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INFLATION TAXES AND INFLATION SUBSIDIES: EXPLAINING THE TWISTED RELATIONSHIP BETWEEN INFLATION AND OUTPUT

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This paper studies the nature of monetary policy in a cash-in-advance model with indivisible labor and with financial intermediaries that provide loans for working capital. Monetary policy occurs through money injections either directly to families or to financial intermediaries. Injections to families produce an inflation tax while injections directly to financial intermediaries provide an inflation subsidy that improves output, consumption, and welfare. This model helps explain why monetary policy based on growth in monetary aggregates can have ambiguous output effects, why central bankers usually prefer interest rate rules to monetary aggregate rules, and why estimated money demand equations tend to be unstable.

JEL classification codes: E31, E50, E52
Key words: inflation, output, working capital, monetary policy

I. Introduction

The relationship between output and money (or inflation) is not well understood. Even the data seem not to be clear about a relationship. Using long term data, McCandless and Weber (1995) show that the relationship for OECD countries is that higher inflation rates are correlated with higher output growth. However, when looking at Latin American countries they find that higher inflation rates are correlated with lower output growth. Econometric studies trying to find Granger causal relationships between money and output have generated very mixed results. Sims (1972) finds that money causes output but in later work (Sims 1980) finds that the Granger causal relationship pretty much disappears once interest rates are added to

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the VARs. The large literature on the instability of an estimated money demand equation (in which output is usually included) is further support on the complexity of the relationship.

In spite of this empirical confusion, many central bankers operate as if money causes output and, specifically, that appropriately timed money injections can increase output or (for example, following Friedman and Schwartz 1969 on the great depression) that withdrawals of money from the economy reduce output. While most (or at least many) central banks currently operate under interest rate rules or at least define their policy responses in terms of interest rates rather than in terms of monetary aggregates, they do this with the presumption that the interest rate rules work through some kind of money channel.

This paper combines and slightly modifies two existing models to put some order on the above observations. The basic model follows from Cooley and Hansen's (1989) model of a cash in advance economy. In this model, money is injected into the economy by, what is pejoratively called helicopter, money transfers to or withdrawals from the households. In this economy, positive lump sum transfers operate as a tax, reducing output and welfare.[1] The second model follows from Christiano (1991), Fuerst (1992), and Lucas (1990) and posits a working capital financial system where households deposit some of their money in a financial intermediary who then lends these funds to firms to pay the wage bill.[2] In this model, a central bank operates by making lump sum transfers or withdrawals of money to the financial system. Positive lump sum transfers to the financial system work as a subsidy, reducing the interest rate on borrowing and increasing output and welfare.

Injecting money directly into the financial system is an extremely simple way of modeling monetary policy. What most central banks really do is change interest rates (either discount rates or short term rates). One could model monetary policy this way.[3] Cooley and Quadrini (1999), in a complicated general equilibrium model with job search, have a central bank that does open market operations.

Models of real business cycles have been incorporating working capital as a way of generating a positive hump shaped response to a monetary impulse. Christiano

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[1] These transfers might include pay as you go social security transfers and unemployment compensation in an economy where the government is running a deficit.

[2] Williamson (2005) attributes "limited participation" models to Grossman and Weiss (1983) and Rotemberg (1984).

[3] Since money can enter the economy in various ways, using interest rate rules means that a central bank is changing the money that goes to the financial system.

(1991), Dotsey and Ireland (1995), and Christiano and Eichenbaum (1995) are examples of real business cycle models where variants of working capital are included in real business cycle models. The model studied here is more stripped down than theirs, there are fewer other elements added, and we get a clearer picture of the implications of how money enters the economy.

The main point of this paper is that it is not just the amount of money that is injected into an economy that matters, but where and how it is injected. Transfers to families, which are something like financing government deficits with money issue, and transfers to the financial system, which are a simplified version of pretty standard monetary policy, are very different. By looking at stationary states with money injections in this way, one can explain the different correlations found in the long run data for the OECD countries (which have mostly used monetary policy) and the Latin American countries (which have mostly used seigniorage). By looking at the dynamic properties of models with different sources of injections, one can explain why money demand equations have coefficients that change with time (and with the way money is injected) and why central banks prefer to use interest rate rules (since the interest rate policies determine the amount of money that goes to the financial system). Modeling money this way also gives some suggestions as to why Sims found that money ceased to have a Granger causal effect on output once interest rates were added to his VARs.

II. The model

The model is a simple cash in advance constraint model with a financial system that takes deposits from the households and lends to the firms working capital to finance the wage bill. There is a time cost to the household of spending their current income in the current period, a kind of search cost that implies that when they want to spend more of their current income quickly they do it less efficiently than if they spend it slower. This is done as a sort of compromise among the existing models, since some authors (for example, Cooley and Hansen 1989, Fuerst 1992, Ireland 2003, and Williamson 2005) choose to not allow current wage income to be used for current consumption while others (for example, Carlstrom and Fuerst 1995, Christiano and Eichenbaum 1995 and Christiano, Eichenbaum and Evans 1997) do. While, in general, households will spend part of their current wages, appropriate adjustment of the parameters of this cost function can generate equilibria at either extreme.

Timing and knowledge usually matter in these economies. Limited participation models are simply ones where the decisions about how much to deposit in the financial intermediary is made before the monetary shock is known. It is usually the case in a limited participation model that the deposit decision for period t is made at the "end" of period $t-1$. In the model presented here, the decision about how much to deposit in period t is made in period t, although the limited participation results will be mentioned. In any case, stationary states are independent of this timing decision.

