

Liquidity Risk Management in Institutional Investment Firms


An Honors Thesis (HONRS 499)

by

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Abstract

Recent economic turmoil has forced institutional investment firms to place more emphasis on liquidity. Firms such as banks, hedge funds, insurance companies, endowments, and pension funds all face a unique set of liquidity risk factors. There are several methods for measuring liquidity risk available to firms. However, these measures are subject to interpretation errors as well as errors in definition. Institutional investment firms need to understand liquidity risk measures as well as the factors that are involved in determining these measures. Firms can only manage their liquidity risk if they understand the risks that they are subject to and how to measure that risk. Liquidity risk management techniques that are viable for certain firms may not pertain to others. Regulatory requirements as well as firm-specific liquidity profiles are also important factors in determining the appropriate methods of quantifying and managing liquidity risk. This paper analyzes the liquidity risk profile of banks, hedge funds, insurance companies, endowments, and pension funds and offers several liquidity measures that can be utilized by firms. I suggest measures that may be more applicable to certain firms. There is also a discussion of the immunization technique for liquidity risk management. While this technique is not always applicable, it is powerful in managing liquidity risk.

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Introduction

Balancing liquidity and return is a crucial part of managing investment for institutional investment firms. Liquidity is the ability of an asset to be readily converted to cash. In more technical terms, it is “the degree to which an asset or security can be bought or sold in the market without affecting the asset’s price (Investopedia).” Most firms understand the balance between return and risk as a whole. Recent events have forced firms to focus specifically on liquidity risk. There are several techniques available that firms may utilize to manage liquidity risk. While these techniques are applicable for all firms, specific businesses have different needs. Firms should consider their specific needs when choosing liquidity risk management techniques.

Liquidity plays a key role in security valuation. Liquid assets have a high level of trading activity which makes it easy to determine an accurate market price for the asset (Investopedia). These assets are typically characterized by low rates of return, but high rates of financial security. As a result, balancing liquidity and return is significant to designing an optimal portfolio (Bangia, Diebold and Schuermann 2). Asset liquidity varies through time, industry, geography, and instrument classes (Oracle Financial Services).

Expected return for an asset is closely tied to the risk associated with that asset. The higher the risk for an asset, the greater the percentage return should be on that asset. Invested money can only yield high profits if it is subject to a higher possibility of being lost (Investopedia). Assets can be affected by liquidity risk, credit risk, market risk and operational risk. Recent events have shown that these risks can each impact each other. For example, mistrust in an assets value due to credit default risk can generate liquidity risk (Barfield and Venkat). A study published in 2003 by Ľuboš Pástor and Robert F. Stambaugh comparing

liquidity risk to stock returns showed that from 1966-1999 the average return on stocks with high liquidity risk exceeded the average return on stocks with low liquidity risk by 7.5 percent annually (Pástor and Stambaugh 642).

Liquidity risks have been identified as the main cause of the failures of institutions in 2008 and 2009. Many of these institutions were thought to be “too big to fail” (Carrel). The economic turmoil of 2008 and 2009 has forced firms to focus on liquidity risk management, historically one of the least scrutinized parts of risk management (Oracle Financial Services). A white paper issued by Oracle Financial services blames the liquidity issues associated with the recent collapse on the global reach of modern institutions, deregulation, widespread securitizations, structured products, active collateral management and other aspects of modern finance (Oracle Financial Services). The 2008-2009 liquidity crunch exposed outdated liquidity risk management tactics (Carrel).

The recent liquidity crunch was one of only many cycles in the economy. Market liquidity typically varies with the state of the economy. Liquidity crisis are associated with economic downturns (Eisfeldt 1). When illiquidity occurs firms may be forced to sell assets in order to meet capital requirements. Due to a decrease in market liquidity, assets will sell with high transaction costs. This triggers more asset sales and can potentially end in a cycle of sales, liquidity losses, and further sales (Duffie and Ziegler 42). The recent collapses of Northern Rock and Bear Stearns resulted from a situation similar to this. The collapses of these companies proves that profitability and capital is not a defense against liquidity risk. Both Bear Stearns and Northern Rock were profitable the quarter before their failure (Barfield and Venkat). The occurrence of liquidity cycles and the recent liquidity crisis as well as the inability of high

returns and capital to protect a firm during a period of illiquidity have forced firms to focus on liquidity risk management.

Discussion of Liquidity Risk

Liquidity risk refers to the risk that occurs due to the lack of marketability in an investment. This lack of marketability prevents an asset from being bought or sold quickly enough to minimize or prevent losses (Investopedia). Any factor that can disrupt the asset/liability equilibrium can be a source of liquidity risk. As a result, each firm, professional group, or government entity can define liquidity risk differently (Carrel). In general, liquidity risk can be broken down into several liquidity risk categories. Each of these categories is composed of both exogenous and endogenous risks (Bangia, Diebold and Schuermann 4).

All liquidity risks are either exogenous or endogenous risks. Exogenous liquidity risk is outside of the control of the market maker or trader. It is the result of market characteristics (Bangia, Diebold and Schuermann 2). Assets that are frequently traded typically have a lower exogenous liquidity risk, because the market is providing the proper liquidation value for these assets (Bangia, Diebold and Schuermann 4). Endogenous liquidity risk is within a firm's control. It is usually the result of the sudden unloading of large positions that the market is unable to absorb. The sudden unloading of assets causes a decrease in the market price of the asset causing firms to lose money on the sale (Bangia, Diebold and Schuermann 2). Exogenous and endogenous liquidity risks are present in the various liquidity risk categories. Liquidity risks can be divided into market or valuation liquidity risk, funding liquidity risk, counterparty linked liquidity risk, regulatory liquidity risk, and concentration liquidity risk (Carrel).

Valuation liquidity risk is the risk associated with assets held in a portfolio or pledged as collateral that are mispriced or impossible to sell due to market conditions (Carrel). This risk is

also known as market liquidity risk (it will be valuation liquidity risk for the duration of this paper). Valuation liquidity risk is created by inadequate market depth and the non-linearity of valuation functions (Oracle Financial Services). Market depth is the volume of an asset that it is possible for the market to absorb without adversely affecting the market price of the asset. Non-linearity of valuation functions, also referred to as “lack of transparency”, refers to the inability to accurately price an asset. Illiquid assets can experience price jumps that cause the valuation function to be non-linear (Carrel).

Funding liquidity risk occurs due to the inability of a firm to effectively meet both expected and unexpected current and future cash flow needs without harming the financial condition of the firm. This type of liquidity risk can be thought of as risk that is created by possible discrepancies in the timing of sources and applications of funds. Sources of funds include cash inflows from assets, the sale of marketable assets, or cash inflows from account growth in products. Applications of funds include cash outflows from liabilities, purchase of marketable assets, cash outflows from business costs (Oracle Financial Services). As a result, funding liquidity risk can be thought of as the cost of selling assets to meet cash flow needs (Carrel).

Counterparty and regulatory liquidity risks are generally clustered into external or systematic sources of liquidity risk. Counterparty liquidity risk stems from unfulfilled obligations by counterparties in collateral and sale agreements. The unfulfilled obligations may be the result of financial problems for the counterparty or failures that create a breakdown in trade (this could be the result of data mismanagement or an inability to contact a trader due to network failures). Regulatory driven liquidity risk is caused by errors and misconceptions in the

regulatory framework. Regulations, such as minimum/maximum asset allocations, can force firms into a liquidity position, which is undesirable (Carrel).

