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An Expectations-Driven Interpretation of the "Great Recession"

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An expectations-driven interpretation of the “Great Recession”

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Abstract

The boom-years preceding the “Great Recession” were a time of rapid innovation in the financial industry. We explore the idea that both the boom and eventual bust emerged from overoptimistic expectations of efficiency-gains in the financial sector. We treat the bankruptcy costs facing intermediaries in a costly state verification problem as a stochastic process, and model the boom-bust in terms of an unfulfilled news-shock where the expected fall in costs are eventually not realized. In response to a change in expectations only, the model generates a boom-bust cycle in aggregate activity, asset prices and leverage, and a countercyclical credit spread.

KEYWORDS: expectations-driven business cycles, intermediation shocks, news shocks, great recession, financial accelerator.
JEL CLASSIFICATION: E3, E44

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1 Introduction

In order to connect fluctuations in the financial sector to real economic activity, most DSGE models of the recent financial crisis and recession introduce disturbances in the financial sector such as shocks to collateral values or to credit constraints[1]. Moreover, this literature typically stresses the role of contemporaneous shocks arriving in 2007/2008 and pays relatively little attention to the years leading up to the crisis. In contrast, we show that changes in expectations about the costs associated with defaults can lead to movements in credit spreads, asset prices, leverage, aggregate net-worth and total quantity of credit as well as aggregate macro quantities to simultaneously explain both the "great recession" period as well as the boom that preceded it[2]. In order to deliver this, we incorporate modeling strategies from the news shock literature and embed them into a relatively standard macro model of financial intermediation.

Before discussing the model further, it is useful to consider some of the boom-bust patterns exhibited by the recent U.S. data. 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 rate spreads, and a boom in liquidity that accompanied the boom in real activity, especially investment. We wish to explore the possibility that these were related 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 rate spreads and facilitated the boom in economic activity. When the events of 2007-2009 led to a re-evaluation of the effectiveness of these new products, agents revised downwards their initial 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 behavior of the spread between the 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

[1]See Gertler and Karadi (2011), Gertler and Kiyotaki (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.

crisis.

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 two instruments elucidates this point. For example, 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 credit default swaps (CDS) rose from about 900 billion in 2001 to 62 trillion in 2007.

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, following the macroeconomic literature on agency costs, we model intermediaries as agents that originate a portfolio of loans, some of which will be defaulted upon. The intermediary expects to lose a fraction of the value of these loans due to various bankruptcy and monitoring costs. As part of our abstraction, we view the emergence of new financial products in terms of these costs: the ability to move risky loans off one's balance sheet or the ability to buy insurance against a default event using a CDS may be interpreted as lowering the expected losses associated with any default episode. The rapid development and adoption of these new financial products suggests the possibility that expectations of future losses associated with defaults may have fallen too much relative to the actual efficiency gains that these products could deliver. The optimism of lenders regarding the costs associated with defaults creates expectations that the return on deposits with financial intermediaries will rise which in turn leads to a large increase in the amount of funds in the financial system.

To this end, we model bankruptcy/monitoring costs as a stochastic process, and interpret shocks to this process as stochastic variation in financial innovation [3]. While it abstracts from the complexity of credit markets, we

[3] Levin et al. (2004) present a partial-equilibrium representation of a costly-state verification problem similar to that in Bernanke et al. (1999), using a time-varying cost of

believe it is useful to think of innovation in the financial sector in terms of a random efficiency parameter in parallel to the way we think of technical change in product markets in terms of TFP shocks [4]. We interpret the period leading up to the crisis as being one in which this parameter governing bankruptcy costs was low or expected to be below its steady state level. Furthermore, we interpret the widespread scrutiny of the financial sector and its products that began in 2007 in terms of revision of expectations - that in the future this parameter would be much higher. We model this change in expectations by exploiting ideas from the recent "news shock" business cycle literature that investigates the role of changes in agents' expectations about future total factor productivity (TFP), extending the idea here to the financial sector to consider anticipated changes in bankruptcy costs [5]. We find the case of an *unfulfilled* news shock especially instructive [6]. In our exercise, agents receive news that this cost parameter will fall at some future date, but this news turns out to be false when the date finally arrives. In anticipation of the cost savings, agents flood the system with liquidity, which creates an investment boom, higher production and employment, a fall in credit spreads and a rise in asset prices. When the news turns out to be false, a bust ensues with falling investment and employment along with a sudden rise in credit spreads and fall in asset prices. Interestingly, the entire boom and bust occur without any actual change in the cost parameter.

We use 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.[7] A

monitoring parameter in order to quantify the time-series properties of this parameter over a panel of 900 firms from 1997Q1 to 2003Q3.

[4]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 shocks 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.

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

[6]Beaudry and Portier (2004) illustrate 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.

[7]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

financial intermediary issues debt instruments to households and uses the proceeds to make loans to entrepreneurs to finance purchases of new capital. 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 must cover the costs associated with those firms that are unable to repay their loans. A fall in these costs allows the spread between rates charged to borrowers and lenders to fall. Interestingly, spreads decline in the boom and rise in the bust even in the absence of any actual movement in the cost parameter. This occurs because net-worth rises endogenously during the boom phase and falls during bust independent of changes in the exogenous bankruptcy costs, improving the overall return recovered from defaulted loans during the boom, and worsening it during the bust. As a result, the financial intermediary can charge a lower interest rate relative to the safe-rate on the loan portfolio during the boom phase as compared to the bust. In this sense, the model generates fluctuations in spreads that are purely driven by changes in expectations.

Our model builds on two strands of the business cycle literature. From the news-shock literature (see Beaudry and Portier (2004)), we borrow the idea that news about future fundamentals can cause a change in expectations which result in an immediate change in actions, in advance of any movement in the fundamental. If the news is later revealed to be incorrect, this leads to further changes in expectations, and in actions. As a result the news-shock literature emphasizes the role of changes in expectations in generating economic fluctuations. While the news-shock literature focuses on imperfect signals about total factor productivity as a source of business cycles, we extend this idea to the financial sector - in this particular instance to variation in expected monitoring/bankruptcy costs as an independent source of business cycles variation. Our macroeconomic model of financial intermediation closely follows the financial accelerator literature exemplified by Carlstrom and Fuerst (1997) and Bernanke, Gertler, and Gilchrist (1999). Relative to this literature, our model introduces variations in intermediation costs and especially variations in expectations about these costs as a source of cycles. To our knowledge, expectations-driven boom-bust cycles that originate in the financial sector are a novel contribution of this paper to both these literatures. Thus, in the process of interpreting the great recession in the context of a boom-bust cycle, we have established a bridge between the literature on news shocks with that of financial intermediation.

may be more under the control of monetary authorities. It is also worth mentioning that if policy-makers receive the same information about the efficiency of the financial sector as all other agents, then there is no reason in our model for them to try and dampen the response of the economy.

In the next section we present our model. Section 3 discusses how we parameterize the linearized model. Section 4 presents both an illustration of the optimal contract, and simulation results for the response of the model to contemporaneous shocks, and fulfilled and unfulfilled news shocks. Section 5 concludes.

2 Model

Our model embeds the financial accelerator mechanism of Bernanke, Gertler, and Gilchrist (1999) into an otherwise standard real business cycle model. Since we will not study the role of monetary policy in this paper, we omit the New Keynesian elements present in that model. The model economy consists of a representative infinitely-lived stand-in household, one each of a single goods-producer, capital-producer and financial intermediary who all nonetheless act competitively, as well as a unit measure of risk-neutral entrepreneurs. The household owns the goods-producer and capital-producer as well as the financial intermediary. The goods-producer produces output with labor and capital, paying wages to households and renting capital from entrepreneurs. Entrepreneurs purchase capital from the capital producer, financing their capital with their own wealth as well as from loans from the financial intermediary. The entrepreneurs' capital returns are subject to idiosyncratic shocks observable to the entrepreneurs but not the financial intermediary, and thus the lending arrangement between the financial intermediary and a given entrepreneur involves agency costs. The financial intermediary finances its loans to entrepreneurs by issuing risk-free securities to households. The capital-producer creates new capital by purchasing output from the goods market and combining it with existing capital.

In addition to markets for labor and goods, we assume the existence of a market for household deposits (financial securities), a market for intermediated loans, and a market for capital goods.

2.1 Household

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

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

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

The household enters into each period with total financial securities A_t, earning the risk-less gross rate of return R_t^d on its financial securities, receiving the wage rate w_t for supplying hours N_t to the goods-producing firms, and receiving a share of profits from the capital-producers, goods-producers and financial intermediary, denoted collectively as Π_t. At the end of the period, the household chooses its consumption C_t and its holdings of financial securities A_{t+1} to deposit with the financial intermediary.

The period t household's budget constraint is given by

$$C_t + A_{t+1} = R_t^d A_t + w_t N_t + \Pi_t, \tag{2}$$

where the interest rate R_t^d is determined in the previous period.

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

$$u_C(C_t, N_t) = \lambda_t \tag{3}$$

$$-u_N(C_t, N_t) = \lambda_t w_t \tag{4}$$

$$\lambda_t = \beta R_{t+1}^d E_t \{\lambda_{t+1}\}, \tag{5}$$

where λ_t refers to the Lagrange multiplier on (2).