A. Households

A unit mass of identical households maximize a utility function that depends on consumption and leisure, $1-h_t^i-v(\eta_t^i)$, where leisure is time available minus time spent working and time used to spend wage income quickly. The problem for household i is to maximize

$$E_0\sum_{t=0}^{\infty}\beta^t\left[\ln c_t^i + A\ln\left(1-h_t^i-v\left(\eta_t^i\right)\right)\right], \tag{1}$$

subject to the cash in advance constraint,

$$c_t^i = \frac{m_{t-1}^i}{P_t} + \eta_t^i w_t h_t^i + \chi\left(g_t-1\right)\frac{M_{t-1}}{P_t} - \frac{n_t^i}{P_t}, \tag{2}$$

and the flow budget constraint (with the cash in advance constraint removed),

$$\frac{m_t^i}{P_t} + k_{t+1}^i = \left(1-\eta_t^i\right)w_t h_t^i + r_t k_t^i + \left(1-\delta\right)k_t^i + r_t^n\frac{n_t^i}{P_t}. \tag{3}$$

The time cost of spending your salary rapidly is

$$v\left(\eta_t^i\right) = a\left(\eta_t^i\right)^{\varphi}, \tag{4}$$

where η_t^i is the fraction of period t wage income spent or deposited in a financial intermediary in period t by household i. In these equations, c_t^i is time t consumption of household i, h_t^i are the hours it worked, m_{t-1}^i the money it carried over from period $t-1$, k_{t+1}^i is its holdings of capital at the end of period t, and n_t^i are its period t nominal deposits in the financial intermediaries. The economy wide variables are prices, P_t, wages w_t, rental on capital, r_t, interest rate on deposits, r_t^n, the growth rate of money, g_t, the money stock from the last period, M_{t-1}, and the fraction of the new money that goes as lump sum transfers to households, χ.

This optimization problem results in six equations for the system, four first order conditions, the cash-in-advance constraint and the budget constraint. Since all households are identical, in equilibrium, $x_t^i = X_t$, for every household variable $x_t^i = \left\{c_t^i, h_t^i, k_{t+1}^i, m_t^i, n_t^i, \eta_t^i\right\}$, where capital letters denote aggregate values (except for η_t). The six equations, in aggregate terms, are

$$\frac{AC_t}{\left(1 - H_t - a(\eta_t)^{\varphi}\right)} = \left[\eta_t + \frac{1}{r_t^n}(1 - \eta_t)\right] w_t, \tag{5}$$

$$\left(1 - \frac{1}{r_t^n}\right) w_t H_t = \frac{AC_t \varphi\, a(\eta_t)^{\varphi - 1}}{\left(1 - H_t - a(\eta_t)^{\varphi}\right)}, \tag{6}$$

$$\frac{1}{r_t^n C_t} = \beta E_t \frac{1}{r_{t+1}^n C_{t+1}} \left[r_{t+1} + (1 - \delta)\right], \tag{7}$$

$$\frac{1}{r_t^n C_t} = \beta E_t \frac{1}{C_{t+1}} \frac{P_t}{P_{t+1}}, \tag{8}$$

$$C_t = \eta_t w_t H_t + \left[1 + \chi(g_t - 1)\right] \frac{M_{t-1}}{P_t} - \frac{N_t^i}{P_t}, \tag{9}$$

and

$$\frac{M_t}{P_t} + K_{t+1} = (1 - \eta_t) w_t H_t + r_t K_t + (1 - \delta) K_t + r_t^n \frac{N_t^i}{P_t}. \tag{10}$$

B. Households in a limited participation version

In a limited participation version of this model, the decision about deposits in the financial intermediaries for period t is made at the end of period t–1. The cash in advance constraint and the budget constraint become

$$c_t^i = \frac{m_{t-1}^i}{P_t} + \eta_t^i w_t h_t^i + \chi(g_t - 1) \frac{M_{t-1}^s}{P_t}, \tag{11}$$

and

$$\frac{m_t^i}{P_t} + k_{t+1}^i + \frac{n_{t+1}^i}{P_t} = (1 - \eta_t^i) w_t h_t^i + r_t k_t^i + (1 - \delta) k_t^i + r_t^n \frac{n_t^i}{P_t}. \tag{12}$$

With these changes in the constraints, the aggregate version of the first order conditions become

$$E_t \frac{1}{C_{t+1}} \frac{P_t}{P_{t+1}} = \beta E_t \frac{1}{C_{t+2}} r_{t+1}^n \frac{P_t}{P_{t+2}}, \tag{13}$$

$$\frac{A}{1 - H_t - a\left(\eta_t^i\right)^{\varphi}} = \left[\frac{1}{C_t}\eta_t + \beta E_t \frac{1}{C_{t+1}} \frac{P_t}{P_{t+1}}\left(1 - \eta_t\right)\right] w_t, \tag{14}$$

$$E_t \frac{1}{C_{t+1}} \frac{P_t}{P_{t+1}} = \beta E_t \frac{1}{C_{t+2}} \frac{P_{t+1}}{P_{t+2}}\left(r_{t+1} + \left(1 - \delta\right)\right), \tag{15}$$

$$\frac{A\varphi a\left(\eta_t^i\right)^{\varphi - 1}}{\left(1 - H_t - a\left(\eta_t^i\right)^{\varphi}\right)} = \left[\frac{1}{C_t} - \beta E_t \frac{1}{C_{t+1}} \frac{P_t}{P_{t+1}}\right] w_t H_t, \tag{16}$$

and the aggregate constraints are

$$C_t = \eta_t w_t H_t + \frac{M_{t-1}}{P_t} + \chi\left(g_t - 1\right)\frac{M_{t-1}^s}{P_t}, \tag{17}$$

and

$$\frac{M_t}{P_t} + K_{t+1} + \frac{N_{t+1}}{P_t} = \left(1 - \eta_t\right) w_t H_t + r_t K_t + \left(1 - \delta\right) K_t + r_t^n \frac{N_t}{P_t}. \tag{18}$$

Both M_t and N_{t+1} represent forms of holding money into period t+1. M_t is held as cash by the households and can be used for period t+1 consumption expenditures. N_{t+1} is held as bank deposits and cannot be used for period t+1 consumption expenditures. An equilibrium condition under limited participation is that the money supply $M_t^s = M_t + N_{t+1}$.

C. Firms

The production sector is standard and assumed to be perfectly competitive. The production function is Cobb-Douglas and can be written as

$$Y_t = \lambda_t K_t^{\theta} H_t^{1-\theta}, \tag{19}$$

where Y_t is aggregate output of the one good and technology, λ_t, follows the path

$$\ln \lambda_t = \gamma \ln \lambda_{t-1} + \varepsilon_t^{\lambda}, \tag{20}$$

with $0<\gamma<1$, and $\varepsilon_t^{\lambda} \sim N\left(0,\sigma^{\lambda}\right)$. Perfectly competitive factor markets give

$$r_t^f w_t = \left(1-\theta\right)\lambda_t K_t^{\theta} H_t^{-\theta}, \tag{21}$$

for the labor market, where r_t^f is the gross interest rate that the firms pay on the working capital they borrowed for the wage bill, and

$$r_t = \theta \lambda_t K_t^{\theta-1} H_t^{1-\theta}, \tag{22}$$

for the capital market.

