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ABSTRACT

Fire Sales, Foreign Entry and Bank Liquidity*

Bank liquidity is a crucial determinant of the severity of banking crises. In this paper, we consider the effect of fire sales and foreign entry on banks' ex ante choice of liquid asset holdings, and the ex post resolution of crises. In a setting with limited pledgeability of risky cash flows and differential expertise between banks and outsiders in employing banking assets, the market for assets clears only at fire-sale prices following the onset of a crisis -- and outsiders may enter the market if prices fall sufficiently low. While fire sales make it attractive for banks to hold liquid assets, foreign entry reduces this incentive. We exhibit international evidence on foreign entry following crises and on banks' ex ante liquidity choice that are consistent with the predictions of the model. Our framework allows us to address the key welfare question as to when there is too much or too little liquidity on bank balance sheets relative to the socially optimal level.

JEL Classification: D61, E58, G21, G28 and G32
Keywords: crises, distress, limited pledgeability, liquidation cost and systemic risk

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1 Introduction

In the aftermath of a major financial crisis, one of the most pressing tasks for a country is to restructure its banking sector which emerges saddled with large non-performing claims against distressed borrowers - claims that are backed by collateral assets whose prices have fallen to a fraction of their levels before the crisis. After the fires have been put out, there follows a protracted period of banking sector resolution. The crises in Scandinavia (Sweden in particular) in 1992, Mexico in 1994-5, Thailand, Korea and Indonesia in 1997-8, and Turkey in 2001, are all instances that highlight the two-stage nature of financial crises, where the initial "acute" stage is followed by the longer-term "chronic" stage of bank restructuring.

The common theme that runs throughout both the academic research and the official pronouncements is the difficulty of finding ready buyers of distressed assets in the midst of a crisis. During times of distress, when a bank needs to restructure its balance sheet, the potential buyers of its assets are other banks that have also been severely affected by the crisis. Indeed, these potential buyers are also likely to be experiencing similar problems, and may not have enough equity capital or debt capacity to purchase these assets. This theme is a familiar one from corporate finance (see Williamson, 1988, and Shleifer and Vishny, 1992), but leads to especially acute problems in banking given the relative opacity of bank balance-sheets and the high sensitivity of banking assets to major macroeconomic shocks.

Allen and Gale (1998) has shown in the context of a banking model in the spirit of Diamond and Dybvig (1983) how "cash-in-the-market" (or fire-sale) pricing leads to distressed pricing in some states wherein asset prices fall below their fundamental value. Anticipation of such crises determines the ex ante portfolio choice of the banks. Allen and Gale's analysis is part of a recent body of work that has explored the propagation of crises through the asset side of banks' balance sheets, where marking to market in an environment of price falls transmits distress across banks. We will review this literature shortly.

Our paper builds on two important themes from this recent literature. The first is the ex post issue of the resolution of a banking crisis. Surviving banks in the crisis-stricken economy may not have the resources to take over failing banks' assets. Banking assets therefore fall in price so as to clear the market. However, if the crisis is severe enough, assets may end up in the hands of foreign buyers (both banks and non-banks). Often, such outside buyers are short-term holders who re-package or securitize the assets for selling on to portfolio investors. However, outsiders may be unable to realize the full value of the assets for the familiar reason that bank assets (loans in particular) derive much of their value from the monitoring and collection efforts of loan officers who can influence the actions of the debtors. Hence, when distressed assets end up in the hands of outsiders, we may expect deadweight costs from inefficient allocation of assets.

The second theme is the ex ante choice of portfolio in anticipation of such crisis events since surviving banks stand to make windfall profits if they can purchase distressed assets at low prices, as well as to take over the depositor base of a failed competitor bank. Even if crises arrive infrequently, the potential gains from acquisitions at fire sales could be large, and we would expect banks' choice of their portfolio to take account of such states. The most important ingredient in banks' portfolio choice is its holding of liquid assets, the objective being to hold enough liquid assets so that in the event that the bank survives the crisis, it will have resources to take advantage of the low purchase price of distressed assets.

Our objective in this paper is to follow up on both themes - the ex post resolution and the ex ante portfolio choice. Our approach is primarily theoretical but we also provide some empirical evidence. First, we examine in a formal model the implications of endogenous price effects, fire sales and foreign entry. We examine the portfolio choice of banks with the goal of ascertaining both the equilibrium level of liquid asset holdings of banks, and the socially optimal level of liquidity. We show that banks' equilibrium holding of liquid assets is decreasing in the pledgeability of risky cash flows and the health of the economy. The pledgeability of risky cash flows also turns out to be the critical determinant of whether banks hold too little liquidity relative to the socially optimal level. When pledgeability is high, banks hold less liquidity than is socially optimal due to risk-shifting incentives; otherwise, banks may hold even more liquidity than is socially optimal in order to capitalize on fire sales.

Second, we present some suggestive evidence in support of our theory based on the asset sales observed in the banking and financial institutions sector in Asian countries following the 1997 Asian financial crisis. In particular, we show that foreign banks are more active players during crises resolution than otherwise: they acquire more assets and also take on greater controlling stakes (greater than 50%). Consistent with our assumption that surviving banks of the banking sector are also liquidity-strapped during crises whereas foreign banks are not, we show that foreign banks acquire larger but weaker targets in the aftermath of crises compared to other years, whereas the pattern is reversed for acquisitions by domestic banks.

We also explore the theme of the relative expertise of domestic banks versus foreign banks in the banking business. We document the following "difference-of-difference" effect. When we compare the acquisitions across industry sectors (compared to within-industry acquisitions), foreign acquirers are involved with larger and better performing targets than are domestic acquirers. In other words, foreign acquirers are more heavily represented in *cross-sector* takeovers of *larger* banks. We believe this to be evidence of the lack of purchasing power of the natural purchasers of distressed assets - namely, the surviving domestic competitors to the failed firms.

Third, we present descriptive cross-country evidence on the asset liquidity of banks across countries. This evidence suggests that banks' choice of liquidity does seem to vary along dimensions that we would expect to be correlated with difficulty in raising external finance and severity of financial distress. We show that banks hold more liquid assets in those countries that have (i) less developed accounting standards; (ii) lower total market capitalization relative to GDP; and, (iii) lower liquidity in stock markets.

Finally, we discuss how our model's implications on management of liquidity by banks over the business cycle square up with existing evidence and the recently documented facts concerning leverage targeting by banks and its effects on amplification of the business cycle.

Section 2 presents the related literature. Sections 3 and 4 set up the benchmark model without outsiders and characterize the effect of fire sales on bank liquidity. Section 5 considers liquidity-endowed outsiders and the effect of their entry on bank liquidity. Section 6 provides descriptive empirical evidence on fire sales, foreign entry and liquid asset holdings of banks. Section 7 concludes. All proofs not in the main text are in the Appendix.

2 Related literature

Our paper is motivated in part by the policy-related literature on bank restructuring and financial crises. The official documents from the IMF (2003) and the Basel Committee on Banking Supervision (2002) arose from an extensive consultation process among the leading industrialized countries following the series of financial crises in the late 1990s. The prefaces to these official documents make it clear that the two reports were coordinated attempts to provide advice on "best practice" on bank resolution, distilling insights from the experience gained from tackling banking crises in the 1980s and 1990s. The literature on banking sector resolution is vast, but shares the key themes examined in our paper (see Acharya and Yorulmazer, 2005, for a summary).

More broadly, our paper has links to the recent literature on the role of foreign direct investment (FDI) flows in the aftermath of financial crises. Aguiar and Gopinath (2004) have recently documented evidence that the high FDI flows into the crisis-stricken countries of the 1997 Asian financial crisis had many of the features of fire-sales: median offer price to book ratios were substantially lower for the purchase of cash-strapped firms, especially in 1998 when national players had low liquidity, resulting in a boost in mergers and acquisitions involving foreign players. Their paper provides a systematic empirical counterpart to the hypothesis raised by Krugman (1998) that the investment flows into Asia following the crisis in 1997 and Mexico following the crisis in 1995 were suggestive of foreign firms taking advantage of low prices of real assets.[1] Although we do not address explicitly the role of "foreign" outsiders in what follows, our model has important implications for their role following a widespread financial crisis. In particular, the welfare implications of our model on the issue of domestic outsider involvement in the resolution of banking problems are closely related to the issue of foreign entry, as we will detail below.

From a more narrow modeling perspective, the relationship between liquidity and asset prices has been used in the literature to examine a number of interesting issues such as financial market runs (Bernardo and Welch, 2004, and Morris and Shin, 2004), strategic lending and trading (Donaldson, 1992 and Brunnermeier and Pedersen, 2005), contagion through asset prices (Diamond and Rajan, 2001, Gorton and Huang, 2004, Schnabel and Shin, 2004, Allen and Gale, 2005, and Cifuentes, Ferrucci and Shin, 2005), and optimal failure resolution (Acharya and Yorulmazer, 2007, 2005). While liquidity can affect asset prices, most of the literature cited above treats the level of liquidity (of banks) as exogenous.

In this paper, we concentrate on the effect of liquidity on (endogenously derived) fire sales during systemic crises, and, in turn, their effect on equilibrium liquidity. On this score, our paper is more in the spirit of recent papers by Allen and Gale (2004) and Gorton and Huang (2004) who investigate how liquidity is endogenously determined. Allen and Gale (2004), for example, build a model where bank runs result in fire-sale liquidation of banking assets. Investors endogenously choose the level of the liquid asset, which they use to purchase banking assets. Since on average the liquid asset has a lower return than the risky asset, investors have to be compensated for holding liquid assets, which can only be possible if they can purchase the risky asset at a discount leading to cash-in-the-market pricing of the risky asset.

Our model highlights the limited pledgeability arising from moral hazard (in the manner of Holmstrom and Tirole (1998)) as an important determinant in precluding the ready inflow of capital to a crisis-stricken banking sector. In this sense, we address the key question of why the high shadow value of capital may co-exist with ready funds outside the system seeking investment opportunities. A similar theme is explored in an asset pricing context by Krishnamurthy and He (2006). Equipped with our richer framework, we can then address the key welfare issues connected with foreign entry and resolution, and the welfare issues consequences of liquidity choice at the ex ante stage.

Since liquid assets usually have lower returns than illiquid assets, banks may rationally choose to rely on an interbank market or a lender of last resort (LOLR). Bhattacharya and

[1] Krugman's article provides interesting headlines from newspapers that talk about foreign entry due to fire-sale prices in crisis-stricken countries: "Korean companies are looking ripe to foreign buyers" (New York Times, Dec 27), "Some U.S. companies see fire sale in South Korea"(Los Angeles Times, Jan 25), "Some companies jump into Asia's fire sale with both feet" (Chicago Tribune, Jan 18), "While some count their losses in Asia, Coca-Cola's chairman sees opportunity" (Wall Street Journal, Feb 6). In news related to the banking sector, Seoul Bank and Korea First Bank were under consideration for auction to foreign bidders.

Gale (1987) build a model of the interbank market where individual banks that are subject to liquidity shocks coinsure each other against these shocks through a borrowing-lending mechanism. However, in this model, the composition of liquid and illiquid assets in each bank's portfolio and the liquidity shocks are private information. Hence, banks have an incentive to under-invest in liquid assets and free-ride on the common pool of liquidity in the interbank market. Repullo (2005) shows that the existence of LOLR results in banks holding a lower level of the liquid asset as they rely on the LOLR for liquidity.[2] While we do not consider inter-bank lending in this paper, we discuss in Section 7 extensions of our model and the implications of regulatory closure policies on bank liquidity.

3 Benchmark model

Before presenting the formal model, we first give an informal description of the building blocks, and the key assumptions. We consider a setting with a large number of banks. Banks solve a portfolio choice problem as to how much to invest in risky assets, which are assumed to have diminishing returns to scale, and how much to park in the safe asset as liquid reserves. This portfolio choice problem acquires an inter-temporal dimension given the limited pledgeability of risky cash flows and the benefit from holding liquidity in states where banks can profit from asset purchases. Specifically, while banks have a preference for the risky asset due to its "option" value in the traditional risk-shifting sense, there is a counteracting preference for the safe asset due to its greater liquidity relative to the risky asset. Banks' choice of liquidity trades off the expected returns from the two kinds of assets (adjusted for option value) taking account of this need for inter-temporal transfers of liquidity. The socially optimal level of liquid asset holdings in banks' portfolio maximizes the value of banks as a whole (that is, without any risk-shifting problem). Throughout our analysis, we assume that deposits are insured by the regulator. To start with, there is no cost of providing insurance to depositors, in which case the assumption of insured deposits does not play a key role in determination of liquidity choices of banks. We introduce outsiders in Section 5 and discuss in Section 7 the implications of costly deposit insurance.

The time line of the formal model is outlined in Figure 1. We consider an economy where time is indexed by t, and where $t \in \left\{0, \frac{1}{2}, 1, 2\right\}$. In our model, there are banks, bank owners, depositors and a regulator, who serves to allocate resources in an efficient manner following a crisis.

[2] Gonzalez-Eiras (2003), using Argentine data, tests this argument. He investigates the episode in December 1996 when the Central Bank of Argentina signed an agreement to have access to contingent credit lines with a group of international banks that enhanced its ability to act as a LOLR. He shows that banks have relied on the enhanced ability of the Central Bank of Argentina for liquidity and this has resulted in an approximately 6.7 % reduction in banks' liquid asset holdings.

In particular, we assume that there is a continuum of banks with measure 1, where each bank has access to its own depositor base. The depositor base of a bank is itself a continuum of depositors of measure 1. Bank owners as well as depositors are risk-neutral, so that banks aim to maximize the sum of expected profit over time.

Depositors receive a unit endowment at $t = 0$ and at $t = 1$. Depositors have access to a reservation investment opportunity that gives them a utility of 1 per unit of investment. At dates $t = 0$ and $t = 1$, depositors choose to invest their good in this reservation opportunity or in their bank. Deposits take the form of a simple debt contract with maturity of one period and the promised deposit rate is not contingent on bank's investment decisions or its realized returns.

Banks collect one unit of deposits from depositors and make investments to maximize the sum of expected profits at $t = 1$ and $t = 2$. There is no discounting. In particular, banks choose a portfolio by investing l units in a safe asset and the remaining $(1-l)$ units in a risky asset, which is to be thought of as a portfolio of loans to firms in the corporate sector.

The payoff of the bank from its loan is $\widetilde{R}_t$, where $\widetilde{R}_t$ is the random variable:

$$\widetilde{R}_t = \begin{cases} R_t & \text{with prob } \alpha_t \\ 0 & \text{with prob } 1-\alpha_t \end{cases} . \tag{1}$$

R_t can be viewed as the notional value of the loan. The realization of $\widetilde{R}_t$ is independent across banks, so that by the law of large numbers, precisely α_t of the banks have positive payoff. Moreover, the returns are independent over time.

However, there is aggregate uncertainty in that α_t is itself random. Hence, there is uncertainty over the proportion of banks that receive positive payoff. In what follows, we will denote by $E(\alpha_t)$ the expected realization of α_t.

We assume that the risky technology $\widetilde{R}_0$ has diminishing returns to scale, that is, the return R_0 is decreasing in $(1-l)$. In order to get a closed form solution, we use a setup similar to Holmstrom and Tirole (2001) and let

$$R_0(l) = \left[b - \frac{(1-l)}{2}\right] \tag{2}$$

Hence, R_0 takes values between $b - \frac{1}{2}$ and b, and $\frac{dR_0}{dl} = \frac{1}{2} > 0$. For simplicity we assume that $\widetilde{R}_1$ is a constant returns to scale technology with $R_1 > 1$. This helps us concentrate on the effect of choice of liquid asset only in the first period and simplifies the analysis without affecting our results.

At the intermediate date $t = \frac{1}{2}$, the outcome of the first-period investments in the risky asset becomes public information, though banks can collect these returns fully only at $t = 1$.

The safe asset is completely liquid and pays one unit at any date for each unit invested. The risky asset is however not completely liquid due to a moral-hazard problem at the bank level. From date $t = 1/2$ to date $t = 1$, if the bank does not exert effort, then when the return is high, it cannot generate R_t but only $R_t - \overline{\Delta}$ and its owners enjoy a non-pecuniary benefit of $B \in (0, \overline{\Delta})$. For the bank owners to exert effort, appropriate incentives have to be provided by giving bank owners a minimum share of the bank's profits. We denote this share as θ. If r_t is the cost of borrowing deposits, then the incentive-compatibility constraint is:

$$\alpha_t \theta (R_t - r_t) \geqslant \alpha_t \left[\theta ((R_t - \overline{\Delta}) - r_t) + B \right] \tag{IC}$$

Using this constraint, we can show that bank owners need a minimum share of $\overline{\theta} = B/\overline{\Delta}$ to monitor these loans properly.[3] Therefore, the bank can raise at most a fraction $\tau = \left(1 - \overline{\theta}\right)$ of its future income in the capital market if it is required to exert effort to monitor loans.[4] We assume that at $t = 0$, the entire share of the bank profits belongs to the bank owners, and therefore, moral hazard is not a concern at the beginning.

We assume that deposits are fully insured in the first period. Note that the second period is the last period in our model and there is no further investment opportunity. As a result, our analysis is not affected by whether deposits are insured for the second investment or not.

Finally, we make technical assumptions (A1)–(A4) which are contained in the Appendix. We refer to these at a few relevant points of our analysis.

If a bank's return from the first-period investment is high, then the bank operates one more period and makes the second-period investment. For a bank to continue operating for another period, it needs to pay its old depositors r_0. But, by our assumption (A2), a failed bank can not generate the necessary funds to avoid default. Thus, if the return is low, then the bank is in default and the deposit insurance provider puts up the bank for sale at $t = \frac{1}{2}$.

When banks with the high return from the first period investment want to acquire failed banks' assets, they use the liquid asset in their portfolio and/or try to raise funds from the capital market against their future return. However, because of moral hazard, banks cannot fully pledge their future income, but only a fraction τ of it.

Depending on the first period returns, a proportion k of banks fail. Since banks are

[3] See Hart and Moore (1994) and Holmstrom and Tirole (1998) for models with similar incentive-compatibility constraints.

[4] Bank-level moral hazard in our model can be addressed by greater ownership of banks by insiders. Caprio et al (2005) document that banks in general are not widely held (a widely-held bank is one that has no legal entity owning 10 percent or more of the voting rights), similar to the findings of La Porta et al (1999) for corporations in general. This observation is stronger for countries with weaker shareholder protection laws. They also find that greater inside ownership enhances bank valuation in such countries. Overall, these findings are consistent with the key assumptions of our model since weaker protection laws should imply a greater risk of cash-flow appropriation by insiders, and, in turn, lead to greater inside ownership of banks in equilibrium.

identical at $t = 0$, we denote the possible states at $t = 1$ with k.

4 Analysis

We analyze the model proceeding backwards from the second period to the first period.

The surviving banks operate for another period at $t = 1$. The probability of having the high return for each bank is equal to α_1 for all banks. As this is the last period, there is no further investment opportunity and no asset sales take place in this period. Since the risky asset has a higher expected return than the safe asset and there is no asset purchase opportunity, banks invest all their funds in the risky asset at $t = 1$. The expected payoff to the bank from its second-period investment is thus $\alpha_1[R_1 - r_1] = \overline{p}$.

Next, we investigate the sale of failed banks' assets and the resulting asset prices.

4.1 Asset sales and liquidation values

In examining the purchase of failed banks' assets, several interesting issues arise. First, surviving banks may compete with each other if there are enough resources with them to acquire all failed banks' assets. Second, unless the game for asset acquisition is specified with reasonable restrictions, an abundance of equilibria arises. To keep the analysis tractable and at the same time reasonable, we make the following assumptions:

(i) The regulator pools all failed banks' assets and auctions these assets to the surviving banks.

