Financial Decisions Journal, Summer 2010, Article 6

Measuring Financial Intermediation Shocks via Asset Pricing Theory

Charles F. Beauchamp[†]
Middle Tennessee State University

Yuanyuan Chen[‡]
Middle Tennessee State University

&

Stuart J. Fowler[§]
Middle Tennessee State University

Abstract

Employing the financial intermediation (FI) model of Díaz-Giménez et al. (1992) enhanced with preferences for assets that back transactions, we quantify and study shocks to the efficiency of the intermediation process. These shocks are found to (i) conform to the business cycle dates; (ii) strongly influence the behavior of the equity prices and various borrowing rates; (iii) generate significant shifts in demands for risk-free assets [called flight to quality]; and (iv) be an important explanator for the most recent recession. Finally, a counterfactual model, where monetary policy is held constant, shows that policy has played an important role in the dampening the latest FI shock.

JEL Classification: E32, E43, E44

Key Words: Financial Intermediation Shocks, Asset Pricing Theory, Financial Crisis

[†] Charles F. Beauchamp is an Assistant Professor of Finance at Middle Tennessee State University. Address: Department of Economics and Finance, Jennings A. Jones College of Business, Post Office Box 27, Murfreesboro, Tennessee, 37132. Office phone: 615.494.8715. Fax: 615.898.5596. Electronic mail: cbeaucha@mtsu.edu.

[‡] Yuanyuan Chen is a Ph.D. Student in Economics at Middle Tennessee State University. Address: Department of Economics and Finance, Jennings A. Jones College of Business, Post Office Box 27, Murfreesboro, TN 37132. Office phone: 615.898.2520. Fax: 615.898.5596.

[§] Stuart J. Fowler is an Associate Professor of Economics at Middle Tennessee State University. Address: Department of Economics and Finance, Jennings A. Jones College of Business, Post Office Box 27, Murfreesboro, Tennessee, 37132. Office phone: 615.898.2383. Fax: 615.898.5596. Electronic mail: sfowler@mtsu.edu.

Measuring Financial Intermediation Shocks via Asset Pricing Theory

1. Introduction

The main goal of this paper is to estimate shocks to the efficiency of financial intermediation (FI). By financial intermediation shocks, we mean shocks to the efficiency of the technologies that financial firms use to intermediate loans from consumer/savers to companies that need resources for investment. Construction of FI shocks allows us to accomplish several goals. First, the estimated shocks can be analyzed for their importance in the determination of the U.S. business cycle. Second, we can assess how large, relative to past innovations, the current FI shock is. Finally, the response of monetary policy to financial intermediation shocks can be estimated. It is important to know how monetary policy responds to these shocks so that its effectiveness can be assessed.

A key for our identification of FI shocks is the theoretical model employed. The model assumes a banking sector, as developed by Díaz-Giménez, Prescott, Fitzgerald, and Alvarez (1992), where financial intermediaries purchase debt to back household deposits. While the deposits are asset backed, they involve intermediation costs. In the model, these costs force wedges between the rates received by the households and paid by the borrowers. Examples of intermediation costs might include wages paid to bank employees, inefficiencies due to incomplete monitoring, credit assessment, and reserve requirements (Dotsey and Ireland, 1995). Given the model's equilibrium conditions that describe household demands for assets and describe how asset rates are shifted by the intermediation process, FI shocks can then be reversed engineered once the model is taken to the data.

By the additional assumption that consumers have preferences for consumption purchases with alternative payment methods, transactions costs (as opposed to intermediation costs) can be distinguish from costs specific to the financial intermediation process. More specifically, because we assume that consumption goods purchased with either cash or checks are not perfect substitutes, the two government supplied-liabilities that back the transactions -- currency and government debt -- will have different risk-free rates of returns. It has long been recognized in economic literature that wealth holdings in the form of government bonds play a special role in facilitating transactions and thus provide transaction returns (Tobin, 1956; Friedman, 1969; Patinkin, 1965; and Bansal and Coleman, 1996). The importance of this assumption is that monetary policy can potentially have real effects. The effects of FI shocks can then be altered if policy can incentivize new intermediated capital by making government supplied savings (currency and debt) more expensive -- it is this substitution link we intend to explore.[**]

Because the model is used to estimate the FI shocks, the estimated series will be only as good as the theoretical assumptions of the model. It is therefore important to ask: how good are the assumptions of the model? We show that the solutions for the asset prices are functions of the money multiplier components. In the model, the money multiplier includes the deposit-to-currency and reserve requirement ratios. Evidence provided in Cagan (1965), Sims (1980), and King and Plosser (1984) suggests that output is primarily correlated with the deposit-to-currency ratio. Subsequent theoretical work includes Freeman and Huffman (1991) and, more recently, Freeman and Kydland (2000). Reserve requirements, the second element of the money multiplier, have also been found to be an important link to real activity (Haslag and Hein, 1989; and Loungani and Rush, 1995). In all, our theory links asset prices, which define the model's FI shocks, to specific components of the money multiplier suggesting that the theory is *a priori* plausible.

The analysis in this paper is related to some other recent studies. Christiano, Motto, and Rostagno (2007) and Nolan and Thoenissen (2009) estimate financial accelerator shocks that shift entrepreneur net wealth (an entrepreneur is the source of external funds for firm investment). Their financial accelerator shock is found to be closely related to the external finance premium -- the spread between AAA rated corporate bonds and the 3-month Treasury bill rate. Our contribution is that the FI shock is not necessarily identified with the external finance premium due to the transactions preferences that we have adopted. Instead, when a FI shock occurs it is then possible for our agents to shift to cash (as opposed to risk free debt). In this case, the external finance premium may be unaffected.

The estimated financial intermediation shocks lead to several results. First, the FI shocks are found to conform to the business cycle dates. In general, the FI cost variable increases during the first part of a recession. In the most recent recession (dated to start in December 2007), the FI shock substantially increases by 1.1682%; that is a change of about 3 standard deviations in the estimated series. Second, these shocks strongly influence the behavior of equity prices and various borrowing rates and, as a result, generate significant shifts in demands for risk-free assets. Finally, a counterfactual model, where monetary policy is held constant, shows that policy has played an important role in the dampening the latest FI shock.