Concentration liquidity risk is caused by similarities in assets (or even holding too much of the same asset). Diversification is fundamental to all types of risk management. Liquidity concentration risk comes from concentration of asset types, funding channels, currencies, market sectors, maturity dates, option strike dates, and counterparties. Dynamic changes in these areas can alter concentration liquidity risk. For example, a series of defaults in a specific market sector can lower the value of assets in that sector (Carrel).

Business Types

This section provides an overview of the liquidity needs of several types of institutional investment firms as well as examples of firms that have suffered from inadequate liquidity risk management practices. The assessment of liquidity needs will be based on the types of liquidity risk inherent in the asset and liability structure of particular types of financial firms. While liquidity risk management is applicable to any individual or firm with assets and liabilities, the purpose of this paper is to provide a general overview of liquidity risk management application to larger financial firms. As a result, the focus will be on insurance companies, hedge funds, endowments, pensions, and banking.

Prior to entering the discussion on liquidity risk in individual firms, it is important to understand the difference between liquidity risk and solvency risk. Liquidity risk is the risk associated with the inability to meet current liabilities (Cade 16). Solvency risk is the ultimate risk of failure due to insolvency. Solvency risk is not the cause of failure, but the failure itself; it has a secondary cause that can be the combination of any other type of risk (Cade 19-20). For

the purposes of this paper any mention of institutional failure and insolvency will primarily be the result of illiquidity.

Banking

The banking world can be divided into three types of banks commercial, investment, and universal. Commercial banks take deposits, lend money, offer clearing and settlement services, transfer money, finance trade, offer guarantees, cash management services, lease financing services, and act as custody holders in agreements. Investment banks help companies issue securities, act as brokers, offer advisory services, offer securitization services, and are involved in proprietary trading. Universal banks operate both commercial and investment banking markets (Frost 485-488).

Three items make up a bank's liquidity profile regardless of the type of bank, expected cash flows, the ability to borrow money in the market, and the stock of high quality liquid assets (Cade 57). Banks estimate cash flows based on expected sales proceeds and revenue receipts as well as estimations based on existing contractual maturities. This estimation takes into account the possibility of scheduled payments not being made when there is reason to believe that they will not be made. Cash outflows for banks include deposit repayments, interest on deposits, staff salaries, bank dividends, drawdown of loans, overdraft fees, and other credit facilities, investments and purchases by the bank. Banks typically estimate the time horizon for cash inflows and outflows. This is due to the flexibility of inflows and outflows in banking products (Cade 58).

Banking products can be broken into three categories, demand deposits, contingencies, and amortizing loans. Demand deposits do not have a maturity. Banks typically model the flow of demand deposits by utilizing a stable balance approach. This method entails banks

considering a certain fraction of deposits as being held permanently by the bank. The remaining portion of demand deposits is treated as short-term debt since they may be withdrawn at any time. More accurate versions of this model include estimates based upon regression that determine what portion of the balances will be withdrawn in a given period. Contingencies are flows of funds which are uncertain since they are contingent upon a certain event. Banking contingencies may come from several areas such as investment contracts, or the willingness of a borrower to utilize available credit lines. These cash flows are typically of an unknown amount (certain contracts may have a stated value given a certain event others such as the amount of available credit a customer may utilize are unknown) and have an unknown time horizon (Bessis 132). Amortizing loans are contractual loan obligations. The maturities may vary from loan to loan. The values of cash flows as well as their time horizons are known as long as late payments and prepayments do not occur (Bessis 133).

Another feature of a bank's liquidity profile is its stock of high quality liquid assets. Bank funding comes from liquid short term deposits which are lent out as long term loans. Loans are inherently illiquid. Banks face the risk of having a large portion of depositors demanding funds bank at the same time, a bank run. As a result, the appropriate balance between holding low yield, liquid assets and high yield illiquid assets, such as loans, must be achieved (Frost 131). Deposit insurance reduces the likelihood of runs. To some extent this reduces the need to hold illiquid assets. However, deposit insurance does not cover investment banks. Regulations treat banks funded by deposits and banks funded by borrowing the same. During the recent crisis, investment banks were illiquid due to mismatched maturity of long and short term debt (When the River Runs Dry). Banks also need to hold liquid assets to cover cash flow needs and

counterparty defaults (Cade 57). The high quality asset cushion should be enough to meet unexpected payment obligations (Cade 60).

Banks rollover liquidity risk by investing in long-term assets and borrowing short-term paper (Brunnermeier 4-5). The ease of access to funds depends on the banks funding needs, stability over time, credit standing of the bank, its financial stature, its solvency, and any other characteristic which can alter the market perception of the bank (such as ratings). Lenders to banks become concerned if any of these items deteriorate and the cost of funds for the bank will rise (Bessis 8). Banks should be aware of their capacity to borrow in the market. They should understand how much cash is available based upon historical and current market conditions. Banks should impose limitations and recognize their vulnerability to overreliance on the market. Liquidity should be accumulated when it is readily available in the market (when the liquidity premium is low). Diversification of counterparties in these agreements is necessary to diversify cash dependency (Bessis 60).

The liquidity risks that are faced by banks can be derived from this liquidity profile. Banks face funding liquidity risk due to cash flow uncertainty. Borrowing is a way to combat this risk, but it may come at a high liquidity premium. Borrowing also presents additional counterparty risk to banks. Lending adds to the counterparty risk of banks. Regulatory errors also create liquidity issues for banks. The perfect example of this is the indifference of regulators to financing with deposits and financing with borrowing. Banks also face concentration liquidity risk. This risk will vary by bank and the products sold at that particular bank. Valuation risk has recently been notable for banks. The recent crisis saw a sharp decline in the value of mortgage loans due to the increase in mortgage defaults.

Bear Stearns and Washington Mutual (WaMu) are two notable recent bank failures. Bear Stearns had liquidity drained from its assets as clients abandoned risky assets in 2008. In three days, Bear Stearns saw its cash and liquid asset pool shrink by nearly 90% (When the River Runs Dry). This was the equivalent of an investment bank run. Bear Stearns was bought by JPMorgan at the price of \$2.00 per share. Less than a year earlier, Bear Stearns had traded for around \$150 per share. WaMu was also purchased by JPMorgan Chase. WaMu was the largest commercial bank failure in American history. The bank had made several risky loans. In purchasing WaMu, Chase absorbed at least \$31 billion in losses; most of these losses were from troubled mortgages and credit card loans (Dash and Sorkin). Liquidity risk led these two banks to failure.

Hedge Funds

Hedge funds are private investment vehicles that are less regulated than traditional investments (Shadab 36). Investment in hedges is limited to institutional investors and the very wealthy. Most hedge funds have a minimum amount that an investor must contribute and many require funds to be committed for a specific period of time prior to allowing withdrawals from the fund. This period is typically twelve months; however, some funds require commitments of up to four years or more (Hedges 8). Many funds rely on high leverage to boost profits. While leveraging expands small profit opportunities into big ones, it also expands small losses into larger losses. Hedge funds often hold large positions and utilize relatively small amounts of collateral to support these positions (A. W. Lo 25). Limited regulation also allows hedge funds to short sell stock and use derivatives without restriction (Frost 268).

