1. Inside versus Outside Money

- Another criticism of the monetary equilibrium business cycle models of Lucas is that they implicitly assume all money is outside money. In practice much of the money supply is inside. It is supplied by financial intermediaries which hold reserves of base money and loans to firms and households as assets against their deposit liabilities. The deposit liabilities of banks are almost as universally acceptable as cash as a medium of exchange. However, changes in the volume of inside money are likely to be associated with changes in the level of loans made by intermediaries. Thus, shocks to the demand for inside money might have a direct effect on the level of investment and these effects cannot be analyzed with a model that assumes all money is outside money.

- Models that focus on the real effects of fluctuations in inside money are also very different from "Keynesian" or "new Keynesian" models that emphasize nominal rigidities. In models with inside money, the nominal price level reflects the value of outside money (liabilities of the central bank) relative to goods and services. The lower liquidity of inside relative to outside money is reflected in the (endogenous) interest yield on inside money. Fluctuations in the average price level result from variations either in the supply of outside money or the demand for outside money as a medium of exchange or as bank reserves. However, incomplete or lagged adjustment of nominal prices to the excess supply or demand for outside money play no role in linking inside money to real variables in these models.

2. Money Aggregates versus Bank Credit

- There is also a growing body of literature that claims empirical evidence linking monetary disturbances to business cycles is stronger for the inside components of the money supply than it is for outside money. For example, Rush has presented evidence that business cycles in the gold standard era were linked to fluctuations in inside money (bank liabilities) but not correlated with

fluctuations in the money base. Mishkin and Bernanke have presented evidence that the collapse of the banking system played a large role in the Great Depression. Most of the massive decline in the US M1 money supply at that time took the form of a decrease in check deposits rather than a decline in base money. Although I would not want to make too much of it, we can also look at the following evidence using Australian data. Recall that we estimated a simple regression linking GDP fluctuations in Australia to *changes* in M3 growth rates (estimated standard errors in brackets):

$$\begin{aligned} GDPG_t = & \underset{(1.5883)}{3.1005} + \underset{(0.0581)}{0.6943}\, GDPG_{t-1} - \underset{(0.0575)}{0.2104}\, GDPG_{t-4} \\ & + \underset{(0.0627)}{0.1378}\, \Delta M3G_{t-1} - \underset{(0.0045)}{0.0171}\, Time \end{aligned}$$

Now add changes in the growth rate of the money base to this regression. Since I only had money base figures for a shorter period, the new regression is based on fewer observations. The results were:

$$\begin{aligned} GDPG_t = & \underset{(1.5480)}{2.3014} + \underset{(0.0752)}{0.7279}\, GDPG_{t-1} - \underset{(0.0745)}{0.2584}\, GDPG_{t-4} \\ & + \underset{(0.0704)}{0.1667}\, \Delta M3G_{t-1} - \underset{(0.0326)}{0.0512}\, \Delta MBG_{t-1} - \underset{(0.0045)}{0.0171}\, Time \end{aligned}$$

Once the effects of changes in M3 growth have been accounted for, changes in money base growth rates have an effect on GDP growth which is not statistically significantly different from zero, and which in any case is of the "wrong" (negative) sign.

- There have been two strands to the literature focusing on real effects of fluctuations in inside money. Some authors, such as Bryant and Diamond and Dybvig have concentrated on explaining bank runs, as occurred in the US in the Great Depression. The basic idea is that bank liabilities are very short term - the banks promise to pay cash on demand in exchange for their deposit liabilities. However, many of the assets of the banks are longer term loans to firms or households

that cannot be rapidly liquidated. Furthermore, if the banks are forced to unload many of their assets in a "fire sale" as occurred in the Great Depression, there is likely to be a large decline in asset values, making it difficult for the banks to meet their obligations to exchange cash for their liabilities. Normally, only a small fraction of a bank's customers wish to claim their deposits on any given day. However, if customers come to believe the bank might not be able to meet its obligations they will all queue to "get their money out" before the bank fails. The belief becomes a self-fulfilling prophecy. As banks call in their loans to meet a bank run, firms are likely to fail unless they have access to an alternative source of finance. Investment will be adversely affected and the economy is likely to slide into a recession or depression.

