News, intermediation efficiency and expectations-driven boom-bust cycles

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Abstract

The years leading up to the "great recession" were a time of rapid innovation in the financial industry. This period also saw a fall in interest rates, and a boom in liquidity that accompanied the boom in real activity, especially investment. In this paper we argue that these were not unrelated phenomena. The adoption of new financial products and practices led to a fall in the expected costs of intermediation which in turn engendered the flood of liquidity in the financial sector, lowered interest rate spreads and facilitated the boom in economic activity. When the events of 2007-2009 led to a reevaluation of the effectiveness of these new products, agents revised their expectations regarding the actual efficiency gains available to the financial sector and this led to a withdrawal of liquidity from the financial system, a reversal in interest rates and a bust in real activity. We treat the efficiency of the financial sector as an exogenous process and study the impact of "news shocks" regarding this process. Following the expectations driven business cycle literature, we model the boom and bust cycle in terms of an expected future efficiency gain which is eventually not realized. The build up in liquidity and economic activity in expectation of these efficiency gains is then abruptly reversed when agent's hopes are dashed. The model generates counter-cyclical movements in the spread between lending rates and the risk-free rate which are driven purely by expectations, even in the absence of any exogenous movement in intermediation costs.

KEYWORDS: expectations-driven business cycles, intermediation shocks, credit shocks, financial intermediation, financial innovation, news shocks, business cycles.
JEL CLASSIFICATION: E3

1 Introduction

> Many of the financial institutions and instruments caught up in the crisis are part of the centuries old phenomenon of financial innovation. The new instruments, often devised to avoid regulation, are then proved to be successful or not by the test of financial stress such as we have been recently encountering (Bordo, 2007).

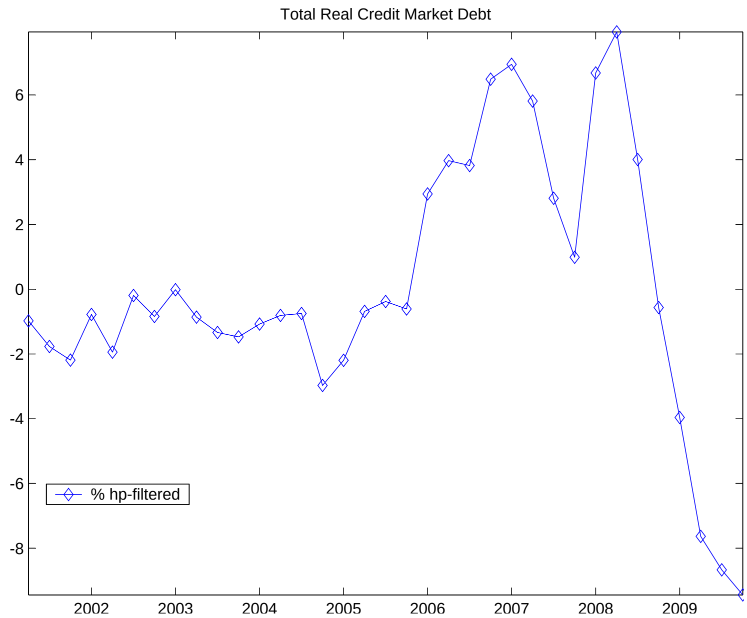
In this paper we explore the role of financial innovation and especially the role of expectations about the efficiency of the financial sector in inducing boom-bust cycles in macro aggregates. Most models of the recent financial crisis and recession focus on falling collateral values and tightening credit constraints in order to connect fluctuations in the financial sector to real economic activity[1]. We eschew these important features to focus on the linkages between intermediation efficiency, interest rate spreads and the quantity of credit flowing through the system to simultaneously explain both the "great recession" period as well as the boom that preceeded it[2].

Relatively little attention has been paid in this literature to the years leading up to the crisis which was a time of rapid innovation in the financial industry. This period also saw a fall in interest rates, and a boom in liquidity that accompanied the boom in real activity, especially investment. We wish to explore the possibility that these were not unrelated phenomena. The linkages are easy to see: the emergence and rapid adoption of new financial products and practices could have led agents to expect a fall in the overall costs of intermediation which in turn engendered the flood of liquidity in the financial sector, lowered interest rates and facilitated the boom in economic activity. When the events of 2007-2009 (especially the stress on financial institutions induced by the collapse in real-estate prices) led to a re-evaluation of the effectiveness of these new products, agents revised their expectations regarding the actual efficiency gains and this led to a withdrawal of liquidity from the financial system, a reversal in interest rates and a bust in real activity. Figures 1 and 2 display this boom-bust cycle in credit and interest rates for the US economy. Figure 1 displays the rapid rise in the total level of real credit relative to its long run trend and the subsequent pronounced bust that followed. Figure 2 displays the behaviour of the spread between the

[1]See Gertler and Karadi (2011), Gertler and Kiyotaki (2010), Christiano, Motto and Rostagno (2010), Gilchrist, Ortiz and Zakrajsek (2009), Jermann and Quadrini (2009), Nolan and Thoenissen (2009).

[2]Beaudry and Lahiri (2009) has a similar interest in linking the crisis to the preceding period. Unlike us they focus on the lack of productive investment opportunities available at that time which induce liquidity in the system.

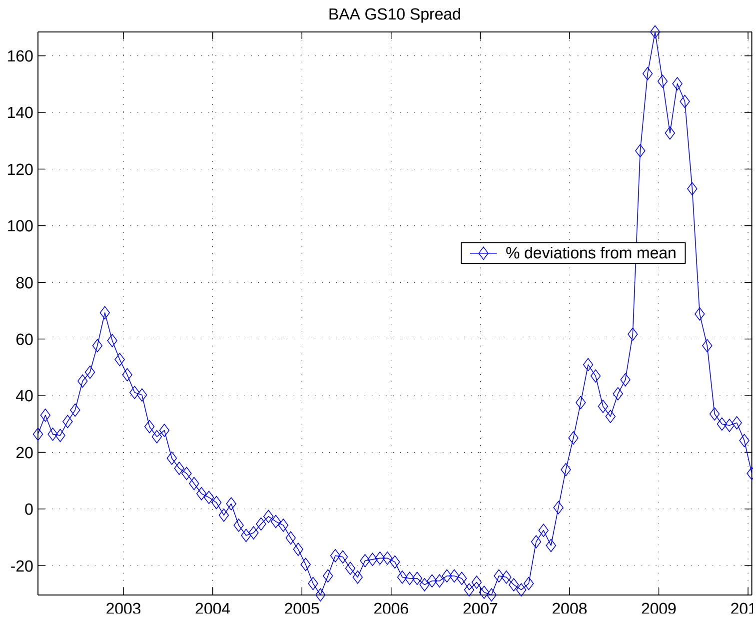
Figure 1: Total Real Credit Market Debt



yield on BAA bonds and the ten year treasury bond over the same period. As is clear from the graph, the spread fell roughly 25 percent below mean levels and then rose to well over 100 percent during the crisis. To investigate the connection between financial innovation and these features of the data we build a model in which changes in agents' expectations of financial efficiency drive liquidity, interest rate spreads and real activity. We view the period before the crisis as a time when agents had high expectations regarding the efficiency of the financial sector but the housing collapse and attendant stress in the financial system led to a downward reevaluation of these efficiency gains.

