Bank asset channel

Vincenzo Quadrini
University of Southern California and CEPR

May 25, 2014

PRELIMINARY AND INCOMPLETE

Abstract

The financial intermediation sector is important not only for channeling resources from agents in excess of funds to agents in need of funds (credit channel). They also facilitate the creation of financial assets that can be used for insurance purposes. Then, when the financial sector experiences difficulties that prevent them from creating these assets, agents in the economy (being them households or firms) are less willing to engage in risky activities. The first goal of this paper is to emphasize this particular channel which I refer to as "bank asset channel". The second goal is to explore the possibility that difficulties in financial intermediation could be driven by pessimistic expectations about the liquidity in the financial sector. The model features multiple equilibria where the liquidity of banks is central for the multiplicity.

1 Introduction

There is a well established tradition in macroeconomics that adds financial market frictions to standard macroeconomic models. The seminal work of Bernanke and Gertler (1989) and Kiyotaki and Moore (1997) are the classic references for most of the work done in this area during the last 25 years. Although these contributions differ in many details ranging from the microfoundation of market incompleteness to the scope of the application, they typically share two common features. The first is that the role played by financial frictions in the propagation of shocks to the real sector of the economy is based on the typical 'credit channel'. The idea is that various shocks can affect the financing capability of borrowers—either in the volume of available credit or in the cost—which in turn affects their economic decisions (consumption, investment, employment, etc.).

The second common feature of these models is that they assign a limited role to the financial intermediation sector. This is not to say that there are not papers that emphasize the role of banks for business cycle dynamics. Holmstrom and Tirole (1997) provided a theoretical foundation for the central roles of banks in general equilibrium, inspiring subsequent contributions such as Van den Heuvel (2008) and Meh and Moran (2010). However, it is only after the recent crisis that the role of financial intermediaries became central to the research agenda in macroeconomics. Recent contributions include Boissay, Collard, and Smets (2010), Brunnermeier and Sannikov (2010), Corbae and D'Erasmo (2012), De Fiore and Uhlig (2011), Gertler and Karadi (2011), Gertler and Kiyotaki (2010), Mendoza and Quadrini (2010), Rampini and Viswanathan (2012).

In most of these studies, the primary role of the intermediation sector is to channel funds to investors (borrowers). Because of frictions, the volume of funds that can be intermediated depends on the financial conditions of banks. When these conditions deteriorate, the volume of intermediated funds declines, which in turn affects investments and other economic decisions of borrowers. Therefore, the primary channel through which the financial intermediation sector affects real economic activities is still the typical 'credit channel'.

The first goal of this paper is to emphasize a second channel through which financial intermediation affects real economic activity. The financial intermediation sector is important not only for channeling resources from agents in excess of funds to agents in need of funds (credit channel). They also facilitate the creation of financial assets that can be used for insurance purposes. Then, when the supply of these assets declines, agents in the economy (being them households or firms) are less willing to engage in risky activities.

This point can be illustrated with an example. Suppose that a bank issues 1 dollar liability and sells it to agent A (this represents a deposit of agent A in the bank). The dollar is then used by the bank to make a loan to agent B. By doing so the bank facilitates a more efficient allocation of resources because, typically, agent B is in a condition to create more value than agent A (either because of higher productivity or higher marginal utility of consumption).

However, if the bank is unable to issue the dollar liability or it does not find agent B worth of credit, the bank will not make the loan and, as a consequence, agent B is forced to cut investments and/or consumption. This example illustrates the standard 'credit channel' of financial intermediation.

In addition to this channel, there is another channel through which the intermediation of funds affects real economic activity. When the bank issues 1 dollar liability, it creates a financial asset that will be held by agent A. For this agent, the holding of the bank liability represents a safe asset that can be used to insure the uncertain outcome of risky economic activities. By holding this asset, the agent is more willing to engage in riskier economic activities including investing, hiring, consumption, etc. It is through the supply of bank liabilities, in addition to the supply of loans, that financial intermediaries play an important role for real economic decisions. Consequently, when the financial conditions of banks deteriorate and they reduce the supply of liabilities (either because they are forced to do so or because they are unwilling to do so), agents hold less insurance assets and, as a result, they become more prudent in their economic decisions. Through this mechanism, the difficulties in the financial intermediation sector are transmitted to the real sector of the economy. I refer to this channel as the 'bank asset channel'.