(ii) Denoting the surviving banks as $i \in [0, (1-k]$, each surviving bank submits a schedule $y_i(p)$ for the amount of assets they are willing to purchase as a function of the price p at which a unit of the banking asset (inclusive of associated deposits) is being auctioned.

(iii) The regulator cannot price-discriminate in the auction.

(iv) The regulator determines the auction price p so as to maximize the output of the banking sector, but subject to the natural constraint that portions allocated to surviving banks add up at most to the number of failed banks, that is,

$$\int_0^{1-k} y_i(p)di \leq k. \tag{3}$$

(v) We focus on the symmetric outcome where all surviving banks submit the same schedule, that is, $y_i(p) = y(p)$ for all $i \in [0, 1]$.

First, we derive the demand schedule for surviving banks. Note that a surviving bank can generate a maximum return of $\overline{p}$ from the risky asset in the second period. Hence, the maximum price a surviving bank is willing to pay for a failed bank's asset is $\overline{p}$. Also, a surviving bank can generate $\tau\left[((1-l)R_0 - r_0) + \overline{p}\right]$ units from the capital market at $t = 1/2$.[5] Hence, the resources available with a surviving bank for purchasing failed banking assets is equal to

$$L = l + \tau\left[((1-l)R_0 - r_0) + \alpha_1\left(R_1 - r_1\right)\right], \tag{4}$$

when the return from the risky asset is enough to pay old depositors, that is, when $(1-l)R_0 \geqslant r_0$, which holds when $l \leqslant l_{max} = \left[\sqrt{b^2-2} + (1-b)\right]$ for $R_0 = \left(b - \frac{1-l}{2}\right)$. It can be shown that under assumptions (A1) and (A2), banks never hold a level of liquidity l greater than l_{max} in equilibrium (see Appendix), so that this condition is always satisfied.

Note that the expected profits of a surviving bank from the asset purchase can be calculated as: $y(p)[\overline{p} - p]$. The surviving bank wishes to maximize these profits subject to the resource constraint $y(p) \cdot p \leq L$. Hence, for $p < \overline{p}$, surviving banks are willing to purchase the maximum amount of failed banks' assets using their resources. Thus, demand schedule for surviving banks is $y(p) = \frac{L}{p}$. For $p > \overline{p}$, the demand is $y(p) = 0$, and for $p = \overline{p}$, $y(p)$ is indeterminate. In words, as long as purchasing bank assets is profitable, a surviving bank wishes to use up all its resources to purchase failed banks' assets.

Next, we analyze how the regulator allocates the failed banks' assets and the resulting price function. The regulator cannot set $p > \overline{p}$ since in this case $y(p) = y_2(p) = 0$. If $p \leqslant \overline{p}$, and the proportion of failed banks is sufficiently small, then the surviving banks have enough funds to pay the full price for all the failed banks' assets. Specifically, for $k \leq \underline{k}$, where

$$\underline{k} = \left(\frac{L}{L + \overline{p}}\right), \tag{5}$$

the regulator sets the auction price at $p^*(k) = \overline{p}$. At this price, surviving banks are indifferent between any quantity of assets purchased. Hence, the regulator allocates a share $y(p^*) = \frac{k}{1-k}$ to each surviving bank.

For values of $k > \underline{k}$, surviving banks cannot pay the full price for all failed banks' assets and the regulator sets the price at

$$p^*(k) = \frac{(1-k)L}{k} \tag{6}$$

Note that, in this region, surviving banks use all available funds and the price falls as the number of failures increase. This effect is basically the cash-in-the-market pricing as in Allen

[5] We assume that banks can generate funds only against the future profits from their own investments but not against the future profits from the assets they plan to purchase. For the case where this assumption is relaxed without disturbing the key results on fire sales, see the unabridged version of Acharya and Yorulmazer (2005).

and Gale (1994, 1998) and is also akin to the industry-equilibrium hypothesis of Shleifer and Vishny (1992). The resulting price function is formally stated in the following proposition and is illustrated in Figure 2.

Proposition 1 *The price of failed banks' assets as a function of the proportion of failed banks is as follows:*

$$p^*(k) = \begin{cases} \overline{p} & \text{for} \quad k \leqslant \underline{k} \\ \frac{(1-k)L}{k} & \text{for} \quad k > \underline{k} \end{cases} . \tag{7}$$

From equation (5), one can easily see that as banks hold less of the liquid asset, $\underline{k}$ decreases, that is, the region over which the price is equal to the fundamental price $\overline{p}$ shrinks.[6] In turn, from Proposition 1 and Figure 2, one can easily see that for all values of k, when banks hold less of the liquid asset, prices deviate more from the fundamental price, that is, $[\overline{p} - p^*(k)]$ (weakly) increases. This gives us the following Corollary.

Corollary 1 *For all k, as aggregate liquidity l decreases, prices deviate more from the fundamental price $\overline{p}$, that is, $[\overline{p} - p^*(k)]$ (weakly) increases.*

4.2 Banks' choice of liquidity

Consider a representative bank at the ex ante stage. Formally, the objective of each bank is to choose a portfolio of the safe and the risky asset, namely $(l, 1-l)$, at date 0 that maximizes the sum of expected profits at $t = 1$ and $t = 2$, the expected profits from their own investments, from the asset purchases when they survive and losses from the opportunity cost of holding liquid assets in their portfolio.

Using the prices derived in Proposition 1, we can calculate profits for surviving banks from asset purchases. When only a small proportion of banks fail, $k \leq \underline{k}$, surviving banks pay the full price for the acquired assets and do not capture any surplus from the asset purchase. In these cases, from an ex-post stand point, banks carry excess liquidity in their portfolio and incur losses from forgone investment in the risky asset.

When the proportion of failed banks is higher, $k > \underline{k}$, each surviving bank captures a surplus from asset purchase that equals

$$y(p^*) \cdot [\overline{p} - p^*] = \frac{k\overline{p}}{(1-k)} - L. \tag{8}$$

[6] This follows from the technical assumption (A2) in the Appendix, which guarantees that the liquidity banks have for asset purchases increases as they hold more liquid asset in their portfolio, that is, $\frac{\partial L}{\partial l} > 0$.

In all cases, bank owners of failed banks have no continuation payoffs.

Given this analysis, we can formalize each bank's portfolio choice that gives rise to a competitive equilibrium as follows. Bank i's problem is to choose l_i that maximizes

$$E(\pi(l_i)) = E\left(\alpha_0 \quad \left[[(l_i + (1-l_i)R_0(l_i)) - r_0] + L\left(\frac{[\overline{p} - p^*(k)]}{p^*(k)}\right) + \overline{p}\right]\right), \tag{9}$$

where $p^*(k)$ is the market clearing price given in Proposition 1. Recall that the return for each bank is independent so that, by law of large numbers, α_0 is also the proportion of banks that have the high return. Hence, we have $k = (1 - \alpha_0)$.

The first order condition (FOC) for the maximization problem is given as:

$$E\left[\alpha_0 \quad \left(\left[1 - R_0 + (1-l_i)\frac{dR_0}{dl}\right] + \left[1 - \tau R_0 + \tau(1-l)\frac{dR_0}{dl}\right]\left[\frac{[\overline{p} - p^*(k)]}{p^*(k)}\right]\right)\right] = 0 \tag{10}$$

We define

$$\phi = \alpha_0 \left[\frac{\overline{p} - p^*(k)}{p^*(k)}\right], \tag{11}$$

as the expected benefit from asset purchase per unit of liquidity. See Figure 3 for an illustration of ϕ as a function of k. Note that ϕ is independent of l when viewed from a price-taking bank's perspective, but in equilibrium, $p^*(k)$ depends on the aggregate liquidity in state k. Hence, banks' equilibrium choice of liquid asset holdings is given by a fixed point that is formally stated below and is illustrated in Figure 4.

Proposition 2 *Banks' choice of liquidity $\widehat{l}$ that satisfies the FOC in (10) is given by*

$$\widehat{l} = \min\left\{1, \max\left\{0, 1 - b + \frac{E(\alpha_0) + E(\phi)}{E(\alpha_0) + \tau E(\phi)}\right\}\right\}. \tag{12}$$

The unique aggregate level of liquidity l^* is the fixed-point of

$$\widehat{l}(E(\alpha_0), \tau, E(\phi(\alpha_0, \tau, l^*))) = l^*. \tag{13}$$

Note that $\widehat{l}$ is a (weakly) declining function of aggregate liquidity l. The intuition for this is that if aggregate liquidity is low, then the deviation of prices from the fundamental value is high, creating a motive to hold liquidity to acquire failed banks at lower prices. Conversely, if aggregate liquidity is high, then the expected gain from asset purchases is low and the incentives of a bank to carry liquid buffers is low as well.

Several aspects of the banks' private choice of liquidity l^* deserve mention and will play an important role in comparison to the socially optimal choice of liquidity. First, under assumption A1 (that $b > 2$), banks never have an incentive to hold liquidity if pledgeability of future cash flows (τ) is sufficiently high. Specifically, if $\tau = 1$, then $l^* = 0$, the portfolio choice that trades off simply the expected returns to the bank owners from the risky asset and the safe asset. In particular, in this case both assets are fully liquid so that portfolio choice is not affected by inter-temporal liquidity considerations.

Note that the strategic benefit of holding liquid assets for an individual bank, given by ϕ, depends on the liquidity in the whole market, since the market liquidity l^* affects the price $p^*(k)$. The endogenous determination of prices, and, in turn, of the strategic benefit to banks from acquiring other banks, is an important distinguishing feature of our model.

Second, if the pledgeability of future cash flows is sufficiently low ($\tau < 1$), then liquidity cannot be generated against full expected value of uncertain cash flows. As a result, there is an inter-temporal motive to hold liquidity: Specifically, liquid holdings exceed those from the portfolio choice problem as liquid assets dominate risky assets in states where there is a strategic benefit from acquiring failed banks at cash-in-the-market prices ($k > \underline{k}$).

4.3 Comparative statics

In this section, we analyze how banks' choice of liquidity is affected by model parameters. Since $R_0 = b - \left(\frac{1-l}{2}\right)$, as b increases, the return from the risky asset increases. This also increases the liquidity banks can generate against their profits in the first period. Hence, as b increases, the liquid asset becomes less attractive and banks choose a lower level of the liquid asset l^*. This relation is apparent from equation (12).

Next, we investigate the effects of the development of capital markets and the business cycle on banks' choice of liquidity, which form the primary testable implications of our model. In developed economies, we would expect highly developed capital markets where banks can generate funds easily against future profits. Hence, one can interpret τ in our model as a metaphor for the level of development in capital markets. Also, we know that the cost of issuing capital rises during economic downturns. Thus, in line with this empirical evidence, we can say that during economic downturns, the pledgeability of future returns, τ, decreases. We show below that for low values of τ, that is for less-developed economies and during economic downturns, banks hoard more liquidity since they cannot have easy or cheap access to capital markets for raising funds.

Also, during boom periods it is more likely that risky investments will pay off well. To this end, we consider two different probability distributions, f and g, to represent recessions and boom periods, respectively, by assuming that g first order stochastically dominates (FOSD) f. We show that in equilibrium, banks invest less in the liquid asset during boom periods. Combining these two results, we get the following formal Proposition.

Proposition 3 *Banks' choice of liquidity l^* has the following features:*

(i) As the pledgeability of future returns, τ, increases, privately optimal levels of liquidity decrease.

(ii) Let f and g be two probability distributions for α_0, where g FOSD f. Let l_f^* and l_g^* be the liquid asset holdings of banks under probability distributions f and g, respectively. We have $l_f^* > l_g^*$.

Note that from expression (11), ϕ is (weakly) decreasing in α_0 (see Figure 3). Increased probability of the high return has two effects on banks' choice of liquidity that work in the same direction. First, the expected return from the risky asset increases, which makes the risky asset more attractive. Also, the proportion of failed banks decreases, which limits the opportunity for making profits from asset purchases at cash-in-the-market prices. This, in turn, makes the liquid asset less attractive. Similarly, as τ increases, banks can generate more funds from the capital market. Hence, banks do not have to heavily rely on their liquid asset holdings which yield lower return than risky assets.

We can combine these two effects by modeling the business cycle in a simple way by assuming that if g FOSD f then $\tau_g > \tau_f$. This assumption amplifies the effect of the business cycle on banks' choice of liquidity. Also, from Corollary 1, we know that as liquidity decreases, we observe bigger deviations in the price of banking assets from its fundamental value of $\overline{p}$. Hence, crises preceded by boom periods result in lower asset prices and higher price volatility, giving us the following result.

Corollary 2 *During economic upturns, banks' choice of liquidity l^* decreases. This, in turn, results in bigger deviations in the price of banking assets from their fundamental value of $\overline{p}$, that is, $[\overline{p} - p^*(k)]$ increases.*

4.4 Socially optimal liquidity

In the following analysis, we derive the liquidity level of banks l^{**} that maximizes the expected total output generated by the banking sector, given as:

$$E(\Pi) = E\left[l + \alpha_0(1-l)R_0(l)\right] + \alpha_1 R_1. \tag{14}$$

The first-order condition for the socially optimal level of l is thus given as:

$$1 - E\left(\alpha_0\right)\left[R_0(l) - (1-l)\frac{dR_0}{dl}\right] = 0, \tag{15}$$

which gives us the following Proposition.

Proposition 4 *The socially optimal level of liquidity l^{**} satisfying the FOC in (15) is given as:*

$$l^{**} = \min\left\{1, \max\left\{0, 1 - b + \frac{1}{E(\alpha_0)}\right\}\right\}. \tag{16}$$

Furthermore, we have $l_f^{**} > l_g^{**}$, when g FOSD f.

Note that the socially optimal level of liquidity is determined by only the portfolio choice. In contrast to the private choice of banks, asset sales do not play a role. When b increases, the return from the risky asset increases and the socially optimal level of liquidity l^{**} decreases, which can be seen from equation (16). Furthermore, l^{**} is independent of τ. Note that under Assumption A1, privately optimal liquidity l^* is zero when τ equals one. But l^{**} may be positive. This is because while the private portfolio choice suffers from the risk-shifting problem, this is not the case for the social portfolio choice. Finally, socially optimal liquidity is higher during recessions (low $E(\alpha_0)$) as was the case with privately optimal bank liquidity.

4.5 Comparing socially and privately optimal levels of liquidity

In this section, we compare the privately and socially optimal levels of liquidity. We show that a crucial determinant of the relationship between privately and socially optimal levels of liquidity is the extent of pledgeability of risky cash flows: When pledgeability is high, banks hold less liquidity than is socially optimal due to risk-shifting incentives, whereas when pledgeability is sufficiently low, (somewhat counter-intuitively) banks may hold even more liquidity than is socially optimal. The intuition for this latter result in the context of our model is that banks stand to gain from acquiring failed banks in some states where there is no misallocation cost but only transfers within the banking system.

Similarly, we also show that the privately optimal level of liquidity is inefficiently low during economic downturns (even though in terms of absolute magnitude it is higher in downturns than in boom times). The result is stated in the following Proposition and is illustrated in Figure 5.

Proposition 5 *Comparing the privately and socially optimal liquidity levels, we obtain that:*

(i) There exist critical values $\tau^*(E(\alpha_0))$, such that, the privately optimal level of liquidity is higher than the socially optimal level if and only if $\tau < \tau^*(E(\alpha_0))$.

(ii) There exists a critical value $\alpha_0^*(\tau)$, such that, the privately optimal level of liquidity is higher than the socially optimal level if and only if $E(\alpha_0) > \alpha_0^*(\tau)$.

Furthermore, $\tau^*(E(\alpha_0)) < E(\alpha_0)$ and conversely $\alpha_0^*(\tau) > \tau$.

5 Entry and inefficient liquidations

In the benchmark model, only banks were present in the market for banking assets. Hence, the sale of banking assets did not result in any misallocation of banking assets. In this section, we analyze the effect of entry by outsiders.

We introduce outside investors (say, foreign banks) who are risk-neutral and competitive and have funds w to purchase banking assets were these assets to be liquidated. These are investors outside the banking sector so that although they have funds for asset purchases, they do not have the skills to generate the full value from banking assets. In particular, outsiders are inefficient users of banking assets relative to the bank owners, provided that bank owners exert effort. Often such outsiders are short-term holders who re-package or securitize the assets for selling on to portfolio investors. However, outsiders may be unable to realize the full value of the assets for the familiar reason that bank assets (loans in particular) derive much of their value from the monitoring and collection efforts of loan officers who can influence the actions of the debtors. Hence, when distressed assets end up in the hands of outsiders, we may expect deadweight costs from inefficient allocation of assets. To capture this formally, we assume that outsiders cannot generate R_t in the high state but only $(R_t - \Delta)$.[7] We also assume that $\overline{\Delta} > \Delta$ so that outsiders can generate more than what the banks can generate from bad projects.

We examine the sale of failed banks and the resulting prices in the presence of outsiders. The demand schedule for surviving banks does not change and we can derive the demand schedule for outsiders in a similar way. Let $\underline{p} = [\alpha_1 ((R_1 - \Delta) - r_1)] = [\overline{p} - \alpha_1 \Delta]$, be the expected profit for the outsiders from the risky asset in the second period. For $p < \underline{p}$, outsiders are willing to supply all their funds for the asset purchase. Thus, demand schedule is $y_2(p) = k$. For $p > \underline{p}$, the demand is $y_2(p) = 0$, and for $p = \underline{p}$, $y_2(p)$ is indeterminate. Thus, for $p > \underline{p}$, there is limited participation in the market for banking assets.

Next, we analyze how the regulator optimally allocates the failed banks' assets and the price function that results. We know that in the absence of financial constraints, the efficient outcome is to sell all assets to surviving banks. However, surviving banks may not be able to

[7] The notion that outsiders may not be able to use the banking assets as efficiently as the existing bank owners is akin to the notion of *asset-specificity*, first introduced in the corporate-finance literature by Williamson (1988) and Shleifer and Vishny (1992). There is strong empirical support for this idea in the corporate-finance literature, as shown, for example, by Pulvino (1998) for the airline industry, and by Acharya, Bharath, and Srinivasan (2004) for the entire universe of defaulted firms in the US over the period 1981 to 1999 (see also Berger, Ofek, and Swary, 1996, and Stromberg, 2000). In the evidence of such specificity for banks and financial institutions, James (1991) shows that the liquidation value of a bank is typically lower than its market value as an ongoing concern. In particular, his empirical analysis of the determinants of the losses from bank failures reveals a significant difference in the value of assets that are liquidated and similar assets that are assumed by acquiring banks.

pay the threshold price of $\underline{p}$ for all assets. If prices fall further, these assets become profitable for outsiders and they participate in the auction. Formally, as long as price is higher than $\underline{p}$, outsiders do not participate in the asset market. However, for $k > \overline{k}$, where

$$\overline{k} = \left(\frac{L}{L + \underline{p}}\right), \tag{17}$$

surviving banks cannot pay the threshold price of $\underline{p}$ for all assets. At this point, outsiders have a positive demand and are willing to supply all their funds for the asset purchase. For $w \geqslant \underline{p}$, with the injection outsider funds, the price is sustained at $\underline{p}$ for all $k > \overline{k}$. However, when $w < \underline{p}$, if the crisis is very severe (sufficiently large k), the total liquidity available within the surviving banks and outsiders may not be enough to sustain the price at $\underline{p}$. Thus, we may observe a second region where the price is downward sloping as a function of the proportion of failed banks k. In other words, there is cash-in-the-market pricing in this region given the limited liquidity of the *entire* set of market players bidding for assets. In particular, for $k > \overline{\overline{k}}$, where

$$\overline{\overline{k}} = \left(\frac{L + w}{L + \underline{p}}\right), \tag{18}$$

the price is again strictly decreasing in k and is given by

$$p_w^*(k) = \left(\frac{(1-k)\,L + w}{k}\right), \tag{19}$$

and $y(p_w^*) = \left(\frac{L}{p_w^*}\right)$ and $y_2(p_w^*) = \left(\frac{w}{p_w^*}\right)$. The resulting price function is illustrated in Figure 6 and is stated in the following proposition.