While the role of technical progress and innovation in goods production has been central to business cycle models in the last three decades, innovation in the financial sector has not received the same attention in the business cycle literature even though it has been widely discussed in the financial press. The decade leading up to the financial crisis was especially a time of rapid innovation in the financial sector. Particularly important to the crisis was the development of new debt instruments such as residential and commercial mortgage-backed securities, collateralized debt obligations (CDOs), collateralized loan obligations, asset-backed commercial paper (ABCP), structured investment vehicles and the widespread use of credit default swaps to insure against default. A brief look at some of these markets elucidates this point.

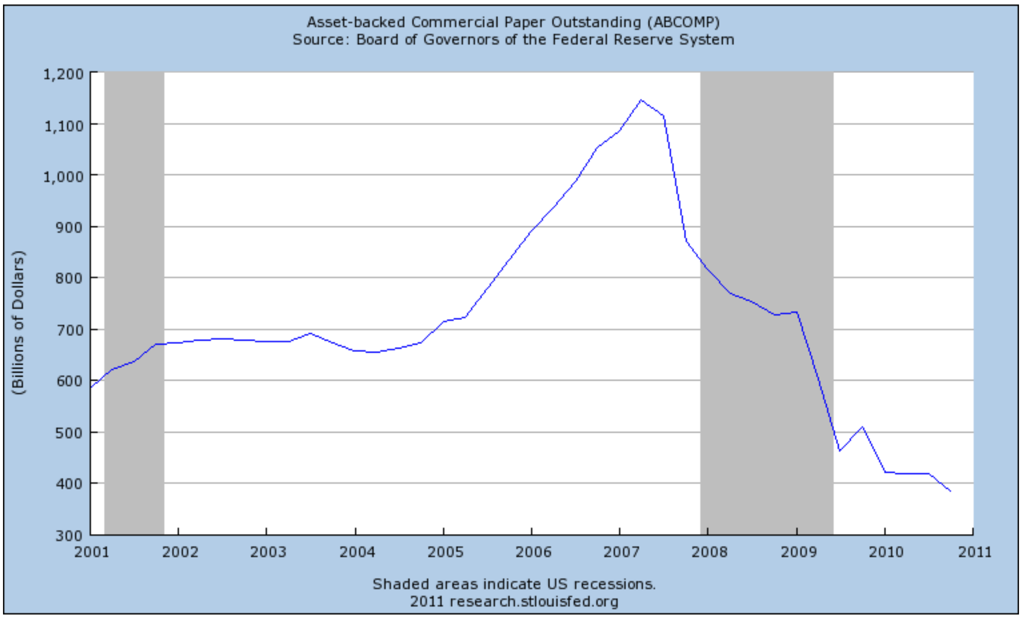
Figure 2: BAA-GS10 Spread



The rapid increase in the quantity of asset backed commercial paper is evident in Figure 3 taken from the FRED database. As can be seen in the figure, the total amount of asset backed commercial paper doubled from around 600 billion in January 2001 to over 1.2 trillion in mid 2007. A similarly rapid expansion took place with credit default swaps. According to the international swaps and derivatives association (ISDA Market Survey 2010), the market for CDS rose from about 900 billion in 2001 to 62 trillion in 2007.

From our perspective, the importance of these rapid developments of new financial products is that they raised the efficiency (or at least the expected efficiency) of the financial system in intermediating funds between borrowers and lenders. Clearly the products were sold in this light and the rapid adoption of these relatively opaque and little understood instruments suggests widespread acceptance of their efficacy. In the publicity material on credit default swaps, Standard and Poors describes them as "... an efficient way to transfer credit risk without buying or selling individual securities. CDS can be created when needed and are often more liquid than their cash market equivalents. Additionally, a CDS is a pure credit risk transfer vehicle, unlike bonds, which have a significant interest rate risk component." Other products that involved the bundling of assets of different quality and the ability to move risk off one's balance sheet by selling these bundles of assets, also appeared to increase the efficiency of the intermediation process by giving

Figure 3: Asset-back commercial paper outstanding



investors exposure to inherently riskier loans with higher yields without a concomitant increase in expected risk.

> Anyone who purchased a AAA-rated tranche of a collateralized debt obligation combined with a credit default swap had reason to believe that the investment had low risk because the probability of the CDS counter-party defaulting was considered to be small....Fund managers, searching for yield, were attracted to buying structured products because they seemingly offered high expected returns with a small probability of catastrophic loss (Brunnermeier, 2009).

In our view, this increased efficiency (including the perceived ability to reduce the inherent risk associated with certain types of loans) led to a large increase in the amount of funds in the financial system in the years leading up to the crisis. As the housing market collapsed, the additional scrutiny of the financial sector revealed that the promoted efficiency gains were somewhat illusory and that many people in fact held assets that were not in the risk class that they had previously thought, leading to a rapid withdrawal of funds from these financial securities.

In the context of our macroeconomic analysis, we abstract from the fact that assets come in many different risk levels and that different investors have varying tolerance for risk. Instead we believe it is useful to think of the financial sector in a purely abstract way where the intermediation between borrowers and lenders is only a function of the credit flowing through the system and an abstract random efficiency parameter.[3] We interpret the period leading up to the crisis as being one in which this parameter was high or expected to be above its steady state level. Furthermore, we interpret the widespread scrutiny of the financial sector and their products that began in 2007 in terms of lowered expectations - that in the future this parameter would be much lower. By interpreting this phenomena in terms of a change in expectations about future fundamentals - in this case the fundamentals of the financial intermediation process - we exploit the ideas of the recent "news shock" business cycle literature that investigates the role of changes in agents' expectations about future total factor productivity (TFP) in producing business cycle fluctuations [4]. We find the case of an *unfulfilled* news shock especially instructive, extending the approach of Beaudry and Portier (2004) who originally investigated a special case where agents first receive news about a future increase in TFP and then subsequently find out that these expectations were "overoptimistic" in the sense that the expected change in TFP fundamentals is not realized ex-post and therefore unfulfilled. In our exercise, agents receive news that the efficiency of the financial sector will rise at some future date, but this news turns out to be false when the date finally arrives. In anticipation of the efficiency gains, agents flood the system with liquidity, lowering interest rates and in the process, creating a boom in real activity. When the news turns out to be false, a bust ensues with falling investment and employment along with rising interest rates. Interestingly the entire boom and bust occur without any actual change in the efficiency parameter.