The example illustrates the insurance role played by financial intermediaries in a simple fashion: issuance of bank deposits which is the traditional activity of commercial banks. But the complexity of assets and liabilities issued by the intermediation sector has grown over time and many of these activities are important for providing insurance. In some cases, the assets and liabilities issued in the financial sector do not involve significant intermediation of funds in the current period but they only create the potential of future payments as in the case of some financial derivatives. In other cases, intermediaries simply facilitate the direct issuance of assets and liabilities in the non-financial sector. Examples include corporate mergers and acquisitions which, in addition to promote operational efficiency, they also allows for corporate diversification (*i.e.*, insurance). Still, the direct involvement of financial intermediaries is crucial for the success of these operations. When the health of financial intermediaries deteriorates, the volume of these activities also deteriorates. This is another way of thinking about the importance of the 'bank asset channel'.

Although the examples described above emphasize a potential channel through which difficulties in financial intermediation are transmitted to the economy at large, it does not explain why the intermediation sector could face difficulties. The second goal of this paper is to explore the possibility that these difficulties could be driven by pessimistic expectations about the liquidity of the intermediation sector. The model features multiple equilibria in which the liquidity of banks is central to the multiplicity: when the market expects the intermediation sector to be liquid, banks can raise funds in financial markets and are liquid. On the other hand, when the market expects the intermediation sector to be illiquid, banks may be unable to raise funds and face liquidity shortage.

In this environment, a liquidity crisis can emerge only if the leverage of banks is sufficiently high. When banks are not excessively leveraged, instead, pessimistic expectations cannot induce a liquidity crisis. As a result of this, the economy can experience medium-run cycles that are exclusively driven by expectations about the liquidity of the intermediation sector: Starting from a state of low leverage for which there is no imminent risk of crises, banks increase their leverage in search of higher returns. But as the intermediation sector leverages up, the economy becomes vulnerable to self-fulfilling liquidity crises. But until a crisis materializes, the economy enjoys sustained economic activity, higher volumes of intermediation and higher bank profits. Eventually, expectations turn pessimistic and the economy experiences a financial crisis that forces banks to de-leverage. The forced de-leveraging brings the economy to a state that is initially immune from crises but it is characterized by depressed economic activity and reduced intermediation. It is at this point that the economy restarts a new cycle of financial expansion.

The focus on 'self-fulfilling banking crises' and the transmission through the "asset channel" is of interest not only from a theoretical point of view but also from an empirical stand point. It is well known that during the last three decades, US corporations have increased the stock of liquid assets. Furthermore, some studies have shown that only a minority of corporations rely on external financing for investments. Although smaller firms seem to be more dependent on external financing, the economy-wide dependence does not appear to be large. See, for example, Shourideh and Zetlin-Jones (2012). Along the same lines, Eisfeldt and Muir (2012) shows that corporations tend to raise external finance and to accumulate liquid assets simultaneously. Focusing more specifically on the recent crisis, Adrian, Colla, and Shin (2012) shows that, although bank credit contracted sharply, corporations were able compensate part of the decline with direct market borrowing (corporate bonds). However, firms may still be affected by a bank crisis even if they do not depend on external financing if the lower functionality of the banking sector affects the supply of assets that are held for insurance purpose. This seems to be confirmed by the drastic drop in the volume of assets held by the intermediation sector during the recent crisis as shown in Figure 1.