2.2 Goods-producer

The goods-producing firm produces output Y_t according to a constant returns to scale technology given by

$$Y_t = \tilde{N}_t^{\alpha} K_t^{1-\alpha}, \tag{6}$$

where $\tilde{N}_t$ is total hours-worked, and K_t is physical capital rented from entrepreneurs at the rental rate r_t. Hours-worked is a composite of both household and entrepreneurial labor, such that

$$\tilde{N}_t = N_t^{\Omega} (N_t^e)^{1-\Omega} \tag{7}$$

where household labor N_t is acquired at wage-rate w_t and entrepreneurial labor N_t^e is acquired at wage-rate w_t^e.

The firm sells its output in the goods market where it is used as consumption by households or as additions to the capital stock by capital-producers. Each period the firm chooses N_t, N_t^e and K_t to maximize its profits $\Pi_t^g = Y_t - w_t N_t - w_t^e N_t^e - r_t K_t$, yielding the first-order conditions

$$w_t = \Omega\alpha \frac{Y_t}{N_t} \tag{8}$$

$$w_t^e = (1-\Omega)\alpha \frac{Y_t}{N_t^e} \tag{9}$$

$$r_t = (1-\alpha)\frac{Y_t}{K_t}. \tag{10}$$

2.3 Financial Intermediary

At the end of each period t the financial intermediary makes a portfolio of loans to the measure of entrepreneurs, with $B_{t+1}(i)$ denoting the loan to the ith entrepreneur, funding this portfolio of loans by issuing securities, A_{t+1}, to the household that promise a risk-less gross return, R_{t+1}^d. For simplicity, the financial intermediary issues no equity and has no other sources of funds. As such, in order for the competitive financial intermediary to guarantee the risk-free return on its household securities each period, it must generate a total return on its loan portfolio in each aggregate contingency to just cover its opportunity cost of funds on the household securities. Although loans to entrepreneurs are subject to both idiosyncratic and aggregate risk, by virtue of the entrepreneurs being risk neutral, as in Bernanke et al. (1999) we can assume that each entrepreneur is willing to bear all the aggregate risk on its loan and thus make state-contingent loan payments that ensure that in each aggregate state of the world the financial intermediary achieves an expected return (where the expectation is over the idiosyncratic returns of the entrepreneur) equal to the intermediary's opportunity cost of funds. This leaves the financial intermediary with only the idiosyncratic risk associated with individual loans, which it can diversify away by virtue of holding a large loan portfolio. As such, in each aggregate state in period t, the financial intermediary's budget constraint is

$$\xi_t = R_t^d A_t, \tag{11}$$

where ξ_t is the intermediary's return on its entire loan portfolio after idiosyncratic uncertainty has been realized, and where R_t^d and A_t are predetermined. We will now first discuss the entrepreneurial technological environment before detailing the financial contracts between the financial intermediary and the entrepreneurs.

2.4 Entrepreneurs

Risk-neutral entrepreneurs accumulate physical capital. At the beginning of each period, entrepreneurs rent their capital $K_t(i)$ to the goods-producer at rental rate r_t. At the end of the period, they sell their existing capital to the capital-producer at price q_t, and then immediately buy back, at price q_t^n, their desired level of capital, $K_{t+1}(i)$, to hold into next period. Entrepreneurs finance these capital purchases with their own end-of-period net-worth, $X_{t+1}(i)$, and new loans from the financial intermediary $B_{t+1}(i)$, such that their financing satisfies

$$q_t^n K_{t+1}(i) = X_{t+1}(i) + B_{t+1}(i). \tag{12}$$

Entrepreneur i's return to capital is subject to both idiosyncratic and aggregate risk, such that its ex-post return to holding capital from t to $t+1$ is given by

$$R_{t+1}^k(i) = \omega_{t+1}(i) R_{t+1}^k \tag{13}$$

where $\omega(i)$ is a random variable providing an idiosyncratic component to entrepreneur i's return, and where

$$R_{t+1}^k = \frac{r_{t+1} + q_{t+1}}{q_t^n}. \tag{14}$$

is the ex-post return on capital averaged across all entrepreneurs. The market prices r_t, q_t and q_t^n and thus R_{t+1}^k are functions of the aggregate state of the economy. The random variable ω is i.i.d across firms and time, has cumulative distribution function $F(\omega)$, and is normalized so that $E\omega = 1$.

To prevent entrepreneurs from self-financing and eliminating the need for external finance in the long run, we assume as in Bernanke et al. (1999) that each entrepreneur faces a constant probability, γ, of surviving into the next period. When entrepreneurs die (and at no other time), they consume their entrepreneurial equity, $c_t^e(i)$.

Finally, entrepreneurs supply a unit time endowment inelastically to the good-producers at wage-rate w_t^e.

2.5 Agency problem and debt-contract

As in Bernanke et al. (1999), we assume that the financial intermediary can observe the average return to capital R_t^k but not an entrepreneur's idiosyncratic component $\omega_t(i)$, unless it pays a monitoring cost. As such, as illustrated by Townsend (1979), the parties can adopt a financial contract that minimizes the expected agency costs, in the form of risky-debt where the monitoring costs are incurred only in states where an entrepreneur fails to make promised debt payments. Under this structure, as discussed by Williamson (1987) and Bernanke et al. (1999), the monitoring costs can be interpreted as "default costs" or "bankruptcy costs". We assume that these default costs are a fraction, θ_t, of the entrepreneur's gross payout, $\omega_t(i) R_t^k q_{t-1} K_k(i)$, however, unlike Bernanke et al. (1999), we follow Levin et al. (2004) in assuming that θ_t is time-varying and follows a stochastic process, the properties of which we will describe below. Moreover, we assume that θ_t is an exogenous aggregate state that is common to all entrepreneurs, and which is observable by all agents in the economy.

The specific timing of a typical entrepreneur's choices and the contract are as follows: at the end of period t, the entrepreneur chooses its capital expenditures, $q_t^n K_{t+1}(i)$ and associated level of borrowing, $B_{t+1}(i)$, with knowledge of neither the aggregate state in period $t+1$ nor the idiosyncratic realization of ω in period $t+1$, $\omega_{t+1}(i)$. Conditional on these choices, the terms of the contract between the financial intermediary and the entrepreneur specify a contractual non-default state-contingent gross interest rate, R^l_{t+1} that ensures that in each aggregate state of the world, the financial intermediary achieves an expected return equal to the its opportunity cost of funds. In the event that the entrepreneur's idiosyncratic returns are insufficient to cover its contracted debt payments, the entrepreneur defaults and goes bankrupt, handing over all remaining gross returns to the financial intermediary, leaving the gross returns less default costs to the financial intermediary. Note that given the state-contingent contract structure, the loan rate $R^l_t(i)$ will adjust in period t to reflect the ex-post realization of the aggregate state in t.

Carlstrom and Fuerst (1997) and Bernanke et al. (1999) show that such a contract can be represented with a cut-off value $\bar{\omega}_t(i)$ defined as

$$\bar{\omega}_{t+1}(i) R^k_{t+1} q_t K_{t+1}(i) = R^l_{t+1}(i) B_{t+1}(i). \tag{15}$$

If the entrepreneur's realization exceeds the threshold such that $\omega_{t+1}(i) \geq \bar{\omega}_{t+1}(i)$, the entrepreneur pays the financial intermediary the contracted amount $R^l_{t+1}(i)B_{t+1}(i)$, keeping the amount $\omega_{t+1}(i)R^k_{t+1}q_t K_{t+1}(i) - R^l_{t+1}B_{t+1}(i)$. If $\omega_{t+1}(i) < \bar{\omega}_{t+1}(i)$, the entrepreneur defaults, receives nothing, and the financial intermediary receives $(1-\theta_t)\omega_{t+1}(i)R^k_{t+1}q_t K_{t+1}(i)$. As with $R^l_t(i)$, $\bar{\omega}_t(i)$ adjusts to reflect the aggregate ex-post realizations of the aggregate state in period t.

Given these contract details, we can write the financial intermediary's expected return on a given loan contract in a given aggregate contingency in period $t+1$ as

$$\xi_{t+1}(i) = [1 - F(\bar{\omega}_{t+1}(i))] R^l_{t+1}(i) B_{t+1}(i) + (1-\theta_{t+1}) \int_0^{\bar{\omega}_{t+1}(i)} \omega R^k_{t+1} q_t K_{t+1}(i) dF(\omega) \tag{16}$$

Substituting in (15), we can write (16) in terms of the cut-off $\bar{\omega}$ as

$$\xi(\bar{\omega}_{t+1}(i), \theta_{t+1}) = \left[[1 - F(\bar{\omega}_{t+1}(i))]\bar{\omega}_{t+1}(i) + (1 - \theta_{t+1}) \int_0^{\bar{\omega}_{t+1}(i)} \omega dF(\omega) \right] R^k_{t+1} q_t K_{t+1}(i). \tag{17}$$