D. Financial intermediaries

A set of perfectly competitive financial intermediaries have the budget constraint

$$N_t + \left(1-\chi\right)\left(g_t - 1\right) M_{t-1}^s = P_t w_t H_t. \tag{23}$$

All that they receive in deposits plus the transfers of new money from the government go to the firms for paying the nominal wage bill. If $\chi = 0$, then all new money issues go to the financial intermediary, if $\chi = 1$, they all go to the households. It is through the parameter χ that we can examine the effects of the different methods of injecting money into the economy.

Since the financial intermediaries are perfectly competitive, there is a zero profit condition of

$$r_t^n N_t = r_t^f P_t w_t H_t. \tag{24}$$

All the income they receive from the firms as payments on the loans are passed on to the depositors. Since the loans made and paid back inside period t and the technology shock is known when the loans are made, there is no uncertainty for the financial intermediaries and all loans are paid back in full. Setting up the model with a zero profit condition so that the financial intermediaries have marginal costs of funds that respond to monetary policy is an important change from Christiano

(1991), Fuerst (1992), and Lucas (1990) and the zero profit equation is one of the reasons the results of this model are quite different from theirs.

The monetary policy rule of the monetary authority follows the process

$$M_t^s = \overline{g} g_t M_{t-1}^s. \tag{25}$$

In the basic model, the equilibrium condition for the money stock is that $M_t^s = M_t$ and, in the limited participation version, the condition is $M_t^s = M_t + N_{t+1}$. Here, $\overline{g}$ is the stationary state growth rate of the money stock and the stochastic monetary shock g_t follows the process,

$$\ln g_t = \pi \ln g_{t-1} + \varepsilon_t^g, \tag{26}$$

with $0 < \pi < 1$, and $\varepsilon_t^g \sim N\left(0, \sigma^g\right)$. In addition, the monetary authority (or the central government) determines the value of the parameter χ. As the model is written, $\chi \in \left[0,1\right]$, but this paper only considers the two extreme cases where $\chi = 0$ or $\chi = 1$.

III. Stationary states

Writing the above system of equations[4] in aggregate terms and as stationary state values, we have the 11 variables, $\left\{ \overline{r}, \overline{w}, \overline{C}, \overline{Y}, \overline{K}, \overline{H}, \overline{N/P}, \overline{M/P}, \overline{r}^n, \overline{r}^f, \overline{\eta} \right\}$, and the 11 equations

$$\frac{A\overline{C}}{\overline{w}\left(1 - \overline{H} - a\left(\overline{\eta}\right)^{\varphi}\right)} = \overline{\eta} + \frac{1}{\overline{r}^n}\left(1 - \overline{\eta}\right), \tag{27}$$

$$\left(1 - \frac{1}{\overline{r}^n}\right)\overline{w}\overline{H} = \frac{A}{\left(1 - \overline{H} - a\left(\overline{\eta}\right)^{\varphi}\right)}\overline{C}\varphi a\left(\overline{\eta}\right)^{\varphi-1}, \tag{28}$$

$$\overline{r} = \frac{1}{\beta} - (1 - \delta), \tag{29}$$

$$\overline{r}^n = \frac{\overline{g}}{\beta}, \tag{30}$$

[4] The standard and the limited participation models reduce to the same stationary states.

$$\overline{C} = \left[1 + \chi(\overline{g} - 1)\right]\frac{\overline{M/P}}{\overline{g}} + \overline{\eta}\overline{w}\overline{H} - \overline{N/P}, \tag{31}$$

$$\overline{M/P} = (1 - \overline{\eta})\overline{w}\overline{H} + (r - \delta)\overline{K} + \overline{r}^{n}\overline{N/P}, \tag{32}$$

$$\overline{Y} = \overline{K}^{\theta}\overline{H}^{1-\theta}, \tag{33}$$

$$\overline{r}^{f}\overline{w} = (1 - \theta)\overline{K}^{\theta}\overline{H}^{-\theta}, \tag{34}$$

$$\overline{r} = \theta\overline{K}^{\theta-1}\overline{H}^{1-\theta}, \tag{35}$$

$$\overline{w}\overline{H} = \overline{N/P} + (1 - \chi)\left(1 - \frac{1}{\overline{g}}\right)\overline{M/P}, \tag{36}$$

$$\overline{r}^{n}\overline{N/P} = \overline{r}^{f}\overline{w}\overline{H}. \tag{37}$$

The stationary state growth rate of money, $\overline{g}$, is a choice variable for the central bank. The figures show a range of money growth rates of $\overline{g} \in [1, 1.5]$. The models are quarterly so a quarterly inflation rate of 1.5 is equivalent to an annualized rate of 506%. The stationary state values of the variables for this economy are shown in Figure 1, for the case where all the money injections go to the financial intermediaries, and in Figure 2, for the case where money injections go to the households. Three economies are shown in each graph (except for the graph of η). A graph is shown for the case where wages cannot be spent until the next period, $\eta = 0$, for the case where they can only be spent in the current period and there are no labor costs to spending quickly, $\eta = 1$ and $a = 0$, and for the case where there are labor costs for spending current wages in the current period. For the economies used in this paper, the parameters are $\beta = .99$, $\delta = .025$, $\theta = .36$, $A = 1.72$ for all economies and for the economy with labor costs for spending in the current period, $a = .056$, for all economies and $\varphi = 1.5$ for the economy with $\chi = 0$ and $\varphi = 1.3$ for the economy with $\chi = 1$.[5]

[5] The parameter values for the sample economy used in this paper come from Cooley and Hansen (1989), except for the values of a and φ which were chosen so that $v(\eta)$ is relatively small and that $\eta = 1$ when gross money growth is less than 1.5. The model is meant to be illustrative and the parameters chosen roughly represent those found for the United States in a number of studies.