The paper is organized as follows. Section 2 lays out the theoretical model with

[**] Intermediation and transaction costs have been suggested by Prescott (1998) as a possible important component of a successful explanation of relative rates of return but have not yet been explored in the asset pricing literature.

transactions and intermediation costs. Section 3 characterizes the equilibrium. Section 4 presents the data and estimation methods. Section 5 displays the results. Finally, Section 6 provides some concluding comments.

2. An Economy with Transaction and Intermediation Costs

2.1 The Cash Flow

The model economy is assumed to have five types of economic agents: the monetary authority, financial intermediaries, nonbank intermediaries, firms, and households. For the agents, time evolves in discrete units, termed periods (which are specified to be one month long in the current study). A period has two parts in which the economic agents make decisions: the beginning and end of the period. At the beginning of the period, households are in possession of the economy's entire stock of money, which they have accumulated from labor, dividend earnings, and past period maturing loans. During the first part of a period, households circulate all their money by two types of consumption purchases: goods purchased with either cash or check. Additionally, currency is used to purchase equity in firms and loan to intermediaries.

The representative financial intermediary accepts deposits and purchases government debt as developed in Díaz-Giménez *et al.* (1992). The financial intermediary incurs an exogenous reserve requirement. The nonbank intermediary is not subject to reserve requirements but is assumed to face a costly intermediation technology. At the end of the period all outstanding loans, dividends, and checks are paid. Additionally, the monetary authority injects money into the economy by transferring, to the financial intermediary, lump-sum cash, which is passed on to the households as dividends.

2.2 The Monetary Authority

The supply of the stock of money at the beginning of the period is M_t. It is assumed that the aggregate stock of fiat money evolves, from one period to another, according to:

$$M_{t+1} = \omega_{1,t+1} M_t .$$

Money is injected and withdrawn at the beginning of the period in two ways: by open market operations and reserve requirements. Reserve requirements are imposed at a rate of $\zeta_t \in [0,1)$ on deposits at the financial intermediary, B_t^f, for the right to purchase debt directly from the monetary authority (MA). The financial intermediary also may hold excess reserves at the MA's vault. At the end of the period, the monetary authority retires existing debt B_t^g at a return of R_t^g, returns reserves, and transfers cash in the amount of N_t.

It is assumed that the current value of money withdrawn at the beginning of the period is a fraction $\omega_{2,t}$ of the money stock M_t. Additionally, money injected back into the system at the end of period is assumed to be a fraction $\omega_{3,t}$ of the money stock M_t. That is, withdrawals and injections evolve according to:

$$B_t^g + \zeta_t B_t^f = \omega_{2,t} M_t$$

$$R_t^g B_t^g + N_t + \zeta_t B_t^f = \omega_{3,t} M_t.$$

In total, the MA's current budget constraint is:

$$\begin{aligned} M_{t+1} &= [M_t - B_t^g - \zeta_t B_t^f] + [R_t^g B_t^g + N_t + \zeta_t B_t^f] \\ &= [1 - \omega_{2,t}] M_t + \omega_{3,t} M_t. \end{aligned}$$

It is assumed that the monetary authority does not have perfect control of the money stock. The value of $\omega_{3,t}$ (hence $\omega_{1,t+1}$ from $\omega_{1,t+1} = 1 - \omega_{2,t} + \omega_{3,t}$) is determine by R_t^g which cannot be preset by the authority (though, it may be targeted); the value of R_t^g will be determined by the household demands (to be defined by the household's problem).

2.3 The Financial Intermediary

The financial intermediary (FI) accepts deposits B_t^f at a return of R_t^f from the households, makes loans of B_t^g to the government, and deposits required reserves at the beginning of the period. Of the total amount of loanable funds, the FI must keep $\zeta_t B_t^f$ as required reserves. At the end of the period, the FI receives maturing loans, reserves, and a lump-sum transfer of N_t dollars from the government and clears all accounts. Additionally, it faces a costly transaction technology. In order to collect loans, the bank must expend an amount of ϕR_t^f per deposit. With the remaining funds, the FI pays outstanding deposits to the households and transfers D_t^f dividends to the households.

Given these facts, the FI chooses B_t^g and B_t^f to maximize:

$$E_0 \left\{ \sum_{t=0}^{\infty} \beta^{t+1} \frac{u_1(t+1)}{P_{t+1}} D_t^f \right\},$$

where

$$D_t^f \equiv R_t^g B_t^g + \zeta_t B_t^f + N_t - R_t^f B_t^f - \phi R_t^f B_t^f,$$

subject to

$$B_t^f \geq \zeta_t B_t^f + B_t^g.$$

Here $u_1(t+1)$ is the marginal utility of consumption at time $t+1$. We assume that both the deposit and the lending technologies are freely accessible and that they display constant returns to scale. These assumptions imply a zero profit condition with respect to funds received from the households. That is, in equilibrium:

$$R_t^g B_t^g + \zeta_t B_t^f = R_t^f B_t^f + \phi R_t^f B_t^f .$$

Note that in equilibrium the FI will choose never to hold excess reserves since they offer an inferior return to government debt.

Though not explicitly modeled, the FI may loan to firms or corporations. It is assumed that these nontransaction deposits are not subject to reserve requirements but subject to an intermediation cost. Specifically, in order to collect private loans, the bank must expend an amount of η_t^f per return and per deposit.

2.4 The Nonbank Intermediary

The nonbank intermediary (NBI) accepts deposits from the households B_t^n at a return of R_t^n from the households and makes loans of B_t^p to private firms at the beginning-of-the-period. At the end of the period, the NBI receives maturing loans, pays outstanding debt to the households, and transfers dividends D_t^n to the households. The NBI does not face a reserve requirement or buy government loans. However, to make loans it faces a costly transaction technology; in order to collect a loan, the nonbank must expend an amount of $\eta_t^n R_t^n$ per deposit.

The formal problem of the NBI is to choose B_t^p and B_t^n to solve the maximization problem:

$$E_0 \left\{ \sum_{t=0}^{\infty} \beta^{t+1} \frac{u_1(t+1)}{P_{t+1}} D_t^n \right\},$$

where

$$D_t^n \equiv R_t^p B_t^p - R_t^n B_t^n - \eta_t^n R_t^n B_t^n ,$$

subject to

$$B_t^n \geq B_t^p .$$

In equilibrium, the nonbank intermediaries also face a zero profit condition with respect to funds received from the households:

$$R_t^p B_t^p = R_t^n B_t^n + \eta_t^n R_t^n B_t^n .$$

Because the NBI and FI may compete over loans to firms, they must offer the same rates on deposits and loans. Thus, for both NBI and FI to coexist,[††] in equilibrium: $(1+\eta_t^n) = (1+\eta_t^f)$.