- Other authors, such as Williamson and Bernanke and Gertler have focused on less extreme episodes than bank runs as possible explanations for a correlation between fluctuations in inside money aggregates and real activity. They have suggested that "normal" fluctuations in bank lending could explain "normal" business cycles. In particular, they have emphasized the pro-cyclical movement in the number of bankruptcies as a key indicator of the role of financial intermediaries in initiating or propagating business cycles.

3. Is Bank Lending Special?

- The assumption that intermediaries finance all investment is an important feature of the Williamson and Bernanke and Gertler models since it implies that disintermediation is impossible. They argue that intermediaries provide a unique service as a result of an asymmetry of information between lenders and borrowers. These asymmetries are also a source of bankruptcy for firms borrowing from intermediaries.

- Williamson's model of bankruptcy can be summarized as follows. All loans and investments last for only one period. A separate firm undertakes each investment. There is a continuum of firms indexed by the productivity of their technology, and firms cannot be replicated (otherwise all investment would be in only the most productive technology). Each of the firms has *ex-post* per

capita output

$$\varepsilon k^{\alpha} + (1 - \delta)k \tag{1}$$

where ε is uniformly distributed over $[0, \varepsilon_0]$ and is known only to the firm. It will always pay the firms to claim ε equals 0 and to offer their lenders the collateral on the loan, (1- δ)k, which will fall short of the agreed upon interest and principal when real loan interest rates are positive. In this environment, financial intermediaries arise in part as specialists in monitoring firms that can go bankrupt. By incurring a monitoring cost ζ, the bank can determine the true ex-post productivity of the investment. In the absence of an intermediary, *each* of the "indirect lenders" to the firm (holders of intermediary liabilities) would have to incur the monitoring costs - the intermediary is a "delegated monitor" for each of the depositors. There will be a level of ε, say ε*, such that if $\varepsilon \geq \varepsilon^*$, it will be in the interest of the firm to pay the agreed upon interest and principal to the bank, while for $\varepsilon < \varepsilon^*$ the borrower defaults. In the default state, the bank pays the monitoring cost ζ and receives net income

$$\varepsilon k^{\alpha} + (1-\delta)k - \zeta. \tag{2}$$

The state where monitoring occurs is interpreted as bankruptcy. Use h to denote the (nominal) interest rate charged to firms that can go bankrupt. Use π to denote the (actual and expected) rate of inflation.

- Firms choose k_0 and a default level of productivity ε* to maximize expected profits

$$-\int_{\varepsilon^*}^{\varepsilon_0} \left(\varepsilon k_0^{\alpha} + (1 - \delta)k - \frac{1 + h}{1 + \pi} k_0 \right) d \tag{3}$$

subject to the constraints:

(i) at ε* the firm is indifferent between declaring bankruptcy and honoring its contractual obligations:

$$\varepsilon^* k_0^{\alpha} + (1-\delta)k_0 = \frac{1+h}{1+\pi}k_0 \tag{4}$$

(ii) the expected return to the bank minus the cost of providing intermediary services equals the interest payments to depositors. Assume a fraction ρ of deposits are held as non-interest bearing reserves by the banks and the cost of intermediary services are a fraction χ of the level of deposits. Then if r = the return on deposits, the expected (nominal) return on bank loans will have to be

$$i = (r + \chi)/(1 - \rho) \tag{5}$$

and the expected return on loan contracts will satisfy

$$\int_0^{\varepsilon^*} (\varepsilon k_0^{\alpha} + (1-\delta)k_0 - \zeta)d\varepsilon + \frac{1}{\varepsilon_0}\int_{\varepsilon^*}^{\varepsilon_0} \frac{1+h}{1+\pi}k_0 d\varepsilon = \frac{1+i}{1+\pi} \tag{6}$$

- Use (4) to eliminate h from (3) and (6). The firm then chooses k_0 and ε^* to maximize

$$= \frac{k_0^{\alpha}}{2\varepsilon_0}(\varepsilon_0 - \varepsilon^*)^2 + \lambda\left[(1-\delta)k_0 + \varepsilon^* k_0^{\alpha} - \frac{\varepsilon^{*2}k_0^{\alpha}}{2\varepsilon_0} - \frac{\varepsilon^*\zeta}{\varepsilon_0} - \frac{1+i}{1+\pi}\right]. \tag{7}$$

