ESSAYS ON ASSET LIQUIDITY, CASH HOLDINGS, AND THE COST OF CORPORATE DEBT

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Abstract: This dissertation examines the relationship between the ability of a firm to sell its real assets (asset liquidity) and its cash holdings behavior as well as its cost of debt. In essay 1, I show that for financially constrained firms there exists a negative relationship between the liquidity of a firm's real assets and the size of its cash holdings, however no such relationship is present for financially unconstrained firms. This indicates a substitution effect between cash balances and liquid real assets when access to external capital markets is limited. Additionally, I find that among financial constrained firms the market value of cash holdings is lower among firms possessing more liquid real assets. In essay 2, I examine the implications of this cash holdings/asset liquidity relationship on the cost of corporate debt. First, I develop a simple two period model of credit spreads endogenizing the cash holdings/asset liquidity trade-off and show that there exists a non-linear (U-shaped) relationship between credit spreads and asset liquidity. Empirically, I show that indeed there is a non-linear relationship between credit spreads and asset liquidity such that credit spreads are decreasing with liquidity for low liquidity firms and increasing for high liquidity firms. In addition, cash holdings plays a mitigating role in the observed effect of asset liquidity on credit spreads.

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CHAPTER 1

Introduction and Motivation

Why do firms choose to invest in cash? In an economy with frictionless capital markets, cash holdings are an irrelevant component of corporate financial policy since firms can access external capital markets instantly at no cost to service any current liquidity needs. Additionally, the absence of a liquidity premium implies that there is no deadweight loss associated with holding cash balances. Therefore, cash is a zero net present value investment and thus the decision of whether or not to hold cash balances has no bearing on the value of the firm. Capital market imperfections, however, impose a significant cost on external financing and, as a result, provide a role for a corporate cash policy. A firm facing a liquidity need can avoid these external financing costs by holding an adequate level of cash reserves ex-ante. If access to external financing through the debt or equity markets is costly or unavailable, cash reserves provide a buffer against negative cash flow shocks and allow firms to continue to invest in negative cash flow states without the assistance of the capital markets.

Kim et al. (1998) and Opler et al. (1999) argue that there exists a value maximizing optimal level of cash holdings that is determined by the trade off between the costs and benefits of holding cash. Many studies[1] find that the level of cash holdings is increasing with external financing costs. As the costs of accessing the debt and equity markets increase, firms will hold larger cash balances in order to avoid accessing them.

In addition to the traditional debt and equity markets, there is another market that firms can access in order to meet a financing or liquidity need: the market for asset sales. A firm can turn to selling its real, productive assets in order to obtain funding. The asset sale market contributes substantially to the total dollar amount of financing firms raise.

[1] e.g. Faulkender and Wang (2006), Denis and Sibilkov (2010), and Almeida et al. (2004)

In 2012, the total value of asset sales reported in the Securities Data Corporation (SDC) database was $131 billion, compared to just $81 billion in seasoned equity offerings (Edmans and Mann, 2013). Figure 1.1 shows that over the time series, the proceeds from asset sales consistently exceeds those from seasoned equity offerings.

[Figure 1.1 about here.]

While a portion of these asset sales may have been due to operational or strategic reasons, there are a number of instances where the motives are explicitly for raising capital. Borisova et al. (2013) find that over half of asset sellers state that financing motives are the reason for the sales, and Hovakimian and Titman (2006) and Borisova and Brown (2013) show that asset sales are related to increases in investment and R&D, respectively, suggesting that they were undertaken for the purpose of raising capital.

Anecdotally, there are several instances in which firms turned to assets sales in order to meet current obligations. Following the Deepwater Horizon oil spill in 2010, BP targeted $45 billion in asset sales to cover the costs of fines and damages related to the disaster. Asset sales were especially prevalent among financial firms in the midst of the financial crisis as a means to stave of financial contagion and build up their capital reserves.[2] More recently, Sears has resorted to selling assets with explicit plans to raise $2 billion in liquidity in 2013.[3]

With assets sales comprising a non-trivial fraction of the total funds raised in the capital markets in any given year, it is important to examine their implications on corporate financial policy. In this dissertation, I examine the relationship between the market for asset sales and the firm's cash holdings policy. There are a number of reasons to suspect that there is a link between the asset sale market and firms' cash holdings. For firms that are financial constrained in the sense that they have limited or no access to the debt or equity markets, the ability to sell assets would represent a relaxing of financial constraints. If this is the case, then it will diminish the utility of precautionary cash holdings. But like debt

[2] For example, BNP Paribas and Societe Generale announced plans to raise $96 billion and $5.4 billion respectively through asset sales.

[3] Reuters: "Sears quells liquidity, not retail, fears" http://www.reuters.com/article/2012/02/23/us-sears-idUSTRE81M0Y720120223

and equity, financing with asset sales comes at a cost. The cost of asset sales is represented by the discount (the difference between the true value and the selling price) the firm incurs when liquidating the assets.

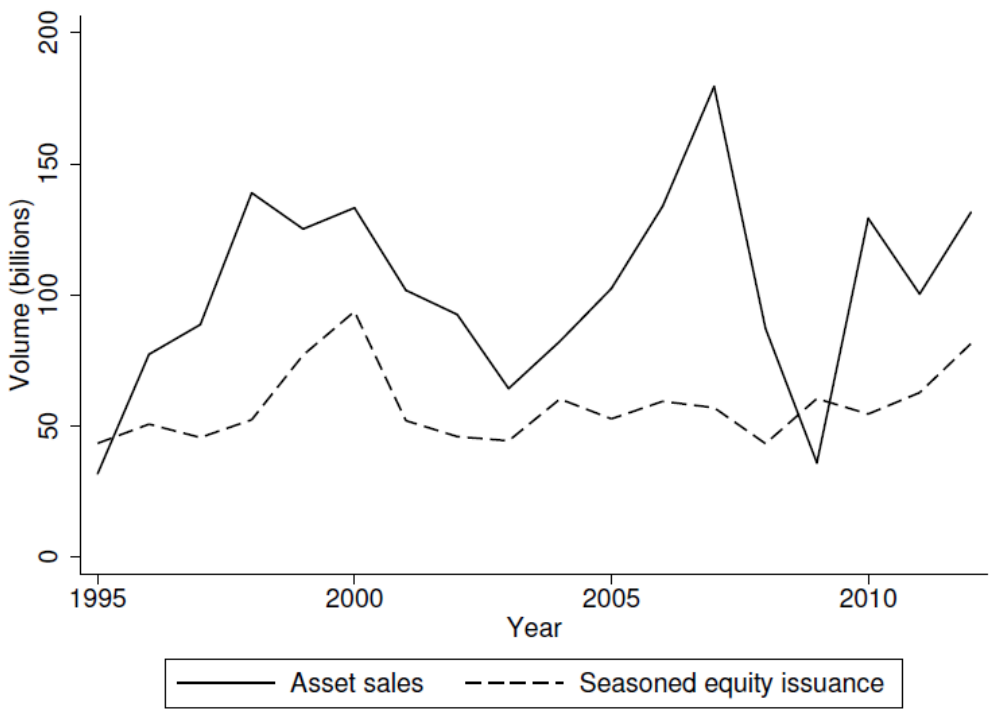
In this dissertation, I extend the literature on cash holdings by examining the role that the asset sale market plays on corporate cash management policies. In particular, I investigate how the liquidity of a firm's real assets affects the firm's choice of cash holdings and examine the impact this relationship has on the cost of corporate debt. In the first essay, I document an empirical relationship between real asset liquidity and corporate cash holdings and make three contributions to the cash holdings literature. First, I identify a substitution effect among financially constrained firms between real assets and cash holdings such that firms with more liquid real assets tend to hold smaller precautionary cash balances. Second, I show that the market value of cash holdings differs on the basis of the liquidity of the firm's real assets, with investors attaching lower values to cash balances held within firms with more liquid real assets. Third, using exogenous shocks to capital markets to identify periods of uncertainty, I find that the presence of liquid real assets has an impact on the cash re-balancing behavior of the firm in the face of increased uncertainty about the capital markets. The magnitude of this increase is partially mitigated by the presence of highly liquid assets. Each of these findings is limited to financially constrained firms, indicating that firms see asset sales as a feasible source of funds when external capital markets are excessively costly or inaccessible.

In the second essay, we explore the theoretical link between real asset liquidity, cash holdings, and corporate credit spreads. Specifically, we develop a model in which a firm can liquidate a portion of its productive assets in order to service debt or finance investment opportunities. Selling assets comes with transaction costs that materialize in two ways. The first transaction cost is the discount the firm incurs on the selling price of the asset. The second cost materializes in the loss of future cash flows resulting from divesting in the productive asset. In order to avoid these costs, the firm may choose to hold precautionary cash reserves. The question then becomes should the firm hold precautionary cash balances or utilize options to voluntarily sell real (productive) assets when necessary to invest in projects or service debt? In our simple, two period model, we assume that the firm is limited in its access to debt and equity markets but has the ability to liquidate assets in order to hedge future cash shortfalls that arise due to debt repayment or profitable investment opportunities. We solve for the optimal level of asset sales and cash holdings and determine the impact of fire-sale discounts on the level of cash holdings. Finally, we examine the theoretical implications of the relationship between asset sales and cash holdings on the cost of corporate debt.

In the final essay, I empirically test the implications of the model as well as implications suggested by other theoretical models using a reduced-form regression model of credit spreads. Within this regression framework I examine the relationship between real asset liquidity and the cost of both secured and unsecured debt. Of particular interest is the interaction effects between cash holdings and asset liquidity. Because liquid real assets increase creditor's recovery value in default, credit spreads for secured debt should be decreasing with asset liquidity (Myers and Rajan (1998) and Morellec (2001)). Acharya et al. (2012) show that because high cash balances provide security for debt holder's claims, cash holdings are also negatively related to credit spreads. I argue that because cash holdings are a function of real asset liquidity, the effects of asset liquidity on credit spreads will depend on the firm's level of cash holdings. In other words, there is an endogenous relationship between cash and asset liquidity such that firms with high asset liquidity tend to hold smaller cash balances. These characteristics individually push credit spreads in opposite directions (i.e. high asset liquidity widens credit spreads for secured debt while lower cash holdings narrow credit spreads. See figure 3.6 for a schematic of these relationships). Therefore the purpose of this essay is to disentangle this relationship and identify which is the driving force affecting credit spreads as well show how the two characteristics work together in determining the cost of corporate debt.

Figure 1.1: Seasoned Equity Issuance and Asset Sale Volume

This figure displays the dollar amount of seasoned equity issuances and the dollar amount of asset sales over the time period of 1995 - 2012. Source: Edmans and Mann (2014)



CHAPTER 2

Essay 1: Cash Holdings and the Market for Asset Sales

2.1 Introduction

When financial frictions are non-existent, the total value of the firm is completely independent of any cash management policies (Miller and Modigliani, 1961). In states of the world where firms have insufficient funds to continue their operations and investments, they are able to secure external funding costlessly and proceed undeterred. On the other hand, because of the absence of a liquidity premium there are no opportunity costs associated with holding cash. Since there are no costs associated with accessing the capital markets and there are no costs in holding liquid assets, the decision of whether or not to hold cash balances is completely irrelevant to firm value.

As we abstract away from a world of perfect capital markets, the role of cash holdings begins to plays a part in the determination of optimal financial policy. If a firm faces a liquidity need, it can issue securities to meet that need. However, obtaining external financing comes at a substantial cost to the firm that could be avoided by holding an adequate level of cash holdings ex-ante. Kim et al. (1998) and Opler et al. (1999) argue that there exists a value maximizing optimal level of cash holdings that is determined by the trade off between the costs and benefits of holding cash. Additionally, Faulkender and Wang (2006), Denis and Sibilkov (2010), and Almeida et al. (2004) find that the level of cash holdings increases as external financing becomes more costly. By holding larger cash balances prior to experiencing liquidity shocks, these firms are able to avoid being compelled to use costly external funds.

In this essay I consider an additional capital market that firms can access that is not often considered in the literature: the market for asset sales. In addition to issuing debt or equity securities, a firm can turn to selling their real, productive assets in order to obtain funding. Just as there are costs of debt and equity, there are costs associated with asset sales as well. The cost of asset sales is the difference between the actual value of the asset and its selling price. The price that real assets command in a sale will depend greatly on the conditions in the market for the particular firm's assets. Assets will be able to be sold at reasonable prices relative to their true value only when they are sold in a competitive market with a sufficient number of willing buyers. That is, when the market for a firm's real assets is sufficiently liquid, the selling price will become closer to the fair value of the assets. Whether asset sales are a rational or feasible funding source will depend largely on the liquidity of the market for the firm's assets.

I examine the relationship between the liquidity of a firm's real assets and its cash holdings and make three main contributions to the cash holdings literature. First, I identify a substitution effect among financially constrained firms between real assets and cash holdings such that firms with more liquid real assets tend to hold smaller precautionary cash balances. Second, I show that the market value of cash holdings differs on the basis of the liquidity of the firm's real assets, with highly liquid firms valuing cash less. Third, consistent with the previous literature I find that following spikes in capital market uncertainty all firms increase their precautionary cash reserves. However I find evidence that the magnitude of this increase is partially mitigated by the presence of highly liquid assets. Additionally, I show that the ameliorating effects of real asset liquidity on the size of cash reserves do not apply to financially unconstrained firms, indicating that asset sales are not a cost effective source of funds when external capital markets are accessible.

2.2 Related Literature

2.2.1 Cash Holdings

Kim et al. (1998) and Opler et al. (1999) argue that there are costs and benefits associated with holding cash and the trade off between them leads to the existence of an optimal level of cash holdings. The liquidity premium leads to low rates of return to cash and represents a substantial cost to holding cash balances. In regards to the benefits, Keynes (1936) identifies two motives for firms to hold cash: the transaction cost motive and the precautionary motive. The transaction cost motive, formally developed by Baumol (1952) and Miller and Orr (1966), acknowledges that firms with liquidity needs face significant costs in raising funds. Firms can raise the needed cash by various means, such as utilizing the external capital markets, decreasing payouts to shareholders, or by selling off assets. Each of these methods imposes significant costs to the firm. Therefore, holding sufficient cash balances alleviates the need to engage in such costly transactions. The precautionary motive suggests that given that firms are limited in their ability to raise external funds, firms with substantial cash balances are better able to withstand negative cash flow shocks and more able to take advantage of unforeseen investment opportunities. By transferring current cash flows into cash reserves the firm gains the flexibility to handle these future events without incurring the costs associated with obtaining external financing. In the Myers and Majluf (1984) pecking order argument, a firm's securities maybe undervalued by the market due to information asymmetry. So even for firms that have access to capital markets, building up financial slack by accumulating cash may be beneficial in order to avoid selling undervalued securities.

Opler et al. (1999) find empirical evidence that is consistent with this trade-off theory of cash holdings. They find that factors associated with the degree of financial constraints (i.e. firm size and credit ratings) tend to be inversely related to cash balances. Similarly Faulkender and Wang (2006), Denis and Sibilkov (2010), and Almeida et al. (2004) each find that firms facing more costly external financing tend to have greater cash holdings. In line with the precautionary motive of cash holdings, Harford (1999) and Opler et al. (1999) find a positive relationship between cash and measures of risk and investment opportunities (cash flow volatility, market-to-book, research and development, capital expenditures, and acquisitions). Additionally, they find that the level of cash holdings are persistent through time and are actually greater than what a static trade off model of cash balances would predict. After observing a dramatic increase in the level of cash holdings over recent years, Bates et al. (2009) find that the increase can largely be attributed to a sharp increase in firms' cash flow volatility in recent years.

Cash reserves played a large part in keeping some firms afloat during the 2008 financial crisis, as was noted by Campello et al. (2010). They find that while cash balances of financially unconstrained firms tended to stay level throughout the crisis period, financially constrained firms drastically depleted their cash, with reserves dropping nearly 20%. Each of these findings gives the indication that the precautionary motive of cash holdings is quite strong.

Recent surveys of corporate executives provide supporting evidence regarding the role of the precautionary motive in determining cash management policies. Lins et al. (2010) find that 47% of CFOs say they hold cash as a buffer against future cash shortfalls. Similarly, Graham and Harvey (2001) find that CFOs rank financial flexibility as their main driver in capital structure decisions. Therefore, by holding cash balances they are better able to enjoy this desired flexibility.

2.2.2 Asset Liquidity

A firm facing a liquidity shortfall may obtain the necessary funding by either by reducing payouts to shareholders, utilizing external capital markets, or selling off existing assets. While selling assets may seem like an unreasonable proposition, a firm facing severe agency costs (Myers, 1977; Jensen and Meckling, 1976) or adverse selection costs (Myers and Majluf, 1984) may find that the costs of external financing through the debt or equity markets are sufficiently high enough to justify incurring the high transaction costs associated with asset sales. In line with these predictions, Kim (1998) finds that managers only sell illiquid assets when other sources of financing are very costly (i.e. severely financially constrained firms).

If a firm chooses to use asset sales as a source of financing, the value they receive will depend largely on the asset's liquidity. Firms that possess assets which can be sold easily and without a significant loss in value may find that asset sales are a relatively cheap source of financing when compared to other external capital markets. The liquidation value of the asset depends largely on two main factors: the number of potential users and the ability of these users to purchase the asset (Williamson, 1988; Shleifer and Vishny, 1992). If there are few firms that have use for the asset or if all potential buyers lack funds themselves to purchase the asset, and/or are financially constrained, the demand for the asset will be low and the asset will sell at a steep discount. Because many assets tend to be industry specific, Shleifer and Vishny (1992) predict that the financial condition of industry participants is the main driver in the liquidation value of assets. Indeed, Ramey and Shapiro (2001) and Pulvino (1998) find that assets that are sold to industry outsiders tend to suffer larger discounts than sales that occur within the industry.

The theoretical literature makes many connections between asset liquidity and capital structure. Williamson (1988) and Shleifer and Vishny (1992) argue that because liquid assets reduce liquidation costs in the event of default, leverage will have a positive association with asset liquidity. Conversely, Myers and Rajan (1998) and Morellec (2001) predict that the impact of asset liquidity on leverage depends on whether or not the assets are posted as collateral. Because the potential for wealth transfers due to asset stripping is higher for firms with liquid assets, bondholders will require higher returns from these firms if their claims are not secured. Sibilkov (2009) tests these predictions and indeed finds a multidimensional effect. While there is a positive relationship between asset liquidity and the level of secured debt, a nonlinear relation exists for unsecured debt.

While asset sales can provide flexibility for firms facing financial constraints or uncertain access to capital, Bates (2005) finds that the probability that a firm retains the proceeds of asset sales (i.e. does not repay debt or pay dividends/share repurchases) is not related to cash holdings. Rather, the probability to retain proceeds is related to the size of the firm's growth opportunities. Similarly, Subramaniam et al. (2011) find that diversified firms hold less cash than focused firms, but they find that this is not due to their increased ability to sell assets. Instead this finding is due to the fact that the cash flows of the diversified firms are imperfectly correlated, thus creating a hedge and diminishing the need for precautionary cash holdings.

Survey responses documented by Campello et al. (2010), however, presents evidence to the contrary. Regarding the financial crisis of 2008, 70% of CFOs of financially constrained firms said that they sold more assets during the crisis than before in order to obtain funds.

In contrast, only 37% of non-constrained CFOs indicated that they sold more assets. This demonstrates that the ability to engage in asset sales does make firms more flexible in the sense that they have more feasible avenues to obtain necessary funding.

2.3 Hypothesis Development

As illustrated above, in the absence of necessary liquidity firms can raise funds either from the external capital markets, by decreasing payouts to shareholders, or by liquidating a portion of their real assets. For firms with illiquid assets, the prospect of using asset sales as a means to meet a liquidity need may not be an economically reasonable decision due to the loss in value incurred during the sale. Firms with more liquid assets, however, incur a much smaller cost. Therefore liquidating assets to meet liquidity needs may be more feasible for this subset of firms.

Since liquid assets can be converted to cash with minimal cost, the ability to sell these assets will reduce the marginal benefit of holding cash reserves. Because cash balances provide little to no return, the firm will try to minimize their holdings as much as possible while transferring these balances into productive real assets. In the extreme case where the firm's real assets are equally as liquid as cash and they are able to liquidate costlessly, their real assets could be seen as a preferred substitute. That is, because the rate of return on productive assets is higher than that of cash, firms will hold no cash balances and liquidate their real assets whenever they encounter a liquidity need. Relaxing this extreme scenario brings me to my first hypothesis.

To the extent that liquid real assets can be liquidated in the event of a cash shortage, they can be seen as imperfect substitutes for cash reserves. Therefore, we would expect a negative relationship between asset liquidity and cash holdings.

Hypothesis 1a *Firms with more liquid real assets will hold smaller cash balances than firms with illiquid real assets*

There will, however, be a limit to which asset sales are effective at reducing a firm's optimal cash balance. At very low ranges of asset liquidity, increasing liquidity does not move asset sales into a feasible proposition. It is only when assets are sufficiently liquid that they will have an impact of cash holdings.

Hypothesis 1b *There will exist a curvilinear relationship between asset liquidity and cash holdings such that firms with very liquid real assets will hold less cash, but firms with very illiquid real assets will not augment their cash policy.*

Since liquidating assets is costly, firms will only engage in asset sales as a source of financing when the costs of external funds are excessively high. So only firms which lack less costly alternatives will treat their real assets as potential substitutes for cash reserves. This substitution effect will not exist for firms that have relatively easy access to capital markets.

Hypothesis 2 *Cash balances for financially unconstrained firms will have no relationship to asset liquidity*

If cash holdings are zero net present value investment, then one dollar of additional cash should be associated with a one dollar increase in the market value of the firm. With imperfect capital markets, however, there are costs associated with capital raising. These financing costs are ultimately borne by the investors giving a role for precautionary cash balances. As such, the valuation of cash holdings within the firm is affected by these costs of capital raising (Pinkowitz and Williamson, 2004). Faulkender and Wang (2006) find that the marginal value of cash declines with better access to capital markets, as the need for precautionary cash holdings in these firms diminishes. If a firm's real assets are an accessible source of financing and thus represent a relaxing of financial constraints, then the value of cash should decrease as the liquidity of those assets increase.

Hypothesis 3 *The market value of cash is lower for firms with high real asset liquidity.*

Given that firms have a strong precautionary motive for holding cash, it is quite natural for their cash management policies to be sensitive to capital market conditions. If a firm's ability to access the capital markets in the future is uncertain, they will try to access them now in order to have funds on hand for future investment and potential cash flow shortfalls.

Ivashina and Scharfstein (2010) note that while commercial and industrial bank lending puzzlingly increased between September and October 2008 (the heart of the financial crisis), the majority of this increase was driven by firms drawing down on existing lines of credit rather than initiating new loans. From news reports, they find that firms that accessed their credit lines did so due to concerns about the health of the financial sector, with one firm stating they drew down their credit lines "to ensure access to liquidity to the fullest extent possible at a time of ambiguity in the capital markets". In a survey of firms following the 2008 financial crisis, Campello et al. (2011) find that a large number of firms utilized their lines of credit to increase their cash reserves over fears that their access to credit will soon be limited. This behavior was, for the most part, limited to financially constrained firms whose access to external capital would most likely be the first to become rationed.

Along similar lines Almeida et al. (2004) and Duchin et al. (2010) find that following negative macroeconomic shocks, the propensity to save cash flows increases among financially constrained firms while remaining constant for unconstrained firms. In the face of political uncertainty, Julio and Yook (2012) find that cash reserves increase in the year leading up to national elections and revert to normal levels once the uncertainty of the election is resolved. This cash hoarding behavior in the face of uncertain future credit conditions is indicative of a strong precautionary motive of cash balances.

Asset sales can serve as a feasible source of financing when access to capital markets is limited. As long as the costs of selling off assets are low enough, liquid real assets on the balance sheet can reduce the marginal benefit of holding cash balances. Therefore, firms with more liquid assets will not find it necessary to increase their cash holdings in response to capital market shocks to the same extent as other more illiquid firms.

Hypothesis 4a *Firms with high asset liquidity will increase their cash holdings to a lesser degree following uncertainty shocks.*

During times of capital market uncertainty, not all firms will be rationed from external financing. While financially constrained firms may have a difficult time obtaining funds, unconstrained firms will face less restrictions. If a firm continues to enjoy relatively unrestricted access to external capital markets even during times of uncertainty, the ability to liquidate assets to raise funds becomes less attractive.

Hypothesis 4b *Asset liquidity will have no relationship with cash holdings in response to uncertainty shocks for financially unconstrained firms.*

2.4 Data and Empirical Strategy

2.4.1 Sample Construction

The sample includes data on all firms covered by COMPUSTAT quarterly database over the period of 1982-2013. Firms in the financial (SIC 6000-6999) and utilities (SIC 4000-4999) industries are excluded, as well as firms with missing cash and total asset values. The final sample results in 18.179 unique firms and 614,377 quarter-year observations. The asset liquidity measure is constructed using the Securities Data Corporation (SDC) Platinum Mergers and Acquisition database. More details on this sample are provided in the next section.

2.4.2 Asset Liquidity Measure

Many studies use balance sheet proxies of asset tangibility, such as research and development expense or the proportion of plant, property, and equipment on the firm's balance sheet to measure asset liquidity (e.g. (Rajan and Zingales, 1995; Lemmon et al., 2008; Faulkender and Petersen, 2006). These measures, however, do not touch on the liquidity of the firms assets because while the assets may be tangible in the sense that they are physical assets, the liquidity value of the assets can not necessarily be determined. As Benmelech (2008) points out, "oil rigs, satellites, and railways are all very tangible, yet their liquidation values are fairly low." Other studies tend to focus on a small subset of firms (e.g. Kim (1998), Benmelech (2008), Pulvino (1998), Ramey and Shapiro (2001)), which inhibits our ability to observe the broad cross-sectional relationship of asset liquidity and other financial variables.

For this paper, I use the industry asset liquidity index of Schlingemann et al. (2002) and Sibilkov (2009) which measures the total value of corporate transactions in an industry relative to the total value of industry assets. This measure follows along with the idea of Shleifer and Vishny (1992) that assets tend to be industry specific. Industries with more active markets for corporate transactions indicates that there are more potential buyers for the assets, and thus smaller discounts in liquidation. Because the measure is not constrained to a specific industry, we are able to get a broader look at the cross-sectional relationship between cash and asset liquidity. Additionally, because the index is exogenous to the individual firms, we are able to examine a clear picture free from other confounding effects within the firm.

The index is constructed as follows. From Thomson Reuters SDC Platinum, I identify 20,362 corporate transactions completed between 1982 and 2013 in which the form of the deal is classified as either an acquisition of assets or an acquisition of certain assets. I require that the value of the deal is disclosed and that the target is either a publicly traded firm or a subsidiary. Each transaction is assigned to the target firm's industry as defined by its 2 digit SIC code. The asset liquidity index is then computed as the ratio of the sum of industry transactions within the year to the total industry book value of assets (each converted to 1984 dollars). Industries which had no corporate transactions within a year receive an index value of 0 for that year. Because the liquidity of the industry should not solely depend on the number of transactions in any one single period, I use a five-year moving average of the index as the proxy for industry-wide asset liquidity. This procedure results in 1,838 industry-year values for the index. All firms within the same industry will each have identical values for the liquidity index each year.

[Table 2.1 about here.]

Table 2.1 shows the distribution and mean values of the asset liquidity index over the sample period. There is quite a large disparity in the degree of asset sale activity amongst the industries. At the bottom end of the distribution are industries which exhibit very little turnover of their assets. For example, firms in the 5th percentile of the asset liquidity index sold 0.18% of their assets in an average year. In contrast, firms at the 95th percentile of the index sold, on average, 3.19% of their assets in a given year. On average, industries in the economy sold off 1.27% of their total assets each year.

[Table 2.2 about here.]

Table 2.2 illustrates the persistence of the asset liquidity index over time. Each year, I segment the asset liquidity index into quartiles, placing the lowest liquidity industries into quartile 1 and the highest liquidity industries into quartile 4. Table 2.2 shows that while there is substantial correlation between contemporaneous asset liquidity and past liquidity, the correlation diminishes over time. This result is not surprising both from an economic as well as a methodological perspective. By construction, the asset liquidity index is smoothed using a five year moving average to limit the effect of extraordinary industry-years in which a few large asset sale transactions which may portray an industry's assets to be more liquid than they actually are. This moving average correction naturally introduces a level of auto-correlation into the index. From an economic point of view, we would expect liquidity to be a characteristic which is relatively slow changing. Mitchell and Mulherin (1996) find that acquisition activity is higher in deregulated and low-tech industries with low research and development activity and low growth options. However, as shown by Andrade et al. (2001) restructuring activity often occurs in industry waves. These facts account for the relatively strong, but diminishing auto-correlation shown in the asset liquidity index.

[Figure 2.1 about here.]

Figure 2.1 plots the time series of the economy-wide average asset liquidity index.[1] While there does not appear to be any distinct, constant trends over the sample period there are some time periods which display some interesting patterns that align closely with historical events. The uptrend in the mid-late 1980s and the subsequent fall in the early 1990s corresponds with the height and fall of the leveraged buyout boom. The peak of the asset index occurred in 1998, around the time of the high-tech boom.

[1] The yearly economy-wide liquidity index is computed by aggregating each industry liquidity index for the particular year.

2.4.3 Capital Market Uncertainty Measure

As a measure of capital market uncertainty, I identify spikes in the VIX index from the Chicago Board of Options Exchange. More specifically, I define a shock as a two standard deviation increase in the VIX within a three month period and the event period as the quarter in which a shock occurs. Using this method, I identify four shocks that occurred during the sample period. The shocks correspond tightly with unanticipated real events which can be consider exogenous to the contemporaneous economic conditions and, as such could affect all firms to an equal degree.

Figure 2.2 plots the VIX index from 1990 to 2012 and identifies the periods in which a jump in implied volatility occurred. The event quarters are Q3 1990, Q3 1998, Q3 2001, and Q3 2008. These dates correspond with the start of the Persian Gulf War, the default of Long Term Capital Management (LCTM), the September 11 terror attacks, and the recent financial crisis, respectively. These dates also coincide with the event date identified by Bloom (2009) and Kim and Kung (2014) who find these shocks affect productivity as well as corporate investments.

[Figure 2.2 about here.]

To identify the effect of a uncertainty shock on firm behavior in regards to cash holdings, I define a set of indicator variables, $After(t)$, where t indicates the number of quarters before or after the uncertainty event and $t = 0$ indicates the event quarter in which the shock occurs.

2.4.4 Control Variables

The main dependent variable used throughout the study is the cash ratio (cash + marketable securities/book value of assets). To control for the known firm-specific determinants of cash holdings, I select variables in accordance with the findings of Opler et al. (1999). Specifically, I calculate Size (log of total assets), market-to-book ratio (market value of equity/total assets), cash flow(EBIT+depreciation-taxes), net working capital(current assets-current liabilities), acquisitions (acquisitions/total assets), R&D (research and development expense/sales), leverage(total debt/total assets), and industry cash flow volatility. Additionally I include an indicator variable for credit rating, that takes on a value of 1 if the firm has an S&P credit rating of BBB- or higher, and 0 otherwise. Similarly, I include a dividend dummy that takes on a value of 1 if the firm paid a dividend and 0 otherwise. All continuous variables are winsorized at the 1% and 99% level to limit the effect of outliers.

2.4.5 Summary Statistics and Univariate Analysis

Table 2.3 presents summary statistics of the variables included in the study. The average firm in the sample has $97.8 in total assets. On average (median), firms hold 17.7% (8.4%) of their assets in the form of cash and marketable securities.

[Table 2.3 about here.]