2.5 The Household

A representative household has preferences over random sequences of two consumption streams: cash goods $C_{1,t}$ and check goods $C_{2,t}$. Their problem is to maximize discounted lifetime utility:

$$E_0\left\{\sum_{t=0}^{\infty}\beta^t u(C_{1,t},C_{2,t})\right\}.$$

The decisions for the cash good, bond holdings, and new equity purchases must be paid for with previously accumulated cash M_t^d. This currency constraint is given by:

$$C_{1,t} + \frac{B_t^f + B_t^n}{P_t} + \frac{P_t^e}{P_t}(z_{t+1} - z_t) \le \frac{M_t^d}{P_t}, \tag{1}$$

where z_t denotes the consumer's beginning-of-period share holdings of the risky asset and P_t^e is the ex-dividend price for a share of the asset. The decisions for the consumption of the check good must not exceed the current value of deposits at the financial intermediary. This constraint is given by:

$$C_{2,t} \le \frac{B_t^f}{P_t}. \tag{2}$$

The households have received money from maturing bond holdings $R_{t-1}^f B_{t-1}^f$ and $R_{t-1}^n B_{t-1}^n$, previous period dividends from held shares of firms $z_t P_{t-1} Y_{t-1}$, previous period dividends from the financial intermediaries D_{t-1}^f, and previous period dividends from the nonbank intermediary D_{t-1}^n. Then next period's currency holdings are, in real terms:

$$\begin{aligned}\frac{M_{t+1}^d}{P_t} \le {} & [\frac{R_t^f B_t^f + R_t^n B_t^n}{P_t} - C_{2,t}] + z_{t+1}Y_t + \frac{D_t^n + D_t^f}{P_t} \\ & +[\frac{M_t^d}{P_t} - \frac{B_t^f + B_t^n}{P_t} - C_{1,t} - \frac{P_t^e}{P_t}(z_{t+1} - z_t)].\end{aligned} \tag{3}$$

[††]See Bencivega and Smith (1992) and Haslag and Young (1998) for an analysis of model in which two types of intermediaries, a bank and an informal bank, coexist.

Because of the possibility of default and checkable accounts are required to be paid on demand, privately issued assets are not as liquid as government issued securities and will have no role in facilitating transactions. Thus, in equilibrium, private debt and public debt will have different returns since public debt backs demand accounts thereby facilitating transactions. Bansal and Coleman (1996) employ a similar type of assumption.

3. Characterization of the Equilibrium

The behaviors of the monetary authority, financial intermediaries, nonbank intermediaries, firms, and households can be described by equilibrium first order conditions. By combining these equilibrium first-order conditions it can be shown that a sequence of intertemporal Euler equations for equity pricing, returns on deposits at the financial intermediaries, and returns at nonbank intermediaries can be derived, respectively, as:

$$\frac{p_t^e}{p_t} u_1(t) = E_t\left\{\beta\, u_1(t+1)\left[\frac{p_{t+1}^e}{p_{t+1}} + \frac{p_t Y_t}{p_{t+1}\omega_{1,t+1}}\right]\right\} \tag{4}$$

$$u_1(t) - u_2(t) = E_t\left\{\beta \frac{u_1(t+1)p_t}{p_{t+1}\omega_{1,t+1}} R_t^f\right\} - E_t\left\{\beta \frac{u_1(t+1)p_t}{p_{t+1}\omega_{1,t+1}}\right\} \tag{5}$$

$$u_1(t) = E_t\left\{\beta \frac{u_1(t+1)p_t}{p_{t+1}\omega_{1,t+1}} R_t^n\right\}, \tag{6}$$

where the lower case variables have been normalized by the stock of money (*e.g.*, $p_t^e = P_t^e / M_t$). Equilibrium behavior of the intermediaries implies the following set of equalities:

$$\begin{aligned} ((1-\zeta_t)R_t^g + \zeta_t)/(1+\phi) &= R_t^f \\ R_t^p/(1+\eta_t^n) &= R_t^n. \end{aligned} \tag{7}$$

The Euler equations can be described in terms of efficiency conditions, costs equating with benefits. Equation (4) says that the real cost of an equity purchase today, in utility, would be $(p_t^e / p_t)u_1(t)$. The real benefits would be the real equity price next period plus the real present value dividend received over the period, all discounted by the stochastic discount factor. In equilibrium, benefits must equate with costs; thus (4) is satisfied. Equation (5) says that if a household were to deposit at the FI, the real costs in utility would be $u_1(t)$. However, these deposits may be used to purchase one unit of consumption, which gives $u_2(t)$ extra units of utility. Thus, the current costs are $u_1(t) - u_2(t)$. The future benefits in today's terms are $R_t^f - 1$ discounted by the stochastic discount factor. By similar reasoning, (6) is derived for nonbank deposits.

Using the above theoretical equations, which describe agent behavior with respect to choices on various consumption and savings choices, to estimate the financial intermediation cost variable η_t^n. Specifically, given observations on allocations, prices and some reasonable calibrations for the model parameters, equations (4)-(7) are used to reverse engineer η_t^n.[‡‡]

Because our estimation method is derived on theory, it is important to ask how good is the theory? It is easy to show (see the appendix to this paper) that the above equations are functions of $\omega_{2,t}$, ζ_t, and $(1-\omega_{2,t})/\omega_{2,t}$. These variables represent the fraction of money used to purchase check goods, required reserves, and the currency-to-deposit ratio, respectively. These variables form the money multiplier. To see this, note that the nominal value of outside money plus required reserves is the monetary base:

$$\begin{aligned} MB_t &= (1-\omega_{2,t})M_t + \zeta_t B_t^f \\ &= P_t C_{1,t} + \zeta_t P_t C_{2,t}. \end{aligned}$$