The flexibility of hedge fund investment strategies presents a unique set of liquidity risks. Like banks, hedge funds can experience runs. These can come in the form of withdrawals from

clients or loans made to clients from a liquid asset pool (Brunnermeier 28). Hedge funds also provide liquidity services to the market (Ding, Shawky and Tian 1). These factors present funding liquidity risk to hedge funds. Hedge funds experience high amounts of concentration risk as well. As previously stated, hedge funds often hold large positions in a particular asset. This can pose concentration liquidity risks in asset types, currencies, market sectors, maturity dates, option strike dates, or even counterparties. The exposure to concentration liquidity risk is dependent upon the trading strategy that the hedge fund utilizes.

Hedge funds also face valuation and counterparty liquidity risk. When market prices fall, the value of the collateral that supports hedge fund positions is reduced. As a result, hedge funds are forced to finance their positions by either posting more collateral or utilizing capital (A. W. Lo 25). Hedge fund asset holdings may also present valuation risk depending on the liquidity the fund's position. Counterparty liquidity risk typically affects hedge funds during market crisis. This risk is typically the result of rehypothecation. Rehypothecation occurs when a broker pledges securities that are held in margin accounts as collateral for loans. During a crisis, hedge funds are often unable to retrieve collateral that brokers used to fund their own transaction. Regulators are currently seeking a way to limit this practice (When the River Runs Dry). Regulatory liquidity risk is limited for hedge funds due to the limited amount of regulation that hedge funds face. However, this may change in the future as regulatory bodies may begin expanding regulation of hedge funds.

Hedge funds are often viewed as being particularly vulnerable in the event of a liquidity crisis. This is primarily due to the use of leverage and the fact that many hedge funds invest in less liquid markets and instruments (Hedges xvii). Shocks to liquidity for hedge funds come from three primary sources: asset illiquidity; cash withdrawals; rare but dramatic macroeconomic

liquidity shocks (Ding, Shawky and Tian 1-2). Leveraging allows small shocks to have a larger impact upon hedge funds. The recent macroeconomic liquidity crisis showcased the vulnerability of hedge funds to such a crisis. In August of 2007, hedge funds lost an average of 6.85% in three days (Ding, Shawky and Tian 2). UBS's internal hedge fund, Dillon Read, suffered \$125 million in losses as a result of subprime mortgages prior to being shut down (Brunnermeier 9). After the collapse of Lehman Brothers, Morgan Stanley saw \$43 billion in withdrawals in a single day. Most of these withdraws were from Morgan Stanley's hedge funds (When the River Runs Dry).

The most notable hedge fund failure, the collapse of Long-Term Capital Management (LTCM), was the result of mismanagement of liquidity risk. LTCM's major liquidity risks included concentration risk, funding risk, and valuation risk. LTCM was a major supplier of liquidity. They were short instruments that were liquid and long instruments that were illiquid. The long position would prevent LTCM from being able to sell assets without taking a loss in the event of a sudden need for liquidity. The short position in liquid assets would lose money for LTCM, creating a liquidity need, in the event of a crisis in which investors rushed to purchase liquid assets. This combination would prevent LTCM from finding liquidity if it needed it beyond existing liquidity buffers (Bookstaber 107). LTCM did not hold a significant quantity of liquid assets. The company's management assumed that in the event of a crisis, it had an ever-ready supply of capital. This capital would come from new investments as well as bank loans (Bookstaber 106).

In 1998, LTCM was hit by two major events. Salomon Brothers, an investment bank, sold-off a large position of assets that LTCM also held. Liquidation of a large quantity of assets typically causes the price of that asset to fall. LTCM saw a ten percent decline in the value of

these assets (Shirreff 138). LTCM also held a large position in Russian bonds. On August 17th, Russia defaulted on its bonds (Shirreff 139). Asset concentration severely damaged LTCM's asset value and ability to liquidate its positions. The banks that had loaned LTCM money became nervous. They demanded repayment of loans. LTCM was not able to liquidate assets and meet these obligations (Shirreff 111). As a result, the company failed. LTCM's positions were taken over by fourteen banks. These banks reaped the rewards of having enough liquidity to be able to finance these once losing positions. Most of LTCM's positions became profitable again and the banks reaped the rewards of having enough liquidity to weather the financial crisis that had occurred (Shirreff 32-33). LTCM's positions were profitable; however, they had not maintained enough liquidity to weather the storm.

Insurance

Insurance companies can be divided into two types, life insurers and non-life insurers. In general, both types of insurance are based on similar principles. Insurance pricing relates to the pricing of risks that are not tradable. The primary liquidity concern of insurance companies is the time horizon of liabilities. Insurance contracts are contingency contracts. The contracts will pay the insured given a certain event happens. In the case of life insurance, this event is death. For non-life insurers events vary, but include things like auto accidents, hospital stays, and hurricane damage (Briys and de Varenne 94). Life insurance has a similar liquidity profile to pension funds. They receive money today for long term future financial obligations. This is not the case for general insurance where most liabilities are short term (Frost 261). Life insurance contracts are comparable to borrowing money in a structured way. Life insurance policyholders get future cash flows that are governed by contractual provisions (Briys and de Varenne 128).

As a result of the long duration of their liabilities, life insurers hold longer term assets. These assets include bonds, stocks, mortgages, real estate, and policy loans (Briys and de Varenne 44). The products that life insurers sell allow them the freedom to invest in these longer duration higher yield assets. Aside from life insurance contracts, life insurers also offer a variety of investment products that are designed to compete directly with mutual funds and bank deposits (Frost 493). This move towards investment products includes new product lines that include interest-rate sensitive policies, making life insurers more sensitive to interest-rate movements than in the past (Briys and de Varenne 102). Modern life products include insurance (those tied to market performance as well as traditional life insurance products), annuities, pensions, and guaranteed investment contracts (Briys and de Varenne 46). The trend towards market sensitive products has forced insurers to turn towards riskier investments for higher yield (Briys and de Varenne 49). This change has triggered a mismatch between asset and liability time horizons, since higher yielding investments are typically longer term (Briys and de Varenne 73). Life insurers base their return objective on maximizing surplus (market value of assets less market value of liabilities) while taking duration into consideration. Regulatory requirements require insurance companies to hold a certain amount of assets in surplus (Frost 261). In order to match duration, insurers invest heavily in bonds (because of their predictable duration) (Frost 262).

Nonlife insurance companies do not offer investment products like life insurers. They provide insurance products such as theft and health insurance that are typically low duration (Frost 271). These types of policies have more volatile claims than those on life policies (because death is inevitable and fairly predictable when a large pool is considered). Things like natural disaster claims and auto accidents are harder to predict than death. As a result, the levels

of claims vary significantly from year to year and nonlife insurers require more liquidity than life insurers (Frost 272).