Proposition 6 *The price of assets as a function of the proportion k of failed banks and outsiders' wealth w is:*

$$p_w^*(k) = \begin{cases} \overline{p} & \textit{for} \quad k \leqslant \underline{k} \\ \frac{(1-k)L}{k} & \textit{for} \quad k \in (\underline{k}, \overline{k}] \\ \underline{p} & \textit{for} \quad w \geqslant \underline{p} \textit{ and } k > \overline{k}, \textit{ or } w < \underline{p} \textit{ and } k \in (\overline{k}, \overline{\overline{k}}] \\ \frac{[(1-k)L]+w}{k} & \textit{for} \quad w < \underline{p} \textit{ and } k > \overline{\overline{k}} \end{cases}. \tag{20}$$

Note that the introduction of outsiders (weakly) increases the price for failed banks. In particular, for $k > \overline{k}$, with the injection of outsiders funds, the price stays at $\underline{p}$, at least for a while, and the price is higher than the price without outsiders, that is, $p_w^*(k) > p^*(k)$, which are given in equations (20) and (7), respectively.

5.1 Banks' choice of liquidity

The introduction of outsiders (weakly) increases the price for failed banks and this, in turn, decreases the benefit from holding the liquid asset in terms of profits from asset purchases. In this case, bank i's problem can be stated in the same way as in the benchmark case (equation(9)), except for the fact that instead of ϕ, we have

$$\phi_w = \alpha_0 \left[\frac{\overline{p} - p_w^*(k)}{p_w^*(k)} \right], \tag{21}$$

as the expected benefit from asset purchase per unit of liquidity. Note that for $k \leqslant \overline{k}$, $\phi_w = \phi$, whereas for $k > \overline{k}$, we have $\phi_w < \phi$.[8] Since $E(\phi_w) < E(\phi)$, the unique aggregate level of liquidity l_w^* is lower than l^* given in Proposition 2. Furthermore, as outsider wealth w increases, the price p_w^* (weakly) increases for each k. This, in turn, decreases the private benefit ϕ_w and induces banks to hold less liquid asset: as w increases, l_w^* (weakly) decreases.

We observe a similar effect of $(\alpha_1\Delta)$ on banks' choice of liquidity. In particular, as the wedge between the expertise of banks and outsiders widens, that is, as $(\alpha_1\Delta)$ increases, the price for assets weakly decreases for all $k > \overline{k}$. Just like a decrease in outsider wealth w, this increases ϕ_w. As a result, banks hold more liquidity and l^* increases. We combine these results in the following Proposition.

Proposition 7 *Banks' choice of liquidity $\widehat{l}_w$ is given by*

$$\widehat{l}_w = \min\left\{0, \max\left\{0, 1 - b + \frac{E(\alpha_0) + E(\phi_w)}{E(\alpha_0) + \tau E(\phi_w)}\right\}\right\}, \tag{22}$$

where ϕ_w is given by (21). The unique aggregate level of liquidity l_w^* is the fixed-point of

$$\widehat{l}_w(E(\alpha_0), \tau, E(\phi(\alpha_0, \tau, l^*))) = l_w^*. \tag{23}$$

As w increases l_w^* decreases. Furthermore, as $(\alpha_1\Delta)$ increases, banks' choice of liquidity l_w^* increases.

Next, we analyze the socially optimal level of liquidity and compare it with the banks' choice.

[8] See Figure 7 for an illustration of ϕ_w. For $k \in [\overline{k}, \overline{\overline{k}}]$, we have $\phi_w = [\alpha_0 (\alpha_1\Delta)]$. Note that ϕ_w is not monotone increasing in k. The reason for this is that, for $k \in [\overline{k}, \overline{\overline{k}}]$, with the participation of outsiders, price stays at $\underline{p}$ and the profit for a surviving bank from purchasing a unit of failed banks' asset is bounded by $(\alpha_1\Delta)$, whereas a bank survives only with probability α_0. Hence, as α_0 decreases, the marginal gain from holding the liquid asset goes down for $k \in [\overline{k}, \overline{\overline{k}}]$. Since, ϕ_w is no longer monotone in α_0, the comparative statics result on $E(\alpha_0)$ in this case is not as clean as the result in the benchmark case. However, we provide interesting results on the effect of expertise $(\alpha_1\Delta)$ and the wealth of outsiders (w) on banks' choice of liquidity.

5.2 Socially optimal liquidity

The socially optimal liquidity level l of each bank maximizes the objective function

$$E(\Pi) = E\left[l + \alpha_0(1-l)R_0(l)\right] + \alpha_1 R_1 - (\alpha_1\Delta)\int_{\overline{k}}^{1} f(k)\left[k - \frac{(1-k)L}{p_w^*(k)}\right]\, dk \tag{24}$$

where $\left[k - \frac{(1-k)L}{p_w^*(k)}\right]$ represents the units of assets purchased by outsiders at the price $p_w^*(k)$, which multiplied by $(\alpha_1\Delta)$ gives the social welfare loss arising from their lack of expertise relative to banks. On the one hand, as banks hold more liquid assets, the first expression decreases since in expected terms, risky asset has a higher return than the safe asset. On the other hand, as banks hold more liquid assets, they have more resources to acquire failed banking assets, which decreases the misallocation cost.

We can write the first-order condition as:

$$1 + E(\alpha_0)\ \left[-b + (1-l)\right] + E(\gamma_w)\ \left[1 + \tau\left(-b + (1-l)\right)\right] = 0, \text{ where} \tag{25}$$

$$E(\gamma_w) = \left(\frac{\alpha_1\Delta}{\underline{p}}\right)\ \left[\left(\int_{\overline{k}}^{\overline{\overline{k}}} f(k)(1-k)\ dk\right) + \left(\int_{\overline{\overline{k}}}^{1} f(k)(1-k)\left[\frac{kw\underline{p}}{\left[(1-k)L+w\right]^2}\right]\ dk\right)\right] \tag{26}$$

is the marginal reduction in expected misallocation cost for an additional unit of liquidity within the set of surviving banks.[9] We thus obtain the following proposition.

Proposition 8 *The socially optimal level of liquidity that satisfies the FOC in (25) is given as:*

$$\widehat{\widehat{l}}_w = \min\left\{1, \max\left\{0, 1 - b + \frac{1 + E(\gamma_w)}{E(\alpha_0) + \tau E(\gamma_w)}\right\}\right\}, \tag{27}$$

where $E(\gamma_w)$ is given in equation (26). The unique level of socially optimal liquidity l_w^{**} is the fixed-point of $\widehat{\widehat{l}}_w(\alpha_0, \tau, E(\gamma(\alpha_0, \tau, l_w^{**}))) = l_w^{**}$. Furthermore, for $w > \left(\frac{L\underline{p}}{2L+\underline{p}}\right)$, the socially optimal level of liquidity l_w^{**} decreases as outsider wealth w increases.

As a function of equilibrium liquidity l, $\widehat{\widehat{l}}_w$ behaves similar to $\widehat{l}$ and $\widehat{l}_w$. When aggregate liquidity is high, misallocation costs are low and it becomes less desirable to carry additional liquidity. Similarly, if aggregate liquidity is low, the misallocation region is large and carrying additional liquidity is attractive from a social standpoint.

[9] Note that for $w \geqslant \underline{p}$, we have $\overline{\overline{k}} \geqslant 1$, and $E(\gamma_w) = \left(\frac{\alpha_1\Delta}{\underline{p}}\right)\ \left(\int_{\overline{k}}^{1} f(k)(1-k)\ dk\right)$.

Next, we analyze the effect of model parameters on the socially optimal level of liquidity. As b increases, the return on risky asset improves and the socially optimal level of liquidity l_w^{**} decreases, which can be seen from the equation (27).

Consider now the effect of $(\alpha_1 \Delta)$ on the socially optimal level of liquidity. Note that as $E(\gamma_w)$ increases, the socially optimal level of liquidity l^{**} increases. Hence, we need to examine the sign of $\frac{\partial E(\gamma_w)}{\partial(\alpha_1\Delta)}$. For $w \geqslant \underline{p}$, we have

$$\frac{\partial E(\gamma_w)}{\partial(\alpha_1\Delta)} = \left(\frac{1}{\underline{p}}\right)\left[\int_{\overline{k}}^{1} f(k)(1-k)\ dk - (\alpha_1\Delta)\, f(\overline{k})(1-\overline{k})\ \frac{\partial \overline{k}}{\partial(\alpha_1\Delta)}\right]. \tag{28}$$

Note that there are two effects at work here. On the one hand, as outsiders become less experienced, that is, as $(\alpha_1\Delta)$ increases, the threshold $\overline{k}$ increases since $\frac{\partial \overline{k}}{\partial(\alpha_1\Delta)} > 0$. Hence, as $(\alpha_1\Delta)$ increases, the region over which we observe misallocation cost shrinks. This has a positive effect on social welfare and relaxes the burden of holding liquid assets to prevent misallocation cost. On the other hand, conditional on ending up in states where some of the banking assets have to be liquidated to outsiders, that is, for $k > \overline{k}$, the misallocation cost per unit of banking asset from sales to outsiders increases. Thus, the combined effect of an increase in $(\alpha_1\Delta)$ on the socially optimal level of liquidity is not unambiguous.[10]

As in the case without outsiders, when $\tau = 1$, the socially optimal liquidity l_w^{**} may exceed zero, the level of privately optimal liquidity for this value of τ. This is because bankowners are concerned only about their return when they survive ("risk-shifting") whereas from a social standpoint, the relevant trade-off is between the expected return of the two assets (and not between the "option" value of risky asset against the return on the safe asset). While this case ($\tau = 1$) is intuitive and well-known, the more interesting possibility arises when risky asset is illiquid ($\tau < 1$) so that inter-temporal motive to hold liquidity arises. We show below that the privately optimal level of liquidity may exceed the socially optimal level in this case.

5.3 Comparing socially and privately optimal levels of liquidity

In this section, we compare the privately and socially optimal levels of liquidity in the presence of outsider entry in the market for asset sales.[11] As argued above, the conflict of interest between bankowners and senior claimants of the bank tends to push the privately optimal level of liquidity below the socially optimal level. In particular, this always holds with $\tau = 1$.

However, if $\tau < 1$, bankowners have an inter-temporal motive to hold liquidity: surviving banks make profits from asset purchases when the proportion of failures is above $\underline{k}$, that is,

[10] For $w < \underline{p}$, the analsis is more involved and the effect is again not unambiguous.

[11] We present our results for the case $w \geqslant \underline{p}$. Similar results hold for the case $w < \underline{p}$.

$k > \underline{k}$, but since $\tau < 1$ they cannot pledge risky cash flows fully to capitalize on this benefit. Hence, there is a benefit from carrying liquidity into such states. In contrast, social welfare losses materialize only when the proportion of failures is above $\overline{k}$, that is, $k > \overline{k}$. For the intermediate region $[\underline{k}, \overline{k}]$, while banks gain by purchasing assets at cash-in-the-market prices, there is no social welfare loss. Thus, if τ is sufficiently small, then the private incentive to hold liquidity for inter-temporal transfers can prevail over the risk-shifting incentive, and, in turn, privately optimal level of liquidity can exceed the social one. To summarize, if sufficient liquidity cannot be raised against risky cash flows in a contingent fashion in future, then banks may carry excess liquidity (inefficiently bypassing profitable lending opportunities) in order to stand ready for acquiring failed banks at attractive prices.

We provide a formal presentation of the above discussion in the following Proposition which is illustrated in Figure 8.

Proposition 9 *With the possibility of outsider entry, there exist critical values* $\tau^*(\Delta)$ *and* $\tau^{**}(\Delta)$, *such that, for* $\tau > \tau^*(\Delta)$, *the socially optimal level of liquidity is higher than the privately optimal level, and for* $\tau < \tau^{**}(\Delta)$, *the privately optimal level of liquidity is higher than the socially optimal level, where* $\tau^{**}(\Delta) \leqslant \tau^*(\Delta)$.

The above proposition states the relationship between the privately optimal and the socially optimal levels of liquidity in relation to τ, the pledgeability of future returns. By the same token, given a value of τ, when the intermediate region $[\underline{k}, \overline{k}]$ is not very wide, that is, Δ is not very large, banks hold less than the socially optimal level of liquidity: The risk-shifting incentive dominates in this case. In other words, when the difference between the fundamental value of bank assets and the price outsiders are willing to pay for them is not very high, banks choose to hold less than socially optimal levels of liquidity.[12]

6 Some empirical evidence

So far, our focus has mainly been to present a theoretical framework for analyzing the liquidity choice of banks in anticipation of financial crises. In this section, we provide some descriptive empirical evidence that is consistent with the model's primitive assumptions and its implications for behavior of liquid holdings on bank balance-sheets.

We address two empirical themes, in keeping with our classification in terms of the ex post resolution and the ex ante choice of portfolios. We begin with the ex post resolution issue, with particular reference to foreign entry following the Asian crisis of 1997.

[12]See the proof of Proposition 9 part (ii) in the Appendix for the result on Δ.

6.1 Foreign entry: Evidence from South East Asian crisis

The Asian financial crisis of 1997-8 is an ideal setting for our inquiry. Unlike the textbook financial crises that have a fiscal origin (via the budget deficit of the government), the Asian financial crisis has often been viewed primarily as a liquidity crisis that hit the financial sector, and which was amplified by the currency crisis that fuelled the distress on the banking sector's balance sheet. Both the severity of the crisis, as well as the sharp V-shaped recovery that ensued is indicative of the many of the forces that we have worked out in our theoretical model.

For these reasons, we believe the Asian financial crisis and its resolution to be a good testing bed for the applications of our concepts. Our dataset is from Thompson Financial Securities Data Company's (SDC) mergers and acquisition database. SDC reports detailed information about the target and acquiring firm, including income statement and balance sheet items, industry, and ownership. Public and private transactions are all included. Given the focus of our paper, we restrict our sample to all Mergers and Acquisitions (M&A) transactions in years 1996 to 2000 where the target was a bank or financial institution in those Asian countries most affected by the 1997 crisis, such as Malaysia, Thailand, Indonesia, Korea and the Philippines, as well as other countries in the region that did not suffer so much - Singapore, Taiwan, Vietnam, Brunei and Cambodia. In the sample, 54% of target firms are in Malaysia, 17% in Singapore, 12% in Thailand, 9% in the Philippines, 6% in Indonesia, and less than 1% in Vietnam, Brunei, and Cambodia.

Our choice of sample enables us compare the patterns in takeovers during the period of the resolution of crisis (primarily, 1998) to other years. In total, we have 1460 completed deals, 1295 of which are by east Asian acquirers and 165 of which are by non-east Asian acquirers. We categorize deals into within- or across-industry acquisitions using industry information provided by SDC. Within-industry acquisitions are deals in which the acquirer and the target belong to the same industry sector, and across-industry acquisitions are deals in which the acquirer and the target belong to different industry sectors, as classified by SDC. While we have ownership and transaction information on most of the deals, income statement and balance sheet items are missing for a number of deals because many of the targets are private firms. Hence, we primarily focus on ownership and transaction patterns in the data.[13]

[13] In tables to follow, Enterprise value is a measure of a company's value, and it is calculated as market capitalization plus debt, minority interest and preferred shares, minus total cash and cash equivalents. Enterprise value can be thought as the theoretical takeover price. Transaction value, on the other hand, is the actual price paid by the acquirer to the target for the portion of equity stake acquired. Transaction value and enterprise value can differ for at least two reasons. First, enterprise value measures the value of the entire firm, whereas transaction value measures only the portion of equity acquired. Second, transaction value includes potential synergies from the merger and is affected by the bargaining powers of the parties involved.

Table 1 Panel A provides the national identities of the acquiring entity and the overall share of acquisitions accounted for my that country. For acquiring firms, 52% are in Malaysia, 17% Singapore, 7% Thailand, 6% Philippines, 3% United States, 3% Indonesia, 2% Hong Kong, 1% Japan, 1% Taiwan, 1% France, and 1% United Kingdom.

Unsurprisingly perhaps, most of the acquisitions are of targets within the country of the acquirer so that the dominance of Malaysia in the overall number of acquisitions is not the relevant dominance from the standpoint of understanding foreign entry.

Table 1 Panel B breaks up the acquisitions in 1998 and in other years into Domestic acquirers, Regional acquirers (within Southeast Asia) and Foreign acquirers. By number, domestic acquisitions fall from 80% in other years to 76.5% in 1998, within SE Asia acquisitions from 7.2% to 5.6%, and correspondingly, foreign acquisitions climb from 12.6% to 17.9%. These percentages are much more striking by size. Based on transaction values, domestic acquisitions fell in 1998 by around 20% compared to their otherwise levels, whereas foreign acquisitions climbed up by almost the same amount. This signifies the role of foreign entry in SE Asian banking and financial institutions sector following the crisis and the suitability of this period for studying its characteristics and implications.

Table 2 reports the summary statistics for the M&A deals in our sample based on SE Asian acquirers (Panel A), foreign acquirers (Panel B), top ten acquisitions in 1998 (Panel C), and top ten acquisitions in other years (Panel D). We focus on Panels A and B first. The median percentages of shares acquired are 100% for Southeast Asian acquirers and 40% for foreign acquirers (a controlling stake would typically correspond to a 50% stake), and the median transaction values are 8.56 million dollars for Southeast Asian acquirers and 15 million dollars for foreign acquirers. Consistent with 1998 being the period of crisis resolution, these panels reveal that the mean P/E ratios and EV/EBITDA ratios (the multiples at which the targets were trading) are lower in 1998 compared to other years, for SE Asian as well as foreign acquisitions. That is, targets were on average far weaker during the crisis compared to the overall period. Consistently, the equity value of targets is also smaller in 1998 for both SE Asian and foreign acquisitions. However, transaction values are lower in 1998 for SE Asian acquisitions compared to other years but are greater in 1998 for foreign acquisitions. Also, enterprise values and total assets are higher in 1998 for SE Asian acquisitions but relatively unchanged or even lower for foreign acquisitions. Finally, acquisitions by SE Asian acquirers represent targets with negative equity returns leading up to the deal in 1998, about 3-5% lower than the average leading equity returns in other years. There is however not much difference in the leading target returns for foreign acquirers between 1998 and other years. We discuss below in greater detail some of these patterns, especially in the context of our paper.