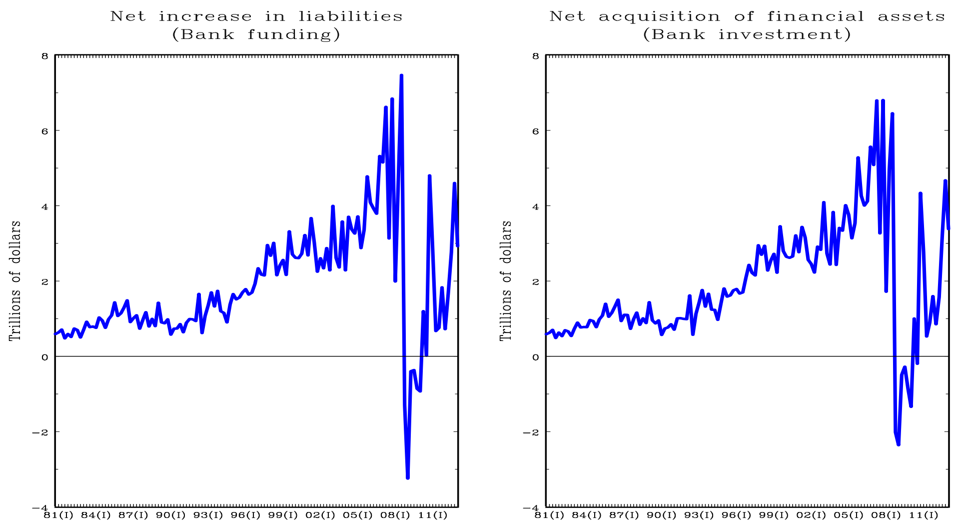

Figure 1: Flows of funds in the financial sector. Source: Flows of Funds.

The focus on 'self-fulfilling banking crises' is also motivated by empirical considerations. It is well-known that financial crises are sudden events that cannot be easily connected to well identified fundamental shocks. And even if they can be reconnected ex-post to some fundamental shocks, it is difficult to predict, ex-ante, the timing in which the shock leads to the crisis. Furthermore, there is now a great deal of empirical evidence about the dynamics that proceed and follow financial crises. See, for example, Reinhart and Rogoff (2009) and Schularick and Taylor (2011). While economic booms are characterized by a gradual expansion of credit, recessions are more sudden and they are typically associated with a fast decline in the size of financing. Furthermore, the higher the leverage of the banking sector, the stronger the contraction of the real economy. As we will see, the model developed in this paper is capable of replicating these dynamics.

As it is common in models with multiple equilibria, governments could play an important role in improving the allocation of the economy by affecting the likelihood of the different equilibria. The last section of the paper studies the role of government policies as well as the practical difficulties in implementing some of the welfare improving policies.

2 Model

There are three sectors: the entrepreneurial sector, the worker sector and the financial intermediation sector. In this model there is borrowing and lending between these two sectors. I describe first the model ignoring the intermediation sector. This allows me to illustrate the 'asset channel' and to differentiate it from the 'credit channel'. The importance of financial intermediaries emerges if borrowing and lending cannot be done directly without the intermediation of banks. Starting from this assumption I will extend the model by adding financial intermediaries. At that point I will be able to show how the performance of the real sector depends on the financial conditions of banks.

2.1 Entrepreneurial sector

There is a continuum of undiversified entrepreneurs with lifetime utility $E_0 \sum_{t=0}^{\infty} \beta^t \ln(c_t)$. Entrepreneurs are individual owners of firms, each operating the production function $F(z_t, h_t) = z_t h_t$, where h_t is the input of labor supplied by workers at the market wage w_t, and z_t is an idiosyncratic productivity shock. The productivity shock is independently and identically distributed among firms and over time, with probability distribution $\Gamma(z)$. Similar to Arellano, Bai, and Kehoe (2011), I assume that h_t is chosen before observing z_t and, therefore, labor is risky. This is an important property of the model and it is central to the asset channel.