Defining the financial intermediary's expected share of gross returns $\Gamma(\bar{\omega})$ as

$$\Gamma(\bar{\omega}_t(i)) = [1 - F(\bar{\omega}_t(i))]\bar{\omega}_t(i) + \int_0^{\bar{\omega}_t(i)} \omega dF(\omega), \tag{18}$$

and defining $G(\bar{\omega})$ as

$$G(\bar{\omega}_t(i)) = \int_0^{\bar{\omega}_t(i)} \omega dF(\omega), \tag{19}$$

we can re-write the financial intermediary's expected return on a given loan contract in a given aggregate contingency as

$$\xi_{t+1}(\bar{\omega}_{t+1}(i), \theta_{t+1}) = [\Gamma(\bar{\omega}_{t+1}(i)) - \theta_{t+1} G(\bar{\omega}_{t+1}(i))] \, R^k_{t+1} q_t K_{t+1}(i) \tag{20}$$

where the terms in square brackets represent the financial intermediary's share of profits net of default costs. The requirement that the financial intermediary earn an expected return in every aggregate contingency equal to its opportunity cost of funds,

$$\xi_{t+1}(\bar{\omega}_{t+1}(i), \theta_{t+1}) = R_{t+1} B_{t+1}(i) \tag{21}$$

then serves as a restriction to define a menu of contracts over loan quantity and cut-off value for the entrepreneur. Substituting in (12) and (20) we can then write this as

$$[\Gamma(\bar{\omega}_{t+1}(i)) - \theta_{t+1} G(\bar{\omega}_{t+1}(i))] \, R^k_{t+1} q_t K_{t+1}(i) = R^d_{t+1} \left(q^n_t K_{t+1}(i) - X_{t+1}(i) \right) \tag{22}$$

which for a given level of net-worth $X_{t+1}(i)$ defines a menu of contracts relating the entrepreneur's choice of $K_{t+1}(i)$ to the cut-off $\bar{\omega}_{t+1}(i)$.

2.6 Entrepreneur's contract problem

The entrepreneur's expected gross return, conditional on the ex-post realization of the aggregate state but before the resolution of idiosyncratic risk, is given by

$$V^k_{t+1}(i) = \int_{\bar{\omega}_{t+1}(i)}^{\infty} \omega R^k_{t+1} q_t K_{t+1}(i) dF(\omega) - R^l_{t+1}(i) B_{t+1}(i). \tag{23}$$

Substituting in the definitions above yields

$$V_{t+1}^{k}(i) = \left[1 - \Gamma(\bar{\omega}_{t+1}(i))\right] R_{t+1}^{k} q_t K_{t+1}(i), \tag{24}$$

where $1 - \Gamma(\bar{\omega}_{t+1}(i))$ is the entrepreneur's expected share of gross returns.

For a given level of net-worth $X_{t+1}(i)$, the entrepreneur's optimal contacting problem is then

$$max_{K_{t+1}(i),\bar{\omega}_{t+1}(i)} E_t\{V_{t+1}^{k}(i)\} \tag{25}$$

subject to the condition that the financial intermediary's expected return on the contract equal its opportunity cost of its borrowing, equation (22). Letting $\lambda_{t+1}(i)$ be the ex-post value of the Lagrange multiplier conditional on realization of the aggregate state, the first-order conditions are then

$$\Gamma'(\bar{\omega}_{t+1}(i)) - \lambda_{t+1}\left[\Gamma'(\bar{\omega}_{t+1}(i)) - \theta_{t+1} G'(\bar{\omega}_{t+1}(i))\right] = 0 \tag{26}$$

$$E_t\left\{\left[1 - \Gamma(\bar{\omega}_{t+1}(i))\right]\frac{R_{t+1}^{k}}{R_{t+1}^{d}} + \lambda_{t+1}\left(\left[\Gamma(\bar{\omega}_{t+1}(i)) - \theta_{t+1} G(\bar{\omega}_{t+1}(i))\right]\frac{R_{t+1}^{k}}{R_{t+1}^{d}} - 1\right)\right\} = 0 \tag{27}$$

$$\left[\Gamma(\bar{\omega}_{t+1}(i)) - \theta_{t+1} G(\bar{\omega}_{t+1}(i))\right] R_{t+1}^{k}(i) q_t K_{t+1}(i) - R_{t+1}^{d}\left(q_t^{n} K_{t+1}(i) - X_{t+1}(i)\right) = 0 \tag{28}$$

where (26) and (28) hold in each contingency, but (27) holds only in expectation.

2.7 Capital-producer

The competitive capital-goods producer operates a within-period technology that combines existing capital with new goods to create new installed capital. At the end of each period it purchases existing capital K_t^k from entrepreneurs at price q_t, combining it with investment I_t purchased from the goods market to yield new capital stock K_t^{nk}, which it sells back to entrepreneurs in the same period at price q_t^n. The capital-producer faces adjustment costs in the creation of new capital, and incurs depreciation in the process, so that

$$K_t^{nk} = (1-\delta)K_t^k + \Phi\left(\frac{I_t}{K_t^k}\right)K_t^k. \tag{29}$$

The capital-goods producer chooses K_t^{nk}, K_t^k and I_t to maximize profits $\Pi_t^k = q_t^n K_t^{nk} - q_t K_t^k - I_t$. Substituting (29) into this expression gives $\Pi_t^k = q_t^n(1-\delta)K_t^k + q_t^n \Phi(\frac{I_t}{K_t^k})K_t^k - q_t K_t^k - I_t$. The producer's optimal choices of I_t and K_t^k then leads to,

$$q_t^n = \frac{1}{\Phi'(\frac{I_t}{K_t^k})} \tag{30}$$

$$q_t = q_t^n \left[(1-\delta) + \Phi(\frac{I_t}{K_t^k}) \right] - \frac{I_t}{K_t}. \tag{31}$$

2.8 Stochastic process θ_t

The default cost process, θ_t evolves according to the stationary AR(1) process

$$\ln \theta_t = \rho \ln \theta_{t-1} + \mu_t, \tag{32}$$

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 so that the financial intermediary's zero-profit condition is satisfied.[8]

2.8.1 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 Christiano et al. (2008). We provide for news about θ_t by defining the innovation μ_t in equation (32) as

$$\mu_t = \epsilon_{t-p}^p + \varepsilon_t, \tag{33}$$

where ϵ_{t-p}^p is a news shock that agents receive in period $t-p$ about the innovation μ_t, 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.

2.9 Equilibrium

Equilibrium in this economy is defined by contingent sequences of C_t, $c_t^e(i)\forall i$, N_t, $N_t^e(i)\forall i$, I_t, A_{t+1}, $K_{t+1}(i)\forall i$, $B_{t+1}(i)\forall i$, $\bar{\omega}_{t+1}(i)\forall i$, K_t^{nk}, K_t^k, w_t, w_t^e, r_t, R_{t+1}^d, $R_{t+1}^l(i)\forall i$, R_t^k, q_t, q_t^n, that satisfy the following conditions: (i) the allocations solve the household's, goods-producer's, financial intermediary's, entrepreneurs' and capital producer's problems, taking prices as given,

[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.

(ii) all markets clear, (iii) the resource constraint $C_t + C_t^e + q_t^n \Phi(\frac{I_t}{K_t} K_t) + \theta_t G(\bar{\omega}_t) q_{t-1}^n R_t^k K_t = Y_t$ holds, where $\int_0^1 K_{t+1}(i) = K_{t+1}$, $\int_0^1 B_{t+1}(i) = B_{t+1}$, $\int_0^1 X_{t+1}(i) = X_{t+1}$, $\int_0^1 c_{t+1}^e(i) = C_{t+1}^e$, $\int_0^1 N^e(i) = N^e = 1$ and where all entrepreneurs choose the same cut-off such that $\bar{\omega}_{t+1}(i) = \bar{\omega}_{t+1} \quad \forall i$, and therefore $R_{t+1}^l(i) = R_{t+1}^l \quad \forall i$.

Equilibrium in the capital goods market implies that $K_t^{nk} = K_{t+1}$ and $K_t^k = K_t$, and equilibrium in the securities market implies that $A_t = B_t$.

In equilibrium the financial intermediary's return on its entire loan portfolio just covers its opportunity cost of funds, implying that its budget constraint holds in every aggregate contingency and after idiosyncratic uncertainty is resolved as

$$[\Gamma(\bar{\omega}_{t+1}) - \theta_{t+1} G(\bar{\omega}_{t+1})] R_{t+1}^k q_t K_{t+1} = R_{t+1}^d A_{t+1}. \tag{34}$$

Aggregate net-worth evolves as the accumulated gross returns of surviving entrepreneurs plus their labor income. Letting V_t be aggregate gross entrepreneurial returns, we can compute it as the average gross idiosyncratic returns,

$$V_t = [1 - \Gamma(\bar{\omega}_t)] R_t^k q_{t-1}^n K_t, \tag{35}$$

which after making substitutions yields

$$V_t = R_t^k q_{t-1}^n K_t - \left[R_t^d B_t + \theta_t G(\bar{\omega}_t) R_t^k q_{t-1}^n K_t \right], \tag{36}$$

so that aggregate net-worth evolves as

$$X_{t+1} = \gamma V_t + w_t^e. \tag{37}$$

Finally, entrepreneurial consumption C_t^e is equal to the aggregated gross return of dying entrepreneurs,

$$C_t^e = (1 - \gamma) V_t. \tag{38}$$

For reference later in the discussion of our results, we also define the equilibrium real risk-free net interest rate as $r_t^f = \frac{1}{E_t \beta \frac{\lambda 1t+1}{\lambda_{1t}}} - 1$, the credit spread as $R_t^l - R_t^d$, and leverage as $L_t = \frac{q_t^n K_{t+1}}{X_{t+1}}$.