The liquidity risks facing insurance companies include funding, valuation, counterparty, regulatory, and concentration liquidity risks. Funding risk comes from the uncertainty of claim amount, quantity, and timing. While these factors are estimated by insurers, massive events such as a large hurricane can ruin a company's finances. Valuation risk is comes from funding securitization deals as well as changing market conditions altering asset value. The recent liquidity crisis resulted in a sharp decline in the value of the long term assets that life insurers hold. Counterparty risk comes from securitization deals as well as sale agreements for insurance companies. Insurance is heavily regulated and as a result faces regulatory risk. Ratings agencies also introduce liquidity risk to insurers. Concentration liquidity risk for insurers can come from asset types, funding channels, currencies, market sectors, maturity dates, counterparties, and/or option strike dates. However, maturity induced concentration liquidity risk is perhaps the most important concentration risk facing insurance companies.

AIG has recently become a prime example of liquidity issues arising at an insurance company. Like many insurance companies, AIG sold financial products other than insurance. AIG's Financial Products division sold credit default swaps to other institutions. Credit default swaps protect against the risk of default on certain securities. In late 2007, the U.S. residential mortgage market began to deteriorate. AIG began seeing losses on its default swap business. At the same time, AIG recorded losses in its securities lending operation. This operation had large investments in residential mortgage backed securities. AIG suffered losses on this line. Due to these losses, AIG was downgraded and had to post billions in collateral to its credit default swap contracts. AIG began seeking capital for the liquidity problem that had been created by the

downgrade and mortgage related losses. The market further deteriorated and AIG was once again downgraded. This triggered more calls for collateral. While AIG remained solvent, the federal government decided to bailout AIG in order to prevent an uncontrolled failure. At the time of the bailout, AIG was providing more than \$400 billion in credit protection through its credit default swap business (AIG). Concentration liquidity risk is ultimately what caused the crisis at AIG. The collapse of the residential mortgage market created their liquidity crisis.

Endowments

Many colleges and universities have endowments. Sources of endowment income include contributions, investment income, and budget surplus (Lapovsky 99). Endowments support a percent of the operating budget of colleges and universities. Large endowments pay for resources such as more faculty, higher faculty salaries, better support of faculty research, more and higher quality space, and financial aid for qualifying students (Lapovsky 104-105). In order to meet these needs, endowments must maintain some liquidity levels

Endowment funds typically have limited liquidity needs. These funds have a very long time horizon. School trustees must balance the fund between meeting current needs and saving the fund for future needs (Frost 272). Asset allocations need to reflect both current needs and future needs. Current needs will be funded by liquid assets. A portion of these liquid assets may be made up of current donations. Endowments typically invest in illiquid assets such as private equity and real estate because they have high expected returns relative to their risk in ordinary market conditions. However, in times of crisis these assets are extremely illiquid and may not even sell at fire sale prices. As a result, it is critical for endowments to manage their funding liquidity risk by allocating assets accordingly (Logue 45).

The recent crisis has created several issues for endowment funds. Between June 2008 and June 2009, average endowment losses were 19%. During this period, Harvard lost 27.3% and Yale lost 24.6%. Over the period from July 2008 thru November 2008, the average endowment suffered losses of 22.5%. Given the long term nature of endowment funds this does not initially seem problematic in liquidity terms. However, many higher education institutions financed new initiatives with debt, utilizing their endowments as collateral. This decrease in the value of endowments created valuation liquidity risk for the endowments. Typically the size of the endowments allowed them to borrow at low interest rates. As a result of the decrease in value, interest rates are rising for higher education institutions (Logue 44). Endowment funds typically supplement income from other sources such as tuition. The recent crisis has led to a decline in tuition income as fewer people can afford to attend college. Funds have also seen a decrease in cash flows from new donations. These cash flows had previously served as part of the liquidity cushion for endowments (Logue 46). The combination of these factors showcases the valuation, and funding liquidity risks that are presented to endowment funds.

Pensions

Pension plans come in two forms, defined benefit and defined contribution. In a defined contribution plan, the plan participant, employee, bears the investment risk. Contributions to the plan are known. The payout from these contributions varies with fund performance. Some plans allow participants to choose asset allocations for their plans (McGill, Brown and Haley 750). In a defined benefit plan, the plan sponsor, employer, bears most of the investment risk (McGill, Brown and Haley 748). The payout on these plans is known and is typically a percentage of income that may include an inflation adjustment (Frost 262). Contributions vary with plan earnings and are adjusted so that the agreed upon payout is available when payout begins. As a

result, a plan sponsor may seek a riskier investment strategy in order to minimize contributions (McGill, Brown and Haley 748).

Liquidity requirements for defined benefit and defined contribution plans are similar, but do have a few notable differences. The primary liquidity risks facing pensions are funding and valuation risk. However, poor investment decisions can also create concentration liquidity risk. Pension plans need liquidity in order to make payouts. Payouts occur at retirement or, depending on plan features, employee termination or death (McGill, Brown and Haley 750). Defined benefit plans differ in liquidity requirements primarily due to their size. These plans are typically established as permanent undertakings for a corporation. As a result, the maturity has an extremely long time horizon. Liability obligations will not mature for years, except in the case of individual employees that are nearing retirement (McGill, Brown and Haley 748). These plans can invest in assets with minimal regard to liquidity due to the cash outflow obligations being covered by current contributions, investment earnings, and maturing investments (McGill, Brown and Haley 749). For defined benefit plans, liquidity requirements adjust based upon employee and pensioner profile. Companies with an aging workforce and/or a large number of pensioners will need to maintain a higher level of liquid assets than one with a young workforce and/or few pensioners (Frost 263).

The failure of the United Airlines pension fund presents an interesting argument on the use of liquidity measures. Loopholes in federal pension laws allowed United Airlines to treat its pension fund as if it were performing well when actually it was nearing failure. Federal law requires plan sponsors to pump money into a troubled pension fund, pay higher insurance premiums to the Pension Benefit Guaranty Corporation, and warn employees of the problem. Prior to its pension fund failure, United Airlines had done none of these things. A loophole in

federal law allowed United Airlines to report to the Labor Department that all of its pensions (the company ran separate funds for different types of employees such as a fund for pilots and one for flight attendants etc.) were either fully funded or nearly fully funded. Filings with the Securities and Exchange Commission require these calculations to be performed differently. United Airlines reported to the SEC that their pensions were only 50 percent funded. As a result, United owed 72.4 million to its pension fund but could not make the contribution. By the time United announced the shortfall it had filed for bankruptcy. Ultimately the PBGC would take over payment of United's pension commitments (Walsh). Regulatory problems allowed United to show that its plans were funded when they were actually not. While there must have been other underlying liquidity risks, this also serves as an example for regulatory liquidity risk. While the pension fund would have probably failed without the regulatory shortfall since United ultimately went bankrupt, regulatory issues such as the one presented here can cause liquidity issues for firms.

Liquidity Metrics

The managers of financial institutions utilize a wide variety of tools for analyzing their company's liquidity profile. According to the Basel Committee on Banking Supervision of the Bank of International Settlements, an international organization of central banks, bank managers utilize more than 25 different measures. These measures consider contractual and estimated cash flows, maturity gaps, assessment of liquidity implications, and the use of market data to monitor liquidity issues. There is, however, a lack of consistency between the measures chosen by each organization (Basel Committee on Banking Supervision 3). For the sake of discussion, this paper will consider several metrics. This includes a set of metrics that are proposed by the Basel

Committee for banks. While these metrics have been proposed for bank use, it can easily be shown that these measures are applicable to other financial institutions.