The first order conditions for a maximum of L are:

$$\left(\frac{\varepsilon^*}{\varepsilon_0} - 1\right) + \lambda\left[k_0^{\alpha}\left(1 - \frac{\varepsilon^*}{\varepsilon_0}\right) - \frac{\zeta}{\varepsilon_0}\right] = \tag{8}$$

$$\frac{\alpha k_0^{\alpha-1}}{\varepsilon_0}(\varepsilon_0 - \varepsilon^*)^2 + \lambda\left[(1-\delta) + \alpha k_0^{\alpha-1}\left(\varepsilon^* - \frac{\varepsilon^{*2}}{2\varepsilon_0}\right) - \frac{1+i}{1+\pi}\right] = \tag{9}$$

- Eliminate λ from equations (8) and (9) and rewrite the constraint (6) to obtain

$$2D\varepsilon_0 k_0 - k_0^{\alpha}\varepsilon_0^2 + \zeta(\varepsilon_0 - \varepsilon^*) = 0 \tag{10}$$

$$k_0^{\alpha}\left(\varepsilon_0 - \frac{\varepsilon^*}{2}\right) - \varepsilon^*\zeta - \alpha\varepsilon_0 D k_0 = \tag{11}$$

where we have defined

$$\alpha D = \delta + \frac{i - \pi}{1 + \pi}. \tag{12}$$

- For given i (and hence D), equations (10) and (11) can be solved for k_0 and ε^*. Equation (4) can then be solved for h. Thus, the firm side of the model (the supply of output and the demand for capital) can be solved as an implicit function of the interest rate i.

- Any shocks that affect the demand for deposits from households, the costs of intermediation (χ or ρ), or equilibrium real interest rates will affect the supply of bank loans, the number of bankruptcies and the level of output. An important feature of Williamson's model, however, is that intermediaries finance all investment. More generally, firms denied bank loans might be able to finance their investment directly from the capital markets or may be displaced by firms that do have access to such finance.

4. Household Borrowing Constraints and Bank Lending

- I have argued that household credit constraints – that is, restrictions on household borrowing – are central to ensuring fluctuations in bank finance have a significant impact on the aggregate economy.

- Banks harness the demand for a medium of exchange to finance investment. In effect, indirect claims to capital circulate in place of outside money. In an economy with only outside money, the capital stock merely reflects the desire of consumers to save for future consumption. It might be thought, therefore, that an economy with inside money would support extra capital and produce more output. There may also be a presumption that shocks to the demand for inside money, or changes in bank costs, would affect the supply of bank loans and make investment more vul-

nerable to financial disturbances.

- If the equilibrium capital stock is higher in an economy with inside money then the marginal product of capital, and thus the equilibrium real interest rate, must be lower. In the absence of household credit constraints, or restrictions on borrowing, intertemporal arbitrage would tie the riskless real interest rate to the household rate of time preference. Increased household borrowing would compensate for increased lending from intermediaries and the equilibrium capital stock would be unaffected.

- Furthermore, if households have sufficient access to capital markets to stabilize real interest rates, the equilibrium capital stock should also remain largely unaffected by shocks that adversely affect the size or efficiency of the intermediary industry. A contraction in bank finance would be accompanied by disintermediation, or an increase in loans to firms from other sources.

- I also discuss an intertemporal general equilibrium model where an asymmetry of information between intermediaries and firms, and the possibility of bankruptcy, restricts some firms to bank finance. I assume, however, that households can also lend directly to *some* firms. Furthermore, *some* firms can either borrow from banks or directly from households. If households do not face credit constraints, the stationary real interest rate on direct loans from households is tied to the household rate of time preference. Arbitrage by firms able to choose their source of finance ties bank interest rates to the real interest rate on direct loans. Thus, the household rate of time preference becomes the key determinant of all real interest rates and therefore the marginal product of capital and the capital stock. Financial shocks that change the supply of bank loans have few effects on the general equilibrium of the economy. Changes in direct investment in firms by households, and changes in household borrowing, substantially offset changes in the size of the banking sector. Disintermediation would become irrelevant only if the economy arrives at a "corner" where *all* firms borrowing from banks have no alternative source of finance.

- If households cannot borrow, however, then I show that the stationary equilibrium real loan in-

terest rate is below the household rate of time preference. The equilibrium capital stock is therefore higher than in an otherwise identical economy with neither inside money nor credit constraints. Households willingly hold inside money and loans at such low interest rates in order to finance consumption or self-insure against unanticipated fluctuations in future liquidity needs.