The term $\omega_{2,t}$ represents the fraction of money used to purchase check goods ($\omega_{2,t}$ is the fraction of inside money). The value of the total money stock is given by the sum of cash plus check good consumption:

$$M_t = P_t C_{1,t} + P_t C_{2,t}.$$

Because $MB_t / [C_{1,t} + \zeta_t C_{2,t}] = P_t$, the total money stock can be shown to be:

$$\begin{aligned} M_t &= \left[1 + \frac{C_{2,t} - \zeta_t C_{2,t}}{C_{1,t} + \zeta_t C_{2,t}}\right] MB_t \\ &= \left[1 + \frac{1-\zeta_t}{(1-\omega_{2,t})/\omega_{2,t} + \zeta_t}\right] MB_t. \end{aligned} \tag{8}$$

The first term in equation (8) is the money multiplier, which is one plus the deposit-to-currency ratio for a monetary economy with reserve requirements. The deposit-to-currency ratio is an important link between real effects and money supply. As found in the literature, the changes in the money supply linked to changes in output primarily take the form of changes in

[‡‡]Details of the estimation method are given in the next section.

the deposit-to-currency ratio.[§§] Reserve requirements, the second element of the money multiplier, have also been found to be an important link to real activity.[***] In all, our theory links the spreads between various deposits, which define η_t^n, to specific components of the money multiplier suggesting that the theory is *a priori* plausible.

4. Estimation

4.1 Shock Identification

To identify the underlying shocks driving the model, the model is written in state-space form and estimated via maximum likelihood (*e.g.*, Harvey 1989; Hamilton 1994). More precisely, it is assumed that the shocks follow a stochastic AR(1) *state equation*:

$$x_{t+1} = \Pi x_t + \varepsilon_{t+1},$$

where x_t is the logs of: growth in real per capita consumption; growth in per capita money stock; fraction of inside money; and financial intermediation shock. The matrix Π is 4×4 that has its off-diagonal elements in the last row set to zero. In this case, the FI shock is identified as purely exogenous.

Given the matrix Π and a small set of pre-calibrated parameters, the model of equations (4)-(7) are logged linearized and solved for the asset prices p_t^e, R_t^n, and R_t^f. The vector solution for the asset prices, that are linearly related to the underlying shocks, are then augmented by observations on the logged growth in real per capita consumption, logged growth in per capita money stock, and the logged fraction of inside money. The resulting vector representation of the asset prices and observations form the *observation equation*:

$$\mathbf{z}_t = Hx_t$$

where $\mathbf{z}_t = [\ln(p_t^e), \ln(R_t^n), \ln(R_t^f), \ln(C_t / C_{t-1}), \ln(\omega_{1,t}), \ln(\omega_{2,t})]'$.

The first three rows in H define the asset pricing solutions while the last three rows are zeroes and ones that identify the shocks with their observational counterparts. In the estimation step, the joint likelihood for the observations $\mathbf{z}_t$ and the Kalman filtered series x_t is formed and maximized for the parameter vector Π.

[§§]See, for example, evidence cited by Cagan (1965), King and Plosser (1984), and Sims (1980) and a theoretic exploration in Freeman and Huffman (1991) and Freeman and Kydland (2000).
[***] See Haslag and Hein (1989) and Loungani and Rush (1995).

4.2 The Data

In the estimation, we analyze monthly data July 1972 to May 2009. The principal macroeconomic time series is obtained taken from the Bureau of Economic Analysis and Federal Reserve Board (using seasonally adjusted data) and converted to per capita by the total population. The *real consumption* series is identified with the consumption of nondurables plus services. Fiat currency, or *outside money*, is identified with the series currency in circulation. The quantity of *inside money* is defined by the series M2 net of currency in circulation and small time deposits plus institutional money market mutual fund balances. Then the *stock of fiat money* is defined as the sum of outside and inside money. The *reserve requirement rate* is calculated as total required reserves divided by M1 less currency in circulation.[†††] For the *private loan rate* (the rate received by households on loans to corporations), Moody's BAA corporate bond rate is used. The S&P 500 price index is used to compute the equity price money supply ratio. Finally, the three-month t-bill rate is used for the *public loan rate* (the rate charged on loans to the government) or the *risk-free rate*.

For estimation, six series are to be constructed. The first, the equity price to money stock ratio, is found by dividing the S&P 500 price index by the per capita stock of fiat money. Again, the BAA corporate bond rate is used for the private loan rate. Next, the rate received by households on deposits at the financial intermediary (R_t^f) is constructed using equation (7), the public loan rate, reserve requirement ratio, and a calibrated value (to be discussed in the next section) for ϕ. Adding real per capita nondurables and services gives consumption used in calculation of the gross growth rate. The growth in the stock of per capita fiat money is used for $\omega_{1,t}$. Finally, inside money is used for calculation of $\omega_{2,t}$. Table 1 provides a statistical summary of the constructed variables.

[†††]It is important to note several issues regarding measurement of the deposit series and the reserve requirement ratio. First, the deposit variable contains savings and time deposits, this series does not consist of strictly transactional deposits. Nevertheless, the series is used since the 30-day notification of withdrawal is typically waived, making savings deposits, in practice, demandable. Second, the FED has changed the deposits covered by required reserves; after 1990 savings and time deposit series were dropped from the reserve requirements since reserve requirements apply only against checkable deposits. Thus, after 1990, the savings and time deposit series are dropped from our calculation of the reserve requirement ratio.

Table 1: Sample Statistics for the Periods 1972:7-2009:4*

Variable	Symbol	Mean	Std. Dev.
Aggregates			
Real Consumption Gross Growth	$\frac{C_t}{C_{t-1}}$	1.00139	0.00405
Growth of Money Stock	$\omega_{1,t}$	1.00566	0.00828
Inside Money/Money Stock	$\omega_{2,t}$	0.89120	0.01000
Nominal Rates and Prices			
Equity Price/Money Stock	p_t^e	171.164	56.0681
Government Debt	R_t^g	1.00483	0.00251
Transactions Deposit Rate	R_t^f	1.00000	0.00246

*Consumption and monetary aggregates are in per capita terms.

4.3 Model Calibration

To help in the estimation, selected parameters are calibrated. The calibrated parameters are of two types; preference and intermediation costs parameters. To start, a utility function of the following form is selected;

$$u(C_{1,t}, C_{2,t}) = \frac{\left(C_{1,t}^{\alpha}\, C_{2,t}^{1-\alpha}\right)^{\gamma}}{\gamma}.$$

In this case, α and γ represent the relative share of the cash good in utility and one minus the relative risk aversion, respectively. For α, the share of cash good consumption found in the data gives $\alpha = 0.1088$. The parameter γ is set to -1 and gives a coefficient of relative risk aversion of two; a number commonly found in the asset pricing literature (e.g., Bansal and Coleman 1996). The subjective discount factor β, the last preference parameter, is chosen to give a discount rate of 3 percent per annum; this sets $\beta = 0.995606$ for the monthly equivalent.