3 Parameterization

In this section we present an illustrative calibration that we will use in the next section for our simulation analysis. We assign values to 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. For parameters relevant to the financial contract, we follow closely the calibration of Bernanke et al. (1999). 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 of 4.1%, and implying a quarterly gross return on household financial assets $R^d = (1 + r^f)^{0.25} = 1.0101$.

On the production side, we set the share of labor in production, $\alpha = .67$, and the depreciation of physical capital, δ to 0.025.

For the capital adjustment cost, our solution method requires that we need only specify the elasticity of the price of capital with respect to the investment capital ratio. We follow Bernanke et al. (1999) in setting this to 0.25. In the next section we report results for a version of the model without adjustment costs.

We use preferences of the form used by King and Rebelo (2000) where the stand-in representative agent has the preference specification

$$u(C_t, N_t) = \frac{1}{1-\sigma} \left\{ C_t^{1-\sigma} \upsilon^*(N_t)^{1-\sigma} - 1 \right\}, \tag{39}$$

where $\upsilon^*(N_t) = \left[\left(\frac{N_t}{H} \right) \upsilon_1^{\frac{1-\sigma}{\sigma}} + \left(1 - \frac{N_t}{H} \right) \upsilon_2^{\frac{1-\sigma}{\sigma}} \right]^{\frac{\sigma}{1-\sigma}}$, 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. For $\sigma > 1$ these preferences are not separable in consumption and leisure, and for $\sigma = 1$ they reduce down to standard separable indivisible labour preferences with log-consumption and linear leisure. We report results for both cases in the next section. We set the fraction of the population working on average, f^w to 0.6, and the average household's share of time allocated to market work N_{ss} to 0.3. In our impulse-response analysis of the non-separable case, we set $\sigma = 2$, which is within the range studies reported by King and Rebelo. This then yields a ratio of consumption of those employed to consumption of those unemployed of 2.26. For our simulations involving separable preferences, we set $\sigma = 1$. We also explored other non-separable preferences which give similar results and these are available from the authors upon request.

For the parameters associated with the financial contract and the entrepreneur, we follow Bernanke et al. (1999) in setting these parameters such that in steady state, the external finance spread, $R^k - R^d$, equals 0.005 quarterly, leverage, K/X, is approximately 2, and the fraction of entrepreneurs defaulting each quarter is 0.076. We set the quarterly survival rate of entrepreneurs to 0.9795, the variance of $\log \bar{\omega}$ to 0.0727, and steady-state fraction of gross returns lost in default, θ, to 0.115.

For our illustrations we choose default cost shocks that cause the credit-spread to fall by roughly the same order of magnitude as seen in the US over the period preceding the financial crisis. Depending on which assets are used for this 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 arbitrarily choose a shock that reduces the spread by 50 percent when the shock is unexpected. The size of the shock is then maintained in the following exercises where news arrives of a future change in θ. This brings us to the persistence of the θ process. Once again we turn to the persistence in measured credit spreads to help in parameterization. We measure the credit spread as 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. We then regress this measure on its first lag and a constant using ordinary least squares. Our estimate of the autoregressive coefficient was .9722 with a standard error of .0143.[10]. Noting that the credit spread depends on θ and $\bar{\omega}$ and that the endogenous persistence of the credit spread created by the model is very small, for the sake of transparency, we set the persistence of the shock process to .9722. As a result, the simulated credit spread generated by the model has an AR(1) coefficient of .99 for our parameterization.

For reference later, we refer to the model with non-separable preferences ($\sigma = 2$) and adjustment costs as the "full-model", and the version of the model with separable preferences ($\sigma = 1$) and no adjustment costs as the "baseline" model.

4 Results

Recall from our earlier discussion that the optimal contract at the end of period t is defined by the pair $(\bar{\omega}_{t+1}, \text{Ł}_{t+1})$, where $\bar{\omega}_{t+1}$ is a list of cut-off productivities specifying the state-contingent cut-off productivity level associated with each aggregate contingency $(\frac{R^k_{t+1}}{R^d_{t+1}}, \theta_{t+1})$ in $t+1$, and L_{t+1} is the end-of-period leverage, predetermined relative to all $t+1$ contingencies, as a function of the aggregate state in period t. We will often refer to this pair

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

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

as “the contract” in our discussions below. Before we discuss how our model responds to both contemporaneous and news shocks it will be helpful to understand how the contract itself responds to expected changes in either $\frac{R^k}{R^d}$ or in θ while holding the other constant. This is potentially useful because a shock to θ will have a direct impact on the contract as well as an indirect impact via the general equilibrium movements in $\frac{R^k}{R^d}$.

4.1 Sensitivity of the contract to $\frac{R^k_{t+1}}{R^d_{t+1}}$ and θ_t

Figure 5 shows the results of this exercise, holding θ constant at its calibrated steady-state value while varying $\frac{R^k}{R^d}$ around its steady-state value. Similarly, Figure 4 shows the results holding $\frac{R^k}{R^d}$ constant at its calibrated steady-state value and varying θ around its steady-state value. As discussed in Bernanke et al. (1999), Figure 5 shows that both leverage and $\bar{\omega}_{t+1}$ rise along with an expected increase in $\frac{R^k}{R^d}$. In contrast, Figure 4 shows that an increase in the cost-of-default, θ_t, is associated with a fall in leverage and in $\bar{\omega}_{t+1}$. To understand this latter result, first note that there is an inefficient loss of surplus in the event of bankruptcy: the contract allocates the surplus generated by the project between the entrepreneur and the lender but a fraction of this surplus is lost to both parties in the event of default. The lender’s zero-profit condition implies that higher leverage is accompanied by a higher interest rate on loans, which in turn implies a higher probability of default. A higher cost-of-default, θ_t, forces the financial intermediary to cover the lower return on defaulted loans with a higher interest rate for each level of leverage. Faced with this new menu of leverage and interest rates, an entrepreneur will prefer to choose a lower combination of leverage and interest rates which in turn implies a lower probability of default, implying a lower cut-off productivity. This has the effect of reducing the dead-weight losses associated with default when default costs are rising.

With an eye on our discussion of impulse responses below, we note that the effects of varying $\frac{R^k}{R^d}$ and θ discussed above provide two opposing forces operating on leverage when θ is shocked. As we will see, the general equilibrium impact of a fall in $\frac{R^k}{R^d}$ on leverage can partially offset and sometimes overturn (such as when adjustment costs are present) the partial-equilibrium contract tendency for leverage to rise in response to a fall in θ. These results serve to emphasize the idea that shocks to the cost-of-default parameter act as a time varying wedge in the relationship between leverage and external finance premium discussed in Bernanke et al. (1999).

4.2 Impulse response to cost-of-default shocks

In this section we use a linearized and parameterized version of the model economy to illustrate how a fall in the default cost, θ_t, can lead to a large boom in economic activity and a fall in the credit spread. We begin by first exploring the response of the model to a contemporaneous shock that reduces default costs before subsequently moving on to explore the response to news shocks about future reductions in default costs.

Figure 5 illustrates the response of the model when θ_t unexpectedly falls fifty percent below it's steady state value for our "full model" with adjustment costs and non-separable preferences. The shock creates an immediate boom in consumption, investment, output and hours-worked, with the largest impact in the period of the shock and a persistent decline towards steady state. The boom in real activity is accompanied by a rise in credit, the price of capital and net-worth while the credit spread and external finance premium fall on impact.

How should we understand this response? It is useful to separate the impact period from the rest of the response since the shock is unexpected. Firstly, in the impact period, certain aspects of the contract are already determined from the end of the last period: the amount borrowed by the entrepreneur (conditional on last period net-worth) and therefore leverage. Since $\bar{\omega}_t$ is state contingent, it is free to move in the impact period. The fall in θ_t in period 1 implies that for a given $\frac{R_t^k}{R_t^d}$, $\bar{\omega}_t$ must change to satisfy the zero profit condition of the financial intermediary. Since the reduction in θ_t means that the financial intermediary recovers a larger fraction of the value of defaulting loans in period 1, it can earn less on its portfolio of non-defaulting loans and still satisfy the zero-profit condition. As a result, $\bar{\omega}$ falls in the impact period. This increases entrepreneurs' share of profits that period, and increases their net-worth in period 1 slightly. Net worth is further raised by the rise in the price of capital due to the presence of adjustment costs.

