TEACHING NOTE

Bank Runs and the Accounting for Illiquid Assets in Financial Institutions

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ABSTRACT Financial services are an increasingly important sector in modern economies, yet many accounting and auditing texts focus on manufacturing and retailing. This teaching note describes the role of financial institutions in transforming long-term, difficult-to-sell assets into short-term bank accounts. This is referred to as liquidity transformation. The social benefits and risks of liquidity transformation are described. The social benefit occurs due to the increased liquidity provided by the bank to depositors. The risk comes in the form of a bank run, wherein difficult-to-sell assets cannot be redeemed in time to cover the rapid and unexpected withdrawals of depositors. The financial statements of a financial institution are presented and the issue of valuation is discussed. Finally, practical relevance for accounting students is enhanced by including discussions of historical precedents and of implications for financial reporting and auditing.

KEY WORDS: Banking, liquidity transformation, accounting, auditing

First of all, let me state the simple fact that when you deposit money in a bank the bank does not put the money into a safe deposit vault. (Franklin Roosevelt, First Fireside Chat, 12 March 1933)

1. Introduction

Financial services, such as banking, merchant banking and insurance, have become an increasingly important part of modern economies. Figure 1 displays financial services
and durable goods as a percentage of GDP in the United States from 1970. The contribution to GDP from financial services has doubled while the contribution from durable goods has been steady or slightly declining. Perhaps even more telling, from 1986 to 2006 the percentage of overall corporate profits derived from financial services increased from 10% to 33% (Palma, 2009). Despite this growth, many auditing texts still focus on industrial or retailing firms. This is unfortunate, as financial institutions present many unique challenges to accountants and auditors not present in other types of firms. One of those challenges is valuing assets that cannot be sold quickly without a substantial loss in value, i.e. illiquid assets. In this note we explore why financial institutions choose to hold illiquid assets and why the valuation of those assets can be problematic.

In order to illustrate the issues surrounding the accounting for illiquid assets, this paper presents a highly accessible yet formal model based on Diamond and Dybvig (1983) and Diamond (2007). The model provides an economic rationale for the existence of a financial intermediary that enters into liquidity transforming transactions. Liquidity transformation is the process by which banks use depositors’ money to acquire long maturity, difficult-to-sell, assets, such as commercial mortgages, but still allow depositors the right to immediately withdraw funds. In this way the long maturity, illiquid assets held by the bank are ‘transformed’ into short maturity, liquid assets (bank accounts) held by depositors. The model is used to demonstrate why liquidity transformation is valuable to society, and hence why financial institutions who perform liquidity transformation arise.

The model is also used to illustrate the risks faced by institutions that perform liquidity transformation and the way those risks interact with the functions of accounting and auditing. Specifically, valuation of assets is critically dependent on the somewhat unpredictable behavior of depositors. The reason is the assets held by the institution cannot be sold

Figure 1. Durable goods and financial services as a percent of US GDP (Source: National Income and Product Accounts, Bureau of Economic Analysis, United States Department of Commerce).
quickly without substantial loss. Therefore, a sudden demand by depositors for redemption of their accounts, commonly referred to as a bank run, can lead to assets yielding much less upon sale than originally anticipated. In addition, attempts to fully extract the benefits of liquidity transformation increase the exposure of the institution to the potential of bank runs. After presenting the model, we discuss its implications for both financial reporting and auditing.

This note has been used in both Undergraduate Honors Accounting and Masters of Accounting Programs. Students in the Masters of Accounting Program are generally finishing up a five-year course of study where they earn a Bachelors and a Master’s degree. Their fifth year includes a course that has a module on financial services. They were assigned the note in order to understand the theory. Subsequently, they presented real world cases to the rest of the class. Some of these cases are discussed below. Students in the Honors Undergraduate Program expect to be exposed to research at least occasionally, and this note is part of that exposure. Students at all levels prepare for the lesson by reading Section 2 of this note and by participating in classroom discussion of the issues.

We recently assigned the note to Honors students. After reading the note and participating in a classroom discussion, the students were asked to answer several questions. When asked how the note changed the student’s view on banking, 93% responded with ‘some’ or ‘a great deal’. When asked how understandable the paper was, 100% responded with ‘somewhat’ or ‘very’. Finally, when asked to what extent the student would like to learn more about banking after reading the paper, 100% responded with ‘somewhat interested’ or ‘very interested’. In addition we designed five questions to test student comprehension, which appear in the Appendix. Students chose the correct answers more frequently than any of the others, with an accuracy rate ranging from 65% to 90%. Our experience and the results of the survey questions indicate that, for Masters students and ‘select’ undergraduate students, the note is sufficiently understandable and enhances interest in a topic not often covered in traditional accounting texts.

The rest of the note is organized as follows. Section 2 presents the case materials that are meant for the students. The case materials begin with historical accounts of two bank runs, to highlight the practical relevance of the topic and then proceed to the model and its implications for accounting. A discussion of auditing issues related to liquidity transformation is also included. Section 3 discusses some further implementation issues, including suggestions for additional lesson material and Section 4 concludes the note.

2. Case Materials

This case involves several accounting and auditing issues related to banks and other financial institutions. Banks are a type of financial intermediary. By intermediary we refer to a person or organization that acts as a go-between for the principals to a transaction; however, in a legal sense, banks often becomes principals themselves. Banks act as financial intermediaries when performing such tasks as screening potential borrowers to determine if they are creditworthy enough to receive depositor’s funds, monitoring existing borrowers to reduce delinquent payments, or providing convenience services such as currency exchange. Banks earn profits through fee-based services and by lending at a higher rate than they borrow.

