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# Universal Banking, Asymmetric Information and the Stock Market\*

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## ABSTRACT

This paper aims to explore the role of the universal banking system in contributing to the stock market bust in the wake of the financial crisis 2008-9 when bankers might have incentive to hide information from shareholders. We set up a stylized model of consumption smoothing involving universal banks that undertake both investment and commercial banking activities. Banks have private information about the outcome of a project that it funds. In the wake of bad news about the project, the banker has an incentive to sell lemon shares in a secondary market with the pretence of a liquidity crunch. Our model shows that such an incentive results in: (i) a sharp discounting of stock prices, (ii) greater loan demand (iii) higher fraction of bank ownership of the borrowing firms, and (iv) heightened consumption risk resulting in precautionary savings by households. The magnitude of these effects depends on the market's perception about the preponderance of lemons in the stock market. A credible punishment scheme implemented by the government in the form of fines may moderate the stock market decline and consumption volatility due to information friction. However, it imposes a deadweight loss on private citizens because of a fall in all banks' expected profit. On the other hand, a "ring-fenced" banking arrangement along the way suggested by the Vickers Commission may entail a first order welfare loss due to the lack of diversification opportunities.

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## I. Introduction

Following the financial crisis of 2008-9, a wave of papers appeared in the finance and economics literature exploring the diagnostics of the stock market crash. The aim of this paper is to explore the role of universal banking arrangement in contributing to the collapse of the stock market and related economic activities. A universal bank combines investment and commercial banking by holding and underwriting securities of non financial firms while performing its usual commercial banking operations. In recent times, functioning of all such activities under the umbrella of a single financial institution has been a subject of much heated debates. A prevailing notion is that such financial integration gave rise to a conflict of interest between retail and investment banking activities which manifested in terms of banks hiding information from its clients and selling lemon securities to ordinary citizens. In a recent book, Akerlof and Shiller (2015) argue that investment banks sold complex financial instruments that contained lemons. Since the public failed to perceive the quality of the mutual funds they were buying, it gave rise to a typical lemon problem in the stock market triggering a crash. Thus, a stock market bust could be the end result of a potential conflict of interest between bankers and ordinary shareholders endemic to the universal banking system.

In this paper, we set up a stylized model of consumption smoothing and banking to demonstrate how such a lemon problem could contribute to a stock market bust. We first show that the institution of universal banking works best in the absence of any such information friction as it provides a perfect consumption risk sharing opportunity to the households. However, due to the universal bank's multifarious financial activities, the system potentially generates an agency problem in terms of bankers using private information to their own advantage. This happens because the banker/underwriter who has funded risky projects has private information about the potential success or failure of the projects. If hit by a bad shock, bankers sell off both these good and bad securities by bundling them together as mutual funds with a pretence of a liquidity crunch. On the receiving end, household/shareholder cannot distinguish whether such a sale is triggered by the wake of bad news about the project outcomes or due to liquidity shortage suffered by the banks. Our paper shows that the perfect consumption risk sharing in the universal banking system breaks down due to this conflict of interests stemming from private information. This leads to: (i) a sharp discount in the price of stocks underwritten by banks, (ii) greater precautionary motive by households for holding more deposit, (iii) loan pushing by

the banks.<sup>1</sup>

A novelty of our paper is that we investigate the impact of such information friction not only on the pricing of securities but also on commercial banking activities of the universal banks which comprise the volume of lending and the magnitude of depository activities. In addition, we also analyze the real output and welfare effects of such a conflict of interest. We show that the conflict of interest that manifests in terms of information friction has potentially harmful real effects on the aggregate economy.

Our stylized model provides insights about the chain reaction caused by the information friction in the universal banking system. First, as rational investors solve a signal extraction problem by assigning a probability that banks might be selling lemons, such securities sell at a discount. The model simulation suggests that this discount is quantitatively substantial and it depends on the probability of a sale of lemon imputed by investors. Second, the immediate effect of this sale of lemon securities disrupts the perfect risk sharing arrangements obtained under full information. This happens because losses incurred by the investors from buying a probable lemon security even at a discount are not fully compensated at the margin when securities turn out to be good. The unevenness in investor's income causes increased volatility in consumption across states of nature which inflicts a welfare loss on households. Third, to mitigate this consumption risk, households undertake more savings resulting in an increased volume of bank deposits. Fourth, banks make extra profit from selling lemon stocks which is channelled (via their balance sheet) towards greater loan pushing to households. Finally, the effect of holding and trading financial claims upon information spills over to both investment and commercial banking activities. This contributes to a decline in the aggregate investment and output because of a higher market interest rate.

The US experiences in the wake of the financial crisis and its aftermath are broadly in line with the predictions of our model. Commercial banking activities showed a spurt after 2004. During 2004Q1-2008Q4, the quarterly savings deposit:GDP ratio rose from 20.6% to 30% while the quarterly commercial and industrial loans also showed an increase from about 7.6% of GDP in 2004 to 11.3% until the onset of the credit crunch. This increase in commercial banking activity was accompanied by a sharp drop in the quarterly GDP growth rate from 1.5% to

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<sup>1</sup>In this paper, the sole focus is on the effect of lender's moral hazard problem on the stock market in the presence of information friction. In a separate paper, Banerji and Basu (2015) deal with the borrower's moral hazard problem.

-0.2% and about a 30% decline in the real S&P index.<sup>2</sup>

Our paper does not aim to provide an explanation of the financial crisis because we do not model the banker's bankruptcy due to liquidity shock which is an important feature of the financial crisis. Nevertheless, our model provides useful insights about the tremendous risk taking incentive of the universal banks. An implication of our model is that the universal banking system could have possibly contributed to the crisis only to the extent that bankers had hidden information about the borrowing firms. This might have led to the lemon problem in the stock market that Akerlof and Shiller (12015) call a "phishing equilibrium". How much information was actually hidden in the banking system is an empirical question which is beyond the scope of this paper.

The policy implication of our model is that a universal banking system could work efficiently if there is full disclosure of negative information. A punitive tax on banks could moderate the lemon problem due to information friction and lower the consumption risk of the households. However, such a tax entails some efficiency loss because the enforcement authority suffers from the same information friction as private citizens. Thus, it poses a burden on all banks regardless of their deviant status. In addition, our model also implies that in the presence of informational friction, even scrupulous rating agencies could make mistakes in rating securities because they face the same signal extraction problem as the household.

The issue still remains whether an effective "ring fencing" as suggested by the Independent Banking Commission in 2011 could perform better than the universal banking system. We show that an artificial separation between retail and investment banking in a "ring-fenced" system gives rise to a first order welfare loss due to lack of diversification opportunities. As a result, efficient consumption risk sharing breaks down when such "ring fencing" is implemented. The result is robust even when we allow for hidden information in the universal banking arrangement.

The paper is organized as follows. The following section is devoted to review the related literature on universal banking. Section 3 lays out the model and the environment. Section 4 solves a baseline model of universal banking with full information about states of nature. Section 5 introduces asymmetric information about the states and the consequent conflict of interest between banks and the stockholders. Section 6 reports results from a simulation experiment based on our model to test robustness of the key results when interest rate is endogenized. In

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<sup>2</sup>These data are reported from the quarterly database of the Federal Reserve Bank of St Louis. The S&P index is deflated by the CPI (all items) to arrive at the real stock price index comparable to our model.

section 7, we report the results of a policy experiment when the government imposes a punitive tax on banks to ameliorate the lemon problem. Section 8 reports results of the comparison between universal banking and stand-alone banking systems. Section 9 concludes.

## II. Background and Literature Review

Our paper contributes to the debate on the efficacy of the universal banking system vis-a-vis retail or stand-alone banking system. Investment banking activity primarily deals with the activity of underwriting of securities while retail banking engages in the business of taking deposits and making loans. Following the great depression in the US, the Glass-Steagall Act of 1933 separated these two activities. Consequently, financial intermediaries could not participate in both equity and bond markets. A series of financial reforms, starting in the late 80s and culminating in the Gramm-Leach-Bliley Act of 1999 finally ended this separation between commercial and investment banking. This banking integration was envisaged to carry out efficient risk sharing in the financial services markets. Benston (1990,1994), Barth et al. (2000), Krozner and Rajan (1994, 1997), Puri (1996), Gande et. al (1997), Stiglitz (2009) among many others contributed to this lively debate in the 90s.

In the aftermath of the financial crisis, universal banking arrangement started losing its virtues. There was widespread speculation that the integrated system posed greater risks for households because too much private information was held by a unified financial system to the detriment of the households. The regulators in the UK and the USA started contemplating to curb multifarious activities of these institutions, especially in areas where commercial banks entered the business of underwriting equities. In 2011, an independent commission on banking chaired by Sir John Vickers made a comprehensive assessment of the extant universal banks and suggested protective a 'ring-fence' around their high street banking activities. The UK banks are expected to implement these reforms no later than 2019.<sup>3</sup>

The extant literature on universal banking covers different features of the universal banking system which includes certification effects or economies of scope or transmission of information to outsiders. For example, Kanatas and Qi (1998, 2003) discuss the trade-off between economies of scope embedded within universal banking versus deteriorations of quality of projects and innovations. Puri (1996, 1999) focuses on the added role of certification of banks while under-

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<sup>3</sup>See Financial Times (21 December, 2012 and April 21, 2011). See also Guardian (12 September, 2011).

writing debt securities versus conflicts of interests in equity holding. Rajan (2002) analyzes the efficiency of universal banking related to competitiveness of the institutions.

