that there is no recordkeeping and therefore, in this baseline model, no role for any form of intertemporal exchange. Agents will only trade money for goods in the daytime Walrasian market, or in bilateral matches at night.

At the beginning of the day in period 0, each seller is endowed with M_0 units of money. In periods $t = 1, 2, 3, ...$, the government makes a lump-sum money transfer τ_t to each seller at the beginning of the day, so that the money stock in period t is given by

$$M_t = M_{t-1} + \frac{\tau_t}{2}, \tag{3}$$

for $t = 1, 2, 3, \ldots$.

5.1 Equilibrium in the Benchmark Model and the Friedman Rule

We first wish to establish some basic properties of the benchmark model, most of which are standard, being shared by many other monetary models. To this end, suppose that the money stock grows at a constant gross rate μ, so that, from (3),

$$\tau_t = 2(\mu - 1)M_{t-1},$$

for $t = 1, 2, 3, \ldots$.

Now, in the daytime, let ϕ_t denote the price of money in terms of consumption goods. Conjecture (we will later establish conditions under which this conjecture is correct) that in equilibrium

$$\frac{\phi_{t+1}}{\phi_t} \leq \frac{1}{\beta}, \tag{4}$$

which will guarantee that no agent will wish to carry money beyond the next sub-period. To illustrate our main points simply, assume that in a nighttime match the buyer makes a take-it-or-leave-it offer to the seller. The problem is altered in interesting ways if the buyer and seller split the gains from trade differently, for example according to a Nash bargain or a competitive search paradigm (Lagos and Wright 2005, Rocheteau and Wright 2005), but for ease of exposition we confine attention here to take-it-or-leave-it offers by the buyer.

Here, the buyer will want to trade all of his or her money balances with the seller. in exchange for a quantity of goods that makes the seller just indifferent to accepting the offer. Letting q_t denote the quantity of goods the seller produces for the buyer, and m_t the quantity of money the buyer has on hand, the seller is indifferent when

$$q_t = \beta\phi_{t+1}m_t, \tag{5}$$

since the seller will sell all of the money balances received in the trade at the price ϕ_{t+1} during the next day. Therefore, during the daytime in period t, a buyer will choose nominal money balances m_t to solve

$$\max_{m_t} \left[-\phi_t m_t + u(\beta\phi_{t+1}m_t)\right], \tag{6}$$

so from (5) and (6), the buyer's consumption in the night, q_t, is determined by the first-order condition

$$u'(q_t) = \frac{\phi_t}{\beta\phi_{t+1}}. \tag{7}$$

Market clearing in the day requires that the money stock be willingly held by buyers, or

$$\frac{m_t}{2} = M_t, \tag{8}$$

and so, since the bargaining protocol yields $q_t = \beta\phi_{t+1}m_t$, from (7) and (8) we obtain

$$u'(q_t)q_t = \frac{q_{t-1}\mu}{\beta}, \tag{9}$$

a first-order difference equation that in principle can be solved for $\{q_t\}_{t=0}^{\infty}$.

One solution to (9), of course, is the stationary equilibrium with $q_t = q$ for all t, where q is a constant determined by

$$u'(q) = \frac{\mu}{\beta}. \tag{10}$$

Note, that in this equilibrium the gross inflation rate is equal to the gross money growth rate μ, and that the quantity of goods traded in the night q decreases with the money growth rate. As well, for our conjecture (4) to be correct, we require that $\mu \geq \beta$.

As is standard, money is neutral in any equilibrium, in that the initial stock of money balances M_0 is irrelevant, from (9), for determining the sequence of equilibrium quantities. However, money growth clearly matters in that μ is a determinant of equilibrium quantities, so that money is not super-neutral. These are standard properties that the model shares with many monetary models, some of which do not contain explicit monetary frictions, such as cash-in-advance models and money-in-the-utility-function constructs.

Another standard property that this model shares with conventional work-horses of monetary economics is that a Friedman rule for monetary policy yields an optimal equilibrium allocation. In nighttime trading, the efficient quantity q_t that maximizes the total surplus from trade is $q_t = q^*$, where q^* is determined by $u'(q^*) = 1$. In the stationary equilibrium determined by (10), the efficient allocation is achieved when $\mu = \beta$. This is a Friedman rule, in that it implies that the implicit nominal interest rate is zero. That is, suppose that there exists a claim to one unit of money in the day during period $t+1$, which trades for s_t units of money in period t. Further, assume that, for unspecified reasons, this one-period nominal bond cannot be exchanged for goods during the night. Then, in equilibrium we must have

$$s_t\phi_t = \beta\phi_{t+1}.$$

The nominal interest rate is $\frac{1}{s_t} - 1$, so in the stationary equilibrium the nominal interest rate is $\frac{\mu}{\beta} - 1$, which is strictly positive when $\mu > \beta$ and zero when $\mu = \beta$. Thus, in line with much of standard monetary economics, there is an intertemporal monetary efficiency, reflected in a a positive nominal interest rate, which can be corrected by a Friedman rule. In this stationary environment, a Friedman rule implies deflation at the rate of of time preference, again a standard result.

The power of new monetarism is not, of course, in replicating standard results, but in permitting explicit analysis that sheds new light on new and old problems in monetary economics. We will demonstrate the flexibility and novelty of the approach in the next sections as we add to the benchmark model.