One particularly important function of banks is to act as an intermediary between depositors who want easy access to their deposits and borrowers who cannot guarantee quick repayment. More specifically, banks invest depositors’ savings in high-yield low-liquidity assets, such as unsecured business loans and commercial mortgages, while offering depositors quick access to funds and guaranteed returns. This service is important
because depositors typically need ready access to at least a portion of their savings and would otherwise be forced to hold non-interest bearing currency. At the same time, borrowers would have very limited funding if they could only borrow from those with deep pockets and a long time horizon. The model we feature in this case highlights how banks can create an asset (bank deposits) with a combination of liquidity and yield that would not otherwise be available. Importantly, this activity is to the benefit of its depositors and would be available even if the bank had no advantages over investors in the form of economies of scale (on screening and monitoring of investments) or diversification. This type of financial intermediation is what economists refer to as liquidity transformation.

Liquidity transformation, although valuable, is not without risks. Because it is difficult to sell illiquid assets quickly, banks face problems if too many customers attempt to withdraw their deposits in a short period of time. In order to pay depositors the bank might need to sell illiquid assets at a significant loss relative to their value at maturity. A period of extremely rapid and unexpected depositor withdrawals can ruin an otherwise solvent bank and can spread to other banks as those depositors fear their bank may be the next to fail. From an accounting and auditing perspective, the issues are how likely is a bank to face rapid withdrawals and how able is the bank to withstand the pressure from depositors? These issues are particularly tricky because they involve the somewhat unpredictable behavior of numerous parties, particularly depositors, regulators and central banks.

2.1. Historical Bank Runs

Before introducing the more formal economic rationale for liquidity transformation, two historical accounts of banks facing bank runs are described. The experiences of these banks will help to illustrate the somewhat precarious position faced by financial institutions that perform liquidity transformation. In both instances, the bank in question was clearly solvent before the run began. That is, given enough time, their assets would have been sufficient to pay off depositors. Despite their solvency, each faced an existential crisis. In the first account, the bank in question got caught up in a general financial panic and simply was next in line for a run. In the second account, the bank was struck by a reckless, random rumor. While the first bank recovered, the second bank never did. We end with a brief description of AIG in the recent financial crisis, to illustrate that ‘bank’ runs are not limited to banks, but can occur at any institution acting as a financial intermediary.

2.1.1. Trust Company of America (1907). The event commonly referred to as the ‘Panic of 1907’ began when speculators tried to short corner the market on a copper mining stock and failed. As a result, two brokerage firms involved in the speculation closed and depositors shifted their funds from those banks involved with lending to the speculators to banks not affiliated with the speculators. The panic spread to Knickerbocker Trust Company of New York. Knickerbocker had not directly participated in the speculation, but its President was a known associate of the speculators. The run on Knickerbocker began on the morning of 22 October 1907 as depositors lined up for blocks to withdraw their deposits. The trust failed by the afternoon. The run occurred despite recent certification by New York State bank examiners of the trust’s solvency.

The panic then spread to the Trust Company of America. Although not in any way associated with the failed speculation or the speculators, the Trust Company of America had the President of Knickerbocker Trust on its board of directors and, in October 1907, it took very little for an institution to become suspect. Runs were also developing or
threatening to develop at a number of other New York City institutions as depositors were quick to seize on any reason to withdraw funds. In response, John Pierpont (J. P.) Morgan, the dean of American financiers (there was no central bank in the United States at the time), arranged a meeting in the early morning hours of 23 October 1907. At the meeting, Morgan was joined by Secretary of the US Treasury George B. Cortelyou, First National Bank President George F. Baker, National City Bank President James Stillman, and J. P. Morgan partner George W. Perkins. Morgan also asked his 35-year-old protégé, Benjamin Strong, who later became the highly respected first president of the Federal Reserve Bank of New York, to assemble a team at once to examine the Trust Company of America. He requested a full report in his office by noon that day.

Before its opening on the morning of the 23 October, nearly 1200 depositors lined up outside the Trust Company of America’s main office, in a line stretching five blocks. Its president, Oakleigh Thorne, was doubtful he could keep its doors open until the end of business at 3 pm; his cash reserve had dwindled from US$2.5 million before the panic to US$1.2 million at the open of business on Wednesday. He strategically kept only two teller windows open to slow the run and arranged to have large piles of cash on view to assuage fears. However, in a replay of the prior day’s events at the Knickerbocker, depositors continued to panic. Twenty minutes after the open, Thorne called on Morgan, his cash reserves were now down to US$800,000. Unless he could raise US$3 million, he would have to close the trust. In the meantime, Benjamin Strong reported to Morgan that the company was solvent and that its capital was not greatly impaired. At 2:15 pm, Thorne called Morgan again and said he only had US$180,000 left and was ready to cease operations. Morgan instructed Thorne to meet with him immediately, and to bring along his company’s most valuable securities. Morgan assessed the securities, and determined that enough collateral was available to save the bank. Every few minutes, money from J.P. Morgan, National City and others was carried in sacks and taken directly to the Trust Company of America’s vault. The doors stayed open until 3 pm and the trust had been saved.

Morgan thought he had stopped the panic with Trust Company of America, however waves of fear rippled through the market for weeks. Before the panic ended, both the solvency of New York City and the continued operations of the New York Stock Exchange were threatened. After the panic subsided, Congress held hearings on the fragility of the banking system. The ultimate result of the hearings was the creation of the Federal Reserve System, the United States’ first true central bank.

2.1.2. Continental of Illinois (1984). At the beginning of 1984, the Continental Illinois National Bank and Trust Company (Continental) was the seventh largest bank in the United States and the largest in its interior. Continental lost money during the second quarter of 1982, due to the participation in $1 billion of loans originated by the reckless Penn Square Bank of Oklahoma. However, relative to its size, it was a manageable loss, which makes the events that followed of great interest.

