LIQUIDITY EFFECTS

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1. Conventional Wisdom

Much of the conventional wisdom stems from Friedman’s (1968a; 1968b) informal discussions and Cagan’s (1972) reduced-form evidence on how nominal interest rates respond to a permanent change in money growth. According to that wisdom, the interest rate response is broken into a “short-run,” a “medium-run,” and a “long-run” response. In the short run, when wages, prices, and portfolios do not adjust much, a monetary expansion raises bond prices and lowers nominal interest rates. This can be thought of as “sliding down a money demand function.” If prices do not much adjust, then agents are willing to hold the higher real money balances only if the opportunity cost of doing so declines. The “liquidity effect” dominates in the short run. The medium run is characterized as a horizon over which incomes begin to rise, but prices continue to lag. Higher income raises the demand for money, shifting up the demand function, and raising the nominal interest rate. (Some authors refer to this as a rise in the demand for loanable funds.) The “income effect” dominates in the medium run. In the long run, all nominal prices have adjusted fully and the permanent increase in money growth raises expected (and actual) inflation proportionally with the rise in money growth. Over this horizon, real variables—except the real money balances—return to their initial levels, reflecting the superneutrality of money, and the expected inflation effect dominates. Some economists refer to the long run as a period over which the Fisher relation holds. Friedman (1968a) was bold enough to say that the liquidity effect last about six months; the nominal interest rate returns to its initial level after 18 months; it can take decades to the long-run impacts to dominate.

Empirical work on liquidity effects, until recently, led to mixed results. As Leeper and Gordon (1992) document, in the absence of strong identifying assumptions, such as that the growth rate of the money supply is an exogenous process, there is no consistent evidence of liquidity effects in U.S. data. As that paper argues, either the liquidity effect truly is absent in the data or the reduced-form approaches have not successfully isolated exogenous movements in money growth. Identified VARs have had more success in producing the kinds of dynamic impacts that Friedman

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2. Theoretical Inadequacies

In the models we have seen so far, the Fisher equation dictates that higher current and expected money growth serves only to raise the nominal interest rate. That is, the models contain only an expected inflation effect and the liquidity effect is completely absent. Indeed, this same feature also makes such models inadequate for studying term structure, as they impose the expectations theory of the term structure holds exactly and movements in long-term interest rates largely reflect only changes in expected inflation, rather than expected changes in real interest rates. Lucas (1990) and Fuerst (1992) addressed the inadequacy of conventional monetary models by introducing a rudimentary banking system into cash-in-advance models [see Christiano (1991) for a nice overview].

3. A Limited Participation Model

Fuerst’s (1992) setup is designed to capture the liquidity effect and the loanable funds effect of the monetary transmission mechanism. Consider the impacts of a monetary injection. With excess cash balances, agents adjust their portfolios by buying other assets, such as bonds and capital, with the extra cash. This bids up the prices of the other assets and forces down their rates of return, generating a pure liquidity effect. The extra money is channeled into the economy through banks, as the open-market purchase increases bank reserves and induces banks to extend more loans. A higher supply of loanable funds forces down the interest rate on loans, generating the loanable funds effect. Eventually, both of these effects are dominated by rising income, and therefore money demand, and prices, and therefore expected inflation. At least at this verbal level, Fuerst’s model is in the spirit of Friedman’s (1968a) story.

Financial intermediaries serve two purposes. First, they bring together savers and borrowers. Second, they act as the funnel through which central banks cash injections occur. Loanable funds available to banks consist of previously deposited balances by savers and newly injected cash. Assume it is too costly for savers to change their investment decisions after each monetary injection—that is, portfolios are rigid. Then the supply of loanable funds is determined by the current monetary injection and only borrowers have access to this. In a world with uncertain monetary injections and uncertain loan demands, savers’ inability to alter investment decisions ex post...
has real consequences. Without uncertainty, the rigid portfolios make no difference because savers anticipate the injection and alter their behavior before it occurs.

When monetary injections are above average (or loan demand is below average), financial markets are “loose.” Similarly, when injections are below average (or loan demand is above), markets are “tight.” Notions of “loose” and “tight” are measured relative to a world where savers can alter their portfolios ex post. A larger-than-anticipated injection now has real effects. Borrowers are more liquid, so purchasing power is redistributed in their favor. They bid up asset prices, which decreases nominal interest rates. With borrowers cash rich, they increase their demand for goods. The opposite is true for non-borrowers. Hence, the injection alters the composition of current output toward goods borrowers consume. It is possible to generate a variety of effects, depending on the preferences of borrowers and non-borrowers.