Secondly, beyond the impact effect, since the θ_t process is persistent, agents will now expect default costs to be below steady state in the following periods. Since agents must choose the amount of new capital and new borrowing for period 2 at the end of period 1, unlike the impact effect of θ_t, this expected change in θ_{t+1} now impacts the optimal contract. In the previous section we showed that an expected reduction in θ implies an increase in leverage and an associated increase in $\bar{\omega}$ for a given external finance premium, $\frac{R^k}{R^d}$. The fall in the external finance premium is enough in this instance to overturn this effect, so that leverage L_2 in fact falls. Nonetheless, the increase in net worth is sufficient to create an increased demand by entrepreneurs for new capital K_2 which is also associated with an increased level of borrowing through the financial intermediary. The extra funds are raised by selling additional financial securities, A_2, to the household, which is willing to supply the additional savings only at a higher rate of return, R^d_2. Note that while both R^k and R^d rise, the spread between them falls due to the lower default costs.[11] The increased demand for capital is accompanied by an increase in investment by capital producers in the impact period in anticipation of the extra demand. The presence of adjustment costs drives up the marginal cost of producing new capital, thus driving up its price, q_t. This yields a capital gain for entrepreneurs which increases the gross return on capital R^k, driving up end-of-period net-worth. The extra investment raises the demand for goods in the impact period which is met by an increased supply from goods producing firms. The additional goods can only be produced by hiring more labor since the current stock of capital is fixed in the impact period. This hiring occurs because the rise in R^d_2 leads to a rise in the household's marginal utility of income in period 1 relative to that of the future which shifts its labor supply outwards, resulting in an increase in hours worked in the initial period. The additional wage income allows both consumption and investment in financial securities to rise. Finally, combining the equilibrium zero-profit condition (34) with the cut-off definition (15), we end up with an expression that relates the credit spread to θ and $\bar{\omega}$,

$$\frac{R^l_t}{R^d_t} = \frac{\bar{\omega}_t}{\Gamma(\bar{\omega}_t) - \theta_t G(\bar{\omega}_t)}. \tag{40}$$

On its own, a fall in θ induces a fall in the credit spread while a fall in $\bar{\omega}$ induces a further decrease in the impact period. As discussed above, in the following periods, $\bar{\omega}$ rises while θ remains below steady state, thus the two exert opposing forces on the credit spread which slowly rises.

The above effects are repeated in the future periods while θ_t remains below steady-state, albeit at a gradually dampening rate as the demand for new physical capital falls with the increasing θ. This can be seen clearly in the figure where investment is at its maximum in the initial period when θ_t is at its minimum.

We now discuss the role of capital adjustment costs and non-separable preferences ($\sigma > 1$) to our results. As might be expected, the main impact of capital-adjustment costs is on investment and the price of capital (which is fixed in their absence). Without adjustment costs, aggregate macro variables

[11] The external finance premium would shrink to zero if the default/monitoring costs were zero. As discussed by Gale and Hellwig (1985) and Levin et al. (2004), a costly-state verification problem with a zero-cost of monitoring is essentially equivalent to the case of symmetric information.

and especially investment rise to higher levels in the impact period but the qualitative behavior of these variables is very similar to those shown in Figure 5. Since the price of capital does not rise, net worth responds less than shown here. The additional demand for capital is financed by additional leverage so the optimal contract picks out higher levels of $\bar{\omega}$ relative to the adjustment cost case to satisfy the zero-profit condition. While not shown here, these impulse response plots are available in Gunn and Johri (2013).[12]

Turning to the role of preferences, since the shock drives a wedge between the return on capital, R^k and R^d, with standard preferences separable in consumption and leisure the shock causes negative co-movement between consumption and investment as the household forgoes consumption in order to increase savings. For the particular preferences we use in this paper, this case occurs when $\sigma = 1$ which yields preferences with log-consumption and linear leisure. For $\sigma > 1$ however, the preferences are non-separable in consumption and leisure, and imply that the consumption of the underlying employed households exceeds that of the underlying unemployed household members. As economic activity increases above steady state, the proportion of unemployed agents falls so that aggregate consumption rises along with total hours. The net effect is thus to make the marginal utility of consumption increasing in hours-worked, causing consumption to track closer to that of hours. As such, the primary purpose of these preferences parameterized under $\sigma > 1$ is to get consumption to co-move with total hours. Impulse responses for the case of $\sigma = 1$, are also available in an appendix. With the exception of consumption which falls below steady state, the qualitative movement of all other variables is very similar to those shown here. For completeness, in the appendix we also show impulse responses to the contemporaneous shock to θ_t for the baseline model (separable preferences and no adjustment costs).

4.3 News shocks

We now explore how the model economy responds to a change in expectations about the future costs of default. As before, we will focus on a fall in θ of the same magnitude, the difference being that agents will now anticipate the shock and respond optimally to it as soon as the news arrives. In all cases discussed in this section, the news is received in period 1 about a shock that occurs after two years (period 8). We begin our analysis with news shocks that are fulfilled, ie., the news turns out to be correct. Since we have already

[12]The working paper Gunn and Johri (2013) contains a full set of simulation exercises exploring the impact of including or excluding capital adjustment costs, as well as various forms of preferences both for contemporaneous and news shocks.

discussed the impact of a decline in θ in the previous section, we will focus our analysis on the response of the model economy to the periods before the shock is actually realized. As before, our "full model" includes both adjustment costs and non-separable preferences. We begin with a discussion of this model and then we show separately the impact of removing adjustment costs and of working with separable preferences corresponding to our "baseline model". As we will see, neither are crucial for generating news based booms, however they help improve the model response in some ways. Following this, we show the response of the"full model" to news that turns out to be false, and discuss how this case may offer some insight into the events of the recent financial crises in the United States.

Before beginning the formal analysis of the impulse responses, it is useful to contrast a default cost shock with a more familiar total factor productivity (TFP) shock. When TFP rises in the future, the economy will have a relative abundance of goods in the future whereas a fall in default costs has no such direct effect on loosening the resource constraint of the economy. Indeed, to the extent that the demand for capital increases in anticipation of a fall in default costs, the shadow value of goods will rise which will raise the marginal utility of consumption and, holding other things constant, shift labor supply out in a manner reminiscent of our discussion in the previous section. This is the opposite of what happens with a TFP shock. [13][14].

4.3.1 A fulfilled news-shock

Figure 6 illustrates the response of our full model to the news that default costs will fall after two years and the news turns out to be correct. As can be seen from the figure, the news creates an immediate expansion in economic activity in the impact period. Investment, hours, output and consumption jump up in the first period and rise until a peak is reached in the period that (or one period before) the actual reduction in θ arrives. During this period, the household increases its investment in the securities of the financial intermediary, which in turn lends more to entrepreneurs who use the extra credit to purchase additional capital goods. The rise in investment and production of goods is accompanied by an increase in total hours worked, consumption and a rise in the price of capital, the net worth of entrepreneurs as well as a

[13] An implication of this is that the typical mechanisms introduced in the"news shock" literature to induce co-movement in response to TFP shocks are not needed for default cost shocks.

[14] In Gunn and Johri (2011b) we demonstrate how including a particular form of portfolio adjustment costs can facilitate a news-boom in a model where firms are constrained to borrow investment and/or their wage bill prior to production.

fall in the credit spread.

Why does the model economy boom from periods 1 to 7, prior to any actual change in θ? To clearly illustrate this mechanism, it is helpful to remove the effect of adjustment costs and non-separable preferences. Figure 7 illustrates the response of our baseline model with no adjustment costs and separable preferences ($\sigma = 1$) to the news that intermediation costs will fall after two years and the news turns out to be correct. To describe how the model produces a news-driven boom when agents receives news in period 1, we will work backwards from period 7 when agents expect that in period 8 the actual shock will reduce θ below its steady state level. Looking forward one period to period 8 when they expect a lower θ, entrepreneurs will choose to borrow more to finance new capital purchases for any given level of net worth while still satisfying the financial intermediaries zero profit condition, leading to an increase in demand for new capital and new loans in period 7. From consumption smoothing motives, we know that the household will accept a big change in its marginal utility of consumption only if its reward for saving jumps up sufficiently. This effect can be seen in the jump in the return on the household's assets, R^d, held between period 7 and 8 which induces the household to trade off its period 7 consumption to fund the increase in demand for loans. Critically, this combination of a high expected marginal utility of consumption in period 8 and the high real interest rate in period 7 imply that the household's marginal utility of consumption in period 7 will also be high. This, as a result, creates an expansionary effort on the household's labor supply in period 7 as the household desires to raise its work effect while its marginal utility of consumption is high.

The general equilibrium consequences of the increase in labor supply on one hand and the increase in demand for capital on the other, lead to an increase in hours-worked in period 7 at good-producing firms and a corresponding rise in investment and output. The additional labor input raises the marginal product of capital and in turn the return on capital, R^k. The rationale for why these variables should also rise above steady state in period 6 and prior can be similarly worked out. Working backwards from period 7, entrepreneurs in period 6 anticipate that R^k will be high in period 7 and this induces them to demand additional capital for next period as well as additional loans, given net worth. At the same time, the household expects its marginal utility of consumption to be high in period 7, and is willing to postpone consumption to provide the additional loans in return for a higher R^d, pushing up the household's real interest rate between period 6 and 7. Once again, the rise in the marginal utility of consumption pushes out labor supply in period 6 thus generating a boom in loans, hours, investment and output as previously discussed. This effect then continues backwards in each period until period 1 when the household first receives the news.

While this baseline model delivers booms in response to good news, a couple of the predictions of the baseline model need improvement. First, the model predicts that relative to the safe rate, loan rates to entrepreneurs rise during the boom phase before shocks are actually realized. This occurs because the extra leverage taken on by entrepreneurs implies higher losses for the financial intermediary on defaulting loans in an environment where borrowing costs, R^d are above steady state. The zero-profit condition of the intermediary is restored by raising loan rates. As a result, the credit spread is above steady state levels before θ actually falls. The addition of adjustment costs fixes this problem. With adjustment costs present, the price of capital rises immediately upon the agents receiving news, driving up the entrepreneurs' net worth, and improving their balance sheets. As a result the financial intermediary can charge a lower interest rate, R^l, relative to its opportunity cost, R^d, thus lowering credit spreads in the periods prior to the expected shock actually hitting. Thus, the model endogenously generates a countercyclical credit-spread and pro-cyclical asset prices, even in advance of any actual changes in the cost of default parameter, θ. Other variables such as consumption, hours, investment and total credit behave similarly to the model without adjustment costs. Second, as discussed above, consumption, while on a rising path, is below steady state levels over this period. Adding in non-separable preferences, gives us the "full model", which as discussed earlier delivers co-movement in consumption and hours. It is worth noting in this context that while consumption rises, the marginal utility of consumption is still above steady state so that our analysis above remains relevant to this case.