Our model has direct or indirect relevance to this large volume of literature on universal banking. However, our stylized model focuses primarily on the information friction endemic to the universal banking system. The building block of our framework is the traditional model of banking in which financial intermediaries transform riskier loans made to individuals to relatively safer deposits by holding a diversified portfolio of loans to many projects with uncorrelated risks. The model in this sense builds on Azariadis (1993, page 238-244), Bhattacharya and Thakor (1993) and Diamond (1984) and Gurley and Shaw (1960). We embed optimal financial contracts into this traditional model of banking where banks hold both deposits and tradable financial securities of their client firms. We follow this approach to grasp the additional mileage of the universal banking over standard framework of intermediation that focuses on economies of scale or scope associated with such banking system. Our paper is closer in spirit to the recent analysis of conflict of interest in other areas of financial services industry rooted in the informational problems.<sup>4</sup>

Our paper also connects to a thread of literature that evaluates whether bank regulations and supervisions could be welfare improving. Kilinc and Neyapati (2012) set up a general equilibrium model and argue that regulation has positive output and welfare effects if it reduces adverse selection and moral hazard problem. However, they focus mostly on borrower's moral hazard problem while in this paper our centre of attention is the adverse selection due to lender's superior information. Tchana (2012) brings banking regulations in an overlapping generations model and demonstrates the trade-off between banking stability and economic growth. In our model, the loss of output and welfare primarily results from the conflict of interest between universal bankers and the shareholders due to hidden information. We argue that an attempt to eliminate this information friction by punitive tax could have mixed effects. While investment and output could rise due to contrived decline in interest rate, aggregate welfare could fall because of a blanket tax on profits of each bank regardless of its deviant status. On the other hand, if the bank regulation takes the form of "ring-fencing" the banking sector, it could have a first order welfare loss due to the loss of diversification opportunities of the households.

Our paper has indirect implications for an emerging debate about the role of rating agencies

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<sup>4</sup>See Mehran and Stultz (2007) (and other papers in the volume) for a comprehensive analysis of such conflicts pertinent to financial services industry originating from asymmetry of information.

in accentuating the financial crisis. Akerlof and Shiller (2015) argue that well known rating agencies did not justifiably rate the new security issuance because of conflict of interest with the investment banks. Hill (2010), however, does not entirely subscribe to this conventional view. He argues that these rating agencies were overwhelmed by the increasing complexity of securitization. In terms of our model, we subscribe to Hill's view. The rating agencies also succumbed to the same informational asymmetry problems as the ordinary shareholders.

### III. The Model

#### A. Households

We consider a simple intertemporal general equilibrium model in which there is a continuum of identical agents in the unit interval who live only for two periods. At  $t = 1$ , a stand-in agent is endowed with  $y$  units of consumption goods, and she also undertakes a physical investment of  $k$  units of capital in the current period which produces a random cash flow/output in the next period. Since the household's initial endowment is insufficient to finance such an investment, the household approaches a bank for financing its project. The financing bank basically owns equity claims to the project which means that the household is contractually bound to pay a state contingent cash flow net of dividend to the bank. The exact design of the contract will be specified later.

The bank manages the production of final goods by delegating it to a nonfinancial firm who has no relations to the household. The production of output is subject to two types of binary shocks: (i) an aggregate shock, (ii) an idiosyncratic shock. The aggregate shock is transmitted to intermediaries/agents via a probabilistic signal. A signal conveys news about the state which could be high ( $h$ ) and low ( $l$ ) with probabilities  $\sigma_h$  and  $1 - \sigma_h$  respectively. A low signal (a recessionary state) triggers widespread liquidation of the current projects and the project is liquidated at a near zero continuation value ( $m$ ).<sup>5</sup> If the signal is  $h$ , agents are still subject to *idiosyncratic* shock which manifests in terms of a project success which means that output is  $\theta_g g(k)$  with probability  $p$  and failure meaning output equal to  $\theta_b g(k)$  with probability  $1 - p$  where  $\theta_g > \theta_b$ .<sup>6</sup>

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<sup>5</sup>This assumption is made in order to preserve a simple structure for analysis. Instead of assuming a fixed salvage value, we could have alternatively proceeded with a lower probability of success in individual projects in the event of a low aggregative signal and this would not change our results.

<sup>6</sup>Since this type of risk is distributed independently across infinite number of projects, the law of large number holds in an economy populated by continuum of agents so that  $p$  fraction of individuals is more successful than

To sum up, the random output in next period has the following representation:

$$\begin{aligned}
& m \text{ with probability } 1 - \sigma_h \\
& \theta_g g(k) \text{ with probability } \sigma_h p \\
& \theta_b g(k) \text{ with probability } \sigma_h (1 - p)
\end{aligned}$$

## B. Banks

In the same spirit as in Azariadis and Smith (1993) and Hart (1995), competitive banks offer a menu contracts to the households as follows. At date 1, competitive universal banks offer an *ex ante* contract that stipulates: (i) deposits ( $s$ ), (ii) loans ( $f$ ), and (iii) contingent payments ( $d_i$ ,  $i = g, b$ ). After writing such a contract and before the realization of the random shock, banks may experience a liquidity shock ( $C$ ) which necessitates banks to sell their ownerships claims ( $\theta_i g(k) - d_i$ ) to the public in a secondary market at a price  $q$ .<sup>7</sup> Let  $N$  be the number of such securities. Let  $x$  and  $nx$  denote the states of liquidity shock and no such shock with probabilities  $1 - \gamma$  and  $\gamma$ . This interim period when the secondary market opens is dated as 1.5.<sup>8</sup>

At this interim date 1.5, the bank may also acquire an early signal about the aggregate shock. If the signal is high ( $h$ ) with probability  $\sigma_h$ , the project's value upon continuation is greater than the same under liquidation. If the signal is low, it means that banks get early information that most of the projects will turn out to be a lemon with a negligible value  $m$  (close to zero).<sup>9</sup>

At  $t = 2$ , uncertainties get resolved and all agents receive pay-off according to the contracts written at date  $t = 1$ , which, in turn, depends on (a) resolution of individual uncertainty and the rest. On the other hand, no such law holds for a low aggregate state.

<sup>7</sup>We only allow the banks to have a liquidity shock and exclude individuals to have similar problem because it makes the exposition simpler and also owing to the fact that the primary purpose of the paper is to investigate the consequence of banks' holding of tradable financial assets on the rest of the economy under both full information and asymmetric information. In particular, we show later how the private information gathered by banks regarding the aggregate state has both financial and real effects.

<sup>8</sup>Under universal banking, banks or intermediaries can hold securities which are otherwise unrestricted and tradable compared with the system where banks can only hold debt securities which cannot easily be traded in the financial/debt market.

<sup>9</sup>The rationale behind such assumption is that since banks lend and monitor a large number of projects across the economy, they gather expertise to collect information relevant not only to a single project but can extract information about the overall economy better than the households. This is a standard function of banks who are also known as "informed lenders" (see Freixas and Rochet, 2008). However, the main difference between the universal and non universal banking is that the former can take its informational advantage by selling stocks to others before the bad event realizes while the latter cannot do such things because they are not allowed to hold equity in the borrowing firms.

(b) occurrences of liquidity shocks of banks. The Figure 1 summarizes the timeline in terms of a flow chart assuming that households and banks have symmetric information about the timing of shocks.

<Figure 1: Timeline of Universal Banking under Symmetric Information>

The expected profit of the bank is thus:

$$\begin{aligned} \pi^{bank} = & \sigma_h \gamma \cdot [p\{\theta_g g(k) - d_g\} + (1-p)\{\theta_b g(k) - d_b\}] \\ & + \sigma_h (1-\gamma) \cdot (qN - C) \\ & + (1-\sigma_h)m - f \cdot (1+r\sigma_h) \end{aligned} \quad (1)$$

The bank's expected profit function is standard and it is borrowed from the optimal contract literature (see for example, Frexias and Rochet, 2008). The expected profit takes into account that the universal bank is an equity holder of the project that it finances. The first square bracket term is the expected cash flow that the bank receives in a high signal ( $h$ ) and no liquidity shock ( $nx$ ) state. The second term is the expected cash flow from selling shares in the secondary market net of the liquidity shock when the bank experiences liquidity shock in a high state. The third term is the expected payoff when the bank liquidates the project in a low aggregate state. Notice that the last term involving the loan ( $f$ ) plus its service cost ( $r\sigma_h$ ) is a negative payoff to the bank because it is disbursed to the household. The loan servicing cost is  $r\sigma_h$  because banks do not pay any interest on savings in a low signal state which occurs with probability  $1-\sigma_h$ . For analytical simplicity we assume until section 6 that the loan interest rate is outside the realm of this contract and is fixed exogenously. In section 6, we analyze the case when interest rate is endogenous and determined by the loan market clearing condition. Hereafter, we also assume that banks issue just enough shares to cover the liquidity crunch which means  $N = C/q$ .<sup>10</sup>

A few more comments are in order to justify the existence of multiple shocks in the model. The presence of idiosyncratic shocks to individual projects induce banks and individuals to allocate risk optimally among themselves. Banks divide ownership claims in the borrowing firms between themselves and the household/shareholders which is a typical feature of universal banking. This division of ownership serves as a mechanism for risk sharing with the households. Second, the introduction of liquidity shock by banks directly provides rationale for banks selling

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<sup>10</sup>In fact, when information friction is present (which we deal in the later section), it is not incentive compatible for any bank to issue more shares such that  $qN > c$ . If a bank does so, it will be labelled as a deviant bank by the investors.

stocks to investors in the secondary market at date 1.5 when the bank could receive bad news about the project and sell such lemon stocks with a pretence of a liquidity shock. We deal with such a scenario of asymmetric information in section 5. Finally, the aggregate shock also provides a rationale for households to hold claims in the form of bank deposits (i.e., demand deposits in addition to holding financial claims via optimal contracts). Household's saving also provides liquidity to the stock market when it opens at the intermediate date 1.5. Saving thus performs two roles: (i) consumption smoothing, and (ii) liquidity for speculative purchase of shares.

All banks are competitive and in equilibrium a zero profit condition holds. However, each generic bank offers a menu of contracts which includes loan ( $f$ ), investment ( $k$ ), dividend payment ( $d_g, d_f$ ) which maximize the expected utility of a stand-in household to which we now turn. Since a bank delegates the production decision to a competitive firm who has no relationship to the household, the latter does not see the firm specific shocks. This separation preserves the information friction problem that we spell out later.<sup>11</sup>

### C. Preferences

The utility function of each household/ borrower/depositor is additively separable in consumption at each date and is of the form:

$$U = u(c_1) + v(c_2) \quad (2)$$

where  $c_t$  = consumption at date  $t$ , where  $t = 1, 2$ ,  $u(\cdot)$  and  $v(\cdot)$  are: (a) three times continuously differentiable, (b) concave, and (c) have a convex marginal utility function. Hence, agents are risk-averse and in addition, they have a precautionary motive for savings.