6 Old Monetarism in a New Monetarist Model: Lucas Signal Extraction

Our first task will be to use a new monetarist construct to illustrate an idea from old monetarism: the explanation for the short run Phillips curve correlation and justification for predictable monetary policy based on monetary confusion. These ideas were first explicated in Friedman's presidential address (Friedman 1960), and in Lucas (1972). Faig and Li (2008) construct a version of Lucas (1972) in a model related to ours, but they take a somewhat different approach.

Here, we need to modify our benchmark model as follows. First, change the preferences of buyers in (1) so that period utility is $-n_t + \theta_t u(q_t)$, where θ_t is an idiosyncratic preference shock with $\theta_t \in \{\theta^l, \theta^h\}$, and $0 < \theta^l < \theta^h$.

Next, assume that, at the beginning of the day, a fraction α_t of buyers receives preference shock θ^h, while $1 - \alpha_t$ receive preference shock θ^l. Here α_t is an aggregate shock, which is not public information, and the individual preference shocks are private information. Preference shocks are revealed to buyers before they make their decisions concerning how much money to carry into the night, so in general the demand for money will be higher the larger is the realization of α_t.

The money growth factor is now a random variable μ_t. In period t, during the day each seller receives a money transfer τ which is a random draw from a distribution $F(\tau; \mu_t, M_{t-1})$ that has support $[aM_{t-1}, bM_{t-1}]$ where a and b are positive constants. Thus, the transfer that a seller receives yields no information about the current aggregate money growth rate.

During the day, each agent learns last period's money stock, M_{t-1} and observes the price of money ϕ_t. However, an agent does not observe the current aggregate money shock μ_t, or the shock α_t. Thus, just as in Lucas (1972), there is a signal extraction problem for the agents in the model to solve. For an individual buyer acquiring money balances during the day, the current price of money may be high (low) because the demand for money is high (low), or because the aggregate money growth rate is relatively low (high).

6.1 Equilibrium

As in the benchmark model, each buyer makes a take-it-or-leave-it offer to the seller during the night. Thus, in a match where the buyer received preference shock θ^i, $i \in \{l, h\}$, the quantity of goods traded will be given by

$$q_t^i = \beta m_t^i E[\phi_{t+1} \mid \phi_t], \tag{11}$$

where m_t^i is the quantity of money acquired by a buyer with preference shock θ^i during the day in period t. Then, given a buyer's optimal choice of money holdings, the first-order condition determining q_t^i is

$$-\phi_t + \beta\theta^i E[\phi_{t+1} \mid \phi_t] u'(q_t^i) = 0. \tag{12}$$

Market-clearing in period t requires that buyers acquire the stock of money in existence at the beginning of period t, or

$$\frac{\alpha_t m_t^h + (1-\alpha_t) m_t^l}{2} = \mu_t M_{t-1}. \tag{13}$$

If μ_t is a continuous random variable, then in principle we could solve for an equilibrium along the lines of Lucas (1972). For illustrative purposes, the approach of Wallace (1992), using a finite state space, is more tractable, and so we use that approach in the following example.

6.2 An Example

Suppose that μ_t is an i.i.d. random variable, where $\mu_t = \mu_1$ with probability $\frac{1}{2}$, and $\mu_t = \mu_2$ with probability $\frac{1}{2}$, where $\mu_1 > \mu_2$. Also suppose that α_t is an i.i.d. random variable that is independent of μ_t and takes on two values, i.e. $\Pr[\alpha_t = \alpha_1] = \Pr[\alpha_t = \alpha_2] = \frac{1}{2}$, where $\alpha_1 > \alpha_2$. Also assume that $u(q) = \ln q$. Note that this assumption concerning preferences does not satisfy the property $u(0) = 0$ that we initially imposed. However, in this instance we do not need that restriction. We will assume that

$$\frac{\alpha_1 \theta^h + (1-\alpha_1)\theta^l}{\mu_1} = \frac{\alpha_2 \theta^h + (1-\alpha_2)\theta^l}{\mu_2}, \tag{14}$$

which will guarantee that there is a signal extraction problem in equilibrium, in that agents will be unable to distinguish between the high-money-demand, high-money-growth state, and the low-money-demand, low-money-growth state.

Using (11)-(13) we can obtained closed-form solutions for prices and quantities. First, letting $\phi(j,k)$ denote the price of money when $(\mu_t, \alpha_t) = (\mu_j, \alpha_k)$,

$$\phi(j,k) = \frac{\alpha_k \theta^h + (1-\alpha_k)\theta^l}{2\mu_j M_{t-1}}, \text{ for } i = 1,2. \tag{15}$$