4.3.2 An unfulfilled news-shock

In this 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 8. The response of the economy in the first seven periods is exactly the same as for the case where the news turns out to be true. Agents arrive into period 8 expecting to observe a large and persistent fall in default costs but these expectations turn out to be completely false. In fact, θ remains at the steady state level and agents must reverse their steps. This reversal leads to a sharp bust in economic activity, as total hours-worked and output fall below steady state levels. The sudden bust is especially evident in investment which goes from being over 4 percent above steady state to below steady state levels. While consumption falls, the movement is relatively muted. The bust in quantities is accompanied with a rapid change in prices: the price of capital falls in period 8 and pulls down the net worth of entrepreneurs. As a result there is a sharp increase in the credit spread from being roughly 4 percent below steady state to over 13 percent above steady state, reflecting the sudden deterioration in the quality of the entrepreneurs' balance sheets. Overall Figure 8 is an illustration of a complete boom-bust cycle which is driven entirely by expectations of future intermediation efficiency gains that are never realized. The bust lasts for a number of years and the economy is still operating below steady state levels roughly ten years or forty quarters after the news is first received. 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 and in the price of capital without any underlying movement in the actual default-cost parameter. In the introduction we showed plots of interest rate spreads and 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 8.

5 Conclusions

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 financial efficiencies resulting from these developments. These over-optimistic expectations may have been tested by the events of 2007-2008 leading 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.

In order to explore these consequences we modify a real business cycle model in the costly-state-verification tradition in which financial intermediaries originate a portfolio of loans, some of which will be defaulted upon. In this literature, intermediaries face monitoring/bankruptcy cost when defaults occur. In our setup, these costs are modeled as a time-varying exogenous process about which agents receive news in advance of any change. The arrival of news causes changes in agents expectations about the future value of these default costs and this leads to immediate actions in anticipation of the changes to come. We show that the arrival of news that costs will fall in the future causes financial contracts to be modified which leads to an immediate expansion in liquidity in the financial system, a fall in credit spreads, a rise in asset values and net worth as well as a boom in economic activity, all of which precedes any actual change in these 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 recent boom-bust cycle in the U.S.

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 in the context of innovation 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 rate spreads during the boom phase followed by sharp increases in these spreads once the bust begins even in the absence of any monetary authority in the model. We note that many spreads in this period were far less under the control of the monetary authority and sometimes moved against the prevailing direction of the policy rate which suggests that they may have been susceptible to changes in expectations. Developing a monetary version of the model which can incorporate the behavior of the fed so that predictions can be made about the level of interest rates would be one interesting avenue for future work. Having established the theoretical possibility that changes in expectations about bankruptcy costs (and more generally intermediation costs) can be a potent source of business cycles, another logical future step is to identify these shocks in the data and empirically evaluate their contribution to fluctuations in macroeconomic quantities relative to more traditional disturbances such as shocks to policy and to total factor productivity.

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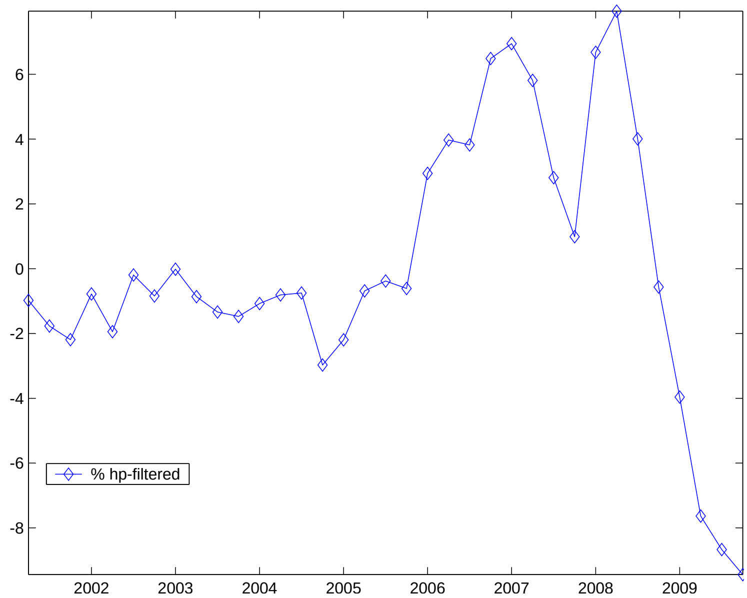

Figure 1: Total Real Credit Market Debt. Total real credit market debt was obtained from the FRED database using the series TCMDO and dividing by the consumer price index CPIAUCSL. Series are percent deviations from trend.

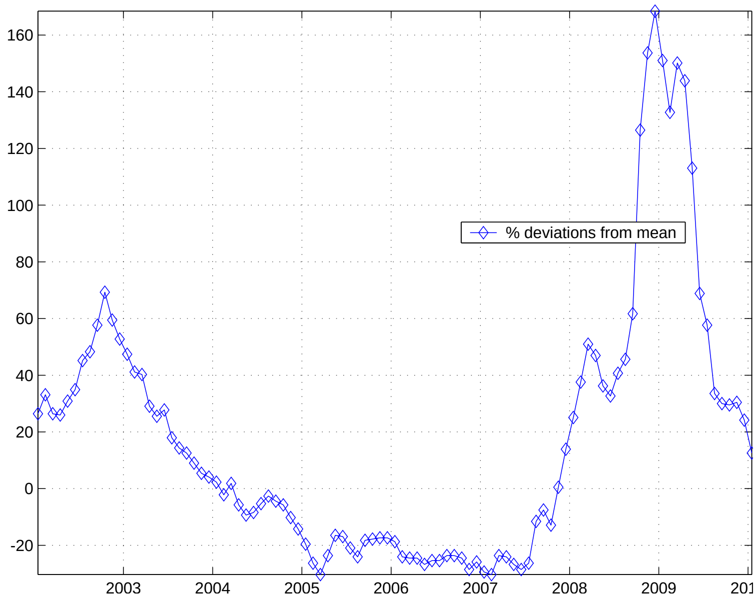

Figure 2: Credit Spread. The credit spread is defined here as the difference in the yield on BAA rated corporate bonds and the 10-Year Treasury Constant Maturity Rate both obtained from FRED. The data were converted to quarterly frequency and percentage deviations from mean values are reported here.

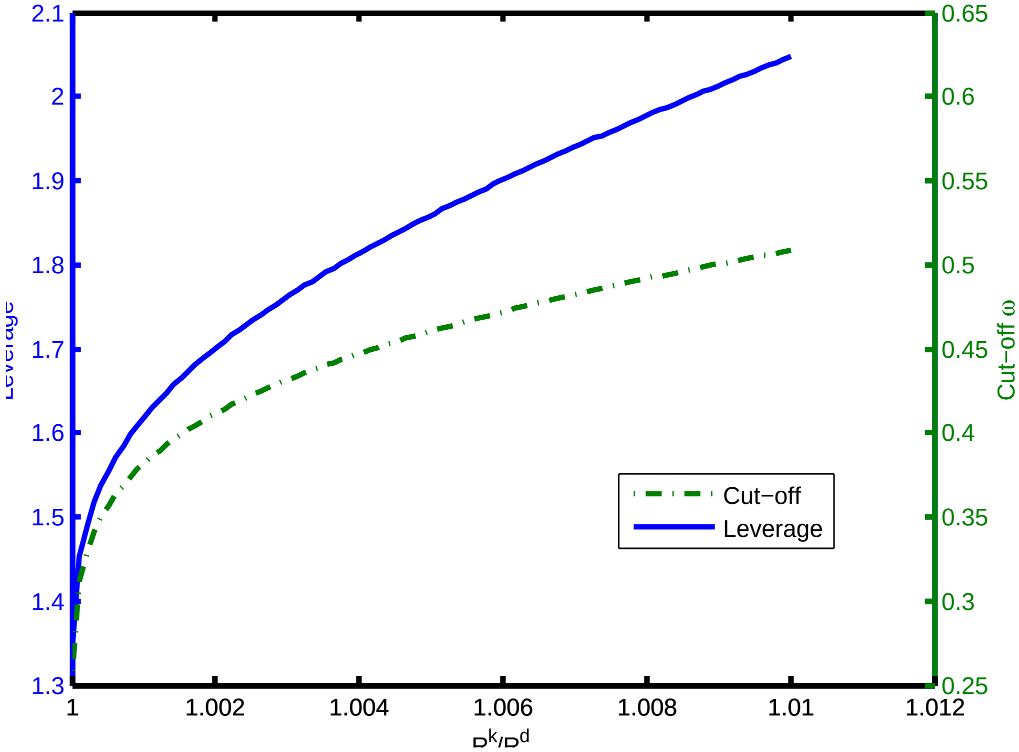

Figure 3: Optimal contract: leverage (L) & cut-off ($\bar{\omega}$) vs. external finance premium ($\frac{R^k}{R^d}$) holding default cost (θ) constant