Apart from the current period, in period 2 there are 5 possible states and the expected utility of an agent from consumption that occur in all such contingencies is given by:

$$\begin{aligned} EU &= [u(c_1) + \sigma_h \gamma \{pv(c_{2g}^{nx}) + (1-p)v(c_{2b}^{nx})\}] \\ &\quad + \sigma_h (1-\gamma) \{pv(c_{2g}^x) + (1-p)v(c_{2b}^x)\} \\ &\quad + (1-\sigma_h)u(c_{2l}) \end{aligned} \quad (3)$$

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<sup>11</sup>The issue remains why in a universal banking environment it is incentive compatible for the household to get involved in such contingent payment contract with the banks. We do not explicitly model this. We implicitly assume that the household needs to incur a fixed cost of running its own production establishment which makes its expected payoff lower compared to a contingency payments arrangement.

The superscripts  $x$  and  $nx$  stand for liquidity or no liquidity shock for banks<sup>12</sup> and the subscript  $2g$  and  $2b$  stand for good and bad project outcomes (idiosyncratic shocks) at date 2 with the good news about aggregate shock (subscript  $h$ ) and the subscript  $l$  refers to the low aggregate state. The other notations are as follows:

- $c_1$  = consumption of the agent in the first period.
- $c_{2j}^{nx}$  = consumption of the agent in the period 2 when the banks with high aggregate signal do *not* suffer liquidity shock ( $nx$ ) and the individual state is  $j = g$  or  $b$ , which means that the cash flow is  $\theta_j g(k)$ .
- In a similar vein,  $c_{2j}^x$  = consumption of the agent in the period 2 when the banks with a high signal suffer liquidity shock ( $x$ ) and the individual state is  $j$ .
- $c_{2l}$  = consumption of the agent when the bank has received a low signal and face liquidation of the project.

The first term,  $u(c_1)$  in (3) is the utility from current consumption. The term  $\sigma_h \gamma \{pv(c_{2g}^{nx}) + (1-p)v(c_{2b}^{nx})\}$  is the probability weighted utility when the aggregate news is good but banks do not suffer liquidity shock. Similarly, the term  $\sigma_h (1-\gamma) \{pv(c_{2g}^x) + (1-p)v(c_{2b}^x)\}$  is the probability weighted utility in a good aggregate state when banks suffer liquidity shock. The final term  $(1-\sigma_h)u(c_{2l})$ , is the weighted utility in the bad aggregate state when banks do not pay interest to depositors.

## D. Budget Constraints

The budget constraint in period 1 and all five contingencies in period 2 are:

$$c_1 = y + f - s - k \quad (4)$$

$$c_{2g}^{nx} = d_g + s(1+r) \quad (5)$$

$$c_{2b}^{nx} = d_b + s(1+r) \quad (6)$$

$$c_{2g}^x = d_g + (s-z)(1+r) + \frac{z}{q} E\tilde{X} \quad (7)$$

$$c_{2b}^x = d_b + (s-z)(1+r) + \frac{z}{q} E\tilde{X} \quad (8)$$

$$c_{2l} = s - z \quad (9)$$

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<sup>12</sup>Although individuals do not suffer any liquidity shock, banks' state of liquidity matter to them because it determines the state whether they will participate in the stock market or not.

where  $\bar{\theta} = p\theta_g + (1-p)\theta_b$ ,  $\bar{d} = pd_g + (1-p)d_b$ ,  $E\tilde{X} = \bar{\theta}g(K) - \bar{d}$  and  $K$  = the average capital stock in the economy.

The equation (4) is the first period budget constraint which states that consumption of an agent is equal to endowment  $y$  plus the fund received from bank  $f$  less the money stored as deposit  $s$  and expenditure on capital good  $k$ .<sup>13</sup> The equations (5) and (6) capture agents' consumption (equal to income) in the good and bad states of production respectively when banks do not suffer any liquidity shocks. In these states of nature, individuals do not participate in the stock market in the intermediate period. In such states, the agent's income consists of two parts: (i) the contingent payments  $d_i$  depending on the state of production, ( $i = g, b$ ), (ii) the principal and the interest income on deposits  $s(1+r)$ .

Equations (7) and (8) are the state dependent budget constraints when banks encounter liquidity shock and the project can be a success ( $g$ ) or failure ( $b$ ). When the household member invests  $z$  in stocks at a unit price  $q$ , it entitles him a claim of  $\frac{z}{q}E\tilde{X}$  units of goods because the bank sells a mutual fund to the household bundling good and bad shares.<sup>14</sup> An atomistic bank while stipulating an optimal contract for an atomistic household takes the average variables,  $K$  and  $\bar{d}$  as given. However, in equilibrium these two average variables are determined by aggregate consistency conditions.

Equation (9) shows that when the bank receives a bad news (state  $l$ ) about the economy, the project is liquidated and the banks receive the liquidation value as it has the first priority over claims. Recall that in such a low signal state (which is a state of macroeconomic shock), banks are unable to make full payment and only return the deposits  $s$  to the households.<sup>15</sup>

## IV. Universal Banking under Full Information

As a baseline case, we first lay out the equilibrium contract in a full information scenario. For a given interest rate  $r$  and stock price  $q$ , each bank offers a package to the household which includes (i) the loan size  $f$ , (ii) payments to the same household  $d_i$  contingent on realizations of idiosyncratic states. In return, the household must put in a deposit  $s$  at the same bank and

<sup>13</sup>The endowment  $y$  is defined as net of the foreign interest paid or received from abroad. See the appendix outlining the equilibrium section for details.

<sup>14</sup>A bank lends out to infinitely many people. Hence, an individual over a unit interval, when buys one such bank's mutual fund receives a payment of  $(p\theta_g + (1-p)\theta_b)g(K) - \bar{d}$  per share.

<sup>15</sup>Nothing fundamentally changes in our model if we assume instead that banks return only a fraction of savings in a low aggregate state.

undertake a physical investment  $k$  in the project. Such a package is stipulated by the bank that solves the expected utility of the household subject to the condition that these universal banks offering such competitive contracts satisfy the participation constraint which means that they must break even.

The optimal contract facing the household is to maximize the expected utility (3) subject to the budget constraints given by (4) through (9) and zero profit constraint of the intermediary, i.e.

$$\pi^{bank} = \sigma_h \gamma [p\{\theta_g g(k) - d_g\} + (1-p)\{\theta_b g(k) - d_b\}] + (1-\sigma_h)m + \sigma_h(1-\gamma)(qN-C) - f \cdot (1+r\sigma_h) \geq 0$$

Since there is full information, the agent exactly knows the node at which the bank operates. Thus at a low signal state agents know that a stock market will not open at date 1.5. This immediately means that  $z = 0$  at this low signal state.

As a baseline case, we assume that the real interest rate,  $r$  is fixed by a policy rule. Any discrepancy between borrowing  $f$  and lending  $s$  is financed by a net inflow of foreign funds (call it  $NFI$ ) from abroad at this fixed interest rate.<sup>16</sup>The Appendix A provides the details of the market clearing conditions.

**Proposition 1:** The competitive equilibrium contract has the following properties:

- (i) Contingent Payments:  $d_g = d_b = d$  (say) such that  $\frac{\gamma u'(c_1)}{1+r\sigma_h} = v'(d + s(1+r))$
- (ii) Share Price:  $q = \frac{E\tilde{X}}{1+r}$  where  $E\tilde{X} = \frac{\bar{\theta}g(K) - \bar{d}}{N}$ .
- (iii) Consumption:  $c_{2g}^{nx} = c_{2b}^{nx} = c_{2g}^x = c_{2b}^x = d + s(1+r) = c_2$  (say)  $> c_{2l} = s$
- (iv) Saving:  $u'(c_1) = \left[ \frac{(1-\sigma_h)(1+r\sigma_h)}{1-\gamma\sigma_h+r\sigma_h(1-\gamma)} \right] v'(s)$
- (v) Investment:  $\sigma_h \gamma \bar{\theta} g'(k) = 1 + r\sigma_h$  where  $\bar{\theta} = p\theta_g + (1-p)\theta_b$  and
- (vi) Loan:  $f = \frac{\sigma_h \gamma (\bar{\theta}g(k) - d) + (1-\sigma_h)m + \sigma_h(1-\gamma)(qN-C)}{1+r\sigma_h}$
- (vii) Consistency of Expectations:  $k = K$

**Proof:** Appendix B.

**Discussion:** (i), (iv), (v) and (vi) together determine  $\{d, s, K, f\}$  and the equation (ii) determines  $q$ , given an exogenous  $r$ . Stocks have fair market value as seen in (ii) and the risk premium is thus zero. The risk neutral bank bears the whole idiosyncratic risks which

<sup>16</sup>This assumption is made for analytical simplicity because it rules out the second order effect of the financial operations of banks and households on the real interest rate. In section 6 where we undertake model simulation, we allow the interest rate to vary to equilibrate the loan market.

explains why the market risk premium is zero. (i) and (ii) together state that conditional on the realization of high signal, an agent receives a constant sum  $d$  across all states of nature. Although idiosyncratic risk is washed out in the high state  $h$ , in the low state individuals are still exposed to negative aggregate shock which explains the last inequality of (iii). The holding of deposit in the form of savings acts as an instrument to deal with this situation. If there is no aggregate risk,  $\sigma_h = 1$ , optimal saving is zero as seen from (iv) which highlights the precautionary motive for savings. (v) states that the expected marginal productivity of investment equals the risk adjusted interest rate,  $1 + \sigma_h r$ . The physical investment  $k$  is lower if the probability of low aggregate state is higher (lower  $\sigma_h$ ) or the probability of liquidity shock is higher (lower  $\gamma$ ). In the latter case, banks may cut back lending and hold less equity stake due to looming insolvency<sup>17</sup>. (vi) states the equilibrium loan size obtained from bank's zero profit condition. Finally, (vii) states the aggregate consistency condition that sum of all individual capital stocks equals the aggregate capital and over a unit interval.