Table 2.4 displays the correlations of the independent and dependent variables.

[Table 2.4 about here.]

Table 2.5 illustrates the difference in characteristics amongst firms which are classified as High Liquidity and Low Liquidity. I designate firms which are at the top 25% on the liquidity index as High Liquidity and those at the bottom 25% as Low Liquidity. Firms in the two liquidity groups differ greatly in regards to their characteristics. High liquidity firms tend to carry larger cash balances. Additionally, high liquidity firms, on average, tend to be smaller, more highly levered, have more capital expenditures, and have less research and development expenses.

[Table 2.5 about here.]

Because many of these characteristics are known determinants of cash holdings, these differences may lead one to conclude that they are the cause of the heterogeneity in cash holdings between the two liquidity groups. However upon closer inspection, the differences in firm characteristics do not result in relationships which we would expect given previous evidence in the literature. For example, Opler et al. (1999) find that larger firms hold smaller cash balances due to their increased access to external capital markets. But as shown in table 2.5

, low liquidity firms are larger on average yet hold more cash. Similarly Opler et al. (1999) find that firms with more volatile cash flows and less net working capital (characteristics of high asset liquidity firms) hold larger cash balances. But puzzlingly, these high liquidity firms hold less cash. The relationship of cash with other characteristics such as the market to book ratio and leverage correspond with the previous literature. However given the fact that these two groups differ in an unpredictable manner, we can not conclude that it is simply differences in these previously determined firm characteristics that is driving the divergence in cash holdings between firms with high and low asset liquidity.

[Figure 2.3 about here.]

Figure 2.3 plots the times series relationship of between asset liquidity and the level of cash holdings for financial constrained (top graph) and financially unconstrained firms (bottom graph).[2] For financially constrained firms a visible pattern appears such that firms with low asset liquidity hold more cash than high asset liquidity firms throughout the entire sample period. Conversely, we see no such pattern for unconstrained firms. The relationship between asset liquidity and cash tends to fluctuate over time with some periods indicating high asset liquidity firms hold more cash, and in other periods the opposite. These graphs hint that that a relationship exists between real asset liquidity among financially constrained firms, but not among unconstrained firms. I will test this conjecture more formally below.

[Table 2.6 about here.]

Table 2.6 displays the behavior of cash over asset liquidity quartiles. Firms in the bottom 25% of the asset liquidity index in a given year are assigned to quartile 1, firms in the top 50% are assigned to quartile 2, and so on. Panel A examines the full sample period. As shown previously, firms with high asset liquidity tend to have smaller cash holdings (13.3% versus 16.4%). Interestingly, there appears to be a degree of non-linearity in the relationship of asset liquidity to cash. Cash holdings are not monotonically increasing as we move from high asset liquidity to low asset liquidity. Instead, cash holdings rise in the

[2]Financial constraint here is represented by credit rating. If the firms is rated BBB+ or better it is classified as unconstrained. If the rating is lower than BBB+ or missing the firm is classified as constrained

middle portion of the distribution before falling again at the low liquidity region. As we segment the sample into the pre and post financial crisis period (defined as observations before and after 2008, respectively) this non-linear pattern remains apparent.

2.5 Results

2.5.1 Asset Liquidity and the Level of Cash Holdings

If cash holdings and liquid real assets can be treated as substitutes, firms with more liquid assets will tend to hold less cash. To test the hypotheses, I estimate cross-sectional regressions, employing the techniques of Opler et al. (1999) and Bates et al. (2009). Controlling for the common determinants of cash holdings, I first examine the relationship between asset liquidity and cash holdings. For each firm I estimate a regression of the form

$$Cash_i = \beta_0 + \beta_1 AssetLiquidity_i + \beta_2 \mathbf{X_i} + \epsilon_{\mathbf{i}}, \tag{2.1}$$

where *AssetLiquidity* is a continuous measure of the asset liquidity index described above and $\mathbf{X_i}$ is a vector of control variables containing asset size, market to book ratio, cash flow, net working capital, acquisitions, research and development, leverage, and cash flow volatility. Because the level of cash a firm chooses to hold may depend on contemporaneous economic and industry conditions, all regression are estimated using time and industry fixed effects. Additionally, standard errors are clustered at the firm level to control for within firm error dependence.

Table 2.7 presents coefficient estimates of equation 2.1. From models (1) and (2) of table 2.7, we can see that a linear relationship between cash and real asset liquidity does not hold.

[Table 2.7 about here.]

In model (1), asset liquidity alone fails to have any explanatory power on the level of cash firms hold. After controlling for various determinants of cash holdings, real asset liquidity continues to lack explanatory power. In model (3) I include a quadratic term into the model to capture any potential non-linearities in the relationship between cash holdings and asset liquidity as predicted by hypothesis 1b. Specifically, I estimate the following model.

$$Cash_i = \beta_0 + \beta_1 AssetLiquidity_i + \beta_2 AssetLiquidity_i^2 + \beta_3 \mathbf{X_i} + \epsilon_\mathbf{i}, \tag{2.2}$$

Consistent with hypothesis 1b, model (3) of table 2.7 illustrates a potential curvilinear relationship between cash and asset liquidity. The quadratic term $AssetLiquidity_i^2$ is negative, suggesting an inverted U-shaped relationship. That is for high levels of asset liquidity, there will be a decrease in cash with respect to an increase in asset liquidity. But for lower levels of liquidity, cash holdings may be increasing with asset liquidity. Model (4) examines this non-linearity further by generating a set of indicator variables $MidLiq1$, $MidLiq2$, and $HiLiq$ which take on a value of 1 if the firm is in the second, third, and fourth quartile of the asset liquidity index, respectively and 0 otherwise. Firms in the first liquidity quartile are omitted, therefore the coefficients on these variables represent the sensitivity of cash to asset liquidity relative to a low liquidity firm. Again, a curvilinear relationship is visible between asset liquidity and cash. While firms in the second quartile hold less cash than those in the first quartile, the direction of the relationship flips as firms move into the third quartile. Firms in the third quartile hold more cash than those in the first quartile.

Relative to low liquidity firms, firms in the top quartile of the asset liquidity index hold significantly larger cash balances. As the relationship between cash and asset liquidity is non-monotonic, I choose to focus on these two extreme liquidity groups (quartile 1 and quartile 4) for further analysis.

[Table 2.8 about here.]

Table 3.6 presents coefficient estimates of a modified version equation 2.1. Rather than using the continuous variable for the asset liquidity index, I instead create an indicator variable $HiLiq$ which represents firms with high degrees of real asset liquidity. $HiLiq$ takes on a value of 1 if the firm is in the top 25% of the liquidity index in a given year and 0 otherwise. Model 1 shows a negative relationship between the level of cash balances and asset liquidity. Firms ranked in the upper 25% in terms of the asset liquidity tend to hold significantly less cash than all other firms. Even after controlling for the main determinants of cash holdings (Opler et al., 1999) in Model 2, the negative relationship between cash and asset liquidity still remains. This result suggests that firms with highly liquid real assets treat these assets as potential substitutes for cash balances. As Bates (2005) and Borisova et al. (2013) show, firms utilize asset sales in order to undertake investment. If assets are sufficiently liquid, selling assets to produce needed cash for investments or other purposes becomes a more feasible prospect. And thus, the need to hold large precautionary balances is diminished. In models (3) and (4), I segment the sample into two time periods: the pre-Financial Crisis period (1982-2007) and the post-Financial Crisis period (2008 and onward). The negative relationship between cash holdings and asset liquidity holds in both of these distinct economic environments.

2.5.2 Financial Constraints, Real Asset Liquidity and Cash

To examine the differential effects of asset liquidity on cash holdings among financially constrained and unconstrained firms, I estimate equation 2.1 on a segmented sample using two measures of external financing constraints commonly used in the literature: the Whited and Wu (2006) index (WW), and the SA index developed by Hadlock and Pierce (2010).[3]

Whited and Wu (2006) measure of financial constraints by using a structural model of investment to determine the relationship of several variables to the shadow price of raising new equity capital. The coefficients from the model are then used to compute index values that order firms by their relative financial constraints. The WW index is computed as

$$WW = -0.091\frac{CF_{i,t}}{Assetsi,t} - 0.062Div_{i,t} + 0.021\frac{LTDebt_{i,t}}{Assets_{i,t}} - 0.044ln(Assets_{i,t}) + 0.102ISG_{i,t} - 0.035SG_{i,t},$$

where DIV equals 1 if the firm pays a dividend and 0 if it does not, LTDebt is long term debt, ISG is industry sales growth rate, and SG is the firm's sales growth rate. Higher values in the WW index correspond with increasing financial constraints.

[3]The Kaplan-Zingales (1996) measure of constraints was also considered, but not used because its construction results in a mechanical negative relation between cash holdings and financial constraints.

Hadlock and Pierce (2010) analyze qualitative information from financial reports to develop their measure of financial constraints. They find that the size and age of the firm are the two major predictors of financial constraints. The SA index is thus constructed as

$$SA = -0.737Size + 0.043Size^2 - 0.040Age,$$

where size is the log of inflation-adjusted book assets and age is the number of years the firm is listed with a non-missing stock price on Compustat. As with the WW index, high SA index values are associated with greater external financing constraints. For both indexes, firms are classified as financially constrained if their index values for a particular year rank in the upper 33% and unconstrained if their index values are in the lower 33%.

[Table 2.9 about here.]

Table 3.6 illustrates the effect that external financing constraints have on the real asset liquidity-cash holdings relationship. In line with hypothesis 2, we see that the negative relationship between asset liquidity and cash is a phenomenon that is largely isolated to financially constrained firms. Model (2) shows that among firms that are constrained as defined by the WW index, those that possess liquid real assets tend to hold significantly less cash. Conversely among firms that are unconstrained according to the WW index, there is no significant difference in the cash holdings of high and low liquidity firms. This same pattern holds as financial constraints are defined by the SA index in models (3) and (4).

This finding supports the argument that liquidating assets for the purpose of generating cash is only a feasible strategy when sources of external financing are excessively costly. The costs of accessing external capital markets for financially unconstrained firms are relatively low. For financially constrained firms, however, the costs may be sufficiently high enough that liquidating assets may be a beneficial method of raising funds.

2.5.3 Asset Liquidity and the Value of Cash

Next, I examine the impact that the liquidity of a firm's real assets has on the market value of cash holdings. From hypothesis 3, if a firm's real assets are sufficiently liquid they can serve as an alternative to using external capital markets. This effectively reduces financing constraints. With reduced financial constraints, the value of precautionary cash holdings should diminish (Faulkender and Wang, 2006; Pinkowitz and Williamson, 2004).

To test this hypothesis, I use the cash valuation methodology of Pinkowitz et al. (2006). Their methodology relates them market value of the firm to various firm characteristics. In particular I am able to examine how the effect of a one dollar increase in cash holdings on the market value of the firm differs between high asset liquidity and low asset liquidity firms. The regression takes the form

$$\begin{aligned} V_{i,t} = \alpha &+ \beta_1 E_{i,t} + \beta_2 dE_{i,t} + \beta_3 dE_{i,t+1} + \beta_4 dNA_{i,t} + \beta_5 dNA_{i,t+1} + \beta_6 RD_{i.t} \\ &+ \beta_7 dRD_{i,t} + \beta_8 dRD_{i,t+1} + \beta_9 I_{i,t} + \beta_{10} dI_{i,t} + \beta_{11} dI_{i,t+1} + \beta_{12} D_{i.t} \\ &+ \beta_{13} dD_{i,t} + \beta_{14} dD_{i,t+1} + \beta_{15} dV_{i,t+1} + \beta_{16} dC_{i,t} + \beta_{17} dC_{i,t+1} + \epsilon_{i,t}, \end{aligned} \quad (2.3)$$

where X_t is the level of variable X in year t divided by the level of assets in year t. dX_t is the change in the level of X from year $t-1$ to year t divided by total assets in year t $((X_t - X_{t-1})/A_t)$. dX_{t+1} is the change in the level of X from year $t+1$ to year t divided by assets in year t $((X_{t+1} - X_t)/A_t)$. A is the book value of assets. V is the market value of the equity plus the book value of debt. E is earnings defined as earnings before extraordinary items plus interest plus deferred tax credits plus investment tax credits. NA is net assets, which is defined as total assets minus cash. RD is research and development expense. When $R\&D$ is missing, it is set to zero. I is interest expense. D is common dividends. C is liquid assets, defined as cash and cash equivalents. The variable of particular interest in this model is $dC_{i,t}$, with the coefficient on this variable representing the marginal value of an additional dollar of cash holdings.

Because of potential cross-correlation in the residuals of the individual firms, the regression in equation 2.3 is estimated using the Fama and MacBeth (1973) methodology, which involves running yearly cross-sectional regressions and using the series of coefficients to make inferences. The coefficients reported are the mean of the cross-sectional regression coefficients, while the standard errors are derived from the time series of coefficients.

[Table 2.10 about here.]

Table 2.10 provides evidence supporting this role of liquid real assets in reducing the value of additional dollar of cash in the firm. The variable of interest is dC_t, which can be interpreted as the marginal value of cash. The coefficient on dC_t represents the dollar change in the market value of firm related to a \$1 increase in cash holdings. For the full sample, we can see that a \$1 increase in cash holdings is associated with a \$1.274 increase in the firm's market value. As we segment firms based on their real asset liquidity, we can see that the market values of cash holdings for these firms are quite different. For firms with highly liquid assets, the marginal value of cash holdings is just \$0.647 versus \$1.208 for low asset liquidity firms. This difference in the marginal value of cash is both statistically and economically significant.[4]

A potential concern of the model in equation 2.3 is that changes in cash holdings may be correlated with expectations of future growth opportunities. So following Pinkowitz et al. (2006), I also estimate the model replacing the changes in cash holdings with the level.

$$
\begin{aligned}
V_{i,t} = \alpha &+ \beta_1 E_{i,t} + \beta_2 dE_{i,t} + \beta_3 dE_{i,t+1} + \beta_4 dNA_{i,t} + \beta_5 dNA_{i,t+1} + \beta_6 RD_{i.t} \\
&+ \beta_7 dRD_{i,t} + \beta_8 dRD_{i,t+1} + \beta_9 I_{i,t} + \beta_{10} dI_{i,t} + \beta_{11} dI_{i,t+1} + \beta_{12} D_{i.t} \\
&+ \beta_{13} dD_{i,t} + \beta_{14} dD_{i,t+1} + \beta_{15} dV_{i,t+1} + \beta_{16} C_{i,t} + \epsilon_{i,t} \quad (2.4)
\end{aligned}
$$

In this model, the coefficient on the level of cash holdings is an estimate of the sensitivity of the market value of the firm to a one dollar increase in cash holdings. However, if the variables in the valuation model adequately capture expectations about future growth, the coefficient on the level of cash holdings can be interpreted as the market value of one dollar of cash in the firm.

[Table 2.11 about here.]

Table 2.11 presents results of this modified regression model. The results indicate that the

[4]Following Pinkowitz et al. (2006), I test the significance of the difference by interacting the dummy variable for high asset liquidity with a constant and every independent variable in equation 2.3 and estimate that equation using the Fama and MacBeth (1973) technique.

market values of firms with high asset liquidity are less sensitive to the level of cash holdings than firms with low asset liquidity. For firms with low asset liquidity, we see a coefficient on C_t of 1.566 compared to 1.199 for high liquidity firms. This indicates that the value of low asset liquidity firms is more sensitive to the size of their cash reserves. Alternatively, this result shows that the market attributes a higher value to the cash holdings of low asset liquidity firms.

Taken together, the findings in tables 2.10 and 2.11 indicate that firms may view their liquid real assets as an additional source of capital that may be used alongside or in lieu of the traditional debt and equity markets. This flexibility effectively reduces their financing constraints and as a result reduces the value that investors attribute to additional precautionary cash balances.

2.5.4 Financial Constraints and the Marginal Value of Cash

Faulkender and Wang (2006) and Denis and Sibilkov (2010) find that the marginal value of cash is higher among financially constrained firms. They argue that because financially constrained firms may face prohibitively high external financing costs, holding large amounts of internal capital is quite valuable. If a financially constrained firm's real assets are sufficiently liquid, then the potential for asset sales may effectively reduce its financial constraints and thus lower the value of an additional dollar of cash within the firm. As hypothesis 2 argues, for unconstrained firms the prospect of selling assets to raise capital is unlikely since other capital markets are readily accessible at reasonable costs. Therefore possessing liquid real assets should not affect the marginal value of cash for these financially unconstrained firms.

To examine whether the effect of asset liquidity on the value of cash depends on the degree of financial constraints the firm faces, I group firms into 4 different financial constraint-asset liquidity groups. I first rank firms according to the asset liquidity index over the entire sample, assigning firms in the upper 25% of the index to the $HiLiq$ group and those at the bottom 25% to the $LowLiq$ group. Similarly, over the entire sample I rank firms on their WW and SA index values and assign firms in the top 33% of the index to the financially constrained group and those at the bottom 33% to the unconstrained group. Firms are then grouped togther across the 4 different constraint-liquidity combinations (i.e. unconstrained/high liquidity, constrained/ low liquidity, etc.).

[Table 2.12 about here.]

I estimate equation 2.3 on this segmented sample. Tables 2.12 and 2.13 present coefficient estimates of the model. The coefficient of interest is $dC_{i,t}$ which represents the marginal value of an additional dollar of cash. Consistent with hypothesis 2, among financially unconstrained firms the marginal value of cash does not differ significantly between high liquidity and low liquidity firms. When constraints are defined by the WW index an additional dollar of cash in an unconstrained firm with high asset liquidity is worth \$0.586, versus \$0.922 for low liquidity firms. The difference between these two values is not statistically different from zero (p-value of difference = 0.412).

In contrast, there does exist a significant difference in the marginal value of cash between high asset liquidity and low asset liquidity firms among those classified as financially constrained. It is among these firms that asset sales may be seen as a method to ease external financing constraints when debt and equity markets are inaccessible. The marginal value of cash for constrained firms with high liquidity is \$0.817, compared to \$1.184 for low asset liquidity firms (p-value of difference = 0.037).

[Table 2.13 about here.]

The same pattern holds when financial constraints are assigned according the SA index as shown in table 2.13. For unconstrained firms, the marginal value of cash is \$0.314 for high liquidity firms and \$0.745 for low liquidity firms. The difference in these values, again, is not statistically significant at a meaningful level (p-value of difference = 0.117). Conversely, there is a significant disparity in the value of among firms with financial constraints. The value of cash for high liquidity firms is \$0.772 versus \$1.216 for low liquidity firms (p-value of difference = 0.014). These findings suggest that the market views the increased potential for asset sales, by way of higher asset liquidity, as a path to lessen financial constraints. Financially constrained firms with liquid real assets do not have to rely as heavily on internal financing, and as a result additional dollars of cash holdings are valued less.

2.5.5 The Response of Cash Holdings to Uncertainty Shocks

Next, I investigate the impact of capital market uncertainty on cash holdings and the role liquid real assets play in firms' reactions to surprise events that shock the capital markets. I augment the baseline regression in equation 2.1 by including the set of capital market uncertainty indicator variables described previously and estimate the following

$$Cash_i = \beta_0 + \beta_1 HiLiq + \beta_2 After(1) + \beta_3 After(1) \times HiLiq + \beta_4 \mathbf{X_i} + \epsilon_\mathbf{i} \tag{2.5}$$

where $After(1)$ is an indicator variable that takes on a value of 1 if it is the period subsequent to the shock event and 0 otherwise. By focusing on the interaction effect between $HiLiq$ and the shock period indicator, we will be able to see how the presence of liquid real assets affects how firms augment their cash balances in response to capital market shocks.

[Table 2.14 about here.]

Table 2.14 shows the effects of capital market shocks on cash holdings in the quarter following the shock event. Control variables are not reported for brevity as they remain fairly constant throughout each specification. Model (1) shows that consistent with the prior literature (Campello et al., 2011), all firms tend to increase their cash balances following a uncertainty shock. This is in line with the precautionary motive of cash holdings. As uncertainty increases, firms will increase their cash balances to ensure that they will have sufficient funds to cover potential operating losses in the future and as well as to take on future investment opportunities when access to external capital markets becomes more uncertain. Model (2) includes an interaction term between the uncertainty shock and asset liquidity ($HiLiq$ x $After(1)$) to highlight the effect asset liquidity has in periods of capital market uncertainty. For the full sample, asset liquidity plays no role in determining the cash adjustment following an uncertainty shock.

For financially constrained firms, however, there is some evidence that asset liquidity has an effect on the degree to which firms increase the cash balances following a shock event. Among firms that are constrained as defined by the WW index, cash balances increasing subsequent to a shock. But firms that have high asset liquidity will increase their cash holdings to a lesser degree. In contrast, high asset liquidity firms that are classified as unconstrained according to the WW index do not display this phenomenon. For unconstrained firms, asset liquidity does not affect firms' cash re-balancing behavior. This is inline with intuition. As financially unconstrained firms will have relatively easy access to capital markets even after a capital market shock, utilizing asset sales to generate funds would remain an unreasonable course of action. Strangely, this result does not obtain when external financing constraints are defined by the SA index. For both constrained and unconstrained firms, real asset liquidity fails to affect cash re-balancing behavior following capital market shocks.

To further examine the role of asset liquidity on cash policy in response to uncertainty, I investigate the dynamic effects of an uncertainty shock to cash balances. The idea is that if liquid real assets are indeed imperfect substitutes for cash balances then we should see significant interaction effects between asset liquidity and time only in periods of increasing uncertainty. To see these dynamic effects, I add additional indicator variables representing the quarters immediately before and after the uncertainty shock. Similarly, to examine whether or not the substitution between liquid real assets and cash still holds through time, I include interactions between the liquidity index and these indicator variables. Specifically, I estimate the following model:

$$\begin{aligned} Cash_i = \beta_0 + \beta_1 HiLiq + \beta_2 After(-1) + \beta_3 After(0) + \beta_4 After(1) + \beta_5 \mathbf{X_i} \\ + \beta_6 After(-1) \times HiLiq + \beta_7 After(0) \times HiLiq + \beta_8 After(1) \times HiLiq + \epsilon_i. \quad (2.6) \end{aligned}$$

[Table 2.15 about here.]

Table 2.15 illustrates the effect of an uncertainty shock over a three quarter window: one quarter before the shock, the actual event quarter, and the quarter following the shock. The coefficients on the shock period indicator variables $After(t)$ confirm the results in the previous section. In general, cash holdings are not sensitive to being in the quarter before the uncertainty shock ($After(-1)$). However, cash balances do tend to increase in the quarter in which an shock occurs ($After(0)$). While this finding is contrary to what is expected, it could simply be the result of differing financial reporting dates between the firms. Some firms may report their quarterly cash balances before the event occurs while others report a few months afterward, so there is a possibility that there is overlapping effects in this variable. The significance of the coefficient on $After(1)$ shows that firms do indeed increase their cash holdings after an uncertainty shock. This behavior is prevalent in both financially constrained and unconstrained firms. Both types of firms are sensitive to uncertainty in the capital markets and cash balances tend to rise in the period following a shock.

The interaction terms $HiLiq \times After(t)$ illustrate the role that liquid real assets play in firms' cash policies. Model (2) shows that, similar to the result in table 2.14, for the full sample asset liquidity plays no role in the cash re-balancing behavior of the firm. Model (3) shows that for those that are designated as financially constrained by the WW index, the size of increases in cash balances following a shock are partially mitigated by the presence of liquid real assets ($HiLiq \times After(1)$ is significant at the 10% level). The interaction of $HiLiq$ with the event quarter as well as the quarter preceding the shock event are not significantly related to cash holdings. This provides some confirmation that the presence of liquid real assets influences firms' cash policies in periods of uncertainty in the capital markets.

But as model (4) shows, this negative relationship between the size of the cash balance increase and asset liquidity is only present within firms classified as financially constrained. For financially unconstrained firms (as defined by the WW index), the interaction terms, $HiLiq \times After(t)$, lack significance throughout all of the quarters surrounding the shock. This finding indicates that firms consider their real assets as a potential source of funds when making their their cash re-balancing decisions following a capital market shock. But when a firm has access to other forms of external financing, the liquidity of its real assets plays no role in it's cash policy decisions.

2.6 Conclusions

With asset sales comprising a non-trivial fraction of the total funds raised by firms in a given year, the role of the potential for asset sales in the setting of corporate financial policy is important to examine. I provide new evidence demonstrating that the liquidity of a firm's real assets plays a role in determining the cash management policy of the firm. Firms that face costly access to external financing and possess assets that can potentially be liquidated quickly and with minimal loss of value are able to treat these assets as imperfect substitutes to holding precautionary cash balances. As a result, the presence of liquid real assets within a firm is associated with smaller cash balances. Additionally, the value of cash holdings is lower among firms with high asset liquidity, suggesting that the benefits of precautionary cash balances diminishes when real assets may serve as an adequate substitute. The relationship between asset liquidity and cash holdings is further illustrated by the reaction of firms to capital market uncertainty. Immediately following an uncertainty shock, firms tend to increase their cash balances. The magnitude of this increase is reduced, however, for firms that possess highly liquid real assets.

Figure 2.1: Aggregated Industry Asset Liquidity Index

The following graph plots the yearly economy wide liquidity index. The yearly economy-wide liquidity index is computed by summing each industry liquidity index for the particular year.

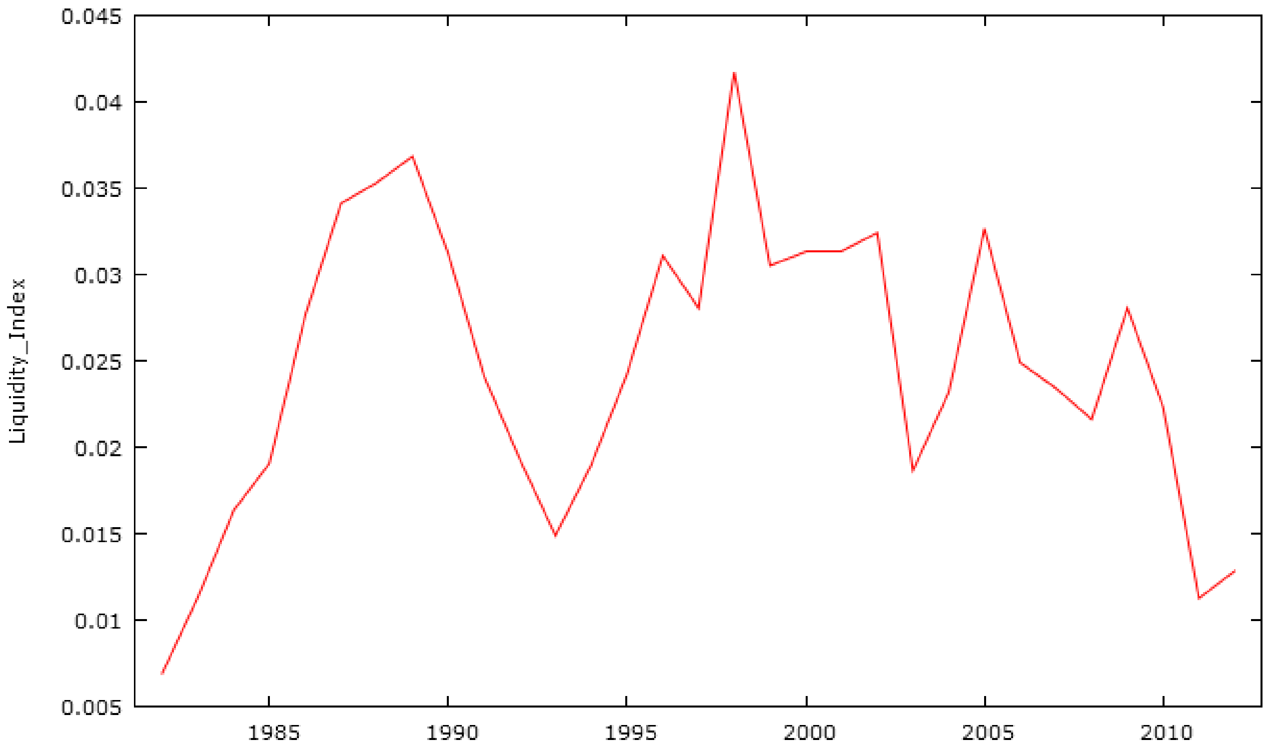


Figure 2.2: VIX index from 1990-2012

The following graph plots the monthly VIX index reported by the Chicago Board of Options Exchange over the period 1990-2012. Shocks (Two standard deviation increase in the VIX within a 3 month period) are indicated by circles.

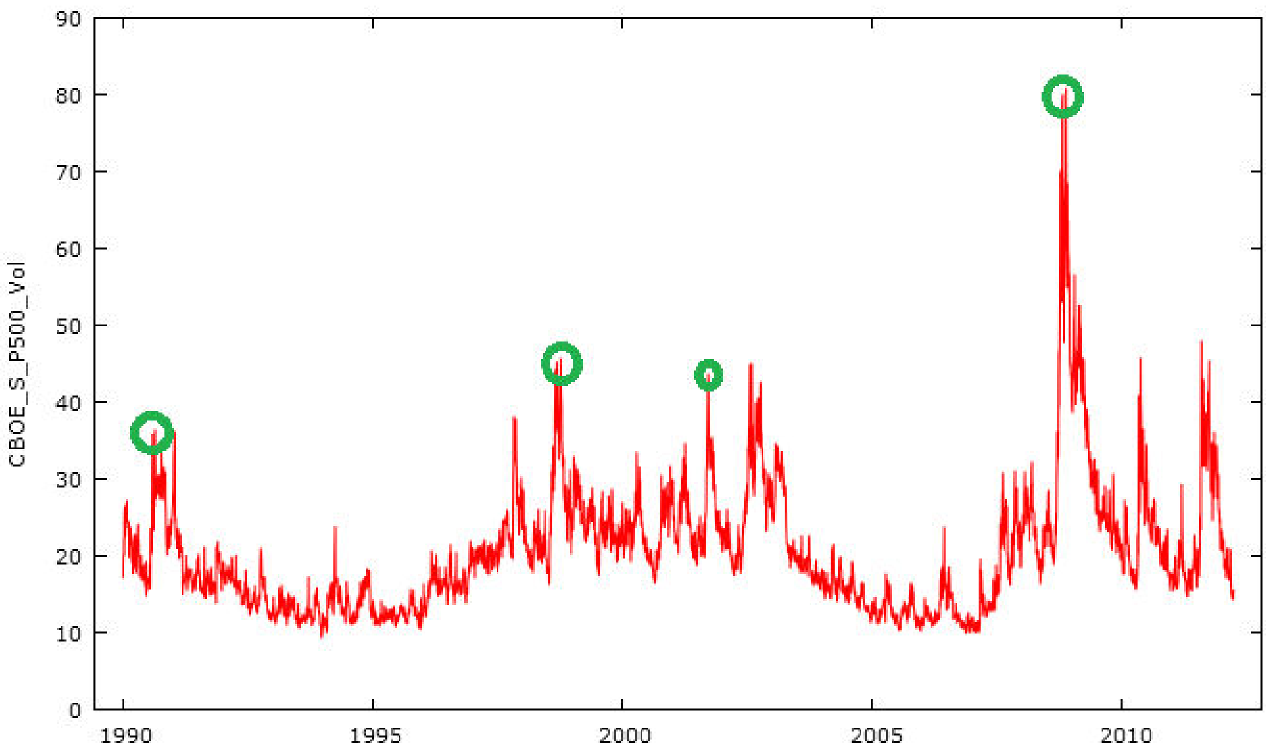


Figure 2.3: Time Series of Cash: Constrained vs. Unconstrained

The following graphs plots the cash/assets for financial constrained firms (top graph) and for financial unconstrained firms(bottom graph). Low asset liquidity is defined as firms ranked in the bottom quartile of the asset liquidity index for a particular year and high asset liquidity are firms in the top quartile. Financially constrained firms are those with an S&P credit rating of BB+ or lower or unrated and financial unconstrained are firms with an S&P credit rating of BBB or higher. NBER recessions are represented by gray bars.