If injections redistribute wealth from cash-rich to cash-poor agents through inflation taxes, this wealth redistribution lasts forever and one must keep track of it. This is difficult. Fuerst follows Lucas (1990) by lumping all sectors of the economy into a big family. During a period, each member of the family does his or her thing. At the end of the period, the family reunites and pools cash so no wealth effects occur from the injections. Hence, injections are asymmetric within a family, but symmetric across families. Eliminating the wealth effect implies that there are only transitory effects from monetary policy. This construct implicitly assumes the private economy can eventually “undo” the central bank action, so wealth risk is diversifiable.

We now specify a model.1 Recall that the distinction between the basic CIA and the Lucas-Fuerst models is that in the basic CIA portfolios are perfectly flexible—all decisions are made after the current realization of the monetary injection occur. Lucas and Fuerst have households make portfolio choices before the monetary injection is known—portfolios are rigid.

Households use money, $M_t$, to make loans to financial intermediaries and purchase consumption goods. They face the CIA constraint

$$P_tC_t \leq M_t - N_t,$$

where $N_t$ is deposits in the financial intermediary. There are four sources of cash at the beginning of each period. The household’s budget constraint is

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1This draws on Christiano (1991).
\[(M_t - N_t) + N_t = R_{t-1}N_{t-1} + F_{t-1} + D_{t-1} + W_{t-1}H_{t-1}, \quad (2)\]

where \(R_{t-1}\) is the gross nominal return on loans made at the beginning of \(t-1\) and paid at end of \(t-1\). This is an intra-temporal rate of return, in contrast to the usual interest rate, which is an inter-temporal rate of return.

In this setup the shopper gets \(M_t - N_t\) with which to buy \(C_t\). But as in the standard CIA model, the lack of synchronization between receipts and expenditures the paycheck that the worker receives cannot be transferred to the shopper within the period.

The crucial distinction between the basic CIA and this limited participation setup involves information. At time \(t\), in the basic CIA model, the household observes the current realizations of all shocks before making any decisions, so the date \(t\) information set for all decisions consists of all variables dated \(t\) and earlier. In the limited participation model, the household’s decision to lend to the intermediaries, \(N_t\), is contingent on shocks realized in periods \(t-j, j > 0\), but its choice of leisure, \(L_t\), is based on shocks realized in periods \(t-j, j \geq 0\). In both models the household takes as given \(\{M_t, R_t, P_t, W_t, F_t, D_t\}\) and forms expectations of \(\{M_{t+j}, R_{t+j}, P_{t+j}, W_{t+j}, F_{t+j}, D_{t+j}, j \geq 1\}\) and chooses \(C_t, L_t, N_t\) and contingency plans for \(\{C_{t+j}, L_{t+j}, N_{t+j}, j \geq 1\}\) to maximize

\[E_t \sum_{j=0}^{\infty} \beta^j u(C_{t+j}, L_{t+j}), \quad (3)\]

where the information sets on which the conditional expectation are based differ between the basic CIA and the limited participation models.

Firms in the two models face identical problems. They have the technology

\[f(K_t, z_tH_t) = K_t^\alpha (z_tH_t)^{1-\alpha} + (1 - \delta)K_t, \quad (4)\]

where \(z\) is a technology shock. Before hiring labor or investing, firms must borrow cash from the intermediaries. All cash accumulated in the previous period has been distributed through dividends, so firms carry no cash from one period to the next. Firms borrow the amount to finance both their wage bill and their investment

\[W_tH_t + P_tI_t, \quad (5)\]
where

\[ I_t = K_{t+1} - (1 - \delta)K_t. \]  

(6)

Dividends from the firm are

\[ D_t = P_tY_t - R_t(W_tH_t + P_tI_t). \]  

(7)

The quantity \( R_t(W_tH_t + P_tI_t) \) is the cash firms need to repay intermediaries at the end of period \( t \) for loans taken at the beginning of \( t \).