The results in the proposition 1 serve to capture the basic functioning of the universal banking in the simplest possible full information framework. The universal banks optimally share project risks by offering a riskfree payment  $d$  and the residual  $\theta_j g(k) - d$  is kept by the bank.<sup>18</sup> Without any conflicts of interest (asymmetric information), this is a Pareto optimal contract. It eliminates idiosyncratic uncertainties in household consumption and makes stock price trade at a fair market value.

## V. Universal Banking under Asymmetric Information

Using the baseline model of full information described in the preceding section, we now turn to the case of asymmetric information. The basic tenet of such informational asymmetry is that banks hold private information about the realization of the aggregate business cycle as well the liquidity shocks.<sup>19</sup> In other words, banks observe true realizations of both liquidity shocks

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<sup>17</sup>In the simulation experiment reported in Table 3 later this conjecture is confirmed.

<sup>18</sup>This contract is equivalent to: (i) agents holding a preferred stock (or any other instrument that ensures a constant sum in all contingencies within good aggregate state), and (ii) banks owning ordinary stocks and thus bear all the residual risks. Thus, banks holding of equity, a hallmark of universal banking, emerges as a mechanism of an optimum allocation of risk.

<sup>19</sup>The banks can observe the aggregate shock at least in a partial manner because they lend it to agents economy-wide and collect/collate information from each borrower. Hence, they tend to have economy-wide information while each agent is too small to acquire aggregate signal. However, bank's signal about aggregate and idiosyncratic shocks need not be perfect and could be even noisy. For the sake of parsimony, simplicity, and without compromising our results below, we ignore the noisiness of bank's signal about aggregate shock and their private information about individual projects.

and the realization of the signal regarding the macro business cycle state but agents know only the distribution of liquidity shocks and the signals. Since interest payment on deposits and liquidation of projects in a bad aggregate state take place at  $t = 2$  after the transaction in intermediate stock market, if the stock market opens at date 1.5, agents cannot ascertain whether banks have received a low signal or simply suffered a liquidity shock. The information friction is further aggravated by the fact that household is separated from the firm undertaking production decisions. This gives rise to a typical lemon problem because universal banks with a low realization of the signal may sell off the equity held by them in the borrowing firm with a pretence of the liquidity shock. This problem of selling lemon stocks can emerge only in the universal banking system as opposed to the non universal system where banks are barred from holding equities in the borrowing firms.

Figure 2 summarizes the timeline of universal banking in the presence of asymmetric information. The only difference from Figure 1 is the dotted line at the node  $t = 1.5$  which represents the fact that the agent cannot ascertain at this node whether the bank has suffered a liquidity shock or has received a low aggregate signal or both. At this node, she only observes whether the stock market has opened or not. If the stock market does not open then she knows for sure (a) high signal has occurred and (b) no bank has suffered a liquidity shock. Of course, she could still either succeed or fail. Given that (a) and (b) happen with probability  $\gamma\sigma_h$ , the expected utility (up to this node) is:

$$\sigma_h\gamma[pv(d_g + s(1+r)) + (1-p)v(d_b + s(1+r))].$$

If the equity market opens at the intermediate date 1.5 where a financial intermediary sells stocks, an agent concludes that either the bank has received a low signal (with a probability of  $1 - \sigma_h$ ) or the bank has received good news about the aggregate shock but it is still selling the stock because it has suffered a liquidity shock. The probability of the latter event is  $\sigma_h(1 - \gamma)$ . Hence, an individual at the node at date 1.5 when she is observing someone selling the stocks will impute the probability  $\left(\frac{\sigma_h(1-\gamma)}{\sigma_h(1-\gamma)+(1-\sigma_h)} = \frac{\sigma_h(1-\gamma)}{(1-\gamma\sigma_h)}\right)$  that the stock is not a lemon. The model thus portrays a situation where banks lend money to its borrowers and also hold other tradable financial claims on them. Hence, our model is rich to capture a scenario whereby a bank can sell off lemon securities to investors when it has private information about bad project state

underlying these securities, enabling it to recover some of its lending losses.

<Figure 2: Timeline of Universal Banking under Asymmetric Information>

Define  $EU_a$  as the expected utility in the presence of information friction. The optimal contract problem can be thus written as:

$$\begin{aligned}
\max_{\{d_g, d_b, s, z, l, k\}} EU_a = & [u(y + f - s - k)] + \sigma_h \gamma [pv(d_g + s(1 + r)) + (1 - p)v(d_b + s(1 + r))] \\
& + (1 - \gamma \sigma_h) \cdot \left( \frac{\sigma_h(1 - \gamma)}{(1 - \gamma \sigma_h)} \right) [pv(d_g + (s - z)(1 + r) + \frac{z}{q} E\tilde{X}) \\
& + (1 - p)v(d_b + (s - z)(1 + r) + \frac{z}{q} E\tilde{X})] \\
& + (1 - \gamma \sigma_h) \left( \frac{(1 - \sigma_h)}{(1 - \gamma \sigma_h)} \right) v(s - z)
\end{aligned} \tag{10}$$

subject to

$$\pi_a^{bank} = \sigma_h \gamma [p\{\theta_g g(k) - d_g\} + (1 - p)\{\theta_b g(k) - d_b\}] + \sigma_h(1 - \gamma)(qN - C) + (1 - \sigma_h)(qN + m) - f(1 + r\sigma_h) \geq 0 \tag{11}$$

There are two important features of this optimal contract problem which require clarification. First, while writing a contract with the bank, household/shareholder takes into account that banks can sell off stocks in the midway (at date 1.5) in the wake of bad news and thus they may incur capital losses. Second, the zero profit constraint (11) now contains an additional term  $(1 - \sigma_h)qN$  which is the extra expected income of the banks from selling securities upon bad news.

**Proposition 2:** The equilibrium contract under asymmetric information has the following properties:

- (ia) Contingent Payments:  $d_{ga} = d_{ba} = d_a$  (say) and  $\frac{\gamma u'(c_1)}{1 + r\sigma_h} = \gamma v'(c_{2a}^{nx}) + (1 - \gamma)v'(c_{2a}^x)$
- (iia) Share Price:  $\frac{E\tilde{X}_a}{q} - (1 + r) = \left( \frac{v'\{(s_a - z)\}}{v'\{d_a + (s_a - z)(1 + r) + \frac{z}{q} E\tilde{X}\}} \right) \frac{1 - \sigma_h}{\sigma_h(1 - \gamma)} > 0$  where  $E\tilde{X}_a = \bar{\theta}g(K) - \bar{d}_a$
- (iiia) Consumption:  $c_{2g}^x = c_{2b}^x \equiv c_{2a}^x = d_a + s_a(1 + r) + \left\{ \frac{E\tilde{X}_a}{q} - (1 + r) \right\} z > c_{2g}^{nx} = c_{2b}^{nx} = c_{2a}^{nx}(\text{say}) = d_a + s_a(1 + r) > c_{1a} = s_a - z$
- (iva) Saving:  $u'(c_{1a}) = \left[ \frac{(1 - \sigma_h)(1 + r\sigma_h)}{1 - \gamma\sigma_h + r\sigma_h(1 - \gamma)} \right] v'(s_a - z)$
- (va) Investment:  $\sigma_h \gamma \bar{\theta} g'(k) = 1 + r\sigma_h$  where  $\bar{\theta} = p\theta_h + (1 - p)\theta_l$  and
- (via) Loan:  $f_a = \frac{\sigma_h \gamma (\bar{\theta}g(k) - d_a) + (1 - \sigma_h)(qN + m) + \sigma_h(1 - \gamma)(qN - C)}{1 + r\sigma_h}$
- (viiia) Consistency of Expectations:  $k = K$

**Proof:** Appendix B.

**Discussions:** We denote the subscript  $a$  as the solution of the variables under asymmetric information. (ia) shares the same feature as (i). Idiosyncratic risks are again borne by the risk neutral bank and household receives a riskfree payment  $d_a$  for its ownership claim to the project. The major difference from the baseline full information setting appears in (iia). Since banks can potentially sell lemon securities in the midway at date 1.5, the optimal contract embeds this possibility. (iia) shows that stocks sell at a discount in the sense that the price is less than the discounted value of the cash flow. To put it alternatively, a positive market risk premium emerges in equilibrium to reflect this lemon problem.

The intuition for (iia) goes as follows. If a household spends one unit to buy stock from a bank, the marginal utility gain is:

$$v' \left\{ d_a + (s - z)(1 + r) + \frac{z}{q} EX \right\} \left\{ \frac{E\tilde{X}}{q} - (1 + r) \right\}$$

which happens with the probability,  $\sigma_h(1 - \gamma)$  that he buys stocks from a good bank suffering from a liquidity shock. On the other hand, the marginal cost is that if the purchased stock is a lemon, then he loses out on his savings and consequent marginal utility loss is  $v'\{(s - z)\}$  which happens with probability  $(1 - \sigma_h)$ . The equivalence between the marginal gain and loss in investing in stocks explains that the stocks are selling at a discount (or equivalently the emergence of risk premium) as shown in the equation (iia). Everything else equal, the greater the ratio of  $\frac{1 - \sigma_h}{\sigma_h(1 - \gamma)}$  (relative proportion of lemon), the lower the price of the stock.

The immediate implication of stocks selling at a discount is captured in proposition (iiia) which shows that the consumption flows of households are smoothed out only partially when banks sell their ownership claims upon bad news. The consumption in the states where households participate in the stock market exceeds the consumption in states where they do not. (iva) and (va) are the usual first order conditions for saving and investment. (via) shows the equilibrium loan size based on the zero profit constraint that binds at the optimum.<sup>20</sup>

Comparison with the full information baseline reveals that the stock market risk premium arises purely due to information friction. Since shareholders are unable to ascertain whether banks sell off shares due to liquidity shock or arrival of bad news, additional premium is required

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<sup>20</sup>The description of overall equilibrium is omitted as they mirror conditions laid out in the appendix, except that the variables now refer to the asymmetric information case.

to lure households to buy shares. The emergence of a risk premium (or stocks selling at a discount) prevents the agents from smoothing out consumption across  $nx$  and  $x$  states. In sharp contrast, a full insurance across  $nx$  and  $x$  is possible under full information setting because agents are perfectly informed about the nodes at which banks sell stocks.