There is little question that many market participants were surprised that the assets they were holding failed to be as secure as initially thought. The BIS discusses this issue at length in a recent report. Focusing merely

[3]This distinguishes us from a number of other studies of the financial crisis that focus on shocks to the system that increase aggregate risk. We do not deny that it may be useful to think of innovations in the financial sector in terms of an increase in risk but think it is useful to study different aspects of the crisis in order to gain a full understanding of what happened.

[4]See Beaudry and Portier (2004), Beaudry and Portier (2006), Christiano, Ilut, Motto and Rostagno (2008), Jaimovich and Rebelo (2009), Gunn and Johri (2011), Den Haan and Kaltenbrunner (2009), Schmitt-Grohe and Uribe (2009), Khan and Tsoukalas (2009), and Dupor and Mehkari (2009).

on managers for example, the report says "...the question arises – to what extent did originators and sponsors of SPEs understand their risk/return profile after the risk disaggregation process had occurred? ...Several market participants interviewed noted that full understanding of the risk/reward profile of SPE usage among senior management was limited, and that in most cases senior management was unaware of the extent of overall linkage and obligations towards SPEs (whether explicit or implicit) until disruption in the credit markets actually made these crystallize" (Basel Committee on Banking Supervision, 2009).

We propose a simple and stylized model of financial intermediaries to capture the essence of the above observations and embed this into a relatively straightforward real dynamic general equilibrium business cycle model.[5] Financial intermediaries issue debt instruments to households and use the proceeds to make loans to output-producing firms. A zero profit condition ties the interest paid to lenders to the interest rate charged to borrowers but the two are not equal because financial intermediaries face costs, similar in spirit to the approach of Curdia and Woodford (2009) and Cooper and Ejarque (2000) who model costs of financial intermediation as a financial friction. There are two ways to think about these costs in the context of the preceding discussion on innovation in the financial sector with similar implications for the model. The most direct way is to simply think of an intermediation technology in which the costs of appropriately matching borrowers and lenders (with potentially different characteristics and requirements) are proportional to the amount of funds that need to be matched. Abstracting from all other inputs, we can then think of the recent innovations in financial products as increasing the efficiency of the intermediation technology. Since fewer resources are now used up in the process of matching up borrowers and lenders, financial intermediaries can either charge a lower rate to borrowers or pay a higher rate to lenders or both. This leads to an increase in demand for loans, an increase in the supply of credit or both. The increase in economic activity unleashed by falling rates in turn induces an increase in supply of credit by households. The other (and complementary) interpretation of these costs is in terms of the expected fraction of a loan portfolio held by a financial intermediary that will default each period or equivalently the probability of default. This interpretation suggests that the introduction of new financial products reduced the average proportion of loans that would default in any

[5]The role of the Federal Reserve and monetary policy before and during the crisis has been the subject of much debate and research. We deliberately choose to work with a real model in order to keep attention focused on the issues at hand. In this context we also note our focus on interest rate spreads as opposed to the level of short term interest rates that may be more under the control of monetary authorities.

period. Since financial intermediaries recovered a higher proportion of loans, they could afford to lower the spread between the rates charged to borrowers and paid to lenders. While it is quite likely that both these aspects of intermediation costs played a role in the huge rise and fall of credit over the past decade, perhaps the relative importance of each is immaterial as far as the model is concerned.

An important feature of our model is the introduction of convex portfolio adjustment costs on households. The main implication of this feature is that news of future changes in intermediation costs leads to an immediate desire to change ones exposure to the debt instruments of intermediaries. This leads to an immediate increase or withdrawal of liquidity from financial intermediaries which in turn induces an endogenous change in interest rate spreads in advance of any actual changes in financial intermediation efficiency. Furthermore, these spreads are counter-cyclical (as in the data) even when they are purely driven by changes in expectations about future financial intermediation costs.

In the next section we present our model. Section 3 discusses how we parameterize the linearized model, and Section 4 presents simulation results. Section 4 concludes.

2 Model

The model economy consists of an infinitely-lived representative household, a single competitive goods-producing firm, and a single competitive financial intermediary. In addition to markets for labour and goods, we assume the existence of a market for intermediated deposits and a market for intermediated loans. The firm is constrained to borrow both its wage bill as well as any investments in its physical capital stock in advance of production and therefore must obtain loans each period from the financial intermediary. Firms own the capital stock and can vary the utilization rate at a cost of higher depreciation.

2.1 Household

The representative household has preferences defined over sequences of consumption C_t and hours-worked N_t with expected lifetime utility defined as

$$\mathcal{U} = E_0 \sum_{t=0}^{\infty} \beta^t U(C_t, (1 - N_t)), \tag{1}$$

where β is the household's subjective discount factor and the period utility function $U(C_t, (1 - N_t))$ follows the class of preferences described in King, Plosser and Rebelo (1988).

The household enters into each period with total financial wealth A_t, which is deposited in the financial securities offered by the intermediary, D_t, and earns a potentially uncertain return given by r_t^D at the end of the period. Once resources have been invested with the intermediary, the household cannot pull them out until the end of the period when the investments mature. The household also interacts with the firm through labour markets, and is the owner of the firm, earning any profits, both of which are received at the end of the period when consumption and saving decisions are made.

Each period, the household receives a wage rate w_t for supplying hours-worked N_t, profits from the firm, Π_t, and the financial intermediary, F_t, as well as payments ξ_t from the financial intermediary associated with the cost the financial intermediary incurs to match loans with deposits. We think inclusion of these costs is appropriate in a closed economy context as operating expenses typically involve payments to households or entities owned by households.[6] These resources are used for consumption, C_t and for carrying wealth, A_{t+1} into the next period.

The period t household's budget constraint is given by

$$C_t + A_{t+1} = (1 + r_t^D)D_t - \Psi\left(\frac{D_t}{D_{t-1}}\right) D_t + w_t N_t + \xi_t + F_t + \Pi_t. \quad (2)$$

The household faces a cost associated with pulling out, or adding to its intermediated asset positions. The form of the cost is similar to the portfolio adjustment costs of Christiano and Eichenbaum (1992) and Cooley and Quadrini (1999) and penalizes changes in the flow of intermediated funds, with properties $\Psi(1) = \Psi'(1) = 0, \Psi''(\cdot) > 0$. These costs go beyond monetary costs associated with brokerage fees, early redemption penalties etc. and include other frictions which may inhibit the speed with which agents can acquire and process the information needed to make financial allocation decisions [7].

All the flows shown on the right hand side are received by the household at the end of the period when it must make it's consumption decision. The remainder is carried into the next period as wealth with the intent to deposit it in the securities offered by the financial intermediary. Thus the household

[6]Allowing these costs to be a net drain to the economy has little quantitative effect on the results.