Liquidity Coverage Ratio

The liquidity coverage ratio identifies the amount of unencumbered high quality liquid assets that an institution holds. These assets can be utilized to offset the cash outflows that occur during a stress scenario (Basel Committee on Banking Supervision 5). This measure addresses funding risk. The metric is defined as:

$$\frac{\text{Stock of Unencumbered High Quality Liquid Assets}}{\text{Net Cash Outflows over a Specified Period}}$$

Basel states that this ratio should be greater than one during a 30-day stress scenario (Basel Committee on Banking Supervision 5). However, the time horizon as well as the minimum amount may vary depending upon managerial preferences. It is even possible that management will institute a maximum value for this ratio in order to cap liquid assets and boost returns.

Net Stable Funding Ratio

The net stable funding ratio measures the amount of long-term, stable sources of funding to the amount of long-term, stable funding requirements. This metric is proposed by the Basel Committee to promote longer term structure of funding for banks (Basel Committee on Banking Supervision 3). In the banking communities stable funding sources include preferred stock with a maturity of one year or less, liabilities with maturities of one year or greater, and a portion of deposits that can be expected to stay with an institution for an extended amount of time. Required stable funds in banking include the liquidity risk associated with assets (assets that may require funding due to liquidity troubles), and contingent liquidity exposures (such as a counterparty call for collateral) (Basel Committee on Banking Supervision 21-22). This metric

could be applied to other types of firms by fitting stable funding sources and requirements to the industry. This metric measures long term funding liquidity risk. It also measures some valuation risk, due to the fact that it considers liquidity potential liquidity risks created by assets with high liquidity risk. The metric is defined as:

$$\frac{\text{Sources of Long-Term Stable Funding}}{\text{Long-Term Stable Funding Requirements}}$$

Again, Basel suggests that this ratio should be greater than 1. However, management may set a higher requirement.

Liquidity Risk Ratio

The liquidity risk ratio compares sources of liquid assets to uses of liquid assets (Farin 316). This ratio measures liquidity risk under a single set of assumptions over a specific period of time. In order for management to effectively utilize this ratio, they must calculate it for a number of different scenarios that factor in various time frames as well as various economic conditions. Sources and uses of liquidity will be adjusted based upon the specified time frame and economic conditions. Companies may develop an expected scenario as well as several stress scenarios in order to properly assess their liquidity risk. The metric is defined as:

$$\frac{\text{Sources of Liquidity}}{\text{Uses of Liquidity}}$$

A liquidity risk tolerance must be developed by the company. Management will adjust liquid asset holdings in order to meet target liquidity risk ratio values (Farin 318-319).

Lambda

Lambda is a liquidity ratio that incorporates liquid reserves, anticipated cash flows, and uncertainty in cash flows. In this case, liquid reserves are assumed to mean both liquid assets

held as well as committed lines of credit. This model assumes that a company's cash flows can be statistically characterized by a mean and standard deviation (Parkinson and Kallberg 374).

The metric is defined as:

$$\frac{\text{Initial Liquid Reserve} + \text{Total Anticipated Cash Flow}}{\text{Standard Deviation of Cash Flows}}$$

The value of lambda will vary of the time period considered for the cash flows. A larger value of lambda implies that a company is more liquid. Lambda values can be interpreted in terms of a normal distribution. A lambda value of 1.645 would mean that a company has a 5% chance of exhausting its liquid reserve over the period of time for which cash flows are calculated (Parkinson and Kallberg 374). This measure factors in funding, counterparty, and valuation liquidity risk.

Contractual Maturity Mismatch

Companies measure contractual maturity mismatch to gain a basic understanding of the timing of liquidity needs (Basel Committee on Banking Supervision 4). In order to understand the gaps between contractual liquidity inflows and outflows, a company places inflows and outflows into time bands based upon contractual maturity. This measure begins to assess maturity mismatch in contractual obligations. While it neglects contingent inflows and outflows, this mismatch is relatively easy to determine for contractual obligations. As a result it is a simple measure of the timing of liquidity needs (Basel Committee on Banking Supervision 25-26).

Concentration of Funding

The Basel Banking Committee suggests an analysis of funding concentration to measure concentration liquidity risk of funding by specific counterparties, instruments, and currencies. This measure is calculated by comparing the amount of funding provided by a category compared to the total amount of available funding. Actual funding concentrations may have to

be estimated depending upon the availability of data (Basel Committee on Banking Supervision 27-28). This metric could easily be adapted to include other categories and more thoroughly measure concentration liquidity risk. Other categories include broader measures such as asset type, market sector, and maturity based measures of concentration.

Available Unencumbered Assets

A measure of available unencumbered assets allows a company to understand the amount of assets available for use as collateral in secured funding agreements. It should be noted that this list of unencumbered assets is not limited to only liquid unencumbered assets. The list would contain any and all assets that are available as collateral in funding agreements (Basel Committee on Banking Supervision 4). The Basel Committee notes that this measure does not capture potential valuation haircuts and that it should be complemented with other liquidity measures for a true understanding of collateral position (Basel Committee on Banking Supervision 29). However, a thorough analysis of all existing funding agreements through all existing counterparties would allow a firm to gain a meaningful estimate of the amount of funding that is available if it collateralizes its assets. This measure would include haircuts if each contract were factored into the measure.

Utilizing Liquidity Measures

When utilizing liquidity measures, it is important that institutions understand both the information that it contained within the measures as well as the information that is not in the measure. For example, lambda is based on the probability of an institution exhausting its liquid assets. While a lambda level of 1.645 states that a company will not exhaust liquid assets with 95% confidence, there is still a chance that the company will exhaust liquid assets. Similarly, a measure of total unencumbered assets shows the total amount of assets that are available for collateral. While it can be safely assumed that a counterparty would accept these assets as

collateral in normal market conditions, during a liquidity crisis, the value of these unencumbered assets can change; counterparties can deny collateral, alter collateral agreements, and/or fail. Essentially, this means that a measure of unencumbered assets can be interpreted as the current maximum amount available for collateralization. There are ways to adjust liquidity measures to account for crisis situations. This is discussed later under the liquidity shocks heading.

Effective utilization of liquidity measures requires management to set target levels for the measures in order to maintain enough liquidity to meet liabilities while also maximizing returns. Institutions must then adjust their liquidity characteristics to meet these target levels (Farin 318). In order to properly set target levels, management needs to evaluate risk-return trade-off associated with varying liquidity levels. Institutions must then consider various strategies for meeting these liquidity targets. Adjustments can be made to either liquidity sources or liquidity uses. Generally speaking, actions that increase liquidity have an impact on another area of an institutions performance, typically profitability. As a result, it is important for management to fully analyze the risk-return trade-offs associated with various strategies for altering their liquidity profile (Farin 319). Another factor in utilizing liquidity measures is defining the variables in the measures. The liquidity metrics that have been discussed are based on time frames, sources of liquidity, and uses of liquidity. It is also important to determine the characteristics that make an asset liquid by the firm's standards.