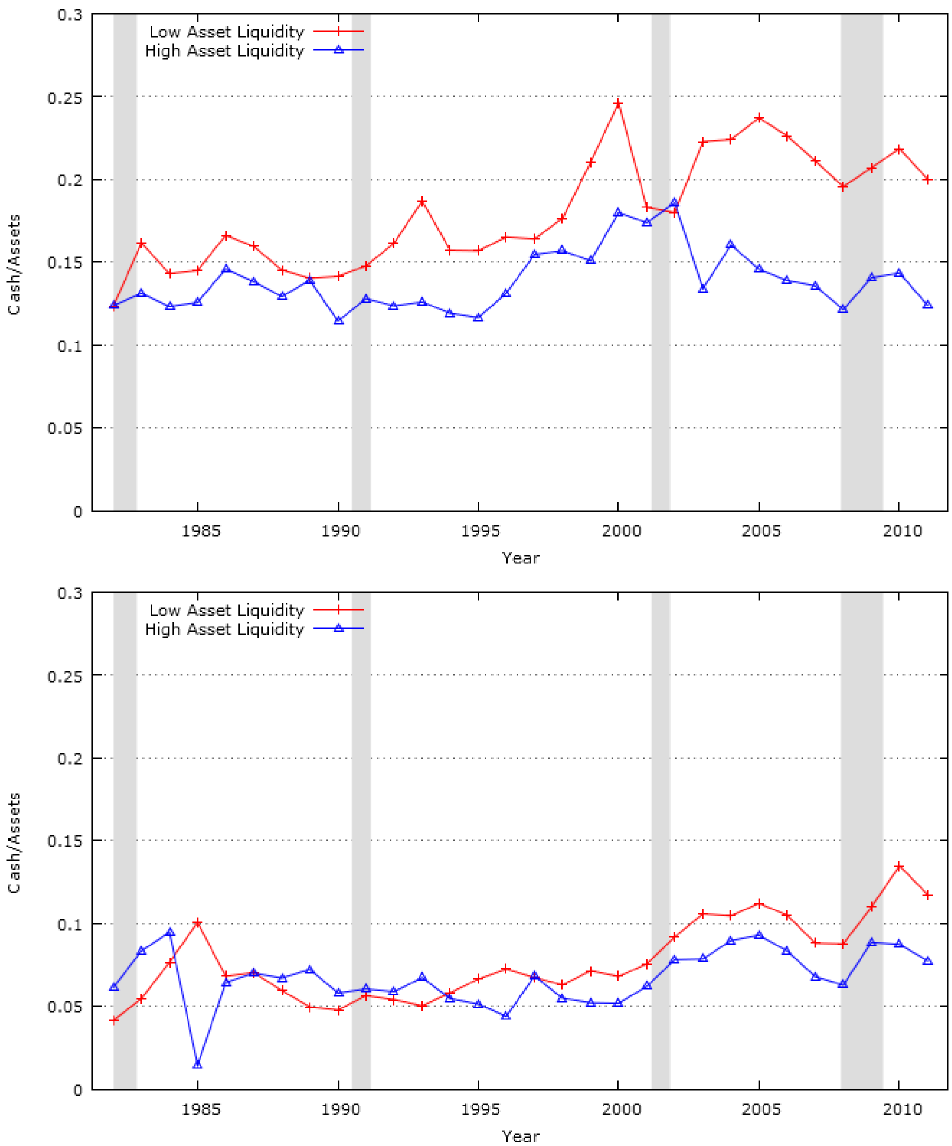


Table 2.1: Distribution of Asset Liquidity Index

This table presents the percentile distribution of the asset liquidity index. The asset liquidity index each year is computed as the sum of the value of industry (defined by 2 digit SIC) transactions within a year divided by total industry book value of assets. The five year moving average of the index is computed each year and serves as the yearly measure of the asset liquidity index.

Percentile	Asset Liquidity Index
1%	0.0003
5%	0.0018
10%	0.0028
25%	0.0061
50%	0.0096
75%	0.0156
95%	0.0319
99%	0.0649
Mean	St.Dev
0.0127	0.0061

Table 2.2: Persistence of Asset Liquidity

This table shows the correlation of the asset liquidity index over time. Each year, the asset liquidity index is segmented into quartiles, placing the lowest liquidity industries into quartile 1 and the highest liquidity industries into quartile 4. *Liqrank* takes on a value of 1 if the firm is in the 1st quartile, 2 if in the 2nd quartile, and so on.

	$Liqrank_t$	$Liqrank_{t-1}$	$Liqrank_{t-2}$	$Liqrank_{t-3}$	$Liqrank_{t-4}$	$Liqrank_{t-5}$
$Liqrank_t$	1					
$Liqrank_{t-1}$	0.825	1				
$Liqrank_{t-2}$	0.694	0.820	1			
$Liqrank_{t-3}$	0.588	0.690	0.819	1		
$Liqrank_{t-4}$	0.560	0.580	0.685	0.815	1	
$Liqrank_{t-5}$	0.546	0.550	0.575	0.680	0.816	1

Table 2.3: Summary Statistics

This table presents the summary statistics of the each of the variables used in this study. The variables are defined as follows: Asset Liquidity is industry level index value of liquidity computed each year as total assets sold/total industry assets. Cash (cash + marketable securities/book value of assets), Size (log(total assets)), Leverage (total debt/total assets), MB (market value of equity/total assets), Cashflow (EBIT+depreciation-taxes/total assets), CapExp (total capital expenditure/total assets), NWC (current assets-current liabilities), Acquis (total acquisition expeditures/total assets), RD (research and development expense/total assets), CFVol (average standard deviation of cash flows for the industry over the past 5 years). All variables are winsorized at the 1% and 99% levels.

	Mean	Median	St. Dev	25%	75%	N
Asset Liquidity	0.013	0.010	0.015	0.006	0.016	614377
Cash	0.177	0.084	0.215	0.022	0.256	614377
Size	4.583	4.502	2.302	2.978	6.121	614377
Leverage	0.261	0.187	0.388	0.030	0.361	614377
MB	2.491	1.469	4.132	1.074	2.364	614377
Cash Flow	-0.020	0.016	0.167	-0.010	0.032	614377
CapEx	0.038	0.018	0.056	0.006	0.045	614377
NWC	0.023	0.078	0.608	-0.041	0.227	614377
Acquis	0.011	0.000	0.040	0.000	0.000	614377
RD	0.292	0.000	1.845	0.000	0.043	614377
CFVol	0.640	0.165	1.362	0.053	0.780	614377

Table 2.4: Correlation Matrix

This table presents the correlations of each of the variables used in this study. The variables are defined as follows: Asset Liquidity is industry level index value of liquidity computed each year as total assets sold/total industry assets. Cash (cash + marketable securities/book value of assets), Size (log(total assets)), Leverage (total debt/total assets), MB (market value of equity/total assets), Cashflow (EBIT+depreciation-taxes/total assets), CapExp (total capital expenditure/total assets), NWC (current assets-current liabilities), Acquis (total acquisition expeditures/total assets), RD (research and development expense/total assets), CFVol (average standard deviation of cash flows for the industry over the past 5 years)

	Asset Liquidity	Cash	Size	MB	Cash Flow	CapEx	NWC	Acquis	RD	Leverage	Dividend	CFVol
Asset Liquidity	1.00											
Cash	-0.05	1.00										
Size	-0.04	-0.19	1.00									
MB	-0.03	0.20	-0.30	1.00								
Cash Flow	0.02	-0.12	0.35	-0.59	1.00							
CapEx	0.03	-0.11	0.03	0.01	0.01	1.00						
NWC	-0.00	-0.08	0.24	-0.61	0.61	-0.03	1.00					
Acquis	0.02	-0.08	0.12	-0.03	0.03	0.01	0.02	1.00				
RD	-0.03	0.30	-0.10	0.16	-0.24	-0.04	-0.11	-0.03	1.00			
Leverage	0.04	-0.22	-0.13	0.41	-0.45	-0.00	-0.68	0.01	0.03	1.00		
Dividend	0.02	-0.19	0.43	-0.11	0.15	0.04	0.10	0.05	-0.08	-0.04	1.00	
CFVol	-0.07	0.13	0.07	0.09	-0.09	-0.02	-0.12	0.01	0.09	0.02	-0.04	1.00

Table 2.5: Summary: High Liquidity - Low Liquidity

This table presents the means of the variables used in this study segment by asset liquidity. Standard deviations are in parentheses. Firms are classified as High Liquidity if their asset liquidity index value is in the top 25% in a given year. Firms are classified as low liquidity if their index value is in the bottom 25% in a given year. Difference is the difference in mean values between High Liquidity and Low Liquidity (t-statistics in parentheses). The variables are defined as follows: Asset Liquidity is industry level index value of liquidity computed each year as total assets sold/total industry assets. Cash (cash + marketable securities/book value of assets), Size (log(total assets)), Leverage (total debt/total assets), MB (market value of equity/total assets), Cashflow (EBIT+depreciation-taxes/total assets), CapExp (total capital expenditure/total assets), NWC (current assets-current liabilities), Acquis (total acquisition expenditures/total assets), RD (research and development expense/total assets), CFVol (average standard deviation of cash flows for the industry over the past 5 years)

	High Liquidity	Low Liquidity	Difference
Asset Liquidity	0.0271	0.005	0.023***
	(0.0242)	(0.003)	(381.97)
Cash	0.133	0.164	-0.031***
	(0.179)	(0.194)	(-46.23)
Size	4.570	4.871	-0.301***
	(2.183)	(2.355)	(-36.93)
Leverage	0.283	0.241	0.043***
	(0.328)	(0.329)	(36.18)
MB	2.125	2.244	-0.120***
	(3.296)	(3.451)	(-9.88)
Cash Flow	-0.008	-0.012	0.004***
	(0.136)	(0.144)	(8.43)
CapEx	0.047	0.036	0.011***
	(0.067)	(0.0486)	(53.15)
NWC	0.030	0.080	-0.051***
	(0.490)	(0.488)	(-28.83)
Acquis	0.013	0.010	0.003***
	(0.043)	(0.0371)	(20.95)
RD	0.108	0.166	-0.058***
	(0.994)	(1.185)	(-14.55)
CFVol	0.521	0.447	0.074***
	(1.181)	(1.317)	(16.35)

Table 2.6: Cash Holdings by Asset Liquidity

This table presents the cash ratio for each liquidity ranking. Each year firms are ranked according to the asset liquidity index. Firms in the bottom 25% are assigned to group 1. Firms between 25% and 50% are assigned to group 2. Firms between 50% and 75% are assigned to group 3. Firms in the top 25% are assigned to group 4. $4-1$ reports the difference in cash holdings between the high and low liquidity groups. Panel A reports results over the full sample period. Panel B reports results in the pre-Financial Crisis period, defined as all observations before 2008. Panel C reports results in the post-Financial Crisis period, defined as 2008 and onward

Panel A: Full Sample						
	Mean	Median	25%	75%	St. Dev	N
1	0.164	0.084	0.022	0.238	0.194	170978
2	0.208	0.105	0.026	0.317	0.238	159548
3	0.203	0.101	0.025	0.307	0.235	140758
4	0.133	0.058	0.016	0.176	0.179	143093
Total	0.177	0.084	0.022	0.256	0.215	614377
4-1	-0.031	**t-stat**	-46.23***			
Panel B: Pre Crisis						
	Mean	Median	25%	75%	St. Dev	N
1	0.160	0.075	0.020	0.231	0.195	141940
2	0.196	0.090	0.022	0.294	0.233	126811
3	0.191	0.087	0.022	0.283	0.232	117670
4	0.137	0.058	0.016	0.183	0.183	116303
Total	0.171	0.076	0.020	0.245	0.213	502724
4-1	-0.023	**t-stat**	-30.77***			
Panel B: Post Crisis						
	Mean	Median	25%	75%	St. Dev	N
1	0.185	0.122	0.043	0.265	0.188	29038
2	0.255	0.166	0.056	0.387	0.250	32737
3	0.264	0.183	0.063	0.409	0.245	23088
4	0.117	0.058	0.015	0.151	0.159	26790
Total	0.206	0.121	0.038	0.299	0.222	111653
4-1	-0.068	**t-stat**	-45.83***			

Table 2.7: Non-Linear Effect of Asset Liquidity on Cash

This table presents coefficient estimates from the model:
$Cash_t = \beta_0 + \beta_1 AssetLiquidity + \beta_2 AssetLiquidity^2 + \beta_3 \mathbf{X_t} + \epsilon_\mathbf{t}$, where $\mathbf{X_t}$ is a vector of control variables. $MidLiq1$ is an indicator variable that takes on a value of 1 if the firm is ranked between 25% and 50% in the asset liquidity index, and 0 otherwise. $MidLiq2$ is an indicator variable that takes on a value of 1 if the firm is ranked between 50% and 75% in the asset liquidity index, and 0 otherwise. $HiLiq$ is an indicator variable that takes on a value of 1 if the firm is in the top 25% of the asset liquidity index, and 0 otherwise. All estimates include time fixed effects and industry fixed effects. T-statistics computed using robust standard errors clustered at the firm level.

	(1)	(2)	(3)	(4)
Constant	0.135***	0.203***	0.204***	0.202***
	(55.62)	(50.97)	(50.99)	(48.08)
Asset Liquidity	0.0193	-0.0460	-0.145	
	(0.30)	(-0.81)	(-1.59)	
Asset Liquidity ^{2}			-0.507*	
			(-1.77)	
MidLiq1				-0.00331*
				(-1.77)
MidLiq2				0.00703***
				(3.19)
HiLiq				-0.00540**
				(-2.33)
Size		-0.00408***	-0.00408***	-0.00408***
		(-6.15)	(-6.15)	(-6.15)
MB		0.00743***	0.00743***	0.00742***
		(21.09)	(21.09)	(21.06)
Cash Flow		0.0532***	0.0531***	0.0534***
		(8.37)	(8.36)	(8.41)
CapEx		-0.279***	-0.279***	-0.277***
		(-23.67)	(-23.68)	(-23.53)
NWC		-0.0838***	-0.0838***	-0.0838***
		(-19.96)	(-19.96)	(-19.95)
Acquis		-0.311***	-0.311***	-0.311***
		(-35.76)	(-35.76)	(-35.82)
RD		0.0224***	0.0224***	0.0223***
		(31.19)	(31.19)	(30.99)
Leverage		-0.236***	-0.236***	-0.236***
		(-36.41)	(-36.41)	(-36.43)
Dividend		-0.0441***	-0.0441***	-0.0440***
		(-19.63)	(-19.64)	(-19.62)
CFVol		0.00130***	0.00130***	0.00110**
		(2.66)	(2.68)	(2.30)
Rating		-0.0227***	-0.0227***	-0.0227***
		(-8.43)	(-8.44)	(-8.44)
Observations	614377	614377	614377	614377
Adjusted R^2	0.161	0.340	0.340	0.341

Table 2.8: High Asset Liquidity and Cash Holdings

This table presents coefficient estimates from the model:
$Cash_t = \beta_0 + \beta_1 HiLiq + \beta_3 \mathbf{X_t} + \epsilon_\mathbf{t}$, where $\mathbf{X_t}$ is a vector of control variables. $HiLiq$ is an indicator variable that takes on a value of 1 if the firm is in the top 25% of the asset liquidity index, and 0 otherwise. Pre-Crisis designates observations before 2008. Post-Crisis, designates observations from 2008 and onward. All estimates include time fixed effects and industry fixed effects. T-statistics computed using robust standard errors clustered at the firm level.

	(1) Full Sample	(2) Full Sample	(3) Pre-Crisis	(4) Post-Crisis
Constant	0.137***	0.204***	0.215***	0.277***
	(56.13)	(51.28)	(53.01)	(36.75)
HiLiq	-0.0104***	-0.00883***	-0.00498***	-0.00545*
	(-5.60)	(-5.27)	(-3.10)	(-1.76)
Size		-0.00406***	-0.00361***	-0.00385***
		(-6.12)	(-5.35)	(-3.21)
MB		0.00743***	0.00985***	0.00337***
		(21.10)	(26.10)	(7.68)
Cash Flow		0.0531***	0.0695***	0.0217**
		(8.36)	(9.30)	(2.51)
CapEx		-0.277***	-0.281***	-0.330***
		(-23.55)	(-23.79)	(-12.82)
NWC		-0.0837***	-0.115***	-0.0321***
		(-19.95)	(-24.67)	(-7.09)
Acquis		-0.311***	-0.271***	-0.461***
		(-35.79)	(-30.39)	(-22.23)
RD		0.0224***	0.0233***	0.0184***
		(31.17)	(29.22)	(18.58)
Leverage		-0.236***	-0.292***	-0.118***
		(-36.43)	(-46.72)	(-15.52)
Dividend		-0.0441***	-0.0465***	-0.0390***
		(-19.66)	(-20.21)	(-9.86)
CFVol		0.00131***	0.00730***	0.000508
		(2.68)	(4.21)	(1.51)
Rating		-0.0228***	-0.0134***	-0.0490***
		(-8.46)	(-4.90)	(-9.94)
Observations	614377	614377	502724	111653
Adjusted R^2	0.161	0.340	0.364	0.311

Table 2.9: Asset Liquidity, Cash Holdings and Financial Constraints

This table presents coefficient estimates from the model:
$Cash_t = \beta_0 + \beta_1 HiLiq + \beta_2 \mathbf{X_t} + \epsilon_t$, where $\mathbf{X_t}$ is a vector of control variables. $HiLiq$ is an indicator variable that takes on a value of 1 if the firm is ranked in the top 25% based on the asset liquidity index and 0 otherwise. Models 1 and 2 include firms that are in the lower 33% and upper 33% of the WW index, respectively. Models 3 and 4 include firms that are in the lower 33% and upper 33% of the SA index, respectively. All estimates include time fixed effects and industry fixed effects. T-statistics computed using robust standard errors clustered at the firm level.

	(1)	(2)	(3)	(4)
	WW Unconstrained	WW Constrained	SA Unconstrained	SA Constrained
Constant	0.278***	0.264***	0.203***	0.186***
	(29.82)	(30.41)	(20.85)	(30.11)
HiLiq	-0.00356	-0.0159***	-0.00436	-0.00942**
	(-1.38)	(-4.25)	(-1.42)	(-2.45)
Size	-0.0106***	0.0105***	-0.0112***	0.0234***
	(-11.22)	(7.82)	(-9.46)	(12.50)
MB	0.0143***	0.00590***	0.0249***	0.00610***
	(14.68)	(13.56)	(16.60)	(16.28)
Cash Flow	0.147***	-0.000826	-0.0148	-0.00830
	(5.92)	(-0.11)	(-0.68)	(-1.21)
CapEx	-0.235***	-0.354***	-0.281***	-0.345***
	(-12.04)	(-17.43)	(-13.43)	(-18.53)
NWC	-0.120***	-0.0597***	-0.224***	-0.0643***
	(-11.44)	(-12.01)	(-22.00)	(-13.83)
Acquis	-0.185***	-0.523***	-0.180***	-0.492***
	(-18.91)	(-25.69)	(-17.00)	(-25.33)
RD	0.0272***	0.0183***	0.0651***	0.0169***
	(9.45)	(25.24)	(3.98)	(22.75)
Leverage	-0.228***	-0.190***	-0.189***	-0.191***
	(-25.70)	(-22.96)	(-22.76)	(-24.00)
Dividend	-0.0371***	-0.0477***	-0.0276***	-0.0100*
	(-15.40)	(-8.95)	(-10.44)	(-1.65)
CFVol	0.000428	0.00181*	0.000327	0.00105
	(0.79)	(1.82)	(0.57)	(1.00)
Rating	-0.00124	-0.0969***	-0.00590**	0.0430
	(-0.49)	(-12.70)	(-2.19)	(1.44)
Observations	187053	186969	196439	196367
Adjusted R^2	0.348	0.311	0.365	0.271

Table 2.10: Change in Cash Valuation and Real Asset Liquidity

I estimate regressions using the method of Fama and MacBeth (1973). Regressions are estimated independently for each subsample (High Liquidity and Low Liquidity) allowing coefficients on control variables to vary across subsamples. X_t is the level of variable X in year t divided by the level of assets in year t. dX_t is the change in the level of X from year $t-1$ to year t divided by total assets in year $t((X_t - X_{t-1})/A_t)$. dX_{t+1} is the change in the level of X from year $t+1$ to year t divided by assets in year $t((X_{t+1} - X_t)/A_t)$. A is the book value of assets. V is the market value of the equity plus the book value of debt. E is earnings defined as earnings before extraordinary items plus interest plus deferred tax credits plus investment tax credits. NA is net assets, which is defined as total assets minus cash. RD is research and development expense. When $R\&D$ is missing, it is set to zero. I is interest expense. D is common dividends. C is cash, defined as cash plus cash equivalents. T statistics are in parentheses.

	(1)	(2)	(3)	(4)
	Full Sample	High Asset Liquidity	Low Asset Liquidity	p-value of difference
Constant	0.839***	0.814***	0.817***	0.953
	(21.86)	(20.93)	(18.10)	
E_t	3.373***	4.034***	3.324***	0.030
	(20.91)	(17.26)	(12.49)	
dE_t	-0.463***	-0.681***	-0.469***	0.159
	(-6.66)	(-5.65)	(-4.79)	
dE_{t+1}	1.979***	2.164***	1.833***	0.136
	(14.16)	(12.06)	(11.91)	
dNA_t	0.288***	0.194***	0.330***	0.065
	(6.10)	(3.39)	(5.10)	
dNA_{t+1}	0.295***	0.231***	0.386***	0.023
	(4.70)	(3.82)	(5.86)	
RD_t	5.649***	5.589***	4.129***	0.126
	(12.27)	(5.64)	(9.94)	
dRD_t	2.397***	4.229**	3.165***	0.529
	(3.23)	(2.73)	(4.72)	
dRD_{t+1}	6.082***	8.890***	5.936***	0.085
	(7.82)	(5.32)	(6.45)	
I_t	1.473***	2.503***	-0.117	0.007
	(3.29)	(4.93)	(-0.15)	
dI_t	-0.602	0.423	-0.628	0.205
	(-1.00)	(0.76)	(-0.83)	
dI_{t+1}	-0.820	0.240	-3.792***	0.004
	(-1.10)	(0.31)	(-3.58)	
D_t	3.609***	3.441***	3.743***	0.653
	(16.31)	(8.17)	(7.10)	
dD_t	-0.814***	-1.997**	-0.220	0.065
	(-3.31)	(-2.60)	(-0.46)	
dD_{t+1}	1.096***	0.759*	2.190***	0.051
	(5.47)	(1.93)	(4.34)	
dV_{t+1}	-0.166**	-0.183**	-0.200***	0.710
	(-2.61)	(-2.55)	(-4.25)	
dC_t	1.274***	0.647***	1.208***	0.011
	(5.17)	(3.82)	(6.47)	
dC_{t+1}	1.016***	0.614***	1.108***	0.022
	(5.71)	(4.26)	(6.17)	
Observations	68198	15874	19353	
Adjusted R^2	0.418	0.467	0.428	

Table 2.11: Cash Valuation and Real Asset Liquidity

I estimate regressions using the method of Fama and MacBeth (1973). Regressions are estimated independently for each subsample (High Liquidity and Low Liquidity) allowing coefficients on control variables to vary across subsamples. X_t is the level of variable X in year t divided by the level of assets in year t. dX_t is the change in the level of X from year $t-1$ to year t divided by total assets in year $t((X_t - X_{t-1})/A_t)$. dX_{t+1} is the change in the level of X from year $t+1$ to year t divided by assets in year $t((X_{t+1} - X_t)/A_t)$. A is the book value of assets. V is the market value of the equity plus the book value of debt. E is earnings defined as earnings before extraordinary items plus interest plus deferred tax credits plus investment tax credits. NA is net assets, which is defined as total assets minus cash. RD is research and development expense. When $R\&D$ is missing, it is set to zero. I is interest expense. D is common dividends. C is cash, defined as cash plus cash equivalents. T-statistics are in parentheses.

	(1)	(2)	(3)	(4)
	Full Sample	High Asset Liquidity	Low Asset Liquidity	p-value of difference
Constant	0.616***	0.680***	0.609***	0.093
	(21.71)	(20.61)	(16.26)	
E_t	3.515***	4.036***	3.470***	0.064
	(23.83)	(17.61)	(14.46)	
dE_t	-0.411***	-0.670***	-0.397***	0.070
	(-6.42)	(-5.56)	(-4.29)	
dE_{t+1}	2.169***	2.228***	2.103***	0.568
	(13.93)	(12.03)	(13.03)	
dNA_t	0.402***	0.294***	0.443***	0.014
	(7.24)	(5.69)	(7.27)	
dNA_{t+1}	0.213***	0.173***	0.282***	0.042
	(3.87)	(3.16)	(5.44)	
RD_t	4.154***	4.279***	2.929***	0.092
	(12.41)	(5.70)	(8.13)	
dRD_t	2.911***	4.598***	3.243***	0.397
	(3.96)	(3.06)	(4.89)	
dRD_{t+1}	5.736***	9.029***	5.806***	0.058
	(6.29)	(5.24)	(5.83)	
I_t	4.461***	3.984***	3.188***	0.361
	(14.40)	(8.54)	(5.48)	
dI_t	-1.128*	0.185	-1.078	0.112
	(-1.98)	(0.32)	(-1.58)	
dI_{t+1}	1.142*	1.188*	-0.967	0.102
	(1.76)	(1.73)	(-1.06)	
D_t	3.412***	3.271***	3.642***	0.603
	(13.90)	(7.49)	(6.95)	
dD_t	-0.900***	-2.001**	-0.495	0.153
	(-3.53)	(-2.57)	(-0.86)	
dD_{t+1}	1.038***	0.744*	1.601***	0.258
	(5.30)	(1.94)	(2.87)	
dV_{t+1}	-0.128**	-0.155**	-0.152***	0.957
	(-2.13)	(-2.24)	(-3.40)	
Ct	1.727***	1.199***	1.566***	0.001
	(9.26)	(10.31)	(12.64)	
Observations	68198	15874	19353	
Adjusted R^2	0.430	0.477	0.434	

Table 2.12: Cash Valuation and Financial Constraints: WW Index

I estimate regressions using the method of Fama and MacBeth (1973). Financial constrainsts are classified according to WW index. X_t is the level of variable X in year t divided by the level of assets in year t. dX_t is the change in the level of X from year $t-1$ to year t divided by total assets in year $t((X_t - X_{t-1})/A_t)$. dX_{t+1} is the change in the level of X from year $t+1$ to year t divided by assets in year $t((X_{t+1} - X_t)/A_t)$. A is the book value of assets. V is the market value of the equity plus the book value of debt. E is earnings defined as earnings before extraordinary items plus interest plus deferred tax credits plus investment tax credits. NA is net assets, which is defined as total assets minus cash. RD is research and development expense. When $R\&D$ is missing, it is set to zero. I is interest expense. D is common dividends. C is cash, defined as cash plus cash equivalents. T statistics are in parentheses.

	(1) Unconst/HiLiq	(2) Unconst/LowLiq	(3) p-value	(4) Const/HiLiq	(5) Const/LowLiq	(6) p-value
Constant	0.520***	0.547***	0.437	0.946***	0.933***	0.758
	(12.48)	(15.37)		(22.96)	(20.76)	
E_t	6.701***	5.887***	0.062	2.546***	1.602***	0.010
	(17.14)	(17.79)		(11.90)	(5.68)	
dE_t	-1.600***	-1.552***	0.885	-0.303***	-0.113	0.229
	(-6.38)	(-6.16)		(-2.93)	(-0.94)	
dE_{t+1}	2.613***	2.589***	0.945	1.614***	1.114***	0.010
	(7.40)	(12.24)		(13.96)	(7.44)	
dNA_t	0.132	0.324***	0.041	0.293***	0.439***	0.151
	(1.64)	(4.82)		(4.45)	(5.88)	
dNA_{t+1}	0.0442	0.274**	0.117	0.323***	0.544***	0.025
	(0.62)	(2.23)		(4.51)	(5.53)	
RD_t	4.253***	2.275***	0.116	4.848***	3.131***	0.310
	(3.10)	(3.16)		(3.03)	(7.57)	
dRD_t	9.085*	5.676***	0.533	2.169	2.875***	0.804
	(1.98)	(3.08)		(0.76)	(4.63)	
dRD_{t+1}	16.15***	8.857***	0.076	7.499***	3.688***	0.017
	(3.84)	(4.60)		(4.75)	(6.82)	
I_t	3.782***	0.0139	0.002	1.524**	-0.0306	0.116
	(5.79)	(0.01)		(2.54)	(-0.04)	
dI_t	3.455**	0.662	0.194	-0.542	-0.661	0.922
	(2.31)	(0.50)		(-0.92)	(-0.62)	
dI_{t+1}	2.231*	-3.414**	0.021	-0.551	-3.034**	0.170
	(1.81)	(-2.11)		(-0.71)	(-2.15)	
D_t	2.882***	3.784***	0.418	3.156	5.427	0.568
	(4.26)	(3.81)		(1.32)	(1.26)	
dD_t	0.219	-0.454	0.664	-5.923	-4.316	0.786
	(0.21)	(-0.53)		(-1.13)	(-1.52)	
dD_{t+1}	2.515*	1.419	0.585	1.819	-8.153	0.187
	(1.79)	(1.07)		(0.76)	(-1.03)	
dV_{t+1}	-0.167**	-0.247***	0.350	-0.204***	-0.192***	0.835
	(-2.37)	(-3.14)		(-2.82)	(-4.02)	
dC_t	0.586	0.922***	0.412	0.817***	1.184***	0.037
	(1.69)	(3.19)		(4.63)	(5.42)	
dC_{t+1}	0.315	0.731**	0.259	0.782***	1.287***	0.090
	(1.41)	(2.76)		(3.91)	(5.35)	
Observations	4781	7273		5039	5457	
Adjusted R^2	0.669	0.633		0.471	0.445	

Table 2.13: Cash Valuation and Financial Constraints: SA Index

I estimate regressions using the method of Fama and MacBeth (1973). Financial constrainsts are classified according to SA index. X_t is the level of variable X in year t divided by the level of assets in year t. dX_t is the change in the level of X from year $t-1$ to year t divided by total assets in year $t((X_t - X_{t-1})/A_t)$. dX_{t+1} is the change in the level of X from year $t+1$ to year t divided by assets in year $t((X_{t+1} - X_t)/A_t)$. A is the book value of assets. V is the market value of the equity plus the book value of debt. E is earnings defined as earnings before extraordinary items plus interest plus deferred tax credits plus investment tax credits. NA is net assets, which is defined as total assets minus cash. RD is research and development expense. When $R\&D$ is missing, it is set to zero. I is interest expense. D is common dividends. C is cash, defined as cash plus cash equivalents. T statistics are in parentheses.