Next, letting $q^i(j,k)$ denote the quantity of output produced in a match during the night between a buyer and seller where the buyer has received preference shock θ^j, and where the aggregate state is $(\mu_t, \alpha_t) = (\mu_j, \alpha_k)$. From (11)-(13) and (15) we obtain

$$q^i(j,k) = \frac{\beta\theta^i[(\alpha_1+\alpha_2)\theta^h + (2-\alpha_1-\alpha_2)\theta^l](\mu_1+\mu_2)}{4\mu_1\mu_2\left[\alpha_k\theta^h + (1-\alpha_k)\theta^l\right]}, \text{ for } (j,k) = (1,2),\ (2,1), \tag{16}$$

$$q^i(1,1) = q^i(2,2) = \frac{\beta\theta^i[(\alpha_1+\alpha_2)\theta^h + (2-\alpha_1-\alpha_2)\theta^l](\mu_1+\mu_2)^2}{8\mu_1\mu_2^2\left[\alpha_1\theta^h + (1-\alpha_1)\theta^l\right]}. \tag{17}$$

Now, we wish to calculate total output in each aggregate state, letting $Q^d(j,k)$ denote daytime output when the money growth factor is μ_j and the fraction of high-preference-shock buyers is α_k for $j,k = 1,2$. As well, $Q^n(j,k)$

similarly denotes nighttime output. Since all output in the day is produced by buyers in exchange for the aggregate money stock held by sellers, we have

$$Q^d(j,k) = \phi_t M_t = \frac{\alpha_k \theta^h + (1-\alpha_k)\theta^l}{2}, \tag{18}$$

for $j,k = 1,2$, from (15). Further, from (16), (17), and 14,

$$Q^n(1,2) = Q^n(2,1) = \frac{\beta[(\alpha_1+\alpha_2)\theta^h + (2-\alpha_1-\alpha_2)\theta^l](\mu_1+\mu_2)}{4\mu_1\mu_2}, \tag{19}$$

$$Q^n(1,1) = \frac{\beta[(\alpha_1+\alpha_2)\theta^h + (2-\alpha_1-\alpha_2)\theta^l](\mu_1+\mu_2)^2}{8\mu_1\mu_2^2}, \tag{20}$$

$$Q^n(2,2) = \frac{\beta[(\alpha_1+\alpha_2)\theta^h + (2-\alpha_1-\alpha_2)\theta^l](\mu_1+\mu_2)^2}{8\mu_1^2\mu_2} \tag{21}$$

Total output is given by $Q(j,k) = Q^d(j,k) + Q^n(j,k)$. From (18), daytime output is independent of the current money growth shock and $Q^d(j,k)$ is higher (lower) when money demand is high (low). That is, when money demand is high (low), the price of money is high (low), and buyers need to produce more (less) in the daytime market to acquire the aggregate stock of money in equilibrium. In the night, from (19)-(21), it is straightforward to show that $\mu_1 > \mu_2$ implies that $Q^n(2,2) < Q^n(1,2) = Q^n(2,1) < Q^n(1,1)$. Thus, given that we have assumed that the money growth shock and the money demand shock are independent, aggregate output will be positively correlated with money growth, and with money demand. Note that the positive correlation of output and money growth results just from agents' confusion, since if there were full information about aggregate shocks, we would have

$$Q^n(j,k) = \frac{\beta[(\alpha_1+\alpha_2)\theta^h + (2-\alpha_1-\alpha_2)\theta^l](\mu_1+\mu_2)}{4\mu_1\mu_2}$$

for all (j,k), so that output would be uncorrelated with money growth. Confusion results from the fact that, if money growth and money demand are both high (low), then agents' subjective expectation of the price of money in the succeeding period is greater (less) than the objective expectation of this price, and so more (less) output is produced in matches during the night than would be the case if agents had full information. The mechanism that gives rise to the nonneutrality of money here is essentially identical to what occurs in Lucas (1972), except that Lucas works in a competitive equilibrium paradigm where the output effects of a money surprise depend on labor supply elasticities, and we include aggregate real shocks, just as in Wallace (1992).

6.3 Optimality

Efficient exchange in nighttime pairwise meetings requires that the quantity of goods produced by a seller for a buyer depend only on the buyer's preference shock, that is $q = q_i^*$ when the buyer has preference shock i, where q_i^* is the solution to

$$\theta^i u'(q_i^*) = 1, \tag{22}$$

for $i = l, h$. Note that this is independent of the aggregate state. The objective of this section is to determine a monetary policy rule that will achieve efficiency in equilibrium.

From (12) and (22), an efficient equilibrium then has the property that

$$\phi_t = \beta E\left[\phi_{t+1}\right]. \tag{23}$$

Then, from (11), (13), and (23), the price of money in an efficient equilibrium is given by

$$\phi_t = \frac{\alpha_t q_1^* + (1-\alpha_t)q_2^*}{2M_t} \tag{24}$$

Now, substituting in (23) using (24) and then solving for the optimal money growth factor, we obtain

$$\mu_{t+1} = \beta \frac{\alpha_{t+1} q_1^* + (1-\alpha_{t+1})q_2^*}{\alpha_t q_1^* + (1-\alpha_t)q_2^*}. \tag{25}$$

This optimal money growth rule is a Friedman rule that dictates that money decrease on trend at the rate of time preference, with a higher (lower) money growth rate in periods when money demand is high (low) relative to what it was in the previous period. It might appear that the monetary authority cannot implement such a rule, as it seems to require that the aggregate shock α_t be publicly observable, but we have assumed it is not. However, note that (24) and (25) imply that

$$\phi_{t+1} = \frac{\phi_t}{\beta},$$

so that prices decrease at a constant rate in the efficient equilibrium. Therefore, the monetary authority need not observe the underlying aggregate shock, and can obtain efficiency by simply achieving a constant rate of deflation. In equilibrium, the price level is predictable, and carries no information about the aggregate state. It is not necessary for the price level to reveal aggregate information, since efficiency requires that, contingent on the individual preference shock, a buyer will acquire the same quantity of real balances in the day and receive the same quantity of goods in the night no matter what the aggregate shock is.