As previously mentioned, liquidity is the ability of an asset to be readily converted into cash. While this definition is universal for financial firms, there is not a universal set of liquid assets. Assets are instead characterized as providing immediate liquidity or intermediate liquidity. All other assets are illiquid. Assets with immediate liquidity include cash and any assets that can be converted into cash within a day. These assets include securities that mature

within a day and securities that are readily saleable. Intermediate liquidity is provided by assets that can be converted into cash within a few days or weeks without significant loss. This typically constitutes a large portion of an institutions investment portfolio (Farin 309). However, assets with intermediate liquidity may become illiquid in certain market conditions. For example, the recent mortgage crisis severely harmed the liquidity of mortgage backed securities. Illiquid assets include assets which cannot be converted into cash within a few days without incurring a substantial loss of value (Farin 309). Many firms make adjustments in the valuation of instruments with intermediate liquidity in order to account for the possible movement of these assets into the illiquid asset pool. This is discussed in a later section on liquidity shocks.

While the division into immediate liquidity, intermediate liquidity, and non-liquidity providing assets is helpful, greater specification is needed. As a result, it is important to consider some of the characteristics of assets and the markets in order to determine an assets liquidity. Liquid assets should have low credit and market risk. As previously mentioned, assets with low risk tend to be more liquid. Assets with low duration, price sensitivity of a fixed income security to changes in interest rate, low volatility, and low inflation risk will have enhanced liquidity. Liquid assets also have certainty of valuation. An asset's liquidity increases if market participants agree upon its valuation (Basel Committee on Banking Supervision 7). Assets with low correlation to risky assets are also more liquid. For example, assets issued by financial firms are more likely to be illiquid during a time of liquidity stress. Liquid assets should have an active and sizable market. An active market allows the asset to be sold quickly. A sizable market allows the asset to be sold in large quantities without a major decrease in the price of the asset. For the same reason, assets with low market concentration have increased liquidity. The

asset should also be sold in a market that is developed. Emerging markets tend to be illiquid due to uncertainty (Basel Committee on Banking Supervision 8).

It is important for institutional investment firms to understand their sources of liquidity. Sources of liquidity will include assets from the institutions portfolio as well as borrowing. Cash is typically considered to be very liquid. While it is a source of liquidity for firms, a portion of this cash cannot be considered to be entirely liquid because it may be committed to a firms daily operating needs. Regulatory bodies also force some firms to hold a minimum level of cash (Farin 311). This reserve may also be considered to be illiquid since going below reserve requirements may have significant regulatory and market repercussions for a firm. Institutions should avoid carrying an unnecessary level of cash since it is a nonearning asset. A firm's investment portfolio is also a source of liquidity. When considering which assets from this portfolio are liquid, firms should consider their threshold for loss on the asset. As previously mentioned, liquid assets can be sold quickly without suffering a substantial loss. The amount that constitutes a substantial loss may vary across firms (Farin 312). Securitization is another source of liquidity for firms. Institutions can use financial markets to turn assets into securities that can then be sold. Examples of this include mortgage loans and credit card payments (Farin 280). Firms may also borrow funds from other institutions, the Federal Reserve (if the firm has access), and the Federal Home Loan Bank system. There is some pressure from experts to not count borrowing a source of liquidity since access to borrowing typically diminishes the greater a firms borrowing needs (Farin 313).

Uses of liquidity also have to be defined when utilizing liquidity measures. Uses of funds include deposit outflows, debt service requirements, meeting loan demand, and calls for collateral. When outflows from an institution exceed inflows, there is a loss of liquidity. For

banks and hedge funds, this occurs when withdrawals exceed deposits (Farin 309-310). Pension funds have a similar issue when there are more pension withdrawals than payments into the fund. For insurance, this occurs when claims exceed premiums. Endowment funds see outflows exceed inflows when there is a lack of donors and/or there are major endowment outflows. Debt repayments also use liquidity. Meeting loan demand is a significant use of liquidity for banks. For banks, this occurs when loan repayment does not meet new loan demand requirements. As a result, banks may decrease liquid assets in order to meet borrowing needs. This problem has decreased for banks in recent years due to the ability of banks to sell loans as asset backed securities (Farin 310-311). As showcased by the AIG crisis, calls for collateral on contracts also represent a liquidity outflow. These calls may occur due to a decrease in the value of assets that have been posted or as the result of a downgrade in the firm's credit rating.

Time frames also affect some of these liquidity measures. The time frame of measurement for liquidity requirements and available liquidity is largely up to a firm's discretion. Farin states that these scenarios should be ran over multiple time frames in multiple economic conditions. However, for some institutions there are regulations may require certain time frames to be reported. While this does not limit the number of time frames that a firm can utilize, it may force a firm to focus on optimizing liquidity within the regulatory framework. The Basel Committee on Banking suggests that liquidity coverage ratios should be conducted for a 30 day period. That is, a company should have enough unencumbered liquid assets to cover liabilities for a 30 day period. However, many investment banks are currently advertising greater liquidity than this requirement. Goldman Sachs currently advertises that their Global Core Excess (liquid asset pool) if pledged or sold would provide funds to replace more than 110% of Goldman's unsecured obligations that are scheduled to mature within the next 12 months

(Goldman Sachs). This liquidity cushion far exceeds the regulatory proposal by the Basel Committee for international investment banks.

Regulatory requirements may also play a role in determining target levels for liquidity, liquidity uses, and liquidity sources. Depending on the type of firm, liquid asset pools may be restricted for regulatory reporting reasons. Typically regulations will consider cash, treasury instruments, federal funds, and state and municipal obligations with a good credit rating and maturity of three years or less as liquid assets. Regulations may also include longer term securities that have their market value protected by a futures contract or option. For regulatory purposes, short term liquid assets are typically defined as cash and liquid assets with maturities of six months or less. Since regulatory requirements are standardized across industries, they do not take into account all of the possible uses of liquidity. They also neglect some of the sources. As a result, an institution may hold assets that are liquid for their purposes, but are not considered liquid for regulatory purposes. The same holds true for uses of liquidity (Farin 315). Target liquidity values will also vary across regulatory bodies and industries.

Liquidity Shocks

Liquidity measures are dependent upon decisions made either by a firm or a regulatory body on time frame, liquidity sources, liquidity uses, and definitions of liquid assets. As a result, liquidity measures may be hindered by improperly defining these values (similar to what happened with the United Airlines pension). Definition of these terms will likely depend on industry, firm, and market history as well as current conditions. During a liquidity crisis these definitions will likely change. In a crisis, liquidity suppliers are likely to recognize the risk associated with an increased demand for liquidity. As a result, they will be reluctant to supply liquidity. Some liquidity suppliers may even find themselves in a position of demanding

liquidity (Bookstaber 94). In this type of environment sources of liquidity diminish. This environment is also typically associated with an increased use of liquidity. During a crisis, asset prices will drop. A flood of companies seeking to liquidate can further decrease prices and lead to more liquidation. A fall in asset prices is typically accompanied by calls for collateral. This can lead to a liquidity spiral like the one that led to the failure of LTCM (Bookstaber 95). The time frame of liquidity crisis may also vary from time frame values utilized by management and/or regulatory bodies. In 1999 Eddie Cade's book and banking risk management states that banks will "not expect to hold sufficient liquidity to survive (much less help others to survive) a prolonged liquidity crisis in the national monetary system as a whole, where remedial action is the responsibility of the central bank (Cade 55)." In this section of the book, Cade writes that the liquidity cushion of banks should only be expected to last for a week. After the recent liquidity crisis, the Basel Committee is recommending that banks be able to survive on their own for at least 30 days and banks like Goldman Sachs are holding much more than this in liquid reserves.