	(1) Unconst/HiLiq	(2) Unconst/LowLiq	(3) p-value	(4) Const/HiLiq	(5) Const/LowLiq	(6) p-value
Constant	0.556***	0.615***	0.125	0.928***	1.022***	0.064
	(17.97)	(14.79)		(19.38)	(18.63)	
E_t	4.759***	4.137***	0.027	3.220***	2.416***	0.080
	(18.32)	(18.09)		(9.75)	(7.07)	
dE_t	-1.052***	-0.891***	0.406	-0.208	-0.00369	0.254
	(-7.08)	(-5.35)		(-1.23)	(-0.03)	
$dEt+1$	2.197***	1.903***	0.154	2.147***	1.617***	0.099
	(11.55)	(11.61)		(7.75)	(7.09)	
dNA_t	0.153**	0.172**	0.813	0.417***	0.597***	0.250
	(2.54)	(2.76)		(4.27)	(4.87)	
dNA_{t+1}	0.0756	0.252**	0.064	0.290***	0.462***	0.132
	(1.26)	(2.68)		(3.15)	(4.59)	
RD_t	3.901***	3.218***	0.291	5.496***	3.264***	0.162
	(4.78)	(5.39)		(3.82)	(5.56)	
dRD_t	4.279	2.845**	0.711	7.932**	3.513***	0.213
	(1.20)	(2.32)		(2.21)	(3.53)	
dRD_{t+1}	7.534**	6.031***	0.670	6.841**	4.759***	0.462
	(2.38)	(3.94)		(2.39)	(7.19)	
I_t	5.610***	0.655	0.000	1.789**	-2.682**	0.001
	(15.30)	(0.59)		(2.21)	(-2.61)	
dI_t	0.786	0.281	0.672	-0.532	0.635	0.534
	(0.99)	(0.27)		(-0.48)	(0.39)	
dI_{t+1}	4.062***	-2.619	0.008	-0.385	-4.183**	0.088
	(4.97)	(-1.19)		(-0.29)	(-2.65)	
D_t	6.976***	7.904***	0.417	3.816**	1.186	0.273
	(15.26)	(7.27)		(2.16)	(0.97)	
dD_t	1.060	-0.687	0.303	-4.646**	-1.718	0.224
	(0.67)	(-0.53)		(-2.11)	(-1.20)	
dD_{t+1}	6.768***	4.812**	0.511	2.782*	-4.005*	0.028
	(3.86)	(2.38)		(1.86)	(-1.84)	
dV_{t+1}	-0.172**	-0.256***	0.285	-0.214***	-0.204***	0.885
	(-2.40)	(-3.74)		(-2.80)	(-3.69)	
dC_t	0.314*	0.745***	0.117	0.772***	1.448***	0.014
	(1.92)	(3.30)		(3.28)	(6.31)	
dC_{t+1}	-0.0303	0.611***	0.014	0.786**	1.216***	0.158
	(-0.22)	(3.03)		(2.47)	(5.00)	
Observations	5548	8096		4383	4633	
Adjusted R^2	0.585	0.589		0.524	0.475	

Table 2.14: Capital Market Uncertainty

This table presents coefficient estimates from the model:
$Cash_t = \beta_0 + \beta_1 After(1) + \beta 2 HiLiq + \beta_3 HiLiq \times After(1) + \beta_4 \mathbf{X_t} + \epsilon_\mathbf{t}$, where $\mathbf{X_t}$ is a vector of control variables. The coefficients for the control variables are omitted for brevity. $HiLiq$ is a dummy variable that takes on a value of 1 if the firm is ranked in the top 25% based on asset liquidity and 0 otherwise. $After(1)$ is a dummy variable that takes on a value of 1 if an uncertainty shock occurred in that quarter and 0 otherwise. $HiLiq \times After(1)$ is an interaction term between asset liquidity and the event dummy. Model 1 and 2 are estimated using the full sample. Models 3-6 segment the sample into financially constrained and unconstrained firms (classified using the Whited and Wu(2006) index, and the SA index). All estimates include time fixed effects and industry fixed effects. T-statistics computed using robust standard errors clustered at the firm level.

	(1)	(2)	(3)	(4)	(5)	(6)
	Full Sample	Full Sample	WW Constrained	WW Unconstrained	SA Constrained	SA Unconstrained
Constant	0.203***	0.204***	0.279***	0.279***	0.210***	0.186***
	(50.92)	(51.27)	(31.51)	(32.69)	(23.18)	(30.11)
After(1)	0.0111***	0.0110***	0.0149***	0.00743***	0.0107***	0.00496**
	(14.62)	(11.86)	(12.20)	(3.58)	(10.50)	(2.39)
HiLiq		-0.00883***	-0.0159***	-0.00337	-0.00911***	-0.00433
		(-5.28)	(-4.25)	(-1.46)	(-2.49)	(-1.47)
HiLiq x After(1)		0.000436	-0.00506*	-0.00103	-0.00131	0.00372
		(0.21)	(-1.91)	(-0.19)	(-0.59)	(0.75)
Observations	614377	614377	187053	186969	196439	196367
Adjusted R^2	0.340	0.340	0.312	0.349	0.273	0.366

Table 2.15: Dynamic Effects of Capital Market Uncertainty

This table presents coefficient estimates from the model:
$Cash_{i,t} = \beta_0 + \beta_1 \sum_{j=1}^{1} After(j) + \beta_2 HiLiq + \beta_3 \sum_{j=1}^{1} After(j) \times HiLiq + \beta_4 \mathbf{X_t} + \epsilon_{\mathbf{t}}$, where $\mathbf{X_t}$ is a vector of control variables. $HiLiq$ is a dummy variable that takes on a value of 1 if the firm is ranked in the top 25% based on asset liquidity and 0 otherwise. $After(t)$ is a dummy variable that takes on a value of 1 if an uncertainty shock occurred t quarters ago and 0 otherwise. $After(t)$ is a dummy variable that takes on a value of 1 if an uncertainty shock will occur t quarters in the future. $HiLiq \times After(t)$ is an interaction term between asset liquidity and the event dummy. Models 1 and 2 are estimated using the full sample. Models 3-6 segment the sample into financially constrained and unconstrained firms (classified using the Whited and Wu(2006) index, and the SA index). All estimates include time fixed effects and industry fixed effects. T-statistics computed using robust standard errors clustered at the firm level..

	(1) Full Sample	(2) Full Sample	(3) WW Constrained	(4) WW Unconstrained	(5) SA Constrained	(6) SA Unconstrained
Constant	0.203***	0.204***	0.264***	0.278***	0.186***	0.203***
	(50.92)	(51.28)	(30.39)	(29.84)	(30.11)	(20.83)
After(-1)	-0.00127	-0.00144	-0.00279	0.000267	-0.00424*	-0.000706
	(-1.63)	(-1.53)	(-1.32)	(0.22)	(-1.94)	(-0.74)
After(0)	0.00206**	0.00177*	-0.00290	0.00637***	-0.00417*	0.00720***
	(2.39)	(1.73)	(-1.25)	(4.59)	(-1.77)	(6.38)
After(1)	0.0113***	0.0111***	0.00642***	0.0158***	0.00371	0.0121***
	(12.43)	(10.49)	(2.67)	(10.80)	(1.55)	(10.13)
HiLiq		-0.00889***	-0.0159***	-0.00283	-0.0100***	-0.00448
		(-5.33)	(-4.25)	(-1.40)	(-2.62)	(-1.49)
HiLiq x After(-1)		0.000754	-0.00223	-0.00636	0.00693	-0.000670
		(0.34)	(-0.38)	(-0.32)	(1.27)	(-0.30)
HiLiq x After(0)		0.00121	0.00187	-0.00852	0.00871	-0.00237
		(0.55)	(0.33)	(-0.95)	(1.64)	(-1.04)
HiLiq x After(1)		0.000510	-0.00481	-0.00201	0.00427	-0.00157
		(0.23)	(-1.74)*	(-0.25)	(0.81)	(-0.67)
Observations	614377	614377	186969	187053	196367	196439
Adjusted R^2	0.340	0.340	0.311	0.349	0.271	0.365

CHAPTER 3

Essay 2: Asset Liquidity, Cash Holdings, and the Cost of Corporate Debt

3.1 Introduction

The presence of liquid real assets (as defined as productive assets that are easily sold without a significant loss in value) within a firm should have an impact on the credit risk of a firm and, as a result, have an impact on the firm's cost of the firm's debt. As shown in structural models of corporate liabilities (e.g. Merton, 1974; Leland, 1994; Leland and Toft, 1996, among others), in addition to the probability of default, credit spreads are directly influenced by the creditor's expected recovery rate in the event of default. That is, if the firm defaults creditors will seize and sell off the firm's assets in order to partially recover their claims. If the ability to find a willing buyer of the firm's assets is in fact a determinant of the recovery value in default, then credit spreads should also be a function of asset liquidity. Higher asset liquidity will result in greater expected recovery rates which, in turn, results in narrower credit spreads.

While the relationship between asset liquidity and credit risk is seemingly straightforward, the existence of agency issues and managerial incentives add an additional layer of complexity. It is true that having more liquid real assets in place provides protection for creditors in the event of default in the sense that recovery rates are higher. But liquid assets also give managers the flexibility to use asset sales to transform the asset composition of the firm after debt has been issued, effectively making the existing debt more risky. Weiss and Wruck (1998) argue that "... unless a credible promise can be made not to engage in asset stripping, [...] asset liquidity [could] reduce, not increase, a firm's ability to issue debt securities". The authors go on to argue that illiquid assets within the firm help to provide such a credible promise and serve as protection from value destructing wealth transfers from bondholders to equityholders. Consistent with this Morellec (2001) shows that when debt is secured by the firm's assets, increased asset liquidity leads to a narrowing of credit spreads. When debt is unsecured, however, asset liquidity widens yield spreads. Similarly, Myers and Rajan (1998) demonstrate that because greater asset liquidity reduces the firm's ability to commit to a specific course of action, high asset liquidity may inhibit the firm's capacity to raise external finance through an increased cost of debt.

Also at play in the asset liquidity/credit risk relationship is the fact the firms may choose to use asset sales as a source of financing along side debt and equity issuances (Edmans and Mann, 2013; Arnold et al., 2014), and the trade-off between cash holdings and asset liquidity illustrated in Essay 1 of this dissertation. In the absence of financial frictions, firms can access external capital markets instantly at no cost to service any current liquidity needs. Capital market imperfections, however, impose a significant cost on external financing. If access to external finance is costly or unavailable, cash reserves provide a buffer against negative cash flow shocks and allows firms to continue to invest in negative cash flow states without the assistance of the capital markets. In other words, cash holdings provide firms with financial flexibility. Here we consider an additional capital market, outside of the traditional debt and equity markets, that firms can access in order to meet a liquidity need: the market for asset sales. There are a number of reasons to suspect that there is a link between the asset sale market and firms' cash holdings. For one, if the costs of obtaining funds from the asset sale market are reasonable, it would represent a relaxing of financing constraints and thus would reduce the need for substantial cash reserves.

In this essay we examine each of these issues using a theoretical model, and we then empirically test the model's implications as well as implications posed by the existing theoretical literature. Specifically, we develop a simple model in which a firm can liquidate a portion of its productive assets in order to service debt or finance investment opportunities. Selling assets come with transaction costs that come about in two ways. The first transaction cost is the discount the firm incurs on the selling price of the asset. The second cost materializes in the loss of future cash flows from the productive asset. In order to avoid these costs, the firm may choose to hold precautionary cash reserves. The question then becomes should the firm hold precautionary cash balances or utilize options to voluntarily sell real (productive) assets when necessary to invest in projects or service debt. In our simple, two period model, we solve for the optimal level of asset sales and determine the impact of the fire-sale discount on the level of cash holdings. Finally, we examine the implications of the relationship between asset liquidity and cash holdings on the cost of corporate debt.

Empirically, we extend the corporate bond literature by examining the role of real asset liquidity on the cost of corporate debt over a broad cross section of firms and investigate the impact of debt covenants (i.e. secured debt vs unsecured debt) on this relationship. In addition, motivated by the theoretical and the empirical findings of the previous essay of this dissertation we also look at the how the interaction between cash holdings and real asset liquidity affect corporate credit spreads.

3.2 Related Literature

3.2.1 Motives for Asset Sales

The sale of a firm's assets has been commonly posed in the literature as a method to resolve financial distress (Shleifer and Vishny, 1992; Asquith et al., 1994) as well as a way to improve corporate efficiency and refocus on core operations (John and Ofek, 1995; Maksimovic and Phillips, 2001; Yang, 2008; Eisfeldt and Rampini, 2006). From the financial distress viewpoint, asset sales are conducted under pressure from creditors to repay their outstanding debt claims. In distress (i.e. when the value of the firm's assets is less than the face value of debt), equity holders have little incentive to engage in asset sales since the proceeds from the sale will go almost entirely to the firm's debt claimants (Jensen and Meckling, 1976). Consistent with this notion Brown et al. (1994) find that asset sales among distressed firm result in significantly lower return to equity holders when the sale proceeds are used to repay debt.

Asset sales, however, need not only occur for reasons of financial distress. Voluntary asset sales are also used frequently for the purposes of corporate restructuring and improving operating efficiency. John and Ofek (1995), Maksimovic and Phillips (2001), and Yang

(2008), among others show that asset sales allow firms to improve efficiency by allocating inefficiently used resources to more productive firms. John and Ofek (1995) find that operating performance tends to increase following asset sales particularly for diversified firms which use divestitures to increase their focus. Maksimovic and Phillips (2001) and Yang (2008) both show that asset sale transactions are associated with productivity gains, suggesting that the acquiring firm is is better able to operate the assets more efficiently. In particular, Maksimovic and Phillips (2001) find that nearly half of all plant re-allocations in a given year take the form of partial-firm asset sales (as opposed to mergers). These asset sales result in increased productive efficiency especially for multi-division firms which sell of a peripheral division. This productivity gain is particularly large for buyer firms who have lower productivity than the asset acquired

Moreover, asset sales can be used as a method to obtain financing for new investment. While much of the literature studies a firm's choice between using debt and equity financing, obtaining financing through the sale of productive assets is also a possible alternative. Edmans and Mann (2013) and Arnold et al. (2014) develop theoretical models in which firms sell assets in order to finance investments. In Edmans and Mann (2013), asset sales are treated along side other security issuance decisions and firms are permitted to use asset sales to both raise capital for investment as well as for operational reasons. From the pecking order argument of Myers and Majluf (1984), firms should utilize the lowest cost source of financing, and the cheapest source of financing is the method which poses the least amount of information asymmetry to potential financiers. Edmans and Mann (2013) argue that there are other considerations in addition to information asymmetry that affect the choice of financing method which lead asset sales to be preferred to equity issuances. Specifically, they argue that because the value of new equity issuances and existing equity are perfectly correlated, selling equity diminishes the market's valuation of the entire firm (Akerlof, 1970). In contrast an asset being sold, even if it is of poor quality, is not necessarily a reflection of the quality of the firm as a whole and thus will not diminish firm value to the same degree. The authors show that when the amount of financing needed is small or if the firm is a conglomerate with many unrelated lines of business, financing through asset sales will be preferred over equity issuances.

Arnold et al. (2014) show that financing with asset sales may be optimal under certain conditions since asset sales help to mitigate the debt overhang problem of Myers (1977). Under equity financed investment, much of the benefits will be diverted to bondholders. Asset sales, however, naturally increase leverage making existing debt riskier (and less valuable). This reduction in wealth transfers from equity to debt gives rise to a preference for financing asset sales . Since the wealth transfer problem is more prominent among highly levered firms, they demonstrate that more levered firms have a stronger incentive to finance through asset sales rather than equity issues. Arnold et al. (2014) also find that financing with asset sales is more likely to occur during business cycle downturns, not because of increased financial constraints but again due to the wealth transfer effect.

There is ample evidence in the literature to support the use of asset sales to finance investment. Bates (2005) finds that firms that retain the proceeds from asset sales (as opposed to payouts to bond or equity holders) tend to use those proceeds to over-invest relative to industry benchmarks. Similarly, Hovakimian and Titman (2006) and Borisova and Brown (2013) show that firms invest more when they generate cash from asset sales and this phenomenon is particularly prevalent among financially constrained firms. Slovin et al. (1995) and Borisova et al. (2013) find that there are significant announcement period returns for firms that state their intention to retain the proceeds from asset sales. Hite et al. (1987) document significant abnormal returns for both buyers and sells following voluntary asset sales and suggest that a portion of the value gains are generated from applying the proceeds to unfunded, positive net present value projects within the firm.

3.2.2 The Impact of Asset Liquidity on Debt Policy

The ability to sell assets for liquidation and financing purposes naturally has implications for the claimholders of the firm, in particular the firm's debtholders. Indeed, the agency cost of debt arises due to the managers incentive to increase the value of equity by transferring wealth from bondholders (Jensen and Meckling, 1976). One way that managers can reallocate wealth from debt to equity is by transforming the asset composition of the firm into a more risky structure, the so called asset substitution problem. Because equity can be viewed as a long position in a call option on the firm's assets and debt a short position in a put option, an increase in asset risk will increase (decrease) the value of equity (debt) (Black and Scholes, 1973; Merton, 1974). Thus, an increased ability to sell assets increases the amount of asset substitution risk the firm's debtholders face. Myers and Rajan (1998) argue that because an increased ability to sell assets reduces the firm's commitment to a particular course of action, debt capacity is diminished.

Extant research has shown that the liquidation value of the firm's assets should be a crucial determinant of a firm's optimal debt policy (Harris and Raviv, 1990; Aghion and Bolton, 1992). An asset's liquidation value is of great importance to creditors since it represents the amount they can expect to receive if they must seize the asset from management and sell it on the open market in order to resolve their debt claims. This liquidation value of an asset is largely dependent on the asset's liquidity. As described by Williamson (1988) and Shleifer and Vishny (1992), the degree to which assets are redeployable to alternative uses is a main determinant of an asset's liquidity (measured as the difference between the true value of the asset and the selling price).

Hart and Moore (1994) argues that in the presence of incomplete contracting, firms with more liquid real assets are desirable in the eyes of creditors because they attract higher liquidation values in the event of default. They state that "...general, nonspecific assets are good for debt and specific or intangible assets are good for equity financing". As such, firms with assets which are more easily redeployed will possess larger debt capacities and longer debt maturities, and tangible assets will facilitate borrowing only to the extent that they are sellable. Shleifer and Vishny (1992) show that the concept of asset liquidity has an additional component that goes alongside redeployability. The authors model the liquidation value of a firm's assets as an endogenous price that is function of both the number of potential users of the asset as well as the financial condition of the potential users. Because assets tend to be industry specific, a distressed firm selling assets in response to a negative industry shock will find that the parties which value the assets the most will likely be distressed too. If there are few firms that have use for the asset or if all potential buyers in the industry lack funds themselves, the demand for the asset will be low and the asset will sell at a steep discount (likely to industry outsiders who value the assets far below their true value). Ramey and Shapiro (2001) and Pulvino (1998) find evidence that confirms this notion that assets that are sold to industry outsiders tend to suffer larger discounts than sales that occur within the industry. Pulvino (1998) finds that these discounts are magnified during economic downturns and among more financial distressed firms.

The extent to which assets may be sold is highly dependent on the laws governing the firm in addition to the covenants attached to firm's debt. Acharya et al. (2011) show that the difference in leverage between a country with equity-friendly laws and a country with debt-friendly laws is a function of the liquidation value of the firm's assets. Firms make their optimal continuation versus liquidation decisions on the basis of the size of their deadweight loss in default which is in part determined by the asset liquidation value. Because equity-friendly laws promote excessive continuation to the detriment of debtholders, higher leverage is optimal in equity-friendly systems relative to debt-friendly systems. But as liquidation values increase, it becomes more optimal to sell assets rather than continue excessively. This negates the deadweight loss advantage of debt in equity-friendly countries and thus negates the leverage disparity between the countries.

Similarly, Myers and Rajan (1998) and Morellec (2001) predict that the impact of asset liquidity on leverage depends on whether or not the assets are posted as collateral. Because the potential for wealth transfers due to asset stripping is higher for firms with liquid assets, bondholders will require higher returns from these firms if their claims are not secured. Morellec (2001) argues that asset sales are optimal for shareholders not only because they allow the firm to allocate resources to their best use, but also because asset sales represent the cheapest source of funds when the firm is distressed. Asset sales allow the firm to continue operations without requiring equity injections. On the other side asset sales may be undesirable for bondholders when their claims are unsecured because they reduce the size of the firm upon closure thus reducing creditors' expected recovery value in default. In general because asset sales increase the strategy space of equityholders without giving creditors any recourse, asset sales should have a positive relationship with the level of unsecured debt.

Sibilkov (2009) tests these predictions and finds a multidimensional effect conditional on the level of security place on the firm's assets. While there is a positive relationship between asset liquidity and secured debt, a nonlinear relation exists for unsecured debt. When asset liquidity is at low levels, the unsecured debt is increasing with liquidity. However, when asset liquidity is high, unsecured debt is decreasing with liquidity.

3.2.3 Asset Liquidity and Credit Risk

Asset liquidity should play a key role in structural models of corporate debt. The credit risk of a firm can typically be decomposed into two components: the probability of default and the recovery rate. Together, these two items give a measure of creditor's expected loss given default. The recovery rate represents the percentage of promised principal and interest payments the creditor will receive in the event of a default on the firm's debt. Often times, an assumption is made that the recovery rate is exogenous, constant and known with certainty in order to facilitate an analysis of the probability of default.[1] However, this assumption may not be always be appropriate. In the structural credit risk models of Merton (1974) and Black and Cox (1976) among others, the recovery rate is a function of the asset value of the firm at default. If asset liquidity is heterogeneous on an industry level as suggested by Shleifer and Vishny (1992), then recovery rates will differ among firms. Morellec (2001) improves upon these earlier models by endogenizing asset liquidity into the structural framework not only in regards to liquidation values in default, but also as a key strategic variable that affects the firm's operating policy. He shows that when debt is secured by the firm's assets, increased asset liquidity narrows credit spreads. When debt is unsecured, however, asset liquidity widens yield spreads. Similarly, Myers and Rajan (1998) demonstrate that because greater asset liquidity reduces the firm's ability to commit to a specific course of action, high asset liquidity may inhibit the firm's capacity to raise external finance through an increased cost of debt.

Empirical work linking asset liquidity to the cost of debt has been limited because it is difficult to measure the market value of a firm's assets prior to realizing the selling price.

[1] For instance, Giesecke et al. (2011) study corporate bond default rates over a 150 year period and assume a constant recovery rate of 50%, equal to the long run historical average recovery rate.

Thus the existing empirical literature tends to utilize small samples focusing on a particular industry or a specific type of asset in which the true value of the asset can be either directly observed or easily inferred (e.g. Pulvino (1998) and Gavazza (2010) examine the airline industry, Ramey and Shapiro (2001) examine the aerospace industry, Kim (1998) looks at the oil drilling industry, and Benmelech et al. (2005) focus on the commercial real estate industry). In regards to the effects of asset liquidity on the pricing of corporate debt, Benmelech and Bergman (2009) examine just secured debt among U.S. airlines. They find that debt that is secured by collateral that is more easily transferred to other firms has lower credit spreads. This is due to the right creditors have to seize and liquidate these secured assets should the firm fail to service its debt properly. The more sellable the collateral, the small the creditor's expected losses in default.

Ortiz-Molina and Phillips (2014) investigate the relationship between asset liquidity and the cost of equity over a broad cross-section of firms. They find that that the liquidity of a firm's real assets is negatively related to its cost of equity capital through the operating flexibility channel. They argue that firms often have the need and desire to restructure their operations. But if assets are illiquid, their ability to sell them when necessary is significantly hampered. In this case, they must either forgo their desired restructuring or else sell the assets and incur a large discount relative to the true value of the assets. It is typically in poor economic conditions in which firms are most likely to be in need of restructuring. Firms may want to divest their unproductive assets during these times, but if the cost of selling their real assets is high they may be forced to continue operating them. Therefore possessing illiquid real assets increases the covariance of firm performance with macroeconomic conditions and thus increases the firm's cost of equity.

3.2.4 The Relationship Between Cash Holdings and Asset Liquidity

Central to the literature on corporate cash holdings are financial constraints. If external financing could be accessed easily and costlessly, there would be no role for cash holdings as firms could simply issue securities whenever funds were needed. But with financial constraints, cash holdings become an integral component of corporate financial policy. Kim et al. (1998) develop a three period model and show that cash accumulation is increasing in the cost of external finance, the variance of future cash flows, and the return on future investment opportunities, but decreasing in the return differential between physical capital and cash.

Han and Qiu (2007) find that the uncertainty of future cash flows and financing constraints give rise to precautionary cash holdings. In their model, financially unconstrained firms have unrestricted access to external financing and are able to make first-best investments regardless of the size of future cash flows. Constrained firms have no external financing, however, and must make an intertemporal trade-off between the size of current and future investment. Since an increase in cash flow volatility increases the expected marginal return on future investment, constrained firms will save more cash. There is no such relationship between cash flow volatility and cash holdings for the unconstrained firms.

Along similar lines, Riddick and Whited (2009) and Gamba and Triantis (2008) use dynamic models of the firm to show that income uncertainty and costly external financing leads to higher precautionary cash holdings. Riddick and Whited (2009)) focuses on the accumulation of cash over time and thus allows for capital adjustments. They find that as capital becomes more productive and cash flows become larger the firm substitutes its cash reserves to purchase additional capital, leading to a negative relationship between savings and cash flows. Acharya et al. (2007) illustrate the hedging component of precautionary cash holdings. They show that when firms are financially constrained and their investment opportunities tend occur in states when cash flows are low, firms hedge this risk by saving more cash. For firms with a positive relationship between investment opportunities and cash flows, cash is used to pay debt rather than saved.

The empirical literature confirms many of these predictions found in these models. Opler et al. (1999), Faulkender and Wang (2006), Denis and Sibilkov (2010), and Almeida et al. (2004) all find that cash holdings are increasing in the degree of external financing constraints. Harford (1999) and Opler et al. (1999) find a positive relationship between cash and measures of cash flow risk and investment opportunities.

Bolton et al. (2011) relate the cash holdings decision to the asset sale decision by considering the idea that the firm may want to engage in asset sales in order to replenish its stock of cash and avoid liquidity defaults. In their model, asset sales are excessively costly both because of underinvestment and physical adjustment costs. Nevertheless, the model shows that when the firm's cash reserves are low, the firm will engage in asset sales to raise cash and move away from the liquidity default boundary. Even when costly equity issuances are possible, they show that asset sales are still feasible when cash balances become depleted.

Warusawitharana (2008) shows that the level of liquid assets on a firm's balance strongly impacts the choice of a firm to sell assets. He finds that a one standard deviation increase in cash holdings increases the odds that the firm will sell assets by 32%. Additionally, the quantity of assets sold depends on the marginal value of capital inside the firm (marginal Q). That is to say less profitable firms with fewer growth opportunities tend to sell a larger quantity of assets. This finding corresponds with financing hypothesis of asset sales put forth by Lang et al. (1995). They argue that firms sell assets to generate funds to pursue its objectives when other sources of funding are either unavailable or too expensive. They find that firms close to financial distress tend to sell assets to raise funds, which provides confirmation of this hypothesis. Similarly, Hovakimian and Titman (2006) find that the sensitivity of investment to asset sale proceeds is related to variables that coincide with financial constraints. That is, younger, unrated, non-dividend payers have a higher sensitivity of investment to asset sale proceeds. Bates (2005) provides additional evidence that asset sales can be used to bypass other methods of financing, especially when other avenues are costly or unavailable. He examines 400 large asset sale transactions and finds that proceeds retention is positively related to the selling firm's growth opportunities and post-sale investment.

3.2.5 The Role of Cash in Credit Risk Models

The ability to costlessly sell equity eliminates the role of precautionary cash holdings in determining financial policy and the value of corporate securities. In the structural credit risk models with endogenous default such as those developed by Black and Cox (1976), Geske (1979), Leland (1994), Leland and Toft (1996), He and Xiong (2012), among others, the default boundary arises as an optimal decision made by the shareholders. In the Geske (1979) model, if the value of assets is sufficiently high, then the value of equity is non-zero. Equity holders will issue new equity in order to continue servicing their debt as long as the value of equity equals the value of the future cash flows. Similarly in Leland (1994) and Leland and Toft (1996), shareholders optimally choose a default boundary which maximizes the value of equity. If debt obligations can not be covered by internal cash flows, equity holders will contribute the necessary funds to fill the shortfall as long as the marginal value of equity is positive. In each of these models if capital markets are frictionless and there are no costs to issuing equity, then there will be no need for a firm to hold cash reserves to hedge such occasions.

Acharya et al. (2012) develop a model in which they restrict access to external financing and thus introduce a role for cash holdings in the context of credit risk. Because default is costly, firms hold precautionary cash balances in order to hedge cash flow risk and avoid default. In their three period model, the firm makes a choice between investing in cash versus investing in a long-term project. Increasing investment in the project results in higher payoffs conditional on not defaulting. Retaining cash reduces the payoff from the long-term project but increases the likelihood of survival. The optimal level of cash holdings is found by choosing the level of investment the maximizes the value of equity.

3.2.6 Contribution

Here, we develop model that is similar in spirit and set up to Acharya et al. (2012). However, we introduce a few key distinctions to evaluate the role of asset sales on the relationship between cash holdings and credit risk. First while Acharya et al. (2012) consider only a single investment opportunity, we introduce a second investment opportunity to generate a second motive for holding cash in addition to simply avoiding default. By holding large cash balances today the firm is increasing their likelihood of survival (i.e. by making the necessary debt payments). But at the same time, they are reducing their outlays in both current and future investment. Second while we assume that the firm does not have access to debt or equity markets, they do have the ability to liquidate their assets in place (at a cost that is a function of the asset's liquidity) to generate funds for debt service and investment. Also, contrary to the literature on the pricing of risky debt in which the level of assets sales is exogenous (i.e. Leland, 1994), our model assumes that the quantity of assets sold is determined endogenously.

Empirically, our work is related to recent work exploring the role of real asset liquidity on firm characteristics (e.g Pulvino, 1998; Ramey and Shapiro, 2001; Benmelech and Bergman, 2009). These studies, however, are limited in the ability to make broad conclusions as they focus their attention on a small number of firms in a particular industry. There are two key exceptions to these small sample studies. Sibilkov (2009) and Ortiz-Molina and Phillips (2014) both use measures of asset liquidity similar to the one I propose here which allow them to investigate the role of real asset liquidity over a broad cross-section of firms. However, while Ortiz-Molina and Phillips (2014) investigate the role of asset liquidity on the cost of equity capital, we examine its role on the pricing of corporate debt.

3.3 Basic Model

3.3.1 Introduction

Our theoretical argument can be summarized as follows. Cash holdings are a zero NPV investment. Therefore it would benefit the firm to direct funds away from cash reserves and into more productive investments. The existence of debt service requirements, future investment opportunities, and restricted access to capital markets gives rise to a precautionary motive for cash holdings. If asset sales are permitted, however, the firm has the option to liquidate its real assets in order to meet its liquidity needs. Therefore, asset sales and cash holdings are substitutes, i.e. with permissible asset sales, firms will hold smaller cash balances. This follows directly from asset sales acting as a means of reducing financing constraint. The degree to which asset sales reduce financial constraints and subsequently reduce the size of cash balances will depend on the liquidation cost of asset. When sold at a fire sale price, the disparity between the selling price and true value of the asset represents a substantial cost to accessing the asset sale market. Therefore asset sales will be decreasing and cash holdings increasing with the cost of liquidation.

The implications of the the expected liquidation cost on the asset sale / cash holdings relationship will play a key role in the pricing of the firm's bonds. As cash balances provide debt holders with additional assurances that their claims will be repaid, asset sales will reduce the potential recovery value for creditors in the event of default. The selling price of the firm's assets will a determining factor in the level of cash the firm will choose to hold and simultaneously affect the level of asset sales the firm will choose to engage in. Both of these actions will have an impact on the expected payoff to creditors and thus impact the cost of corporate debt. With the proposed model we will detail these relationships and derive testable empirical implications.