[7]Also see Bonaparte and Cooper (2010) for a recent study that finds significant empirical evidence for portfolio adjustment costs.

faces the additional constraint:

$$A_t \geq D_t. \tag{3}$$

In what follows, we will impose the optimality condition that this equation holds with equality.

The household's problem is to choose sequences C_t, N_t, A_{t+1}, and D_t to maximize (1) subject to (2), and (3), yielding the respective first-order conditions

$$u_C(C_t, 1 - N_t) = \lambda_{1t} \tag{4}$$

$$u_{(1-N)}(C_t, 1 - N_t) = \lambda_{1t} w_t \tag{5}$$

$$\lambda_{1t} = \beta E_t \left\{ \lambda_{2t+1} \right\} \tag{6}$$

$$\begin{aligned} \lambda_{1t}(1 + r_t^D) = \lambda_{2t} + \lambda_{1t} &\left\{ \Psi\left(\frac{D_t}{D_{t-1}}\right) + \Psi'\left(\frac{D_t}{D_{t-1}}\right)\frac{D_t}{D_{t-1}} \right\} \dots \\ &\dots - \beta E_t \left\{ \lambda_{1t+1} \Psi\left(\frac{D_{t+1}}{D_t}\right)\left(\frac{D_{t+1}}{D_t}\right)^2 \right\} \end{aligned} \tag{7}$$

where λ_{1t} and λ_{2t} refer to the Lagrange multipliers on (2) and (3) respectively.

2.2 Financial Intermediary

There exists one financial intermediary (that nonetheless behaves competitively) that issues securities to households that promise a return given by r_t^D each period. The return on these securities is funded by loans made to the firm at the interest rate r_t^L.

The financial intermediary incurs costs in order to develop and sell securities to households and to manage and monitor loans that it originates to firms. Similar to Curdia and Woodford (2009), we represent this cost as a function of intermediated quantities and an exogenous process θ_t.

The financial intermediary's profits are given by

$$F_t = (1 + r_t^L)L_t - (1 + r_t^D)D_t - X(\theta_t)D_t, \tag{8}$$

where D_t is the quantity of deposits from households, L_t is the quantity of loans to firms, and $X(\theta_t)$ is the marginal cost of intermediation where $X'(\theta_t) < 0$. The intermediary's ability to make loans is restricted by the amount of deposits it collects, implying

$$L_t \leq D_t. \tag{9}$$

Each period the financial intermediary chooses D_t and L_t to maximize (8) subject to (9). Since a positive return must be paid out on D_t, the financial intermediary would never issue more securities than loans, implying the optimality condition

$$L_t = D_t. \tag{10}$$

The financial intermediary will then issue a positive level of loans as long as the following condition holds:

$$r_t^L - r_t^D \geq X(\theta_t). \tag{11}$$

Thus the costs introduce a spread between the interest rate charged on loans and the return paid on securities issued to households since in equilibrium, the profit maximizing financial intermediary must cover these costs.

Finally, we assume that the financial intermediary's total costs are associated with payments ξ_t which ultimately end up with households, such that each period the financial intermediary pays out $\xi_t = X(\theta_t)D_t$ to the household.

The efficiency shock, θ, evolves according to the stationary AR(1) process

$$\ln \theta_t = \rho \ln \theta_{t-1} + \mu_t, \tag{12}$$

where $\rho < 1$ and μ_t is an exogenous period t innovation which we will define further below. Note that shocks to θ will cause the spread between interest rates charged to borrowers and paid to lenders to vary over time.[8]

2.2.1 News shocks

We want to explore the possibility that agents react to information about changes in the financial sector in advance of the actual occurrence of these shocks. This fits in with the idea of expectations driven cycles in the news shock literature. Our representation of news shocks is standard and follows Gunn and Johri (2011). We provide for news about θ_t by defining the innovation μ_t in equation (12) as

$$\mu_t = \epsilon_{t-p}^p + \varepsilon_t, \tag{13}$$

[8] This is reminiscent of the risk-premium shocks used in Amano and Shukayev (2009) which induce exogenous movements in the spread between risk-free and risky assets. Note that in our model, the spread between the loan rate and the risk-free rate is actually endogenous. Indeed as discussed in the results section, movements in this latter spread can be induced, purely by changes in agents' expectations.

where ϵ_t^p is a news shock that agents receive in period t about the innovation μ_{t+p}, and ε_t is an unanticipated contemporaneous shock to μ_t. The news shock ϵ_t^p has properties $E\epsilon_t^p = 0$ and standard deviation σ_{ϵ^p}, and the contemporaneous shock ε_t has properties $E\varepsilon_t = 0$ and standard deviation σ_{ε_x}. The shocks ϵ_t^p and $\varepsilon_{A,t}$ are uncorrelated over time and with each other.

2.3 Firm

The firm produces output according to a constant returns to scale technology given by

$$Y_t = N_t^{\alpha} \tilde{K}_t^{1-\alpha}, \tag{14}$$

where $\tilde{K}_t$ refers to capital services defined as

$$\tilde{K}_t = u_t K_t, \tag{15}$$

where K_t is the firm's stock of physical capital and u_t is the utilization rate of that capital.

The firm is constrained to pay for both new investment in physical capital I_t and wages in advance of production, and therefore at the beginning of each period must borrow an amount $L_t = w_t N_t + I_t$ from the financial intermediary, after which at the end of the period it repays principal and interest at the loan rate r_t^L. Thus the firm faces the constraint

$$L_t \geq w_t N_t + I_t. \tag{16}$$

The firm accumulates capital according to

$$K_t = [1 - \delta(u_{t-1})]K_{t-1} + I_t, \tag{17}$$

where the function $\delta(\cdot)$ imposes a cost on the firm for increasing capacity utilization in the form of increased depreciation of capital, such that $\delta(\cdot)$ satisfies the conditions $\delta'(\cdot) > 0$, $\delta''(\cdot) \geq 0$. Note that we have altered the timing convention here to maintain the standard assumption that household savings in period $t-1$ ultimately impact goods production one-period later in period t through the new investment that these savings create. Since in this model the firm must fund investment with a pool of loans funded by period $t-1$ household savings, its investment must then impact production in the period that the investment is purchased.

Each period, the firm pays out any profits earned to the household that owns it. Profits are given by

$$\begin{aligned} \Pi_t &= \{Y_t - (1 + r_t^L)L_t\} - \{w_t N_t - I_t + L_t\} \\ &= Y_t - w_t N_t - I_t - r_t^L L_t, \end{aligned} \tag{18}$$

where the terms inside the left and right parenthesis on the right-hand side are the end-of-period and beginning-of-period flows respectively.