- Furthermore, real interest rates are affected by changes in bank costs or the demand for inside money. Since the demand for direct loans to firms is itself related to liquidity needs, disintermediation becomes less effective in insulating firms from changes in the supply of bank loans. Changes in real interest rates are accompanied by changes in the equilibrium capital stock, output, the number of bankruptcies, and the terms of the loans offered to borrowers liable to declare bankruptcy.

- It is informative to consider the way monetary factors and household credit constraints alter the first order conditions for the intertemporal consumption decision of a representative household. Throughout this discussion, we shall use "loans" to refer to direct household loans to firms that by-pass intermediaries. In practice, such capital market instruments could be equities instead of corporate bonds.

- In order for inside or outside money to provide liquidity services, households either must choose not to, or must not be able to, freely exchange loans for liquid assets at any time. Otherwise, households would choose to hold all their wealth as loans. They would use cash or check deposits for the briefest interval of time and only because convention demands that direct loans to firms are not acceptable as a medium of exchange. We implicitly assume that transaction and information costs limit the acceptability of loans as a medium of exchange and imply that it is optimal for households to exchange loans for liquid assets at discrete intervals. In the intervening periods, household consumption is subject to a "liquidity in advance" constraint.

- Inside money yields a positive nominal return while outside money does not. If both types of assets are to be in positive demand then outside money needs to yield additional liquidity services.

I assume that outside money is more universally acceptable than inside money in the sense that outside money can be used to make any purchase whereas inside money is unacceptable for a subset of purchases. The implicit liquidity services of inside and outside money will be reflected in positive Lagrange multipliers from the liquidity constraints. These positive Lagrange multipliers raise the returns on holding outside and inside money to equal the higher real yield on loans. They also drive a wedge between the marginal utility of consumption and the marginal value of wealth.

- For a household that is *unaffected* by credit constraints, a first order condition of the form

$$(1+i_t)^{-1} = \beta E_t V'(W_{t+1})/V'(W_t) \tag{13}$$

will apply to the intertemporal consumption versus savings decision where V(W) is an indirect utility of wealth function and i_t is the real return on loans. However, the marginal utility of wealth will differ from the marginal utility of consumption by a Lagrange multiplier reflecting the liquidity value of the monetary assets required to finance consumption. If these liquidity returns are represented by a multiplier μ_t the first order condition becomes

$$(1+i_t)^{-1} = \beta E_t[u'(c_{t+1})-\mu_{t+1}]/[u'(c_t)-\mu_t]. \tag{14}$$

The marginal utility of consumption *exceeds* the marginal indirect utility value of wealth by μ. Hence, the level of consumption will be lower than it would be if loans could be used directly to finance consumption. The requirement to use lower yielding liquid assets effectively raises the cost of consumption and therefore reduces the amount consumed.

- The first order condition for a *credit constrained* household would be further modified by a positive Lagrange multiplier from the credit constraint. Specifically, if λ_t is the multiplier for the credit constraint, the intertemporal consumption versus savings decision of a credit constrained household would obey

$$(1+i_t)^{-1} = \beta E_t[u'(c_{t+1})-\mu_{t+1}+\lambda_t]/[u'(c_t)-\mu_t]. \quad (15)$$