3.3.2 Assumptions

We consider a two period model of firm's investments vis-a-vis financing decisions when asset sales are permissible. The firm i has real assets in place which can be liquidated in a timely fashion at any time t for a price of A_t. However, a fire-sale would demand a discount. We assume that the fire-sale price, $A_t(\eta)$, is a direct function of percentage of assets liquidated, η, and that while the liquidation value is decreasing function of liquidation percentage, that is, $\partial A_t(\eta)/\partial\eta < 0$, the decrease decelerates as the percentage liquidated increases, or, $\partial^2 A_t(\eta)/\partial\eta^2 \geq 0$. We assume that the selling price is a linear function of percentage assets liquidated and the liquidity of the asset market, whereby $A_t(\eta, \alpha) = A_t - (1-\alpha)A_t\eta = A_t(1-(1-\alpha)\eta)$. $\alpha \in [0,1]$ can be viewed as the liquidity of asset market in that $\alpha = 1$ denotes an infinitely liquid market in which the percentage of liquidation has no bearing on selling price of the asset. $\alpha = 0$ denotes an illiquid market in which full liquidation leads to a selling price of zero. With any other value of α, at full liquidation, the liquidation price is αA_t.

Figure 3.1 provides a simple illustration of this linear pricing function. In this example, the true value of the asset is \$100 per unit. When $\alpha = 1$, that is when market for the firm's assets are very liquid, the selling price will equal the true value no matter the quantity sold. If $\alpha = 0.6$, the assets will yield a price of \$60 per unit in full liquidation and \$80 per unit if the firm sells 50% of its assets. In the extreme case where $\alpha = 0$ which represents a very illiquid market for the firm's assets, full liquidation leads to a selling price of \$0 per unit and selling 50% of its assets yields a selling price of \$50 per unit.

[Figure 3.1 about here.]

The firm's real assets generate a sequence of cash flows of $x_0, \tilde{x}_1, x_2$ at times $t = \{0, 1, 2\}$. From this sequence, only $\tilde{x}_1$ is random. We consider two cases where $\tilde{x}_1$ is distributed: (1) uniformly, $\tilde{x}_1 \sim U[\overline{x}, \underline{x}]$, and (2) normally, $\tilde{x}_1 \sim \Phi[\mu_x, \sigma_x]$. We assume that a firm undertakes an investment project at $t = 0$ by outlaying I_0 in return for receiving a sure payoff of $f(I_0)$ at time t_2. At time $t = 0$, the firm issues bonds with face value B which is due at time $t = 1$. At time $t = 0$, the firm and bondholders agree on permissible level of asset sales. Thus at $t = 0$, the firm must decide how much cash, c, to hold. At time $t = 1$, the firm has the opportunity to expand by investing I_1 amount in a project which yields $g(I_1)$ at time $t = 2$. For simplicity, as in Acharya et al. (2012), we also assume that the risk-free interest rate is zero and investors are risk-neutral.

3.3.3 The Model

Consider the case of an expansion project in which after repaying debt, residual resources (cash holdings and incoming cash flows) plus full liquidation asset value are not large enough to afford the initial outlay of the project. In an intuitive sense, in the presence of such an expansion project, asset sales are not large enough to simply bifurcate states of nature over a set where investment is paid with asset sales and another set where asset sales prevents default. With expansion, there exists a set of states of nature that despite not defaulting, the firm cannot undertake the investment. To elucidate this situation, we now explore such a case in which there are five possible states of nature the firm can face at $t = 2$. Here we present each state and the payoff outcomes for both equity holders and bond holders.

State 1 $c + \tilde{x}_1 \geq B$ and $c + \tilde{x}_1 - B \geq I_1$

The cash flow received at $t = 1$ in addition to cash holdings is sufficient to to repay debt, as well as undertake the expansion project *without* asset sales. At $t = 1$, equityholders (i.e., the firm) will fully repay the bondholders and invest I_1 to expand. Bondholders will receive the full par value of their claim, B. At $t = 2$, equityholders will receive total cash flows of $f(I_0) + x_2 + A_2 + g(I_1) + c + \tilde{x}_1 - B - I_1$.

State 2 $c + \tilde{x}_1 \geq B$ and $c + \tilde{x}_1 - B < I_1$

The cash flow received at $t = 1$ in addition to cash holdings is sufficient to to repay debt, but not sufficient enough to undertake the expansion project. However, there exists a unique percentage of assets liquidated, η^*, at which the proceeds from a liquidation, $A(\eta^*)$, is equal to the investment shortfall, $I_1 - |c + \tilde{x}_1 - B|$.

At $t = 1$, the firm will fully repay bondholders. But the firms sells η^* percentage of assets to invest I_1 for expansion. Bondholders receive the full par value of their claim, B. At $t = 2$, equityholders receive total cash flows of $(1-\eta^*)\left[f(I_0) + x_2 + A_2\right] + g(I_2)$.[2]

State 3 $c + \tilde{x}_1 \geq B$ and $c + \tilde{x}_1 - B < I_1$

Cash flows received at $t = 1$ in addition to cash holdings are sufficient to repay debt. However, there does not exist any percentage of assets liquidated, η_I, at which the proceeds from asset sales, $A(\eta^*)$, is equal to the shortage needed to invest and expand, $I_1 - |c + \tilde{x}_1 - B|$.

At $t = 1$, the firm fully repays bondholders and forgoes the expansion project. Bondholders will receive the full par value, B. At $t = 2$, equityholders will receive total cash flows of $f(I_0) + x_2 + A_2$.

State 4 $c + \tilde{x}_1 < B$

Cash flows received at $t = 1$ in addition to cash holdings are insufficient to fully repay bondholders. Additionally, there does not exist any percentage assets liquidated, η_*, at which the proceeds from liquidation, $A(\eta^*)$, is enough to undertake the expansion. Even at full liquidation, asset sale proceed are less than what is necessary to invest and expand: $A(\eta = 1) < I_1 - |c + \tilde{x}_1 - B|$. However, there does exist a unique percentage assets liquidated, $\eta^\dagger$, at which the proceeds from a liquidation, $A(\eta^\dagger)$, is

[2]It is noteworthy that η^* is a function of $\tilde{x}_1$ and can be solved for via $A(\eta^*) \equiv A_1(1 - (1-\alpha)\eta^*) = I_1 - |c + \tilde{x}_1 - B|$.

equal to what is needed to fully pay the bondholders, $B - c - \tilde{x}_1$.

At $t = 1$, the firms sells $\eta^\dagger$ percentage of assets in order to fully repay bondholders. Bondholders receive the full par value, B and at $t = 2$, equityholders receive total cash flows of $(1 - \eta^\dagger)\,[f(I_0) + x_2 + A_2]$.[3]

State 5 $c + \tilde{x}_1 < B$

Cash flows received at $t = 1$ in addition to cash holdings are insufficient to repay creditors. Moreover, there does not exist any percentage assets liquidated, $\eta^\dagger$, at which the proceeds from asset sales, $A(\eta^\dagger)$, is equal to what is needed to fully repay the bondholders, $B - c - \tilde{x}_1$.

At $t = 1$, the firm defaults and bondholders take over the firm. Bondholders force full liquidation and receive $c + \tilde{x}_1 + A(\eta = 1)$. Equity holders receive a payoff of zero.

Pricing of Debt and Equity Claims

To price equity and debt claims, we need to find the risk-neutral expected payoff of each claim. We first derive the debt claim value since given the above states, only under state (5) do bondholders receive anything less than the face value, B. The value of debt, D, is given by:

$$\begin{aligned} D &= \int_{B-c-A(\eta=1)}^{\bar{x}} B\,\mathbf{Pr}[\tilde{x}_1 \geq B - c - A(\eta = 1)]\,d\tilde{x}_1 \\ &+ \int_{\underline{x}}^{B-c-A(\eta=1)} [c + \tilde{x}_1 + A(\eta = 1)]\,\mathbf{Pr}[\tilde{x}_1 < B - c - A(\eta = 1)]\,d\tilde{x}_1. \end{aligned} \tag{3.1}$$

Equation 3.1 has two parts: 1) the repayment of the face value conditioned on using both cash holdings and liquidating assets, and 2) receiving cash holdings, the cash flow at $t = 1$, and the asset value at full liquidation upon default. With the assumption that cash flows (or alternativly, cash flow shocks) are uniformly distributed, $\tilde{x}_1 \sim U[\overline{x}, \underline{x}]$, we can rewrite

[3] It is noteworthy that $\eta^\dagger$ is a function of $\tilde{x}_1$ and can be solved for via $A(\eta^\dagger) \equiv A_1(1-(1-\alpha)\eta^{\dagger)} = B-c-\tilde{x}_1$.

equation 3.1 as

$$D = \frac{\bar{x} + c + A(\eta = 1) - B}{\overline{x} - \underline{x}} B + \frac{B - c - A(\eta = 1) - \underline{x}}{\overline{x} - \underline{x}} (c + A(\eta = 1)) + \frac{\frac{1}{2}\left[(B - c - A(\eta = 1))^2 - \underline{x}^2\right]}{\overline{x} - \underline{x}} \tag{3.2}$$

Since with η fractional asset liquidation, the asset value at liquidation is given by $A(\eta)_1 = (1-(1-\alpha)\eta)A_1$ where α is the discount per dollar liquidated, we know that $A(\eta = 1) \equiv \alpha A_1$, and thus we can find the value of debt as

$$D = \frac{\bar{x} + c + \alpha A_1 - B}{\overline{x} - \underline{x}} B + \frac{B - c - \alpha A_1 - \underline{x}}{\overline{x} - \underline{x}} (c + \alpha A_1) + \frac{\frac{1}{2}\left[(B - c - \alpha A_1)^2 - \underline{x}^2\right]}{\overline{x} - \underline{x}} \tag{3.3}$$

or,

$$D = \frac{1}{\overline{x} - \underline{x}} \left[B\overline{x} - (c + \alpha A_1)\underline{x} - \tfrac{1}{2}\left[\underline{x}^2 + (B - c - \alpha A_1)^2\right] \right] \tag{3.4}$$

Because the debt is a discount bond and investors are risk neutral, the corporate yield spread is given by $s = \frac{B}{D} - 1$.

Aggregating the cash flows over each of the five possible states of nature, the value of equity is given by

$$\begin{aligned} E \quad = \quad & \int_{B+I_1-c}^{\bar{x}} \left[f(I_0) + x_2 + A_2 + g(I_1) + c + \tilde{x}_1 - B - I_1\right] \; \mathbf{Pr}[\tilde{x}_1 \geq B + I_1 - c] \; d\tilde{x}_1 \\ + \quad & \int_{B+I_1-c-A(\eta=1)}^{B+I_1-c} \left[(1 - \eta^*) \left[f(I_0) + x_2 + A_2\right] + g(I_2)\right] \; \mathbf{Pr}[B + I_1 - c - A(\eta = 1) \leq \tilde{x}_1 < B + I_1 - c] \; d\tilde{x}_1 \\ + \quad & \int_{B-c}^{B+I_1-c-A(\eta=1)} \left[f(I_0) + x_2 + A_2\right] \; \mathbf{Pr}[B - c \leq \tilde{x}_1 < B + I_1 - c - A(\eta = 1] \; d\tilde{x}_1 \\ + \quad & \int_{B-c-A(\eta=1)}^{B-c} \left[(1 - \eta^\dagger)[f(I_0) + x_2 + A_2]\right] \; \mathbf{Pr}[B - c - A(\eta = 1) \leq \tilde{x}_1 < B - c] \; d\tilde{x}_1. \end{aligned} \tag{3.5}$$

As noted, in state 2, the firm liquidates η^* fraction of assets so as to raise enough funds to undertake the expansion project. This necessitates that $A(\eta^*) = I_1 - |c + \tilde{x}_1 - B|$. Replacing $A(\eta^*)$ with its corresponding functional value, we can show that

$$\eta^* = \frac{1}{1-\alpha}\left[1 - \frac{I_1 + B - c - \tilde{x}_1}{A_1}\right]$$

Similarly, in state 4, the firm liquidates $\eta^\dagger$ fraction of assets so as to raise enough funds to undertake the expansion project. This necessitates that $A(\eta^\dagger) = B - c - \tilde{x}_1$. Replacing $A(\eta^\dagger)$ with its corresponding functional value, we can show that

$$\eta^\dagger = \frac{1}{1-\alpha}[1 - \frac{B - c - \tilde{x}_1}{A_1}]$$

Substituting the above values of η^* and $\eta^\dagger$ as well as the identity $A(\eta = 1) \equiv \alpha A_1$ into equation 3.5, we then have

$$\begin{aligned}
E \;=\; & \int_{B+I_1-c}^{\bar{x}} [f(I_0) + x_2 + A_2 + g(I_1) + c + \tilde{x}_1 - B - I_1]\ \mathbf{Pr}[\tilde{x}_1 \geq B + I_1 - c]\ d\tilde{x}_1 \\
+ & \int_{B+I_1-c-A(\eta=1)}^{B+I_1-c} \left[\left(\frac{I_1 + B - c - \tilde{x}_1 - \alpha A_1}{(1-\alpha)A_1}\right)(f(I_0) + x_2 + A_2) + g(I_2)\right] \times \\
& \qquad \times\ \mathbf{Pr}[B + I_1 - c - \alpha A_1 \leq \tilde{x}_1 < B + I_1 - c]\ d\tilde{x}_1 \\
+ & \int_{B-c}^{B+I_1-c-A(\eta=1)} [f(I_0) + x_2 + A_2]\ \mathbf{Pr}[B - c \leq \tilde{x}_1 < B + I_1 - c - A(\eta^*)]\ d\tilde{x}_1 \\
+ & \int_{B-c-\alpha A_1}^{B-c} \left[\left(\frac{B - c - \tilde{x}_1 - \alpha A_1}{(1-\alpha)A_1}\right)(f(I_0) + x_2 + A_2)\right] \times \\
& \qquad \times\ \mathbf{Pr}[B - c - \alpha A_1 \leq \tilde{x}_1 < B - c]\ d\tilde{x}_1. \qquad (3.6)
\end{aligned}$$

Evaluating the integrals, we then have

$$
\begin{aligned}
E = \frac{1}{\overline{x} - \underline{x}} \quad \times \quad & \Bigg\{ \Big(\bar{x} - B - I_1 - c - \alpha A_1\Big) \Big[f(I_0) + x_2 + A_2 + g(I_1) + c - B - I_1\Big] \\
+ \quad & \tfrac{1}{2}\Big(\bar{x}^2 - (B + I_1 - c)^2\Big) \\
+ \quad & \Bigg[\left(\frac{I_1 + B - c - \alpha A_1}{(1-\alpha)\alpha^{-1}}\right) \Big(f(I_0) + x_2 + A_2\Big) + g(I_2)\Bigg] \\
- \quad & \left(\frac{f(I_0) + x_2 + A_2}{2(1-\alpha)A_1}\right) \Bigg[(B + I_1 - c)^2 - (B + I_1 - c - \alpha A_1)^2\Bigg] \\
+ \quad & \big(I_1 - \alpha A_1\big) \big(f(I_0) + x_2 + A_2\big) \\
+ \quad & \left(\frac{B - c - \alpha A_1}{(1-\alpha)\alpha^{-1}}\right) \Bigg(f(I_0) + x_2 + A_2\Bigg) \\
- \quad & \left(\frac{f(I_0) + x_2 + A_2}{2(1-\alpha)A_1}\right) \Bigg[(B - c)^2 - (B - c - \alpha A_1)^2\Bigg] \Bigg\}.
\end{aligned}
\tag{3.7}
$$

After some algebra, we can show that

$$
\begin{aligned}
E = \frac{1}{\overline{x} - \underline{x}} \quad \times \quad & \Bigg\{ \left(\bar{x} - B + c - \frac{\alpha(1-2\alpha)}{1-\alpha} A_1\right) \Big[f(I_0) + x_2 + A_2\Big] \\
+ \quad & g(I_1)\big(\bar{x} - B - I_1 + c + \alpha A_1\big) \\
+ \quad & \tfrac{1}{2}\Big(\bar{x} - B - I_1 + c\Big)^2 \Bigg\}.
\end{aligned}
\tag{3.8}
$$

Equation 3.8 represents three components. First, the expectation of receiving $f(I_0)$ proceeds from investing I_0, the terminal asset value A_2, and the terminal cash flow, x_2, conditional on the probability that firm does not default. To avoid default, the firm utilizes cash flows, cash holdings, and even partial asset sales. Second, the expectation of receiving $g(I_1)$ proceeds from investing I_1 conditional on the probability that firm does not default and is able to undertake the investment at $t = 1$. And third, the conditional volatility of cash flows in excess of debt repayment and investment outlay in presence of cash holdings.

Optimal Cash Holdings

From equation 3.4, we can show that

$$\frac{\partial D}{\partial c} = \frac{1}{\overline{x} - \underline{x}} \left[-\underline{x} + B - c - \alpha A_1 \right] \tag{3.9}$$

This implies that from the bondholder's perspective, the optimal cash holding, $c^* = B - \alpha A_1 - \underline{x}$, is equal to the par value minus the combined full liquidation asset value and the minimum cash flow. This reflects a desire to fully hedge the business risk that the bondholders are exposed to using the firm's cash holdings. Obviously from equityholders point of view this can be much too excessive since it forces the firm to set aside resources that could otherwise be deployed towards profitable investment projects. Assuming that managers are working to maximize shareholder value, the firm will choose the level of cash holdings that maximizes the value of equity given in equation 3.8.

Proposition 1 *Consider the case of an expansion project whereby even if all resources on hand (both cash and asset sales) are utilized, there would be states of nature in which the firm would not default but still be forced to forgo expansion. Then assuming that profit functions f and g are linear functions of initial investments, that is, $f(I_0) = \beta_0 I_0$ and $g(I_1) = \beta_1 I_1$, the equityholders' optimal cash holding, c^*, is given by*

$$c^* = \frac{1}{2\beta_0 - 1} \left[\beta_0 x_0 + x_2 + A_2 + (\beta_1 - 1) I_1 + (1 - \beta_0)(\overline{x} - B) + \beta_0 \frac{\alpha(1 - 2\alpha)}{1 - \alpha} A_1 \right]. \tag{3.10}$$

Optimal cash holdings, c^*:

- *is an increasing function of cash flows at $t = 0$ and $t = 2$ (i.e., x_0, x_2), asset value at $t = 2$, A_2, the size of the expansion outlay, I_1, the profitability of the expansion project, β_1, and par value of the bond, B; and a decreasing function of the maximum cash flow, $\overline{x}$.*

- *is a increasing (decreasing) function of asset value at time $t = 1$, A_1, when $0 \leq \alpha < \frac{1}{2}$ $\left(\frac{1}{2} \leq \alpha < 1\right)$.*

- *is a increasing (decreasing) function of asset market liquidity* α*, when* $0 \leq \alpha < 1 - \frac{1}{\sqrt{2}}$ $\left(1 - \frac{1}{\sqrt{2}} \leq \alpha < 1\right)$

- *is a decreasing (increasing) function of initial investment's profitability,* β_0*, when* $x_0 + \overline{x} + 2\Big(x_2 + A_2 + (\beta_1 - 1)I_1\Big) > (\leq) B + \dfrac{\alpha(1-2\alpha)}{1-\alpha}A_1$.

Proof. Substituting I_0 for $x_0 - c$, we can then take the derivative of equation 3.8 with respect to cash holdings, c, which yields

$$\frac{\partial E}{\partial c} = \frac{1}{\overline{x} - \underline{x}} \times \left[f(x_0 - c) + x_2 + A_2 + g(I_1) - I_1 + \Big(1 + \frac{\partial I_0}{\partial c}\frac{\partial f}{\partial I_0}\Big)\Big(\overline{x} - B + c\Big) + \frac{\partial I_0}{\partial c}\frac{\partial f}{\partial I_0}\frac{\alpha(1-2\alpha)}{1-\alpha}A_1 \right] \tag{3.11}$$

Substituting $\partial I_0/\partial c = -1$, $\partial f(I_0)/\partial I_0 = \beta_0$, $g(I_1) = \beta_1 I_1$, and, $I_0 = x_0 - c$, we then have

$$\beta_0(x_0 - c) + x_2 + A_2 + (\beta_1 - 1)I_1 + (1 - \beta_0)(\overline{x} - B + c) + \beta_0 \frac{\alpha(1-2\alpha)}{1-\alpha}A_1 \equiv 0$$

It is trivial to show that by re-arranging the above, we arrive at equation 3.10. To arrive at the comparative statics, we take partial derivative of above equation with respect to the appropriate variable. $\partial c/\partial x_0 = \beta_0/(2\beta_0 - 1) > 0$ because $\beta \geq 1$. $\partial c/\partial x_2 = \partial c/\partial A_2 = 1/(2\beta_0 - 1) > 0$. Additionally, $\partial c/\partial I_1 = (\beta_1 - 1)/(2\beta_0 - 1) \geq 0$ and $\partial c/\partial \beta_1 = I_1/(2\beta_0 - 1) > 0$. Moreover, $\partial c/\partial B = -\partial c/\partial \overline{x} = (\beta_0 - 1)/(2\beta_0 - 1) > 0$. We then have:

$$\frac{\partial c}{\partial A_1} = \frac{\beta_0}{2\beta_0 - 1}\,\frac{\alpha(1-2\alpha)}{1-\alpha}$$

The first term is always positive since $\beta_0 \geq 1$. In the second term, the denominator is always positive for $0 \leq \alpha \leq 1$. Since the roots of the numerator in the second term are zero and $\frac{1}{2}$, then we can show that for $0 \leq \alpha < \frac{1}{2}$, the numerator is positive making $\partial c/\partial A_1$ positive. For $\frac{1}{2} \leq \alpha < 1$, $\partial c/\partial A_1$ is then negative.

Having taken the partial derivative of equation 3.10 with respect to α, we have:

$$\frac{\partial c}{\partial \alpha} = \frac{\beta_0}{2\beta_0 - 1}\left[2 - \frac{1}{(1-\alpha)^2}\right]$$

As before, the first term is always positive since $\beta_0 \geq 1$. The second term's roots are $1 \pm \frac{1}{\sqrt{2}}$. Since $0 \leq \alpha < 1$, only $\alpha = 1 - \frac{1}{\sqrt{2}}$ is relevant which then implies that when $0 \leq \alpha < 1 - \frac{1}{\sqrt{2}}$, $\partial c / \partial \alpha$ is positive and negative otherwise.

Taking partial derivative with respect to β_0, we have that:

$$\frac{\partial c}{\partial \beta_0} = \frac{-1}{\left(2\beta_0 - 1\right)^2} \left[x_0 + \overline{x} + 2\Big(x_2 + A_2 + (\beta_1 - 1) I_1 \Big) - B + \frac{\alpha(1 - 2\alpha)}{1 - \alpha} A_1 \right]$$

As long as the second term is positive, $\dfrac{\partial c}{\partial \beta_0} > 0$. ■

Credit Spreads, Optimal Cash Holdings, and Asset Liquidity

By substituting the optimal level of cash holding from equation 3.10 into equation 3.4, we can arrive at a closed-form expression for the bond value. We first compute the optimal level of cash holdings (i.e. the level which maximizes the value of equity) and then determine the credit spread at this optimized level of cash holdings. The closed form expression is rather unwieldy and complex. Therefore, to facilitate the intuition we illustrate the comparative statics of the credit spread, $s = \dfrac{B}{D} - 1$, with respect to firm and asset sale market conditions graphically. We consider a baseline case where $x_0 = 10, x_1 \sim U[20, 10]$, and, $x_2 = 20$. Additionally, $B = 150$, $I_0 = 100$, and, $I_1 = 120$. Moreover, $f(I_0) = \beta_0 \, I_0$, where, $\beta_0 = 1.3$ and $g(I_1) = \beta_1 \, I_1$, where, $\beta_1 = 1.5$. Figures 3.2 to 3.5 illustrate some of the comparative statics of the model. In each, we examine the relationship between asset liquidity and credit spreads for while varying different parameters of the model. In particular we vary the degree of initial leverage (B), the profitability of the project (β_0).

A consistent feature in each figure is a convex relationship between the liquidity of the firm's assets and credit spreads. For low levels of liquidity, an increase in asset liquidity, α, is associated with a lowering of credit spreads. But for higher levels of asset liquidity, the relationship reverses. At high levels of asset liquidity, increasing α results in a widening of credit spreads. This finding is consistent with the argument put forth by Myers and Rajan (1998) in which managers will not sell assets to expropriate wealth from bondholders if they gain little compared to the benefits the gaining from operating the assets. If the costs of transferring wealth from bondholders by way of asset sales is too high (as measured by α), then managers will chose not to do so. Therefore the creditor's claims to the assets are protected from expropriation even when the debt is unsecured. When the cost of asset sales is low (i.e. α is large), selling assets to expropriate wealth from bondholders becomes more attractive. Thus creditors compensate for this possibility ex-ante by increasing the cost of debt and widening credit spreads.

In figure 3.2 we vary the face value of debt, B, to show the effects of leverage on the asset liquidity-credit spread relationship. Because the size of the expansion project is constant, varying the face value of debt is analogous to varying the firm's leverage ratio. Figure 3.2 shows that while this convex relationship exists across a wide range of leverage ratios, it is most apparent among high leverage firms. And it is among these high leverage firms in which the threat and degree of wealth expropriation from bond holders is the highest (Maxwell and Rao, 2003; Maxwell and Stephens, 2003).

[Figure 3.2 about here.]

Figure 3.3 illustrates the asset liquidity-credit spread relationship while varying the profitability of the initial investment opportunity, β_0. In general, credit spreads are increasing with the project's profitability. When the profitability of the firm's investment opportunity is high the firm has an incentive to investment more funds into the project and hold less cash, this leaving less protection for the bondholders. We can see that at lower levels of profitability, the relationship between asset liquidity and credit spreads becomes flatter. This is precisely because these firms with less profitable investments will hold more cash and thus the likelihood and intensity of asset sales will be less. As such, the cost of assets sales will have minimal impact on the bondholder's claims. Conversely for firms with more profitable initial investment opportunities, funds will be diverted away from cash and into the project and as a result the intensity and likelihood of asset sales will be greater. Therefore the firm's creditors must consider the impact the asset sales on their claims and increase the price of debt ex-ante. This results in a large disparity in the credit spreads between low and high profitability firms in the high liquidity regions where wealth expropriating asset sales are likely to take place.

[Figure 3.3 about here.]

Intuitively if the expected cash flows to the firm are higher, the firm will be less likely to default. Therefore credit spreads will be decreasing with the size of expected cash flows. Figure 3.4 illustrates this simple and intuitive relationship by varying the expected size of the uncertain cash flow at time 1, $E[x_1]$. We can see that at all levels of asset liquidity, credit spreads a lower for firms with higher expected cash flow size. But similar to figure 3.3, the disparity in credit spreads between low and high average cash flow firms widens substantially in the high asset liquidity regions. This occurs because firms with low cash flows and high asset liquidity are more likely to undertake asset sales in order to fund future investment opportunities, to the detriment of the bond holders. Additionally, the scale of these asset sales will be larger among the firms with lower expected cash flows since there would be a larger financing gap. Because the likelihood and degree of asset sales will be greater for firms with low expected cash flows, the bond holders will require greater compensation to offset the probable wealth transfers.

[Figure 3.4 about here.]

Figure 3.5 varies the range of the uncertain cash flow at time 1 (i.e. $\overline{x}-\underline{x}$) to demonstrate the impact of cash flow volatility on the asset liquidity-credit spread relationship. When cash flows are more volatile, it is more likely to have a cash shortfall leading to financial distress or default. Consistent with this logic, Minton and Schrand (1999), Molina (2005), and Tang and Yan (2010) each find that credit spreads are generally increasing with the volatility of the firm's cash flows. In our model, however, this relationship only holds partially. In the lower liquidity regions, we do indeed see that firms with more cash flow volatility have higher credit spreads. This pattern flips in the high asset liquidity regions, with firms with more cash flow volatility having smaller credit spreads.

[Figure 3.5 about here.]

3.4 Empirical Analysis

3.4.1 Hypotheses

The following hypotheses are motivated by the comparative statics results illustrated in the previous section as well as results developed in the extant literature.

From the perspective of structural credit risk models (e.g. Merton, 1974; Black and Cox, 1976), the value of assets only serves to determine the probability of default as well as the recovery value given default. When firms may choose to voluntarily sell assets, however, the selling price potentially has an impact on optimal firm behavior.

Myers and Rajan (1998) suggest that when debt is unsecured, greater asset liquidity makes it less costly for managers to sell firm assets, change the risk of the firm, and expropriate value from creditors. Although managers have the ability to sell assets at any level of liquidity, they will choose not to do so when liquidity is low. If the transaction cost incurred while selling the illiquid asset is greater than the benefits the equityholders would receive by simply operating the assets, managers would prefer to forgo asset sales. Therefore, unsecured debt of firms with low asset liquidity will behave similarly to secured debt in the sense that managers are constrained in the ability to expropriate wealth through asset sales. When asset liquidity is high, transaction costs associated with selling assets are reduced, giving managers a greater incentive to transform the firm's asset composition and expropriate wealth from bondholders.

The general non-linear shape of figures 3.2 to 3.5 demonstrates this idea as well. For low levels of asset liquidity, credit spreads are decreasing with liquidity. However for higher level of liquidity, spreads are increasing with asset liquidity.

Hypothesis 1 *There will exist a non-linear relationship between asset liquidity and credit spreads such that for low levels of asset liquidity credit spreads are decreasing with liquidity, and for higher level of liquidity credit spreads are increasing with asset liquidity.*

Figure 3.2 suggests that while the relationship between asset liquidity and credit spreads is somewhat flat at lower levels of leverage, at high leverage a convex relationship becomes apparent. This effect arises because the threat and degree of wealth expropriation is higher among firms with high leverage. Consistent with this idea, Maxwell and Rao (2003) find that following a spin-off announcement bondholders suffer significant losses partially through the loss of coinsurance. If the cash flows generated from a firm's assets are not perfectly correlated, then a sale of assets increases the bondholder's risk and make his claims less valuable. The authors find evidence that the magnitude of these bondholder losses is amplified as the firms become more highly levered and these losses are transferred to equityholders. Thus as assets become more easily sold, bondholders of high leverage firms will be more exposed to potential losses and thus require additional compensation for this risk.

Hypothesis 2 *The relationship between asset liquidity and credit spreads will be stronger among high leverage firms*

The comparative statics analysis of the model suggests that firms with large growth opportunities will exhibit a stronger relationship between real asset liquidity and credit spreads. Equation 3.3 shows that when the profitability of the expansion project is low, the relationship between asset liquidity and credit spreads is relatively flat. When the expansion project becomes more profitable, however, a U-shaped pattern becomes apparent.

The literature has shown that asset sales are related to investment opportunities (e.g. Bates, 2005; Borisova and Brown, 2013). Bates (2005) shows that firms are more likely to retain the proceeds from an asset sale rather than make payoffs to claimholders when they have large growth opportunities. Firms with better growth opportunities will be more likely to sell off their assets to fund investments. If the proceeds generated from selling existing assets are used to fund more risky investment opportunities, then there will be a transfer of wealth from debtholders to equityholders.

For firms with less profitable growth opportunities, selling assets to finance investment may not be worthwhile at any level of liquidity due to the costs associated with asset sales. The additional cash flows generated from the expansion are not sufficiently large enough to greatly outweigh the costs of asset sales. Therefore, creditors' payoffs are unaffected by the presence of growth opportunities. For more profitable projects, asset sales become more feasible to finance investment. But the costs of asset sales are so high at low levels of liquidity that the firm will choose not to expand, leaving bondholder payoffs unaffected. At higher levels of liquidity the firm may choose to sell assets to expand and, as a result, creditors become more exposed to potential losses. Creditors will demand compensation for this risk ex-ante in the form of wider credit spreads.