Consider first the version of this economy where money injections go to the financial intermediary, where $\chi = 0$, shown in Figure 1. In these cases, where there are no costs to spending wages quickly, higher inflation rates are accompanied by higher output, wages, consumption, employment, capital and real money holdings. Borrowing interest rates decline (because of the money issued to the financial intermediaries) and so do real deposits in the financial system. Interestingly, this is true whether wages are included in the cash in advance constraint or not (for η equal to both 0 and 1), as long as there are no shopping costs. These models produce a Phillips curve type result where higher inflation is correlated with higher output.

Some might object to a model where additional inflation increases output without bound. Adding shopping costs makes the results more complicated and probably more realistic. Increasing inflation first improves the economy and later makes it worse off, at least until all current wages are consumed in the current period. Since, in the model, shopping costs no longer increase, increases in inflation then give results that parallel those of the no shopping cost economies. Putting shopping costs into the model is one way of partially taking into account the higher levels of velocity that are usually found in higher inflation economies. Velocity is further explored in the next section.

For the version where money injections go directly to the households, $\chi = 1$, higher stationary state inflation implies lower output, consumption, etc., and uniformly makes the households worse off. This is the standard Cooley-Hansen inflation tax result. Spending current wage in the current period reduces the effect of the tax and can be seen to mitigate the inflation tax (seen clearly in the graph for output, Y, in Figure 2).

A. Changes in velocity

Velocity is normally defined through an equation of exchange of the form

$$v = \frac{pY}{M}, \tag{38}$$

where the M used here is some definition of money. For our stationary state economies, we can write the above equation in terms of stationary state velocity, $\bar{v}$, as

$$\bar{v}_0 = \frac{\bar{Y}}{\overline{M / P}},. \tag{39}$$

when we define money as M_0 and as

$$\bar{v}_1 = \frac{\overline{Y}}{\overline{M/P} + \overline{N/P}}, \tag{40}$$

when we define money as M_1. For the case where $\chi = 0$, so all money injections go to the financial intermediaries, velocity as a function of the inflation rate is shown in the left hand side of Figure 3 and the case where $\chi = 1$ and money injections go directly to the families is shown in the right hand side of the same figure.

Velocity increases with inflation as individuals use more current wages to purchase current consumption. Once all of current wages are being used in the current period, $\bar{v}_0$ becomes constant, although $\bar{v}_1$ continues to rise with inflation, but much more slowly. As long as they can do so, increasing inflation causes households to consume faster. The fixed length periods in this cash-in-advance model mean that once all of current wages are being used for current consumption, there is no more the households can do to respond to higher inflation. In real economies with high inflation, wages tend to be paid more frequently than in lower inflation economies, so what we think of as a period becomes shorter.

IV. Dynamics

We use a log-linear version of the model to study the dynamic effects of a monetary shock on the economy.[6] Two points are important here. First, we want to see how the value of χ affects the dynamics: how the short term responses of the economy to a monetary shock change according to the way money is injected into the economy. Second, we want to consider the relative importance of the timing of the savings decision. In the basic model, the decision on how much money to deposit with the financial intermediary is made after the monetary shock is known. In limited participation models, the decision about how much to deposit for period t is made at the end of period $t-1$, before the monetary shock and the technology shock are known.

The impulse response functions shown below have been found using standard undetermined coefficients techniques that are described in Uhlig (1999) or McCandless (2008). The only minor complication occurred in the limited participation version of the model where the existence of two step ahead expectations required finding the roots of a cubic matrix equation rather than the quadratic equation described in

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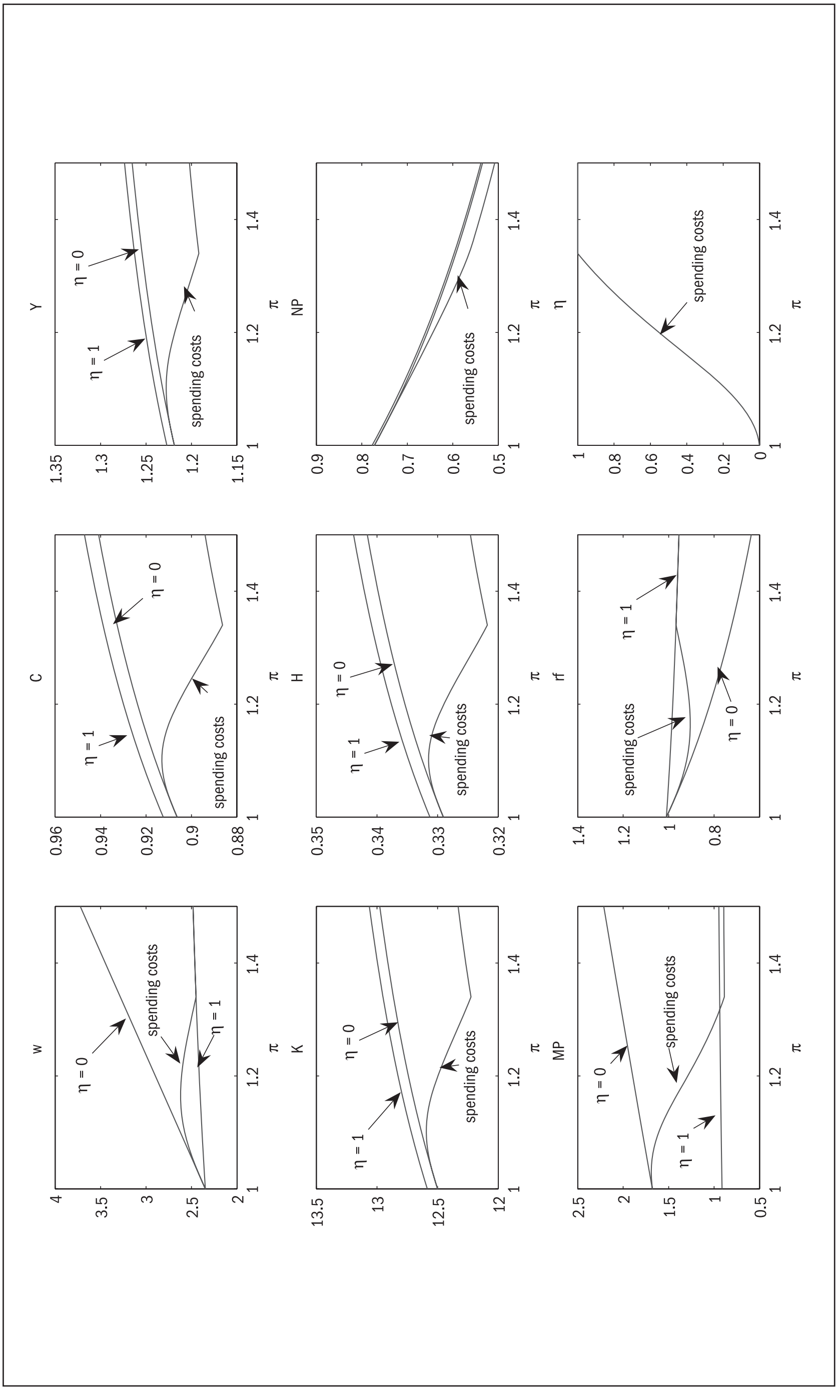
[6] The dynamic economy shown here is one with zero inflation in the stationary state, $\bar{g} = 1$. The basic features of the dynamics do not change for higher stationary state inflation rates.

