Co-Collateral Risk

Massimo Massa[*], Chengwei Wang[†], Hong Zhang[‡]

Abstract

This paper proposes a novel measure of stock-level margin constraints to study the impact of funding risk on the cross-section of stock returns. More specifically, we use daily cash collateral information collected from the short selling market to construct the measure, and decompose it into two components reflecting either co-movements in margin requirements (co-collateral risk) or idiosyncratic variations. Since co-collateral risk tightens margin constraints faced by major traders, it is expected to be associated with positive return premium. We test this implication for available U.S. stocks, and indeed find a significantly positive relationship between co-collateral risk and out-of-sample stock returns. The strategy of buying/shorting stocks with top/bottom 10% co-collateral betas can deliver an annualized DGTW-adjusted return of 6%. Additional tests further confirm that co-collateral beta imposes constraints on short-selling activities and that our results are not explained by a list of asset pricing anomalies.

Keywords: Funding risk, Collateral, Short-selling, Stock Returns.

JEL Codes: G14, G30

[*] INSEAD, Boulevard de Constance, 77305 Fontainebleau Cedex, France; E-mail: massimo.massa@insead.edu

[†] INSEAD, 1 Ayer Rajah Avenue, Singapore, 138676; E-mail: chengwei.wang@insead.edu

[‡] PBC School of Finance, Tsinghua University, 43 Chengfu Road, Haidian District, Beijing, PR China 100083, Email: zhangh@pbcsf.tsinghua.edu.cn

Introduction

The recent global financial crisis has brought forth new considerations regarding the asset pricing role of funding risk and margin constraints. While traditional asset pricing models assume that sophisticated traders have unlimited capital, in practice, capital is often limited by margin requirements, which can consequently affect asset returns (e.g., Geanokoplos and Fostel 2008, Brunnermeier and Pedersen 2009, Garleanu and Pederson 2011, He and Krishnamurthy 2012, 2013, Brunnermeier and Sannikov 2014, Kondor and Vayanos 2015, similar intuitions can actually be traced back before the crisis—see, e.g., Shleifer and Vishny 1997, Allen 2001, and Kyle and Xiong 2001). A common feature of these theoretical studies is that funding constraints induce asset prices to deviate from the prediction of traditional asset pricing models. However, compared to the burgeoning theoretical literature, empirical evidence regarding how stock-level funding conditions in the equity market affect asset price still remains scarce.[4]

Our paper aims to fill this gap by constructing an *explicit* measure of funding risk based on information on the stock-level margins in the short selling market. The key intuition behind our measure is that stock margins can be attributed to both a "*co-margin*" part, which captures a stock's exposure to market-wide margin requirement, and an idiosyncratic part, which captures stock-specific variations in margin requirement. The existing literature provides vast evidence on the existence of the two components. Brunnermeier and Pedersen (2009), for instance, show that margins can be affected by the market liquidity of the securities which, as demonstrated in Acharya and Pedersen (2005), can exhibit strong co-movement. On the other hand, asset-specific institutional frictions, such as those in the over-the-counter search markets (e.g., Duffie, Garleanu, and Pedersen, 2005, 2007, Vayanos and Weill 2008), can also affect margins.

The asset pricing implications of co-margins can be most clearly demonstrated based on the theoretical model of Garleanu and Pederson (2011), in which expected asset returns are affected by the margin constraints of assets in addition to the traditional CAPM covariance risk. If we decompose the impact of margin into its two components, we can see that co-margin tightens the capitals of the traders and, consequently, contributes positively to expected asset returns. The idiosyncratic part of stock margin, by contrast, can be diversified away. Hence, it neither tightens capitals nor affects stock return.

[4] Adrian, Etula, and Muir (2014) and He, Kelly, and Manela (2015) are notable exceptions in the recent literature to provide direct evidence related to the equity market. These authors show that shocks to primary dealers' leverage and capital ratio conditions may play an important role in affecting asset price. Their proxies, however, do not explore funding conditions for individual stocks. Building on the intuition of Frazzini and Pedersen (2014) that a market-neutral strategy exploiting the implicit leverage conditions of stocks can earn abnormal return, Chen and Lu (2015) build indirect stock-level proxies of funding liquidity risk. Footnote 3 provides more discussions on various funding liquidity measures.