The firm chooses sequences of N_t, $\tilde{K}_t$ I_t and L_t to maximize current and expected future profits,

$$\sum_{s=0}^{\infty} \beta^{t+s} \frac{\lambda_{1t+s}}{\lambda_{1t}} \Pi_{t+s} \tag{19}$$

where $\beta^{t+s}\frac{\lambda_{1t+s}}{\lambda_{1t}}$ is the household-owner's stochastic discount factor.

Since the firm must pay interest on all loans, it will only borrow up to the point necessary to purchase its productive inputs, implying the optimality condition

$$L_t = w_t N_t + I_t. \tag{20}$$

The remainder of the firm's first-order conditions are then

$$(1 + r_t^L) = \alpha \frac{Y_t}{N_t} \tag{21}$$

$$\beta E_t \frac{\lambda_{1t+1}}{\lambda_{1t}} (1 + r_{t+1}^L) \delta'(u_t) K_t = (1 - \alpha) \frac{Y_t}{u_t} \tag{22}$$

$$1 + r_t^L = (1 - \alpha) \frac{Y_t}{K_t} + \beta E_t \frac{\lambda_{1t+1}}{\lambda_{1t}} (1 + r_{t+1}^L)[1 - \delta(u_t)]. \tag{23}$$

2.4 Equilibrium

Equilibrium in this economy is defined by a contingent sequence of allocations C_t, N_t, I_t, K_{t+1}, u_t, L_t,D_t,and prices w_t, r_t^D, r_t^L that satisfy the following conditions: (i) the allocations solve the household's problem taking prices as given, (ii) the allocations solve the firm's and financial intermediary's problem taking prices as given, (iii) all markets clear, (iv) the resource constraint $C_t + I_t = Y_t$ holds.

Note that perfect competition in the markets for intermediated assets ensures that the financial intermediary makes zero profits, implying that (11) holds with equality, yielding

$$r_t^L - r_t^D = X(\theta_t). \tag{24}$$

For reference later in discussion of our results, we also define the equilibrium real risk-free interest rate as $r_t^f = \frac{1}{E_t \beta \frac{\lambda_{1t+1}}{\lambda_{1t}}} - 1$, the credit spread as $r_t^L - r_t^f$ and the FI-spread as $r_t^L - r_t^D$.

3 Parameterization

In this section we present an illustrative calibration that we will use to demonstrate the impact of a change in expectations about financial intermediation efficiency in our model economy. We assign values to the parameters using typical values established in the literature, or where there is a lack of precedent, we choose the parameters to match relevant steady state quantities in the model economy with analogous quantities in the data. Additionally, in the results section we illustrate sensitivity of the model dynamics to changes in key parameter values. Finally, we solve the model by using standard methods to linearize the non-linear system about the unique steady state.

Beginning with the parameters common to standard real-business cycle models, we set the household's subjective discount factor β to 0.99, implying a net annualized risk-free interest rate r^f of 4.1%. Since the portfolio adjustment costs are zero in steady state, $r^D = r^f$, implying that the annualized real interest received by the household on intermediated funds is also 4.1%.

We use preferences not separable in consumption and leisure of the form used by King and Rebelo (2000) where the the stand-in representative agent has the preference specification

$$u(C_t, L_t) = \frac{1}{1-\sigma}\left\{C_t^{1-\sigma}\upsilon^*(L_t)^{1-\sigma} - 1\right\} \tag{25}$$

where $\upsilon^*(1 - N_t) = \left[\left(\frac{N_t}{H}\right)\upsilon_1^{\frac{1-\sigma}{\sigma}} + \left(1 - \frac{N_t}{H}\right)\upsilon_2^{\frac{1-\sigma}{\sigma}}\right]^{\frac{\sigma}{1-\sigma}}$, and where H is the fixed shift length, and υ_1 and υ_2 are constants representing the leisure component of utility of the underlying employed group (who work H hours) and unemployed group (who work zero hours) respectively. We set the fraction of the population working on average f^w to 0.6 and $\sigma = 3$ following King and Rebelo. Then setting the average household's share of time allocated to market work N_{ss} to 0.3 yields a ratio of consumption of those employed to consumption of those unemployed of 3.24.

On the production side, we set $\alpha = 0.67$ to yield a labour share in production of 0.67, depreciation of physical capital in steady state δ to 0.025, and steady state capacity utilization u_{ss} to 1.

For the convex cost of capacity utilization, our solution method requires that we need only specify the elasticity of marginal depreciation to utilization, $\epsilon_u = \frac{\delta''(u)}{\delta'(u)}u$, which we set to 0.15, the same as that used by Jaimovich and Rebelo (2009), Gunn and Johri (2011), and within the range of values considered by King and Rebelo (2000).

For the portfolio adjustment costs, we adopt the portfolio adjustment cost specification of Cooley and Quadrini (1999) of $\Psi(\frac{D_t}{D_{t-1}}) = \psi_0\left(\frac{D_t}{D_{t-1}} - 1\right)^2$, also similar to the portfolio adjustment cost specification used by Christiano and Eichenbaum (1992). Following Cooley and Quadrini, we set $\psi_0 = 3$. In the results section we present sensitivity results for this parameter.

Our model implies that in steady state the spread between the loan rate and deposit rate is $r^l - r^d = X(\theta)$, where $X(\theta)$ is the exogenous intermediation marginal cost. Recalling that in steady state r^d equals the risk-free rate r^f, we calibrate $X(\theta) = r^l - r^f$ to match the average spread between BAA corporate bonds and ten year government bonds of 0.0056 on a quarterly basis. This then yields a value for the steady state loan rate r^l of 6.5%.

For our illustrations we choose intermediation efficiency shocks that cause the spread between the interest rate on loans and the risk free rate to fall by the same order of magnitude as seen in the US over the period preceding the financial crisis. Depending on which assets are used in the calculation, the spread decreased from 25 percent to over 120 percent between 2002 and 2007. [9] Since these exercises are meant to be a quantitative illustration of the mechanisms in our model, we normalize the elasticity of the function $X(\theta)$ to unity and then arbitrarily choose a shock that delivers a 50 percent fall in the credit spread. In all the exercises shown below agents receive "news" that a shock will raise the efficiency of the financial intermediary after eight quarters. Except for the sensitivity graphs in Figure 4 where we vary the persistence of the shock process, the shock has an AR(1) co-efficient of .9722 which we estimated from the spread between the BAA corporate bond yield and the ten year government bond yield measured as percent deviations from the mean value of the spread[10].