Journalist Shana Alexander once said: ‘trying to squash a rumor is like trying to unring a bell’. Continental was about to find out how true that was. On Sunday morning, 6 May 1984, on the news program The McLaughlin Group one of the journalists, upset over recent moves at the Federal Reserve, concluded: ‘The only thing that’s going to get Volcker to loosen up would be a bank failure – maybe something like the Continental Illinois in Chicago.’ On Tuesday 8 May, an unnamed Reuters correspondent asked Continental to comment on rumors that the bank was on the road to bankruptcy. A mid-level manager condemned the story as ‘totally preposterous’. Reuters printed his denial, but in a way that gave the rumor creditability. Anxious overseas depositors began to shift
their deposits away from Continental. The Japanese banks alone withdrew US$1 billion on 9 May. The crisis seemed to settle down for a day or two, but on Friday 11 May, Continental lost another US$3.6 billion in deposits from its European clients. In an effort to calm the situation, C. Todd Conover, the Comptroller of the Currency, took the extraordinary step of issuing a statement denying the agency had sought assistance for Continental. During the weekend, Continental attempted to solve its problems by obtaining a US$4.5 billion loan package provided by 16 banks – this only deepened depositors’ suspicions. Despite the denials and the aid packages, the run continued; in fact, each announcement meant to ease depositors’ fears made the run worse.

As the situation continued to deteriorate, bank regulators were faced with a potential crisis that might envelop the entire banking system. The FDIC, which would bear the brunt of any major banking panic, became particularly worried. FDIC Chairman William Isaac met with Conover and Federal Reserve Chairman Paul Volcker to inform them he had decided to take action. On 17 May 1984, Continental announced that a group of 28 American banks, together with the FDIC, had agreed to provide assistance in a total of US$7.5 billion. The Fed also committed to meet any extraordinary liquidity requirements – all depositors would be covered. The bank was saved, but it was never again the major financial institution it had been. This treatment accorded Continental was soon given the pejorative label ‘too big to fail’. Amazingly, in less than two weeks, the seventh largest bank in the United States had essentially failed, largely due to a meritless rumor.

2.1.3. AIG (2008). AIG is a very large, multi-sector insurance company. Despite its size, it has deceptively limited liquidity. Due to state regulations, most of its assets are locked in insurance operating companies and are not available to cover losses at the holding company level. We briefly describe AIG’s ‘securities lending program’ which contributed to the company’s effective takeover the by US government in 2008.

As an insurance company, AIG held (and continues to hold) many long-term securities used to cover claims and annuity payments. Prior to the takeover, as a way to increase the yield on these assets, AIG would lend the securities to traders (mainly hedge funds) wishing to take a short position in the securities. The hedge funds would deposit money with AIG to cover the asset borrowed and to provide compensation for the loan. Prudence as well as state regulations dictate that AIG invest such funds in ultra-safe, ultra-liquid assets, because the security borrowers may return the securities for cash at any time. By 2008, the amount of lent securities exceeded US$70 billion. When the crisis hit, hedge funds and others were frantically trying to unwind their trades, which caused them to return borrowed securities and demand cash. AIG, instead of having invested the security borrower’s money in safe assets such as treasury bills, had invested it in Asset-Backed Commercial Paper (ABCP), where the ‘assets’ backing the commercial paper were mainly mortgages. The commercial paper had been rated AAA by the rating agencies because the deals were structured so that the commercial paper holders would not suffer losses until many less senior investors had been wiped out. However, the mortgages tended to be subprime and losses actually reached the commercial paper level. More importantly, with respect to liquidity, the ABCP market froze; no one was willing to trade. A classic run situation developed: AIG had ‘depositors’ who wanted their money back all at once, but not the liquid assets with which to satisfy the demands.

2.2. Model

As the historical events described above illustrate, it is dangerous for financial institutions to engage in liquidity transformation. Banks can fail even when solvent due to general fear
or unfounded beliefs of depositors. So it is natural to ask why banks and other financial institutions are willing to provide liquidity transformation. In order to answer this question we use a model of depositors and a financial intermediary to demonstrate that liquidity transformation is valuable to society.\footnote{The term model refers to a simplification of some real-world phenomenon. The purpose of the simplification is to better understand phenomena by having them yield easily to direct calculation. As an example, political scientists have developed models that are accurate at predicting election results using inputs such as macroeconomic and polling data. These models omit inputs on the idiosyncrasies of millions or tens of millions of voters, but are nonetheless very useful. In our model we make simplifying assumptions, such as there are only two points in time at which depositors may withdraw their money. Clearly this is not an accurate representation of most real-world banking relationships. However, it is sufficient to illustrate the central insights of the phenomenon, without making things excessively complex.}

In the model there is a representative investor who invests money at time zero but will need to spend that money at a later date. However, the investor faces uncertainty regarding the need to redeem the investment earlier than planned. Early redemption might occur because the investor is unable to secure short-term credit or because it becomes important to spend earlier than expected. In either case, at the time of investment the investor will be uncertain whether redemption will occur earlier than planned. The probability the investor will need (not need) to redeem early is .2 (.8) in all ensuing illustrations.

We assume that each investor has $1 of wealth to invest. In the absence of financial intermediation the investor has available only two investments, which vary in terms of liquidity. Liquidity refers to the ease with which an investment can be converted to cash, without resorting to steep discounts. Of course, the liquidity of an investment will partially reflect current market conditions. For example, an asset may be traded in a liquid market that suddenly dries up due to a macro-economic shock.\footnote{Examples of potentially illiquid investments are commercial aircraft backed loans, unsecured business loans and collateralized debt obligations (CDOs). Generally, investors are rewarded with higher returns for holding less liquid assets; this assumption is maintained in the model.} The two possible investments are referred to as ‘illiquid’ and ‘cash’. Both require a payment of $1 at time zero to buy a single security of the investment. The illiquid security will return $2 at maturity.\footnote{The two possible investments are referred to as ‘illiquid’ and ‘cash’. Both require a payment of $1 at time zero to buy a single security of the investment. The illiquid security will return $2 at maturity. However, if for any reason it must be liquidated before maturity, it will return $0.80. An ‘investment’ in cash will return $1 at any time in the future. For simplicity, we assume the appropriate discount rate for both types of investments is zero. Therefore, without financial intermediation the investor in the model either receives $1 with certainty (for the cash investment) or a ‘lottery’ (from the illiquid investment) with a .8 probability of $2 and a .2 probability of $0.80. The investor is like most people; somewhat risk-averse and preferring more consumption to less. For simplicity we assume all funds are used for consumption. Formally, we represent the investor with a utility for consumption $c$ equal to $U(c) = - c^{-2}/2$. This utility function is always increasing, which implies the investor prefers more consumption to less. Further it is concave (has a second derivative that is negative), implying the investor is risk averse. Risk aversion means the investor would rather receive the expected payout from an uncertain outcome than face the uncertainty. For example, a risk-averse person would rather receive $50 for certain than face the uncertainty associated with receiving a 50/50 lottery over $100 and $0. However, risk aversion does not mean avoiding all risks \textit{per se}. In fact, in this example the investor would prefer to hold the illiquid security, which yields an expected utility of $(.8)(-2^{-2}/2) + (.2)(-.8^{-2}/2) = -0.2563$,}$^\textcopyright$
rather than hold cash with an expected utility of \((1.0)\left(-1^{-2}/2\right) = -0.5\). See Table 1 for more details.\(^{10}\)