Figure 1. Stationary states when $\chi = 0$



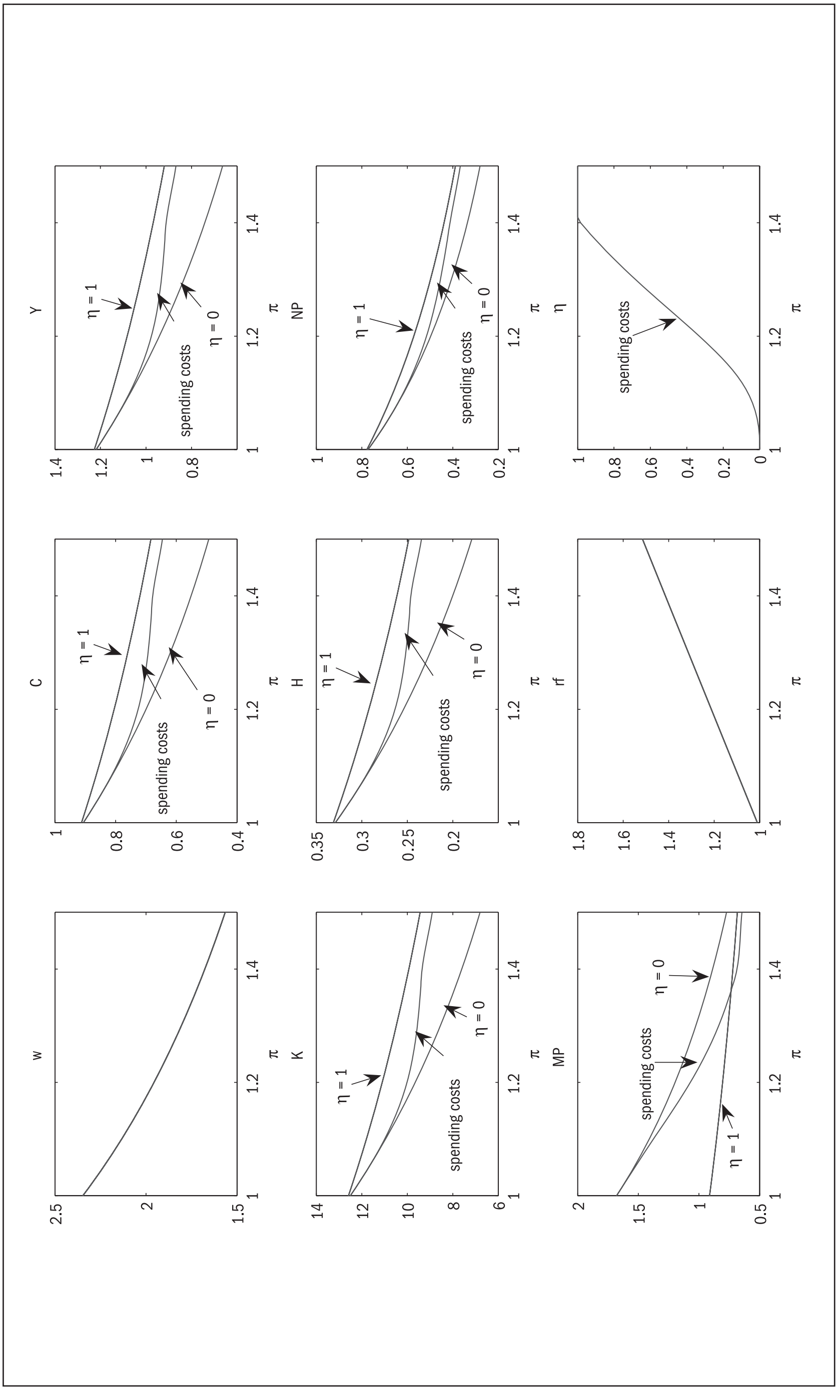
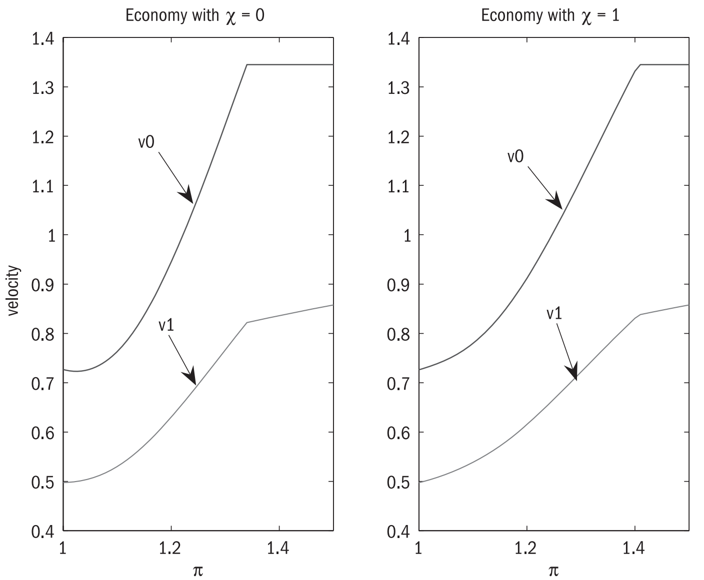


Figure 2. Stationary states when $\chi = 1$

Figure 3. Velocity for economies with labor costs for spending wages in current period



the references. The results are from rational expectations solutions of log-linear versions of the models, found around their stationary states. The coefficients used for examples are the same as were used for the stationary states found earlier with the addition of the coefficients of the error processes of $\gamma = .95$ and $\pi = .48$.