In one sense, as in Lucas (1972), our results are consistent with the thrust of Friedman (1968). Monetary policy can confuse price signals, and as a result of this confusion there is a nonneutrality of money that can lead to a positive correlation between the rate of money growth and the level of aggregate real output, and Phillips curve correlations, provided that real shocks do not dominate. However, the policy prescription derived from the model is in line with Friedman's (1969) optimum quantity of money argument rather than Friedman (1969). That is, constant money growth is not optimal, as money growth should respond to real aggregate disturbances at the optimum so as to correct intertemporal distortions. This feature of the model appears consistent with some of the reasons that money growth targeting by central banks failed in practice in the 1970s and 1980s.

7 A New Keynesian Version of the Benchmark Model

In this section, we will modify the benchmark new monetarist model to incorporate a sticky price friction, capturing ideas in New Keynesian economics along the lines of Woodford (2003) and Clarida, Gali, and Gertler (1999), for example. We will first construct a "cashless" model, as does Woodford (2003), and then modify this to include currency transactions.

7.1 Cashless Model

We start with a "cashless" version of our benchmark model, where all transactions in the day market are carried out using credit. New Keynesian models typically use a monopolistically competitive setup (Woodford 2003) where individual firms set prices, usually according to a Calvo (1983) pricing mechanism. Here, to fit a sticky price friction into our benchmark model, we assume that some prices are sticky during the night when there is bilateral random matching between buyers and sellers.

In the cashless model, in spite of the fact that money is not held or exchanged for anything else, prices are denominated in units of money. As in the benchmark model, let ϕ_t denote the price of goods in units of money during the day, and suppose that ϕ_t is flexible. During the night, when there are random bilateral matches between buyers and sellers, each buyer/seller pair conducts a credit transaction where goods are received by the buyer during the night in exchange for a promise to pay during the next day. To support credit transactions and rule out a role for money, we assume that there is perfect memory or recordkeeping. That is, if a buyer defaults during the day, then this is observable to everyone, and we further assume an exogenous legal system that can impose infinitely severe punishment on a defaulter. Thus, in equilibrium all borrowers pay off their debts.

During the day, suppose that in an individual match the terms of trade between a buyer and seller is either flexible with probability $\frac{1}{2}$, or fixed with probability $\frac{1}{2}$.In a flexible match, as in the benchmark model, the buyer makes a take-it-or-leave-it offer to the seller. Letting $\frac{1}{\psi_t}$ denote the number of units of money the buyer offers to pay in the following day for each unit of goods produced by the flexible-price seller during the night, and s_t^1 the quantity of goods produced by the seller, the take-it-or-leave it offer satisfies

$$s_t^1 = \frac{\beta s_t^1 \phi_{t+1}}{\psi_t},$$

so that

$$\psi_t = \beta\phi_{t+1}.$$

Now, assume that in each fixed-price exchange during the night, that the seller is constrained to offering a contract which permits the buyer to purchase as much output as they would like in exchange for $\frac{1}{\psi_{t-1}}$ units of money in the next day, per unit of goods received.

Then, in a flexible price contract, the buyer chooses s_t^1 to satisfy

$$\max_{s_t^1} \left[u(s_t^1) - s_t^1\right],$$

so that $s_t^1 = q^*$, the surplus-maximizing quantity of output. However, in a fixed-price contract, the buyer chooses the quantity s_t^2 to solve

$$\max_{s_t^2} \left[u(s_t^2) - \frac{s_t^2\phi_{t+1}}{\phi_t}\right],$$

so s_t^2 satisfies

$$u'(s_t^2) = \frac{\phi_{t+1}}{\phi_t}. \tag{26}$$

Now, thus far there is nothing to determine the sequence $\{\phi_t\}_{t=0}^{\infty}$. In Woodford (2003), one solution approach is to first determine the price of a nominal bond. In our model, during the day in period t, the price z_t in units of money of a promise to pay one unit of money in the daytime during period $t+1$ is given by

$$z_t = \beta\frac{\phi_{t+1}}{\phi_t}. \tag{27}$$

Then, following Woodford's approach, we would argue that z_t can somehow be set by the central bank, perhaps in accordance with a Taylor rule. Then, given determinacy of z_t we can solve for $\{\phi_t\}_{t=0}^{\infty}$ given (27).

Given the model, it seems consistent with New Keynesian logic to consider $\{\phi_t\}_{t=0}^{\infty}$ as an exogenous sequence of prices that can be set by the government. Then, it is clear what an optimal policy is. The equilibrium is in general inefficient due the the sticky price friction, and the inefficiency is manifested in a suboptimal quantity of output exchanged in fixed-price contracts. For efficiency, we require that $s_t^2 = q^*$, which implies from (26) that $\phi_t = \phi$, a constant, for all t, so that the optimal inflation rate is zero. Further, from (27), the optimal nominal bond price consistent with price stability, is $z_t = \beta$.