The above setting is used to illustrate that uncertainty about liquidity needs combined with investor risk aversion creates a demand for financial intermediation in the form of liquidity transformation. The financial intermediary in the model has characteristics of a mutual savings bank, in that the depositors are the de facto equity holders. We choose this form of intermediary so as to avoid incorporating a rate of return on equity for the investors in the intermediary. Instead, the depositors own any residual from the bank; there are no shareholders expecting a return on investment. This assumption is merely for convenience and does not change the basic conclusions of the model.

Depositors join the mutual savings bank in order to ease the loss of expected utility occurring from the unpredictable need for early consumption. In response, the mutual savings bank designs a ‘synthetic security’ which costs \$1 to invest in and pays \(r_1\) if

<table>
<thead>
<tr>
<th>Property</th>
<th>Cash</th>
<th>Illiquid security</th>
<th>Synthetic security (optimal)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consumption if must redeem illiquid asset early ((r_1))</td>
<td>1.00</td>
<td>0.80</td>
<td>1.42</td>
</tr>
<tr>
<td>Consumption if must redeem illiquid asset on time ((r_2))</td>
<td>1.00</td>
<td>2.00</td>
<td>1.79</td>
</tr>
<tr>
<td>Expected consumption</td>
<td>1.00</td>
<td>1.76</td>
<td>1.72</td>
</tr>
<tr>
<td>Expected utility</td>
<td>-0.50</td>
<td>-0.2563</td>
<td>-0.1744</td>
</tr>
<tr>
<td>CE</td>
<td>1.00</td>
<td>1.3969</td>
<td>1.6931</td>
</tr>
</tbody>
</table>

Investor utility = \(c^{-2/2}\).
The certainty equivalent (CE) is the minimum an individual would require to sell a lottery. (CE) solves:

\[ CE^{-2/2} - 2 = E[u(c)] \]

The synthetic security (optimal) maximizes depositor utility.

![Figure 2](Figure 2. Liquid and illiquid assets: investment decisions and payouts.)
redeemed early and $r_2$ if redeemed at maturity (see Figure 2). The mutual savings bank can only invest in the two ‘naturally occurring’ securities: illiquid and cash. The role of the mutual savings bank in this model is to decrease its depositors’ risk, so intuitively the bank should increase the return to early redeemers even at a cost of decreasing the return to on-time redeemers. A realistic constraint is imposed wherein the mutual savings bank must be able to keep its promises to both early and on-time redeemers. In particular, the mutual savings bank must be able to pay on-time redeemers from the proceeds left over after paying off the early redeemers. For ease of exposition, let us assume there are 100 depositors that are members of the mutual savings bank, each of whom will deposit $1, and exactly 20 of them will be early redeemers.

In order to determine the characteristics of the synthetic security, we need to consider how the bank will go about its role as liquidity transformer. Given cash is worth more (1.0) than early liquidation of the illiquid asset (0.8), but less than on-time liquidation of the illiquid asset (2.0), the bank optimally chooses to hold just enough cash to satisfy the 20 early redeemers, equal to $20r_1$. For example, if the bank chooses $r_1 = 1.25$, it will hold exactly $20(1.25) = 25$ in cash. The remainder of what it raises from depositors will be invested in illiquid securities. The number of illiquid securities in which the bank invests is equal to the total number of securities the bank can purchase minus the number of cash securities it purchases, or $100 - 20r_1$. Continuing the example where $r_1 = 1.25$, if the bank holds 25 in cash, it will have 75 left over to purchase 75 illiquid securities. At maturity the value of each illiquid security is 2.0, so the value of the bank’s holdings of illiquid securities at maturity is equal to $75(2.0) = 150$. If the bank is to both remain solvent and to return all of its holding to its depositors, the bank must pay each of the 80 depositors who redeem when the illiquid assets matures an amount such that $80r_2$ is exactly equal to 150, or $r_2 = 1.875$.

Generalizing, in order to have sufficient funds to pay off the on time redeemers, the bank’s choice of $r_1$ and $r_2$ must satisfy inequality (1).

$$2(100 - 20r_1) \geq 80r_2$$

Many values of $r_1$ and $r_2$ satisfy (1). However the optimal synthetic security for the mutual savings bank is that which maximizes the expected utility of depositors subject to the constraint shown in Equation 1. The program to find the optimal synthetic security is as follows.

$$\max_{r_1, r_2} \frac{r_1^2}{2} + 0.8 \frac{r_2^2}{2}$$

subject to: $$2[100 - 20r_1] - 80r_2 \geq 0$$ (2)

The approximate solution is $r_1 = 1.42$ and $r_2 = 1.79$. The expected utility to depositors is equal to -0.1744, which exceeds the expected utility of -0.2563 obtained from acquiring an illiquid security.