4 Results

In this section we use a linearized and parameterized version of our model to illustrate how a fall in the costs of intermediation can lead to a large boom in economic activity. Figure 4 illustrates the response of our model to the news that intermediation costs will begin to fall after two years. The news creates an immediate expansion in economic activity which slowly builds up to a boom that reaches its peak roughly 20 quarters after the news arrives. The boom is accompanied by an expansion in liquidity (increase in D) in the financial system and a fall in the cost of borrowing funds for firms. Despite charging a lower rate for their loans, intermediaries are able to offer a better return to households on their depository instruments because of the

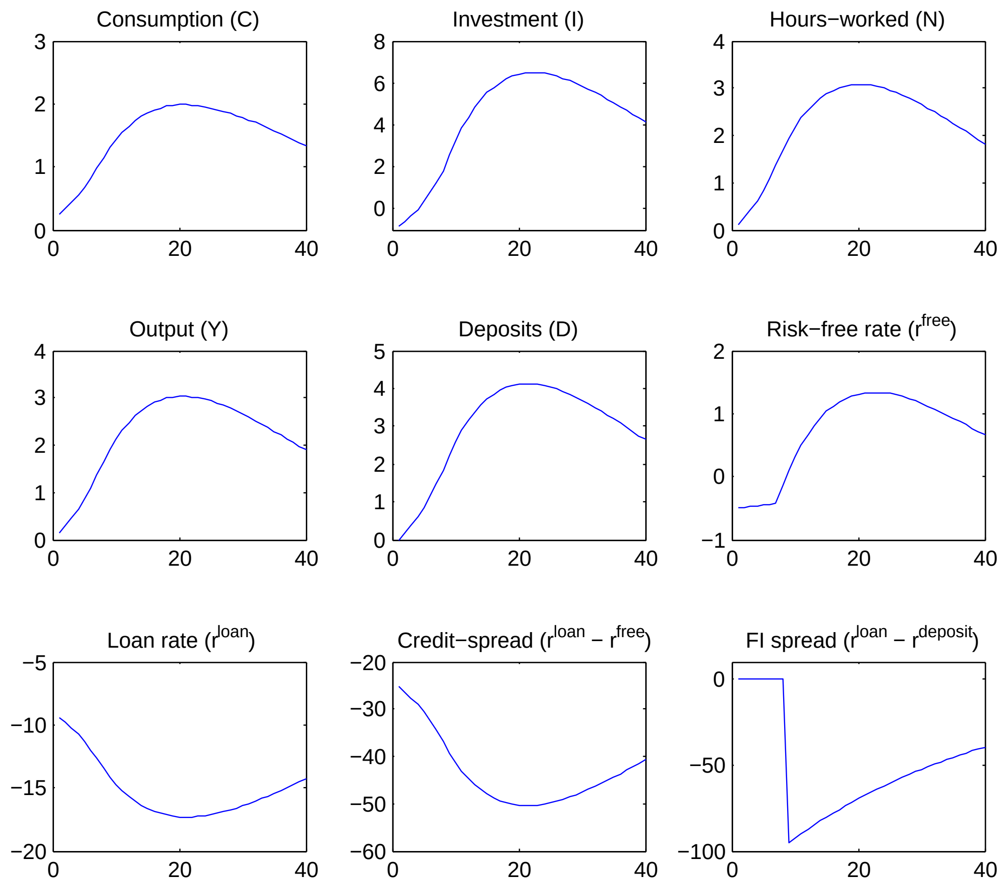
[9]Details of these calculations are available from the authors.

[10]These series were obtained from FRED and the annualized rates were converted to quarterly frequency to be consistent with the model

substantial cost savings enabled by the new efficiency gains. Since households incur costs if they wish to change the size of their investment portfolio, and since they anticipate the higher returns soon to be available from the financial intermediary, households begin to increase their investments with the intermediary as soon as possible after the news arrives. Since households are constrained to invest no more than the available wealth, A_t in any given period, they cannot immediately contribute additional amounts to the intermediary but do so beginning in the period after the news arrives. Household deposits rise smoothly and peak at roughly 4 percent above their steady state value. This injection of liquidity in the financial intermediary induces them to expand lending to goods-firms both to finance their capital expenditure as well as working capital loans to finance their wage bill. As the supply of loanable funds increase, the equilibrium loan rate falls and this induces additional borrowing on the part of firms who use these resources to expand production both by hiring more workers as well as investing in capital accumulation. We see from Figure 4 that both aggregate hours and output rise immediately, while investment initially falls a bit but displays the same smooth upward sloping profile as all the other aggregate variables. Investment rises to a peak of roughly 6 percent while hours and output rise about 3 percent above their steady state values respectively. In anticipation of future wealth increases, consumption initially rises slightly more than output but overall is less volatile than output, reaching a peak of roughly 2 percent above its steady state value.

Beyond the boom in real activity, an interesting feature of the model is that it induces endogenous movements in the spread even in advance of any actual changes in the efficiency of the financial intermediary. Recall that the actual shock to costs does not occur until eight quarters after the news arrives. Thus any changes in the credit spread, ie., the spread between the loan rate charged to firms and the risk-free rate is purely induced by the expectations driven actions of the agents. As can be seen in Figure 4, the credit spread falls 25 percent below its steady state value immediately on arrival of the news. How can we understand this? Note first of all that the risk-free rate falls and the loan rate falls more than that in order to generate a fall in the spread. Given unchanged costs, the only way the fall in the loan rate can be profitable is if the return offered to households also falls. Once again, adjustment costs are crucial to generating this fall in r_d. Households know they will wish to expand deposits in the future when intermediation costs falls. The presence of adjustment costs imply that it is advantageous to smoothly begin to increase those deposits immediately. In other words, the marginal value of deposits to households rises immediately (with news) and in particular rises above r_d which is tantamount to an outward shift in the