The sale of stocks at a discount ex post, certainly changes the structure of contracts between banks and the borrowing households and it affects investment and commercial banking directly. The following proposition makes it evident.

**Proposition 3:** (i)  $d > d_a$ , (ii)  $s < s_a$ , (iii)  $f < f_a$ .

Proof: Appendix C.

Since  $s < s_a$  and  $f < f_a$ , the immediate implication is that the equilibrium loan size is higher under asymmetric information. From (iii) and (iiia), it follows that the spread between the expected consumption in the high and low aggregate signals under adverse selection is greater than under full information.

The intuitive reasonings of the above results are as follows. Since risk averse households take greater risks in the equity market than before due to possibilities of buying lemons, they are compensated by lower equity stake in production, implying  $d > d_a$ . The additional risks of losing their investment in the bad aggregate state makes marginal utility of households in that state even higher. This prompts households to make more deposits at the bank for precautionary purposes. Finally, the loan size increases because banks make more profit from both equity holding ( $\bar{\theta}g(k) - \bar{d}_a$ ) and trading shares ( $(1 - \sigma_h)qN$ ), which lure more competitive banks to enter the commercial banking industry. The end result is that the size of the commercial banking activity in the form of loans and deposits expands under asymmetric information. On the other hand, this spurt in commercial banking activity also leads to an increased volatility of household's consumption.

Since households bear greater consumption risk in the asymmetric information environment, it entails welfare loss compared to the full information baseline scenario. In the following proposition, we establish that for a range of interest rates, the expected utility under asymmetric information ( $EU_a$ ) is less than the baseline full formation expected utility ( $EU$ ).

**Proposition 4:**  $EU > EU_a$

**Proof:** Appendix E.

A few comments are in order before concluding this section. When banks sell stocks upon

news, there is a redistributive element where banks receive  $(1 - \sigma_h)C$  from households (because in equilibrium,  $qN = z = C$ ). The inefficiency is thus rooted in two elements:  $q$  is traded at a discount ( proposition 2) and an increase in precautionary savings ( $s$ ) (proposition 3). Both lead to a loss of welfare manifested in greater consumption risk (proposition 2). Here, a tax on trading could partially ameliorate this welfare loss which we deal in section 7.<sup>21</sup>

## VI. Endogenous Interest Rate

The analytical results in propositions 2 and 3 are established in the neighborhood of a full information equilibrium and also with an assumption of a small open economy which means that the real interest rate is exogenous. In this section, we perform a simulation experiment to check the robustness of these results. Assume logarithmic utility functions which means:  $u(c_1) = \ln c_1$  and  $v(c_2) = \ln c_2$ . The production function is assumed to be Cobb-Douglas, meaning  $g(k) = k^\alpha$  with  $0 < \alpha < 1$ . The interest rate ( $r$ ) is now determined by the loan market equilibrium condition,  $s = f$ . There are nine parameters in this stylized model, namely  $y, \sigma_h, \gamma, p, \alpha, \theta_g, \theta_b, C$  and  $m$ . The first period output  $y$  is normalized at unity with a view to express relevant macroeconomic aggregates as a fraction of the first period output (GDP). The average growth rate of the economy is then  $\sigma_h \bar{\theta} k^\alpha + (1 - \sigma_h)m$ .<sup>22</sup> After fixing the capital share parameter  $\alpha$  at its conventional value 0.36, the remaining parameters are fixed to target the average quarterly growth rate of GDP in the US and a real interest rate of 4.62% (computed by subtracting the bank prime rate from the CPI rate of inflation) during the crisis period 2004Q1-2008Q4.<sup>23</sup> The Federal Reserve Bank of St Louis database is used to arrive at these summary measures for output growth and real interest rate. Table 1 summarizes the baseline parameter values.

Table 1: Baseline Parameters

$\alpha$	$y$	$\theta_b$	$\theta_g$	$\sigma_h$	$\gamma$	$p$	$m$	$C$
0.36	1.00	1.00	2.25	0.92	0.766	0.6	0.05	0.1

Table 2 compares two economies: (i) with symmetric information (Symm Info), (ii) with

<sup>21</sup>One has to take into account that such a tax also penalizes the honest banks who sell due to adverse liquidity. An optimal tax can be designed which is beyond the scope of this paper.

<sup>22</sup>In the context of our two period model, the ratio of the second period to first period outputs approximates the long run average GDP growth rate.

<sup>23</sup>Given the stylized nature of this two period model, we do not aim to fully calibrate our model economy. The goal of this simulation is rather to illustrate the comparative statics effects on relevant aggregates setting parameters at reasonable values. These comparative statics results are reasonably robust to alternative choice of parameter values.

asymmetric information (Asymm Info) for different probabilities of low signal states ( $1 - \sigma_h$ ). The appendix describes the key equation system and the methodology for this model simulation. The lemon effect on the stock market is reflected by a sharply lower stock price ( $q$ ) in the economy with information friction and a higher consumption volatility ( $c\text{-vol}$ ) measured by the standard deviation of consumption levels for two dates and states together. In conformity with proposition 3, when information friction is present, banks hold a higher equity stake (thus lower  $d/y$ ) in the borrowing firms<sup>24</sup> and issue more loans (higher  $f/y$ ). While the households also save more as a precautionary motive, the loan demand far outpaces the supply ( $f > s$ ) which explains why the real interest rate rises. A higher interest rate raises the opportunity cost of investment (see equations v and va in propositions 1 and 2) and has an adverse output effect.<sup>25</sup> Consumption volatility is higher when information friction is present. Notice also that a greater probability of a low aggregate state (higher  $1 - \sigma_h$ ) simply magnifies all these effects. All these results are in conformity with propositions 2 and 3.

Table 2: Effect of a change in the probability of low signal state

$\sigma_h$		$q$	$d/y$	$f/y$	$r(\%)$	<i>output effect</i>	<i>c volatility</i>
0.92	Symm Info	0.27	0.79	0.20	4.56%	-0.27%	0.41
	Asymm Info	0.13	0.64	0.30	5.12%		
0.91	Symm Info	0.30	0.76	0.22	3.4%	-0.31%	0.39
	Asymm Info	0.13	0.62	0.32	4.04%		
0.90	Symm Info	0.34	0.74	0.24	2.22%	-0.35%	0.38
	Asymm Info	0.12	0.59	0.34	2.93%		

In Table 3, we perform similar sensitivity analysis by varying the probability ( $1 - \gamma$ ) of the liquidity crisis state. The effect of information friction is again the same as in propositions 2 and 3. A greater probability of a liquidity crisis (lower  $\gamma$ ) heightens the speculative motive of households for saving which lowers the interest rate in both economies with or without information friction. Banks keep a lower equity stake and also push less loans in response to a greater anticipation of a liquidity crisis because of the looming insolvency. The output effects of information friction is insensitive to change in  $\gamma$  and so is the consumption volatility.<sup>26</sup>

<sup>24</sup>Note that bank's equity share is simply  $\{1 - (d/y)\}100\%$ .

<sup>25</sup>The adverse output effect of information friction, however, depends on the risk aversion parameter. We have specialized to a log utility function which means the relative risk aversion parameter is unity. For a more general power utility function, a higher relative risk aversion parameter entails greater precautionary savings which might reverse the direction of the output effect because the supply of loans could then outpace the demand.

<sup>26</sup>The effect of a change in  $p$  is not reported here for brevity. Such a change in project risk has very little effects on the economy except the loan size and contingent payments. In response to a higher project downside risk (lower  $p$ ), banks cut back loans ( $f$ ) and contingent payments ( $d$ ) to the borrowers significantly.

Table 3: Effect of a change in the probability of liquidity crisis

$\gamma$		$q$	$d/y$	$f/y$	$r$ (%)	<i>output effect</i>	<i>c volatility</i>
0.766	Symm Info	0.27	0.79	0.20	4.56%	-0.27%	0.41
	Asymm Info	0.13	0.64	0.30	5.12%		0.46
0.75	Symm Info	0.27	0.80	0.19	2.22%	-0.28%	0.41
	Asymm Info	0.13	0.66	0.29	2.76%		0.47
0.74	Symm Info	0.27	0.81	0.18	0.72%	-0.28%	0.41
	Asymm Info	0.13	0.67	0.28	0.12%		0.47

Table 4 reports the sensitivity analysis of a change in the size of the liquidity shock,  $C$ . While the size of the liquidity shock has negligible consequences for the symmetric information economy, it has significant effects on the economy with information frictions. This difference in effects arises particularly due to the fact that  $C$  appears in the bank's equilibrium profit equation (see equation (11)). Banks issue lemon shares with a pretence of a liquidity crunch and in equilibrium banks can issue shares worth the size of the liquidity shock,  $C$ . Thus a greater size of the liquidity shock provides an incentive to the banks to hold a greater equity stake in borrowing firms (lower  $d/y$ ) and push more loans ( $f/y$ ) because banks make more profit by selling lemon shares. The equilibrium interest rate in economies with asymmetric information is higher which reflects bank's propensity to create more loan demand that far outpaces the household savings. A higher interest rate has an adverse output effect because investment responds negatively to interest rate via proposition 2v(a). Consumption volatility in economies with information friction is significantly higher when the size of the liquidity shock is higher. This happens because in the presence of information friction, household's equilibrium consumption in the low signal state ( $c_{2l}$ ) is  $s - C$  which responds negative to a rise in  $C$ .

Table 4: Effect of a change in the size of the liquidity shock

$C$		$q$	$d/y$	$f/y$	$r$ (%)	<i>output effect</i> (%)	<i>c volatility</i>
0.1	Symm Info	0.27	0.79	0.20	4.56%	-0.27%	0.41
	Asymm Info	0.13	0.64	0.30	5.12%		0.46
0.15	Symm Info	0.28	0.79	0.20	4.56%	-0.41%	0.40
	Asymm Info	0.14	0.57	0.35	5.4%		0.53
0.2	Symm Info	0.28	0.81	0.20	4.56%	-0.54%	0.41
	Asymm Info	0.14	0.50	0.40	5.68%		0.60

Figures 3 through and 5 summarize the salient features of this sensitivity analysis for a longer ranges of probabilities and size of the liquidity shocks. In response to a higher probability of low signal state ( $1 - \sigma_h$ ), the ratio of stock prices in an asymmetric to symmetric information scenarios

(denoted as  $q^a/q$ ) declines by nearly 60% while the corresponding consumption volatility ratio (denoted as  $evol_a/cvol$ ) increases by nearly 48%. A higher probability of liquidity crunch ( $1-\gamma$ ) has a mixed effect on the same stock price ratio ( $q_a/q$ ) which declines when the probability of liquidity crunch exceeds 0.35 while a greater size of the liquidity shock ( $C$ ), however, keeps the stock price ratio nearly the same but it raises the consumption volatility quite sharply.