The return from early redemption is greater than it would have been otherwise ($1.42 > 0.80$), and the return from late redemption is less than it would have been ($1.79 < 2.00$). This follows from the assumption that the depositors are risk-averse. It is better to reduce the ‘spread’ in the returns, even though it decreases the expected return. The expected
return from the mutual savings bank is \(0.2(1.42) + 0.8(1.79) = 1.716\); recall the expected return from the illiquid security is 1.76. So in expectation the mutual savings bank returns less money than the illiquid security, but returns higher expected utility. This liquidity transformation is socially beneficial.

It is useful to interpret \(r_1\) as the ‘degree of liquidity transformation’, in that the higher the payment for early redemption the more liquid is the synthetic security. Figure 3 illustrates that the benefit of liquidity transformation is generally concave in the degree of liquidity transformation. That is, the benefits of liquidity transformation increase at a decreasing rate. Depositor expected utility corresponding to a particular value of \(r_1\) appears on the \(y\)-axis. It is determined by first finding the highest feasible value of \(r_2\), and then computing the resultant expected utility. As illustrated in Figure 3, expected utility has a maximum at \(r_1 = 1.42\).

In summary, two aspects of the synthetic security are noteworthy. First, as mentioned, the synthetic security improves the welfare of depositors, even while reducing overall consumption. Thus, the model provides conditions under which the demand for liquidity transformation arises naturally. This is one of the central insights of the Diamond and Dybvig (1983) model. Second, the term ‘synthetic security’ is used because the security is created by the bank. Only illiquid investment and cash would exist without financial intermediation in our model.

### 2.2.1. Bank Runs

Thus far liquidity transformation appears to be unequivocally beneficial. A financial intermediary pools the savings of depositors and creates a better security than is otherwise available. However, this result was obtained in a model having the unrealistic assumption that the bank could accurately predict how many depositors would redeem early. This assumption is now relaxed, exposing how liquidity
transformation can lead to a bank run. As illustrated in the description of events at the Trust Company of America, Continental of Illinois and AIG, a bank run occurs when a large number of depositors attempt to withdraw their money at once in response to concerns regarding the bank’s ability to pay its claims. It is somewhat intriguing that bank runs can result even if these concerns are merely imagined. Bank runs are known to have potentially devastating economic implications (Bernanke 1983; Friedman and Schwartz, 1963).

We now incorporate the idea of a bank run into the basic model, similar to Diamond (2007). The added element is that depositors may believe that more than 20% of depositors will redeem early even though, in fact, only 20% of depositor’s need to redeem early. The bank is aware that 20% of its depositors need to redeem early, and plans on that in designing the synthetic security. Let $\hat{f}$ be the belief that depositors have about the percent of total depositors that will redeem early, where $\hat{f} \geq 20\%$. So, if depositors believe 30% of them will redeem early, but the bank had planned on 20%, by implication they believe there would be $100 - 0.2(100)(1.42) - 0.1(100)$ $(1.42/0.8) = 53.85$ illiquid securities left for those who redeem on time. In explanation of the above calculation, because the bank planned on 20% early redemptions, it held just enough cash to satisfy 20 early redeemers, represented by the term $0.2(100)(1.42)$. In order to satisfy the unexpected additional 10 early redeemers, the bank must liquidate some of its holdings of illiquid securities before maturity. Specifically, in order to produce enough funds to pay off a single additional early redeemer the bank liquidates $1.42/0.8 = 1.775$ illiquid securities. The last term, $.01(100)$ $(1.42/0.8)$, represents the 17.75 illiquid securities that must be liquidated early in order to satisfy the extra 10 depositors who showed up unexpectedly. The 17.75 illiquid securities liquidated before maturity have produced only 14.20 in funds so as to satisfy the extra 10 early redeemers, but would have produced funds of $17.75(2.0) = 35.50$ if the bank did not have to liquidate them early. The lesson here is that unexpected withdrawals can be costly.

With respect to the 53.85 illiquid securities left over, this amount has a value of 2.00 at maturity, so there will be $53.85(2.0) = 107.7$ for on-time redeemers. With 10 depositors unexpectedly redeeming early there are only 70 remaining depositors. Each receives a portion of what remains in the bank, equal to $107.7/70 = 1.54$. Because $1.54 > 1.42$, depositors who believe 30% will redeem early and have the option to wait are therefore still better off not redeeming early. The point here is that even if depositors expect there to be some additional early redemptions, there would not necessarily be a ruinous bank run. Of course, even without a failure the increased liquidity demands harms bank, although in financial institutions other than mutual savings banks it would be the equity holders, not the depositors, who would absorb the first loss.

At what common set of beliefs, or tipping point, $\hat{f}$, does it become rational for all depositors to demand their money early? The answer, 33.9%, is found by locating the value of $\hat{f}$ that equates the expected return for early and on-time redemption, as shown in (3).

$$\frac{2(100 - 100(0.2)(1.42) - 100(\hat{f} - .2)(1.42/0.8))}{100(1 - \hat{f})} = 1.42$$

The significance here is that if a depositor believes 33.9% or more of all depositors will redeem early, it is best for that depositor to redeem early. And if all depositors held this belief, the mutual savings bank will fail, because they all will try to redeem early.

Importantly, there are only two equilibrium (self-fulfilling) beliefs, $\hat{f} = 20\%$ and $\hat{f} = 100\%$. A belief of 30% percent is not self-fulfilling; anyone who believes this and does
not need to early redeem should wait. Hence, as previously explained, a common belief of 30\% would still lead to only 20 early redeemers. Conversely, a common belief of 50\% would lead everyone to redeem early.

Recall that we need not push liquid transformation to its limits to extract most of the benefits. The synthetic security used earlier as an example had $r_1 = 1.25$ and $r_2 = 1.875$. This synthetic security has less liquidity transformation than the socially optimal synthetic security in that early redeemers receive a lower payment, $1.25 < 1.42$. The expected utility of $(.8)(-1.25^2/2) + (.2)(-1.875^2/2) = 0.1778$ is only slightly less than the optimal $-1.716$. However, the tipping point rises from 33.9\% to 46.7\%, a desirable thing. This illustrates that there may be reasons not to push liquidity transformation to the extreme.