Next, the means for the intermediation costs faced by all intermediaries are calibrated. In the financial intermediary's case, ϕ is set so that the average return on transactions accounts are zero.[‡‡‡] Finally, the average intermediation cost faced by the nonbank intermediary is set so, if

[‡‡‡]Most checking accounts do not pay interest. If they do, many require fees that ultimately imply zero interest.

households could intermediate their own loans to firms, the average return will be equivalent to equity's return. This gives $\overline{\eta}^{n} = 0.003544$. Table 2 presents the results of the calibrations.

Table 2: Parameter Calibrations

Parameter	***Value***
β	0.995606
α	0.108800
γ	-1.0
ϕ	1.004754
$\overline{\eta}^{n}$	0.003544

5. Results

5.1 Estimation Results

Figure 1 plots the estimated FI shock and the NBER business cycle reference dates. We see that the conformity of the FI shock to the business cycle dates is striking. In general, the FI shock increases during the first part of the six recessions. The positive relationship surpasses economic reasoning; positive innovations in η_t^n imply private loans are more costly to intermediate and, therefore, should lead to less economic activity. In the most recent recession, dated to start in December 2007, the FI shock substantially increases by 1.1682%; that is a change of about 3 standard deviations in η_t^n.

Figure 1: Estimated Financial Intermediation Shock

Figure 1 plots financial intermediation shocks $\eta^n(t)$ (the line) across time. The highlighted vertical ranges represent the NBER business cycle dates occurring between 1970-Present.

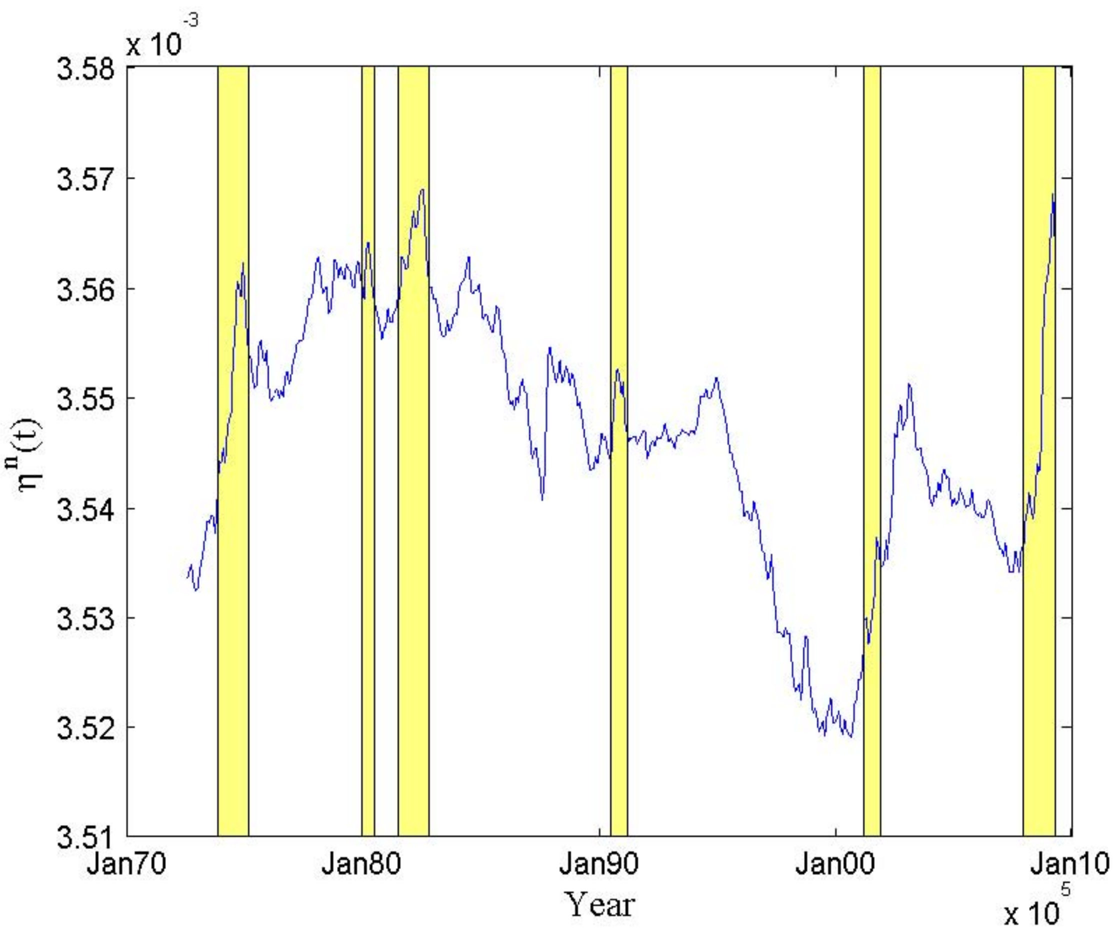


Figure 2 illustrates how FI shocks are transmitted to the aggregates in the economy. In Panel A of Figure 2, the growth in real consumption is plotted against the FI shock. There is a strong negative correlation between the two; the correlation coefficient is -95%. Panel shows that the growth in the stock of fiat money, ω_1, is positively correlated with the FI shock. Finally, Panel 3 illustrates a negative relationship between the fraction of inside money, ω_2, and the FI shock.

Figure 2: Responses of Aggregates to Financial Intermediation Shocks
Panel A plots the growth in real consumption against the FI shock. The growth in the stock of money is plotted against the FI shock in Panel B. Panel C plots the fraction of money held inside against the FI shock.