Entrepreneurs have access to a market for non-contingent bonds with gross interest rate R_t^b. An individual entrepreneur, indexed by i, enters period t with risk-free bonds b_t^i and chooses the labor input h_t^i. After the realization of the idiosyncratic shock z_t^i, the entrepreneur chooses the next period bond b_{t+1}^i. The entrepreneur's budget constraint is

$$c_t^i + \frac{b_{t+1}^i}{R_t^b} = (z_t^i - w_t)h_t^i + b_t^i. \tag{1}$$

Because the choice of labor h_t^i is made before the realization of z_t^i, while the saving decision is made after the observation of z_t^i, it will be convenient to define the entrepreneur's wealth after production, $a_t^i = b_t^i + (z_t^i - w_t)h_t^i$. Given the timing structure, the labor choice h_t^i depends on b_t^i while the saving choice b_{t+1}^i depends on a_t^i. The following lemma defines some key properties of the entrepreneur's policies.

Lemma 2.1 *Define $\phi(w_t)$ the value of ϕ_t that satisfies $\mathbb{E}_z\left\{\frac{z-w_t}{1+(z-w_t)\phi_t}\right\} = 0$. Then the optimal entrepreneur's policies take the form*

$$\begin{aligned} h_t^i &= \phi(w_t)b_t^i, \\ c_t^i &= (1-\beta)a_t^i, \\ b_{t+1}^i &= \beta R_t^b a_t^i, \end{aligned}$$

where $\phi'(w_t) < 0$

The demand of labor is linear in the initial wealth of the entrepreneur b_t^i. The factor of proportionality, $\phi(w_t)$, changes over time because the equilibrium wage rate changes. However, it is the same for all entrepreneurs since w_t is determined in the aggregate labor market. I can then derive the aggregate demand for labor as

$$H_t = \phi(w_t)\int_i b_t^i = \phi(w_t)B_t,$$

where I have used capital letters to denote average (per-entrepreneur) variables.

The aggregate demand of labor depends negatively on the wage rate—which is a standard property—and positively on bonds—which is a special property of this model. In a general equilibrium, the stock of bonds held by entrepreneurs depends on the ability of the system to supply bonds. For tractability reasons, entrepreneurs are allowed to hold only non-contingent bonds for insurance purposes. In reality, however, there is a large variety of assets whose payout could be more directly related to the performance of the real activity (state-contingent). I interpret b_t as representative of all these assets.

Also linear is the consumption policy of entrepreneurs. This property allows for linear aggregation and makes the problem extremely tractable. Therefore, even if entrepreneurs are heterogeneous in asset holdings, for the aggregate dynamics of the model we only need to keep track of the average wealth B_t.

Another property worth emphasizing is that in a stationary equilibrium with constant B_t, the interest rate must be lower than the intertemporal discount rate, that is, $R^b < 1/\beta - 1$. To see this, consider the first order condition of an individual entrepreneur in the choice of b^i_{t+1}. This is the typical euler equation that, with log preferences, takes the form,

$$\frac{1}{c^i_t} = \beta R^b \mathbb{E}_t \left(\frac{1}{c^i_{t+1}} \right).$$

Because c^i_{t+1} is stochastic, $\mathbb{E}_t(1/c^i_{t+1}) > 1/\mathbb{E}_t c^i_{t+1}$. Therefore, if $\beta R^b = 1$, we would have that $\mathbb{E}_t c^i_{t+1} > c^i_t$ and aggregate consumption would not be bounded. This violates the hypothesis of a stationary equilibrium. I will come back to this property after the description of the worker sector.

2.2 Worker sector and general equilibrium

There is a continuum of workers with lifetime utility $\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left(c_t - \alpha \frac{h_t^{1+\nu}}{1+\nu} \right)$, where c_t is consumption and h_t is the supply of labor. The assumption of risk neutrality is not important but it makes the analysis simpler once we introduce the intermediation sector.