7.2 Cash/Credit Model

Now, suppose an environment where memory is imperfect, so that money plays a role. In a fraction α of non-monitored meetings between buyers and sellers during the night, the seller does not have access to the buyer's previous history of transactions, and anything that happens during the meeting remains private information to the individual buyer and seller. Further, assume that it is the same set of sellers that engage in these non-monitored meetings for all t. A fraction $1-\alpha$ of matches during the night are monitored, just as in the cashless economy. In a monitored trade, the seller observes the buyer's entire history, and the interaction between the buyer and the seller is public information. The buyer and seller continue to be matched into the beginning of the next day, so that default is publicly observable. As before, we assume an exogenous legal system that can impose infinite punishment. The Walrasian market on which money and goods are traded opens in the latter part of the day, and on this market only the market price (and not individual actions) is observable.

Just as with monitored transactions involving credit, half of the nonmonitored transactions using money are flexible-price transactions, and half are fixed-price transactions. The type of meeting that a buyer and seller are engaged in (monitored or nonmonitored, flexible-price or fixed-price) is determined at random, but the buyer knows during the day what the type of transaction will be during the following night.

As in the cashless model, the quantities of goods traded in credit flexible-price and fixed-price transactions, respectively, are s_t^1 and s_t^2, with $s_t^1 = q^*$ and s_t^2 determined by (26). For flexible-price transactions where there is no monitoring, and money is exchanged for goods, the buyer will carry m_t^1 units of money from the day into the night and make a take-it-or-leave-it offer to the seller which involves an exchange of all this money for goods. The quantity of goods q_t^1 received by the buyer is then

$$q_t^1 = \beta\phi_{t+1}m_t^1, \tag{28}$$

so that the implicit flexible price of goods in terms of money is $\frac{1}{\beta\phi_{t+1}}$. In a fixed-price transaction where money is exchanged for goods, we assume that the seller must charge a price equal to the flexible price in a money transaction in the previous period. Therefore, for a buyer engaged in a fixed-price transaction using money, he or she carries m_t^2 units of money forward from the day to the night, and spends it all on a quantity of goods q_t^2, where

$$q_t^2 = \beta\phi_t m_t^2, \tag{29}$$

As buyers choose money balances optimally in the daytime, we then obtain the following first-order conditions for buyers in monetary flexible-price and fixed-price transactions, respectively.

$$-\phi_t + \beta\phi_{t+1}u'(q_t^1) = 0, \tag{30}$$

$$-\phi_t + \beta\phi_t u'(q_t^1) = 0. \tag{31}$$

Assume that money is injected by the government by way of lump-sum transfers to sellers during the day, and suppose that the aggregate money stock grows at the gross rate μ. In equilibrium, the entire money stock must be held by buyers at the end of the day who will be engaged in monetary transactions at night. Thus, we have the equilibrium condition

$$\frac{\alpha}{2}\left(m_t^1 + m_t^2\right) = M_t \tag{32}$$

Now, consider the equilibrium where $\frac{1}{\phi_t}$ grows at the gross rate μ and all real quantities are constant for all t. Then, from (26), and (28)-(32), equilibrium quantities s_t^i, q_t^i, for $i = 1, 2$, are the solution to

$$\begin{aligned} s_t^1 &= q^*, \\ u'(s_t^2) &= \frac{1}{\mu}, \\ u'(q_t^1) &= \frac{\mu}{\beta}, \\ u'(q_t^2) &= \frac{1}{\beta}. \end{aligned}$$

In equilibrium the money growth rate is equal to the inflation rate, and higher money growth increases the quantity of goods exchanged in fixed-price transactions relative to what is exchanged in flexible-price transactions.

From a policy perspective, it is impossible to support an efficient allocation in equilibrium where $s_t^i = q_t^i = q^*$ for $i = 1, 2$. However, we can find the money growth rate that maximizes welfare $W(\mu)$, defined here as the weighted average of total surplus across nighttime transactions, or

$$W(\mu) = \frac{\alpha}{2}\left[u(q_t^1) - q_t^1 + u(q_t^2) - q_t^2\right] + \frac{(1-\alpha)}{2}\left[u(s_t^1) - s_t^1 + u(s_t^2) - s_t^2\right]$$

Then, we have

$$W'(\mu) = \frac{\alpha}{2\beta u''(q_t^1)}\left(\frac{\mu}{\beta} - 1\right) - \frac{(1-\alpha)}{2\mu^2 u''(s_t^2)}\left(\frac{1}{\mu} - 1\right). \tag{33}$$

Now, for an equilibrium we require that $\mu \geq \beta$. From (33) note that $W'(\beta) > 0$ and $W'(\mu) < 0$ for $\mu \geq 1$, so that the optimal money growth factor μ^* satisfies $\beta < \mu^* < 1$. This reflects a tradeoff between two distortions. Inflation distorts the relative price between flexible-price and fixed-price goods, and this distortion is corrected if there is price stability, as in the cashless model, achieved when $\mu = 1$. Inflation also results in a typical intertemporal relative price distortion, in that too little of the flexible-price good purchased with cash is in general consumed. This distortion is corrected with a Friedman rule or $\mu = \beta$ here. At the optimum, since the monetary authority trades off the two distortions, the optimal money growth rate is larger than at the Friedman rule and smaller than what would be required for a constant price level.