Diamond and Dybvig (1983) and Diamond (2007) provide a powerful yet accessible way to think about liquidity transformation and bank runs. Adapting the models, we have illustrated both the social benefit and the vulnerability of liquidity transformation: less risk in future consumption at the cost of a potentially ruinous bank run. We will now consider the balance sheet of a liquidity transformer.

### 2.2.2. Accounting Valuation

In a world of certainty, asset valuation on the balance sheet for the mutual savings bank is straightforward, as shown in Table 2 (Panel A). The bank holds $20(1.42) = 28.40$ in cash representing a promise to pay 1.42 each to 20 expected early redeemers. The remaining funds, $100 – 28.4 = 71.60$ are held in illiquid securities. Treating the bank as a going concern, these assets are valued without an expectation of a bank run (no ‘fire sale’). Therefore, the bank’s illiquid securities are assumed to be held to maturity and are assigned a value of 2 each, or $71.6(2.0) = 143.20$ in total. However, demand deposits, which are liabilities for the mutual savings bank, are valued at the amount made available by the bank to early redeemers: $100(1.42) = 142.00$. The

<table>
<thead>
<tr>
<th>Assets</th>
<th>Liabilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Panel A: Optimal Liquidity Transformation ($f = 0.20$)</td>
<td></td>
</tr>
<tr>
<td>Cash</td>
<td>$ 28.40^a$</td>
</tr>
<tr>
<td>Long-term assets</td>
<td>$143.20^b$</td>
</tr>
<tr>
<td>Total assets</td>
<td>$171.60$</td>
</tr>
<tr>
<td>Demand deposits</td>
<td>$142.00^c$</td>
</tr>
<tr>
<td>Owner’s (depositors’) equity</td>
<td>$29.60^d$</td>
</tr>
<tr>
<td>Total liabilities</td>
<td>$171.60$</td>
</tr>
</tbody>
</table>

| Panel B: Liquidity Transformation ($f = 0.30$) | |
| Cash | $ 28.40^e$ |
| Long-term assets to be liquidated | $14.20^f$ |
| Long-term assets | $107.70^g$ |
| Total assets | $150.30$ |
| Demand deposits | $142.00^h$ |
| Owner’s (depositors’) equity | $8.30^i$ |
| Total liabilities | $150.30$ |

<table>
<thead>
<tr>
<th>Note</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>$^a$Based on 20 early redemptions of $1.42(20)$, held as cash.</td>
<td></td>
</tr>
<tr>
<td>$^b$Based on 80 on-time redemptions and held as 71.6 illiquid securities that will each return $2$. If these were redeemed early they would instead be valued at $0.80 (71.6) = 57.28$.</td>
<td></td>
</tr>
<tr>
<td>$^c$Amount owed to depositors if all redeem early: $1.42(100)$.</td>
<td></td>
</tr>
<tr>
<td>$^d$Expected additional amount owed to depositors holding deposits to maturity.</td>
<td></td>
</tr>
<tr>
<td>$^e$Based on 20 early redemptions of $1.42(20)$, held as cash.</td>
<td></td>
</tr>
<tr>
<td>$^f$Based on subsequent notification that 30 will be redeemed early: $1.42(30-20)$, representing 17.75 illiquid securities.</td>
<td></td>
</tr>
<tr>
<td>$^g$Based on 70 on-time redemptions and held as 53.85 illiquid securities that will each return $2$. If these were redeemed early they would be valued at $0.80(53.85) = 43.08$.</td>
<td></td>
</tr>
<tr>
<td>$^h$Amount owed to depositors if all redeem early: $1.42(100)$.</td>
<td></td>
</tr>
<tr>
<td>$^i$Expected additional amount owed to depositors holding deposits to maturity.</td>
<td></td>
</tr>
</tbody>
</table>
liability is valued this way because all depositors have the right to redeem early, even though they may choose not to do so. Importantly, if all the depositors were to redeem early, the bank could only raise 85.68, equal to its cash on hand of \(20 \times 1.42 = 28.40\) plus the early redemption value of its holding of illiquid assets of \(71.6 \times 0.8 = 57.28\) – well short of its liability of 142 (see note b in Panel A of Table 2). Thus, the balance sheet reflects not only the going concern assumption (i.e. there will not be a bank run), but further that exactly 20 depositors will redeem early. As should now be clear, balance sheet valuation implicitly makes an assumption regarding which equilibrium is ‘chosen’ by investors.

Assume, as above, that the bank designed the synthetic security based on an assumption of 20% redeeming early and that it took full advantage of liquidity transformation, so \(r_1 = 1.42\) and \(r_2 = 1.79\). Let us now take things a step further and produce a balance sheet based on a change in common beliefs, so the new belief about early redemption is something other than \(f = 0.2\). For ease of exposition, assume that at some point after those who know they will need to redeem early learn who they are and that the bank requests that those who intend to redeem early give notification. These statements of intent are assumed for purposes of this illustration to be irrevocable – only those who have stated their intent to redeem early will be permitted to do so and anyone who stated such intent must do so. We reexamine the balance sheet of the mutual savings bank below in Table 2 (Panel B), assuming that 30% of depositors gave notice of intent to redeem.

Panel B illustrates that the value of equity is a function of \(f\). As \(f\) increases from 20% to 30%, cash on hand remains the same, 28.40, because cash holdings were originally planned for only 20 early redemptions. Therefore, payments to the additional 10 early redeemers can only be met through the redemption of illiquid securities. The promised payment of \(10 \times 1.42 = 14.20\), requires liquidation of \(14.2 / 0.8 = 17.75\) illiquid securities, prior to maturity. The bank has \(100 - 28.4 - 17.75 = 53.85\) illiquid securities remaining with a total value of \(53.83 \times 2.0 = 107.67\). The value of the equity decreases from 29.60 to 8.30, which is entirely due to the early liquidation of illiquid assets by the bank. To illustrate, the loss per security from early liquidation is \(2 - 0.80 = 1.20\) and \((10 \times 1.42 / 0.8 = 17.75\) is the number of illiquid securities redeemed early. The total loss is thus equal to \(1.20 \times 17.75 = 21.30\). A bank run can be costly, even if it does not cause failure.