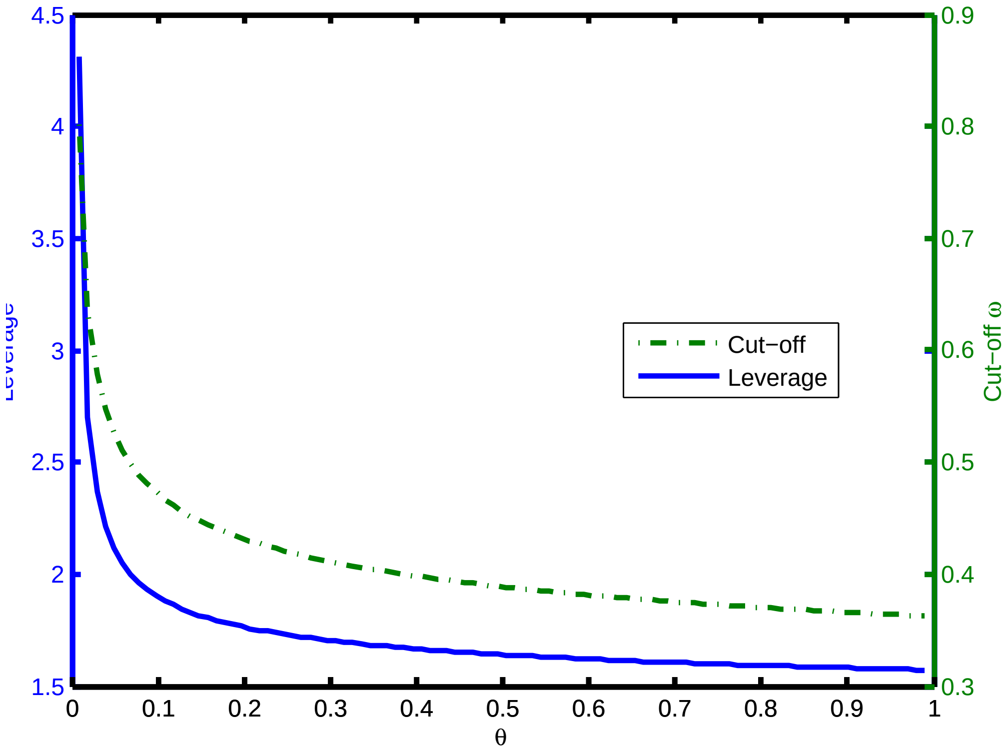

Figure 4: Optimal contract: leverage (L) & cut-off ($\bar{\omega}$) vs. default cost (θ) holding the external finance premium ($\frac{R^k}{R^d}$) constant.

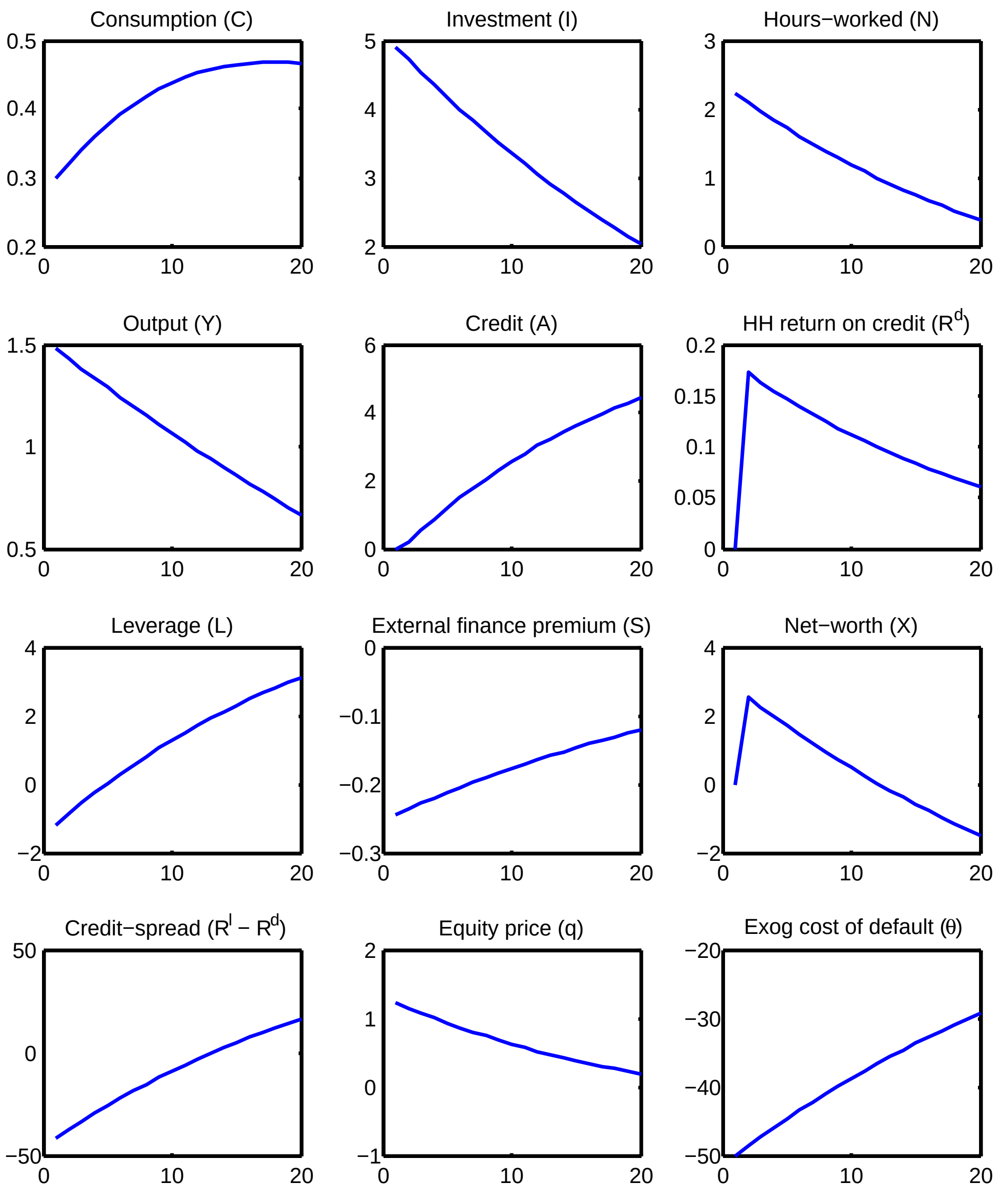

Figure 5: Impulse response functions, *full-model*. Contemporaneous reduction in default cost, θ, in period 1.

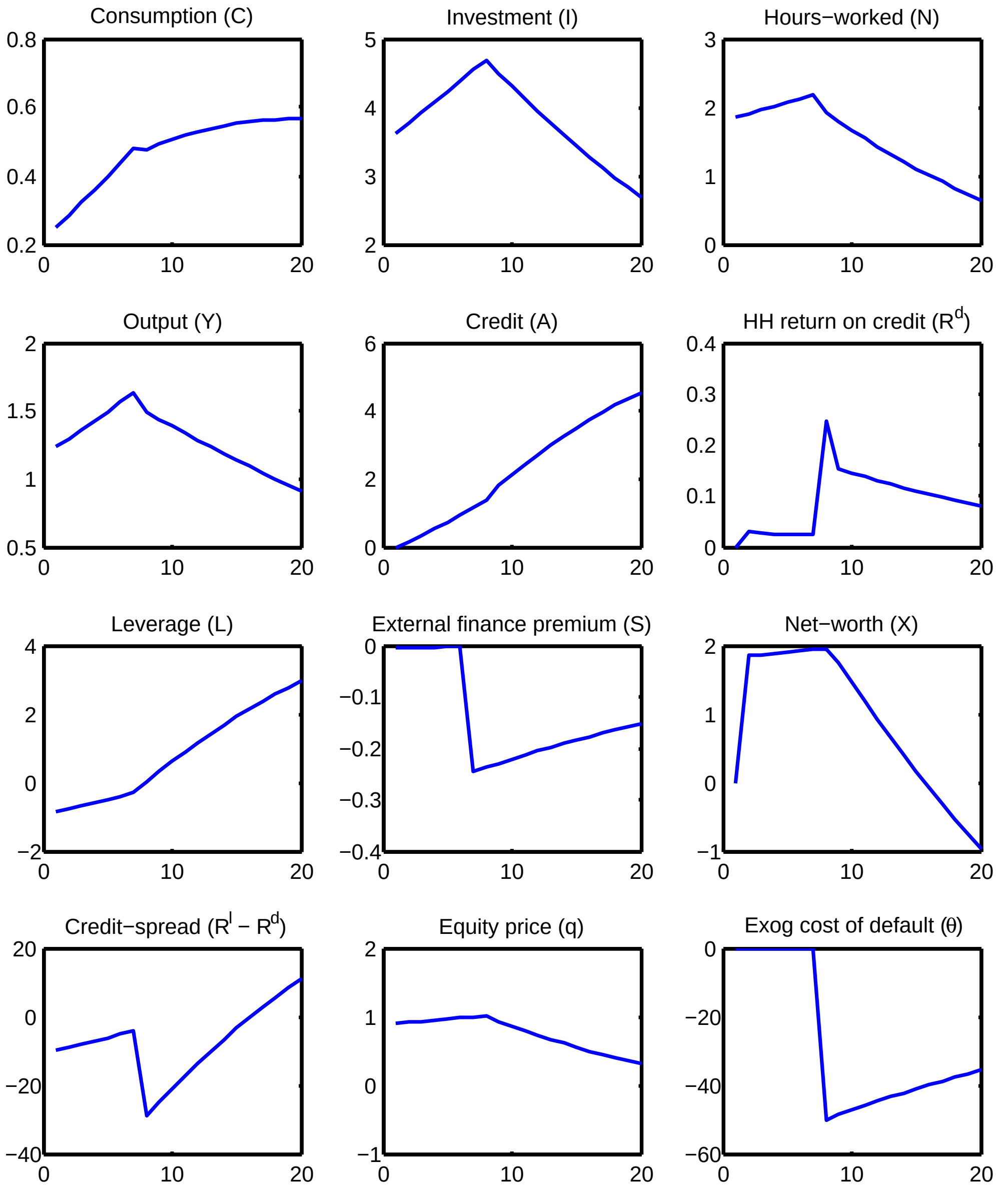

Figure 6: Impulse response functions, *full-model*. News received in period 1 about reduction in default cost, θ, in period 8 that actually occurs in period 8.