Hypothesis 3 *The relationship between asset liquidity and credit spreads with be stronger among firms with larger growth opportunities.*

When the debt is secured, the firm's creditors do not face the threat of asset substitution. Because their claims are explicitly backed by the assets of the firm, wealth transfers from debtholders to equityholders by way of asset sales are prohibited. Because the agency problems related to asset sales are contractually restricted for secured debt, holders of this debt should only consider their expected loss given default when valuing their claims. In default, secured bondholders will be able to seize the firm's assets when they default on their obligations. Since the value of the firm's assets in default is partially determined by the ability to locate a willing and able buyer, the liquidity of the assets effects the bondholder's recovery value in default. Firms with higher asset liquidity will have higher recovery values and thus require a lower yield on their investment.

Hypothesis 4 *For secured debt and debt with covenants restricting asset sales, credit spreads will be negatively related to real asset liquidity*

Myers and Rajan (1998) and Morellec (2001) suggest that there is a negative relationship between the liquidity of a firm's assets and their credit spread when the debtholders claims are secured. This results because the higher the liquidity of the firm's real assets, the higher the market price during liquidation. Thus for firms with liquid real assets, in the event of default the recovery value to creditors will be greater. Morellec (2001) shows that when debt is unsecured, high asset liquidity allows the firm to use asset sales to increase the operating flexibility of the firm to the detriment of the firm's creditors. This results in a widening of spreads.

Acharya et al. (2012) demonstrate that there is a negative relationship between cash holdings and credit spreads.[4] This arises due to the certainty effect of cash. With more cash on the balance sheet, the firm becomes more able to service its debt and as a result the probability of default as well as credit spreads decrease.

Finally, in the first essay of this dissertation I document a negative empirical relationship between cash holdings and asset liquidity. These three facts suggest that that an endogenous relationship exists between these three items: cash, asset liquidity, and credit spreads. The main issue is summarized graphically in figure 3.6.

[Figure 3.6 about here.]

All else equal, a firm with a high degree of liquid real assets will have larger credit spreads. However, it is not the case that all else is equal. Firms with liquid real assets tend to hold less cash and the impact of lower cash holdings is an increase in credit spreads. If highly liquid assets are accompanied by large cash balances, the credit spread increasing impact of asset liquidity will be diminished.

Hypothesis 5 *The positive relationship between asset liquidity and credit spreads is reduced with higher cash holdings.*

3.4.2 Data

In this section, I briefly describe the data sources and variable construction. Firm-level accounting and stock price information are gathered from COMPUSTAT and CRSP for the 1996-2013 time period. All accounting data from COMPUSTAT is winsorized at the 1% and 99% level to control for potential outliers and reporting errors. Merger and acquisition data is obtained from Thompson Reuters SDC Platinum. We exclude financial firms (SIC codes 6000 - 6999).

Bond Data

Daily corporate bond yields for the period of 1994 to 2005 are obtained from transaction prices reported in the Mergent Fixed Income Securities Database (FISD). FISD reports

[4] Using basic OLS regressions they actually find a positive relationship, but after addressing the endogenous relation between credit risk and the choice of cash holdings with instrumental variables and identifying the effect 'pure' cash holdings on credit spreads, they observe a negative relationship.

transaction data from the National Association of Insurance Commissioners (NAIC), and therefore only trades conducted by insurance companies are included. While insurance companies are the most prominent investors in corporate bonds (Campbell and Taksler, 2003), I supplement the FISD data with transactions reported to the Trade Reporting and Compliance Engine (TRACE) provided by FINRA.[5] Introduced in 2002, TRACE reports tick-by-tick transaction data for all US corporate bonds and as of 2005 approximately 99% of all public bond transactions are reported.

I delete erroneous bond prices by removing transactions conducted at prices greater than $220 (per $100 par) and less than $25 (per $100 par).[6] Additionally, I implement the algorithm of Dick-Nielsen (2009) to filter reporting errors (i.e canceled trades, corrections, reversals, etc.). Additionally, I remove bonds with less than one year and greater than 30 years until maturity. Finally, following the methodology of Bessembinder et al. (2009), I eliminate trades of less than $100,000 and convert intra-day yields into daily yields using a trade-size weighted average. The resulting combination of FISD and TRACE transactions results in a total of 3,397,682 daily transactions. I take the average of the daily yields within the month to obtain monthly bond yields. To ensure homogeneity among the bonds in the sample I exclude all bonds with option-like features (convertibles, putable, callable, and floating rate bonds), non US firms, and bonds denominated in foreign currencies. After merging with COMPUSTAT and FISD bond characteristic data and covenant information, I am left with 34,041 firm-month bond yields.[7] I consider a bond to be secured if the issue contains an 'SS' flag in FISD. Similarly, I consider a firm to have covenants restricting or limiting asset sales if the "Sale Assets" flag takes on a value of yes.[8]

I compute the credit spread, $CSPRD$ as the difference between the corporate bond

[5]Insurance companies hold about 25% of corporate bonds in the US market from 2004 to 2012.See:`http://www.naic.org/capital_markets_archive/140307.htm`

[6]Asquith et al. (2013) considers $220 the maximum price for a risk-free bond and thus prices greater must be errors in reporting. Similarly, Ederington et al. (2012) consider prices of less than $25 to either be errors or defaulted bonds.

[7]Firm-month observations with an S&P credit rating of D or with a credit spread greater than 40% are also deleted. This filter removes 215 observations (158 removed due to credit rating, 57 removed due to credit spread).

[8]Surprisingly, very few bond issues contained in FISD report either bonds as secured or containing asset sale covenants. On 1489 observations explicitly contain restrictions on asset sales, 10,543 explicitly report no covenants, and 22,009 report no information for asset sale covenants. Similarly, only 599 observations in the sample are classified as secured.

yield and its matching maturity Treasury bond yield.

$$CSPRD_{i,t} = Yield_{i,t} - TYield_{i,t} \tag{3.12}$$

Matched maturity Treasury yields are constructed by interpolation as in Collin-Dufresne et al. (2001). Using Treasury Constant Maturity rates from the St. Louis Federal Reserve Bank's Federal Reserve Economic Data (FRED) for maturities of 1, 2, 3, 5, 7, 10, 20, and 30 years, I use a linear interpolation scheme to estimate the yield between the Treasury dates in order to get a matching time to maturity for each bond in the sample.

Asset Liquidity

As a measure of real asset liquidity, I use an industry based index of asset turnover (Schlingemann et al., 2002; Sibilkov, 2009; Ortiz-Molina and Phillips, 2014). The index is motivated by the notion that firm assets tend to be industry specific as shown in both the theoretical and empirical literature (Shleifer and Vishny, 1992; Ramey and Shapiro, 2001; Benmelech and Bergman, 2009). The index is constructed as follows. From Thomson Reuters SDC Platinum, I identify 20,362 corporate transactions completed between 1982 and 2011 in which the form of the deal is classified as either an acquisition of assets or an acquisition of certain assets. I require that the value of the deal is disclosed and that the target is either a publicly traded firm or a subsidiary. Each transaction is assigned to the target firm's industry as defined by its 2 digit SIC code. The asset liquidity index is then computed as the ratio of the sum of industry transactions within the year to the total industry book value of assets (each converted to 1984 dollars). Industries which had no corporate transactions within a year receive an index value of 0 for that year. Because the liquidity of the industry should not solely depend on the number of transactions in the one single period, I use a five-year moving average of the index as the proxy for industry-wide asset liquidity. This procedure results in 1,663 industry-year values for the index. All firms within the same industry will each have identical values for the liquidity index each year.

Control Variables

Structural models of corporate debt (Merton (1974), Black and Cox (1976), among others) show that yield spreads should reflect the bondholder's expected loss given default. That is, credit spreads should be function of the probability of default and the expected recovery rate. While many papers in the literature use structural estimation to generate quantitative estimates from these models, others (e.g. Collin-Dufresne et al., 2001; Chen et al., 2007; Güntay and Hackbarth, 2010; Acharya et al., 2012; Nejadmalayeri et al., 2013) translate the theoretical determinants of credit spreads into their empirical counterparts and estimate reduced-form linear regression models. Following this literature, I use a set of variables to control for a number of firm specific characteristics, macroeconomic conditions, and bond level features which have been shown to be related to credit risk.

At the firm level and bond level, I include controls for:

Size: Ln(Total Assets)

Leverage: Computed as the book value of debt divided by the sum of the book value of debt and the market value of equity.

Asset Volatility: Computed using the iterated process of Bharath and Shumway (2008) who use the Merton (1974) model to infer the market value of assets each day. Asset volatility is then the standard deviation of implied daily asset returns over each year.

Distance to Default: Computed as $d2$ from the Merton (1974) model using the iterative procedure of Bharath and Shumway (2008).

Credit Rating: S&P Long-Term Issuer Rating from COMPUSTAT. As in Collin-Dufresne et al. (2001), I translate the S&P letter ratings into numeric ratings from 1-23 such that AAA=1, AA+=2, ... CCC+=17, ... D=23.

Time to Maturity: The number of years to maturity for the firm's bonds. If a firm has more than one debt issue outstanding, time to maturity equals the average time to maturity of all outstanding bonds. Obtained from FISD.

To control for macroeconomic conditions, I include:

Risk-free interest rate: 10 year constant-maturity Treasury rate obtained for the Federal Reserve Bank of St. Louis (FRED).

Slope of Term Structure: Difference between the 10 and 2 year constant maturity Treasury yields. Interest rates obtained from FRED.

Level of the VIX Index: Monthly level of the implied market level volatility obtained from the Chicago Board Options Exchange (CBOE).

S&P 500 index monthly return: Obtained from CRSP.

Summary Statistics

Table 3.1 provides summary statistics for the main variables of interest as well as the control variables. The mean credit spread over the sample period is 2.32% and a median of 1.34%. These values are consistent with credit spreads observed in other studies (e.g. Güntay and Hackbarth, 2010; Acharya et al., 2012).

[Table 3.1 about here.]

Table 3.2 presents the S&P credit rating distribution of the bonds in the sample. A majority of the bonds in the sample have a credit rating of either A (A+, A, or A-) or BBB (BBB+, BBB, BBB-). 33% and 39% of the bonds have either an A rating or BBB rating, respectively. Very few bonds (2%) have a rating in the AAA range. Consistent with intuition, as credit ratings decline the credit spread increases. The average time to maturity for the bonds in the sample is 8.25 years.

[Table 3.2 about here.]

The asset liquidity index has an average value of 0.009 over the sample period. This means that on average, each industry in the economy (as defined by two digit SIC code) sells off about 0.90% of its assets each year. The value for the index ranges from 0% to 21.3% indicating that there may be substantial heterogeneity in the index across both industry and time.

[Table 3.3 about here.]

Table 3.3 illustrates the persistence of the asset liquidity index over time. Each year, I segment the asset liquidity index into quartiles, placing the lowest liquidity industries into quartile 1 and the highest liquidity industries into quartile 4. Table 3.3 shows that while there is substantial correlation between contemporaneous asset liquidity and past liquidity, the correlation diminishes over time. This result is not surprising both from an economic as well as a methodological perspective. By construction, the asset liquidity index is smoothed using a five year moving average to limit the effect of extraordinary industry-years in which a few large asset sale transactions which may portray an industry's assets to be more liquid than they actually are. This moving average correction naturally introduces a level of auto-correlation into the index. From an economic point of view, we would expect liquidity to be a characteristic which is relatively slow changing. Mitchell and Mulherin (1996) find that acquisition activity is higher in deregulated and low-tech industries with low research and development activity and low growth options. However, as shown by Andrade et al. (2001) restructuring activity often occurs in industry waves. These facts account for the relatively strong, but diminishing auto-correlation shown in the asset liquidity index.

Table 3.4 presents the correlations of the main variables of interest and the control variables used in this study. Surprisingly, asset liquidity displays very little unconditional correlation with credit spreads or any of the control variables

[Table 3.4 about here.]

Univariate Analysis

To gain insight into the relationship between real asset liquidity and credit spreads, I sort firms each year into quartiles based on their asset liquidity index value. Firms with low asset liquidity are placed into group 1 and firms with high asset liquidity are placed into group 4.

[Table 3.5 about here.]

Table 3.5 presents the credit spread statistics for each of these liquidity groups. Panel A considers bonds over the entire sample period (1996 - 2013). We can see that firms in the low liquidity group on average have smaller credit spreads than firms with high liquidity. For the full sample the difference in means between the high and low liquidity groups is a relatively small 7 basis points. However, the difference is statistically significant at the 10% level. Additionally, consistent with the theoretical predictions, a non-linear relationship between credit spreads and asset liquidity is apparent. This non-linear relationship is especially apparent in the time period prior to the Financial Crisis.[9] While mean credit spreads are high for low liquidity firms, they decrease in the middle range of asset liquidity, finally rising again in the upper quartile. As expected, credit spreads are substantially higher in the post-crisis period. The patterns observed in the full sample as well as the pre-crisis period break down in the post-crisis period. After 2008, we see that credit spreads for low liquidity firms are higher than for high liquidity firms (3.34% versus 3.12%). Yet, the non-linearity of credit spreads across liquidity groups continues to persist.

3.4.3 Results

Following recent literature I estimate a reduced-form model of credit spreads taking into account the firm and macroeconomic characteristics which have been shown to be the main determinants of credit risk (e.g. Collin-Dufresne et al., 2001; Acharya et al., 2012, among others).

The baseline specification is estimated as:

$$CSPRD_{i,t} = \alpha + \beta_1 AssetLiq_{i,t} + \Phi \mathbf{X}_{i,t} + \varepsilon_{i,t} \tag{3.13}$$

where $CSPRD_{i,t}$ is the credit spread on a bond issue of firm i at month t and $AssetLiq_{i,t}$ is the Industry Asset Liquidity Index as described previously. $\mathbf{X}_{i,t}$ is a vector of control variables motivated by structural credit risk models. Specifically, $\mathbf{X}_{i,t}$ contains monthly observations of size, leverage, asset volatility, distance to default, credit rating, the risk free

[9] Observations prior to 2008 are designated as pre-crisis. Observations from 2008 - 2013 are designated as post-crisis.

rate, the slope of the term structure, the level of the VIX, and the S&P 500 return. The each model in the baseline specification is estimated using pooled OLS regressions with standard errors corrected for clustering at the firm level.

Asset Liquidity and Credit Spreads

Table 3.6 reports estimation results from the baseline credit spread regression model in equation 3.13. In model (1), the coefficient on asset liquidity is positive and significant. This indicates that firms that possess assets that are highly marketable tend to have higher credit spreads. To identify potential non-linearity in the relationship between asset liquidity and credit spreads, I introduce a quadratic term into the regression model: $Asset\ Liquidity^2 = Asset\ Liquidity \times Asset\ Liquidity$.

[Table 3.6 about here.]

Consistent with hypothesis 1, the coefficient on the squared asset liquidity variable is positive, indicating that the shape of the relationship is convex. For lower values of asset liquidity, credit spreads are decreasing, and for higher values credit spreads are increasing. This result is similar to that of Sibilkov (2009) who finds non-linearity in the relationship between firm leverage and asset liquidity. When asset liquidity is low, it is too costly for managers to engage in asset sales that could be detrimental to bondholders. This notion is reflected both in the cost of debt as well as the degree of firm leverage.

Models (3) - (6) segment the sample period into the pre-Financial Crisis years (before 2008) and the post-Financial crisis period (2008 and beyond). Models (3) and (4) indicate that the positive relationship between credit spreads and asset liquidity holds regardless of the time period. The non-linearity, however, is present primarily in the post-Financial Crisis period.

To get an indication of the form of the non-linearity in the relationship between bond spreads and asset liquidity, I design a piecewise linear regression with breakpoints corresponding to low, medium, and high asset liquidity. This methodology is used in Yu (2005) to investigate non-linearities in corporate bond term structures and by Das and Hanouna

(2009) to control for non-linear effects of the interest coverage ratio on CDS spreads. To implement this model, I compute percentile breakpoints for the asset liquidity index each year and assign firms to their corresponding liquidity group. These breakpoints serve as knots which allow us to examine the slope of the regression function over a particular range of values.

Table 3.7 presents the function imposed to capture the non-linearity in the credit spread-asset liquidity relationship.

[Table 3.7 about here.]

Specifically, for firms that have low asset liquidity (those with index values between 0 and the 15th percentile of that year) take on a values of the index value, 0, 0, and 0 for the variables Z_1, Z_2, Z_3, and Z_4, respectively. Similarly, firms in the highest liquidity group (with index values ranging from the 85th and 100th percentile of that year) take on values equal to the 15th percentile, 15th percentile, 50th percentile, and the index value minus the 85th percentile for Z_1, Z_2, Z_3, and Z_4, respectively. I augment the regression model in 3.13 to include these terms. I estimate using pooled OLS the following.

$$CSPRD_{i,t} = \alpha + \beta_1 AssetLiq_{i,t} + \beta_2 Z_1 + \beta_3 Z_2 + \beta_4 Z_3 + \beta_1 Z_4 + \Phi \mathbf{X}_{i,t} + \varepsilon_{i,t} \qquad (3.14)$$

Table 3.8 presents regression estimates of equation 3.14.

[Table 3.8 about here.]

Model (1) presents estimates on the model over the full sample period. The coefficient on Z_1 is negative and statistically significant. This finding suggests that for firms with low asset liquidity (in the range of 0 to the 15th percentile) will experience decreasing credit spreads as asset liquidity increases. This, again, is consistent with convex relationships between credit spreads and liquidity depicted in figures 3.2 to 3.5. This result holds in the pre-Financial Crisis period, but the relationship reverses post-2007. The coefficient on Z_1 becomes positive, suggesting a concave relationship between spreads and liquidity among low liquidity firms. That is as liquidity increases within this range, credit spreads increase as well. This finding could a result of increased asset sales that were undertaken by firms in distress during the financial crisis period. Firms which possess assets with low liquidity will usually choose not to use asset sales during normal times as they fetch prices lower than their true values. However during the financial crisis period all firms increased their level of assets sales (Campello et al., 2010). If these asset sales conducted by low asset liquidity firms during the crisis were conducted for reasons of distress, we would observe this concave relationship.

The Effects of Leverage

Bondholders of high leverage firms are more exposed to agency problems than creditors of less levered firms. The potential for asset sales magnifies this agency problem as it becomes more feasible for managers to engage in asset substitution and expropriate wealth from bondholders. To test this hypothesis, I segment the firms into categories based on leverage ($\frac{book\ value\ of\ debt}{book\ value\ of\ debt+market\ value\ of\ equity}$). Each year I rank firms into three leverage groups with the lowest 33% going to low leverage and the to 33% going to high leverage.

[Table 3.9 about here.]

Consistent with hypothesis 2, table 3.9 shows that asset liquidity is positively related to credit spreads only among firms with high leverage. In models (1) and (2), we see got low leverage firms, asset liquidity has no association with credit spreads. As the the bondholders of these firms are not as exposed to the risks of wealth transfers due to asset sales, creditors will not demand as much of a premium for their investment. Conversely, among high leverage firms, the positive relationship between real asset liquidity and credit risk continues to persist.

The Effects of Growth Opportunities

Hypothesis 3 suggests that the impact of asset liquidity on credit spreads should be stronger among firms with larger growth opportunities. The rationale is that selling assets to finance investment may not be worthwhile when the gains to investment are minimal. Especially for firms with low levels of asset liquidity, the costs associated with asset sales outweigh the benefits from investment. When profitable growth opportunities are prevalent, asset sales become more feasible particularly for those firms that can liquidate assets are relatively low costs. The increased possibility of asset sales increases the risk of bondholder payoffs and, as a result, the value of debt will fall (credit spreads will rise).

[Table 3.10 about here.]

To test this hypothesis, I subset the sample according to the size of each firm's growth opportunities. I measure a firm's growth opportunities with an industry level proxy. Specifically, a firm's growth options is defined as the median ratio of intangible assets to total assets in the firm's industry each year. Each year, firms are ranked on this measure of growth opportunities and placed into three groups. The highest 33% of firms are classified as having high growth opportunities and the lowest 33% are classified as having low growth opportunities.

3.10 presents regression results on this segmented sample. Model (1) shows that for firms with low growth opportunities there is a negative relationship between asset liquidity in credit spreads. This is consistent with the notion that firms with low growth opportunities will choose not to sell assets in order to finance investment. In this case, the assets within the firm will remain in place and thus increased liquidity increases the recovery value to bondholders rather than increase the probability of wealth transfers due to asset sales. Consistent with hypothesis 3, model (3) indicates that for firms with high growth opportunities, increased asset liquidity results in higher credit spreads.

The curvilinear relationship displayed previously exhibits puzzling properties when focusing on growth options. While there exists a U-shaped pattern in the credit spread-asset liquidity relationship over the full sample, the negative coefficient on the quadratic terms in models (2) and (4) suggests that an inverted U-shape exists when the sample is segmented by growth options.

The Role of Debt Covenants

Debt covenants are put into bond contracts in order to protect bondholders from firm behaviors that could be harmful to debt claims. One such protective covenant is a restriction on asset sales. While some covenants outright prohibit asset sales, others simply place restrictions on the usage of the asset sale proceeds, often requiring the proceeds be used to repay debt. These restrictions explicitly makes bondholders' debt claims safer and in turn should result in lower credit spreads (Morellec, 2001; Myers and Rajan, 1998). When asset sales are prohibited, the real assets of the firm serve as collateral no matter how liquid the assets are. In fact, increased asset liquidity should increase the recovery rate to creditors in the event of default, again making debt safer. Therefore hypothesis 4 predicts that among secured bonds or bonds with asset sale restrictions, the will be a negative association between credit spreads and asset liquidity.

I test this hypothesis in two ways. First, I create an indicator variable, *Covenant* that takes on a value of 1 if the firm's debt has covenants restricting asset sales and 0 otherwise. I do the same regarding secured debt. I create an indicator variable *Secured* that has a value equal to 1 is the firm's debt is listed as secured, and 0 otherwise. Table 3.11shows the impact of protective covenants on the relationship between asset liquidity and credit spreads.

[Table 3.11 about here.]

Panel A uses a continuous measure of the asset liquidity index in the regression model. Model (1) of table 3.11 shows that asset sale covenants do indeed make corporate debt safer by restricting the behavior of the firm. While credit spreads are increasing with asset liquidity, the inclusion of an asset sale clause is associated with smaller credit spreads. In model (2) I introduce an interaction variable, *Asset Liquidity* $\times$ *Covenant*, in order to demonstrate the effect. The results from model (2) suggest that the presence of asset sale restrictions mitigate the risk that bondholders face when firms possess liquid real assets. The negative coefficient on the interaction term indicates that when there are asset sale covenants in place, increasing asset liquidity works to reduce credit spreads. Also interesting, the coefficient on *Covenant* loses significance after the inclusion of the interaction term. This suggests that the existence of asset sale covenants do not, by themselves, reduce credit spreads. It is only when the firm has sufficiently salable assets that the covenant demonstrates its value.

Models (3) and (4) present similar analysis with secured debt. Intuitively, secured debt should have narrower credit spreads than unsecured debt. Because secured debt claims are tied directly to the firm's assets, they have priority in the event of default and thus have great recovery values. Consistent with this logic, the coefficient on *Secured* is negative and statically significant. Securing bonds results in smaller credit spreads. Unlike the case for asset sale covenants, however, the interaction term, *Asset Liquidity* $\times$ *Secured*, shows no significant association with credit spreads.

Panel B focuses just on firms classified as highly liquid (i.e. firms in the 25% of the asset liquidity index in a given year). After controlling for the existence of asset sale covenants or secured debt, the positive relationship seen previously between asset liquidity and credit spreads diminishes. For secured debt the coefficient on the interaction term *Asset Liquidity* $\times$ *Secured* is negative and significant. This suggests that when debt claims are secured, possessing liquid real assets reduces the risk that these bondholders are exposed to. In the event of default, these secured creditors will recover a larger fraction of the claim if the firm's assets are highly liquid.

It is necessary to view these results with a bit a skepticism because very few bond issues contained in FISD report either bonds as secured or as containing asset sale covenants. Only 1489 observations (4.4% of the sample) explicitly contain restrictions on asset sales, 10,543 (31% of the sample) explicitly report no covenants, and 22,009 (64.6% of the sample) report no information for asset sale covenants. Similarly, only 599 observations (1.8% of the sample) in the sample are classified as secured. Therefore the results in this section may be influenced by the fact that there are very few firms in the sample which issue bonds that have features which explicitly protect bondholders from the risks associated with asset liquidity.

The Intermediating Effects of Cash

Hypothesis 5 suggests that cash holdings play an intermediating role in the connection between corporate credit spreads and real asset liquidity. To examine this effect I introduce an interaction term, $AssetLiq_{i,t} \times Cash_{i,t}$ into the model, where $Cash$ is the ratio of cash and short-term investments to total assets. Specifically, I estimate equation 3.15.

$$CSPRD_{i,t} = \alpha + \beta_1 AssetLiq_{i,t} + \beta_2 Cash_{i,t} + \beta_3 AssetLiq_{i,t} \times Cash_{i,t} + \Phi \mathbf{X}_{i,t} + \varepsilon_{i,t} \quad (3.15)$$

Coefficient estimates from equation 3.15 are presented in table 3.12. Models (1) and (2) are estimated using OLS. In both models indicate that after introducing the effects of cash, a positive relationship remains between asset liquidity and credit spreads. The positive coefficient on the interaction term $AssetLiq_{i,t} \times Cash_{i,t}$ suggests that higher cash balances amplify the credit risk effects of asset liquidity. That is at higher levels of cash holdings, the positive effects of asset liquidity on credit spreads become stronger. This result is at odds with intuition.

Additionally, the positive coefficient on cash found in models (1) and (2) is counterintuitive. Common economic intuition suggests that larger cash reserves should make a firm's corporate debt safer and decrease its probability of default and thus lower its spreads. As shown in equation 3.9, the optimal level of cash from the bondholder's perspective reflects the desire to completely hedge the firm's business risk. A positive relationship between cash and credit spreads suggests, however, that holding more cash increases the risks that bondholders are exposed to. Acharya et al. (2012) argue that the an endogenous connection cash holdings to credit spreads drives the puzzling positive correlation observed in OLS regressions. Riskier firms naturally hold larger cash balances simply because they are exposed to more risks.

The authors utilize an instrumental variables approach to remove the confounding effects of endogeniety in the relationship between cash and credit spreads isolate the effects of cash which are unrelated to credit. The instruments are selected so as to affect the level of cash holdings, and at the same time have no impact on payoffs to debtholders. To ensure that I examine the 'pure' effect of cash holdings on the asset liquidity-credit spreads relationship in my analysis, I employ the instrumental variables approach of Acharya et al. (2012).

Acharya et al. (2012) determine that a firm's growth options and managerial agency costs are appropriate instruments for cash. I proxy for growth options using the median ratio of intangible assets to total assets in the firm's industry each year ($GrowthOps_{i,t}$). Managerial agency is measured as the ratio of the CEO's cash compensation to the market value of his shares and options ($Agency_{i,t}$).[10]

[Table 3.12 about here.]

Models (3) - (5) of table 3.12 are estimated using this instrumental variable regression approach. Model (5) includes the interaction term $AssetLiq_{i,t} \times Cash_{i,t}$, which itself is an endogenous variable. Balli and Srensen (2013) show that in the case where a variable, X_2 is endogenous, X_1 is exogenous, and Z is a valid instrument for the endogenous variable X_2, then the interaction $X_1 Z$ will be a valid instrument for the interaction $X_1 X_2$. Therefore, I include interactions with the instruments ($AssetLiq_{i,t} \times GrowthOps_{i,t}$ and $AssetLiq_{i,t} \times Agency_{i,t}$) to serve as an instruments for $AssetLiq_{i,t} \times Cash_{i,t}$.

Model (3) confirms the result of Acharya et al. (2012). After controlling for the endogenous nature of cash and credit risk, credit spreads are decreasing with cash. Including asset liquidity into model (4) we see that the positive cash and credit spreads remain positively related. Model (5) introduces the interaction variable $AssetLiq_{i,t} \times Cash_{i,t}$. While the sign on the interaction coefficient is negative, it lacks any meaningful statistical significance. This may be, however due to the non-linearity in the relationship between bond spreads and asset liquidity. As illustrated previously, the relationship between credit spreads and asset liquidity is convex. That is, spreads are decreasing with asset liquidity in the low liquidity ranges and increasing in high liquidity ranges. Therefore, we would not expect to see any ameliorating effects of cash holdings on the relationship among firms with low asset liquidity. It is the firms with high asset liquidity which pose the greatest threat to the claims of bondholders. High cash balances will work to partially alleviate this threat.

[10] Managerial agency is computed using ExecuComp and is defined as (salary + bonus + other annual compensation + long-term incentive plan + all other compensation) / (value of the CEO's equity stake + value of all unexercised options owned.

To test if there are differential impacts at the two extreme ends of the asset liquidity index, I classify firms as high and low liquidity according to the non-linear regression scheme in table 3.7. Specifically, I define High Asset Liquidity as an indicator variable which takes on a value of 1 if the firm is ranked in the top 15th percentile and 0 otherwise. Similarly, I define Low Asset Liquidity as an indicator variable that takes on a value of 1 if the firm is ranked in the bottom 15th percentile and 0 otherwise.

[Table 3.13 about here.]

Indeed as shown in table 3.13, the intermediating effect of cash holdings for high asset liquidity firms is quite apparent. Model (1) shows that while firms with high asset liquidity tend to have larger credit spreads, increasing cash balances works to diminish the magnitude of the impact. Conversely for firms with low real asset liquidity, the interaction term in Model (2) is statistically insignificant. This consistent with the notion that the likelihood that the firm with low liquidity would choose to sell its assets. Firms with low asset liquidity would receive low prices in asset sales and thus they are unlikely to exhibit such behavior. Therefore, the mitigating impact of cash holdings on firms with low real asset liquidity is negligible.

3.5 Conclusion

Motivated by recent ideas that asset sales can indeed as means for raising capital, we extend the Acharya et al. (2012) model and show that the market liquidity for a firms real assets affects credit spreads non-linearly in a U-shaped manner. The intuition is as follows: a firm will partially liquidate assets so long as the liquidation can prevent default and safeguard future lucrative payoffs. Such a firm essentially may trade-off having larger cash holdings upfront in favor of asset liquidation when the market liquidity for asset sales is high enough. However, as market liquidity dissipates, so does the cost of making such a trade-off. The firm would at some point find it more beneficial to hold large cash at hand and consider asset liquidation infeasible. Comparative statics analysis demonstrates that as the firm's leverage and growth options increase, so does the aforementioned non-linearity of the relationship between real asset liquidity and credit spreads. We empirically test our predication and find that indeed the link between credit spreads and real asset liquidity is U-shaped. Moreover, highly levered firms and firms with growth option face much more pronounced non-linearity.

Our empirical analysis confirm some of these findings. Using an industry-based measure of real asset liquidity, we show that a convex relationship exists between credit spreads and asset liquidity such that at low (high) levels of liquidity credit spreads are decreasing (increasing) with real asset liquidity. This is consistent with the notion that at low levels of liquidity financing with asset sales is not a reasonable choice. Therefore increasing asset liquidity in a sufficiently low range of liquidity raises creditors' expected recovery value without increasing the threat of wealth expropriation. At higher ranges of liquidity, the threat of wealth expropriation through asset sales is possible and therefore credit spreads are increasing with real asset liquidity. Additionally, this effect is isolated among high leverage firms in which wealth expropriation effects to creditors is the greatest. Finally within firms with high asset liquidity, the presence of large cash balances works to offset increases in credit spreads that are due to the increased ability to sell assets.