<Figure 3: Effect of a higher probability of a low signal state>

<Figure 4: Effect of a higher probability of a liquidity crunch>

<Figure 5: Effect of a higher liquidity shock,  $C$ >

### A. What drives the stock market discount?

The upshot of this paper is that the information friction due to bank's conflict of interest could give rise to a lemon problem which could translate into a stock market discount. The model predicts that such a discount (measured by the percent change in  $q$  from the symmetric information scenario) could be quite deep. For example, at the baseline parameter values, the stock market discount is about 52%. The size of the discount is crucially determined by the relative proportion of lemon in the stock market. Recall that the relative proportion of lemon is  $(1-\sigma_h)/(1-\gamma)\sigma_h$  which is decreasing in  $\sigma_h$  and increasing in  $\gamma$ . Thus a higher probability of a low aggregate state (lower  $\sigma_h$ ) and/or a lower probability of liquidity crisis (higher  $\gamma$ ) heightens this stock market discount. This results in a higher consumption volatility because investors demand a larger risk premium on shares. This basically summarizes the rational market's reaction to the potential lemon problem

## VII. Punishment

Suppose the government enforces a punishment in the form of a fine  $\Phi$  if banks misbehave. Let the probability of being caught for such a misbehavior be  $\lambda$ . The expected profit of the bank then changes to:

$$\begin{aligned} \pi_a^{bank} &= \sigma_h \gamma [p\{\theta_g g(k) - d_g\} + (1-p)\{\theta_b g(k) - d_b\}] \\ &\quad + \sigma_h (1-\gamma)(qN - C) + (1-\sigma_h)[(1-\lambda)(qN + m) - \lambda\Phi] \\ &\quad - f(1 + r\sigma_h) \end{aligned}$$

Table 3 reports the effects of an increase in the fine amount setting the probability of detection ( $\lambda$ ) at 0.5. An increase in the size of penalty has little effect on share prices and bank's capital structure  $d/f$ . However, the interest rate sharply falls due to such policy intervention. This happens because for a given interest rate, a higher penalty lowers the loan size at which the zero profit condition holds.<sup>27</sup> Since the fine amount  $\Phi$  does not directly appear in the first order conditions of the household, it has little effect on savings at a given interest rate. The interest rate, therefore, adjusts downward to equilibrate in response to such a decline in loan demand. This raises investment and output. This effect is magnified if the fine amount is larger. The stock market discount due to information friction is also considerably less (40% for a hefty fine of  $\Phi = 2$  as opposed to 52% when  $\Phi = 0$ ). Consumption volatility is also lower when the fine amount is larger. For a sufficiently large fine amount (around  $\Phi = 3$ ), it is possible to replicate the same consumption volatility as in a symmetric information economy.

Table 5: Effect of a change in the size of the fine for bank misbehaviours

$\Phi$		$q$	$d/y$	$f/y$	$r$ (%)	<i>output effect</i> (%)	<i>c volatility</i>	<i>EU</i>
0.0	Symm Info	0.27	0.79	0.20	4.56%	-0.27%	0.41	-0.43
	Asymm Info	0.13	0.64	0.30	5.12%		0.46	-0.42
0.5	Symm Info	0.27	0.79	0.20	4.56%	0.62%	0.40	-0.43
	Asymm Info	0.14	0.63	0.29	3.31%		0.45	-0.45
1.0	Symm Info	0.27	0.79	0.20	4.56%	1.32%	0.40	-0.43
	Asymm Info	0.15	0.61	0.30	1.93%		0.44	-0.47
2.0	Symm Info	0.27	0.79	0.20	4.56%	2.75%	0.40	-0.43
	Asymm Info	0.16	0.59	0.29	0.00%		0.42	-0.53

Since the policy authority does not know precisely the node at which the bank operates at date 1.5, it suffers from exactly the same information friction as private citizens. The expected fine amount thus appears as a tax on all banks' expected profit regardless of their deviant behaviour. As a result, the punishment is not costless to the society because it is a deadweight loss. This decreases welfare of private citizens which appears in the last column of Table 5.

## VIII. A comparison with a stand alone banking system

Will private citizens be better off if retails banks are "ring-fenced" and legally mandated not to underwrite securities? The question is relevant in the present context of banking commission's

<sup>27</sup>To see this note that in the presence of fine  $f_a = \frac{\sigma_h \gamma (\bar{\theta} g(k) - d_a) + (1 - \sigma_h) [\lambda (qN + m) - (1 - \lambda) \Phi]}{1 + r \sigma_h}$  which is lower than  $f_a$  as shown in proposition 2 for a given  $r$ .

legislation. Using our model, we now demonstrate that in such a restricted environment when banks cannot diversify away the liquidity shocks by trading securities, full consumption risk sharing fails even under full information.

Consider an environment where retail banks and investment banks are separated. Retail banks only perform loan and depository activities while households mimic the operation of investment bankers by issuing securities to each other. Banks issue loans ( $F$ ) to the household/entrepreneur and incur the same loan servicing cost as before. As in the previous scenario, there is a state of a global liquidity shock where all banks suffer a liquidity shock  $C$ . However, unlike the universal banking regime, in a low aggregate state banks instead of issuing securities in a secondary share market, call off the loan and sell the capital at a salvage value  $m$ . Thus we merge the two states  $x$  and  $l$  in a single state where banks liquidate the project early and pay zero interest on saving deposits.

Bank's zero expected profit condition thus changes to:

$$E\pi = \gamma\sigma_h(pR_g + (1-p)R_b) - (1-\sigma_h)m - \sigma_h(1-\gamma)C - F(1+r\sigma_h) \geq 0$$

where  $R_g$  and  $R_b$  are the payments stipulated by the banks in good and bad states,  $g$  and  $b$ . The expected profit of the bank reflects the following facts. First, the bank receives pay-off from the project only in the high state with no liquidity shock which explains the first term. Second, banks sell off the capital at the salvage value  $m$  and do not pay interest in states  $l$  and  $x$ , which explains the second term. Third, the liquidity shock  $C$  hits the bank with the probability  $\sigma_h(1-\gamma)$  that explains the third term. Finally, the last term captures the fact that banks pay interest with probability  $\sigma_h$ .

For the household, we assume that a stand-in household holds a fractional claim ( $\varkappa$ ) to the value of the stock ( $Q$ ) at date 1 and issues out  $(1-\varkappa)Q$  to others. In equilibrium only a single share is traded (which means  $\varkappa = 1$ ). The rest of the institutional arrangement is the same as in the earlier banking scenario.

Household's flow budget constraints are now:

$$c_1 + s + k + \varkappa Q = y + Q + F \quad (12)$$

$$c_{2g}^{nx} = s(1+r) + \varkappa f(k)\theta^g - R_g \quad (13)$$

$$c_{2b}^{nx} = s(1+r) + \varkappa f(k)\theta^b - R_b \quad (14)$$

$$c_2^x = c_l = s \quad (15)$$

The optimal control problem is:

$$\underset{\{F, R_g, R_b, k, s, \varkappa\}}{Max} \quad u(c_1) + \sigma_h \gamma [pv(c_{2g}^{nx}) + (1-p)v(c_{2b}^{nx}) + (1-\gamma\sigma_h)v(s)] \quad (16)$$

subject to (12) through (15).

It is straightforward to check now that derivative of the maximand (16) with respect to the debt instruments  $R_g$  and  $R_b$  yields the following first order conditions:

$$\frac{u'(c_1)}{1+r\sigma_h} = v'(c_{2g}^{nx}) = v(c_{2b}^{nx}) \quad (17)$$

which means that  $c_{2g}^{nx} = c_{2b}^{nx} = c_2^{nx}$  (say). Thus debt instruments can eliminate the idiosyncratic risks in a state of no liquidity shock.<sup>28</sup> However, full consumption insurance is not possible because  $c_{2g}^{nx} = c_{2b}^{nx} \neq c_2^x = c_l$ . In addition, a positive risk premium ( $RP$ ) arises that is given by the following expression:

$$RP = \frac{(1-\gamma\sigma_h)v'(s)}{\gamma\sigma_h v'(c_2^{nx})} > 0 \quad (18)$$

The failure of full consumption risk sharing and the emergence of a positive risk premium stands in sharp contrast with universal banking. In the latter case, the presence a secondary stock market mimics a complete market scenario and enables the household to strike full consumption insurance through the efficient operation of the equity market. On the other hand, in a stand alone banking system, the financial markets are fundamentally incomplete due to insufficient number of financial instruments. This makes full consumption insurance impossible.<sup>29</sup>

The issue still arises whether private citizens could be better off in a stand alone banking

<sup>28</sup>Note that unlike universal banking optimal  $R_g$  is not equal to  $R_b$ . Rather  $R_g - R_b = (\theta^g - \theta^b)f(k)$  to ensure consumption equalization between good and bad states.

<sup>29</sup>In a companion paper with borrower's moral hazard (Banerji and Basu, 2015), we arrive at a similar conclusion.

system as opposed to a universal banking environment where information friction is endemic. Table 6 makes an expected utility comparison of the stand alone banking system with the same as in the universal banking system with information friction for different values of probabilities,  $\sigma_h$  and  $\gamma$  around the baseline levels. The expected utility is uniformly higher in the latter banking arrangement. One needs to be careful about this kind of expected utility comparison because such a comparison is very model specific and it does not capture numerous features of both banking systems. Nevertheless, one can at best conclude that everything else equal, private welfare is higher in a scenario of universal banking where risk diversification opportunities exist even though conflict of interest between bankers and share holders is present as opposed to a stand alone banking regime where all these risk sharing opportunities are shut down by legislation.