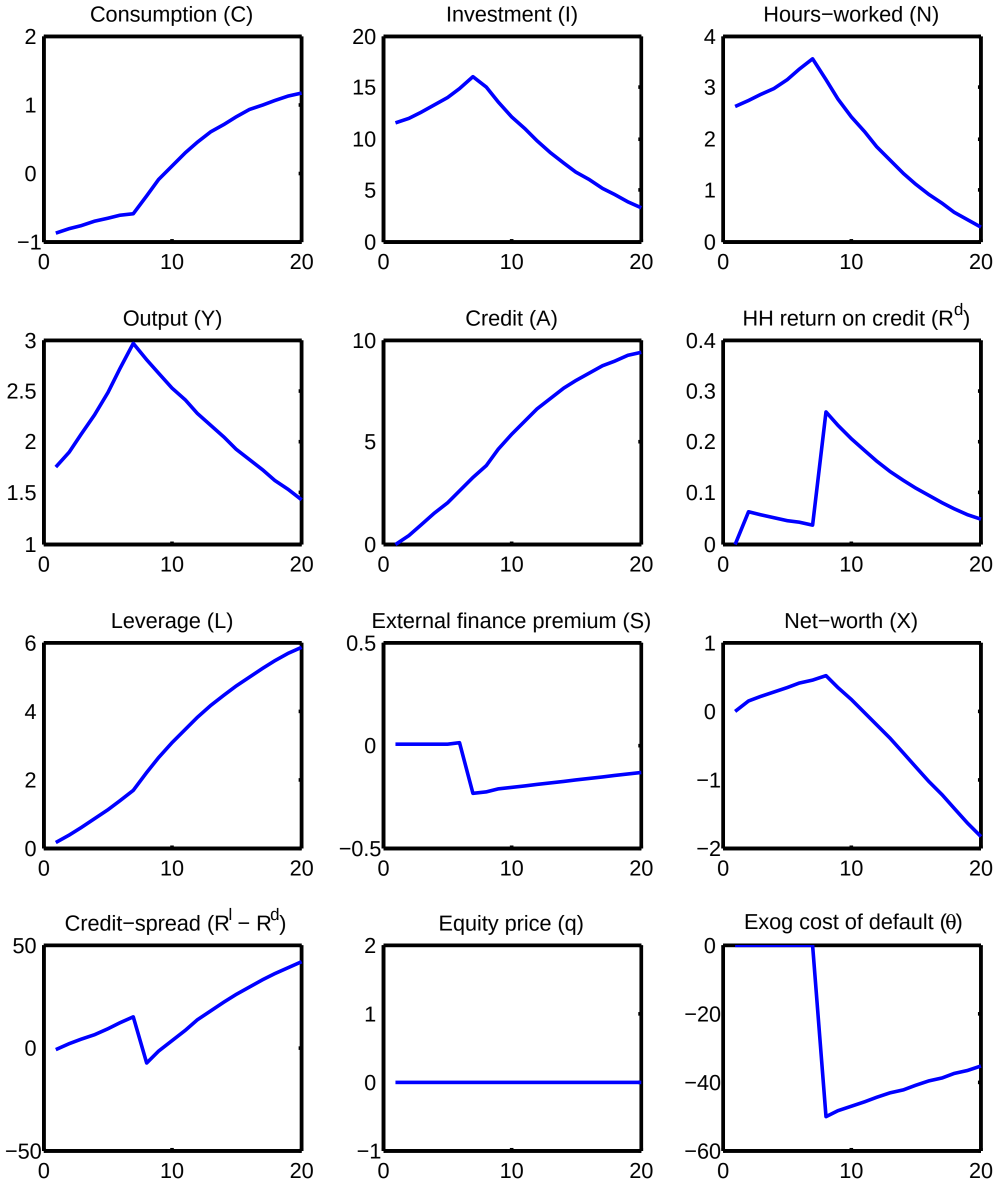

Figure 7: Impulse response functions, *baseline model (no adjustment costs, separable preferences)*. News received in period 1 about a reduction in default cost, θ, in period 8 that actually occurs in period 8.

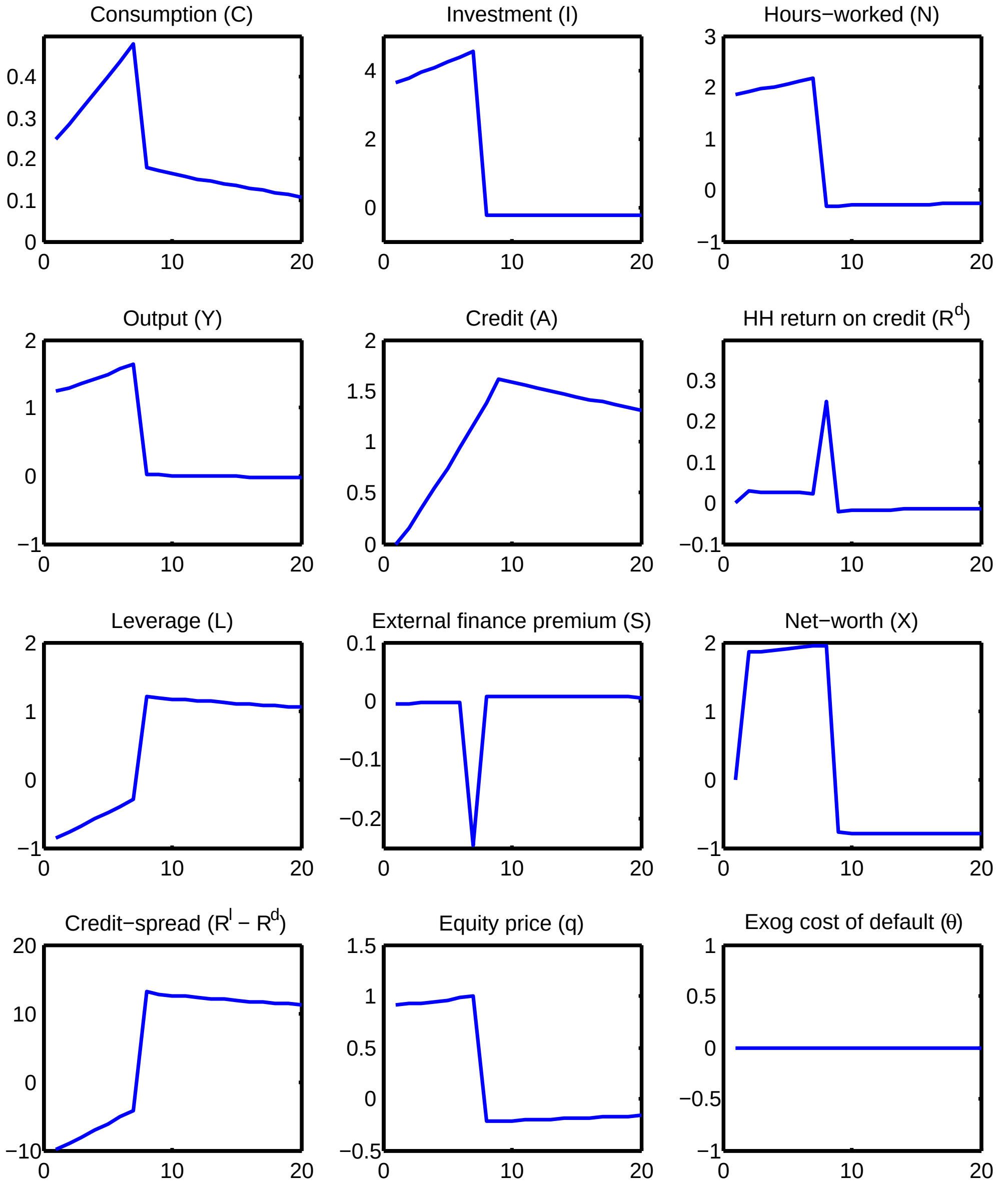

Figure 8: Impulse response functions, *full model*. News received in period 1 about a reduction in default cost, θ, in period 8, but then **no reduction** occurs in period 8.