Each household holds a non-reproducible asset available in fixed supply $\overline{K}$, with each unit producing χ units of consumption goods. The asset is divisible and can be traded at the market price p_t. We can think of the asset as housing and χ as the services from one unit of housing. Households can borrow but face the collateral constraint,

$$\frac{l_{t+1}}{R^l_t} \leq \eta p_t k_{t+1},$$

where l_{t+1} is the loan contracted in period t and due in period $t+1$, R^l_t is the gross interest rate, and η is the fraction of the asset recovered by lenders if the household defaults. The budget constraint is

$$c_t + l_t + (k_{t+1} - k_t)p_t = \frac{l_{t+1}}{R^l_t} + w_t h_t + \chi k_t.$$

Households do not face idiosyncratic risks and their policies satisfy the first order conditions,

$$\alpha h_t^\nu = w_t, \tag{2}$$
$$1 = \beta R_t^l + \mu_t, \tag{3}$$
$$1 = \beta \mathbb{E}_t \left(\frac{\chi + p_{t+1}}{p_t} \right) + \eta \mu_t, \tag{4}$$

where μ_t is the Lagrange multiplier associated with the collateral constraint.

Before describing the financial intermediation sector in details, I first consider the general equilibrium where borrowing and lending is done directly without financial intermediaries and $R_t^l = R_t^b = R_t$.

Proposition 2.1 *In a stationary equilibrium households borrow up to the limit and $\beta R < 1$.*

Since entrepreneurs face uninsurable risks, they would save and hold bonds if $\beta R = 1$. However, to induce households to issue bonds, the interest rate must decline. Once the interest rate is lower than the intertemporal discount rate, households will continue to borrow until the collateral constraint binds.

The equilibrium in the labor market can be characterized as the simple intersection of aggregate demand and supply. The aggregate demand has been derived in the previous subsection and it is equal to $H_t^d = \phi(w_t)B_t$, with $\phi'(w_t) < 0$, and B_t are the financial assets (bonds) held by the business sector. The supply of labor is given by the households' first order condition (see equation (2)) and it is equal to $H_t^S = (w_t/\alpha)^{1/\nu}$. The equilibrium in the labor market is depicted in Figure 2.

The important property of the model is that the labor demand depends on B_t. Suppose that the parameter η declines so that households are forced to cut their borrowing L_t. Since in equilibrium $L_t = B_t$, this shifts the demand for labor inward and results in lower employment and wages. Importantly, the reason lower credit decreases the demand of labor is not because employers have less funds to finance hiring. In fact, there is no need of any financing for production. Instead, the reason is that the business sector does not have enough assets to insure the production risk. This mechanism, which I termed 'asset channel', is clearly distinct from the 'credit channel' where firms are in need of funds to finance employment (for example, because wages are paid

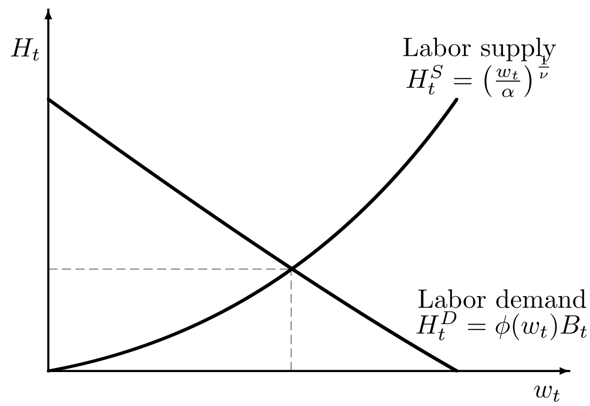

Figure 2: Labor market equilibrium.

in advance) and a credit contraction impairs their ability to produce. This additional channel could also be formalized in the context of this model by assuming, for example, that K is reproducible. This would make the exposition more complex but would not change the key mechanism illustrated here.

Of course, if workers could borrow directly from entrepreneurs, there is no need of financial intermediation. However, if direct borrowing is not feasible or costly, financial intermediaries play an important role. It is under this assumption that I now introduce the banking sector.