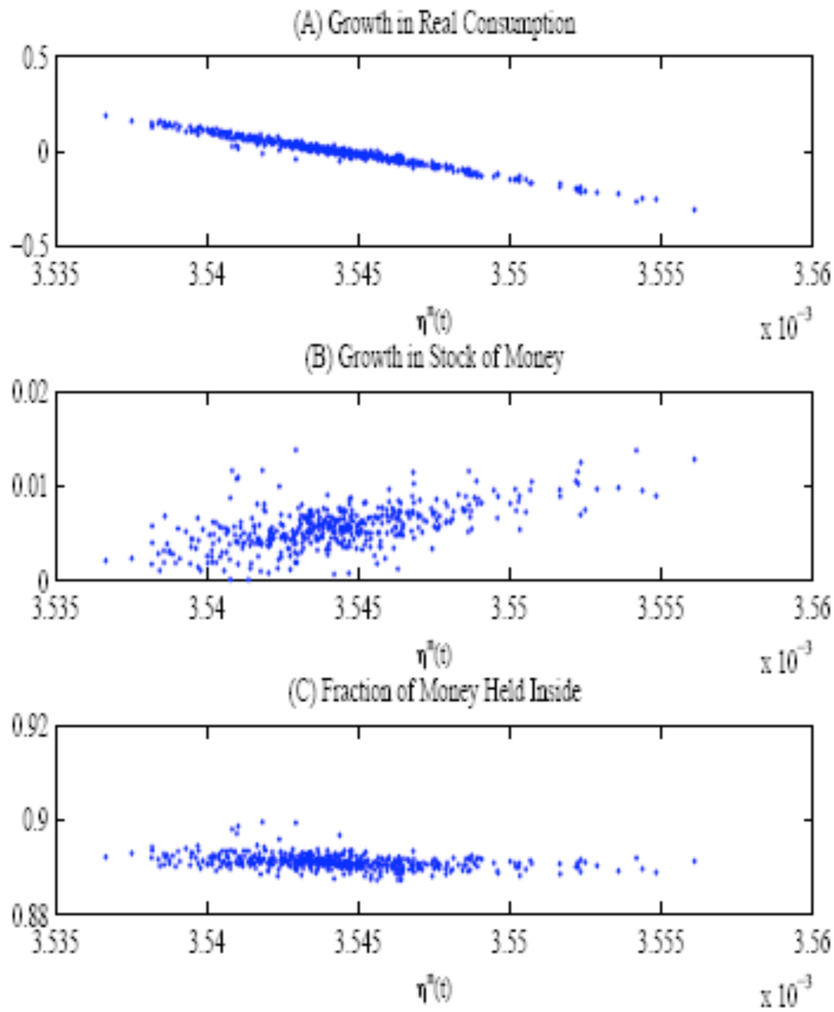
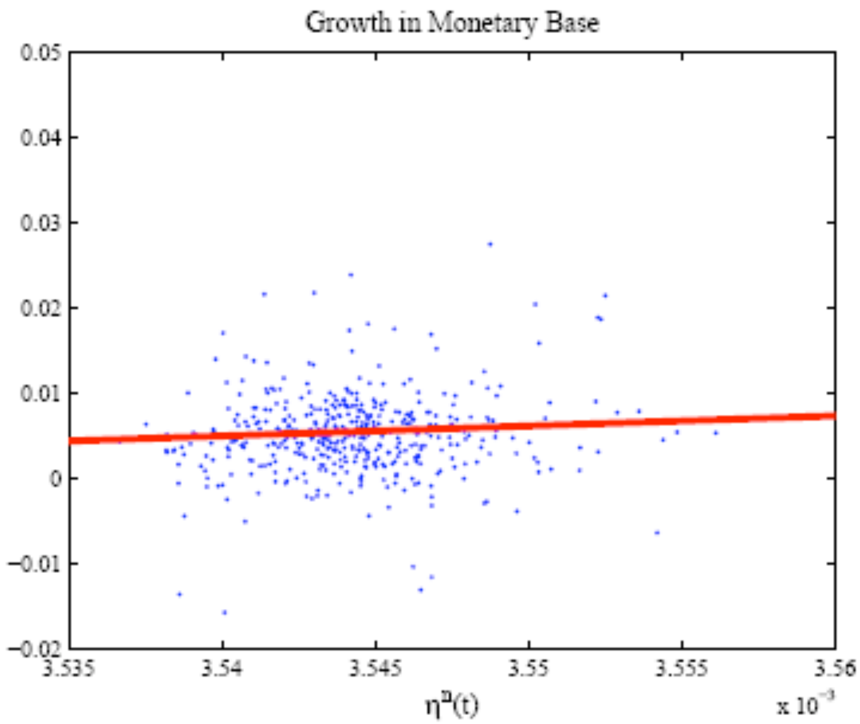


Figure 3 plots the responses of the monetary policy to changes in η_t^n. Because the FED has direct control of monetary base, we use the monetary base for policy's reaction. The monetary base has been constructed by equation (8) and the model's predictions for $\omega_{1,t}$ and $\omega_{2,t}$. We see that the monetary base is positively correlated with the FI shock.

Figure 3: Monetary Policy Responses to Financial Intermediation Shocks

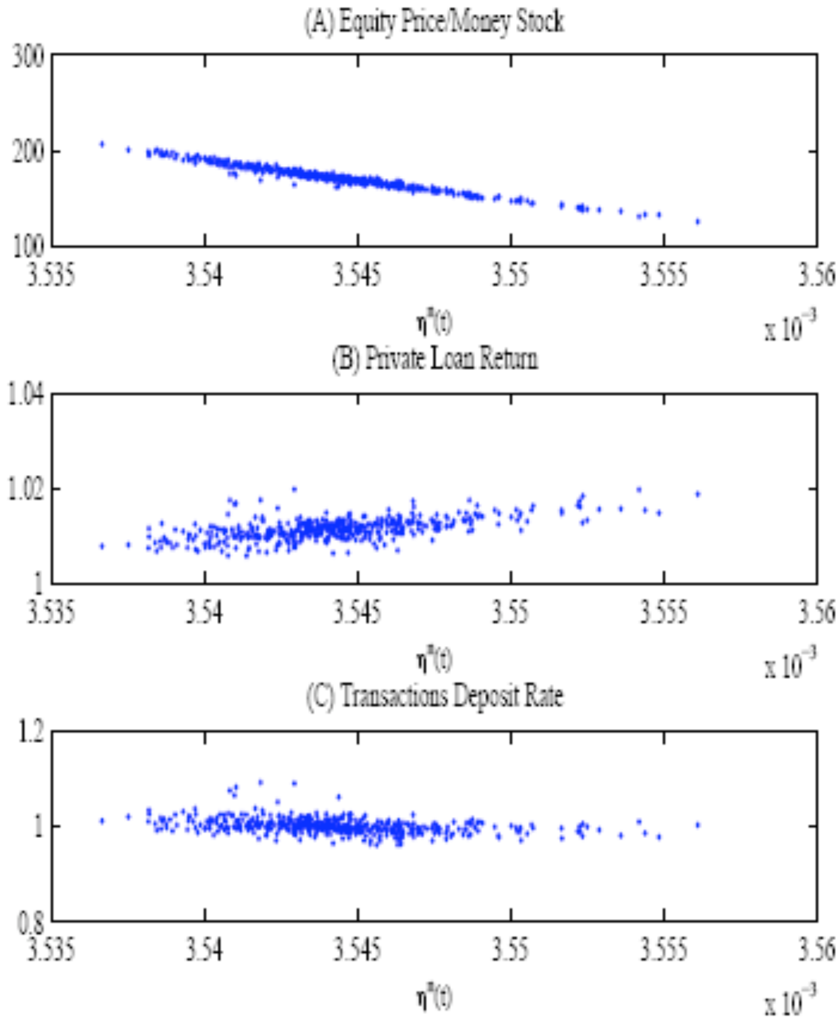
Figure 3 plots the growth in the monetary base (Equation (8)) against the financial intermediation shocks.