Building on this intuition, we propose to use the collateral information in the short selling market to construct an explicit measure of funding constraint at the stock level. In particular, the short selling market typically uses cash-dominated collateral as a specific form of margin requirement. When short sellers borrow shares of domestic securities, they typically pass the value of the borrowed shares in collateral—mostly in cash—to the lenders. Our short selling database allows us to identify, on a daily basis, the value of cash collaterals posted by short sellers. The typical value of cash collateral is around 94% of the value of the borrowed shares in our sample, with significant variations in both time series and the cross section (the standard deviation is about 10% in the whole sample). An increase in this cash collateral ratio indicates a stricter margin requirement.[5]

Using this information, we regress daily *changes* in the cash collateral ratio of an asset on those of the market, and derive from this regression the "co-movement" part. We will call it "co-collateral risk" or simply "co-collateral". Also, following the convention of the literature, we refer to the regression coefficient as "co-collateral beta" and the stock-specific part as "idiosyncratic collateral volatility".[6] Co-collateral provides an explicit proxy of co-margin and should be associated with positive return premium when funding risk is priced in the market.

Compared to the standard proxies for funding risk—e.g., Libor rate, TED spread, credit spread credit financing[7]—our proxy of funding constraint has two merits. First, the proxy is stock-specific and not just market-wide. Second, its variations both in time series and in the cross section allow us to capture the co-movement in funding risk across different assets in the equity market.

Moreover, the focus on the short selling market is ideal for our purpose not only because it is among the few areas that can offer data to directly describe the funding conditions of individual stocks, but also because it fits the above theoretical arguments of margin-based asset pricing models very well. The funding constraint described Garleanu and Pederson (2011), for instance, implies that short selling ties up capital rather than freeing up capital, which is consistent with the aforementioned margin requirement in the real short selling market. Moreover, the focus on the short-selling market

[5] In practice, lenders typically ask for an additional 2% value of the stocks in collateral, making the total collateral 102% of the value of the stocks lent. This 2% haircut, however, is smaller than the cross-stock variation in cash collateral. Hence our study focuses mostly on cash collateral rather than this haircut. Moreover, in addition to collateral, SEC Regulation T further asks the retail customers of brokers to post 50% of the market value of the stock in their margin account as initial margin, which can be posted in Treasury Bills (see, e.g., Duffie, Garleanu, and Pedersen, 2002).

[6] More explicitly, for each month we construct co-collateral measures based on the daily information in the three-month period up to the current month (inclusive) for publically listed U.S. firms with available information for the sample period from 2006 to 2010. Daily cash collateral information is available starting June 2006.

[7] Existing funding liquidity proxies include the TED spread (Gupta and Subrahmanyam 2000), broker-dealers' asset growth (Adrian and Shin 2010), financial sector leverage, major investment banks' CDS spread, hedge fund leverage, investment bank excess returns, 3-month LIBOR rate, the term spread, and the VIX (Ang, Gorovyy, and Van Inwegen 2011), Treasury security-based funding liquidity (Fontaine and Garcia 2012; Fontaine, Garcia, and Gungor 2015), the swap spread (Asness, Moskowitz, and Pedersen 2013), percentage of loan officers tightening credit standards for commercial and industrial loans (Lee 2013), broker-dealers' leverage factor and credit spread (Adrian, Etula, and Muir 2014).

has three additional benefits. First, short-sellers are sophisticated and better informed investors (Cohen, Diether and Malloy, 2007, Boehmer, Jones and Zhang, 2008, Diether, Lee and Werner, 2009, Engelberg, Reed and Ringgenberg, 2012). Second, short-sellers are able to scale up their trades to a very high multiple of their underlying capital. This means that any restriction on such ability may have bigger impact on the market than those of the other traders (individuals or long-only mutual funds). Third, short-sellers are among the major liquidity providers in the market (e.g., Boehmer, Jones and Zhang, 2008, Saffi and Sigurdsson, 2011, Boehmer and Wu, 2013). Therefore, any restriction on their activity are likely to impact the market in general and stock return in particular.

The nutshell of our empirical results is that co-collateral beta significantly predicts stock return, while idiosyncratic collateral volatility do not have such a power. More explicitly, when we regress monthly DGTW-adjusted stock returns on lagged collateral beta, we find a strong and positive relationship. If we focus on the Fama-MacBeth (Panel) specification, a one-standard-deviation increase in co-collateral beta is related to 2.55% (2.26%) higher expected return per year. Although idiosyncratic collateral volatility also predicts returns in some specifications on its own, its prediction power is weakened, if not totally absorbed, by co-collateral beta. We get very similar results when alternative measures of risk-adjusted returns are used: CAPM 1-factor alpha, Fama-French 3-factor alpha, Carhart 4-factor alpha and Pastor-Stambaugh 5-factor alpha. A one-standard-deviation increase in co-collateral beta is typically related to an annualized risk-adjusted return premium between 1.88% and 2.15% (between 1.45% and 1.73%) in Fama-MacBeth (Panel) specifications based on these factor models.