2.3 Banking sector

There is a continuum of banks held by workers. Banks start the period with loans l_t and liabilities (deposits) b_t. Given the initial balance sheet position, the bank could default on its liabilities. In the event of default the creditors have the right to liquidate the assets of the bank, l_t, but they recover only a fraction ξ_t, which is stochastic. Anticipating this, the bank uses the threat of default to renegotiate the liabilities to the liquidation value. Therefore, after renegotiation, the liabilities of the bank are

$$\tilde{b}_t(b_t, l_t) = \begin{cases} b_t, & \text{if } b_t \leq \xi_t l_t \\ \\ \xi_t l_t & \text{if } b_t > \xi_t l_t \end{cases} \tag{5}$$

The variable ξ_t will be derived endogenously in the model. For the moment, however, to facilitate the intuition, ξ_t will be treated as an exogenous stochastic variable.

Since the debt could be renegotiated, the price of new liabilities will reflects the potential losses incurred by the creditor in the event of default. Denoting by $\bar{q}_t$ the price of a risk-free bond, the price q_t of the new liabilities b_{t+1} satisfies the condition

$$q_t b_{t+1} = \bar{q}_t E_t \tilde{b}_{t+1}(b_{t+1}, l_{t+1}). \tag{6}$$

Although the bank would gain ex-post from from renegotiating its liabilities, renegotiation also involves a cost for the bank that takes the form

$$\tilde{\varphi}_t(b_t, l_t) = \begin{cases} 0, & \text{if } b_t \leq \xi_t l_t \\ \\ \varphi\left(\frac{b_t - \xi_t l_t}{l_t}\right) l_t & \text{if } b_t > \xi_t l_t \end{cases}, \tag{7}$$

where the function $\varphi(.)$ is strictly increasing and convex, differentiable and satisfies $\varphi(0) = \varphi'(0) = 0$. These assumptions implies that $\tilde{\varphi}_t(b_t, l_t)$ is continuously differentiable.

The final assumption is that the bank incurs an operation cost τ per unit of raise funds.

The optimization problem of the bank can be written recursively as

$$V_t(b_t, l_t) = \max_{d_t, b_{t+1}, l_{t+1}} \left\{ d_t + \beta E_t V_{t+1}(b_{t+1}, l_{t+1}) \right\}$$

subject to

$$d_t = l_t + (1-\tau)\bar{q}_t E_t \tilde{b}_{t+1} - \tilde{b}_t(b_t, l_t) - \tilde{\varphi}_t(b_t, l_t) - \frac{l_{t+1}}{R_t^l}.$$

The optimization problem is subject to the budget constraint with $\tilde{b}_t(b_t, l_t)$ and $\tilde{\varphi}_t(b_t, l_t)$ defined in (5) and (7). Differentiating with respect to b_{t+1} and l_{t+1} wee derive the first order conditions,

$$(1-\tau)\bar{q}_t = \beta + \Phi_t(\omega_{t+1}), \tag{8}$$

$$\frac{1}{R_t^l} = \beta + \Psi_t(\omega_{t+1}), \tag{9}$$

where the terms $\Phi_t(\omega_{t+1})$ and $\Psi_t(\omega_{t+1})$ are functions of the bank's leverage $\omega_{t+1} = b_{t+1}/l_{t+1}$. The following proposition characterize the these two functions.

Proposition 2.2 *There exists $\underline{\omega}_t$ for which the functions $\Phi_t(\omega_{t+1})$ and $\Psi_t(\omega_{t+1})$ are zero for $\omega_{t+1} <= \underline{\omega}_t$ and strictly increasing for $\omega_{t+1} > \underline{\omega}_t$.*

The fact that the two functions depend on the leverage ratio (and not separately on b_{t+1} and l_{t+1} follows from the assumption that the cost function in the event of renegotiation is homogeneous of degree 1. The two functions are zero when the leverage is low because in this case the probability of default is zero. Once the leverage has reached a certain level, however, default arises with some probability. The convexity of the renegotiation cost function then implies that the derivative of this function is increasing. The two functions $\Phi_t(\omega_{t+1})$ and $\Psi_t(\omega_{t+1})$ captures, effectively, the derivative of this cost.

