Liquidity, Financial Intermediation, and Monetary Policy in a New Monetarist Model

Stephen Williamson
Washington University St. Louis
Richmond Fed
St. Louis Fed

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Questions:

- What is the role of a central bank?
- What is a liquid asset, and what roles do privately-provided and publicly-provided liquid assets play in exchange?
- Do open market operations matter, and if so, why?
- How do we organize our thinking about the financial crisis and the monetary policy response to it?
- What are the effects of central bank purchases of private assets?
- How does monetary policy work when there is a positive stock of excess reserves?
Plan for the Talk

- Model:
  - Lagos-Wright structure
  - financial intermediaries - hold government bonds and make private loans; can also borrow from the central bank and hold interest-bearing reserves.
  - currency and intermediary deposits exchanged in retail transactions.

- Fiscal policy is important - matters whether it is “passive” with respect to monetary policy, or fixed in some fashion.

- Determine effects of open market operations - sometimes matters in unconventional ways, sometimes not.

- Look at effects of “quantitative easing.”

- Show how monetary policy works with a positive quantity of excess reserves in the system.
**Model**

- Basic structure from Lagos-Wright (2005)
- Some results related to: Lagos (2008), Lagos-Rocheteau (2008), Lester-Postlewaite-Wright (2009)
- \( t = 0, 1, 2, \ldots \), and two subperiods, day (centralized trading) and night (decentralized trading).
- Continuum of buyers with unit mass, each having preferences
  \[
  E_0 \sum_{t=0}^{\infty} \beta^t \left[ -H_t + u(x_t) \right],
  \]
  Define \( x^* \) by \( u'(x^*) = 1 \).
- Continuum of sellers with unit mass, each having preferences
  \[
  E_0 \sum_{t=0}^{\infty} \beta^t \left[ X_t - h_t \right],
  \]
• Production: one unit labor supply produces one unit output for buyers in the day and for sellers in the night.
• Each period, a continuum of entrepreneurs with mass $\alpha$ is born, and each lives until the day of the following period.
• Each entrepreneur risk neutral, consumes in the next day.
• Has access to an investment project - requires one unit consumption good as input, yields return $w$ the next day.
• Project returns i.i.d. across entrepreneurs.
• Distribution function $F(w)$; density function $f(w)$ strictly positive on $[0, \bar{w}]$, where $\bar{w} > 0$.
• Costly state verification - verification cost $\gamma$ specific to the entrepreneur.
• $G(\gamma)$ denotes the distribution of verification costs across entrepreneurs, with $\gamma \geq 0$. 
• Day: Everyone meets in the same place, and trade on a Walrasian market.

• Night: Each buyer matched at random with a seller - buyer makes a take-it-or-leave-it offer.

\[ \rho = \text{fraction of nighttime bilateral meetings not monitored} \]

\[ 1 - \rho = \text{fraction of monitored meetings at night - can trade claims to payoffs on investment projects.} \]

• Personal IOUs never accepted at night - buyer’s history not observable.

• Currency necessary to trade in non-monitored meetings,

• Buyer does not know type of meeting in the subsequent night when production, consumption decisions made in the day - learns this at the end of the day.
Costs Associated With Currency Exchange

- Will be important ultimately for getting the model to fit the facts.
- Want to include a factor or factors that imply some inefficiency from the use of currency.
- Could include counterfeiting of currency, exchange of counterfeit goods, exchange of illegal goods and services, tax evasion, costs of maintaining the currency stock.
- Simple approach: 2 costs of currency exchange
  - costs of maintaining the stock of currency (replace worn-out notes and design notes to prevent counterfeiting): proportional to real stock of currency in the daytime centralized market.
  - fraction $\nu$ of nonmonitored exchanges (fraction $\rho \nu$ of nighttime trades) have no value to society.
Standard costly state verification intermediary structure - comes directly from Williamson (1987).

Intermediary diversifies perfectly across loans to entrepreneurs - delegated monitoring (Diamond).

Zero profits:

\[ r = R(\gamma) - \gamma F[R(\gamma)] - \int_{0}^{R(\gamma)} F(w) \, dw \]

Default premium for entrepreneur \( \gamma \):

\[ D(\gamma) = \gamma F[R(\gamma)] + \int_{0}^{R(\gamma)} F(w) \, dw \]
Marginal borrower \((\gamma^*, R^*)\) solving

\[
1 - \gamma^* f(R^*) - F(R^*) = 0,
\]

\[
r = R^* - \gamma^* F(R^*) - \int_0^{R^*} F(w) \, dw
\]

Total loans:

\[
L = \alpha G(\gamma^*),
\]

or more simply,

\[
L = L(r).
\]
Government

- Fiscal authority
  - taxes buyers lump sum during the day.
  - issues one-period nominal bonds to finance the deficit - bonds are deposits with the Treasury.