Note: $corr(\eta_t^n, \log MB_t / MB_{t-1}) = 0.0617$

The three panels in Figure 4 plot the responses of the economy's prices to the FI shock. Panel A shows that, as expected, equity prices are negatively related to changes in η_t^n. Because firms rely on intermediated capital to fund investment projects, more costly funding should imply lower values for claims to the dividends produced by firms' capital. Panel B in Figure 4 shows that the return on private loans is positively related to the FI shock. Alternatively, the last panel indicates that deposit rates are inversely related to changes in η_t^n.

Figure 4: Responses of Prices and Returns to Financial Intermediation Shocks
Panel A plots the relationship between equity prices and FI shocks. The relationship between the returns on private loans and FI shocks in plotted Panel B. Panel C plots the relationship in deposit rates and FI shocks.



Note: $corr(\eta_t^n, p_t^e) = -0.9495$, $corr(\eta_t^n, R_t^n) = 0.3395$, and $corr(\eta_t^n, R_t^f) = -0.3218$.

Several conclusions can be drawn from the relationships presented in Figures 2-4. First, intermediated capital falls. Because equity prices are equivalent to the value of firm's income producing capital, falling equity prices imply less firm capital. Additionally, as the supply of investment falls (loanable funds) loan rates should rise; this is exactly what we see. Second, FI shocks negatively affect GDP. Lower consumption growth, lower equity prices, and higher loan rates all imply household expenditures decrease with increases in η_t^n; suggesting households are economizing on all their expenditures. Holding all else equal, falling expenditures imply falling GDP.

Third, cash (outside money) is an inferior form of money relative to transactions deposits (inside money). The FI shock induces consumers to shift their relative money holdings to cash (outside money) from transactions deposits (inside money). This is seen by the falling inside money rates ω_2. Fourth, the FED is more accommodating after an FI shock. This is evident as the monetary base increases in response to an FI shock.

Finally, FI shocks induce a flight to quality to short-term government debt. Though ω_2 falls, the increased money stock implies both cash and transactions deposits holdings increase (total transactions deposits holdings are $\omega_2 M$). Because short-term government securities back transactions deposits, the increased demand for transactions deposits increases the demand for government securities. This is confirmed in panel (C) of Figure 4 where deposit returns are negatively related to the FI shock.

5.2 A Counterfactual Experiment

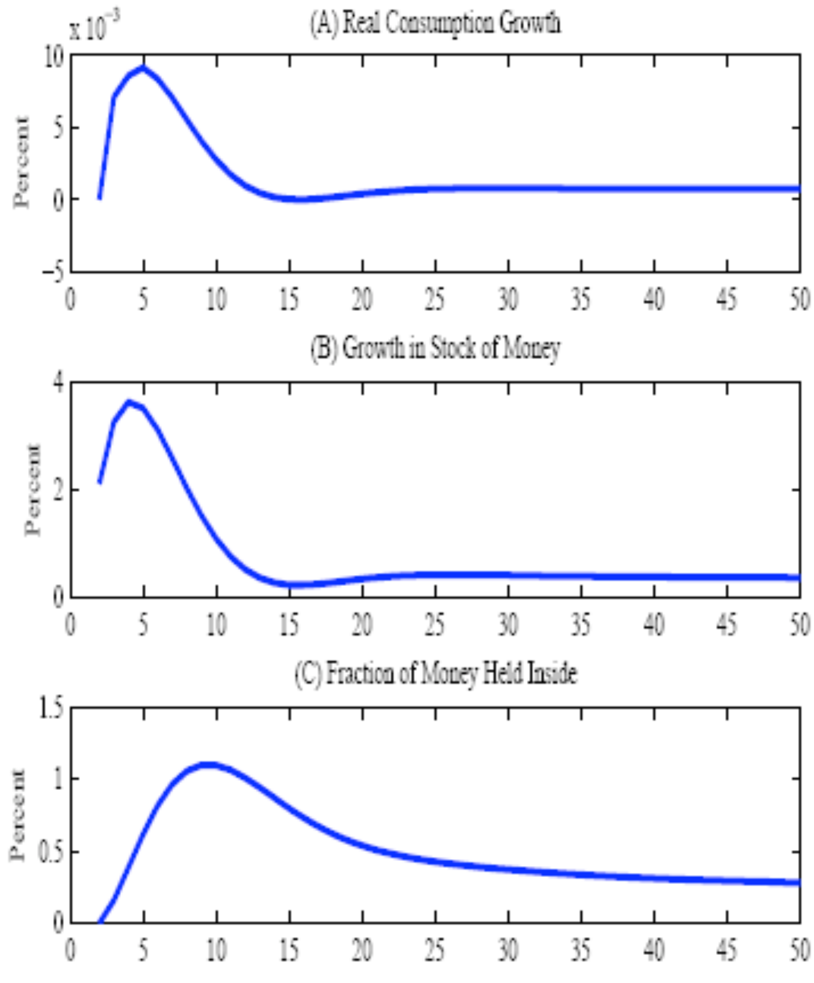
An interesting question to ask is: what effects are generated by making policy accommodating to FI shocks? To study this question, we restrict changes in the monetary base to zero. This restriction entails setting changes in the money stock to changes in the money multiplier.[§§§] With this restriction imposed, the model is resolved and presented as a *counterfactual model*.