7.3 What Do We Learn Form This Version of the New Keynesian Model?

One principle of New Monetarism is that it is important to be explicit about the frictions underlying the role for money in the economy, as well as other financial frictions that might be important in analyzing monetary policy. What do the explicit frictions in this model tell us that typical New Keynesian models do not?

A line of argument in Woodford (2003) is that it is sufficient to use a cashless model, analogous to what is constructed above, to analyze monetary policy. Woodford views typical intertemporal monetary distortions that can be corrected by a Friedman rule as secondary to sticky price distortions. Further, he argues that one can construct monetary economies that behave essentially identically to the cashless economy, so that it is sufficient to analyze the economy that we get with the "cashless limit."

In our model, the cashless limit would be achieved if, in the cash/credit model, we take the limiting behavior of the model as $\alpha \rightarrow 0$. In the cash/credit model, quantities traded in different types of transactions are independent of α. The only effects of changing α are on the price level and the fraction of exchange that is supported by cash vs. credit. As well, the optimal money growth rate will tend to rise as α decreases, with $\mu^* = 1$ in the limit as $\alpha \rightarrow 0$. The key feature of the equilibrium we study in the cash/credit model that is different from the cashless economy is that the behavior of prices is tied to the behavior of the aggregate money stock, in line with the quantity theory of money.

Confining analysis to the cashless economy is certainly not innocuous. First, it is important that we not assume at the outset which frictions are the key ones for monetary policy. It is crucial that all potentially important frictions, including the intertemporal distortions, play a role in the model, and then quantitative work can sort out which ones are important. Indeed, in contrast to Woodford's assertion that intertemporal distortions are irrelevant for monetary policy, some New Monetarist models (for example Lagos and Wright 2005) imply that the welfare losses from intertemporal distortions are much larger than in traditional monetary models (for example Cooley and Hansen 1989).

Second, the cash/credit model gives the monetary authority control over a monetary quantity, not direct control over a market interest rate, the price level, or the inflation rate. In reality, the central bank intervenes mainly through exchanges of central bank liabilities for other assets, and through lending to financial institutions. Though central banks may conduct this intervention so as to target some market interest rate, it is important to model the means by which this is done. How else could we evaluate whether, for example, it is preferable in the short run for the central bank to target a short-term nominal interest rate or the growth rate in the aggregate money stock?

The cash/credit model above is certainly not intended to be taken seriously as a model to be used to analyze monetary policy. New monetarists are generally uncomfortable with New Keynesian sticky price models even when, for example in the model studied by Golosov and Lucas (2005), there are explicit costs to changing prices. The source of these "menu costs" is typically left unexplained, and it seems that we should consider many other types of costs in a firm's profit maximization problem if we take menu costs seriously.

8 New Monetarist Economics: An Example with a Payments System

The purpose of this section is to analyze an economy which is an extension of the benchmark New Monetarist model that incorporates payments arrangements. Along the lines of Freeman (1995), we construct an environment where outside money is important not only for accomplishing the exchange of goods but for supporting credit arrangements.

8.1 A Payments Model

We first modify the benchmark New Monetarist model by including two types of buyers and two types of sellers. A fraction α of buyers and a fraction α of sellers are *type 1 buyers and sellers*, respectively, and these buyers and sellers meet during the night in non-monitored matches. That is, when a type 1 buyer meets a type 1 seller, they can trade only if the buyer has money. As well, there are $1-\alpha$ type 2 buyers and $1-\alpha$ type type 2 sellers, who are also randomly matched during the night, but in monitored matches. A type 2 buyer can acquire goods from a type 2 seller in the night in exchange for an IOU. We assume, as in the New Keynesian model, that infinite punishments are available to enforce repayment in credit contracts.

During the day, type 1 sellers, and types 1 and 2 buyers, meet in the first Walrasian market, on which money is traded for goods, with ϕ_t^1 denoting the price of money in terms of goods. Then, bilateral meetings occur between the type 2 buyers and type 2 sellers who were matched during the previous night. Finally, type 1 buyers meet in the second Walrasian market with type 2 sellers, with the price of money denoted by ϕ_t^2. During the day, buyers can only produce in the Walrasian markets where they are present.

The government intervenes by making lump-sum money transfers in Walrasian markets during the day, so that there are two opportunities to intervene during any period. Lump-sum transfers are made in equal quantities to the sellers in the Walrasian market.

Our interest is in studying an equilibrium in this model where trade occurs as follows. First, in order to purchase goods during the night, type 1 buyers need money, which they can acquire either in the first Walrasian market or the second Walrasian market during the day. Arbitrage guarantees that $\phi_t^1 \geq \phi_t^2$, and we will be interested in the case where $\phi_t^1 > \phi_t^2$. Then, in the first Walrasian market during the day, type 2 buyers produce in exchange for the money held by type 1 sellers. Then, type 2 buyers meet type 2 sellers and repay the debts acquired in the previous night with money. Next, in the second Walrasian market during the day, type 2 sellers exchange money for the goods produced by type 1 buyers. Then, in the night, meetings between type 1 buyers and sellers involve the exchange of money for goods, while meetings between type 2 buyers and sellers are exchanges of IOUs for goods.