- Central bank - a financial intermediary, owned by the government.
  - has a monopoly on currency issue.
  - liabilities are currency, reserves (deposits).
  - assets are nominal bonds issued by the fiscal authority, loans to the banks, and direct loans to entrepreneurs.

- Consolidated government budget constraints:

\[
\begin{align*}
\phi_t(M_t + B_t + E_t - F_t) - K_t + \tau_t \\
= \phi_t(M_{t-1} + q_t B_{t-1} + s_t E_{t-1} - w_t F_{t-1}) - r_t K_{t-1}.
\end{align*}
\]

\[
\phi_0(M_0 + B_0 + E_0 - F_0) - K_0 + \tau_0 = 0.
\]
Set $K_t = E_t = 0$ for now.

Confine attention to policies where total nominal debt outstanding, $M_t + B_t - F_t$, grows at gross rate $\mu$, and the ratio of currency to total debt outstanding is a constant,

$$M_t = \delta (M_t + B_t - F_t), \text{ for all } t.$$

If $\bar{B}_t = \text{bonds issued by the fiscal authority}$, and given the central bank’s balance sheet constraint, $M_t = F_t + \bar{B}_t - B_t$, we have

$$\delta = 1 + \frac{F_t - B_t}{\bar{B}_t}$$

Implies that we cannot rule out any $\delta \in (-\infty, \infty)$ at this stage.
At the beginning of the day, bank issues deposits to buyers and acquires a portfolio of currency, loans to entrepreneurs, government bonds, and borrows from the central bank.

At the end of the day, buyers learn their types, and those who need it withdraw currency from the bank.

At night, buyers meet sellers and purchase goods with currency or deposit claims.

In equilibrium, bank gets payoff $r_t$ on all assets - diversified loan portfolio, government bonds, reserves, etc., and

$$\frac{\phi_{t+1}}{\phi_t} \leq r_t \leq \frac{1}{\beta}. $$
Bank’s Problem

Choose \( (m, a, m', a') \) to maximize the expected utility of the representative depositor (a characterization of equilibrium).

- \( m = \) real currency balances acquired by the bank.
- \( a = \) other assets acquired by the bank.
- \( m' = \) cash put in the ATM machine for non-monitored depositors to withdraw.
- \( a' = \) assets that are not traded away (through trade of deposits) during the night.

\[
\max_{m,a,m',a'} \left( -m - a + \rho u \left( \beta \frac{\phi_{t+1} m'}{\phi_t} \right) \right)
+ (1 - \rho) \left\{ u \left[ \beta r_{t+1} \left( \frac{a-a'}{1-\rho} \right) + \beta \frac{\phi_{t+1} (m-m')}{\phi_t (1-\rho)} \right] + \beta r_{t+1} \frac{a'}{1-\rho} \right\}
\]
Central bank sets \((\delta, \mu)\), and fiscal authority levies whatever lump-sum taxes support that policy.

**asset market-clearing condition:**

\[
a = \left(\frac{1}{\delta} - 1\right) m + L(r),
\]

**taxes:**

\[
\tau = -\frac{m}{\delta} \left(1 - \frac{1}{\mu}\right) + \left(\frac{1}{\delta} - 1\right) m \left(r - \frac{1}{\mu}\right),
\]

\[
\tau_0 = -\frac{m}{\delta}.
\]
Four Types of Equilibria

- **Liquidity Trap:** $\frac{1}{\mu} = r < \frac{1}{\beta}$
  - Currency and other assets all carry a liquidity premium (they are collectively scarce), and all these assets are traded every night.
  - Banks in general will hold some outside money as reserves.
  - $\delta$ irrelevant - open market operations do not matter for quantities or prices.

- **Plentiful interest-bearing Assets:** $\frac{1}{\mu} < r = \frac{1}{\beta}$
  - Currency carries a liquidity premium, other assets do not; not all other assets traded in the night.
  - One-time open market operation just changes prices.

- **Scarce interest-bearing assets:** $\frac{1}{\mu} < r < \frac{1}{\beta}$
  - Currency and other assets both carry a liquidity premium; all assets are traded at night.
  - Open market operations matter: $\delta$ increases and $r$ falls, $a$ falls, $L(r)$ rises, even though price level rises in proportion - less liquidity, less goods exchanged in the night, but more investment projects funded and potentially more output in the day.
Equilibria: $L \left( \frac{1}{\beta} \right) < (1-\beta) x^*$
Equilibria: $(1-\beta)x^* < \xi(\overline{\beta}) < x^*$
Equilibria: $x^* < c(\beta)$. 