2.2.3. Auditing. The simple model and historical accounts included in this note illustrate that the liquidity transformation performed by banks carries both rewards and risks. An external auditor is expected to assess these risks as they would assess any threat to the continued existence of an audit client. Therefore, it is important that accounting students learn about the risks of liquidity transformation and how the profession expects them, as future audit professionals, to assess those risks.

The focus in this section is on auditing standards in the United States, which can be viewed as representative of standards internationally. The current guidance on auditing banks from the American Institute of Certified Public Accountants (AICPA) is found in Depository and Lending Institutions: Banks and Savings Institutions, Credit Unions, Finance Companies and Mortgage Companies with Conforming Changes (AICPA, 1 June 2010). The guide identifies three types of balance sheet risks: interest rate risk, asset quality risk and liquidity risk. Interest rate risk deals with factors related to changes in interest rates, such as the potential for fixed rates loans to decline in value due to increasing interest rates. Asset quality risk deals with factors related to the potential non-repayment of credits, such as underwriting standards and overall macroeconomic trends. Liquidity risk, our primary focus, deals with the maturity mismatch on financial institutions’ balance sheets, wherein short term liabilities are used to fund long term
assets. The problem, as illustrated above, is that rapid withdrawals may force the sale of long term assets for much less than their value at maturity.

In testing for liquidity risk, the auditor is faced with assessing two related exposures. The first is the likelihood that the financial institution will face sudden, large redemptions. In terms of the model, this exposure might loosely be described as the ‘nervousness’ of depositors. The second is the potential damage that such redemptions may cause. In terms of the model, this exposure may be described as the degree of liquidity transformation the financial institution has undertaken – a firm that has undertaken very little liquidity transformation can withstand much greater redemption than a firm that has stretched liquidity transformation to the limit.

In assessing the likelihood of sudden redemptions, the auditor should investigate several issues. First, the auditor should ascertain how active is the institution in the overnight borrowing or ‘repo market,’ which can dry up faster than branch deposits. Second, an investigation should be made into whether the institution has had difficulty in raising short-term cash in the past. Third, the auditor should consider the composition of its deposits. The larger the ratio of demand deposits (those available for immediate withdrawal like checking and savings accounts), to time deposits (such as certificates of deposit), the more easily depositors can withdraw their funds. Fourth, if the bank offers non-FDIC insured investment options, depositors may be more apt to withdraw their funds suddenly.

In assessing the potential damages associated with sudden redemptions (asset impairment, meaning the asset may be sold at considerably less than market value), the auditor should first consider the extent to which the institution has liquid assets to satisfy redemption demands, as there will be little discount for these assets if they must be sold quickly. Second, the auditor should investigate the losses the bank will incur by selling core loan assets (AICPA, 2010) or, put differently, the degree to which the institution’s assets are truly illiquid. If the institution has collateral that is acceptable to lenders, the auditor should consider the discount the bank might have to pay on repo loans. Finally, auditors need to be aware that replacing lost demand deposits usually requires the bank to use deposit products that do not qualify for FDIC insurance (Stein, 1998) or brokered deposits, which can be expensive. In general, audit guidance specifically notes that increases in transaction volume, increases in account complexity and new deposit products may increase liquidity risk (AICPA, 2010). Bruner and Carr (2007) came to similar conclusions with respect to complexity as a root cause for liquidity crises.

3. Additional Implementation Issues

Our interest in this topic arose due to the increased likelihood that our students would be working in or with the financial services industry, as noted in the Introduction. At first we tried to directly introduce Diamond (2007). While Diamond (2007) is a useful, well-written simplification of Diamond and Dybvig (1983), we found many of our students still struggled with the material. Further, there were several issues of importance to accountants, such as balance sheet valuation, that are absent from Diamond (2007). This was our motivation for creating this note.

When utilizing this note, prior to class we have the students read Section 2, Case Materials. Then at the start of the class discussion we give them a short ‘pre-quiz’ composed of simple questions such as ‘How many naturally occurring investments are there in the model?’ The purpose is merely to ensure the students have performed the reading, rather than to test for deep comprehension.

Following the ‘pre-quiz’, the students are given a problem set to work on with the instructor. The problem set may consist of the examples in the text or minor variations
of them. Although these problems are worked out in this note, providing problems in a succinct format to the students can be very useful for teaching purposes. A set of possible questions that the instructor can use in class after the students have done the reading is below. Additional questions could be asked about maximizing social welfare and calculating tipping points. Also, different characteristics of the naturally occurring securities and different probabilities of early redemption can be used, and the students can be asked to recalculate the optimal synthetic security \((r_1 \text{ and } r_2)\), etc. Fully articulated solutions can be shown on media such as a blackboard or via PowerPoint.

(1) Given the assumptions in the paper, would the investor rather hold cash or the illiquid security?

(2) If \(r_1 = 1.25\) and \(r_2 = 1.875\) what is the expected utility of the investor given the utility function in the paper?

(3) If \(r_1 = 1.25\) and \(r_2 = 1.875\) would the mutual savings bank be able to satisfy both early and on-time redeemers?

(4) What values of \(r_1\) and \(r_2\) maximize the expected welfare of depositors?

(5) Using your answer from (4), how many illiquid securities would have to be liquidated to satisfy the claims of 10 early redeemers?

(6) Given your answer in (5), what would the value of the illiquid securities have been if they were held to maturity?