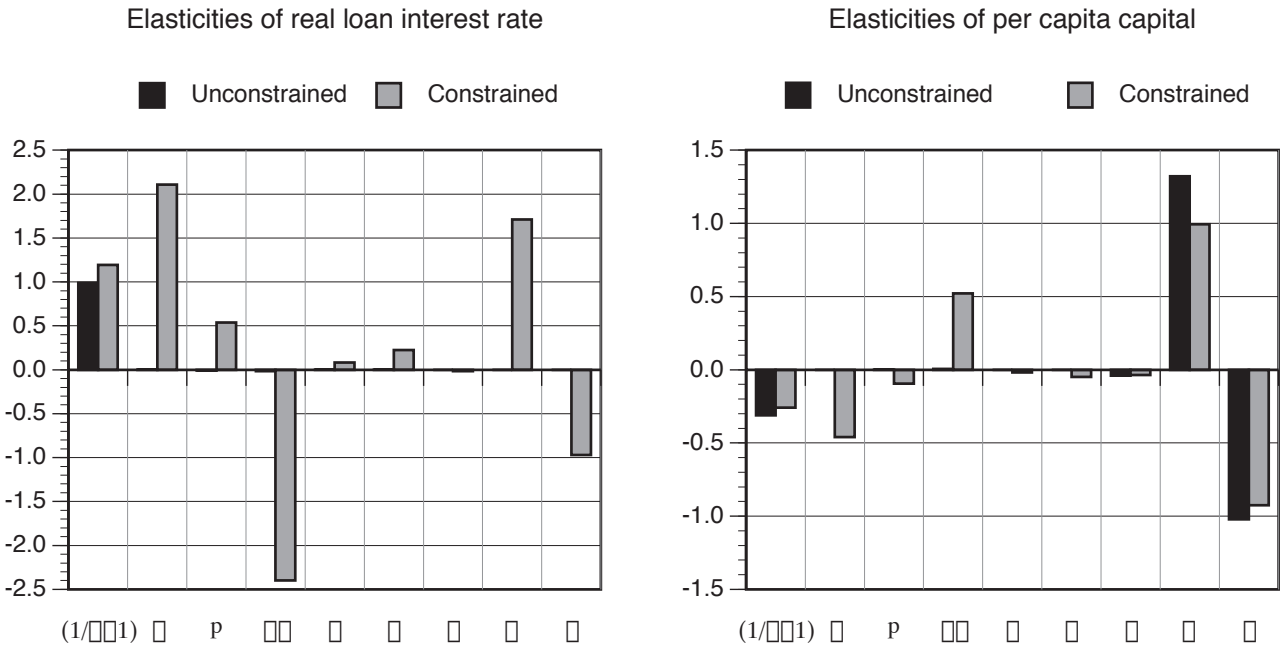
- The key modification resulting from the presence of liquidity and credit constraints, however, is that *both the values of the liquidity and credit multipliers and the proportion of households that are credit constrained in any period depend on the interest rate* i_t. As a result, firms effectively face an upward sloping supply curve of investment funds as a function of the interest rate. The equilibrium real interest rate and the level of investment become *jointly determined* by household and firm behavior. In particular, shocks to the marginal productivity of capital or the depreciation rate of capital alter the equilibrium real interest rate even in a stationary state where per capita consumption is not expected to change from one period to the next. In contrast, in the standard representative agent model, real interest rates are determined by household behavior. Firms face a horizontal supply curve of investment funds from households at a real interest rate determined by the household rate of time preference and anticipated changes in household consumption.

- In an economy with inside money and household credit constraints, there would be some funds available to firms to finance investment even at very low equilibrium real interest rates. Inside money with a positive yield is preferable to outside money with a zero rate of return. Even when the real yield on inside money is close to zero, households will hold some inside money to finance purchases that could be made with either type of liquid asset. As a result, equilibrium between the supply and demand for investment funds occurs at a lower real rate of interest than would apply in the standard representative agent economy with neither inside money nor credit constraints.

- Intermediaries would also finance investment in an economy with inside money but no credit constraints. However, many households would exploit any tendency for real interest rates to decline by borrowing. Such increased borrowing would occur up to the point where households were indifferent between consuming today and consuming tomorrow. Intermediaries thus have

little impact upon equilibrium real interest rates and investment. Increased household borrowing compensates for the increased availability of funds from the intermediaries.

- In the credit constrained economy with inside money the equilibrium real interest rate is very sensitive to shocks affecting the demand for inside money or shocks to the banking sector that affect the supply of loans corresponding to a given demand for inside money. Changes in real interest rates are accompanied by changes in the equilibrium capital stock and equilibrium per capita output. For example, the real effects of shocks to the demand for inside money or bank costs are about 100 to 200 times greater when households face credit constraints. The elasticities of the real interest rate on direct household loans to firms (upon which the other interest rates are based) and the stationary per capita capital stock with respect to key parameters of the model are graphed in the following figures.



- The key parameters included in the figures are the household time discount factor β, the coefficient of relative risk aversion γ, the probability of non-zero demand for the transaction services of inside money in any given period p, the utility value (at the same consumption levels) of goods which can be bought with inside money relative to goods which can only be bought with cash θ*, the reserve ratio for banks ρ, the marginal cost of bank services per unit of deposits χ, the

fixed cost of bankruptcy in units of per capita output ζ, the coefficient of capital in the Cobb-Douglas production function α and the per period depreciation rate of capital δ.