Diagram with regions labeled 'plentiful' and 'scarce'.
Demand and Supply of Assets - Scarce Assets Case

\[ (1-\rho)\omega(r) \]

\[ L(r) + \frac{(1-\delta)\rho m}{\delta} \]

Liquidity
Increase in $\delta$ - Scarce Assets

\[
\frac{(1-\rho)\omega(r)}{(1-\delta)\rho m/\delta} - \text{Liquidity}
\]
Friedman Rule Equilibrium

- $\frac{1}{\mu} = r = \frac{1}{\beta}$
  - Achieve this with $\mu = \beta$ and any $\delta$.
  - This is efficient - maximizes nighttime surplus (all buyers consume $x^*$), and the intermediation sector efficiently allocates resources between buyers/sellers and entrepreneurs for any $r$.

- For example:
  - $\delta \rightarrow \infty$ implies zero taxes forever - central bank lends out the cash, then retires it over time.
  - $\delta = 1$ implies standard pure currency world with lump sum taxation supporting Friedman rule.

- Undesirable feature: Friedman rule implies an equilibrium where
  - all transactions carried out with currency.
  - banks serve only a delegated monitoring role - no bank deposits exchanged.
  - bad things can happen in the intermediation sector - low payoffs on investment, higher risk, higher verification costs - but no implications for exchange and monetary policy.
Assume the fiscal authority fixes the deficit at $\sigma$, in real terms, forever, and the central bank chooses how the deficit is financed.

$$\sigma = \frac{m}{\delta} \left( 1 - \frac{1}{\mu} \right).$$

Write welfare as social surplus from non-monitored trade + surplus from monitored trade - costs of maintaining currency, or

$$W = \rho [(1 - v)u(x_n) - x_n] + (1 - \rho)[u(x_m) - x_m] - \frac{\rho x_n \omega}{\beta}.$$
Example - Square Root Utility

- $u(x) = 2x^{\frac{1}{2}}$, $\alpha = 0$ (no entrepreneurs).
- Can get multiple equilibria - given $\delta$ (monetary policy), there can be more than one $\mu$ that finances the deficit.
- Laffer curve phenomenon.
Example: $u(x) = 2x^{\frac{1}{2}}$, $x = 0$.

Policy Menu.
Optimal Policy - Log Utility Example

- $u(x) = \log(x)$; $L(r) = \alpha - \psi r$.
- Unconstrained monetary policy implies
  $$\mu = \mu^* = \frac{\beta + \omega}{1 - \nu}.$$ 
and $\delta$ sufficiently small - implies efficient monitored exchange and efficient taxation of currency transactions.
- Look at the case $\sigma > 0$, and consider constrained monetary policy:
  - $\sigma$ sufficiently large implies that unconstrained policy is optimal.
  - could be that optimal policy implies scarce interest-bearing assets or a liquidity trap, in which case $\mu < \mu^*$
  - higher inflation taxes currency transactions, which is good, but can reduce public liquidity, which is bad.
- Optimal policy with scarce assets:
  - Optimal $(\delta, \mu)$ depends on all parameters
  - Higher $\psi$ implies less private liquidity (less lending) and $\mu$ and $\delta$ fall, which increases $r$. 

Williamson ()

Liquidity, Financial Intermediation, and Money
Example: \( u(x) = \log(x) \), \( L(r) = \alpha - \frac{4r}{1-\alpha} \) 

\( 1 - \alpha > 0 \).
Suppose banks hold interest-bearing reserves in equilibrium.

- Equilibrium now works in a different way - effectively the central bank chooses \( r \), the interest rate on reserves, then \( \delta \) determined endogenously so that all assets bear interest rate \( r \).
- Open market purchases do not matter (reserves identical to T-bills).
- Monetary policy works by changing \( r \) - lower \( r \) implies higher \( \delta \), less reserves held, and higher price level (except in a liquidity trap equilibrium).

Private Asset Purchases by the central bank.

- Lending on same terms as by private sector implies irrelevance.
- Lending on better terms implies reallocation of credit, losses on central bank portfolio.
Consider what Larry Christiano would call a “risk shock” (also in Williamson 1987)

Mean-preserving spread in the payoff distribution for entrepreneurs, $F(\cdot)$, which

- increases default premia (spreads).
- reduces $L(r)$ for each $r$.
- reduces lending.
- tends to reduce $r$.

Supply of liquid assets has fallen, so central bank should reduce $\delta$, which implies that $\mu$ falls - increases public liquidity to compensate for the reduction in private liquidity - but note this is an open market sale rather than an open market purchase.
Conclusions

- A one-time open market operation can be nonneutral - permanently.
- Can get a liquidity trap equilibrium with an inflation rate above the Friedman rule rate where open market purchases are irrelevant.
- Fiscal policy can constrain monetary policy.
- Currency is important: finances most of the central bank's portfolio in normal times and has important costs that we need to account for.
- With positive excess reserves: open market purchases irrelevant (like the liquidity trap equilibrium); monetary policy works through the setting for the interest rate on reserves; inflation control is not a problem.
- Can generate financial crisis features
  - default premia (spreads) increase
  - lending and output fall
  - monetary policy should increase public liquidity through open market sales