The set of dynamic models that we show is restricted to cases where wages are either completely included or excluded from the cash in advance constraint ($\eta = \{0,1\}$) and where deposits in the financial intermediary are made with or without knowledge of the aggregate shocks (an in-period version or a limited participation version). What we are really interested in is how the models respond to monetary shocks when monetary injections go directly to the households (and are included in the cash in advance constraint) or the monetary injections go to the financial intermediary.

Figures 4 shows the impulse response functions (in response to a .01 shock in the money growth rate in period 2) for the real variables in the basic model when $\chi = 0$, where the money transfer goes to the financial intermediaries, and Figure 5 shows them for the nominal variables. The graph on the left is the case where $\eta = 0$, current wages cannot be used for current consumption, and the one on the right shows the case for $\eta = 1$, where current wages can be used for current consumption. Figures 6 and 7 show the same response functions for the economy with $\chi = 1$, where the money transfers go directly to the households. The responses

Figure 4. Responses of the real variables in the basic model with $\chi = 0$

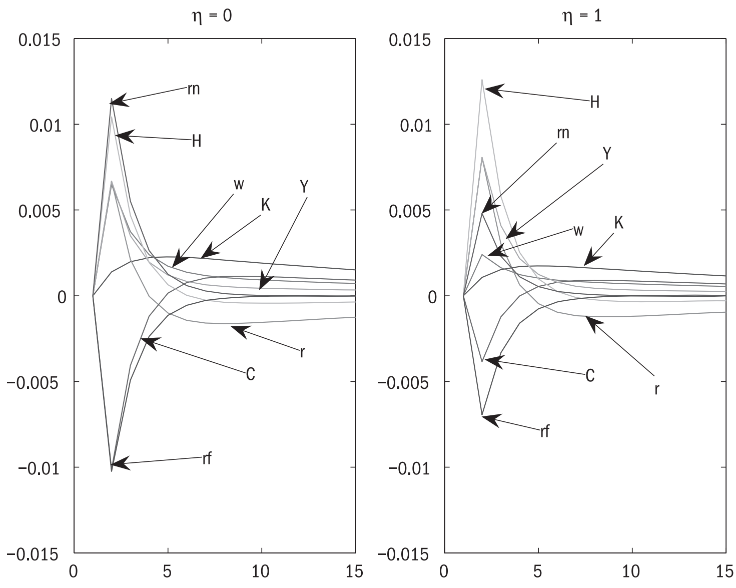


Figure 5. Responses of the nominal variables in the basic model with $\chi = 0$

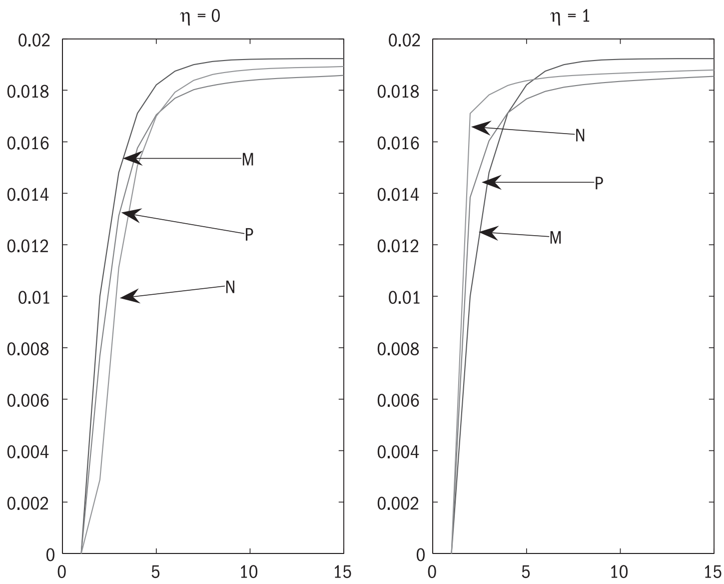


Figure 6. Responses of the real variables in the basic model with $\chi = 1$

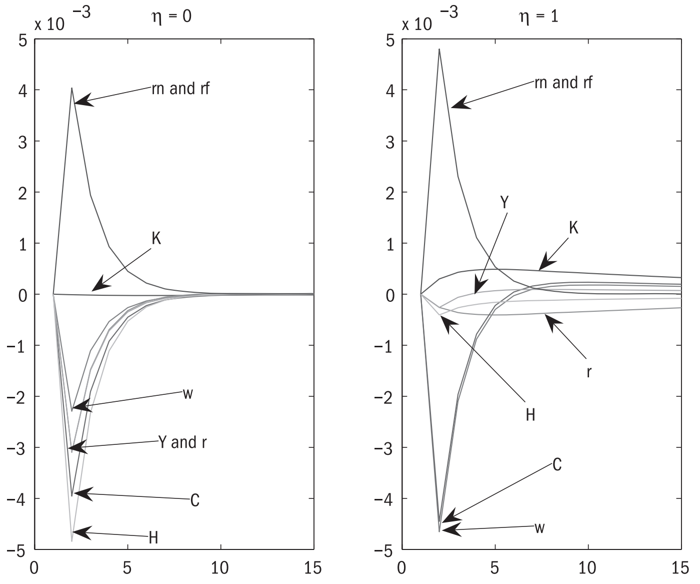
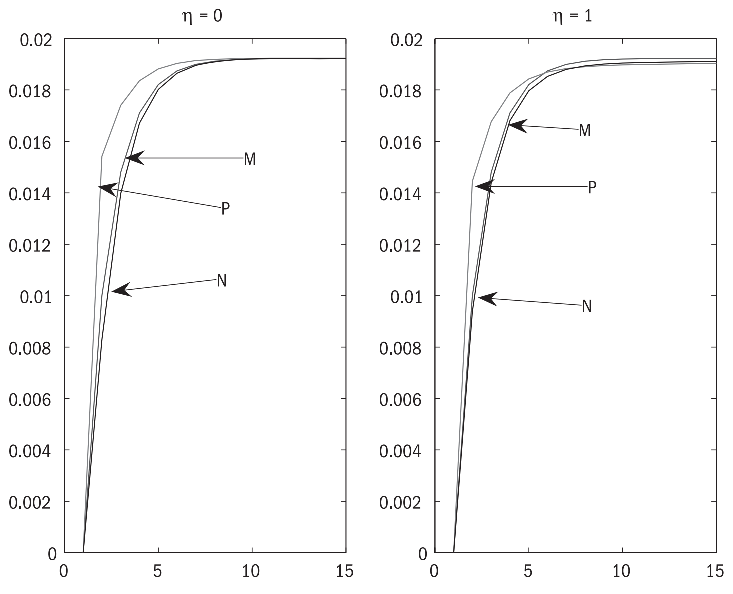