In Panel C of Table 2, almost all of top ten acquisitions in 1998 involved controlling stakes (higher than 50% and close to 100%), there are four non-domestic acquisitions (involving Goldman Sachs, General Electric, Lehman Brothers, and GIC), and that two of these non-domestic acquisitions involve complete purchases of the restructured pools of the financial sector assets (Financial Sector Restructuring-BL by Goldman Sachs, China, and Financial Sector Tranche ABCD by GE Capital, United States). In contrast, in Panel D, we find that acquisition stakes are not always controlling in other years, even in the top ten acquisitions, there are only two non-domestic acquisitions, and in fact both are non-controlling stakes (Allied Irish Bank's purchase of 24.9% stake in Keppel TatLee Bank of Singapore and Brandes Investment Partner's purchase of 6.9% stake in DBS Bank of Singapore).[14]

Next, we explore some time-series and cross-sectional patterns of the data that are of most relevance to our paper. The first interesting time-series pattern in the data is that the crisis led to significant increase in foreign acquisitions of Southeast Asian banks and financial institutions. Figure 9 illustrates that for acquisitions by foreign companies over the sample period, there was a greater fraction that occurred in 1998 than in any other year. This pattern is true for both within-industry and across-industry mergers. Moreover, Figure 10 shows that out of total acquisitions in Southeast Asia in a given year, the percentage of acquisitions made by foreign companies also peaked in 1998. Again, this pattern is again true for within- as well as across-industry acquisitions.

The second interesting time-series pattern in the data is that greater extent of asset sales took place during the crisis, especially for foreign acquisitions. Table 2 Panel B illustrates that foreign acquirers took larger stakes in 1998 (median of 50%) than in other periods (median of 32.5%). Table 3 confirms that this pattern holds for both within-industry and across-industry transactions involving foreign acquirers. While the median ownership of SE Asian acquirers is always 100% (throughout our sample period, see Table 2), the means in Table 3 reveal that SE Asian acquirers also took larger stakes in acquired firms during 1998 than they did in other years.

Third, Table 2 Panel B shows that the median transaction value of foreign acquisitions is higher in 1998 as well. This is especially noteworthy given that the average enterprise values and total assets of targets are somewhat smaller in 1998 than in other years. We also observe that Assets/EBITDA of foreign acquisitions is much lower in 1998 (median of 15.77) than in other periods (median of 75.56). Table 4 confirms this pattern for within-industry as well as across-industry deals. That is, during the crisis, foreign acquisitions involved larger stakes but weaker targets compared to other years. Interestingly, both these patterns are reversed for SE Asian acquirers: they acquired smaller stakes in 1998 and firms with better Assets/EBITDA ratios.[15] This suggests that foreign acquirers enter the market for asset sales

[14] See Chari et al (2004) for the effect of acquisition of majority control on positive acquirer gains.

[15] Note that EV/EBITDA (and similarly E/P ratio) is smaller in 1998 for both SE Asian and Domestic acquirers. However, data prints on these ratios are relatively sparse for our sample firms.

when the crisis is deep, targets have weak balance sheets, and simultaneously, the domestic acquirers (also hit by the crisis) are in a weaker position than foreign acquirers to engage in asset purchases.

Next, we document that in the overall cross-section, there is evidence consistent with there being greater expertise with SE Asian acquirers than foreign acquirers for acquisitions in SE Asia and there being greater expertise for within-industry acquisitions than across-industry ones for both types of acquirers, but particularly for foreign acquirers.

First, Table 5 reports foreign acquirers targeted larger firms. Specifically, for within-industry acquisitions, foreign acquirers targeted firms with average enterprise value of 2436 million dollars and average total assets of 3400 million dollars, while Southeast Asian acquirers targeted firms with average enterprise value of 1088 million dollars and average total assets of 1313 million dollars. Similarly, for across-industry acquisitions, foreign acquirers targeted firms with average enterprise value of 4684 million dollars and average total assets of 2519 million dollars, while Southeast Asian acquirers targeted firms with average enterprise value of 1908 million dollars and total assets 2033 million dollars. This finding is consistent with the prior that smaller firms, which lack transparency and require greater expertise upon acquisition, find less entry from foreign companies relative to domestic companies.

Next, we explore the pattern across within-industry and across-industry acquisitions. Table 5 also shows that, on average, targets in cross-industry acquisitions have higher total assets (2033 million for Southeast Asian acquirers and 2519 million for foreign acquirers) than do targets in within-industry acquisitions (1313 million for local mergers and 3400 for foreign mergers). In addition, Southeast Asian industry outsiders acquired firms with higher total assets and equity value than Southeast Asian industry insiders. These pieces of evidences confirm that industry outsiders are less likely to acquire smaller firms, perhaps because smaller firms are opaque and require greater expertise upon acquisition.

Finally, we corroborate this evidence by reporting difference of differences in Table 6. We first report means and differences in means of various target size measures (enterprise value and equity value) and target's leading returns up to the deal announcement date for different types of deals. The last column presents the differences (between foreign- and Southeast Asian-acquisitions) in differences (between across- and within-industry acquisitions) of the means. We observe that the differences in differences are positive for enterprise value, equity value, target's return 4 to 1 week prior to merger announcement, and target's return 4 week to 1 day prior to the merger announcement. This suggests that compared to Southeast Asian acquirers, foreign acquirers purchased firms that are larger and have better return performance for across-industry mergers than for within-industry mergers. That is, the relative expertise of domestic acquirers compared to foreign acquirers is witnessed more acutely in across-industry mergers than in within-industry mergers.

Overall, these findings are supportive of the key assumptions and the resulting outcomes in our theoretical analysis of asset sales for banks and financial institutions, and the role played by crises, fire sales and entry of outsiders and foreign institutions.

Next, we turn to a brief examination of the cross-country and time-series empirical evidence on the liquid asset holdings of banks.

6.2 Bank liquidity and ease of external finance

One robust implication of our analysis is that banks' portfolios will be influenced in part by the strategic interactions arising from a shock to the banking system and the ensuing resolution. Our theory suggests that the more severe is the banking crisis, that is, the greater is the price discount that arises in the fire-sale and the greater is the difficulty banks face in raising external finance, the more acutely conscious would banks be of anticipating the resolution stage by holding more liquid assets. We explore this hypothesis by examining the liquid asset holdings of banks in a cross-section of countries.

In a recent paper, Freedman and Click (2006) show that banks in developing countries choose to channel only a modest portion of their funds to private sector borrowers, while keeping a sizeable percentage of their deposits in liquid assets, such as cash, deposits with other banks, central bank debt, and short-term government securities. They construct a liquidity ratio for banks, which is basically the ratio of Liquid Assets to Total Deposits. In particular, they employ data from International Financial Statistics provided by the IMF and calculate Liquid Assets as the sum of Reserves (line 20) and Claims on Central Government (usually line 22A), and Total Deposits as the sum of Demand Deposits (line 24), Time and Savings Deposits (line 25), Money Market Instruments (line 26A), and Central government Deposits (line 26D). They show that for developing countries the ratio ranges from 14% in South Africa to 126% in Argentina, with a mean value of 45%, with values of 2% for the UK, 6% for the US, 21% for Japan, 31% for France and 34% for Germany, with an average of 19% for developed countries.

They attribute this difference among developed and developing countries to banks' reluctance to lend in developing countries. Such reluctance, they argue, could be a response due to inefficiencies in credit markets resulting from factors such as higher reserve requirements due to greater macroeconomic risk and volatility, and significant deficiencies in the legal and regulatory environment which make it difficult to enforce contracts and foreclose on collateral. In this paper, we argue that an alternative channel may also be at work. Banks in poor legal and regulatory environments may find it difficult to raise liquidity against future profits and thus end up hoarding greater liquidity.

To this end, we expand on the data set of Freedman and Click (2006) to cover about

70 countries with data on liquidity ratios dating back to September 2003 (See Table 7 for complete data used for this part of the paper). Then, we link bank liquidity to a number of institutional variables that capture country's financial development in terms of quality of disclosures, and the extent of stock and credit intermediation (relative to country's size). These proxies should thus all measure the ease of raising external finance. Specifically, we employ five measures based on Rajan and Zingales (1998, 2003). These measures are:

1. **Accounting standards** is an index developed by the Center for International Financial Analysis & Research ranking the amount of disclosure in annual company reports in each country. Though this index from Rajan and Zingales dates back to 1990, they report that it does not change much over time.

2. **Total capitalization to GDP** is the ratio of the sum of equity market capitalization (as reported by the IFC) and domestic credit (IFS line 32a-32f but not 32e) to GDP. Stock market capitalization is measured at the end of the earliest year in the 1980's for which it is available.

3. **Domestic credit to GDP** is the ratio of domestic credit to the private sector, which is from IFS line 32d, over GDP.

4. **Deposits to GDP** is the ratio of domestic deposits to the GDP.

5. **Stock market capitalization to GDP** is the ratio of the aggregate market value of equity of domestic companies divided by GDP, based on data for 1999.

We find that in the cross-section of countries, the correlation of country-level average for the banking system's ratio of Liquid Assets to Total Deposits with these five measures is uniformly and significantly negative, the values being -0.55, -0.38, -0.36, -0.33, and -0.50, respectively. We also plot the best regression fit of the Liquidity Ratio to Accounting standards (Figure 11) and to Total capitalization to GDP (Figure 12). The graphs illustrate that the negative relationship is quite robust to exclusion of outliers such as Argentina, whose Liquidity Ratio is inflated due to the recent turmoil.

While this evidence is striking, it is potentially also consistent with the explanation of Freedman and Click (2006) that these measures of financial development (especially Domestic credit to GDP and to some extent Accounting standards) also proxy for frictions in the market for lending. That is, the negative relationship may be due to lower attractiveness of risky loans in these countries rather than due to greater attractiveness of safe assets. To help at least partially address this issue, we examine data on international stock market liquidity measured over the period 1989 to 2000 from Levine and Schmukler (2005). In particular, we consider for a subset of countries three measures of stock-market liquidity, namely **Turnover**

in Domestic Market, and two inverse proxies, **Illiquidity Ratio** of Amihud (2002), and **Proportion of Zero Return Days** advocated by Bekaert, Harvey and Lundblad (2003).

While the first two measures show little correlation with the banking-system liquidity ratio, we find that the third measure of stock-market illiquidity, the proportion of zero return days, is significantly positively correlated. The correlation is 0.25 (Figure 13 shows the best regression fit of banks' Liquidity Ratio versus the Proportion of Zero Return Days). When the Brazil outlier is excluded, it is around 0.35, the corresponding correlations with Accounting standards and Total Capitalization to GDP being -0.25 and -0.60, respectively (for the limited sample where stock market liquidity proxies are available). This suggests that the relationship between financial development and bank liquidity is not entirely due to credit-market frictions, but that a part of this relationship also stems from the fact that financial development is associated with greater ease of external finance, which in turn reduces the attractiveness of liquidity in banks' portfolio choice. Overall, this cross-country evidence is suggestive, even if not conclusive, that the hoarding of liquidity to be used for profitable investments such as acquisitions may be an important determinant of its equilibrium levels on bank balance-sheets.

6.3 Bank liquidity management, leverage targeting, and the business cycle

While the effect of business cycle on bank liquidity is ambiguous in our model once we allow for outside entry, in the benchmark model without entry, we showed that bank liquidity would be higher during economic downturns and smaller in boom times. Aspachs et al. (2005) analyze the determinants of UK banks' liquidity holdings and find evidence supportive of this hypothesis. They use balance sheet and profit and loss data, for a panel of 57 UK-resident banks, on a quarterly basis, over the period 1985Q1 to 2003Q4. These data are obtained from the Bank of England Monetary and Financial statistics and relate to the banks' resident (UK) activity, excluding activities abroad. They measure liquidity as the sum of cash, reverse Repos, bills and commercial papers and comprise in addition all types of investments securities, such as equities and bonds. They use two alternative liquidity ratios. The first is the share of liquid assets in the bank's total assets. This measure captures the split between liquid and illiquid assets on the bank's balance sheet. And, to capture the liquidity mismatch inherent in the bank's balance sheet, they use a second measure, which is the ratio of liquid assets to total deposits. However, their results do not change materially whether they use ratio of liquidity over assets, or the ratio of liquidity over deposits.

In their regression analysis, they test among other effects the role of GDP growth in determining banks' liquid asset holdings. They find that banks in the UK appear to hold smaller (larger) amounts of liquidity, relative to both total assets and total deposits, in periods of stronger (weaker) economic growth. In particular, a 1% increase in GDP growth results in about a 20% decrease in liquidity, where the effect is significant at the 1% level. In other words, banks appear to build up their liquidity buffers during economic downturns and draw them down in economic upturns. Again, while business cycle fluctuations are certainly associated with fluctuations in demand for risky loans, put together with the cross-country evidence, this suggests at least preliminary support for our model's hypotheses. More research differentiating the alternative determinants of banks' liquid asset holdings is warranted.

Some recent literature (most notably, Adrian and Shin, 2006, Figures 1, 2, 7 and 10) has focused on targeting of leverage ratios by banks and its implications for the business cycle. In particular, this literature has argued that individual bank risk management leads to unwinding of assets in response to negative asset-side shocks, which depresses prices, and, in turn, could lead to more unwinding and thus cause significant price drops. It has also been documented that there is a negative relationship between equity cushion maintained by banks and their total assets. In theory, these facts are consistent with risk management at banks being primarily achieved by management of their liquidity.

Leverage ratios would be targeted in a "net" sense, that is, with leverage being net of cash reserves or liquid holdings of banks. Negative asset-side shocks increase the risk of a crisis which give banks incentives to build up their liquid asset holdings by liquidating their assets. If such shocks are systematic, there may not be a sufficiently large pool of outsider buyers (such as pension funds, insurance companies, university endowments, hedge funds, etc., depending on the type of assets) to absorb liquidations by banks, resulting in cash-in-the-market pricing that can lead to downward pressure on prices with additional liquidations. As asset liquidations increase, size of banking assets falls but due to liquidation proceeds in the form of cash balances, the net equity cushions would rise. All these effects would be exaggerated if negative asset-side shocks are associated with a deterioration in market liquidity (see, for example, Acharya and Pedersen, 2005, Figure 1) since this would strengthen banks' precautionary and strategic motives to increase liquid buffers.

These linkages of our model's implications are intriguing and exploring them fully in a truly dynamic model with endogenous cycles remains a promising line for future enquiry.

7 Concluding remarks and policy implications

Our objective in this paper has been to develop a theoretical framework for bank portfolio choice between liquid (safe) and illiquid (risky) assets that is set against the backdrop of potential crisis and foreign entry. Given the potentially large rewards and costs that arise in the context of crisis and resolution, the endogeneity of bank portfolios is easily motivated in the positive theory of bank behavior. Although our focus in the paper has been mainly theoretical, the descriptive evidence of M&A during the SE Asian crisis resolution underscores that the channel of fire sales and foreign entry warrant more attention in models of bank liquidity. Also, our cross-country empirical evidence on bank portfolios is suggestive of systematic variation in banks' choice of liquidity in the face of differing institutional quality variables. This evidence holds out some hope that a more comprehensive empirical study can unearth and provide further insights into the relationship between financial development, incidence of crises, and banking system liquidity.

Of greater consequence for policy, we have been able to conduct a normative welfare analysis comparing the equilibrium liquidity choice of banks to the socially optimal level. Welfare analysis is made possible in our model due to our assumption that outside investors (from outside the banking sector) do not have the skills to generate the full value from banking assets. This assumption is motivated by the familiar argument that bank assets (loans in particular) derive much of their value from the monitoring and collection efforts of loan officers who can influence the actions of the debtors. Hence, when distressed assets end up in the hands of outsiders, we may expect deadweight costs from inefficient allocation of assets. The empirical evidence reported by James (1991) on the substantial losses incurred due to liquidation of bank assets in the United States is one aspect of such inefficiency. We may expect the losses to be much larger in emerging market countries with less developed markets for distressed assets and the poor quality of legal and accounting infrastructure backing the insolvency process.

The policy implications that flow from our analysis are worthy of further study, both theoretically in more sophisticated set-ups, for example, allowing for dynamics, but also empirically in the area of bank resolution, for example, in the form of specific case studies linking the regulatory choice of closure policies to the ex-ante choice of bank liquidity. In particular, the role of foreign investors in bank restructuring presents important trade-offs for a country in the aftermath of a major financial crisis. Foreign capital will be attracted by the very low prices of distressed assets, and fulfil the role of the "purchaser of last resort" when domestic capital is exhausted. However, the ultimate welfare effects of such foreign entry will depend on the complex interplay between the cushioning of price in the event of a crisis, the ex ante portfolio choices in anticipation of such entry, and the ability of the foreign entrant to manage the assets they acquire.

Foreign entry also presents important distributional questions. The perception that foreigners are able to buy up large swathes of the banking sector at fire-sale prices, and then sell them off at a large profit once the crisis has abated, presents important challenges, not least in political economy, as witnessed by the current fierce debates in South Korea about the role of foreign private equity firms. Such issues concerning the role of foreign entry are being studied separately in a companion piece to the current paper.

We conclude by touching on a few other important themes in the regulation of financial institutions. In unreported results, our theoretical framework can be extended readily to incorporate costly provision of deposit insurance and crises resolution policies such as government-sponsored bailouts and granting of liquidity to surviving banks. It can be shown that fiscal costs of deposit insurance make it more likely that banks will hold less liquidity than is socially optimal. Also, bailouts result in lower bank liquidity only if they are excessive in the sense of covering more banks than is necessary to avoid costly liquidations to outsiders. In contrast, liquidity grants to surviving banks that are not contingent on banks' liquidity holdings always lower bank liquidity. However, if the amount of liquidity provided is increasing in liquid holdings of surviving banks, then incentives for banks to hold liquid assets are strengthened. Such analysis suggests that the model holds promise for further normative analysis and can also provide impetus for empirical work linking regulatory actions to banking system liquidity.

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Appendix

Technical model assumptions: We make the following parametric assumptions to analyze the model.

(A1) $b > 2$: In this case, the return from the bank's portfolio, $[l + (1 - l)R_0]$, without the profits from the asset purchase, is decreasing as the liquid asset l in bank's portfolio increases. This creates the trade off between the liquid and the illiquid asset *only once benefits from* *fire-sales are introduced*. In other words, the pure portfolio choice problem would lead to liquidity choice of $l = 0$. Furthermore, this condition also guarantees that $R_0 > r_0 = 1$.[16]

(A2) $\tau < \min\{1/b, b/\overline{p}\}$: $\tau < 1/b$ guarantees that the liquidity banks have for asset purchases increases as they hold more liquid asset l in their portfolio and $\tau < b/\overline{p}$ guarantees that $r_0 \geqslant 1 > l + \tau\overline{p}$, so that a failed bank cannot generate the needed funds to avoid default.

(A3) $\overline{\Delta} < \left(b - \frac{3}{2}\right)$: Note that the maximum value $\overline{\Delta}$ can take, denoted by $\overline{\Delta}_{max}$, is equal to $(R_0 - r_0)$. This condition guarantees that $\overline{\Delta} < \overline{\Delta}_{max}$.

(A4) $B \leqslant \left(\frac{\overline{\Delta}^2}{b-1}\right)$: This condition guarantees that banks cannot generate a higher proportion of their future profits in the capital market when they invest in the bad project. In particular, when bank owners are left with a share of profits less than $\overline{\theta}$, they shirk, which results in a lower return from these investments. However, in that case, they can generate a higher proportion of their future profits in the capital market, that is, they can generate up to $\left(R_t - \overline{\Delta} - r_t\right)$. Banks can generate higher funds from the capital market when they choose the good project if

$$\left(1 - \overline{\theta}\right)(R_t - r_t) \geqslant R_t - \overline{\Delta} - r_t, \tag{29}$$

which gives us $\overline{\theta} \leqslant \frac{\overline{\Delta}}{(R_t - r_t)}$. Thus, we have $\overline{\theta} = \frac{B}{\overline{\Delta}} \leqslant \frac{\overline{\Delta}}{(R_t - r_t)}$. In that case, it is optimal to leave a minimum share of $\overline{\theta}$ of future profits to bank managers, both for higher output as well as better liquidity generation through the capital market. This condition simplifies to $B \leqslant \left(\frac{\overline{\Delta}^2}{b-1}\right)$.