A common method of handling the potential changes in a firm's liquidity profile due to market conditions is liquidity stress testing. In a liquidity stress test, a firm will base a variety of liquidity measures on a scenario or scenarios in which the firm is facing a liquidity crisis. While there is no definitive scenario, scenarios may include: a significant downgrade of the institution's credit rating; a partial loss of cash inflows; a loss of unsecured funding; a significant increase in secured funding haircuts (decreases in an asset's collateralized value i.e. an asset valued at \$100 may only give an institution access to \$80 in secured funds); a loss of some channels of secured funding; increases in collateral calls and an increase in contractual and non-contractual exposures; and a decrease in asset values (Basel Committee on Banking Supervision 3).

Companies may run multiple versions of these stress scenarios to get a feel for their liquidity

profile in a particular market environment. However, since there is no definitive model for how the market will act in a given crisis, these scenarios can only go so far. Firms should utilize these stress tests to understand how their liquidity exposure will change in a variety of environments. They can then use this information to make some adjustments to their liquidity exposure. However, this does not guarantee safety during a liquidity crisis.

Immunization

Immunization is an investment strategy that consists of investing in fixed income securities that match liabilities (Bodie 58). The goal of immunization is to match the duration of assets and liabilities (Vanderhoof 4). Duration is a measure of the average maturity of an income stream (Bierwag 725). The basic idea behind immunization is that all investments that have the same duration have the same changes in value when interest rates change (Vanderhoof 4-7). This is based on the fact that investing short with falling interest rates or investing long with rising interest rates yields a loss (Vanderhoof 1). If asset and liability durations match, then their change in value will also match. Asset and liability portfolios of financial institutions generate patterns of future cash flows that when following the restrictions of immunization will assure solvency as well as profitability. Institutions, including insurance and pension funds, that have definite and certain future commitments of funds or at least predictable future commitments of funds can utilize immunization to avoid liquidity problems (Bierwag 725). Studies have shown that while immunization does not always work perfectly, it is an effective tool (Vanderhoof 7).

The basic immunization model is based on the underlying assumption that the yield curve can only make parallel moves up or down. Advanced immunization techniques such as bucket or factor immunization address the issue of yield curve shape changes (Nielson 2). This paper will focus on the basic immunization model. In the basic model, a portfolio of bonds is created

such that the portfolio's net present value matches the net present value of liabilities (Nielson 4). In order to immunize the portfolio against shifts in interest rates, the duration of assets and liabilities must also be the same. (Nielson 4).

A portfolio's duration is the weighted duration of all portfolio assets. For portfolios that also contain equities, the duration values are also weighted by beta value. Beta is the magnification value of a stock's returns relative to the market (Leibowitz 23). While the duration of equities can be calculated, the basic model discussed here will include only bonds in the portfolio. The most common duration measures that are utilized for an immunization model are Macaulay duration and modified duration. Modified duration is calculated by dividing the negative of the first derivative of a bond's present value function with respect to yield rate by the bond's present value. Macaulay duration is the weighted average of the times to arrival of cash flows. Macaulay duration is equal to one plus the yield rate times the modified duration of the bond (Nielson 5). Liabilities can be modeled in the same way as the asset portfolio for duration calculation.

Duration matching of assets and liabilities protects against small shifts in interest rates, so that asset value and liability values stay approximately balanced. However, another condition must be met for full immunization, convexity. Convexity measures changes in duration due to changes in interest rate. It is defined as the second derivative of the present value function with respect to yield rates (Nielson 6). Convexity should be as small as possible to obtain a portfolio with cash flows that are more centralized over time. However, if convexity is too small, the first bond cash inflows will arrive after the first liability cash outflows. Mathematically this means that asset convexity should be no less than liability convexity. This condition insures that if

interest rates change, asset and liability values will change roughly equally and any difference in these changes will cause assets to be worth more than liabilities (Nielson 7).

The conditions for basic immunization are present value matching of assets and liabilities, duration matching of assets and liabilities, and asset convexity must be greater than liability convexity (Nielson 7). If these conditions are met, then a company is protected from losses due to changes in interest rates. Again this is for the basic model that assumes the yield curve shifts parallel, but the shape of the yield curve does not change. Current models rely on various interest rate scenarios in order to immunize in the event of a yield curve shape change (Nielson 8). There is also another type of immunization known as contingent immunization. Contingent immunization is an investment strategy that places some assets in risky securities such as equities as long as the present value of assets in the portfolio exceeds the present value of liabilities. If the value of assets falls below a certain threshold relative to the value of liabilities, this strategy changes a portfolio's asset composition until it is a fully immunized fixed income portfolio (Bodie 58). As a result, contingent immunization does not necessarily offer the solvency and profitability protection that full immunization does. Mismanagement of the portfolio or extreme market conditions could create losses if the portfolio is not switched over to a fully immunized fixed income portfolio at the right time. However, it does offer the benefit of potentially higher returns on the investment portfolio.

Technique Application

When selecting which liquidity measures to use, a firm should consider its specific needs as well as regulatory requirements. The following section includes a discussion of the application of some of the above liquidity measures to various types of institutional investment firms. The liquidity measures that are being utilized are based on measures that are historically

used within that market as well as measures that are required by regulatory bodies. Any firm could use any of the liquidity measures or techniques that are mentioned above (though the firm may have to make some assumptions or adaptations to utilize the measures or technique).

Banking

Incentives exist for banks to take risk. Individual institutions are concerned with their own risk exposure. The amount of risk that a bank is willing to take on will vary by bank. As a result, banks will utilize liquidity measures differently depending on a specific bank's risk preferences. Regulators are concerned with the risk faced by the whole banking system as the result of the actions of a particular bank (Bessis 39). Banking liquidity regulations vary worldwide. They typically involve liquidity ratios and more developed nations are heading towards federal supervision of banks instead of federal regulation of banks (Frost 422). Due to the variety of banking regulations worldwide, this paper will focus on the liquidity regulations that have been proposed by the Basel Committee on Banking Supervision of the Bank for International Settlements. These liquidity standards have been proposed for all internationally active banks. This committee is made up of central banks and supervisors from 27 countries worldwide. These requirements could be adopted by the Bank of International Settlements as early as 2012 (When the River Runs Dry).

The Basel Committee proposed regulations for the liquidity coverage ratio and net stable funding ratio. For the liquidity coverage ratio the Basel Committee suggests a 30-day time frame in which firms can cover liabilities from its high quality liquid asset pool during a liquidity stress scenario. This ratio should be larger than 1. The scenario that is proposed by the committee includes a significant downgrade of the institution, a partial loss of deposits, a loss of unsecured funding, a significant increase in secured funding haircuts, and increases in derivative collateral

calls and calls on contractual and non-contractual exposures (Basel Committee on Banking Supervision 3). The liquid assets that Basel defines for consideration in this metric include cash, central bank reserves, marketable securities that are guaranteed by a central bank, the International Monetary Fund, or the Bank for International Settlements, and government issued debt. High quality corporate and covered bonds are also considered to be liquid asset pool, but at a significant haircut (Basel Committee on Banking Supervision 7-10). Basel also requires the net stable funding ratio to be greater than one. The committee defines available stable funding as an institutions capital, preferred stock with maturity greater than one year, liabilities with maturities of one year or greater, and the portion of stable deposits that would be expected to stay with an institution during a stress scenario (Basel Committee on Banking Supervision 22). Basel defines required stable funds as unencumbered marketable securities, unencumbered corporate bonds, gold, unencumbered equity securities, loans to clients with a maturity of less than one year, and all other assets excluding cash and money market instruments, securities with remaining maturities of less than one year, and outstanding loans to financial institutions with maturities of less than one year. Each of these values asset categories has a corresponding weight factor that the committee assigns for the calculation (Basel Committee on Banking Supervision 23-24).