The first order conditions (8) and (9) have simple intuition in the special case in which $\omega_{t+1} < \underline{\omega}_t$ so that the probability of default is zero and $\Phi_t(\omega_{t+1}) = \Psi_t(\omega_{t+1}) = 0$. In this case the first equation reduces to $(1-\tau)\bar{q}_t = \beta$, which implies that the price of the bond is equal to the discount factor β, corrected by the operation cost τ. If this condition is not satisfied then either the bond price is too low—in which case the bank does not issue any liabilities—or the price must be higher—in which case the bank has incentive to leverage more until default becomes possible and the term $\Phi_t(\omega_{t+1})$ becomes positive. The second condition reduces to $1/R_t^l = \beta$. This implies that the lending rate must be equal to the intertemporal discount rate.

The characterization of the bank's problem provides insights about the property of the model once integrated in a general equilibrium. A decrease in ξ increases the fraction of outstanding debt on which the bank defaults. This implies that the wealth of entrepreneurs declines. With lower wealth entrepreneurs are less willing to take risk and hire less workers, leading to a recession.

2.3.1 Endogenous ξ_t

The variable ξ_t is now interpreted as the liquidation price of bank assets and the endogeneity is based on the following two assumptions.

Assumption 1 *In the event of liquidation, the bank's assets l are perfectly divisible and can be sold either to other banks or to other sectors (households or entrepreneurs). However, banks can recover a fraction $\overline{\xi}$ of the liquidated assets while other sectors can recover a smaller fraction $\underline{\xi} < \overline{\xi}$.*

Assumption 2 *Banks can purchase the assets of liquidated banks only if they have liquidity.*

The first assumption implies that the sales of liquidated assets to other banks is more efficient. However, the second assumption imposes that sales to other banks is possible only if banks have the liquidity to purchase the assets. When does a bank have liquidity? In the context of this model, a bank has liquidity when it can issue additional liabilities.

To better understand this assumption, consider the condition for not renegotiating $b_t \leq \xi_t$, where now ξ_t is the liquidation price of bank assets at the beginning of the period. If this condition is satisfied, banks have the option to raise additional funds at the beginning of the period to purchase the assets of defaulting banks. This implies that there are banks that have the ability to purchase the assets of a defaulting bank and the market price of liquidated assets is $\xi_t = \overline{\xi}$. However, if $b_t > \xi_t$, there will not be any liquid bank with unused credit. As a result, the liquidated assets can only be sold to non-banks and the price will be $\xi_t = \underline{\xi}$.

Under assumptions 1 and 2, the value of liquidated assets depends on the financial choice of banks, which in turn depends on the expected liquidation value of their assets. This interdependence creates the conditions for potential self-fulfilling equilibria. More specifically, multiple equilibria arise when $\underline{\xi} l_t < b_t < \overline{\xi} l_t$. This condition can also be written as

$$\underline{\xi} < \omega_t < \overline{\xi}$$

that is, the leverage of the bank is within the two liquidation prices.

To see why, suppose that the market expects that the liquidation price is $\xi_t = \overline{\xi}$. Because of this banks are liquid, that is, $b_t < \xi_t l_t$. As a result, the liquidation price is $\xi_t = \overline{\xi}$ and the debt is not renegotiated. On the other hand, suppose that the market expects that the liquidation price is $\xi_t = \underline{\xi}$. Because of this, banks are illiquid, that is, $b_t > \xi_t l_t$. As a result, the liquidation price is $\xi_t \underline{\xi}$ and the debt is renegotiated.

What would happen if the leverage ω_t is outside the two liquidation prices. In this case the equilibrium is unique. More specifically, if $\omega_t < \underline{\omega}$, banks never renegotiate. Instead, when $\omega_t > \overline{\omega}$, renegotiation takes place with probability 1. The next question is whether the economy ever reaches the renegotiation region. This is established in the following proposition.