Proof that $l \leq l_{max}$ in equilibrium: In the first case when $(1 - l)R_0 \geqslant r_0$, a proportion τ of the remaining return from the risky asset, that is, $\tau\left[((1 - l)R_0 - r_0)\right]$ can be pledged in the capital market. Thus, from equation (4), we have

$$\frac{\partial L}{\partial l} = 1 - \tau R_0 + \tau(1 - l)\left(\frac{\partial R_0}{\partial l}\right) = 1 - \tau b + \tau(1 - l). \tag{30}$$

Hence, for $\tau < \left(\frac{1}{b-1+l}\right)$, we have $\frac{\partial L}{\partial l} \geqslant 0$ and liquidity available for asset purchase increases as banks hold more of the liquid asset in their portfolio. A sufficient condition for this to hold is $\tau < 1/b$, which holds by our assumption (A2).

For the other case, $l > l_{max}$ and the return from the risky asset is not enough to pay old depositors. Hence, some of the liquid asset l has to be used to pay old depositors, which gives us

$$L = \left[l + ((1 - l)R_0 - r_0)\right] + \tau\overline{p}. \tag{31}$$

[16] We show below that when $b > 2$, there is a threshold level of liquidity, denoted by l_{max}, such that for $l > l_{max}$, liquidity that banks have for asset purchase decreases as l increases. In turn, this implies that in equilibrium, we always have $l \leqslant l_{max}$.

Thus, for $b > 2$, which holds by (A1), $\frac{\partial L}{\partial l} < 0$ and the liquid asset available for asset purchase decreases as banks hold more of the liquid asset. Furthermore, without the asset purchase, the expected return on bank's portfolio is $E\left[\alpha_0\left(l + (1-l)\left(b - \frac{1-l}{2}\right)\right)\right]$, is decreasing in l for $b > 2$. Hence, for $b > 2$, banks never hold a level of liquidity l greater than l_{max} in equilibrium. $\diamondsuit$

Proof of Proposition 2: We have $R_0(l) = \left[b - \frac{(1-l)}{2}\right]$ and $\frac{dR_0}{dl} = \frac{1}{2}$. Plugging these expressions into the FOC in (10), we get:

$$E(\alpha_0)\ \ [1 - b + (1-l)] + E(\phi)\ \ [1 + \tau\,[-b + (1-l)]] = 0, \tag{32}$$

where ϕ is the expected benefit per unit of failed banks' assets from asset purchase. From here, we can find banks' choice of liquidity $\widehat{l}$ that satisfies the FOC as:

$$\widehat{l} = 1 - b + \frac{E\left(\alpha_0\right) + E(\phi)}{E(\alpha_0) + \tau E(\phi)}, \tag{33}$$

which is given in Proposition 2.

We have the following:

$$\phi = \begin{cases} 0 & for \quad k \leqslant \underline{k} \\ \alpha_0\left(\frac{(1-\alpha_0)\overline{p}}{\alpha_0 L} - 1\right) & for \quad k > \underline{k} \end{cases}. \tag{34}$$

Note that $\underline{k}$ is continuos in l. Thus, $E(\phi)$ is continuos in l. Hence, $\widehat{l}$ is continuos in l. Since, $\widehat{l}$ is a continuos function from the compact, convex set $[0,1]$ into itself, by Brouwer's fixed point theorem, a fixed point of the mapping in equation (33) exists. Next, we show that the fixed point is unique.

Note that as l increases, the aggregate level of liquidity increases, and the region over which the price of the failed banks' assets fall below their fundamental value shrink, that is, $\frac{\partial \underline{k}}{\partial l} > 0$. Hence, we have $\frac{\partial E(\phi)}{\partial l} < 0$. Note that, we have $\frac{\partial \widehat{l}}{\partial E(\phi)} = (1-\tau)E(\phi) > 0$, that is, as the expected private benefit from holding the liquid asset decreases, banks hold less liquid asset in their portfolio. Thus, we have $\frac{\partial \widehat{l}}{\partial l} < 0$. As a result, the fixed point is unique. $\diamondsuit$

Proof of Proposition 3: First, we prove part (i). Note that if $\widehat{l}$ given in equation (12) increases, the privately optimal level of liquidity l^* increases. We have

$$\begin{aligned} sign\left(\frac{\partial \widehat{l}}{\partial \tau}\right) &= sign\left[\left(\frac{\partial E(\phi)}{\partial \tau}\right)[E(\alpha_0) + \tau E(\phi)] - [E(\alpha_0) + E(\phi)]\left(E(\phi) + \tau\left(\frac{\partial E(\phi)}{\partial \tau}\right)\right)\right] \\ &= sign\left[\left(\frac{\partial E(\phi)}{\partial \tau}\right)[(1-\tau)E(\alpha_0)] - E(\phi)\left[E(\alpha_0) + E(\phi)\right]\right]. \end{aligned}$$

We have $\frac{\partial E(\phi)}{\partial \tau} < 0$, since $\frac{\partial E(\phi)}{\partial p^*} < 0$ and $\frac{\partial p^*}{\partial \tau} > 0$. Hence, we have $\frac{\partial \widehat{l}}{\partial \tau} < 0$, that is, the privately optimal level of liquidity l^* decreases as τ increases.

Next, we prove part (ii). Note that ϕ is (weakly) increasing in k, therefore, is (weakly) decreasing in α_0. Hence, if g FOSD f, we have $E_g(\phi) < E_f(\phi)$. We have $\frac{\partial \widehat{l}}{\partial E(\phi)} > 0$. Hence, if g FOSD f, then we have $l_g^* < l_f^*$. $\diamondsuit$

Proof of Proposition 5: From the expressions for these two values of liquidity, we have

$$\widehat{l} - \widehat{\widehat{l}} = \frac{E(\alpha_0) + E(\phi)}{E(\alpha_0) + \tau E(\phi)} - \frac{1}{E(\alpha_0)} = \frac{E(\phi)\left[E(\alpha_0) - \tau\right] - E(\alpha_0)\left[1 - E(\alpha_0)\right]}{E(\alpha_0)\left[E(\alpha_0) + \tau E(\phi)\right]}. \tag{35}$$

Note that a sufficient condition for the socially optimal level of liquidity to be higher that the privately optimal level of liquidity is $E(\alpha_0) < \tau$. Hence, we analyze the case where $E(\alpha_0) \geqslant \tau$. As $E(\alpha_0)$ converges to 1, we have the privately optimal level of liquidity to be higher than the socially optimal level. Next, note that $\widehat{l} = \widehat{\widehat{l}}$ when

$$E(\phi)\left[E(\alpha_0) - \tau\right] = E(\alpha_0)\left[1 - E(\alpha_0)\right]. \tag{36}$$

Since the left hand side is decreasing in τ, but the right hand side is not affected by τ, this equation implicitly defines a unique critical $\tau^*(E(\alpha_0))$ such that $\widehat{l} < \widehat{\widehat{l}}$ if and only if $\tau > \tau^*(E(\alpha_0))$.

Using the implicit function theorem, we get:

$$E(\phi)\left[\frac{d\tau^*}{dE(\alpha_0)}\right] = E(\phi) + \left[E(\alpha_0) - \tau\right]\left[\frac{dE(\phi)}{dE(\alpha_0)}\right] + \left[1 - 2E(\alpha_0)\right]. \tag{37}$$

Note that $\left(\frac{dE(\phi)}{dE(\alpha_0)}\right) < 0$ so that we obtain

$$\frac{d\tau^*}{dE(\alpha_0)} < 0 \text{ for } E(\alpha_0) < \left(\frac{1 - E(\phi)}{2}\right). \tag{38}$$

See Figure 5 for an illustration. $\diamondsuit$

Proof of Proposition 8: We have the FOC as:

$$T_1 + T_2 \underbrace{- \left(\alpha_1 \Delta\right) \frac{d}{dl}\left[+ \int_{\underline{\underline{k}}}^{1} f(k)\left[\left(\frac{kw}{(1-k)L + w}\right) - \left(k - \frac{(1-k)L}{\underline{p}}\right)\right] dk\right]}_{=T_3} \tag{39}$$

where T_1 is given as:

$$T_1 = 1 + E(\alpha_0)\ \left[-b + (1-l)\right]. \tag{40}$$

Using Leibniz's rule, we get:

$$\begin{aligned} T_2 &= -\left(\alpha_1 \Delta\right) \left[\int\limits_{\overline{k}}^{1} f(k) \left[-\frac{(1-k)}{\underline{p}} \right] \left[1 - \tau R_0(l) + \tau(1-l) \left(\frac{dR_0}{dl} \right) \right] \ dk \right] \\ &\quad + \left(\alpha_1 \Delta\right) \underbrace{\left[\overline{k} - \frac{(1-\overline{k})L}{\underline{p}} \right]}_{=0} \left(\frac{d\overline{k}}{dl} \right). \end{aligned} \tag{41}$$

Note that at $k = \overline{k}$, all failed banks' assets are purchased by surviving banks and the second term in equation (41) is equal to 0. Using $R_0(l) = \left[b - \frac{(1-l)}{2}\right]$ and $\frac{dR_0}{dl} = \frac{1}{2}$, we get:

$$T_2 = \left[1 + \tau\left(-b + (1-l)\right)\right] \ \underbrace{\left[\left(\frac{(\alpha_1 \Delta)}{\underline{p}} \right) \int\limits_{\overline{k}}^{1} f(k)(1-k)\ dk \right]}_{=E(\gamma)}. \tag{42}$$

Again, using Leibniz's rule, we get:

$$T_3 = -\left(\alpha_1 \Delta\right) \ \int\limits_{\overline{\overline{k}}}^{1} f(k)(1-k) \left(\frac{dL}{dl} \right) \left[\frac{1}{\underline{p}} - \frac{kw}{\left[(1-k)L + w\right]^2} \right] \ dk, \tag{43}$$

since at $k = \overline{\overline{k}}$ we have $p_w^*(k) = \underline{p}$, which gives us $\left(\frac{L}{\underline{p}}\right) = \left(\frac{\overline{\overline{k}}L}{(1-\overline{\overline{k}})L+w}\right)$. We have $\left(\frac{dL}{dl}\right) = \left[1 + \tau(-b + (1-l))\right]$. Thus, the FOC can be written as

$$1 + E(\alpha_0)\ \left[-b + (1-l)\right] + E(\gamma_w)\ \left[1 + \tau\left(-b + (1-l)\right)\right] = 0, \tag{44}$$

where $E(\gamma_w)$ is given in equation (26).

Note that equation (44) looks very much like the FOC for banks' choice of liquidity with the slight difference that in the first expression, we have 1 instead of α_0, since banks can benefit from their liquid assets only when they survive, which happens with a probability of α_0, whereas the regulator always benefits from banks' liquid assets.

From here, we can find the socially optimal level of liquidity $\widehat{\widehat{l}}_w$ that satisfies the FOC as:

$$\widehat{\widehat{l}}_w = 1 - b + \frac{1 + E(\gamma_w)}{E(\alpha_0) + \tau E(\gamma_w)}, \text{ where} \tag{45}$$

$$\gamma_w = \begin{cases} 0 & for \quad k \leqslant \overline{k} \\ \alpha_0 \left(\frac{\alpha_1 \Delta}{\underline{p}}\right) & for \quad \overline{k} < k \leqslant \overline{\overline{k}} \\ \alpha_0 \left(\frac{\alpha_1 \Delta}{p_w^*(k)}\right) \left(\frac{w}{(1-k)L+w}\right) & for \quad k > \overline{\overline{k}} \end{cases} \tag{46}$$

We can show that a fixed point of the mapping in equation (45) exists and is unique.

Note that $\overline{k}$ and $\overline{\overline{k}}$ are continuos in l. Thus, $E(\gamma_w)$ is continuos in l. Hence, $\widehat{\widehat{l}}_w$ is continuos in l. Since, $\widehat{\widehat{l}}_w$ is a continuos function from the compact, convex set $[0,1]$ into itself, by Brouwer's fixed point theorem, a fixed point of the mapping in equation (45) exists. Next, we show that the fixed point is unique.

Note that as l increases, the aggregate level of liquidity increases, the region over which sales to outsiders take place shrinks, that is, $\frac{\partial \overline{k}}{\partial l} > 0$. Hence, we have $\frac{\partial E(\gamma_w)}{\partial l} < 0$. We have

$$\frac{\partial \widehat{\widehat{l}}_w}{\partial E(\gamma_w)} = \frac{E(\alpha_0) + \tau E(\gamma_w) - \tau \left[1 + E(\gamma_w)\right]}{\left[E(\alpha_0) + \tau E(\gamma_w)\right]^2} = \frac{E(\alpha_0) - \tau}{\left[E(\alpha_0) + \tau E(\gamma_w)\right]^2}.$$

Thus, for $E(\alpha_0) > \tau$, we have $\frac{\partial \widehat{\widehat{l}}_w}{\partial E(\gamma_w)} > 0$, which gives us $\frac{\partial \widehat{\widehat{l}}_w}{\partial l} < 0$. As a result, the fixed point is unique.

Next we analyze how the socially optimal level of liquidity l_w changes with outsider wealth w. Now, let

$$h = \frac{kw\underline{p}}{\left[(1-k)L + w\right]^2}. \tag{47}$$

Note that as the function h increases, $E\left(\gamma_w\right)$ and the socially optimal level of liquidity l_w increases. We have

$$\frac{\partial h}{\partial w} = \frac{k\underline{p}\left[(1-k)L + w\right]^2 - 2kw\underline{p}\left[(1-k)L + w\right]}{\left[(1-k)L + w\right]^4} = \frac{k\underline{p}\left[(1-k)L - w\right]}{\left[(1-k)L + w\right]^3}. \tag{48}$$

If $\frac{\partial h}{\partial w} < 0$ for $k \in [\overline{\overline{k}}, 1]$, then the socially optimal level of liquidity l_w decreases as outsider wealth w increases.

We have $\frac{\partial h}{\partial w} < 0$ when $w > (1-k)L$. For $k = 1$, this trivially holds.

For $k = \overline{\overline{k}}$, we have

$$w > \left(\frac{\underline{p} - w}{L + \underline{p}}\right) L \Longleftrightarrow w\left(L + \underline{p}\right) > \left(\underline{p} - w\right) L \Longleftrightarrow w > \left(\frac{L\underline{p}}{2L + \underline{p}}\right).$$

Hence, for $w > \left(\frac{L\underline{p}}{2L+\underline{p}}\right)$, we have $\frac{\partial h}{\partial w} < 0$ for $k \in [\overline{\overline{k}}, 1]$ and the socially optimal level of liquidity l_w decreases as outsider wealth w increases.

Proof of Proposition 9: We investigate how the difference between the privately and socially optimal levels of liquidity behaves as a function of τ and Δ.

Note that for $w \geqslant \underline{p}$, the actual value of w does not have an effect on the price. Hence, to simplify the notation, we suppress the subscript w in the expressions.

We have

$$\widehat{l} = 1 - b + \frac{E(\alpha_0) + E(\phi)}{E(\alpha_0) + \tau E(\phi)} \quad \text{and} \quad \widehat{\widehat{l}} = 1 - b + \frac{1 + E(\gamma)}{E(\alpha_0) + \tau E(\gamma)}. \tag{49}$$

Note that for regions where $k \in [0, \underline{k}]$ and $k \in [\overline{k}, 1]$, ϕ and γ are identical. However, in the interim range of failures, $k \in [\underline{k}, \overline{k}]$, surviving banks gain from asset purchases through cash-in-the-market prices while there is no social welfare loss since all banking assets are operated by the most efficient users. Thus, in this region, we have $\gamma = 0$ and $\phi > 0$. This implies that $E(\phi) > E(\gamma)$ for a given level of aggregate liquidity. Given these facts, we first prove part (i).

In the extreme case where $\tau = 1$, $E(\phi) = 0$ and $E(\gamma) = 0$, so that for all Δ,

$$\widehat{l} = 2 - b \leqslant \widehat{\widehat{l}} = 1 - b + \frac{1}{E(\alpha_0)}. \tag{50}$$

Since $\left(\widehat{\widehat{l}} - \widehat{l}\right)$ is continuos in τ, there exists a critical level $\tau^*(\Delta) \leqslant 1$, such that, for all $\tau > \tau^*(\Delta)$, socially optimal level of liquidity is higher than the privately optimal level of liquidity.

Next, for $\tau = 0$, we obtain that $\widehat{l} > \widehat{\widehat{l}}$ if and only if

$$h(\Delta) = E(\alpha_0) + E(\phi) - [1 + E(\gamma)] > 0. \tag{51}$$

For $\Delta = 0$, we know that $E(\phi) = E(\gamma) = 0$, so that $h(0) = E(\alpha_0) - 1 < 0$. Next, we have

$$\frac{\partial h}{\partial \Delta} = \frac{\partial h}{\partial \Delta}\left[E(\phi) - E(\gamma)\right], \tag{52}$$

which is greater than 0 as shown below.

We know that except for the region $k \in [\underline{k}, \overline{k}]$, ϕ and γ are identical. Thus we have:

$$E(\phi) - E(\gamma) = \int_{1-\overline{k}}^{1-\underline{k}} \phi f(\alpha_0) d\alpha_0. \tag{53}$$

Note that in this region, we have

$$\phi = \alpha_0 \left(\frac{(1-\alpha_0)\overline{p}}{\alpha_0 L} - 1\right) = \frac{\overline{p} - \alpha_0(\overline{p} + L)}{L} = \frac{\overline{p}}{L} - \frac{\alpha_0}{\underline{k}}. \tag{54}$$

Note that as Δ increases, $\underline{p}(= \overline{p} - (\alpha_1\Delta))$ decreases. Thus, $\overline{k}$ increases whereas $\underline{k}$ does not change. Hence, the interval $[\underline{k}, \overline{k}]$ widens and $(E(\phi) - E(\gamma))$ increases. Formally, using Leibniz's rule, we get

$$\frac{\partial\left(E(\phi)-E(\gamma)\right)}{\partial\Delta} = \phi(1-\underline{k})\left[\frac{\partial\left(1-\underline{k}\right)}{\partial\Delta}\right] - \phi(1-\overline{k})\left[\frac{\partial\left(1-\overline{k}\right)}{\partial\Delta}\right] + \int_{1-\overline{k}}^{1-\underline{k}} \frac{\partial\left(\phi\right)}{\partial\Delta} f(\alpha_0)d\alpha_0. \quad (55)$$

Note that $\phi(1-\underline{k}) = 0$. And since $\underline{k}$ does not change with $(\alpha_1\Delta)$, from equation (54), we have $\frac{\partial(\phi)}{\partial\Delta} = 0$. Thus, we have

$$\frac{\partial\left(E(\phi)-E(\gamma)\right)}{\partial\Delta} = -\phi(1-\overline{k})\left[\frac{\partial\left(1-\overline{k}\right)}{\partial\Delta}\right]. \quad (56)$$

Note that $\overline{k}$ increases with Δ so that $\left[\frac{\partial(E(\phi)-E(\gamma))}{\partial\Delta}\right] > 0$.

In other words, there exists a critical Δ^* such that $h(\Delta^*) = 0$ and $h(\Delta) > 0$ for all $\Delta > \Delta^*$, and $h(\Delta) < 0$ otherwise.

Since $\left(\widehat{\widehat{l}} - \widehat{l}\right)$ is continuos in τ, there exists a critical level $\tau^{**}(\Delta) \leqslant 1$, such that, for all $\tau \leqslant \tau^{**}(\Delta)$, the privately optimal level of liquidity is higher than the socially optimal level of liquidity.