At the graduate level, students give presentations on relevant historical events in successive class sessions. Two particular presentations that are useful are Trust Company of America and Continental of Illinois. We use these two cases in Section 2.1 because they closely follow the point made in the theory: a bank run can be almost purely rumor-driven. The students are fascinated that banks can fail solely on the basis of erroneous (but ultimately self-fulfilling) beliefs. Other interesting cases are Long Term Capital Management, the hedge fund that was rescued in 1998, and Icelandic Banks in 2008. One concern we always have is making the cases as relevant as possible to an international student body. We often have students present the Asian Financial Crisis of 1997–1998 and, to the extent possible, relate their personal experiences. Additionally we ask students if there is a historical precedent relevant to the course that might not be known to students of different backgrounds. At the undergraduate level the emphasis is more on introducing students to research, in which case this note is used with other teaching notes that discuss research findings such as Antle and Demski (1988) and Arya et al. (1996). Students are asked to discuss the papers and occasionally present some of the research findings to other students.

4. Conclusion

A model is used to illustrate the social benefit of liquidity transformation performed by financial intermediaries, such as banks. The model is further used to show that liquidity transformation exposes the intermediary to the potential for bank runs and that valuation on the financial intermediary’s balance sheet is crucially dependent on depositors’ beliefs about early redemption. By grounding the discussion in a model and then relating the model findings to accounting standards, students are (hopefully) better able to appreciate the fragility of asset valuations.

The model and historical precedents are additionally used to introduce auditing issues related to financial intermediaries. We note that the risks faced by financial
intermediaries are broader than the type covered in this note, but we focus on liquidity risk and we relate the two facets of liquidity risk to the model. Specifically, we trace the risk that the financial intermediary will face a bank run, and the risk that the bank run will be ruinous, from the model into the auditing standards. Students consistently show enthusiasm for this topic.

Acknowledgments

We thank participants at the 2011 American Accounting Association Public Interest Section Annual Meeting and the 2011 American Accounting Association Mid-Atlantic Regional Meeting for their helpful comments.

Notes

1The growth of the financial services sector was criticized both before and after the financial crisis (Johnson and Kwak, 2010; Phillips, 2006). One prominent economist went so far as to call for radical re-structuring of the sector, specifically due to its practice of borrowing short and lending long, i.e. liquidity transformation (Kotlikoff, 2010).

2For example, when a bank uses customer deposits to make a loan, they are principal to that transaction. In contrast, a real estate agent helps bring together buyers and sellers, but does not take possession of the property (i.e. never becomes a principal).

3See Bernanke (1983) and Diamond (1984) for the role of monitoring and screening in financial intermediation.

4The historical accounts are primarily drawn from the following sources: Bruner and Carr (2007; Trust Company of America), McCollom (1987; Continental of Illinois) and McLean and Nocera (2010; AIG).

5A short corner is a tactic where a speculator tries to gather all the outstanding stock in a company and force short sellers to buy back stock from him or her.

6In the end the panic only subsided with the forced merger of two steel companies and an emergency waiver of anti-trust laws from President Theodore Roosevelt.


8See Shleifer and Vishny (2010) for an accessible discussion of illiquid assets and fire-sale prices.

9Unrealistically small numbers are used for cash consequences, to keep the calculations in this note simple.

10We here and henceforth suppress dollar signs.

11In effect, the bank possesses no advantages over its depositors in the form of diversification opportunities or economies of scale. It has access to the same securities to which its depositors have access.

12A subsequent section explores the possibility that the actual number of early redeemers might exceed that planned by the bank.

13An analytical (as opposed to numerical) solution can be found by recognizing constraint (2) is tight, which implies \( r_2 = 2.5 - 0.5 r_1 \). Substituting into the objective function and taking the derivative with respect to \( r_1 \) provides \( r_1 = 200/(40 + 80(2.0^{1.5})) \approx 1.42 \), and hence \( r_2 \approx 1.79 \). Students can solve the problem analytically as described above, or by using spreadsheet software capable of performing constrained optimization. Note this solution slightly improves upon that proposed immediately above of \( r_1 = 1.25 \) and \( r_2 = 1.875 \), wherein the expected utility is \(-0.1778 < 0.1744\).

14Although there are only two equilibria, \( \hat{f} = 20\% \) or \( \hat{f} = 100\% \), it is entirely possible that depositors, without a coordinating mechanism, will not coordinate to either one.

15This is more or less the procedure for redemptions from hedge funds, which are notorious for holding high-yield illiquid assets (Ang and Bollen, 2010).

16Repo loans are overnight loans between institutions or between an institution and the Federal Reserve. The loans are typically collateralized by securities.

17A scene in the movie Mary Poppins provides a useful, if whimsical, illustration of a spontaneous bank run closing an otherwise healthy bank. When asked to present the material related to this note in class, several times our students have discovered and shown this scene to the rest of the class.
References

### Appendix: Comprehension Questions on Student Questionnaire

1. Valuation of bank assets is dependent on:
   - 3% a. Compensation of bank executives
   - 80% b. Choices of depositors
   - 3% c. Which state the bank is located in
   - 15% d. The number of months till assets mature

2. The reserve requirement means the bank must:
   - 0% a. Have a minimum percent of assets reserved as bad debts
   - 10% b. Have a minimum percent of deposits as checking accounts
   - 90% c. Have a minimum amount of cash as a percent of deposits
   - 0% d. Have a minimum number of loan officers for the amount of loans made

3. In the model the bank holds ‘cash’ because:
   - 18% a. It’s required by law
   - 70% b. It’s cheaper to use cash than the illiquid asset to pay off early redeemers
   - 0% c. The bank fears interest rates will be high when it needs cash
   - 13% d. Depositors are risk averse

4. Continental of Illinois almost failed because of:
   - 90% a. A rumor
   - 3% b. Bad loans
   - 5% c. Changes in interest rates
   - 3% d. Intense competition

5. According to the paper, which of these should be updated more frequently?
   - 38% a. Liquidity information
   - 63% b. Solvency information

*Percent choosing answer appear on the left.*