All bilateral meetings in the night involve exchange subject to a take-it-or-leave-it offer by the buyer. Letting q_t denote the quantity of goods received by a type 1 buyer in exchange for goods during the night, optimal choice of money balances by the type 1 buyer yields the first-order condition

$$-\phi_t^2 + \beta\phi_{t+1}^1 u'(q_t) = 0. \tag{34}$$

To repay his or her debt that supported the purchase of s_t units of goods, the type 2 buyer must acquire money in Walrasian market 1 at price ϕ_{t+1}^1, and then give the money to the type 2 seller, who then exchanges the money for goods in Walrasian market 2 at the price ϕ_{t+1}^2. Therefore, s_t satisfies the first-order condition

$$-\phi_{t+1}^1 + \phi_{t+1}^2 u'(s_t) = 0. \tag{35}$$

Now, let M_t^i denote the quantity of money (post transfer) supplied in the i^{th} Walrasian market during the day, for $i = 1, 2$. Then, market clearing in Walrasian markets 1 and 2, respectively, gives

$$(1-\alpha)s_{t-1} = \beta\phi_t^2 M_t^1, \tag{36}$$

$$\alpha q_t = \beta\phi_{t+1}^1 M_t^2. \tag{37}$$

8.2 Results

To solve for equilibrium quantities and prices, substitute for prices in (34) and (35) using (36) and (37) to obtain

$$-\frac{\alpha q_t}{M_t^2} + \frac{(1-\alpha)s_t u'(s_t)}{M_{t+1}^1} = 0, \tag{38}$$

$$-\frac{(1-\alpha)s_{t-1}}{\beta M_t^1} + \frac{\alpha q_t u'(q_t)}{M_t^2} = 0. \tag{39}$$

Then, given $\{M_t^1, M_t^2\}_{t=0}^{\infty}$, we can determine $\{q_t, s_t\}_{t=0}^{\infty}$ from (38) and (39), and then $\{\phi_t^1, \phi_t^2\}_{t=0}^{\infty}$ can be determined from (36) and (37). Note that, in general, intervention in both Walrasian markets matters. For example, suppose that $\frac{M_t^1}{M_t^2} = \gamma$ for all t, $\frac{M_{t+1}^i}{M_t^i} = \mu$, where $\gamma > 0$ and $\mu > \beta$, so that the ratio of money stocks in the two markets is constant for all t, and in individual Walrasian markets the money stock grows at a constant (and common) rate over time. Further, suppose that $u(c) = \ln c$. Then, in an equilibrium where $s_t = s$ for all t and $q_t = q$ for all t, where s and q are constants, from (38) and (39) we obtain

$$q = \frac{(1-\alpha)}{\alpha\gamma\mu},$$

$$s = \frac{\alpha\beta\gamma}{(1-\alpha)}.$$

Here, note that a higher money growth rate μ decreases the quantity of goods traded in cash transactions during the night, as is standard. However, a higher γ (relatively more cash in the first Walrasian market) will increase the quantity of goods exchanged in credit transactions and reduce goods exchanged in cash transactions during the night.

What is efficient here? To maximize total surplus in the two types of trades that occur, we need $q_t = s_t = q^*$ for all t. So from (38) and (39), this gives

$$\mu = \beta$$

$$\gamma = \frac{1-\alpha}{\alpha\beta}$$

at the optimum. Thus, in line with Friedman-rule-type results, money stocks should shrink over time at the rate of time preference, but we also require that the central bank make a money injection in the first Walrasian market that increases with the fraction of credit transactions relative to cash transactions, so as to support the optimal clearing and settlement of credit.

9 New Monetarist Economics: An Example with Banking

This example extends the benchmark New Monetarist model by including banking, in the spirit of Diamond and Dybvig (1983). Currency and credit are both used in transactions, and a diversified bank permits agents to insure against the event that they need currency to purchase goods.

9.1 Model

Just as in the payments model in the previous section, there are there are α type 1 sellers who engage in non-monitored exchange using currency during the night and $1-\alpha$ type 2 sellers who engage in monitored exchange. During the night there will be α type 1 buyers (each one matched with a type 1 seller) and $1-\alpha$ type 2 buyers (each one matched with a type 2 seller), but a buyer's type is random, and learned at the end of the previous day, after production and portfolio decisions are made. There exists an intertemporal storage technology, which takes as input the output produced by buyers during the afternoon of the day, and yields R units of the consumption good per unit input during the morning of the next day. Assume that $R > \frac{1}{\beta}$. All buyers and type 1 sellers are together in the Walrasian market that opens during the afternoon of the day, while only type 2 buyers are present during the morning of the day.