Next, we prove part (ii). In fact, for any τ, a sufficient condition to obtain that $\widehat{\widehat{l}} > \widehat{l}$ is

$$h(\Delta) = E(\alpha_0) + E(\phi) - [1 + E(\gamma)] < 0.$$

As shown for $\tau = 0$, it is the case that $\frac{\partial h}{\partial\Delta}$ for all τ and $h(\tau, 0) < 0$.

It follows that there exists a $\Delta^*(\tau)$ such that for all $\Delta < \Delta^*(\tau)$, $h(\tau, \Delta) < 0$ and the socially optimal level of liquidity is higher than the privately optimal level of liquidity. Furthermore, $\Delta^*(0) > 0$ and $\Delta^*(1) = \Delta_{\max}$. $\diamondsuit$

Table 1
Panel A: Deals by Acquiring Nations

	1996	1997	1998	1999	2000	Total Obs.	Total %	Median Ent. Value	Median Trans. Value	% Domestic Acq.	% Foreign Acq.
Malaysia	214	172	137	144	86	753	51.58%	539	6	96.28%	3.72%
Singapore	32	29	44	84	52	241	16.51%	305	14	74.27%	25.73%
Thailand	10	17	34	21	19	101	6.92%	751	6	97.03%	2.97%
Philippines	25	8	7	32	19	91	6.23%	1222	12	96.70%	3.30%
United States	7	5	10	13	13	48	3.29%	121	14	0.00%	100.00%
Indonesia	11	14	12	4	3	44	3.01%	248	8	93.18%	6.82%
Hong Kong	3	10	7	4	6	30	2.05%	176	6	0.00%	100.00%
Japan	3	4	6	7	1	21	1.44%	17295	22	0.00%	100.00%
Australia	4	2	3	4	4	17	1.16%	9	4	0.00%	100.00%
Taiwan	0	0	5	2	4	11	0.75%	212	24	0.00%	100.00%
France	2	2	5	0	1	10	0.68%		26	0.00%	100.00%
United Kingdom	5	0	1	2	0	8	0.55%		8	0.00%	100.00%
Canada	0	2	2	1	2	7	0.48%		17	0.00%	100.00%
Germany	0	1	1	3	2	7	0.48%		38	0.00%	100.00%
Netherlands	1	1	2	3	0	7	0.48%		10	0.00%	100.00%
Switzerland	0	1	3	0	2	6	0.41%		5	0.00%	100.00%
China	0	2	1	1	1	5	0.34%		86	0.00%	100.00%
British Virgin	3	0	0	1	0	4	0.27%	118	11	0.00%	100.00%
Belgium	0	1	0	0	1	2	0.14%		90	0.00%	100.00%
India	0	0	2	0	0	2	0.14%			0.00%	100.00%
South Korea	0	0	0	1	1	2	0.14%		5	0.00%	100.00%
Vietnam	1	0	0	1	0	2	0.14%		4	100.00%	0.00%
Bermuda	0	0	0	1	0	1	0.07%			0.00%	100.00%
Cayman Islands	0	0	1	0	0	1	0.07%			0.00%	100.00%
Colombia	0	0	1	0	0	1	0.07%		100	0.00%	100.00%
Ireland-Rep	0	0	0	1	0	1	0.07%		847	0.00%	100.00%
Kuwait	0	1	0	0	0	1	0.07%		70	0.00%	100.00%
Luxembourg	0	0	0	1	0	1	0.07%			0.00%	100.00%
South Africa	0	1	0	0	0	1	0.07%			0.00%	100.00%
Spain	0	0	1	0	0	1	0.07%		3	0.00%	100.00%
Unknown	5	6	11	9	2	33	2.26%	2349	1	-	-
Total Obs.	326	279	296	340	219	1460	100.00%	425	9	77.60%	22.40%

Panel B: Deals by Acquirer Type

	1998				Years other than 1998			
Acquirer Type	Obs.	% Obs.	Size (Trans. Value)	% Size	Obs.	% Obs.	Size (Trans. Value)	% Size
Domestic	218	76.49%	4511.01	61.41%	916	80.21%	26292.83	80.52%
Within SE Asia (but not domestic)	16	5.61%	339.44	4.62%	82	7.18%	2243.23	6.87%
Foreign	51	17.89%	2495.21	33.97%	144	12.61%	4117.49	12.61%
Total	285	100.00%	7345.66	100.00%	1142	100.00%	32653.54	100.00%

Table 2: Summary Statistics of M&A Transactions

Panel A: Southeast Asian Acquirers

	All (1996-2000)			Excluding 1998			1998		
	Mean	Median	Std. Dev.	Mean	Median	Std. Dev.	Mean	Median	Std. Dev.
Shares Acquired (%)	73.13	100.00	34.90	71.34	100.00	35.18	81.17	100.00	32.52
Shares Owned (%)	76.12	100.00	33.21	75.02	100.00	33.26	80.83	100.00	32.65
Shares Sought (%)	71.09	100.00	35.83	69.90	100.00	35.76	76.12	100.00	35.77
Transaction Value ($mil)	53.76	8.56	143.86	54.98	9.40	148.16	47.55	3.98	120.05
Enterprise Value ($mil)	1520.37	561.45	2893.17	1376.62	491.62	2129.31	2194.16	586.25	5221.82
Equity Value ($mil)	518.71	178.02	1060.65	567.35	193.22	1118.56	262.03	55.91	640.65
Target Total Assets ($mil)	1687.33	656.40	2455.36	1434.22	506.85	1818.49	2446.68	969.00	3693.80
P/E	28.10	16.19	52.09	28.72	16.67	53.13	25.43	11.29	49.96
EV/EBITDA	56.56	32.20	72.45	53.89	32.96	59.97	76.53	19.43	142.48
Assets/EBITDA	84.18	27.65	276.95	65.99	26.46	221.85	166.83	35.25	448.54
4 week to 1 day return	0.09	0.01	0.38	0.09	0.03	0.29	0.07	-0.03	0.55
4 to 1 week return	0.05	0.00	0.29	0.04	0.01	0.19	0.08	-0.02	0.45

Panel B: Foreign Acquirers

	All (1996-2000)			Excluding 1998			1998		
	Mean	Median	Std. Dev.	Mean	Median	Std. Dev.	Mean	Median	Std. Dev.
Shares Acquired (%)	44.49	40.00	32.51	40.82	32.50	31.45	54.92	50.00	33.58
Shares Owned (%)	48.79	42.60	33.32	45.22	40.00	32.59	58.83	51.00	33.66
Shares Sought (%)	44.46	40.00	32.18	41.87	36.00	31.25	51.33	47.50	33.90
Transaction Value ($mil)	59.57	15.00	136.44	50.83	13.46	130.97	83.17	21.55	150.03
Enterprise Value ($mil)	3626.09	149.47	7916.19	3973.22	149.47	8679.27	2989.67	150.25	7008.61
Equity Value ($mil)	630.47	110.53	1695.15	825.00	121.29	2005.83	176.58	58.15	324.82
Target Total Assets ($mil)	2898.89	213.15	6748.81	3781.58	572.90	8000.90	1343.68	192.90	3255.83
P/E	57.25	28.10	70.90	80.05	35.60	85.88	23.04	20.88	13.62
EV/EBITDA	61.09	18.64	79.23	77.54	29.72	102.60	44.64	6.55	65.97
Assets/EBITDA	93.73	38.92	128.75	134.24	75.56	151.51	30.71	15.77	30.69
4 week to 1 day return	0.11	0.05	0.27	0.13	0.05	0.26	0.09	0.06	0.28
4 to 1 week return	0.10	0.05	0.25	0.09	0.04	0.23	0.11	0.06	0.29

Panel C: Ten Largest Transactions in Year 1998 (by Transaction Value)															
Target Name	Target Nation	Acquiror Name	Acquiror Nation	Shares Acq. (%)	Shares Owned (%)	Shares Sought (%)	Trans. Value ($mil)	Enterp. Value ($mil)	Equity Value ($mil)	Target Total Assets ($mil)	P/E	EV /EBITDA	Assets /EBITDA	4 week to 1 day return	4 to 1 week return
Post Office Savings Bank	Singapore	DBS Bank	Singapore	100	100	100	933								
Finl Sector Restructuring-BL	Thailand	Goldman Sachs(Asia)Ltd	China	100	100	100	645								
Financial Sector-Tranche ABCD	Thailand	General Electric Capital Corp	United States	100	100	100	497								
Bank Bumiputra Malaysia Bhd	Malaysia	Commerce Asset-Holdings Bhd	Malaysia	99.9	99.9	100	438								
Tat Lee Bank Ltd	Singapore	Keppel Bank of Singapore Ltd	Singapore	100	100	100	401	3986	402	6920	9			-48.00%	-12.31%
POSBank Tower,Singapore	Singapore	Pidemco Land Ltd	Singapore	100	100	100	277								
Thailand-Residential Mtg	Thailand	Lehman Brothers Holdings Inc	United States	100	100	100	275								
Thai Farmers Bank PCL	Thailand	GIC	Singapore		15	14.6	266	21296	2758	16473	166	366	283	-2.70%	-3.18%
Krungthai Thanakit Fin & Sec	Thailand	Krung Thai Bank PCL	Thailand	78.9	78.9	78.9	230	751	61	1014				0.55%	-2.28%
Finl Sector Restructuring-BL-5	Thailand	Kiatnakin Finance & Securities	Thailand	100	100	100	226								

Panel D: Ten Largest Transactions in years other than 1998 (by Transaction Value)															
Target Name	Target Nation	Acquiror Name	Acquiror Nation	Shares Acq. (%)	Shares Owned (%)	Shares Sought (%)	Trans. Value ($mil)	Enterp. Value ($mil)	Equity Value ($mil)	Target Total Assets ($mil)	P/E	EV /EBITDA	Assets /EBITDA	4 week to 1 day return	4 to 1 week return
DBS Land Ltd	Singapore	Pidemco Land Ltd	Singapore	75.1	100	75.1	1503	3145	2001	4555	14	30	44	12.95%	-0.91%
Public Bank-Commercial Banking	Malaysia	Hock Hua Bank Bhd	Malaysia	100	100	100	1423								
Far East Bank & Trust Co	Philippines	BPI	Philippines	100	100	100	1216	3908	1209	3468	25	55	49	19.56%	11.29%
CityTrust Banking Corp	Philippines	BPI	Philippines	100	100	100	909	1450	606						
Kwong Yik Bank Bhd	Malaysia	Rashid Hussain Bhd	Malaysia	75	75	75	854	3819	1141						
Keppel TatLee Bank Ltd	Singapore	Allied Irish Banks PLC	Ireland-Rep	24.9	24.9	24.9	847			12138			178	4.62%	3.26%
Philippine Commercial Intl Bk	Philippines	Investor Group	Philippines		72	72	846	4124	1175	3783	17	48	44	19.31%	-1.13%
DBS Bank	Singapore	Brandes Investment Partners	United States	6.9	6.9	6.9	744	27674	7660	39021	33				
Hicom Holdings Bhd	Malaysia	Diversified Resources Bhd	Malaysia	65.79	96.3	65.8	714			1617			34	21.58%	17.99%
Renong Bhd	Malaysia	UEM Bhd	Malaysia	32.6	32.6	32.6	685	3980	2071	5190	10	37	49	-9.22%	-3.86%

Table 3: Mean % Shares Acquired Across Time and Acquisition Types

Year	SE Asian; Within-industry	SE Asian; Across-industry	Foreign; Within-industry	Foreign; Across-industry
1996	69.33	73.82	34.58	58.32
1997	68.14	72.92	27.39	40.92
1998	**80.86*** **	**81.36*** **	**54.36***	**55.46** **
1999	70.11	71.15	53.87	28.89
2000	72.77	71.10	43.62	42.66
Overall	71.72	74.16	44.32	44.67

(***: 1%; **: 5%; *: 10% significance; H0: Mean(1998)=Mean(excluding 1998))

Table 4: Mean Assets/EBITDA of Targets Across Time and Acquisition Types

	SE Asian acquirers		Foreign acquirers	
Year	Within-industry	Across-industry	Within-industry	Across-industry
1996	22.47	45.35	DATA MISSING	DATA MISSING
1997	42.91	40.65	74.12	103.56
1998	**85.49**	**213.31**	**44.16**	**23.98** **
1999	61.34	32.23	318.02	70.99
2000	206.12	67.79	104.97	88.25
Overall	89.17	79.80	138.08	53.07

(***: 1%; **: 5%; *: 10% significance; H0: Mean(1998)=Mean(excluding 1998))

Table 5: Mean Target Size Measures Across Acquisition Types

	Within-industry			Across-industry		
	SE Asian Acquirer	Foreign Acquirer	Diff	SE Asian Acquirer	Foreign Acquirer	Diff
Enterprise Value ($mil)	**1087.9**	**2435.93**	**1348.03**	**1907.79**	**4684.01**	**2776.22**
Total Assets ($mil)	**1312.57**	**3400.54**	**2087.97** **	**2033.27**	**2518.85**	**485.58**
Equity Value ($mil)	435.08	263.32	-171.76	578.26	1079.22	500.96

(***: 1%; **: 5%; *: 10% significance; H0: Diff = 0)

Table 6: Differences in Mean Target Size and Performance Measures Across Acquisition Types

		Enterprise Value ($mil)	Equity Value ($mil)	4 week to 1 day return	4 week to 1 week return
SE Asian Acquirer	Within-industry (A)	1087.9	435.08	9.93%	5.75%
	Across-industry (B)	1907.79	578.26	7.73%	4.18%
	Diff (B-A)	**819.89**	**143.18**	**-2.20%**	**-1.60%**
Foreign Acquirer	Within-industry (C)	2435.93	263.32	9.57%	8.63%
	Across-industry (D)	4684.01	1079.22	12.87%	10.94%
	Diff (D-C)	**2248.08**	**815.9**	**3.30%**	**2.31%**
Diff of Diff	**Diff(D-C) -Diff(B-A)**	**1428.19**	**672.72**	**5.50%**	**3.91%**

Table 7: Cross-country Data on Bank Liquidity, Financial Development and Stock-market Liquidity

Country	Liquidity ratio	Accounting standards	Total cap/GDP	Dom. Credit/GDP	Deposits/GDP	Stock market cap.	Turnover in Domestic Market	Amihud Illiquidity ratio	Prop. of Zero return days
United States	6.50				0.17	1.52			
Argentina	126.40				0.24	0.15	0.4	1.67	0.48
Armenia	34.70								
Australia	1.31	75	0.82	0.28	0.49	1.13			
Austria	16.43	54	1	0.77	0.7	0.17			
Bangladesh	28.31		0.2	0.07					
Belgium	50.42	61	0.65	0.29	0.85	0.82			
Bolivia	17.30								
Bosnia-Herzigova	16.80								
Brazil	98.60	54	0.33	0.23	0.17	0.45	0.33	0.61	0.4
Bulgaria	29.10								
Canada	14.01	74	0.98	0.45	0.61	1.22			
Chile	20.99	52	0.74	0.36	0.19	1.05	0.09	1.12	0.5
Colombia	33.00						0.1	1.31	0.63
Costa Rica	28.06		0.53	0.26					
Croatia	37.10						0.05		
Denmark	12.43	62	0.56	0.42	0.54	0.67			
Dominican Republic	33.10								
Egypt	41.40	24	0.74	0.21	0.51	0.29	0.3	1.18	0.2
El Salvador	31.30								
Finland	12.79	77	0.52	0.48					
France	31.00	69	0.7	0.54	0.47	1.17			
Germany	34.00	62	1.08	0.78	0.35	0.67			
Greece	27.28	55	0.47	0.44			0.6	1.02	0.23
Guatemala	32.50								
Honduras	25.80								
Hungary	46.00						0.65	1.21	0.28
India	44.90	57	0.5	0.24	0.09	0.46	0.34	2.07	0.23
Indonesia	69.80						0.96	1	0.55
Israel	18.34	64	1.18	0.67			0.26	0.27	0.15
Italy	21.46	62	0.98	0.42	0.28	0.68			
Jamaica	72.20								
Japan	21.00				0.53	0.95			
Jordan	53.20						0.13		
Kenya	39.70								
Korea	13.59	62	0.63	0.5			3.87	0.24	0.17
Lithuania	37.80						0.11	3.64	0.66
Malaysia	23.69	76	1.19	0.48			1.29	0.57	0.25
Mexico	53.50	60	0.39	0.16			0.32	0.26	0.27
Moldova	33.40								
Morocco	36.90								
Netherlands	19.17	64	0.91	0.6	0.69	2.03			
New Zealand	7.20	70	0.59	0.19					
Nicaragua	67.20								
Nigeria	65.20								
Norway	7.18	74	0.63	0.34	0.49	0.7			
Pakistan	50.85		0.53	0.25					
Paraguay	39.00								
Peru	39.00	38	0.28	0.28			0.75	1.33	0.51
Philippines	36.60	65	0.46	0.28			0.71	1.41	0.46
Poland	38.60						0.78	1.21	0.27
Portugal	8.42	36	0.82	0.52			0.27	1.19	0.43
Romania	54.50						0.24	1.26	0.75
Russia	45.90						0.28	1.67	0.69
Singapore	30.07	78	1.96	0.57					
South Africa	13.70					1.2	0.22	0.44	0.37
Spain	24.98	64	1.02	0.76	0.21	1.2			
Sri Lanka	29.08		0.44	0.21					
Sweden	0.49	83	0.79	0.42	0.71	0.69			
Switzerland	10.17				0.39	1.77			
Tanzania	35.40								
Turkey	71.13	51	0.35	0.14			2.09	0.3	0.42
Uganda	62.26								
UK	2.00	78	0.78	0.25	0.39	2.25			
Ukraine	18.00								
Venezuela	49.29	40	0.34	0.3			0.13	0.78	0.52
Zimbabwe	25.75		1.01	0.3			0.13	1.21	0.56

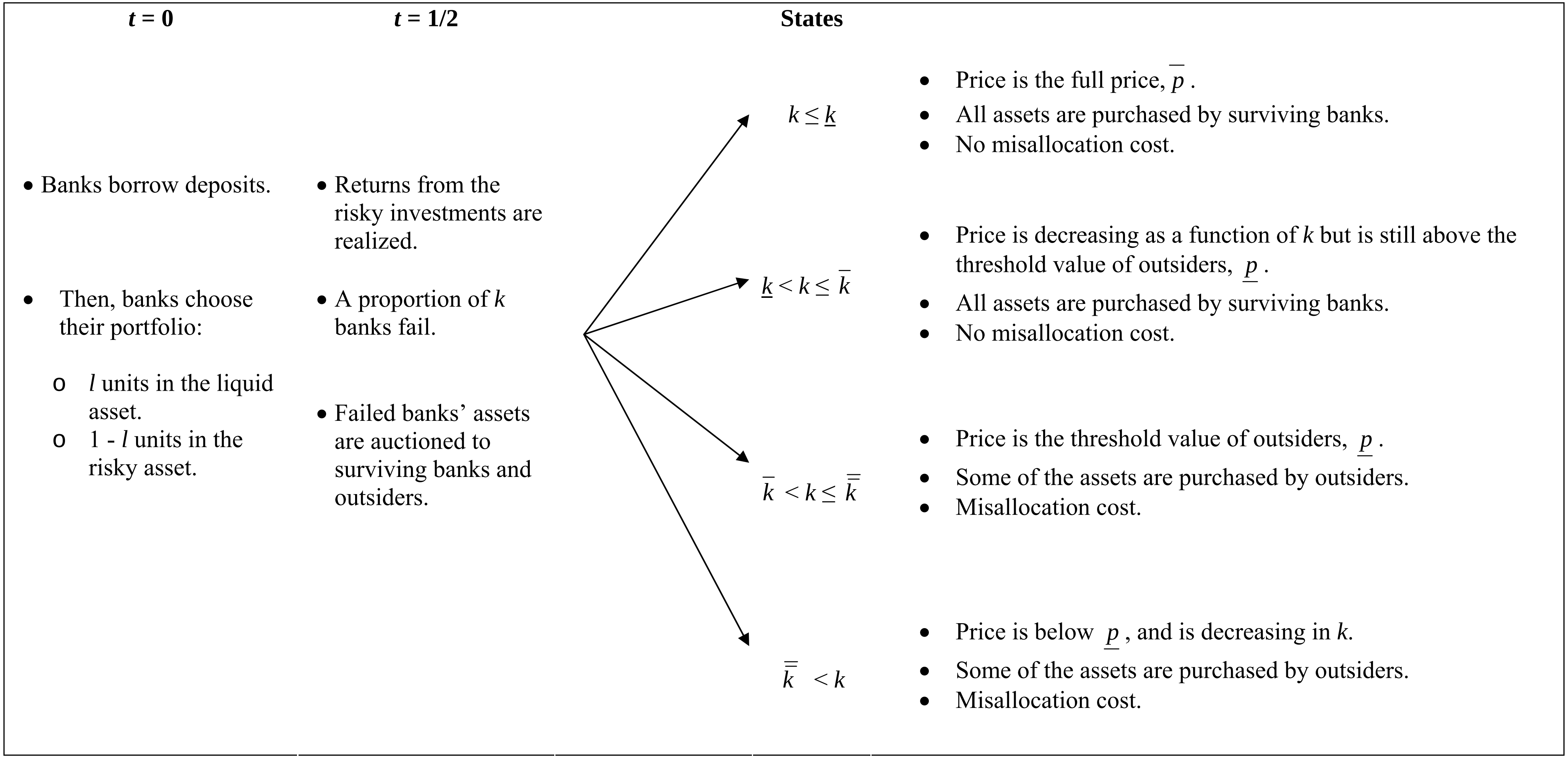

Figure 1: Timeline of the model.