Figure 7. Responses of the nominal variables in the basic model with $\chi = 1$



of the economies are qualitatively similar for $\eta = 0$ or $\eta = 1$ when the values of χ are the same. While letting the households spend their wage income in the same period it is earned does change the dynamics a bit, the general direction of the responses are much the same as in the case where they must wait until the next period to spend their wage income. The biggest difference is in the case where the money transfers go directly to the households, where the responses of the labor supply, rental income and output are much smaller and the capital stock moves in the opposite direction.

However, the differences in economies with $\eta = 0$ or $\eta = 1$ pale compared to the differences between the responses caused by the injecting money into the economy through the household or the financial intermediary (between those economies with $\chi = 0$ and those where $\chi = 1$). For almost all economies, a monetary shock when injections go to the household ($\chi = 1$) results in declines in the real variables and increases in interest rates. For the economies where injections go to the financial intermediaries ($\chi = 0$), most real variables increase, although there is usually a short term drop in consumption. This drop in consumption is reverted after a couple of periods. These consumption declines mean that even in economies where output increases with inflation, in the short run it is not a free lunch.

The economy with the smallest negative response for real variables (except consumption) to a monetary transfer to the households is the basic economy with wages in the cash in advance constraint. I suggest that this economy is somewhat strange in its timing, things happen very fast. Households have wages in their cash in advance constraint and make their deposits decision including that wage. There is little in the way of lags in the financial sector: today's wages go into today's bank deposits that go into today's loans to the firms that are used to pay today's wages. Even for a quarterly model, such a turnover is very, probably too, fast. When a limited participation assumption is added that lags deposit decisions, as in Figure 10, the response functions are more similar to the others.

Figures 8 through 11 show the same set of response functions for a similar economy with limited participation (lp), where bank deposits are chosen before the monetary (or technology) shock is known. Here the differences caused by the value of η, whether wage income can be spent immediately or must be held to the next period, are much less and the differences caused by the location of money injections are even clearer. For the case in figure 8 where $\chi = 0$ and when $\eta = 1$ show the lagged effect that comes from combination of all of wages going into the cash in advance constraint and savings being determined in the previous period. However, correcting for that delay, the response functions are similar to those of the other models.