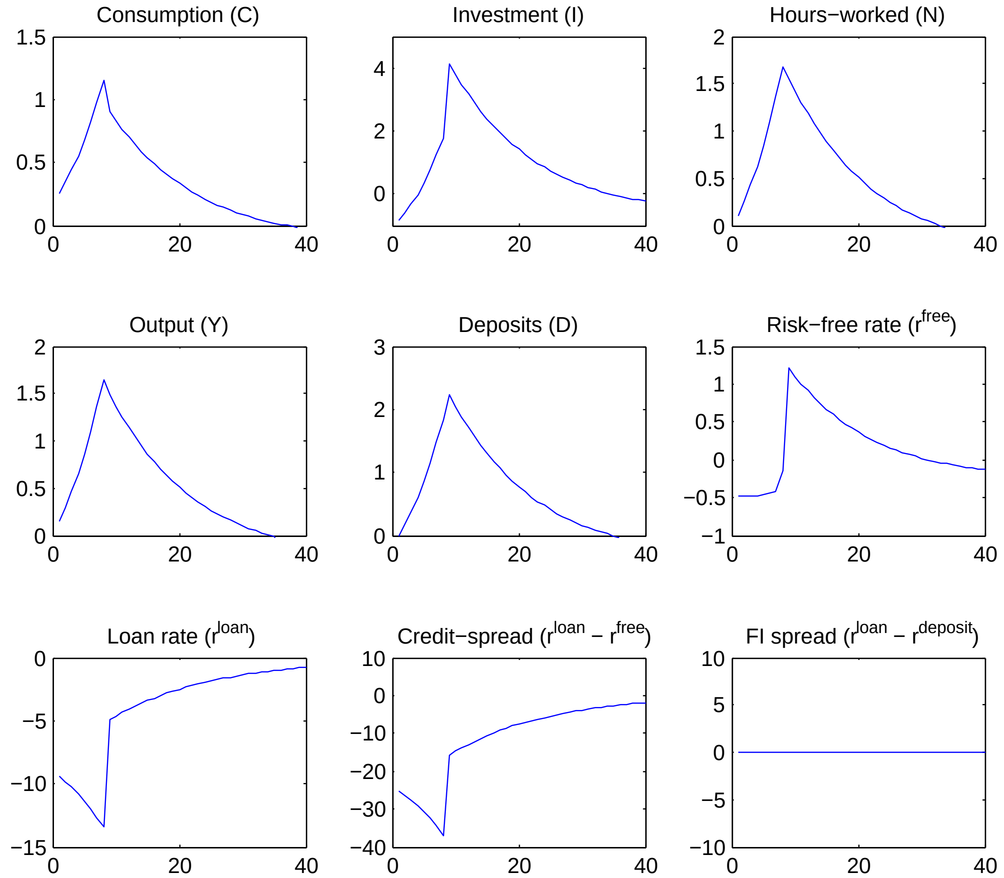
Figure 4: News about increase in intermediation efficiency 8 periods in future - efficiency increase **realized** in period 8



supply of deposits by households. Since households are in fact constrained by their wealth in how much they can actually deposit with the intermediary, the equilibrium value of the interest rate paid on deposits falls. Once the efficiency gains arrive, the spread between the loan and deposit rates begins to shrink exogenously and the interest paid on deposits can rise as discussed above.

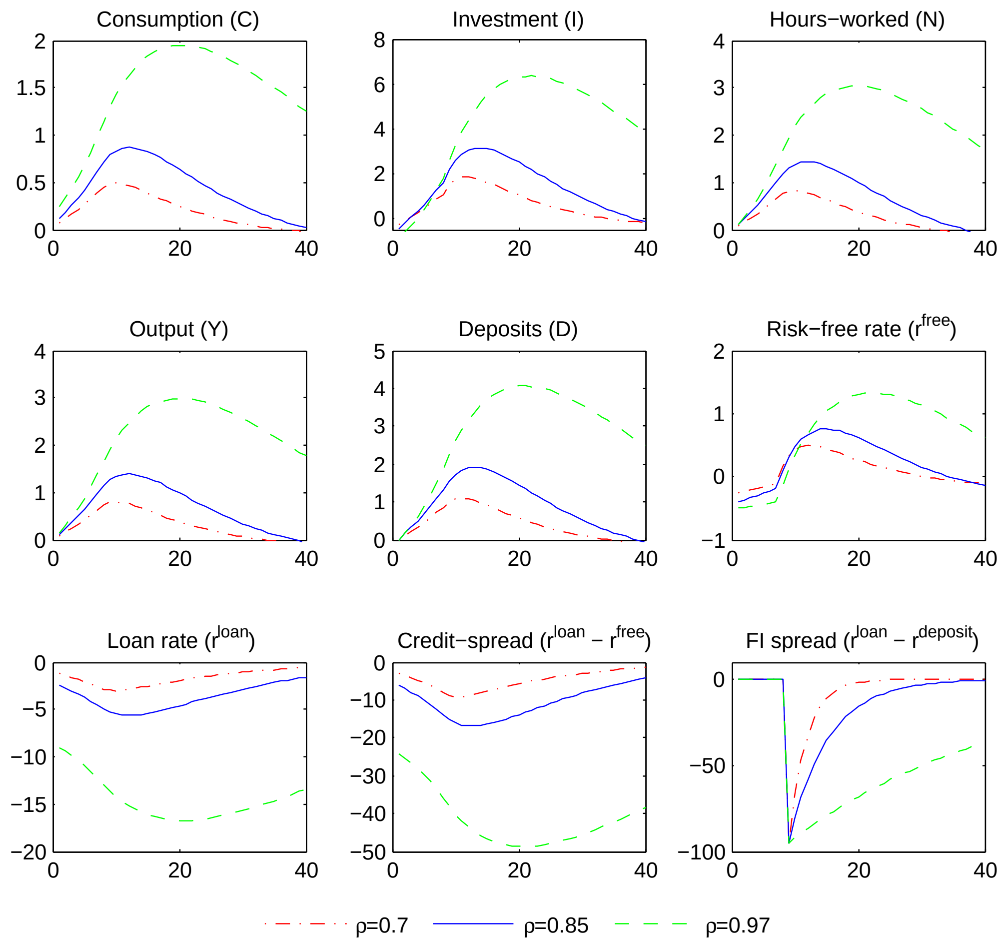
The above discussion suggests that expectations play an important role in determining the value of the spread over and above the actual current value of the intermediation costs. In the next exercise, we explore the role of expectations more fully by studying the case where the news of future efficiency gains turn out to be completely false in that the gains never materialize. This situation is depicted in Figure 5. The behaviour of the economy to the news

Figure 5: News about increase in intermediation efficiency 8 periods in future - efficiency increase **unrealized** in period 8