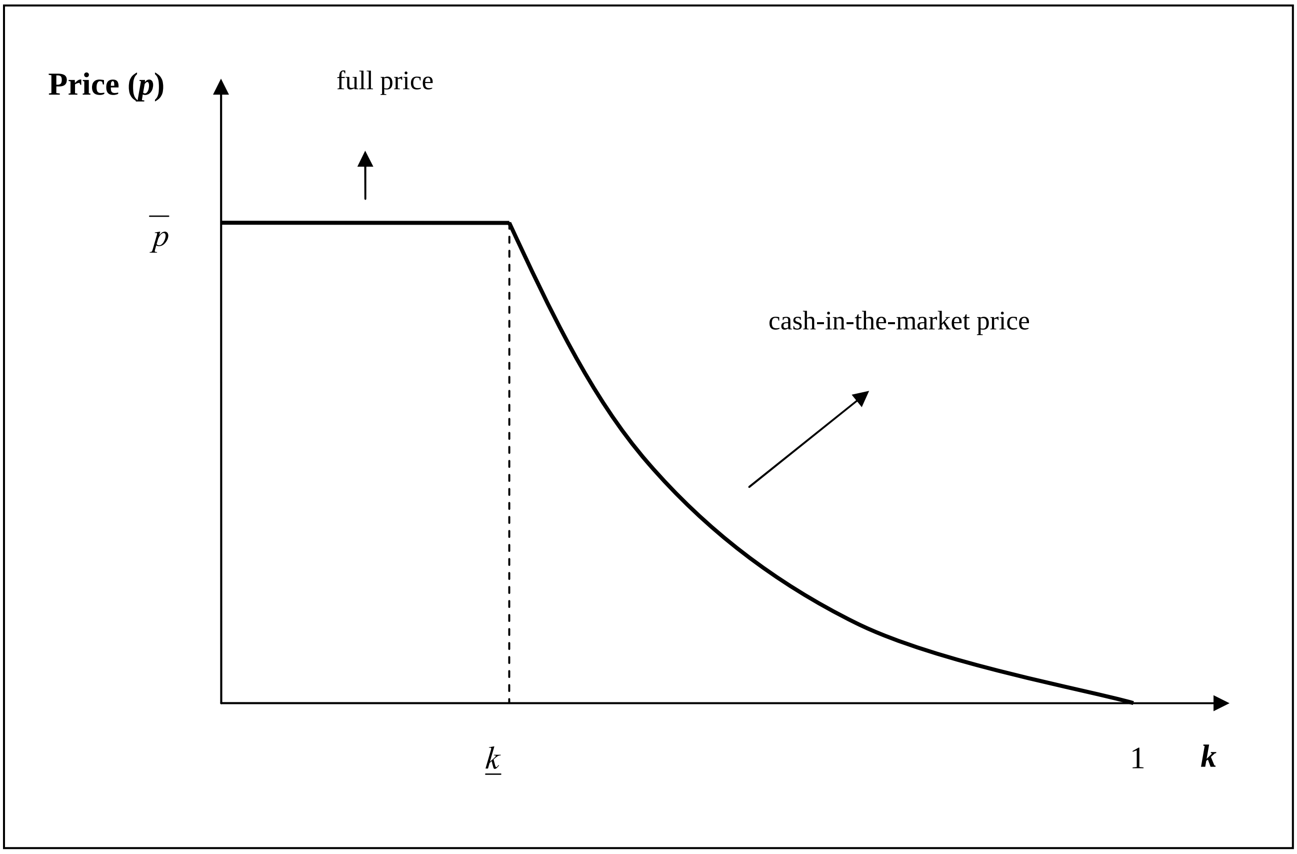

Figure 2: Price in Proposition 1.

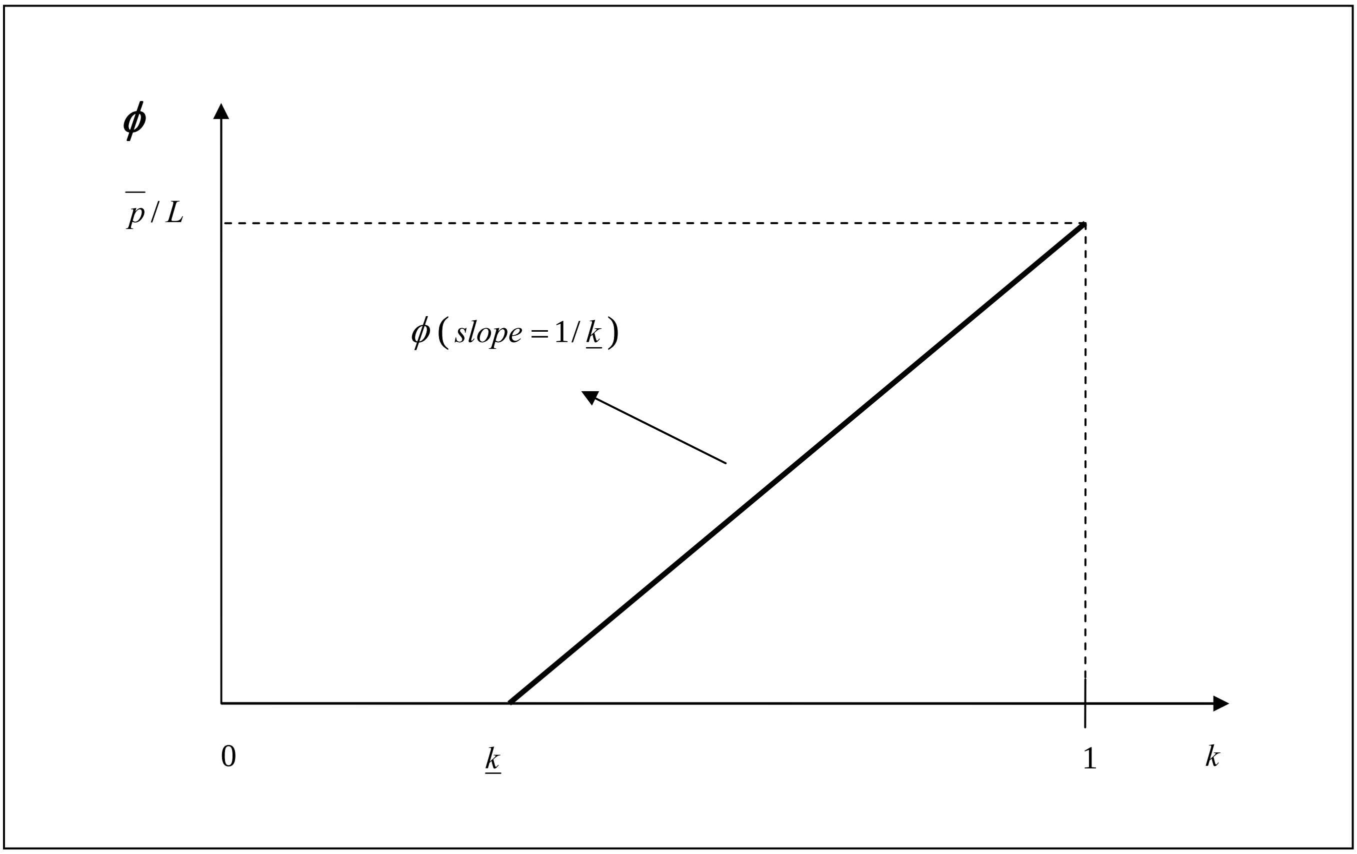

Figure 3: Marginal private (ϕ) benefit from the liquid asset (no outsiders).

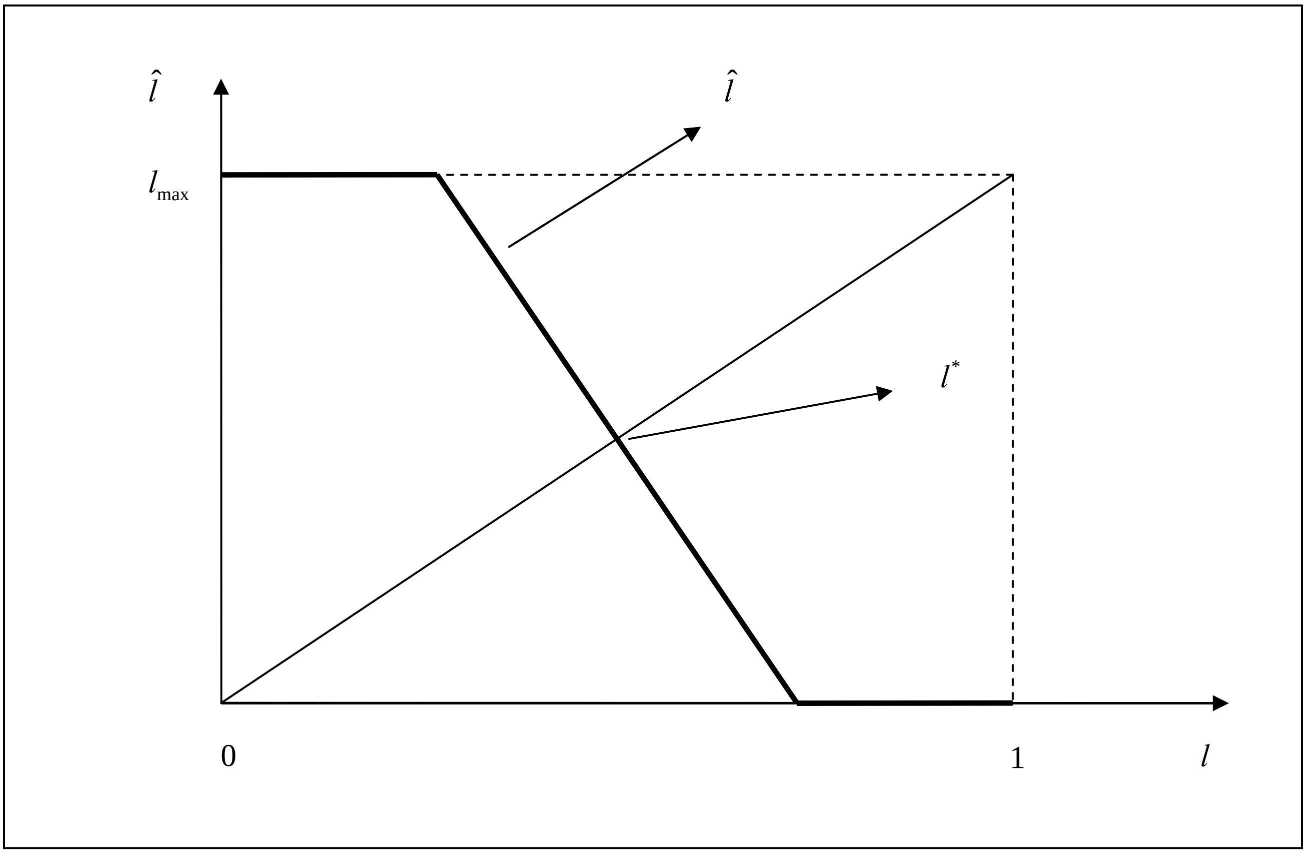

Figure 4: Privately optimal choice of liquidity and the equilibrium (Proposition 2).

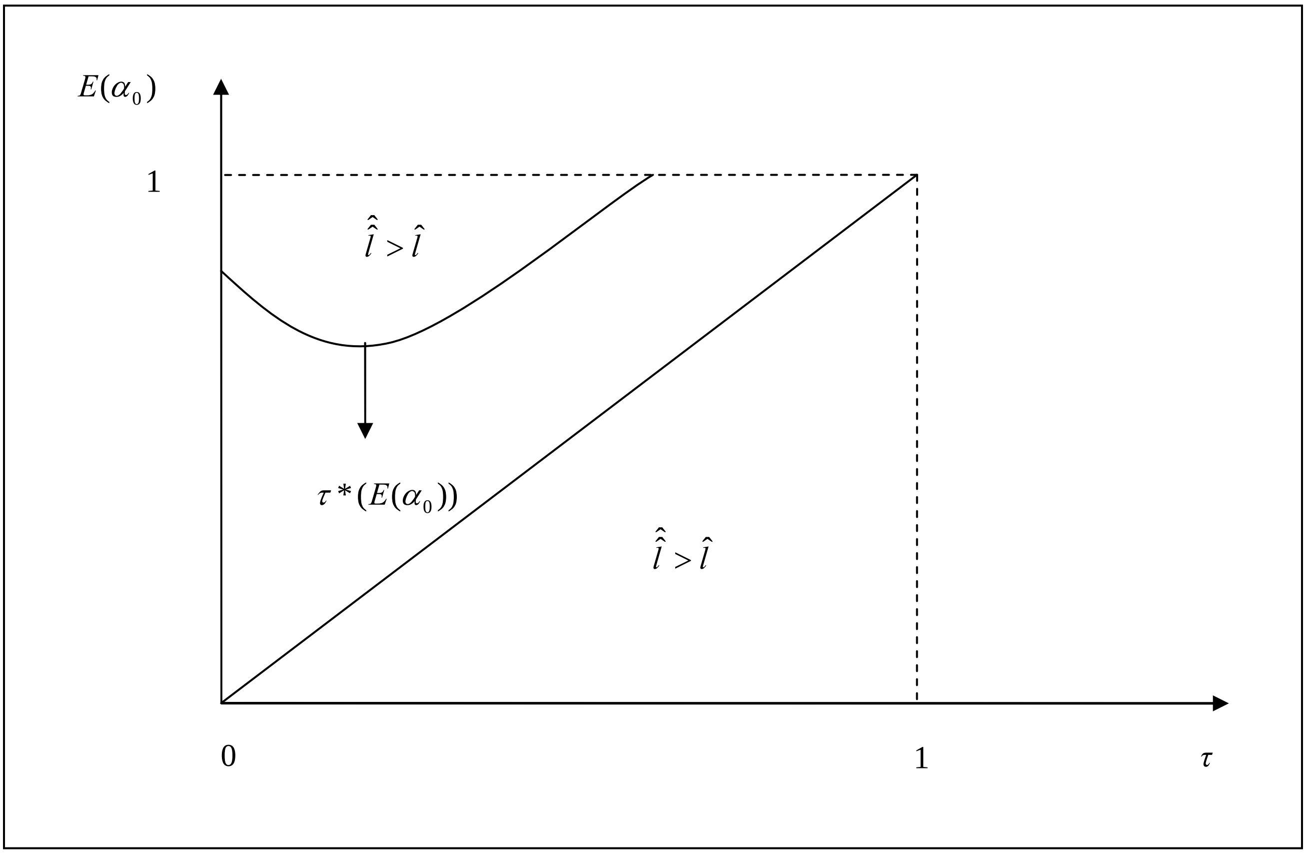

Figure 5: Comparison of privately and socially optimal levels of liquidity.

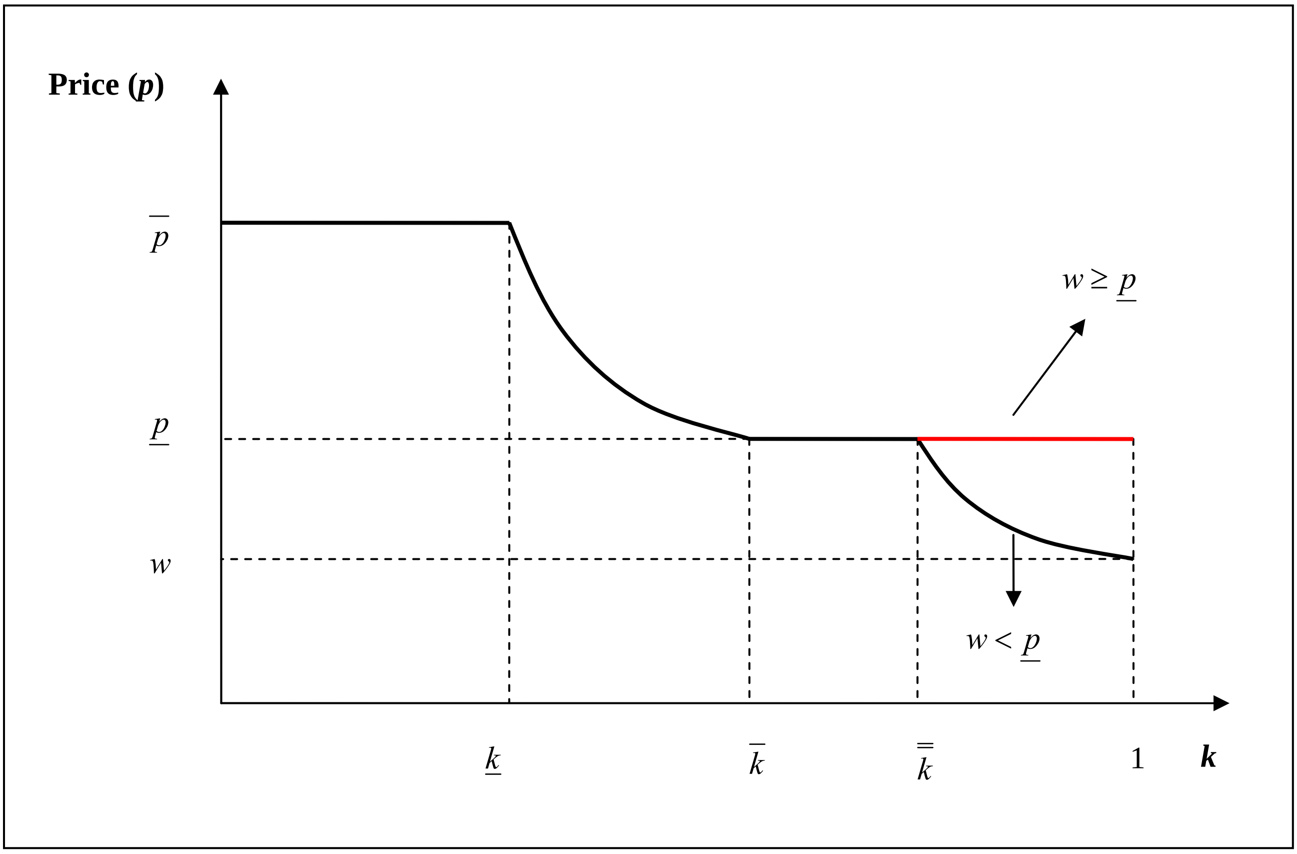

Figure 6: Price in Proposition 6.