Figure 3.1: Asset Selling Price Function

This figure shows illustrates the selling price of assets which is determined by both the liquidity of the asset sale market and the quantity of assets sold.

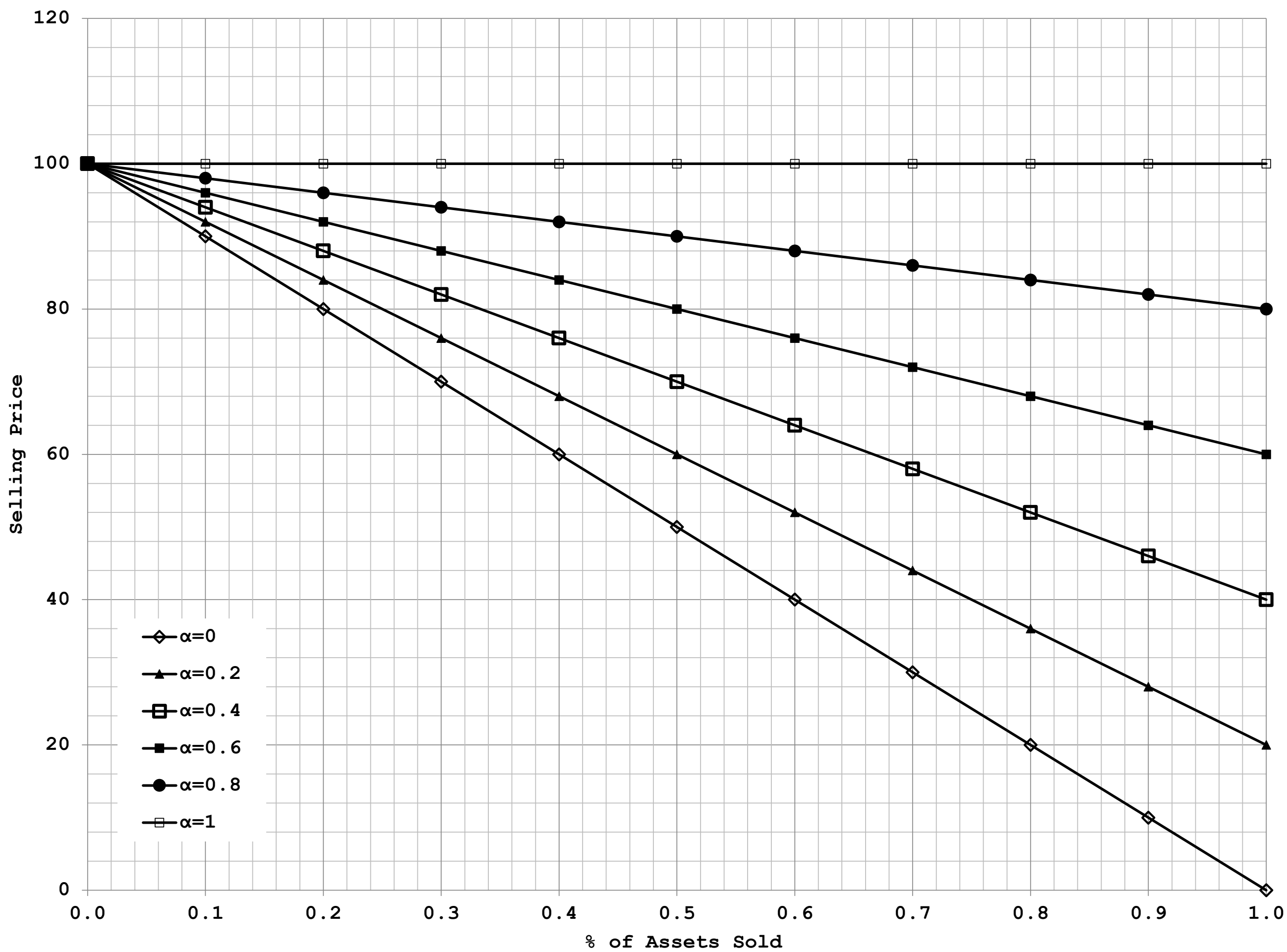


Figure 3.2: Credit Spread vs. Asset Market Liquidity: Leverage

This figure illustrates how credit spreads changes with asset market liquidity α for various leverage ratios. The face value of debt, B, denotes the leverage ratio since the expansion project size is kept constant. The parameter settings are as follows: $x_0 = 10, x_1 \sim U[20, 10]$, and, $x_2 = 20$. Additionally, $I_0 = 100$, and, $I_1 = 150$. Moreover, $f(I_0) = \beta_0 I_0$, where, $\beta_0 = 1.3$ and $g(I_1) = \beta_1 I_1$, where, $\beta_1 = 1.4$.

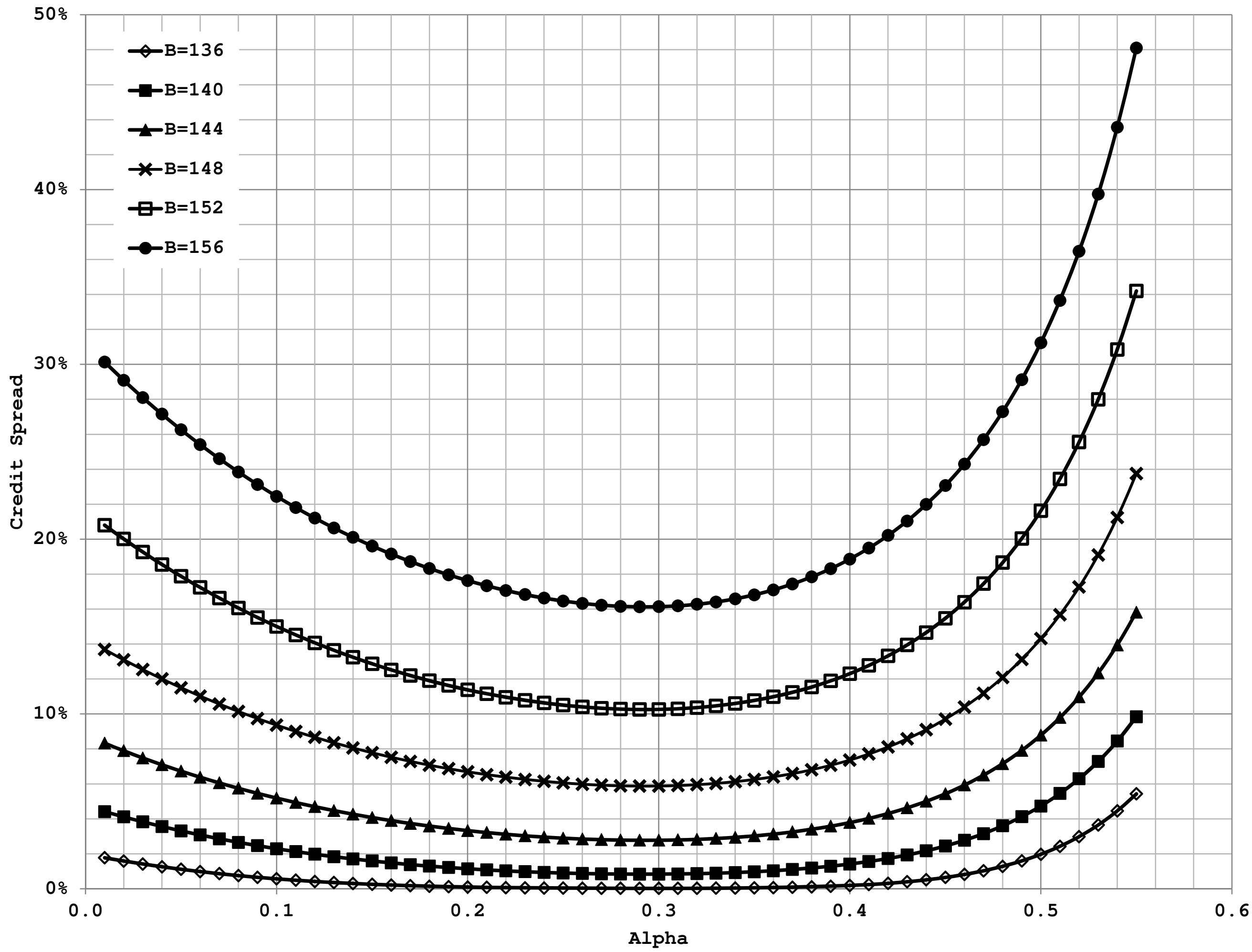


Figure 3.3: Credit Spread vs. Asset Market Liquidity: Project Profitability

This figure illustrates how credit spreads changes with asset market liquidity α for various levels of profitability, β_0. The parameter settings are as follows: face value of debt $B = 150$, $x_0 = 10, x_1 \sim U[20, 10]$, and, $x_2 = 20$. Additionally, $I_0 = 100$, and, $I_1 = 150$. Moreover, $f(I_0) = \beta_0 \, I_0$, where β_0 varies and $g(I_1) = \beta_1 \, I_1$, where $\beta_1 = 1.4$.

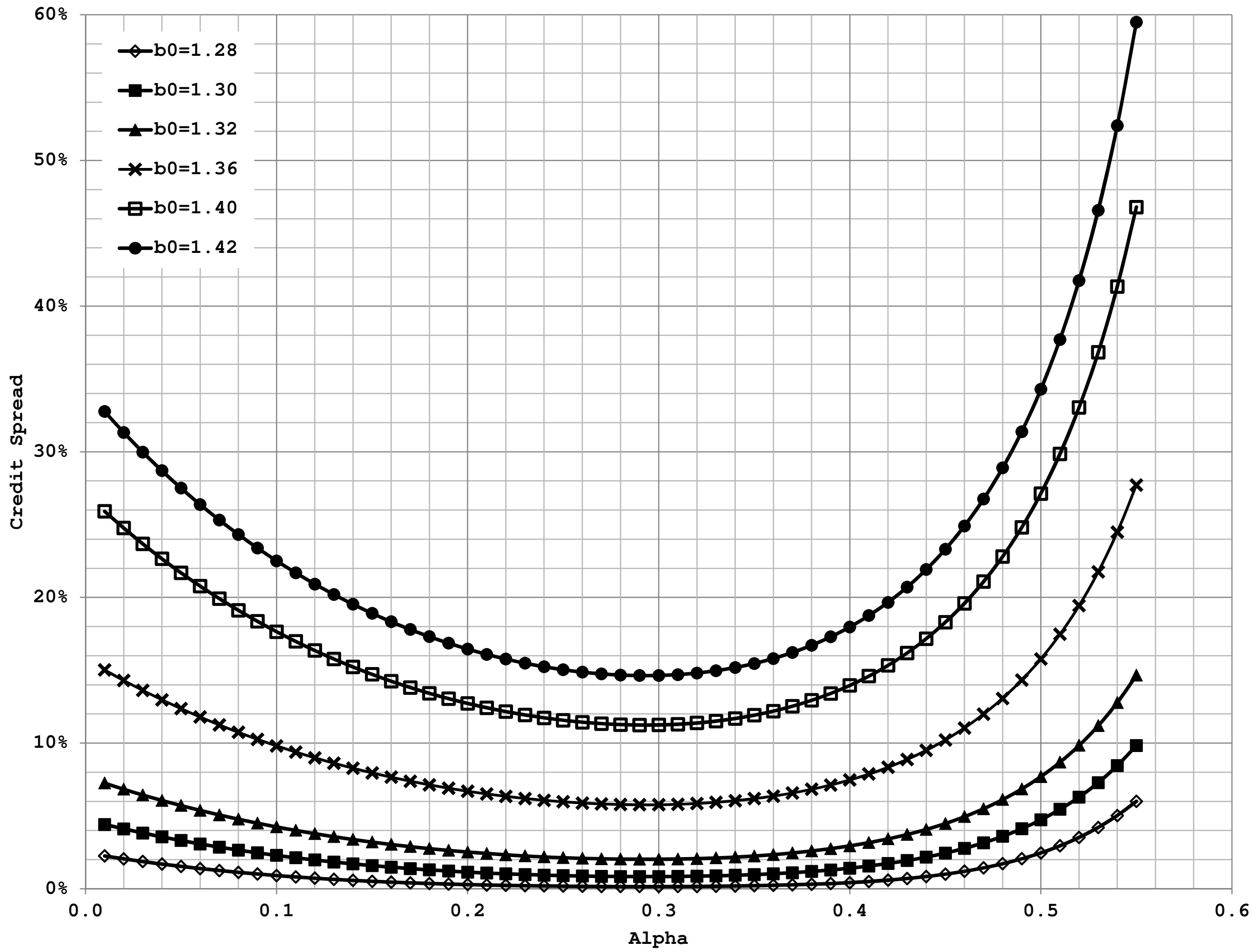


Figure 3.4: Credit Spread vs. Asset Market Liquidity: Average Cash Flow

This figure shows how credit spreads changes with asset market liquidity α for various levels of expected cash flows, x, at time 1. The parameter settings are as follows: face value of debt $B = 150$ $x_0 = 10$ and $x_2 = 20$. Additionally, $I_0 = 100$, and, $I_1 = 150$. Moreover, $f(I_0) = \beta_0\, I_0$, where $\beta_0 = 1.3$ and $g(I_1) = \beta_1\, I_1$, where $\beta_1 = 1.4$.

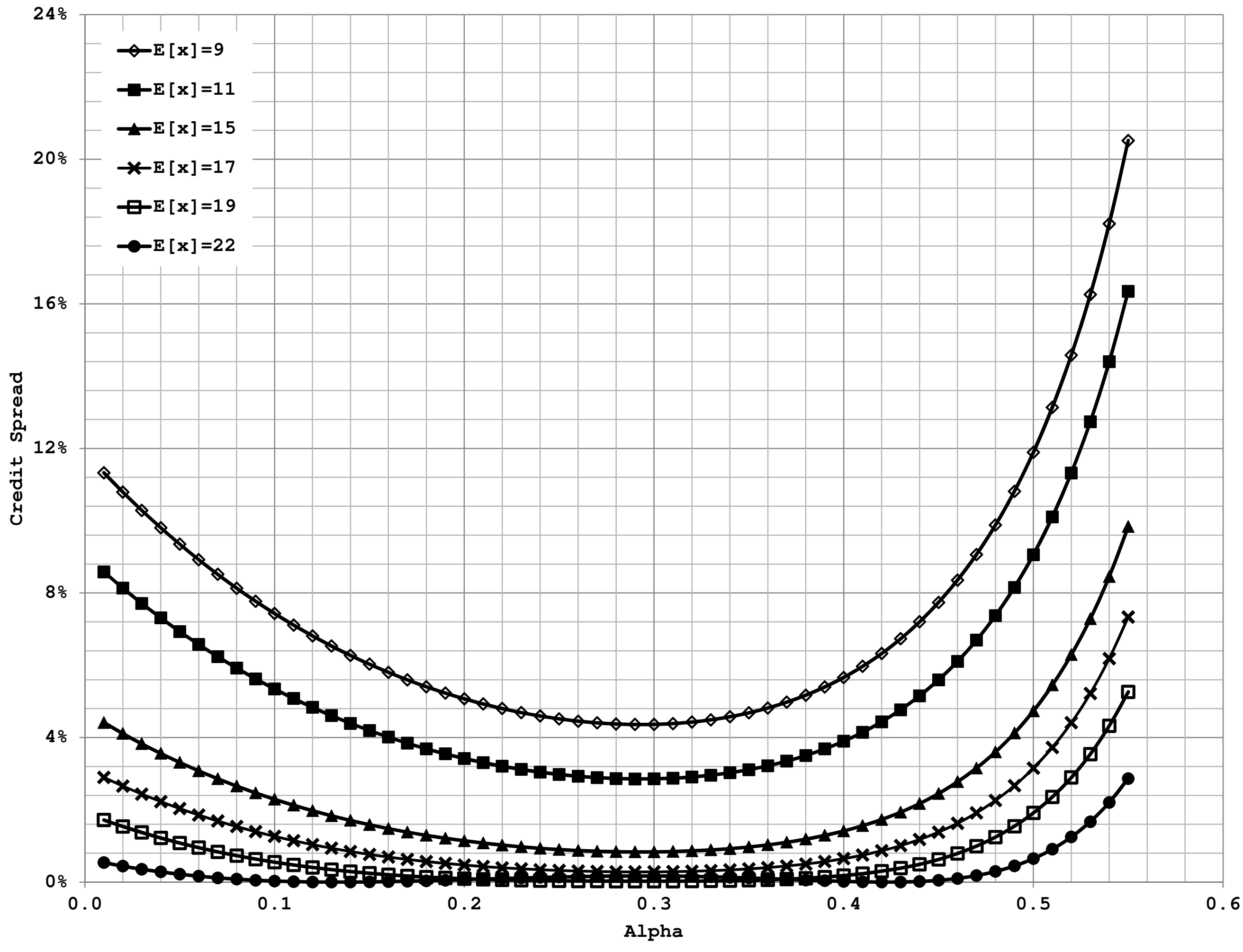


Figure 3.5: Credit Spread vs. Asset Market Liquidity: Cash Flow Range

This figure shows how credit spreads changes with asset market liquidity α for various ranges of cash flows at time 1, $\overline{x} - \underline{x}$. The parameter settings are as follows: face value of debt $B = 150$ $x_0 = 10$ and $x_2 = 20$. Additionally, $I_0 = 100$, and, $I_1 = 150$. Moreover, $f(I_0) = \beta_0\, I_0$, where $\beta_0 = 1.3$ and $g(I_1) = \beta_1\, I_1$, where $\beta_1 = 1.4$.

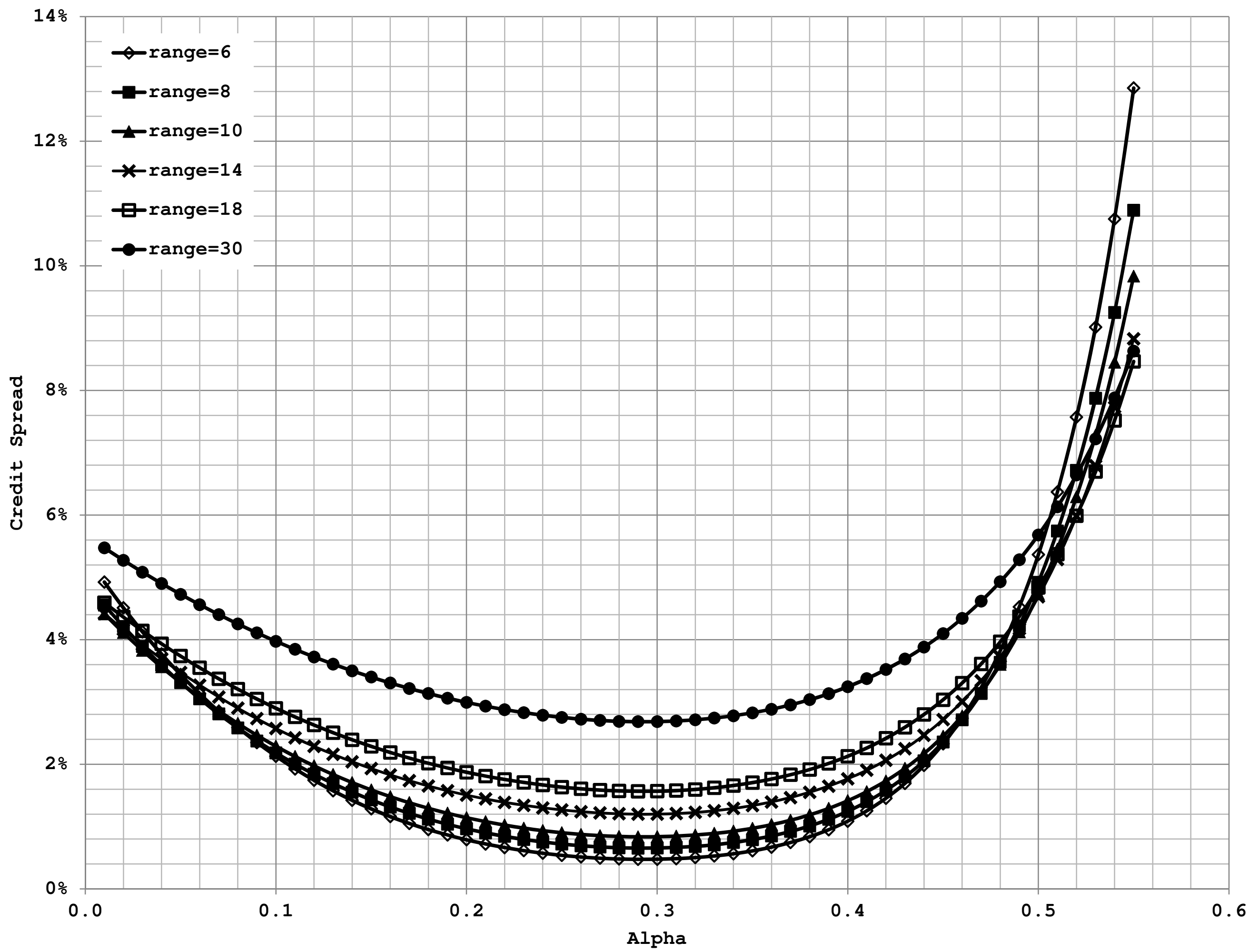


Figure 3.6: Relationships Between Asset Liquidity, Cash, and Credit Spreads

This diagram illustrates the channels through which asset liquidity and cash holdings can affect credit spreads.

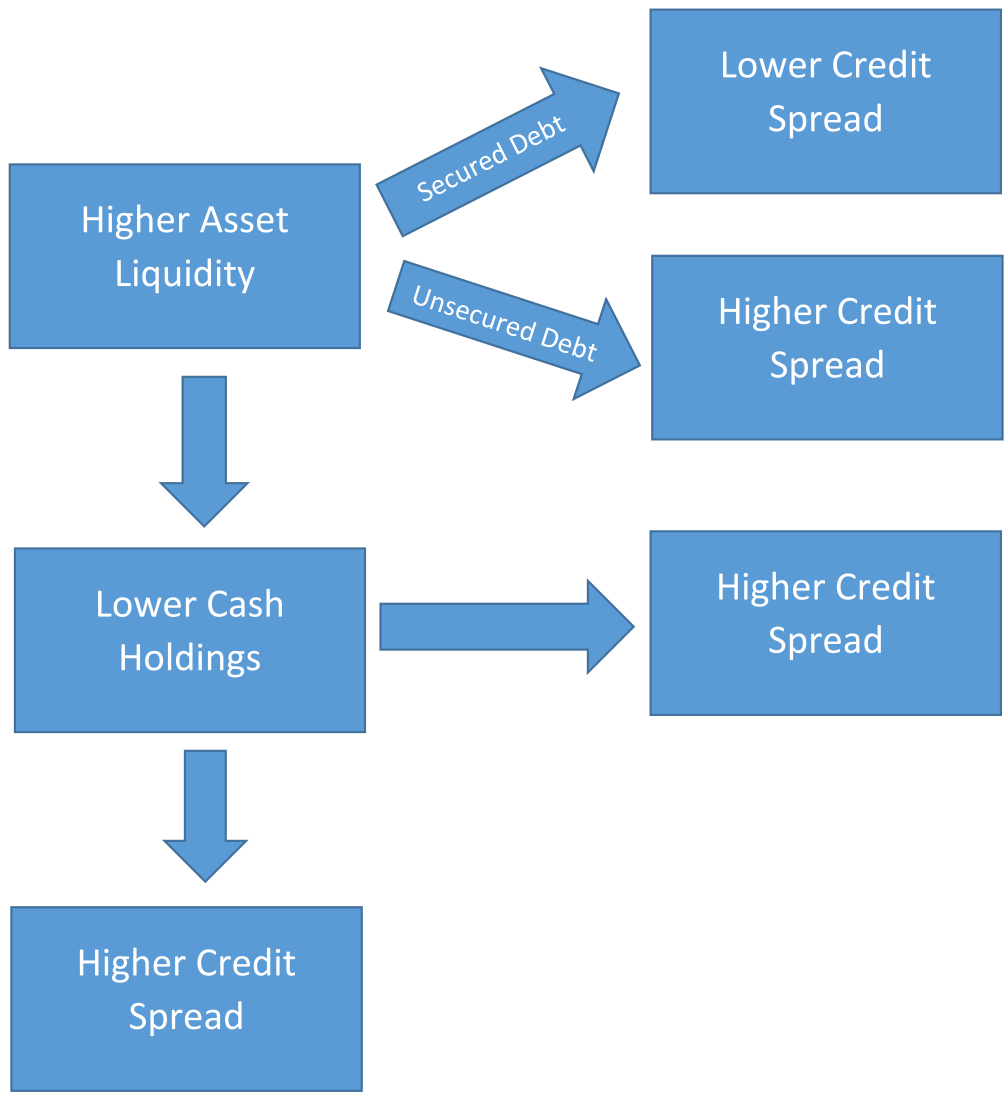


Table 3.1: Summary Statistics

This table presents the summary statistics of the each of the variables used in this study. The variables are defined as follows. Credit Spread: yield on a bond over an equivalent maturity Treasury bond, Asset Liquidity: industry-based measure of asset liquidity measured as total assets sold in an industry / total industry assets, Leverage: book value of debt divided by the sum of the book value of debt and the market value of equity, Size: ln(Assets), Distance to Default: $d2$ from the Merton (1974) model using the iterative procedure of Bharath and Shumway (2008), Asset Volatility: standard deviation of implied daily asset returns, Maturity: average number of years to maturity for the firm's bonds, Risk-free: 10 year constant-maturity Treasury rate, Slope: Difference between the 10 and 2 year constant maturity Treasury yields, VIX: Monthly level of VIX index, S&P500: Monthly return on S&P500, Rating: Numerical credit rating.

	Mean	Median	St. Dev	Min	Max	N
Credit Spread	2.065	1.334	2.588	0.001	39.997	34041
Asset Liquidity	0.009	0.006	0.009	-0.000	0.213	34041
Leverage	0.269	0.224	0.190	0.000	1.000	26591
Size	9.083	9.077	1.206	6.021	13.649	34041
Distance to Default	7.324	6.635	4.842	-6.652	40.427	25557
Asset Volatility	0.287	0.260	0.157	0.010	9.616	25557
Maturity	8.278	6.577	6.060	1.000	29.995	34041
Risk-free	4.674	4.610	1.201	1.510	6.960	34041
Slope	1.079	0.700	0.969	-0.470	2.840	34041
VIX	0.217	0.211	0.075	0.104	0.599	33833
S&P500	0.007	0.010	0.045	-0.169	0.108	34041
Rating	7.864	8.000	2.995	1.000	20.000	33000

Table 3.2: Credit Spread by Issuer Credit Rating

This table presents credit spreads by issuer credit rating. AA contains firms with ratings of AA+, AA, and AA-, BBB contains firms with ratings of BBB+, BBB, and BBB-, etc.

	Mean	Median	25%	75%	St. Dev	N
AAA	0.592	0.490	0.363	0.733	0.381	780
AA	0.744	0.617	0.414	0.918	0.489	2710
A	1.149	0.955	0.633	1.455	0.794	11435
BBB	1.979	1.590	1.010	2.437	1.553	13204
BB	4.149	3.352	2.260	4.960	3.108	3233
B	6.374	4.818	3.086	7.712	5.141	1498
CCC or below	4.746	2.154	1.108	4.920	6.573	1181
Total	2.065	1.334	0.772	2.357	2.588	34041

Table 3.3: Persistence of Asset Liquidity

This table shows the correlation of the asset liquidity index over time. Each year, the asset liquidity index is segmented into quartiles, placing the lowest liquidity industries into quartile 1 and the highest liquidity industries into quartile 4. *Liqrank* takes on a value of 1 if the firm is in the 1st quartile, 2 if in the 2nd quartile, and so on.

	$Liqrank_t$	$Liqrank_{t-1}$	$Liqrank_{t-2}$	$Liqrank_{t-3}$	$Liqrank_{t-4}$	$Liqrank_{t-5}$
$Liqrank_t$	1					
$Liqrank_{t-1}$	0.825	1				
$Liqrank_{t-2}$	0.694	0.820	1			
$Liqrank_{t-3}$	0.588	0.690	0.819	1		
$Liqrank_{t-4}$	0.560	0.580	0.685	0.815	1	
$Liqrank_{t-5}$	0.546	0.550	0.575	0.680	0.816	1

Table 3.4: Correlation Matrix

This table presents the correlations of each of the variables used in this study. The variables are defined as follows. Credit Spread: yield on a bond over an equivalent maturity Treasury bond, Asset Liquidity: industry-based measure of asset liquidity measured as total assets sold in an industry / total industry assets, Leverage: book value of debt divided by the sum of the book value of debt and the market value of equity, Size: ln(Assets), Distance to Default: $d2$ from the Merton (1974) model using the iterative procedure of Bharath and Shumway (2008), Asset Volatility: standard deviation of implied daily asset returns, Maturity: average number of years to maturity for the firm's bonds, Risk-free: 10 year constant-maturity Treasury rate, Slope: Difference between the 10 and 2 year constant maturity Treasury yields, VIX: Monthly level of VIX index, S&P500: Monthly return on S&P500, Rating: Numerical credit rating.

	CSPRD	AssetLiq	Lev	Size	Dist to Def	AssetVol	Maturity	Risk-free	Slope	VIX	S&P	Rating
Credit Spread	1.00											
Asset Liquidity	-0.01	1.00										
Leverage	0.52	-0.09	1.00									
Size	-0.13	-0.17	-0.06	1.00								
Distance to Default	-0.46	0.04	-0.64	0.14	1.00							
Asset Volatility	0.26	0.04	-0.04	-0.10	-0.41	1.00						
Maturity	-0.01	-0.05	-0.01	0.10	-0.01	0.00	1.00					
Risk-free	-0.25	0.14	-0.02	-0.27	-0.02	0.02	0.01	1.00				
Slope	0.24	-0.12	0.08	0.12	-0.10	0.08	-0.03	-0.62	1.00			
VIX	0.29	0.03	0.11	-0.01	-0.35	0.29	0.05	-0.14	0.23	1.00		
S&P500	-0.08	0.00	-0.04	-0.03	0.06	-0.03	0.01	0.05	-0.06	-0.36	1.00	
Rating	0.58	-0.03	0.62	-0.35	-0.51	0.15	-0.09	-0.08	0.07	-0.03	-0.01	1.00

Table 3.5: Credit Spreads by Asset Liquidity

This table presents credit spreads for each asset liquidity ranking. Each year firms are ranked according to the asset liquidity index. Firms in the bottom 25% are assigned to group 1. Firms between 25% and 50% are assigned to group 2. Firms between 50% and 75% are assigned to group 3. Firms in the top 25% are assigned to group 4. $4-1$ reports the difference in cash holdings between the high and low liquidity groups. Panel A reports results over the full sample period. Panel B reports results in the pre-Financial Crisis period, defined as all observations before 2008. Panel C reports results in the post-Financial Crisis period, defined as 2008 and onward

Panel A: Full Sample						
	Mean	Median	25%	75%	St. Dev	N
1	2.097	1.296	0.772	2.233	2.797	11439
2	2.101	1.456	0.840	2.588	2.179	6406
3	1.904	1.255	0.708	2.180	2.274	8642
4	2.170	1.396	0.792	2.506	2.892	7554
Total	2.065	1.334	0.772	2.357	2.588	34041
High - Low	0.072	**t-stat**	1.90*			
Panel B: Pre Crisis						
	Mean	Median	25%	75%	St. Dev	N
1	1.894	1.185	0.731	1.953	2.634	9827
2	1.735	1.157	0.737	1.912	2.062	4537
3	1.695	1.116	0.664	1.896	2.086	7274
4	1.944	1.220	0.730	2.034	2.874	6163
Total	1.827	1.169	0.715	1.944	2.475	27801
High - Low	0.051	**t-stat**	1.26			
Panel B: Post Crisis						
	Mean	Median	25%	75%	St. Dev	N
1	3.340	2.326	1.465	3.918	3.379	1612
2	2.989	2.479	1.695	3.494	2.202	1869
3	3.016	2.230	1.390	3.634	2.841	1368
4	3.172	2.681	1.576	3.908	2.753	1391
Total	3.126	2.431	1.543	3.734	2.807	6240
High - Low	-0.168	**t-stat**	-1.64			

Table 3.6: Real Asset Liquidity and Credit Spreads

This table presents coefficient estimates from the model: $CSPRD_{i,t} = \alpha + \beta_1 AssetLiq_{i,t} + \beta_2 AssetLiq^2_{i,t} + \Phi \mathbf{X}_{i,t} + \varepsilon_{i,t}$, where $\mathbf{X_t}$ is a vector of control variables. Models (1) and (2) are estimated using the full sample period. Models (3) and (5) are estimated over the pre-Financial Crisis period, defined as prior to 2008. Models (4) and (6) are estimated over the post-Financial Crisis periods, defined as 2008 and onward. t-statistics are computed using robust standard errors clustered at the firm level.