The three panels in Figure 5 plot the impulse responses of the model's aggregates, relative to the estimated baseline model, from a one-standard deviation shock to financial intermediation equation. The solid line plots the baseline minus the counterfactual responses. We first see that consumption growth falls initially by about 0.01 percent more in the counterfactual case. The second and third panels show similar results for the counterfactual responses in both the growth of the stock of money and the fraction of money held inside. It is also interesting to note (not shown in the graphs) that the growth in the stock of fiat money actually declines in the counterfactual experiment. When the financial shock occurs, households economize on their transactions deposits towards currency holdings. Given these facts and a constant monetary base, equation (8) shows that the stock of money should decrease.

[§§§]This is accomplished by altering the state equation matrix Π so that $\omega_{1,t}$ is always a fraction of $\omega_{2,t}$.

Figure 5: Impulse Responses from a Counterfactual Experiment

Figure 5 plots the impulse response of the model's aggregates (Real Consumption Growth, Growth in the Stock of Money, and the Fraction of Money Held Inside) against a one-standard deviation shock to financial intermediation equation. The solid line plots the baseline less the counterfactual responses.



Note: Baseline Minus the Counterfactual Response is Plotted

Several conclusions can be drawn from the counterfactual experiment. First, the variations in the aggregates are more dramatic in the counterfactual model. An accommodating policy, therefore, has a more moderating effect compared to the case of a laissez-faire policy (as is the counterfactual model). Second, and most importantly, policy has real effects on household welfare. In the baseline case, the monetary authority increases the monetary base and, thus, smoothes household responses in ω_2. As a result, real consumption is smoother and households are better off under an accommodative policy.

6. Conclusion

This study seeks to estimate shocks to the efficiency of financial intermediation. Specifically, we develop a theoretical model that links asset prices to specific components of the money multiplier. Then, utilizing the model in estimations, we attempt to answer three questions concerning FI shocks. First, we determine how important these estimated shocks are to the U.S. business cycle. Our model suggests that these shocks increase during the first part of each of the six recessions documented during the study's economic period of 1970 to the present. We then assess whether the current shock is larger relative to past shocks. In particular, we find that the current economic shock is quite severe increasing by 1.17% or 3 standard deviations. This finding is significant in that it validates the common perception of the severity of the current financial crisis.

Second, we use the estimations to gauge the effects of the shocks on numerous monetary relationships. As expected, we find a negative correlation between household consumption and FI shocks, which ultimately leads to a decrease in GDP. Additionally, we find intermediated capital decreases because of falling equity prices and increasing loan rates. Also, we find that FI shocks induce consumers to shift their money holdings cash away from transactional deposits. This shift of inside to outside money is the result of decreasing inside money rates. Lastly, we find that the monetary base increases as the FED responds to FI shocks.

Finally, we analyze the effectiveness of these responses by the FED response to FI shocks. Specifically, we observe that the accommodating policy of the FED is successful in that it has a greater moderating effect on consumers than laissez-faire policies. Therefore, we conclude that accommodating FED responses to FI shocks ultimately benefit household welfare. Consequently, the actions taken by the FED beginning in 2008 should have had a smoothing effect real consumption and have at least maintained household welfare over the past year.

References

Bansal, R., and J.W. Coleman II (1996), A Monetary Explanation of the Equity Premium, Term Premium, and Risk-Free Rate Puzzles, *Journal of Political Economy* **104**, 1135-1171.

Bencivenga, V., and B. Smith (1992), Deficits, Inflation, and the Banking System in Developing Countries: the Optimal Degree of Financial Repression, *Oxford Economic Papers* **44**, 767-790.

Cagan, P. (1965), *Determinates and Effects of Changes in the U.S. Money Stock, 1875--1960*. New York: National Bureau of Economic Research.

Díaz-Giménez, J., E.C. Prescott, T.J. Fitzgerald, and F. Alvarez (1992), Banking in Computable General Equilibrium Economies, *Journal of Economics Dynamics and Control* **16**, 533-559.

Christiano, L., R. Motto, and M. Rostagno (2007), Financial Factors in Business Cycles, Northwestern Department of Economics Working paper.

Dotsey, M., and P. Ireland (1995), Liquidity Effects and Transaction Technologies, *Journal of Money, Credit, and Banking* **27**, 1441-1457.

Freeman, S., and G.W. Huffman (1991), Inside Money, Output, and Causality, *International Economic Review* **32**, 645-667.

Freeman, S., and F. Kydland (2000), Monetary Aggregates and Output, *American Economic Review* **90**, 1125-1135.

Friedman, M. (1969), *The Optimum Quantity of Money and Other Essays*, Chicago: Aldine.

Hamilton, J. (1994), *Time Series Analysis*, Princeton University Press.

Harvey, A.C. (1989), *Forecasting, Structural Models and the Kalman Filter*, New York: Cambridge University Press.

Haslag, J., and S. Hein (1989), Reserve Requirements, the Monetary Base, and Economic Activity, *Federal Reserve Bank of Dallas Economic Review*, 1-15.

Haslag, J., and E. Young (1998), Money Creation, Reserve Requirements, and Seigniorage, *Review of Economic Dynamics* **1**, 677-698.

King, R., and C. Plosser (1984), Money, Credit, and Prices in a Business Cycle, *American Economic Review* **74**, 363-380.

Loungani, P., and M. Rush (1995), The Effect of Changes in Reserve Requirements on

Investment and GNP, *Journal of Money, Credit, and Banking* **27**, 511-525.

Nolan, C., and C. Thoenissen (2009), Financial shocks and the US business cycle, *Journal of Monetary Economics, Elsevier* **56(4)**, 596-604.

Patinkin, D. (1965), *Money, Interest, and Prices: An Integration of Monetary and Value Theory*, New York: Harper & Row.

Prescott, E.C. (1998), Business Cycle Research: Methods and Problems. Federal Reserve Bank of Minneapolis Working Paper No. 590.

Sims, C.A. (1980), Comparison of Interwar and Postwar Cycles: Monetarism Reconsidered, *American Economic Review* **70**, 250-275.

Tobin, J. (1956), The Interest-Elasticity of Transactions Demand for Cash, *Review of Economics and Statistics* **38**, 241-247.