9.1.1 No Banking

To understand the role for banks, first suppose that banking is prohibited. To trade with a type 2 seller, a buyer needs to store goods during the day before meeting the seller at night. Then, since the trade is monitored, the seller is able to verify that the claim to storage offered in exchange for goods by the buyer is indeed what the buyer claims it to be. To trade with a type 1 seller, a buyer needs to have money on hand. Thus, during the afternoon of the day, the buyer acquires nominal money balances m_t and stores x_t units of output and therefore, given take-it-or-leave-it offers during the night, solves

$$\max_{m_t, x_t} -\phi_t m_t - x_t + \alpha u(\beta\phi_{t+1}m_t) + (1-\alpha)\left[u(\beta R x_t) + \beta\phi_{t+1}m_t\right],$$

and the first-order conditions for an optimum are

$$-\phi_t + \beta\phi_{t+1}\left[\alpha u'(q_t) + 1 - \alpha\right] = 0, \tag{40}$$

$$-1 + (1-\alpha)\beta R u'(s_t) = 0. \tag{41}$$

Assume that the monetary authority makes lump sum transfers during the afternoon of the day to buyers. Then, a Friedman rule is optimal, whereby the money supply grows at the gross rate β and $\frac{\phi_{t+1}}{\phi_t} = \frac{1}{\beta}$ in equilibrium. This implies from (40) that $q_t = q^*$, and an efficient quantity of output is traded when there is monetary exchange between buyers and sellers. However, claims to storage have no use for a buyer, so if the buyer does not meet a type 2 seller, the buyer's storage is wasted, even when the central bank runs the Friedman rule.

9.1.2 Banking

There is an insurance role for banks here, much as in Diamond-Dybvig (1983). A diversified bank can be formed in the afternoon of the day, which takes as deposits the output of buyers and issues Diamond-Dybvig deposit claims. For each unit deposited with the bank in period t, the bank permits the depositor to either withdraw $\hat{m}_t$ units of money at the end of the day, or have the right to trade away claims to $\hat{x}_t$ units of storage during the ensuing night. Assume that a buyer's type is publicly observable at the end of the day. Suppose the bank acquires d_t units of deposits from a depositor at the beginning of period t. The bank then chooses a portfolio of m_t units of money and x_t units of storage satisfying the constraint

$$d_t = \phi_t m_t + x_t \tag{42}$$

The bank then maximizes the expected utility of the depositor given the deposit d_t. If the bank is perfectly diversified (which it will be in equilibrium), then it offers agents who wish to withdraw $\hat{m}_t = \frac{m_t}{\alpha}$ units of currency, and permits agents who do not withdraw to trade away claims to $\hat{x}_t = \frac{x_t}{1-\alpha}$ units of storage. Then, the depositor's maximized expected utility is given by

$$\psi(d_t) = \max_{m_t, x_t}\left[\alpha u\left(\frac{\beta\phi_{t+1}m_t}{\alpha}\right) + (1-\alpha)u\left(\frac{\beta x_t R}{1-\alpha}\right)\right] \tag{43}$$

subject to (42). Then, letting q_t denote the quantity of output exchanged during the night in a monetary transaction, and s_t the quantity of output exchanged in a credit transaction, the first-order condition from the bank's problem gives

$$u'(q_t)\frac{\phi_{t+1}}{\phi_t} = u'(s_t)R. \tag{44}$$

Then, from (43) and using the envelope theorem, optimal choice of d_t by the depositor gives

$$u'(s_t) = \frac{1}{\beta R}, \tag{45}$$

which determines s_t, and then from (44) and (45) we get

$$u'(q_t) = \frac{\phi_t}{\beta \phi_{t+1}}, \tag{46}$$

which determines q_t. Note that, in equilibrium, all buyers choose the same deposit quantity in the day, and the bank is perfectly diversified and can thus fulfil the terms of the deposit contract.

Given the banking arrangement, the quantity of goods s_t traded in nighttime credit transactions is efficient. Without banking, not only is the quantity of goods traded in credit transactions inefficient, from (41), but some storage is wasted in every period. With banking, the quantity of goods q_t exchanged in monetary transactions during the night is efficient under the Friedman rule, under which the money growth factor is $\mu = \beta$, implying an equilibrium with $\frac{\phi_t}{\phi_{t+1}} = \beta$, so that (46) gives $q_t = q^*$.

Now, one policy that we can analyze in this model is Friedman's 100% reserve requirement. This effectively shuts down the financial intermediation arrangement and constrains buyers to holding outside money and storing independently, rather than holding deposits backed by outside money and storage. We then just revert to our solution where banking is prohibited, and we know that the resulting equilibrium allocation is inefficient. It would also be straightforward to consider, for example, random fluctuations in α or R, which would produce endogenous fluctuations in the quantity of inside money. Optimal monetary policy would involve a response to these shocks, but at the optimum the monetary authority should not want to smooth fluctuations in a monetary aggregate.

10 Conclusion

New Monetarists are committed to modeling approaches that are explicit about the frictions that make monetary exchange socially useful, and that capture the relationship among credit arrangements, banking, and currency transactions. Ideally, economic models that are designed for analyzing and evaluating monetary policy should be able to answer basic questions concerning the necessity and role of central banking, the superiority of one type of central bank operating procedure over another, and the differences in the effects of central bank lending and open market operations.

New Monetarist economists have made progress in advancing the understanding of the key frictions that make monetary exchange socially useful, and in the basic mechanisms by which monetary policy can correct intertemporal distortions. However, much remains to be learned about the sources of short-run nonneutralities of money and their quantitative significance, and the role of central banking. This paper takes stock of how a new monetarist approach can build on advances in monetary theory and the theory of financial intermediation and payments, constructing a basis for progress in the theory and practice of monetary policy.

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