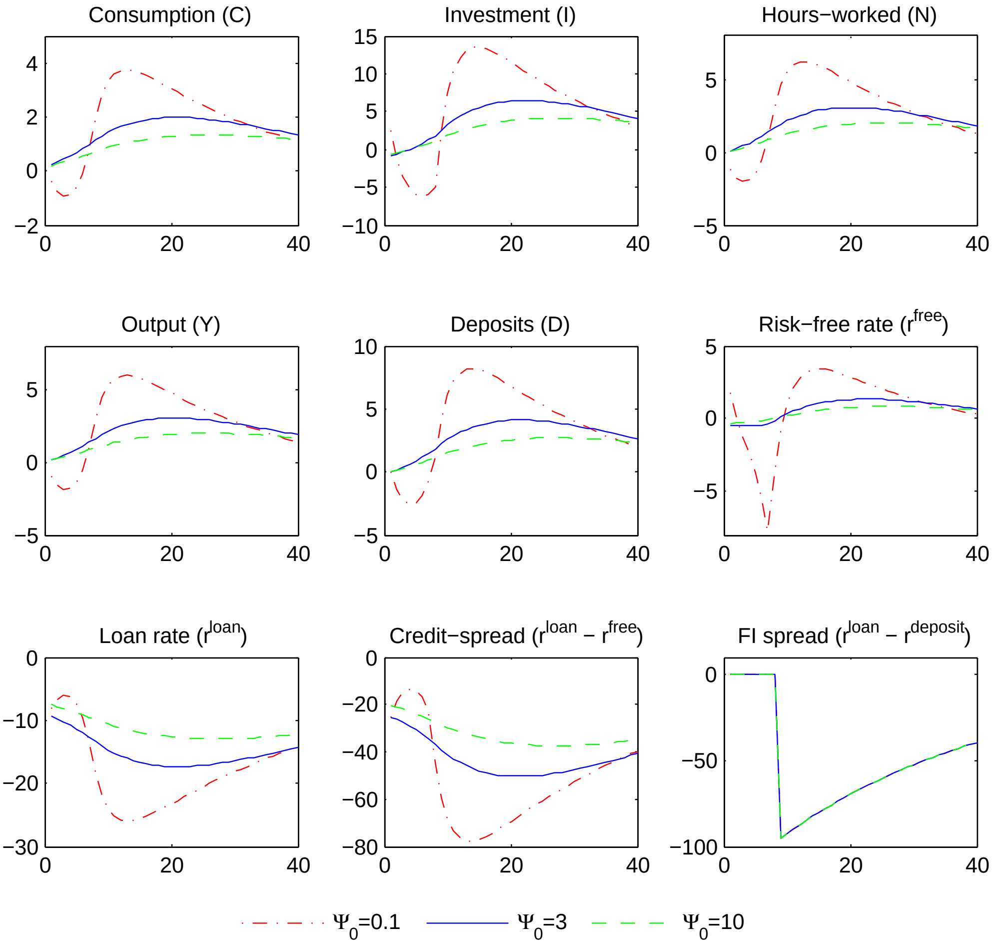
of efficiency gains in the first eight periods is the same as in the previous exercise since the agents are operating as if costs will decrease in the future. However in period 9, agents find out that costs will not change at all and therefore they reverse their steps and return to steady state. This reversal leads to a sharp bust in economic activity, especially evident in investment due to the ex-post inefficient build up of physical capital. Overall Figure 5 is an illustration of a complete boom-bust cycle which is driven entirely by expectations of future intermediation efficiency gains that are never realized. As firms fire workers and cut back on investment spending, the credit spread (which had fallen to about 40 percent below its steady state value over the first eight periods) jumps sharply back up and households start to withdraw liquidity from the financial intermediary. The bust lasts for a number of years

Figure 6: Sensitivity to persistence parameter ρ: News about increase in intermediation efficiency 8 periods in future - efficiency increase **realized** in period 8



and the entire boom bust episode plays out over roughly ten years or forty quarters. Over this period, investment rises about 4 percent above steady state and then falls back while the other variable have smaller booms. The sharp rise in the spread in one quarter is particularly compelling as it goes from roughly 39 percent below steady state to 16 percent below steady state. We find this scenario particularly interesting because a change in expectations is the only source of a large and persistent endogenous movement in the credit spread without any underlying movement in the actual efficiency parameter. In the introduction we showed plots of interest rate spreads and

Figure 7: Sensitivity to adjustment cost parameter Ψ_0: News about increase in intermediation efficiency 8 periods in future - efficiency increase **realized** in period 8



credit just before and during the recession. Figures 1 and 2 showed that the fall in spreads was accompanied by an expansion of credit in the economy in the period before the financial crisis. This was followed by the crisis period during which spreads spiked sharply and credit plummeted. This inverse relationship between spreads and credit is also delivered by the model as can be seen in Figure 5.

The next two figures explore the sensitivity of the model responses to a couple of important parameters. Figure 6 shows the sensitivity of the model to the assumed persistence of the shock process. For illustrative purposes, we picked this parameter based on the observed persistence of the BAA to ten year government bond spread. Since in our model, these spreads are at least somewhat endogenous, this is far from satisfactory. However, reducing the persistence first to .85 and then to .7 suggests that the character of the model responses seen in Figure 4 are preserved. The main findings from this sensitivity exercise appear to be that the boom induced by the news is smaller which is consistent with a smaller fall in the credit spread. Figure 7 explores the role of the parameter ψ_0 which governs the cost of adjusting D_t. As these costs become smaller, agents are less concerned about responding to future efficiency gains and prefer to wait until the shock actually occurs. As a result when costs are close to zero, we get a fall in economic activity when news arrives which converts into a boom only after the efficiency gains materialize. The model displays a trade-off between the amplitude of the fluctuations and the ability to induce a boom in advance of the shock occurring. As adjustment costs go to zero, all variables display delayed, but stronger booms and vice-versa.

5 Conclusions

In this paper we build a model in which changes in agent's expectations about future intermediation cost savings can lead to an immediate expansion in liquidity in the financial system which in turn leads to a fall in credit spreads and a boom in economic activity, all of which precedes any actual change in intermediation costs. Likewise, expected increases in costs would lead to a credit contraction, higher spreads and a fall in economic activity. We go on to show that an expectations driven boom in production and credit can subsequently be followed by a bust if the expectations turn out to be false. Consistent with the model, the negative co-movement of credit spreads on the one hand and total credit and economic activity on the other was part of the boom-bust cycle experienced by the US economy recently.

We argue that the years preceding the financial crisis were a period of rapid technological change in the financial sector when a number of new financial products as well as practices were introduced. Given the novelty of many of these innovations and speed of adoption, it is likely that agents had very high expectations of the efficiencies that were to be expected from these developments. The events of 2007 led to a sharp downward revision in the expected efficacy of these products. At the same time, concerns regarding the stability of the financial system may have also contributed to the expectation that intermediation costs would be much higher going forward, than previously expected. Our model attempts to provide a stylized economy that can help understand the consequences of these changes in expectations about intermediation costs. Intermediation efficiency is incorporated into the financial sector using an exogenous process. While we do not argue that balance sheet affects that other researchers have focused upon were unimportant in understanding the "great recession", we think that the great boom in liquidity that was experienced by the economy in the period leading up to the crisis and its subsequent decline contributed to the magnitude of the recession.

The events of 2007-2009 have cast a spotlight on the financial sector and revealed a complex set of phenomena that contributed to the worst recession in the post-war era. We have tried to contribute to our overall understanding of what happened in this period by focusing on one possible source of the great expansion in liquidity that preceded the recession and its eventual decline. Our explanation of this liquidity boom has focused on overoptimistic expectations of efficiency gains in the financial sector whereas much of the discussions in the financial press have focused on the effect of low policy rates such as the Federal Funds Rate. Interestingly, our model generates declines in interest rates during the boom phase followed by sharp increases in these rates once the bust begins even in the absence of any monetary authority. Moreover we emphasize the importance of spreads in this period that may be less under the control of the monetary authority and more susceptible to changes in expectations. Nonetheless, developing a monetary version of the model which can incorporate the behaviour of the fed would be an interesting avenue of future work.

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