Table 6: Expected utilities in universal and stand alone banking systems

$\gamma \rightarrow$ $\sigma_h \downarrow$	0.766	0.78	0.79
0.92	$EU^u = -0.42$ $EU^n = -2.49$	$EU^u = -0.42$ $EU^n = -2.14$	$EU^u = -0.41$ $EU^n = -1.96$
0.93	$EU^u = -0.40$ $EU^n = -2.26$	$EU^u = -0.40$ $EU^n = -1.99$	$EU^u = -0.39$ $EU^n = -1.84$
0.94	$EU^u = -0.38$ $EU^n = -2.09$	$EU^u = -0.38$ $EU^n = -1.87$	$EU^u = -0.38$ $EU^n = -1.75$
Note: $EU^u$ = Expected utility in the universal banking			
and $EU^n$ = Expected utility in the stand alone banking			

## IX. Conclusion

The universal banking system has been a subject of controversy especially in the wake of current financial crisis. The critics argue that such a system could inflict excessive risks on the financial system. In this paper, we evaluate the nature of such risks and the consequent impact on overall banking activities. We find that discounting of stocks, volatilities in consumption, pushing of loans and excessive savings could emerge if hidden information is pervasive and if particularly the probability of bad aggregate shock is high.

The major policy question still remains open whether Glass-Steagall banking should be brought back and ring fencing should be strengthened. The recommendation of the independent banking commission in the UK and the recent trends in the US banking system point to this

direction. While a full blown comparison of universal banking and a stand-alone banking systems is beyond the scope of this paper, one can argue on the basis of our model that a universal banking system could efficiently allocate risk and could replicate the first best optimum under an ideal scenario of no information friction. In the presence of information friction, the undesirable consequences have to be weighed against the inefficiency imposed by the artificial separation between commercial and investment banking in a Glass-Steagall banking regime. The universal banking could work well if the regulatory authorities are committed to enforce strict disclosure of regimes to eliminate the information frictions. This together with a small punitive tax on trading of stocks can reduce the lemon problem of the universal banking and can improve the efficiency of the banking sector although it could still entail some welfare loss due to a blanket tax in all banks' profits.

## Appendix

### A. Equilibrium Conditions

In equilibrium, three conditions hold:

1. Each bank stipulates an optimal contract laid out in proposition 1 with each household taking the average capital stock,  $K$  and average contingent payments  $\bar{d}$  as given.
2. Expectations are consistent which means  $k = K$ .
3. All markets clear which means:
  - In the contingent claims market at date 1, each bank's state contingent shares are given by  $\frac{\theta_g g(k) - d_g}{\theta_g g(k)}$  and  $\frac{\theta_b g(k) - d_b}{\theta_b g(k)}$  while household's shares are given by  $\frac{d_g}{\theta_g g(k)}$  and  $\frac{d_b}{\theta_b g(k)}$ .
  - In the secondary share market at date 1.5, the demand for shares equals the supply which means  $qN = z = C$ .
  - Goods markets clear at each date which mean
    - At date 1,  $c_1 + k = \tilde{y} - r\sigma_h NFI = y$
    - At date 2,

$$\sigma_h [p\theta_g + (1-p)\theta_b]g(k) + (1-\sigma_h)m - \sigma_h(1-\gamma)C(1+r) = Ec_2 \equiv$$

$$\sigma_h \gamma [pc_{2g}^{nx} + (1-p)c_{2b}^{nx}] + \sigma_h (1-\gamma) [pc_{2g}^x + (1-p)c_{2b}^x] + (1-\sigma_h)c_{2l} \quad (19)$$

The following remarks about market clearing conditions are in order: First the contingent claims  $d_i$  are not traded in a market. These are stipulated by optimal contracts and that is why there is no price attached to each such contingent claim. Second, the secondary shares are traded in a market that opens at date 1.5. The demand for such shares is  $z$  which is the amount a household agent apportions from her savings. The supply is the amount that banks issue consequent on a liquidity shock. We assume that given  $q$ , banks issue shares exactly worth the amount of the exogenous liquidity crunch  $C$ . This means that  $qN = z = C$

Third, about the date 1 goods market clearing conditions, the imbalance between saving ( $s$ ) and loan ( $f$ ) is financed by net foreign investment ( $NFI \equiv f - s$ ) at a fixed world interest rate ( $r$ ) after adjusting for the probability of aggregate high state ( $\sigma_h$ ). Although the payment from such net foreign investment comes at date 2, we net out the interest payment from date 1 endowment ( $\tilde{y}$ ) as a fixed transfer payment. This explains the presence of the term  $r\sigma_h NFI$  and why  $y = \tilde{y} - r\sigma_h NFI$ . Finally, the date 2 goods market clearing condition basically means that the right hand side term which is the consumption plus the foreign debt retirement aggregated across all individuals must balance the corresponding left hand side term which is the aggregate output net of the liquidity shock including the interest payment on it. Since this shock is exogenous, it appears like a tax on date 2 output. This explains the presence of the term  $\sigma_h(1-\gamma)C(1+r)$  on the left hand side of (19).<sup>30</sup>

## B. Proof of Proposition 1

Plugging consumption of individual agents in each contingency outlined above in the expected utility function, we get:

$$\begin{aligned} Max EU &= [u(y + f - s - k)] + \sigma_h \gamma [pv\{d_g + s(1+r)\} + (1-p)v\{d_b + s(1+r)\}] \\ &\quad + \sigma_h (1-\gamma) [pv\{d_g + (s-z)(1+r) + \frac{z}{q}\tilde{EX}\} + (1-p)v\{d_b + (s-z)(1+r) + \frac{z}{q}\tilde{EX}\}] \\ &\quad + (1-\sigma_h)v(s) \end{aligned}$$

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<sup>30</sup>It is easy to verify that the Walras law holds here so that if all but one market clears, then adding all the budget constraints would ensure that the remainder market must clear as well. To see this, one can plug the budget constraints (4) through (9) and the zero profit condition ((vi) in Proposition 1 into the date 2 aggregate demand for good ( $Ec_2$ ) and by using the secondary market equilibrium condition ( $q^n = C = Z$ ) in the resulting expression will verify that the market for goods at date 2 automatically clears.

subject to:

$$\pi^b = \sigma_h \gamma [p\{\theta_g g(k) - d_g\} + (1-p)\{\theta_b g(k) - d_b\}] + (1 - \sigma_h)m - f.(1 + r\sigma_h) = 0$$

First order conditions with respect to  $d_g, d_b, s, k$  and  $z$  respectively are :

$$d_g : \frac{\gamma u'(c_1)}{1 + r\sigma_h} = \gamma v'(c_{2g}^{nx}) + (1 - \gamma)v'(c_{2g}^x) \quad (\text{A1})$$

$$d_b : \frac{\gamma u'(c_1)}{1 + r\sigma_h} = \gamma v'(c_{2b}^{nx}) + (1 - \gamma)v'(c_{2b}^x) \quad (\text{A2})$$

$$s : \frac{u'(c_1)}{1 + r\sigma_h} = \gamma \sigma_h [pv'(c_{2g}^{nx}) + (1-p)v'(c_{2b}^{nx})] \\ + (1 - \gamma)\sigma_h [pv'(c_{2g}^x) + (1-p)v'(c_{2b}^x)](1+r) + (1 - \sigma_h)v'(c_{2l}) \quad (\text{A3})$$

$$k : u'(c_1)[\sigma_h \gamma \bar{\theta} g'(k) - (1+r)] = 0 \quad (\text{A4})$$

$$z : [pv'(c_{2g}^x) + (1-p)v'(c_{2b}^x)]\left(\frac{EX}{q} - (1+r)\right) \geq 0 \quad (\text{A5})$$

(i) We will show now that  $d_g = d_b = d$ .

Let us suppose that  $d_g > d_b$ . Let us make the adjustment such that  $d_g$  is reduced and  $d_b$  is increased so as to reduce the gap in such a way that the zero profit constraint is not affected, i.e.  $[pd_g + (1-p)d_b]$  is constant. Hence,  $[p(d_g - \Delta_1) + (1-p)(d_b + \Delta_2)]$  is a constant so that  $(1-p)\Delta_2 = p\Delta_1$ .

Now, evaluate the expected utility with small increments that satisfy the above equality.

$$\Delta EU = \sigma_h [\gamma \{-pv'(c_{2g}^{nx})\Delta_1 + (1-p)v'(c_{2b}^{nx})\Delta_2\} + (1-\gamma)\{-pv'(c_{2g}^x)\Delta_1 + (1-p)v'(c_{2b}^x)\Delta_2\}] \\ \Rightarrow$$

$$\Delta EU = \sigma_h [\gamma \{v'(c_{2b}^{nx}) - v'(c_{2g}^{nx})\} + (1-\gamma)\{v'(c_{2b}^x) - v'(c_{2g}^x)\}](1-p)\Delta_2 > 0 \quad (\text{A6})$$

Since,  $c_{2b}^{ns} < c_{2g}^{ns}$  it implies that  $v'(c_{2b}^{nx}) - v'(c_{2g}^{nx}) > 0$  (due to concave utility function) and since  $c_{2b}^x < c_{2g}^x$ ,  $v'(c_{2b}^x) - v'(c_{2g}^x) > 0$  and  $\Delta_2 > 0$  because  $d_b$  was increased.

Hence, adjustment can be made until  $v'(c_{2b}^{nx}) - v'(c_{2g}^{nx}) = 0$  and  $v'(c_{2b}^x) - v'(c_{2g}^x) = 0$ . Hence,  $c_{2b}^{nx} = c_{2g}^{nx}$  and  $c_{2b}^x = c_{2g}^x$  which implies  $d_g = d_b$ .

One can start with the reverse inequality  $d_g < d_b$  and make the opposite adjustments to

reach this equality. This proves (i).

(ii) and (iii): From (A5), it follows that  $(\frac{E\tilde{X}}{q} - (1+r)) = 0$  and plugging the result in  $c_{2g}^x = d_g + (s-z)(1+r) + \frac{z}{q}E\tilde{X}$  and  $c_{2b}^x = d_b + (s-z)(1+r) + \frac{z}{q}E\tilde{X}$  and using the result from (i) that  $d_g = d_b = d$  yields  $c_{2g}^{nx} = c_{2b}^{nx} = c_{2g}^x = c_{2b}^x = c_2(say)$ . This proves (ii) and (iii).