Figure 8. Responses of the real variables in the lp model with $\chi = 0$

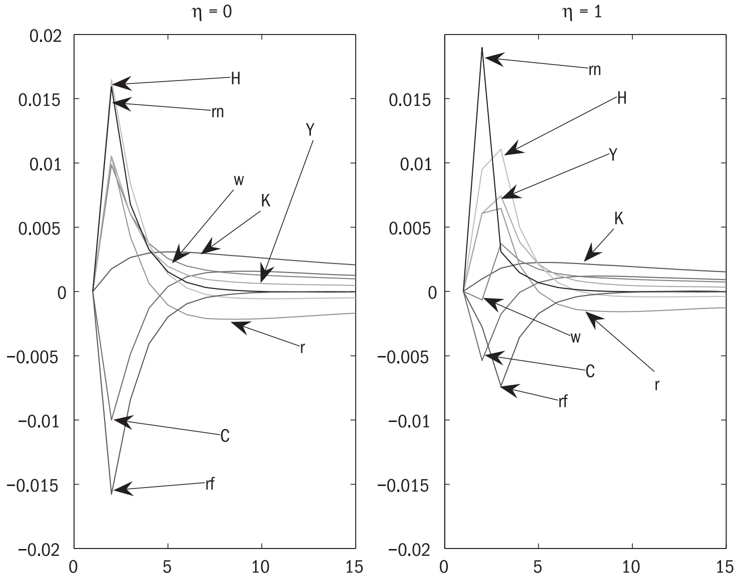


Figure 9. Responses of the nominal variables in the lp model with $\chi = 0$

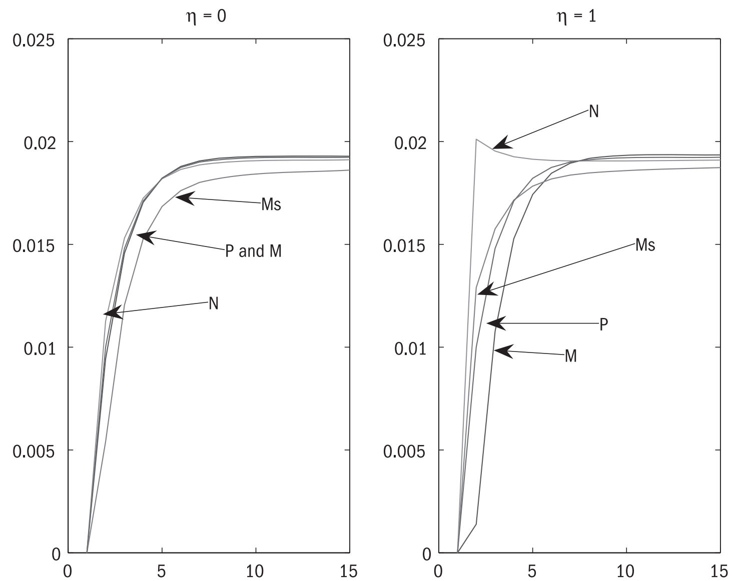


Figure 10. Responses of the real variables in the lp model with $\chi = 1$

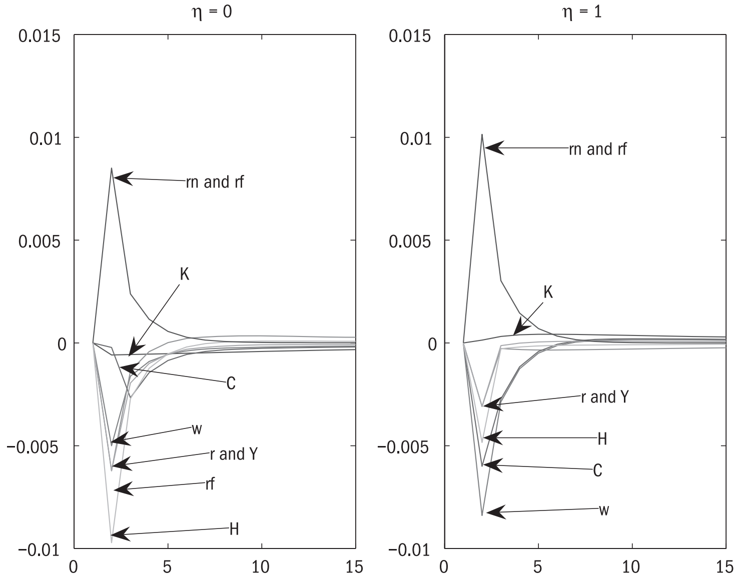
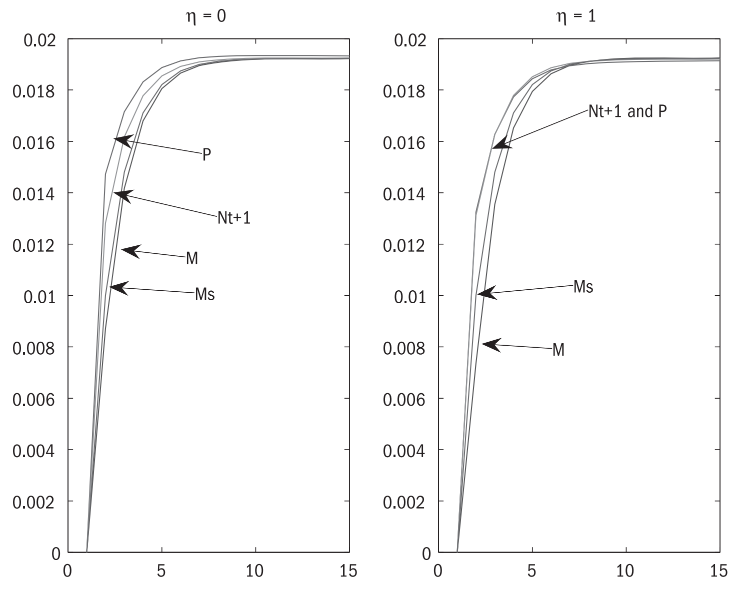


Figure 11. Responses of the nominal variables in the lp model with $\chi = 1$



V. Conclusions

There is a broad literature on monetary policy channels. Here I consider two possible money channels: lump sum transfers from the government directly to households, a policy that might be likened to a government paying its unemployment or retirement obligations by money creation, and transfers to financial intermediaries, a kind of subsidy to the financial system which may be likened to the effects of changing the interest rate at which banks can borrow from a central bank. I would suggest that both of these (and possibly other) channels are in operation in many countries and the relative importance of one or the other changes with time and the condition of the economy. What is particularly interesting about the two channels studied here is that they generate very different and, in general, diametrically opposed responses to the same size monetary shock. The characteristics of the two channels are fairly robust and are maintained in models where wages do or do not enter the cash in advance constraint and in models where the timing of the savings decision occurs before or after the monetary shock is known (as in the limited participation model). Lump sum money transfers directly to households function as a tax and similar transfers to the financial intermediaries function as a subsidy, changing the relative price of the factors of production that are bought with credit.

These results provide insights into a number of economic puzzles. Central banks prefer interest rate rules over monetary aggregate rules because interest rate rules work through the financial system and cause the financial intermediaries (in equilibrium) to borrow more or less from the central bank. Interest rate rules work exactly on the kind of money injections that are positively correlated with output in our model. Monetary aggregates are misleading (and have a ambiguous effect on output) because they are measuring a composite of the two types of money injections that are working with conflicting results.

Another result is the often mentioned instability of estimated money demand equations, which usually measure real effects on the economy as a function of monetary aggregates. Since the model says that there are two money demand equations, one for each channel of monetary injection, the aggregate money demand equation that econometricians try to estimate is a composite of these two equations where the weights between them change over time. Not surprisingly, it is difficult to find stable results for such an aggregate money demand equation.

The disparate results for the relationship between output and inflation (or money growth) in the OECD countries and Latin American that McCandless and Weber (1995) found can also be explained under this model, simply by looking at the results for stationary states. The long history of Latin American countries of using seigniorage as a way of covering their central government's expenses and the unimpressive growth performance of Latin America are consistent with this model. So is the much better growth record of the OECD countries, where central banks use "money issue" through open market operations (which go to the financial system) and where monetary policy has not generally been dominated by fiscal constraints. The model also points out why fiscal dominance ruins the effectiveness of monetary policy. Depending on how money enters the economy, inflation can be associated with output growth or decline. This paper shows quite clearly how the different forms of money injection, that is, of policy, provide reasonable, consistent explanations of the different relationships between money and output that have been observed.

The Granger causality relationships of Sims (1980) fit this model quite well. Since appropriately chosen interest rates do a good job of measuring the monetary policy effects on the financial system and are free of the mixed signal that comes from the composite of the two channels found in monetary aggregates, it is not surprising that money ceased to Granger cause output once interest rates were added to the VARs.

In the model presented here, monetary injections through financial intermediaries produce the hump shaped response to monetary injections that is found in the empirical literature.[7] This is true independent of whether the households know the money shock before or after they make their deposits decision and whether wages are in the cash in advance constraint or not. One need not have "limited participation" for the economy to produce this result. It is a direct outcome of the subsidy effect of money injections to the financial system. Economists have a lot of practice thinking about the effects of taxes and subsidies and using this experience is a useful way of thinking about monetary policy as well.

[7] See, for example, Christiano and Eichenbaum (1995) or Dotsey and Ireland (1995).

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