- Since cash is universally acceptable as a medium of exchange while inside money is not, an increase in risk aversion γ increases the demand for cash at the expense of inside money. In both the credit constrained and the unconstrained economies there is a large fall in the per capita demand for inside money. As a result, household risk aversion is a major determinant of equilibrium real interest rates and per capita capital in the credit constrained economy. In the unconstrained economy, however, a large fall in borrowing by less wealthy households, and a rise in direct household lending by more wealthy households, offset the tendency for real interest rates to rise. The increase in net direct lending to firms offsets the decline in bank loans so that per capita capital is virtually unaffected.

- An increase in the probability p of being able to use inside money to fund purchases reduces consumption uncertainty and therefore the demand for liquid assets. The same inventories of cash and inside money finance a higher level of per capita expenditure. In the unconstrained economy, households substitute out of liquid assets into direct loans to firms. Equilibrium real interest rates fall marginally and there is an extremely small positive effect on the equilibrium per capita capital stock. In the credit constrained economy, the increase in p reduces average excess liquid assets held by households after goods market trade. The demand for direct loans to firms as well as the demand for liquid assets declines. Equilibrium interest rates rise and the equilibrium per capita capital stock falls.

- An increase in the value of goods that can be bought with inside money relative to goods that can only be bought with cash θ^* raises the demand for inside money. In the credit constrained economy, the increased demand for inside money dramatically reduces equilibrium real interest rates and produces a large increase in the equilibrium per capita capital stock. In the unconstrained economy, a large decrease in net direct household loans to firms again offsets the tendency for real interest rates to fall.

- While the elasticities of real interest rates and per capita capital with respect to changes in bank costs χ or the bank reserve ratio ρ are not large in either economy, they are still about 100 to 200 times larger in the credit constrained case. Again endogenous increases in direct household loans to firms offset the fall in bank loans in the unconstrained economy.

- A striking feature of the figure is that the household rate of time discount ($1/\beta$-1) is the only parameter to have much off an effect on equilibrium real interest rates when there are no household credit constraints. In all other cases, endogenous changes in direct household lending to firms offset any tendency for real interest rates to change. In the case of changes in α, δ and ζ stationary equilibrium real interest rates are completely unaffected in the unconstrained economy. By contrast, in the credit constrained economy α and δ are key determinants of equilibrium real interest rates. In addition, changes in the cost of bankruptcy ζ affect only those firms at risk of bankruptcy in the unconstrained economy whereas changes in ζ affect all firms in the credit constrained case.

- A simple partial equilibrium model of the market for loans provides a useful conceptual framework for viewing the results for the credit constrained economy. Changes in α, δ and ζ can be thought of as shocks to the demand for loans from firms. Since such a shock would produce a movement along the upward sloping supply curve, the result is a positively correlated movement in equilibrium real interest rates and the equilibrium quantity of loans. On the other hand, changes in $(1/\beta-1)$, γ, p, θ^*, ρ and χ can all be thought of as shocks to the supply of loans from households and banks. A movement of the supply curve along a downward sloping demand curve for loans then produces a negatively correlated change in real interest rates and the equilibrium quantity of real loans. It is also noteworthy that most[1] of the loan supply shocks also produce endogenous movements in the money supply (measured as the sum of inside money and cash balances) and average nominal prices that are positively correlated with movements in per capita capital. By contrast, changes in α and δ produce endogenous movements in the money supply

[1.] The change in the probability of check goods demand p is the only exception.

and nominal prices that are negatively correlated with movements in per capita capital.

- There is now considerable evidence, particularly from panel data sets, that constraints on household borrowing can explain deviations of observed household consumption from the levels predicted by the permanent income hypothesis. Households with relatively high levels of wealth can maintain their consumption when income is temporarily low. They effectively "self-insure" by holding assets they can liquidate in time of need. Households without much wealth, however, appear to have limited access to capital markets and therefore tend to display consumption levels that more closely track their current income. We have argued that credit constraints in the presence of a demand for inside money and a role for financial intermediation can in a similar manner explain many apparently anomalous phenomena in financial markets. In particular, they offer an explanation for apparently low riskless real rates of interest, relatively high risk premiums, relatively large fluctuations in real interest rates in the face of smooth per capita consumption profiles and a large effect on real interest rates of real shocks such as shocks to the marginal productivity of capital. They also would appear to account for large effects on real interest rates, investment and output of "financial sector shocks" to the demand for inside money, the cost of financial intermediation and the extent or cost of bankruptcy.