Firms face a tradeoff between current and future dividends. If they set \( I_t \) high they will generate higher future dividends but lower current dividends. Because firms are owned by households, we assume they behave in the interest of shareholders and that they value a dividend dollar in \( t \) by the marginal utility to households of that dollar at the end of \( t \). Firms maximize

\[ E_t \sum_{j=0}^{\infty} \left[ \beta^{j+1} \frac{u_{c,t+j+1}R_tP_t}{P_{t+j+1}} \right] D_{t+j}, \]  

(8)

where \( \beta^{j+1} \frac{u_{c,t+j+1}R_tP_t}{P_{t+j+1}} \) is the marginal utility of $1 received at the end of \( t + j \). Note that the subscript is for \( t + j + 1 \) because a dollar at the end of \( t + j \) cannot be spent until \( t + j + 1 \). Firms take \( \{u_{c,t+j}, P_{t+j}, W_{t+j}, R_{t+j}, j \geq 0\} \) as given functions of shocks realized at \( t + j \) and earlier. In both models, firms maximize (8) by choice of contingency plans for \( \{I_{t+j}, H_{t+j}\} \) as functions of shocks at \( t + j \) and earlier, for \( j \geq 0 \).

Financial intermediaries accept loans \( N_t \) from the household, which are repaid at the end of \( t \) at gross interest rate \( R_t \). The intermediary receives cash injections \( X_t \) from the monetary authority, which is lends to firms at rate \( R_t \). This is distributed to households as dividends:

\[ F_t = R_tX_t. \]  

(9)

Equilibrium requires market clearing. The conditions are: in the loan market,

\[ W_tH_t + P_tI_t = N_t + X_t, \]  

(10)

in the labor market,

\[ H_t = L_t, \]  

(11)

and in the goods market,
\[ C_t + I_t = Y_t. \]  (12)

Combining the CIA constraint at equality with loan market clearing implies the money market clears:

\[ P_tC_t + W_tH_t + P_tI_t = M_t + X_t = M_{t+1}. \]  (13)

We can now discuss the margins in the two models. Employment margins are the same in the two models. Let \(-u_{L,t} = -\partial u(C_t,L_t)/\partial L_t\), evaluated at the optimal choices, and \(u_{C,t+1} = \partial u(C_{t+1},L_{t+1})/\partial C_{t+1}\), also evaluated at the optimal choices. Then

\[-u_{L,t} = \frac{W_t}{P_t} \beta E_t u_{C,t+1}\left(\frac{P_t}{P_{t+1}}\right), \]  (14)

where \(W_t/P_{t+1}\) is the real value of the nominal wage, since labor earning cannot be spent until the next period. Firms borrow to pay the wage bill. Letting \(f_{H,t} = \partial f(K_t,z_tH_t)/\partial H_t\), the firm’s first-order condition is

\[ \frac{W_t R_t}{P_t} = f_{H,t}. \]  (15)

In (15), firms borrow \$1 at the beginning of \(t\), which costs them \(R_t\) at the end of \(t\). They use the \$1 to hire \(1/W_t\) units of time, which increases the firm’s revenue by \(P_t f_{H,t}/W_t\).

We turn now to savings/investment decisions. In the basic CIA model, if the household increases saving, \(N_t\), by \$1, the cost of doing so, in units of goods is \(1/P_t\), and the utility cost is \(u_{C,t}/P_t\). The benefit from \$1 higher saving is the household receives \(R_t\) from the intermediary, which has real value in \(t+1\), when it can be spent, of \(R_t/P_{t+1}\). That real value, in expected utility terms discounted back to period \(t\), is \(\beta R_t E_t u_{C,t+1}/P_{t+1}\), yielding the first-order condition

\[ \frac{u_{C,t}}{P_t} = \beta R_tE_t \frac{u_{C,t+1}}{P_{t+1}}. \]  (16)