Proposition 2.3 *There exists τ_L such that if $\tau \geq \tau_L$ then ω_t will eventually become smaller than $\underline{\omega}$ so that the equilibrium is unique from that point on. If $\tau < \tau^L$ then ω_t will eventually become bigger than $\underline{\omega}$ and stays bigger than $\underline{\omega}$ so that the economy could switch between two equilibria.*

TO BE COMPLETED

References

Adrian, T., Colla, P., & Shin, H. S. (2012). Which Financial Frictions? Parsing the Evidence from the Financial Crisis of 2007-9. Unpublished manuscript, Federal Reserve Bank of New York, Bocconi University and Princeton University.

Arellano, C., Bai, Y., & Kehoe, P. (2011). Financial Markets and Fluctuations in Uncertainty. Research Department Staff Report, Federal Reserve Bank of Minneapolis.

Bernanke, B., & Gertler, M. (1989). Agency Costs, Net Worth, and Business Fluctuations. *American Economic Review*, *79*(1), 14–31.

Boissay, F., Collard, F., & Smets, F. (2010). Booms and Systemic Banking Crises. Unpublished manuscript, European Central Bank.

Brunnermeier, M., & Sannikov, Y. (2010). A Macroeconomic Model with a Financial Sector. Unpublished manuscript, Princeton University.

Corbae, D., & D'Erasmo, P. (2012). A Quantitative Model of Banking Industry DYnamics. Unpublished manuscript, University of Wisconsin and University of Maryland.

De Fiore, F., & Uhlig, H. (2011). Bank Finance versus Bond Finance. *Journal of Money Credit and Banking*, *43*(7), 1399–1421.

Eisfeldt, A., & Muir, T. (2012). Aggregate Issuance and Savings Waves. Unpublished manuscript, Anderson School of Management, UCLA.

Gertler, M., & Kiyotaki, N. (2010). Financial Intermediation and Credit Policy in Business Cycle Analysis. In Friedman, B. M., & Woodford, M. (Eds.), *Handbook of Monetary Economics*, Vol. 3, chap. 11, pp. 1341–96. Elsevier, Amsterdam: Elsevier Science.

Gertler, M., & Karadi, P. (2011). A Model of Unconventional Monetary Policy. *Journal of Monetary Economics*, *58*(1), 17–34.

Holmstrom, B., & Tirole, J. (1997). Financial Intermediation, Loanable Funds, and the Real Sector. *Quarterly Journal of Economics*, *112*(3), 663–91.

Kiyotaki, N., & Moore, J. H. (1997). Credit Cycles. *Journal of Political Economy*, *105*(2), 211–48.

Meh, C. A., & Moran, K. (2010). The Role of Bank Capital in the Propagation of Shocks. *Journal of Economic Dynamics and Control*, *34*(3), 555–76.

Mendoza, E., & Quadrini, V. (2010). Financial Globalization, Financial Crises and Contagion. *Journal of Monetary Economics*, *57*(1), 24–39.

Perri, F., & Quadrini, V. (2011). International Recessions. NBER Working Paper No. 17201.

Rampini, A., & Viswanathan, S. (2012). Financial Intermediary Capital. Unpublished manuscript, Duke University.

Reinhart, C. M., & Rogoff, K. S. (2009). *This Time is Different: Eight Centuries of Financial Folly*. Princeton University Press, Princeton, New Jersey.

Schularick, M., & Taylor, A. M. (2011). Credit Booms Gone Bust: Monetary Policy, Leverage Cycles and Financial Crises, 1870-2008. *American Economic Review*, *102*(2), 1029–61.

Shourideh, A., & Zetlin-Jones, A. (2012). External Financing and the Role of Financial Frictions over the Business Cycle: Measurement and Theory. Unpublished manuscript, Wharton School.

Van den Heuvel, S. J. (2008). The Welfare Cost of Bank Capital Requirements. *Journal of Monetary Economics*, *55*(2), 298–320.