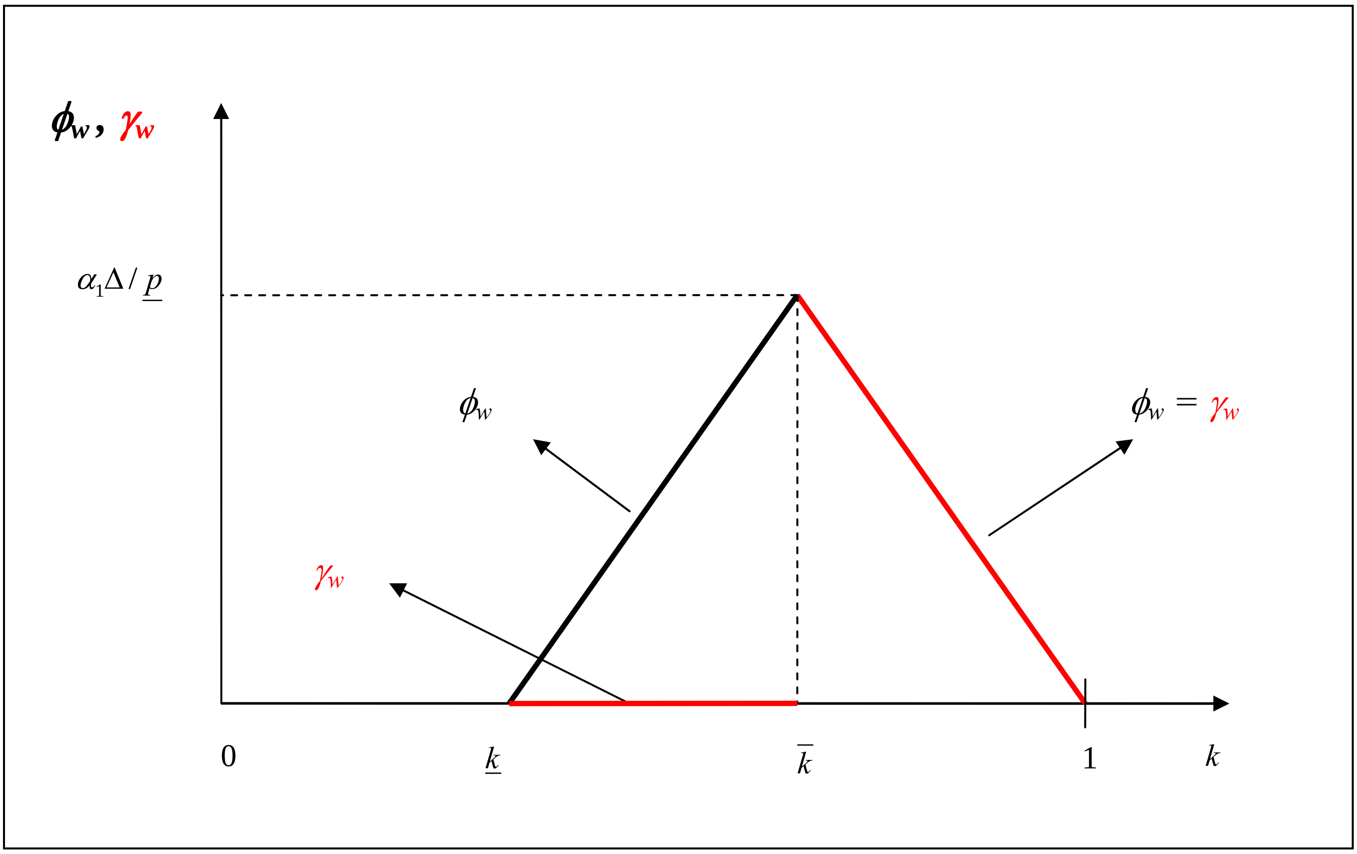

Figure 7: Marginal private (ϕ_w) and social (γ_w) benefit from the liquid asset for $w \geq \underline{p}$.

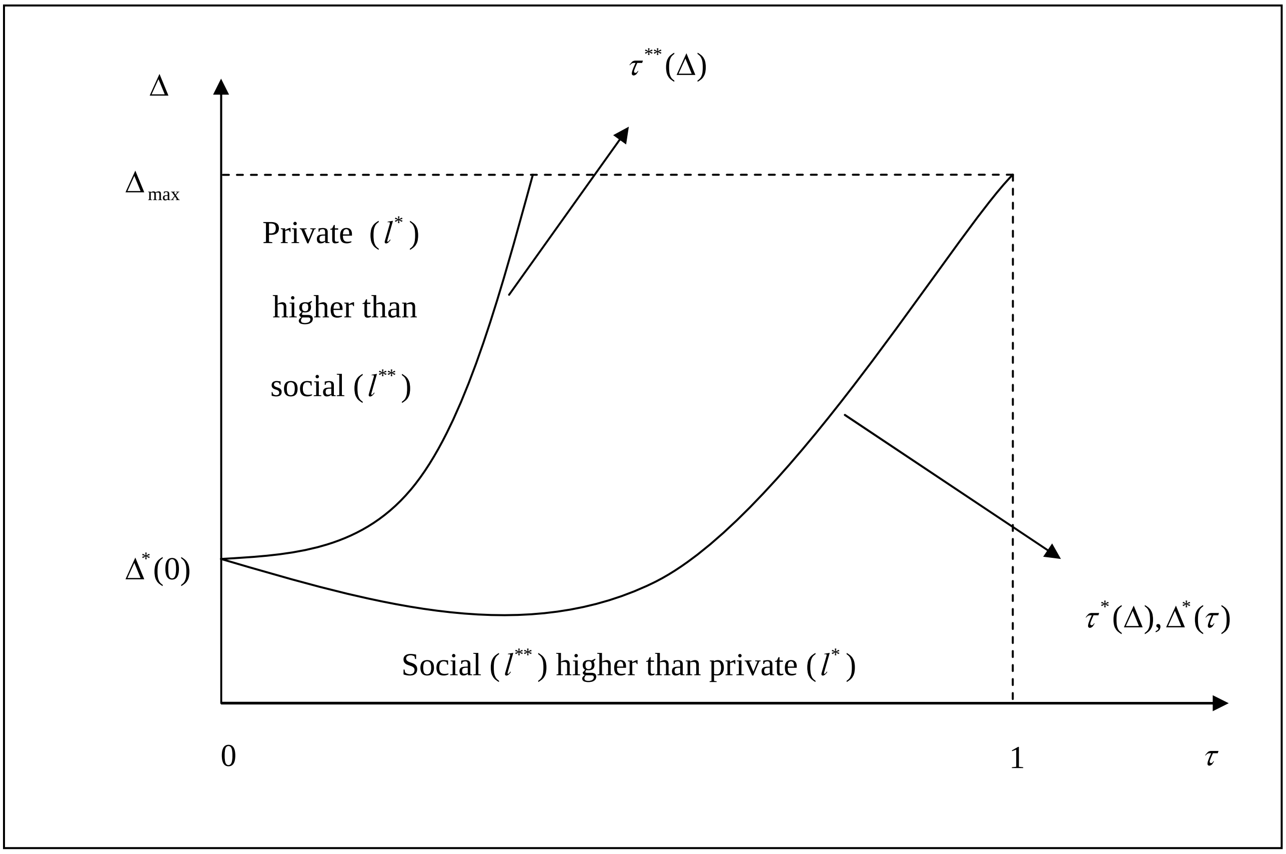

Figure 8: Comparing socially and privately optimal levels of liquidity (Proposition 9).

Figure 9: Percent of Foreign Acquisition Each Year

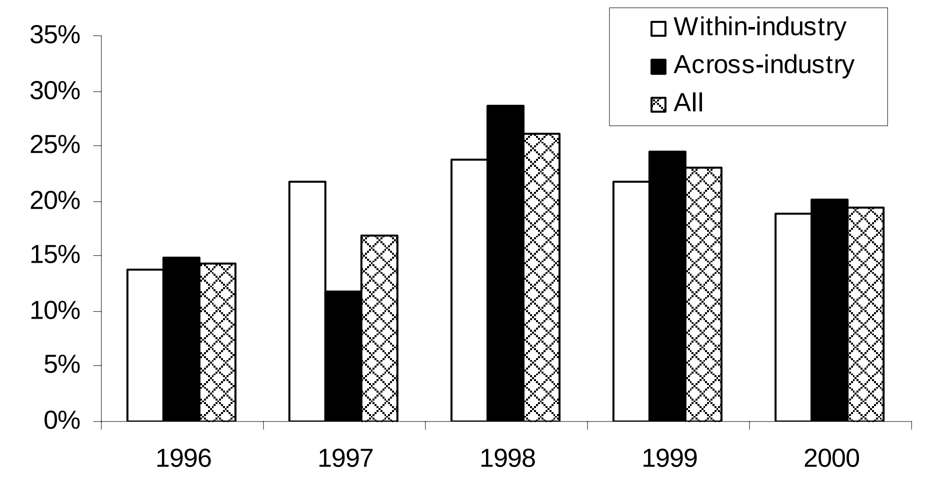

Figure 10: Percent of Total Acquisition Each Year with Foreign Acquiror

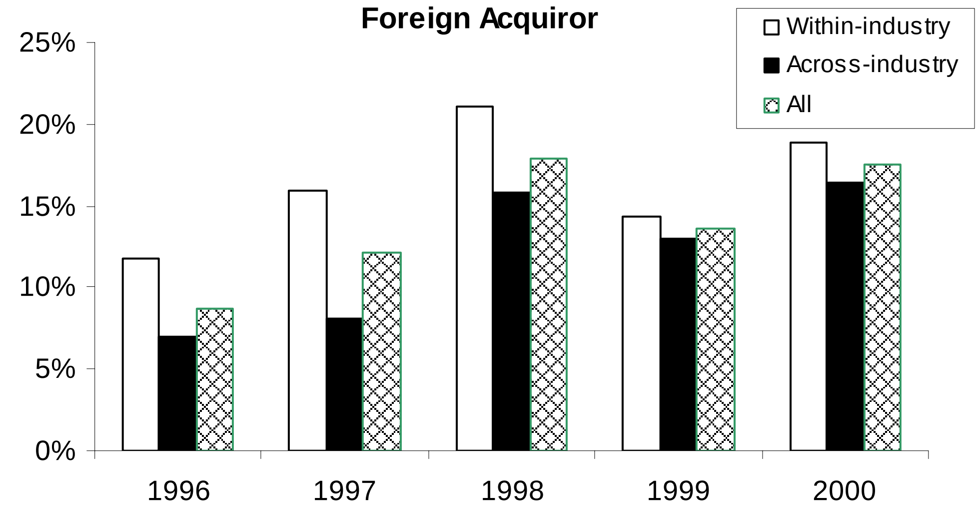

Figure 11: Liquidity ratio and its Fitted value vs Accounting standards

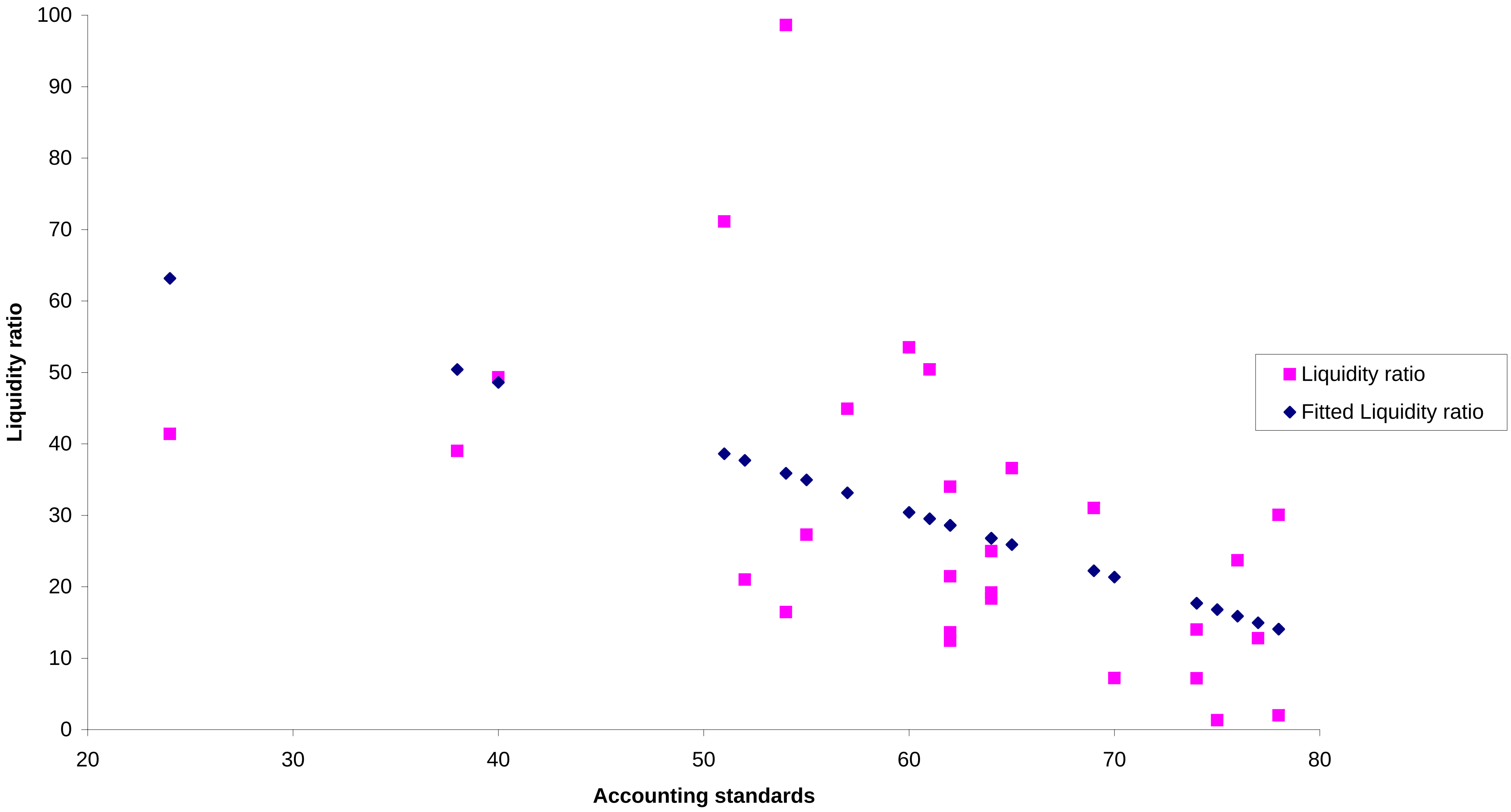

Figure 12: Liquidity ratio and its Fitted value vs Total Cap to GDP ratio

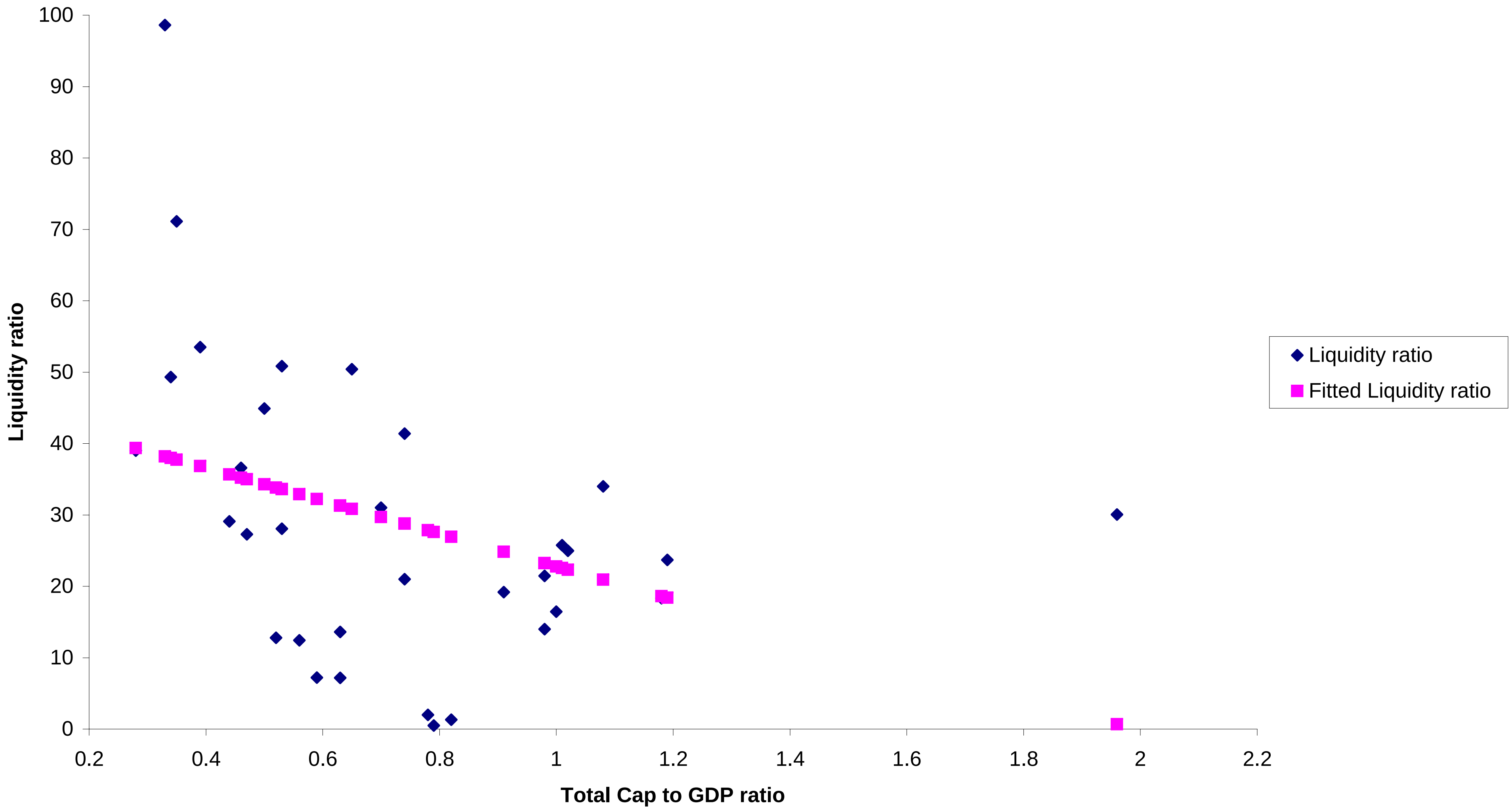

Figure 13: Liquidity ratio vs Stock market illiquidity (% Zero return days)