(16) implies

\[ R_t = \frac{u_{C,t}}{P_t} \left[ \beta E_t \frac{u_{C,t+1}}{P_{t+1}} \right]^{-1} = \left\{ E_t \left[ \beta \frac{u_{C,t+1}}{u_{C,t}} \frac{P_t}{P_{t+1}} \right]^{-1} \right\}, \]  (17)

so the household chooses \(N_t\) to equate the relative utility value of \$1 in \(t\) and \(t+1\) to \(R_t\).
Note that in the basic CIA, interest rates are governed by what Fuerst refers to as “Fisherian fundamentals,” meaning the nominal rate equals the real rate plus expected inflation. To see this, we price a real bond that pays interest rate $r_t$:

$$r_t = \left[ \beta E_t \frac{u_{C,t+1}}{u_{C,t}} \right]^{-1}. \tag{18}$$

Rewrite (17) as

$$R_t = r_t E_t \left( \frac{1}{\pi_{t+1}} \right) + \text{cov}_t \left( \beta \frac{u_{C,t+1}}{u_{C,t}} \frac{P_t}{P_{t+1}} \right) \left( \frac{1}{\pi_{t+1}} \right)^{-1}, \tag{19}$$

where $\pi_{t+1} = P_{t+1}/P_t$. Without uncertainty, $R_t = r_t \pi_{t+1}$, exactly the Fisher relation we see in undergraduate textbooks. If $\text{cov}_t \left( \beta \frac{u_{C,t+1}}{u_{C,t}} \frac{P_t}{P_{t+1}} \right)$ is small, then it is still the case that $R_t \approx r_t \left( E_t \frac{1}{\pi_{t+1}} \right)^{-1} \approx r_t + E_t \pi_{t+1}$.

Hence, in the basic CIA model, the nominal interest rate, $R_t$, is determined by Fisherian fundamentals. This is an immediately outgrowth of allowing households to adjust their savings/lending decisions, manifested in $N_t$, quickly.

We now examine the limited participation model. Recall that in the basic CIA there is neutrality of surprise monetary injections because all cash expenditures—by both households and firms—increase in the same proportion as $M$. This requires that $N_t$ falls when $X_t$ rises. Suppose instead that $N_t$ is chosen before $X_t$ is realized (and agents know $P_t, R_t, W_t$). Then $N_t$ cannot change with $X_t$. This is the essence of the rigid portfolio assumption. If $N_t$ is fixed, the more of the extra money is absorbed by firms. But firms will absorb this extra money only if $R_t$ falls. With more cash on hand, firms will be able to hire more workers and investment more. Another important component if this setup is that the extra cash gets injected into the financial intermediary, which is then able to extend more loans to the firms. Hence, it matters how $M$ gets injected into the model.

This central result arises by breaking the link between $R_t$ and Fisherian fundamentals. Now equation (16), the asset pricing equation for deposits into the financial intermediary, $N_t$, no longer holds. If households must make their portfolio decision before they observe the monetary injection, this condition is transformed to

$$E_{t-1} \frac{u_{C,t}}{P_t} = \beta E_{t-1} R_t \frac{u_{C,t+1}}{P_{t+1}}. \tag{20}$$

Define

$$\Lambda_t = R_tE_t \beta \frac{u_{C,t+1}}{P_{t+1}} - \frac{u_{C,t}}{P_t}. \tag{21}$$
and note that \( E_{t-1} \Lambda_t = 0 \). Now we find that the nominal interest rate is given by

\[
R_t = \frac{\Lambda_t + u_{C,t}/P_t}{\beta E_t[u_{C,t+1}/P_{t+1}]}. \tag{22}
\]

(22) is the limited participation version of the standard Fisher equation in (17).

\( \Lambda_t \) is the liquidity effect. It reflects the value of a dollar in the loan market relative to the goods market. In Fuerst’s original formulation, he expressed it as

\[
\Lambda_t = \frac{\lambda_2 - \lambda_1}{M_t}, \tag{23}
\]

where \( \lambda_2 \) is the shadow price of borrowing and \( \lambda_1 \) is the shadow price of money. In any case, \( \Lambda_t < 0 \) implies that money is more valuable in the goods market since households would be willing to borrow at a rate higher than \( R_t \) if they could, while firms are willing to borrow at rate \( R_t \). In this case, financial markets are relatively liquid, so \( R_t \) is low. When \( \Lambda_t > 0 \) money is more valuable in the loan market. Financial markets are relatively illiquid (while the goods market is liquid), so \( R_t \) is high.

Note that because \( E_{t-1} \Lambda_t = 0 \) implies that \( EA_t = 0 \), on average \( R_t \) is determined by Fisherian fundamentals, even thought it is not on a period-by-period basis.

References