Basel also requires banks to utilize contractual maturity mismatch, concentration of funding, and available unencumbered assets. Banks will then report this data to the committee. Currently, the Basel Committee does not outline any target values for these measures. The committee simply points out that they should be monitored and reported. Banks should also report any plans for dealing with problems that these metrics present to the banks operations (for

example if there is maturity mismatch the committee wants a report on what the bank will do to handle it) (Basel Committee on Banking Supervision 25-30).

Insurance

The problem for insurers is that the maturity composition of their assets and liabilities diverge. Immunization works because it accounts for interest rate changes (Nye and Kolb 149). Insurance companies can utilize immunization by creating actuarial models for their liabilities and immunizing their portfolio based on these models. This works for insurance lines, however, like AIG many insurance companies have a financial products division. The products offered by these divisions cannot typically be fully immunized. Moody's suggests that good asset-liability management for these types of products requires cash flow matching of assets and liabilities over a near-term horizon, the next one to two years. These cash flows should also be duration matched. Moody's considers firms riskier when cash flow mismatches are large, investments are high risk, and/or investments are over-concentrated (Moody's Insurance). It is important to note that insurers place importance on the suggestions of Moody's since a downgrade has financial ramifications for the institution (as it did for AIG).

Regulations also affect the liquidity constraints of insurance companies. Regulators place three basic constraints on insurance companies: minimum capital requirements; asset compositions; and ceilings on rates guaranteed to policyholders (Briys and de Varenne 89). These regulations impose a mandatory reserve on insurance companies. These reserves act as a buffer to protect policyholders from the impact of low asset values (Frost 261). The level of equity holdings may also be limited to a specified percentage of assets by regulators. State regulations may place more requirements on insurance firms (Frost 272). Insurance companies may find it necessary to utilize other liquidity measures. For example, concentration of funding

measures can help insurance companies mitigate concentration risk. During a crisis insurance companies will likely take stock of unencumbered assets in order to find liquidity. Additional measures will depend either upon regulatory restrictions or the economic environment at the time.

Hedge Funds

Hedge funds present a particularly interesting set of regulatory and managerial considerations when considering which liquidity measures to utilize. Hedge funds are typically exempt from registration and disclosure requirements of federal securities law. Funds are not prohibited from leveraged trading, short selling, or concentrated investment. In order to qualify for these exemptions hedge funds cannot advertise and may only accept investments from large institutions and wealthy individuals. Hedge funds are subject to some regulations particularly they may not commit fraud or insider trading (Shadab 36). While hedge fund regulation is certainly possible in the future, it will be extremely difficult. Regulation would have substantial costs for the SEC as well as hedge funds. Hedge funds rely primarily on secretive trading strategies. If these strategies were revealed, the funds would not function. The SEC would have to deal with the costs of collecting hedge fund data. Fund managers that want transparency will typically create mutual funds instead of hedge funds (A. W. Lo 250-252). Recently, hedge funds have been proactive in balancing their need to inform investors while protecting the confidentiality that is essential to their investment strategies (Hedges 23). As a result of the lack of regulation and the diverse trading strategies of hedge funds, the liquidity metrics that are utilized by the fund will vary with the fund manager's preferences.

The most prominent method for examining liquidity risk for a hedge fund is to examine the autocorrelation coefficients of the funds monthly returns. This measure is equal to the

covariance of returns at time t and returns at time t minus k . The resulting value measures the correlation between monthly returns. Autocorrelation analysis is based on the assumption that markets are efficient and as a result behave randomly. Since markets are unlikely to be entirely efficient, there is some correlation in returns. This correlation is assumed to be explained by market frictions. Illiquidity is the most common of these frictions. As a result a high correlation is assumed to coincide with illiquidity (A. W. Lo 28). There are, however, several aspects of liquidity that are not captured by autocorrelation. There are also investment strategies that generate autocorrelation despite being extremely liquid positions (A. W. Lo 29).

Endowments

Endowments face several types of liquidity risk. However, the long time horizon of endowments limits their liquidity needs. The Yale model of endowment investment emphasizes diversification. The recent crisis has led critics to claim that diversification does not work. Yale's endowment manager, David Swensen, states that this recent criticism is due to the recent focus on short term measurement of returns. He argues that this time horizon is inappropriately short for an endowment (Hettena). The limited liquidity needs of endowments seem to lend themselves to just a few liquidity measures. Endowments should consider a concentration of funding measure due to their desire to diversify. It may also be desirable for endowments to monitor their liquidity coverage ratio. It seems reasonable that the period of time for consideration in this ratio should vary with the liquidity requirements of the endowment fund.

Pensions

The primary liquidity management technique for pension funds is immunization. Pension fund liabilities are predictable. For the purposes of immunization pension plans make actuarial assumptions concerning mortality, turnover, disability, interest rates, and plan expenses. They

then create a model for liabilities that factors in assumptions for employee withdrawal, retirement benefits, salary levels, replacement of withdrawn employees, past service liability, benefits vesting, interest rates, disability and death benefits, and plan expenses. These assumptions allow the pension to create a reasonably accurate model for liabilities (Keintz and Stickney 227-229). The pension fund may then follow utilize traditional immunization. If the fund is seeking greater returns, they may rely on contingent immunization where the portfolio contains equities as well as fixed income securities (Bodie 58).

Regulation of pension funds depends on the entity that manages the fund. As a result, additional liquidity measures may be required (McGill, Brown and Haley 746). As mentioned in the United Airlines example, pension funds must submit information to government bodies regarding the funding of their liabilities. Companies are liable for plan shortfalls (Bodie 58). However, if a fund is utilizing an immunization strategy, it would be fully funded. There is also an Employee Retirement Income Security Act provision regarding the diversification of funds in a pension portfolio. The act does not highlight levels for diversification. However, it does state that a policy statement have some general discussion of how the policy is diversified (McGill, Brown and Haley 755). The company managing the pension may choose to utilize a concentration of funding measure to monitor diversification.

Conclusion

Recent events have forced firms to focus on liquidity risk. Balancing liquidity risk and return is a crucial part of managing an institutional investment firm. However, decisions on how much risk is acceptable should consider liquidity issues. Different investment firms face a varying set of regulatory and managerial constraints. These constraints will factor into liquidity decisions. Different liquidity metrics and techniques for mitigating liquidity risk will be

applicable for varying asset and liability as well as risk profiles. As a result, there is no single liquidity measure or technique that is applicable to all firms. Each firm should decide on which liquidity measures are relevant to their business. For firms where immunization is an option, the best way to manage liquidity risk is through immunization. A fully immunized firm will not typically become insolvent. Firms should choose the liquidity risk management techniques that fit their business.

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