	(1) Full Sample	(2) Full Sample	(3) Pre-Crisis	(4) Post-Crisis	(5) Pre-Crisis	(6) Post-Crisis
Constant	-2.765***	-2.823***	-2.073***	-3.603***	-2.135***	-3.484***
	(-8.87)	(-9.06)	(-6.09)	(-5.27)	(-6.26)	(-5.06)
Asset Liquidity	8.877***	17.19***	4.137***	28.94***	11.76***	3.094
	(6.67)	(4.19)	(3.53)	(5.49)	(2.58)	(0.42)
Asset Liquidity ^{2}		155.4**			134.9	723.2***
		(1.99)			(1.57)	(2.73)
Leverage	3.917***	3.934***	3.641***	6.541***	3.660***	6.493***
	(11.98)	(12.09)	(9.80)	(15.07)	(9.89)	(15.11)
Size	-0.0191	-0.0166	-0.0163	-0.166***	-0.0141	-0.170***
	(-1.59)	(-1.37)	(-1.37)	(-4.12)	(-1.18)	(-4.20)
Distance to Default	0.0456***	0.0455***	0.0366***	0.0922***	0.0365***	0.0931***
	(3.82)	(3.82)	(2.71)	(7.42)	(2.72)	(7.48)
Asset Volatility	2.762***	2.748***	2.755***	2.678***	2.742***	2.694***
	(4.28)	(4.27)	(3.55)	(6.68)	(3.54)	(6.68)
Maturity	0.00838***	0.00826***	0.00430***	0.0135***	0.00419***	0.0152***
	(6.10)	(5.99)	(3.32)	(2.89)	(3.21)	(3.28)
Risk-free	-0.317***	-0.319***	-0.269***	0.0900***	-0.269***	0.0949***
	(-27.48)	(-27.85)	(-19.02)	(2.90)	(-19.00)	(3.13)
Slope	0.0780***	0.0784***	0.102***	-0.564***	0.102***	-0.569***
	(5.58)	(5.61)	(6.60)	(-11.81)	(6.62)	(-11.98)
VIX	6.976***	6.967***	4.686***	10.47***	4.671***	10.53***
	(20.27)	(20.31)	(12.41)	(19.26)	(12.45)	(19.36)
S&P500	1.367***	1.384***	0.176	7.114***	0.185	7.190***
	(3.99)	(4.04)	(0.50)	(9.51)	(0.52)	(9.59)
Rating	0.316***	0.316***	0.277***	0.372***	0.277***	0.371***
	(28.46)	(28.55)	(21.59)	(18.14)	(21.66)	(17.98)
Observations	24664	24664	19720	4944	19720	4944
Adjusted R^2	0.504	0.504	0.438	0.661	0.439	0.662

Table 3.7: Non-Linear Regression Scheme

This table illustrates the breakpoints a the piecewise linear regression. Firms that have low asset liquidity (those with index values between 0 and the 15th percentile of that year) take on a values of the index value, 0, 0, and 0 for the variables Z_1, Z_2, Z_3, and Z_4, respectively. Firms in the highest liquidity group (with index values ranging from the 85th and 100th percentile of that year) take on values equal to the 15th percentile, 15th percentile, 50th percentile, and the index value minus the 85th percentile for Z_1, Z_2, Z_3, and Z_4, respectively.

	Z_1	Z_2	Z_3	Z_4
Liq $\in [0, P15)$	Liq	0	0	0
Liq $\in [P15, P50)$	$P15$	$Liq - P15$	0	0
Liq $\in [P50, P85)$	$P15$	$P15$	$Liq - P50$	0
Liq $\in [P85, P100]$	$P15$	$P15$	$P50$	$Liq - P85$

Table 3.8: Non-Linearity of Asset Liquidity

This table presents coefficient estimates from the model:
$CSPRD_{i,t} = \alpha + \beta_1 AssetLiq_{i,t} + \beta_2 Z_1 + \beta_3 Z_2 + \beta_4 Z_3 + \beta_1 Z_4 + \Phi\mathbf{X}_{i,t} + \varepsilon_{i,t}$ is a vector of control variables. Z_is are the piece-wise linear censored asset liquidity variables which are constructed as described in Table 3.7. Models (1) is estimated using the full sample period. Model (2) is estimated over the pre-Financial Crisis period, defined as prior to 2008. Model is estimated over the post-Financial Crisis periods, defined as 2008 and onward. t-statistics computed using robust standard errors clustered at the firm level.

	(1) Full Sample	(2) Pre-Crisis	(3) Post-Crisis
Constant	-2.732***	-1.924***	-3.311***
	(-8.83)	(-5.84)	(-5.00)
Z_1	-28.35***	-67.64***	132.1**
	(-2.98)	(-7.11)	(2.13)
Z_2	55.94***	77.99***	-87.65***
	(6.62)	(8.78)	(-2.61)
Z_3	5.767	5.165	13.86
	(1.03)	(0.80)	(1.34)
Z_4	2.738	-4.648**	58.01***
	(1.34)	(-2.43)	(5.16)
Leverage	3.925***	3.694***	6.486***
	(12.17)	(10.23)	(14.98)
Size	-0.0247**	-0.0239**	-0.175***
	(-2.03)	(-2.00)	(-4.45)
Distance to Default	0.0470***	0.0380***	0.0933***
	(3.96)	(2.88)	(7.55)
Asset Volatility	2.761***	2.730***	2.631***
	(4.29)	(3.56)	(6.54)
Maturity	0.00825***	0.00410***	0.0162***
	(5.91)	(3.09)	(3.49)
Risk-free	-0.317***	-0.275***	-0.00442
	(-27.21)	(-18.94)	(-0.06)
Slope	0.0748***	0.0916***	-0.478***
	(5.20)	(5.74)	(-5.86)
VIX	7.022***	4.700***	10.31***
	(20.53)	(12.81)	(18.85)
S&P500	1.396***	0.287	7.141***
	(4.07)	(0.81)	(9.50)
Rating	0.318***	0.277***	0.369***
	(28.97)	(22.04)	(18.30)
Observations	24615	19683	4932
Adjusted R^2	0.504	0.440	0.664

Table 3.9: Effects of Leverage

This table presents coefficient estimates from the model: $CSPRD_{i,t} = \alpha + \beta_1 AssetLiq_{i,t} + \beta_2 AssetLiq^2_{i,t} + \Phi \mathbf{X}_{i,t} + \varepsilon_{i,t}$, where $\mathbf{X_t}$ is a vector of control variables. Firms are segmented by leverage. Each year firms are ranked into three leverage groups with the lowest 33% going to low leverage and the to 33% going to high leverage. t-statistics computed using robust standard errors clustered at the firm level.

	(1)	(2)	(3)	(4)
	Low Leverage	Low Leverage	High Leverage	High Leverage
Constant	-0.493***	-0.501***	-5.087***	-5.246***
	(-2.80)	(-2.85)	(-10.22)	(-10.39)
Asset Liquidity	0.589	1.796	25.00***	42.56***
	(0.75)	(1.00)	(7.02)	(6.60)
Asset Liquidity ^{2}		-24.29		-370.0***
		(-0.79)		(-3.82)
Observations	8400	8400	8016	8016
Adjusted R^2	0.508	0.508	0.532	0.533

Table 3.10: Effects of Growth Opportunities

This table presents coefficient estimates from the model: $CSPRD_{i,t} = \alpha + \beta_1 AssetLiq_{i,t} + \beta_2 AssetLiq^2_{i,t} + \Phi \mathbf{X}_{i,t} + \varepsilon_{i,t}$, where $\mathbf{X_t}$ is a vector of control variables. Firms are segmented by growth opportunities. Each year, firms are ranked on this measure of growth opportunities and placed into three groups. Growth options are defined as the median ratio of intangible assets to total assets in the firm's industry each year The highest 33% of firms are classified as having high growth opportunities and the lowest 33% are classified as having low growth opportunities. t-statistics computed using robust standard errors clustered at the firm level.

	(1) Low Growth	(2) Low Growth	(3) High Growth	(4) High Growth
Constant	0.102	0.0329	-3.684***	-3.806***
	(0.26)	(0.09)	(-7.91)	(-8.07)
Asset Liquidity	-5.206***	4.264	11.31***	21.73***
	(-3.00)	(1.21)	(7.01)	(4.92)
Asset Liquidity ^{2}		-190.0***		-180.2***
		(-4.27)		(-3.09)
Observations	6006	6006	9189	9189
Adjusted R^2	0.524	0.525	0.506	0.506

Table 3.11: The Impact of Restrictive Covenants

This table presents coefficient estimates from the model: $CSPRD_{i,t} = \alpha + \beta_1 AssetLiquidity_{i,t} + \beta_2 Covenant + \beta_3 Secured + \beta_4 AssetLiquidity \times Covenant + \beta_5 AssetLiquidity \times Secured + \Phi \mathbf{X}_{i,t} + \varepsilon_{i,t}$, where $\mathbf{X_t}$ is a vector of control variables. *Covenant* is an indicator variable that takes on a value of 1 if the firm has asset sales covenants and 0 otherwise. *Secured* is an indicator variable that takes on a value of 1 if the firm's debt is secured and 0 otherwise. Panel B replaces the continous variable *AssetLiquidity* with an indicator variable *HighLiquidity* which takes on a value of 1 if the firm is in the upper 25% of the asset liquidity index and 0 otherwise. t-statistics computed using robust standard errors clustered at the firm level.

Panel A:

	(1)	(2)	(3)	(4)
Constant	-0.921***	-1.061***	-2.686***	-2.686***
	(-3.58)	(-3.88)	(-8.58)	(-8.58)
Asset Liquidity	11.43***	26.51***	8.622***	8.556***
	(6.12)	(3.06)	(6.51)	(6.41)
Covenant	-0.120**	0.0366		
	(-2.55)	(0.45)		
Secured			-0.198**	-0.241**
			(-2.52)	(-2.43)
Asset Liquidity x Covenant		-15.67*		
		(-1.81)		
Asset Liquidity x Secured				6.679
				(0.58)
Observations	12032	12032	24664	24664
Adjusted R^2	0.492	0.492	0.504	0.504

Panel B:

	(1)	(2)	(3)	(4)
Constant	-0.695***	-0.640**	-2.530***	-2.526***
	(-2.74)	(-2.49)	(-8.22)	(-8.21)
High Liquidity	0.0578	-0.137	0.0360	0.0427
	(1.47)	(-1.25)	(1.31)	(1.54)
Covenant	-0.124***	-0.197***		
	(-2.63)	(-3.64)		
Secured			-0.232***	-0.175**
			(-2.95)	(-2.13)
High Liquidity x Covenant		0.227**		
		(2.03)		
High Liquidity x Secured				-0.834***
				(-5.53)
Observations	12032	12032	24664	24664
Adjusted R^2	0.490	0.490	0.503	0.503

Table 3.12: The Intermediating Effects of Cash

This table presents coefficient estimates from the model: $CSPRD_{i,t} = \alpha + \beta_1 AssetLiquidity_{i,t} + \beta_2 Cash_{i,t} + \beta_3 AssetLiquidity \times Cash + \Phi \mathbf{X}_{i,t} + \varepsilon_{i,t}$, where $\mathbf{X_t}$ is a vector of control variables. Models 1 and 2 are estimated using pooled OLS regressions. Models 3-5 are estimated using an Instrumental Variables regression. t-statistics computed using robust standard errors clustered at the firm level.

	(1) OLS	(2) OLS	(3) IV	(4) IV	(5) IV
Constant	-2.736***	-2.704***	-3.865***	-3.905***	-3.942***
	(-8.95)	(-8.86)	(-13.22)	(-13.56)	(-13.63)
Asset Liquidity	9.213***	6.640***		8.000***	11.00***
	(6.96)	(4.37)		(6.06)	(3.52)
Cash	1.346***	0.952***	-6.161***	-4.697***	-4.125***
	(9.55)	(5.85)	(-6.02)	(-4.79)	(-3.28)
Asset Liquidity x Cash		45.91***			-54.26
		(3.87)			(-1.05)
Observations	24664	24664	21710	21710	21710
Adjusted R^2	0.507	0.508	0.442	0.478	0.480

Table 3.13: Asset Liquidity, Cash, and Credit Spreads

This table presents coefficient estimates from the model: $CSPRD_{i,t} = \alpha + \beta_1 HighLiquidity_{i,t} + \beta_2 LowLiquidity_{i,t} + \beta_3 Cash_{i,t} + \beta_4 HighLiquidity \times Cash + \beta_5 LowLiquidity \times Cash + \Phi \mathbf{X}_{i,t} + \varepsilon_{i,t}$, where $\mathbf{X_t}$ is a vector of control variables. Models (1) and (2) are estimated using instrumental variables. t-statistics computed using robust standard errors clustered at the firm level.

	(1)	(2)
Constant	-3.802***	-3.918***
	(-13.15)	(-13.32)
High Asset Liquidity	1.384***	
	(5.17)	
Low Asset Liquidity		-0.571
		(-1.62)
Cash	0.485	-5.390***
	(0.36)	(-5.65)
High Asset Liquidity x Cash	-19.47***	
	(-5.22)	
Low Asset Liquidity x Cash		4.792
		(0.82)
Observations	21710	21710
Adjusted R^2	0.420	0.472

BIBLIOGRAPHY

Acharya, Viral, Sergei A. Davydenko, and Ilya A. Strebulaev, 2012, Cash holdings and credit risk, *Review of Financial Studies* 25, 3572–3609.

Acharya, Viral V., Heitor Almeida, and Murillo Campello, 2007, Is cash negative debt? A hedging perspective on corporate financial policies, *Journal of Financial Intermediation* 16, 515–554.

Acharya, Viral V., Rangarajan K. Sundaram, and Kose John, 2011, Cross-country variations in capital structures: The role of bankruptcy codes, *Journal of Financial Intermediation* 20, 25–54.

Aghion, Philippe, and Patrick Bolton, 1992, An Incomplete Contracts Approach to Financial Contracting, *Review of Economic Studies* 59, 473–94.

Akerlof, George G., 1970, The market for "lemons": Quality uncertainty and the market mechanism, *Quarterly Journal of Economics* 84, 488–500.

Almeida, Heitor, Murillo Campello, and Michael S. Weisbach, 2004, The cash flow sensitivity of cash, *The Journal of Finance* 59, 1777–1804.

Andrade, Gregor, Mark Mitchell, and Erik Stafford, 2001, New Evidence and Perspectives on Mergers, *Journal of Economic Perspectives* 15, 103–120.

Arnold, Marc, Dirk Hackbarth, and Tatjana-Xenia Puhan, 2014, Financing Asset Sales and Business Cycles, Working paper, Swiss Finance Institute.

Asquith, Paul, Thom Covert, and Parag Pathak, 2013, The Effects of Mandatory Transparency in Financial Market Design: Evidence from the Corporate Bond Market, NBER Working Papers 19417, National Bureau of Economic Research, Inc.

Asquith, Paul, Robert Gertner, and David Scharfstein, 1994, Anatomy of financial distress: An examination of junk-bond issuers, *The Quarterly Journal of Economics* 109, 625–58.

Balli, Hatice, and Bent Srensen, 2013, Interaction effects in econometrics, *Empirical Economics* 45, 583–603.

Bates, Thomas W., 2005, Asset sales, investment opportunities, and the use of proceeds, *The Journal of Finance* 60, 105–135.

Bates, Thomas W., Kathleen M. Kahle, and Rene M. Stulz, 2009, Why do u.s. firms hold so much more cash than they used to?, *The Journal of Finance* 64, 1985–2021.

Baumol, William J., 1952, The transactions demand for cash: An inventory theoretic approach, *The Quarterly Journal of Economics* 66, 545–556.

Benmelech, Efraim, 2008, Asset salability and debt maturity: Evidence from nineteenth-century american railroads, *Review of Financial Studies* 22, 1545–1584.

Benmelech, Efraim, and Nittai K. Bergman, 2009, Collateral pricing, *Journal of Financial Economics* 91, 339–360.

Benmelech, Efraim, Mark J. Garmaise, and Tobias J. Moskowitz, 2005, Do Liquidation Values Affect Financial Contracts? Evidence from Commercial Loan Contracts and Zoning Regulation, *The Quarterly Journal of Economics* 120, 1121–1154.

Bessembinder, Hendrik, Kathleen M. Kahle, William F. Maxwell, and Danielle Xu, 2009, Measuring Abnormal Bond Performance, *Review of Financial Studies* 22, 4219–4258.

Bharath, Sreedhar T., and Tyler Shumway, 2008, Forecasting default with the merton distance to default model, *Review of Financial Studies* 21, 1339–1369.

Black, Fischer, and John C Cox, 1976, Valuing corporate securities: Some effects of bond indenture provisions, *Journal of Finance* 31, 351–67.

Black, Fischer, and Myron S Scholes, 1973, The pricing of options and corporate liabilities, *Journal of Political Economy* 81, 637–54.

Bloom, Nicholas, 2009, The impact of uncertainty shocks, *Econometrica* 77, 623–685.

Bolton, Patrick, Hui Chen, and Neng Wang, 2011, A Unified Theory of Tobin's q, Corporate Investment, Financing, and Risk Management, *Journal of Finance* 66, 1545–1578.

Borisova, Ginka, and James R. Brown, 2013, R&D sensitivity to asset sale proceeds: New evidence on financing constraints and intangible investment, *Journal of Banking & Finance* 37, 159 – 173.

Borisova, Ginka, Kose John, and Valentina Salotti, 2013, The value of financing through cross-border asset sales: Shareholder returns and liquidity, *Journal of Corporate Finance* 22, 320 – 344.

Brown, David T., Christopher M. James, and Robert M. Mooradian, 1994, Asset sales by financially distressed firms, *Journal of Corporate Finance* 1, 233 – 257.

Campbell, John Y., and Glen B. Taksler, 2003, Equity volatility and corporate bond yields, *The Journal of Finance* 58, 2321–2350.

Campello, Murillo, Erasmo Giambona, John R. Graham, and Campbell R. Harvey, 2011, Liquidity management and corporate investment during a financial crisis, *Review of Financial Studies* 24, 1944–1979.

Campello, Murillo, John R. Graham, and Campbell R. Harvey, 2010, The real effects of financial constraints: Evidence from a financial crisis, *Journal of Financial Economics* 97, 470 – 487.

Chen, Long, David A. Lesmond, and Jason Wei, 2007, Corporate yield spreads and bond liquidity, *Journal of Finance* 62, 119–149.

Collin-Dufresne, Pierre, Robert S. Goldstein, and Spencer J. Martin, 2001, The Determinants of Credit Spread Changes, *Journal of Finance* 56, 2177–2207.

Das, Sanjiv R., and Paul Hanouna, 2009, Hedging credit: Equity liquidity matters, *Journal of Financial Intermediation* 18, 112–123.

Denis, David J., and Valeriy Sibilkov, 2010, Financial constraints, investment, and the value of cash holdings, *Review of Financial Studies* 23, 247–269.

Dick-Nielsen, Jens, 2009, Liquidity Biases in Trace, *Journal of Fixed Income* 19, 43–55.

Duchin, Ran, Oguzhan Ozbas, and Berk A. Sensoy, 2010, Costly external finance, corporate investment, and the subprime mortgage credit crisis, *Journal of Financial Economics* 97, 418 – 435.

Ederington, Louis, Wei Guan, and Zongfei Yang, 2012, Bond Market Event Study Methodology, Working paper, University of Oklahoma.

Edmans, Alex, and William Mann, 2013, Financing through asset sales, Working paper, The University of Pennsylvania Wharton School.

Eisfeldt, Andrea L., and Adriano A. Rampini, 2006, Capital reallocation and liquidity, *Journal of Monetary Economics* 53, 369–399.

Fama, Eugene F, and James D MacBeth, 1973, Risk, return, and equilibrium: Empirical tests, *Journal of Political Economy* 81, 607–36.

Faulkender, Michael, and Mitchell A. Petersen, 2006, Does the source of capital affect capital structure?, *Review of Financial Studies* 19, 45–79.

Faulkender, Michael, and Rong Wang, 2006, Corporate financial policy and the value of cash, *The Journal of Finance* 61, 1957–1990.

Gamba, Andrea, and Alexander Triantis, 2008, The Value of Financial Flexibility, *Journal of Finance* 63, 2263–2296.

Gavazza, Alessandro, 2010, Asset liquidity and financial contracts: Evidence from aircraft leases, *Journal of Financial Economics* 95, 62–84.

Geske, Robert, 1979, The valuation of compound options, *Journal of Financial Economics* 7, 63–81.

Giesecke, Kay, Francis A. Longstaff, Stephen Schaefer, and Ilya Strebulaev, 2011, Corporate bond default risk: A 150-year perspective, *Journal of Financial Economics* 102, 233 – 250.

Graham, John R, and Campbell R Harvey, 2001, The theory and practice of corporate finance: evidence from the field, *Journal of Financial Economics* 60, 187–243.

Güntay, Levent, and Dirk Hackbarth, 2010, Corporate bond credit spreads and forecast dispersion, *Journal of Banking & Finance* 34, 2328–2345.

Hadlock, Charles J., and Joshua R. Pierce, 2010, New Evidence on Measuring Financial Constraints: Moving Beyond the KZ Index, *Review of Financial Studies* 23, 1909–1940.

Han, Seungjin, and Jiaping Qiu, 2007, Corporate precautionary cash holdings, *Journal of Corporate Finance* 13, 43–57.

Harford, Jarrad, 1999, Corporate cash reserves and acquisitions, *The Journal of Finance* 54, 1969–1997.

Harris, Milton, and Artur Raviv, 1990, Capital Structure and the Informational Role of Debt, *Journal of Finance* 45, 321–49.

Hart, Oliver, and John Moore, 1994, A Theory of Debt Based on the Inalienability of Human Capital, *The Quarterly Journal of Economics* 109, 841–79.

He, Zhiguo, and Wei Xiong, 2012, Rollover Risk and Credit Risk, *Journal of Finance* 67, 391–430.

Hite, Gailen L., James E. Owers, and Ronald C. Rogers, 1987, The market for interfirm asset sales: Partial sell-offs and total liquidations, *Journal of Financial Economics* 18, 229 – 252.

Hovakimian, Gayane, and Sheridan Titman, 2006, Corporate Investment with Financial Constraints: Sensitivity of Investment to Funds from Voluntary Asset Sales, *Journal of Money, Credit and Banking* 38, 357–374.

Ivashina, Victoria, and David Scharfstein, 2010, Bank lending during the financial crisis of 2008, *Journal of Financial Economics* 97, 319–338.

Jensen, Michael C., and William H. Meckling, 1976, Theory of the firm: Managerial behavior, agency costs and ownership structure, *Journal of Financial Economics* 3, 305–360.

John, Kose, and Eli Ofek, 1995, Asset sales and increase in focus, *Journal of Financial Economics* 37, 105 – 126.

Julio, Brandon, and Youngsuk Yook, 2012, Political uncertainty and corporate investment cycles, *The Journal of Finance* 67, 45–83.

Keynes, J.M., 1936, *The General Theory of Employment, Interest and Money* (Harcourt, Brace, Jovanovich, London).

Kim, Chang-Soo, David C. Mauer, and Ann E. Sherman, 1998, The determinants of corporate liquidity: Theory and evidence, *The Journal of Financial and Quantitative Analysis* 33, 335–359.

Kim, Chyhe Esther, 1998, The effects of asset liquidity: Evidence from the contract drilling industry, *Journal of Financial Intermediation* 7, 151 – 176.

Kim, Hyunseob, and Howard Kung, 2014, The asset redeployability channel: How uncertainty affects corporate investment, Working paper, Cornell University.

Lang, Larry, Annette Poulsen, and Rene Stulz, 1995, Asset sales, firm performance, and the agency costs of managerial discretion, *Journal of Financial Economics* 37, 3–37.

Leland, Hayne E, 1994, Corporate Debt Value, Bond Covenants, and Optimal Capital Structure, *Journal of Finance* 49, 1213–52.

Leland, Hayne E, and Klaus B Toft, 1996, Optimal capital structure, endogenous bankruptcy, and the term structure of credit spreads, *Journal of Finance* 51, 987–1019.

Lemmon, Michael L., Michael R. Roberts, and Jaime F. Zender, 2008, Back to the beginning: Persistence and the cross-section of corporate capital structure, *The Journal of Finance* 63, 1575–1608.

Lins, Karl V., Henri Servaes, and Peter Tufano, 2010, What drives corporate liquidity? an international survey of cash holdings and lines of credit, *Journal of Financial Economics* 98, 160–176.

Maksimovic, Vojislav, and Gordon Phillips, 2001, The market for corporate assets: Who engages in mergers and asset sales and are there efficiency gains?, *The Journal of Finance* 56, 2019–2065.

Maxwell, William F., and Ramesh P. Rao, 2003, Do Spin-offs Expropriate Wealth from Bondholders?, *Journal of Finance* 58, 2087–2108.

Maxwell, William F., and Clifford P. Stephens, 2003, The Wealth Effects of Repurchases on Bondholders, *Journal of Finance* 58, 895–920.

Merton, Robert C, 1974, On the Pricing of Corporate Debt: The Risk Structure of Interest Rates, *Journal of Finance* 29, 449–70.

Miller, Merton H., and Franco Modigliani, 1961, Dividend policy, growth, and the valuation of shares, *The Journal of Business* 34, pp. 411–433.

Miller, Merton H., and Daniel Orr, 1966, A model of the demand for money by firms, *The Quarterly Journal of Economics* 80, 413–435.

Minton, Bernadette A., and Catherine Schrand, 1999, The impact of cash flow volatility on discretionary investment and the costs of debt and equity financing, *Journal of Financial Economics* 54, 423–460.

Mitchell, Mark L., and J. Harold Mulherin, 1996, The impact of industry shocks on takeover and restructuring activity, *Journal of Financial Economics* 41, 193–229.

Molina, Carlos A., 2005, Are Firms Underleveraged? An Examination of the Effect of Leverage on Default Probabilities, *Journal of Finance* 60, 1427–1459.

Morellec, Erwan, 2001, Asset liquidity, capital structure, and secured debt, *Journal of Financial Economics* 61, 173–206.

Myers, Stewart C., 1977, Determinants of corporate borrowing, *Journal of Financial Economics* 5, 147 – 175.

Myers, Stewart C., and Nicholas S. Majluf, 1984, Corporate financing and investment decisions when firms have information that investors do not have, *Journal of Financial Economics* 13, 187 – 221.

Myers, Stewart C., and Raghuram G. Rajan, 1998, The paradox of liquidity, *The Quarterly Journal of Economics* 113, 733–771.

Nejadmalayeri, Ali, Takeshi Nishikawa, and Ramesh P. Rao, 2013, Sarbanes-oxley act and corporate credit spreads, *Journal of Banking & Finance* 37, 2991–3006.

Opler, Tim, Lee Pinkowitz, Rene Stulz, and Rohan Williamson, 1999, The determinants and implications of corporate cash holdings, *Journal of Financial Economics* 52, 3–46.

Ortiz-Molina, Hernn, and Gordon M. Phillips, 2014, Real asset illiquidity and the cost of capital, *Journal of Financial and Quantitative Analysis* 49, 1–32.

Pinkowitz, Lee, Rene Stulz, and Rohan Williamson, 2006, Does the Contribution of Corporate Cash Holdings and Dividends to Firm Value Depend on Governance? A Cross-country Analysis, *Journal of Finance* 61, 2725–2751.

Pinkowitz, Lee, and Rohan Williamson, 2004, What is a dollar worth? the market value of cash holdings, Working paper, Georgetown University.

Pulvino, Todd C., 1998, Do asset fire sales exist? an empirical investigation of commercial aircraft transactions, *The Journal of Finance* 53, 939–978.

Rajan, Raghuram G., and Luigi Zingales, 1995, What do we know about capital structure? some evidence from international data, *The Journal of Finance* 50, pp. 1421–1460.

Ramey, Valerie A., and Matthew D. Shapiro, 2001, Displaced capital: A study of aerospace plant closings, *Journal of Political Economy* 109, 958–992.

Riddick, Leigh A., and Toni M. Whited, 2009, The Corporate Propensity to Save, *Journal of Finance* 64, 1729–1766.

Schlingemann, Frederik P., Rene M. Stulz, and Ralph A. Walkling, 2002, Divestitures and the liquidity of the market for corporate assets, *Journal of Financial Economics* 64, 117–144.

Shleifer, Andrei, and Robert W. Vishny, 1992, Liquidation values and debt capacity: A market equilibrium approach, *The Journal of Finance* 47, 1343–1366.

Sibilkov, Valeriy, 2009, Asset liquidity and capital structure, *Journal of Financial and Quantitative Analysis* 44, 1173–1196.

Slovin, Myron B., Marie E. Sushka, and Steven R. Ferraro, 1995, A comparison of the information conveyed by equity carve-outs, spin-offs, and asset sell-offs, *Journal of Financial Economics* 37, 89 – 104.

Subramaniam, Venkat, Tony T. Tang, Heng Yue, and Xin Zhou, 2011, Firm structure and corporate cash holdings, *Journal of Corporate Finance* 17, 759–773.

Tang, Dragon Yongjun, and Hong Yan, 2010, Market conditions, default risk and credit spreads, *Journal of Banking & Finance* 34, 743–753.

Warusawitharana, Missaka, 2008, Corporate asset purchases and sales: Theory and evidence, *Journal of Financial Economics* 87, 471–497.

Weiss, Lawrence A., and Karen H. Wruck, 1998, Information problems, conflicts of interest, and asset stripping: Chapter 11's failure in the case of eastern airlines, *Journal of Financial Economics* 48, 55–97.

Whited, Toni M., and Guojun Wu, 2006, Financial Constraints Risk, *Review of Financial Studies* 19, 531–559.

Williamson, Oliver E, 1988, Corporate finance and corporate governance, *Journal of Finance* 43, 567–91.

Yang, Liu, 2008, The real determinants of asset sales, *The Journal of Finance* 63, 2231–2262.

Yu, Fan, 2005, Accounting transparency and the term structure of credit spreads, *Journal of Financial Economics* 75, 53–84.

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