(iv): The equation (A3) can be written as

$$\frac{u'(c_1)}{1+r\sigma_h} = \sigma_h[p\{\gamma v'(c_{2g}^{nx}) + (1-\gamma)v'(c_{2g}^x)\} + (1-p)\{\gamma v'(c_{2b}^{nx}) + (1-\gamma)v'(c_{2b}^x)\}](1+r) + (1-\sigma_h)v'(c_{2l})$$

Plugging (A1) and (A2),  $\frac{u'(c_1)}{1+r\sigma_h} = \sigma_h \frac{u'(c_1)(1+r)}{1+r\sigma_h} + (1-\sigma_h)v'(c_{2l})$  and by rearrangement, we get:

$$u'(c_1) = \left[ \frac{(1-\sigma_h)(1+r\sigma_h)}{1-\gamma\sigma_h + \gamma\sigma_h(1-\gamma)} \right] v'(s)$$

which proves (iv).

The part (v) follows from the straightforward differentiation with respect to  $k$  and the binding zero profit constraint of the intermediary together with (i) yields the last proposition. //

### C. Proof of Proposition 2

Using the same line of reasoning as in Proposition 1, one can establish that

$$v'(c_{2b}^{nx}) - v'(c_{2g}^{nx}) = 0 \tag{B1}$$

and

$$v'(c_{2b}^x) - v'(c_{2g}^x) = 0 \tag{B2}$$

On the other hand, the first order condition for  $z$  is:

$$v'(d_a + (s_a - z)(1+r) + \frac{z}{q_a}E\tilde{X}_a) \cdot \left\{ \frac{E\tilde{X}}{q_a} - (1+r) \right\} \sigma_h(1-r) = v'(s_a - z)(1-\sigma_h)$$

Since  $v'(\cdot) > 0 \Rightarrow \frac{E\tilde{X}_a}{q_a} - (1+r) > 0 \Rightarrow c_{2g}^x > c_{2b}^{nx}$ . Hence, (B1) and (B2) can hold if

$$c_{2g}^x = c_{2b}^x > c_{2g}^{nx} = c_{2b}^{nx} \tag{B3}$$

The part (ia) follows from the above result and the two first order conditions with respect

to  $\{d_g, d_b\}$

$$d_g : \frac{\gamma u'(c_1)}{1+\gamma\sigma_h} = \gamma v'(c_{2g}^{nx}) + (1-\gamma)v'(c_{2g}^x)$$

$$d_b : \frac{\gamma u'(c_1)}{1+\gamma\sigma_h} = \gamma v'(c_{2b}^{nx}) + (1-\gamma)v'(c_{2b}^x)$$

The part (iia) follows directly from the first order with respect for  $z$ , which is,

$$v'\{d_a + (s_a - z)(1+r) + \frac{z}{q_a} E\tilde{X}_a\} \left\{ \frac{E\tilde{X}_a}{q_a} - (1+r) \right\} \{\sigma_h(1-\gamma)\} = v'\{(s_a - z)\}(1-\sigma_h)$$

The part (iiia) follows from (B3) and (ia).

Finally, (iva) and (va) can be shown exactly using similar line of reasoning as in the earlier section. //

#### D. Proof of Proposition 3

All variables are evaluated at their full information values obtained in the proposition 1. This means that we start from a full information equilibrium with zero information friction. Thus at date 1, in the absence of information friction,  $c_1 = c_{1a}$ . Given the same  $r$ , it means that  $k = k_a$ . From the date 1 resource constraint (4), it follows that  $f - s = f_a - s_a$ .

Starting from this scenario of no information friction, with the onset of information friction,  $z$  and the risk premium terms turn positive from 0. Given  $c_1 = c_{1a}$ , from proposition 1(iv) and proposition 2(iva) it follows that  $v'(s) = v'(s_a - z)$  which means that  $s < s_a$ . Since  $f - s = f_a - s_a$ , the immediate implication is that  $f < f_a$ .

Next compare the expressions for  $f$  and  $f_a$  in proposition 1(vi) and proposition 2vi(a) evaluated at equilibrium  $qN = C$  and note that since  $f - f_a < 0$ , the following inequality holds

$$\gamma\sigma_h(d - d_a) + C(1 - \sigma_h) > 0$$

For a sufficiently small  $C$ , the above inequality means that  $d > d_a$  //

#### E. Proof of Proposition 4

Using the risk sharing results from proposition 2, the expected utility ( $EU_a$ ) in (10) can be written in a compact form as:

$$EU_a = u(y + f_a - s_a - k) + \sigma_h[\gamma v(c_{2a}^{nx}) + (1-\gamma)v(c_{2a}^x)] + (1-\sigma_h)v(c_{2a}^l)$$

Next note that the expected utility under full information (with full risk sharing) is given by:

$$EU = u(y + f - s - k) + \sigma_h v(c_2) + (1 - \sigma_h)v(c_2^l)$$

Since our baseline of comparison is full information equilibrium, by construction  $f - s = f_a - s_a$  and  $c_2^l = c_{2a}^l$  (see proposition 3).

The comparison of two expected utilities  $EU$  and  $EU_a$  thus hinges on the relative magnitudes of  $v(c_2)$  and  $[\gamma v(c_{2a}^{nx}) + (1 - \gamma)v(c_{2a}^x)]$ . Note from proposition 1(iii) that  $c_2 = s(1 + r) + d$ . On the other hand, recall from proposition 2(iia),  $c_2^{nx} = d_a + s_a(1 + r)$  and  $c_{2a}^x = d_a + s_a(1 + r) + \left\{ \frac{E\tilde{X}_a}{q} - (1 + r) \right\} \cdot c$ .

Since the comparison is made in the neighbourhood of a full information equilibrium, we set the interest rate  $r$  such that

$$c_2 = \gamma c_{2a}^{nx} + (1 - \gamma)c_{2a}^x$$

By strict concavity of the utility function (applying Jensen's inequality), it then follows that  $v(c_2) > \gamma v(c_{2a}^{nx}) + (1 - \gamma)v(c_{2a}^x)$ . This proves that  $EU > EU_a$ . //

## F. Methodology for Model Simulation

### Case of symmetric Information

With a log utility function and Cobb-Douglas production function  $g(k) = k^\alpha$  the equation system in Proposition 1 reduces to:

$$\gamma(d + s(1 + r)) = (1 + r\sigma_h)c_1 \text{ based on (i)} \quad (20)$$

$$s = \left[ \frac{(1 - \sigma_h)(1 + r\sigma_h)}{1 - \gamma\sigma_h + r\sigma_h(1 - \gamma)} \right] c_1 \text{ based on (iv)} \quad (21)$$

$$k = \left[ \frac{1 + r\sigma_h}{\gamma\sigma_h\theta\alpha} \right]^{\frac{1}{1-\alpha}} \text{ based on (v)} \quad (22)$$

$$f = \frac{\sigma_h \gamma (\bar{\theta} k^\alpha - d) + (1 - \sigma_h) m}{1 + r \sigma_h} \text{ based on (vi) after plugging } qN - C = 0 \quad (23)$$

Given the loan market clearing condition  $s = f$ , the first period resource constraint for the economy reduces to  $c_1 + k = y$  which after plugging into (21) and (22), one gets

$$\gamma(d + s(1 + r)) = (1 + r \sigma_h)(y - k) \quad (24)$$

$$s = \left[ \frac{(1 - \sigma_h)(1 + r \sigma_h)}{1 - \gamma \sigma_h + r \sigma_h(1 - \gamma)} \right] (y - k) \quad (25)$$

Eqs (22), (23), (24) and (25) solve for  $d, f, k, r$ . The security price  $q$  can be obtained by using the equation  $q = \frac{\bar{\theta} k^\alpha - d}{1 + r}$ .

### Case of Asymmetric Information

With the same log utility function and the Cobb-Douglas production function, the risk sharing condition (ia) in Proposition 2 (together with the loan market clearing condition,  $s_a = f_a$  and the share market clearing condition  $z = C$ ) reduces to

$$\frac{\gamma}{(y - k_a)(1 + r_a \sigma_h)} = \frac{\gamma}{d_a + s_a(1 + r_a)} + \frac{1 - \gamma}{d_a + s_a(1 + r_a) + RP \cdot C} \quad (26)$$

where  $RP$  stands for risk premium equal to  $\left\{ \frac{E\tilde{X}_a}{q_a} - (1 + r_a) \right\}$  and the subscript  $a$  stands for the interest in the asymmetric information scenario.

Next use the expression for risk premium in Proposition 2(ia) and solve the equilibrium  $RP$  (imposing the aggregate consistency condition  $k = K$ ) explicitly as follows:

$$RP = \lambda_1 \cdot \frac{(d_a + f_a(1 + r))}{f_a - C(1 + \lambda_1)} \quad (27)$$

where

$$\lambda_1 = \frac{1 - \sigma}{\sigma(1 - \gamma)}$$

After plugging the goods market clearing condition  $c_1 + k = y$  and the loan market and share market clearing conditions  $f_a = s_a$  and  $z = C$ , Proposition 2(iva) reduces to

$$(f_a - C) = \left[ \frac{(1 - \sigma_h)(1 + r_a \sigma_h)}{1 - \gamma \sigma_h + r_a \sigma_h(1 - \gamma)} \right] (y - k_a) \quad (28)$$

The investment equation is the same as before and can be written as:

$$k_a = \left[ \frac{1 + r_a \sigma_h}{\gamma \sigma_h \bar{\theta} \alpha} \right]^{\frac{1}{1-\alpha}} \quad (29)$$

Finally the zero profit condition reduces to

$$f_a = \frac{\sigma_h \gamma (\bar{\theta} g(k_a) - \bar{d}_a) + (1 - \sigma_h)(m + C)}{1 + r_a \sigma_h} \quad (30)$$

Eq (26) through (30) can be solved for five unknowns,  $f_a, d_a, r_a, k_a, RP$ . The resulting share price  $q_a$  is given by  $\frac{\bar{\theta} k_a^\alpha - d_a}{1 + r_a + RP} //$

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