Next, we conduct two types of portfolio analyses. In the first analysis, we ask whether co-collateral is also priced in the 25 size and book-to-market sorted Fama-French portfolios. To explore this question, we aggregate co-collateral beta at the portfolio level, and examine how it predicts stock return in the following month together with the exposures of these portfolios with respect to the standard Fama-French-Carhart factors. We find that, consistently with the previous stock-level results, that collateral risk is also priced at the portfolio level. A one-standard-deviation increase in co-collateral beta is related to 2.04% higher annualized return. Note that this result holds even when we control for the standard risk factors, suggesting that the impact of margin goes beyond what traditional asset pricing factors can describe.

In the second portfolio analysis, we build our own portfolios in each month by sorting stocks into ten deciles according to their lagged co-collateral beta (decile 10 is associated with high co-collateral beta). We rebalance the portfolios monthly, and calculate the out-of-sample abnormal returns of these co-collateral beta-sorted portfolios. We find that, consistent with our stock-level analysis, decile 10 portfolio delivers significant risk-adjusted return, whereas decile 1 portfolio has insignificant performance. Furthermore, the long-short strategy of buying/selling stocks in the top/bottom deciles can deliver a DGTW-adjusted long-term performance of 6% per year, which is both statistically significant and economically relevant. Likewise, the long-short strategy delivers 4.8%, 6.2%, 5.8%, and 5.8% risk-adjusted return per year when stock return are adjusted by the CAMP model, the Fama-French 3-factor model, the Fama-French-Carhart 4-factor model, and the Pastor-Stambaugh 5-factor model, respectively.

The above tests establish a fundamental relationship between co-collateral risk and stock returns. We further conduct a list of additional tests to shed more lights on the economic mechanism behind the scene. First of all, we have argued that co-collateral imposes a funding constraint on short-selling. If so, co-collateral should also be associated with less short selling activities. To test this implication, we investigate how co-collateral beta affects the future borrowing by short sellers (i.e., the fraction of outstanding shares that are "on loan") as well as the utilization ratio of lendable shares (i.e., the fraction of lendable shares that are borrowed by short sellers). Indeed, in Fama-MacBeth (panel) specifications, a one-standard-deviation increase in co-collateral beta is related to a reduction of short interest by 0.02% (0.01%) and a reduction of utilization ratio by 0.06% (0.04%) in the following month, confirming that co-collateral risk put funding constraints on short selling activities.

Secondly, we test whether margin requirement increases the total volatility of assets in addition to asset returns (Garleanu and Pederson 2011). To examine this implication, we explore the relationship between co-collateral beta and total volatility of stocks in Fama-MacBeth (panel) specifications. We indeed find that co-collateral beta enhances total volatility: a one-standard-deviation increase in co-collateral beta is associated with 0.03% (0.02%) higher stock volatility.

In the third additional test, we notice that co-collateral may also affect asset price by imposing a stricter short sale constraint when investors have dispersed opinions (e.g., Miller 1977; Hong and Stein 2003). To explore whether the impact of co-collateral is more related to margin or more through the channel of differences in opinion, we focus on one prediction of Hong and Stain (2003) that enhanced short selling constraints should lead to more crashes when investors have different opinions. Hence, we examine the relationship between skewness (market crash leads to negative skewness) and co-collateral beta. We find that co-collateral beta actually enhances skewness, suggesting that dispersed opinions is not the major mechanism behind our findings.

Finally, we conduct a list of robustness checks. We have already controlled for value premium, the size premium, and momentum in our main specification. In robustness checks, we further show that our results are not spuriously generated by various more recently documented anomalies associated with the ratio of gross profit to assets (Novy-Marx, 2013), operating profit (Fama and French, 2015), asset growth (Cooper et al., 2008), investment-to-asset (Hou, Xue, and Zhang, 2015), net stock issuance (Xing, 2008), accruals (Fama and French, 2008), and the logarithm of net operating assets (Hirshleifer, Hou, Teoh, and Zhang, 2004). Our second robustness check illustrate that co-

collateral beta can predict quarterly return. Finally, we show that our results are robust to alternative definitions of co-collateral beta.

Our findings contribute to several strands of literature. First, we contribute to studies on the impact of funding risk and margin results (Shleifer and Vishny 1997, Allen 2001, and Kyle and Xiong 2001, Geanokoplos and Fostel 2008, Brunnermeier and Pedersen 2009, Garleanu and Pederson 2011, He and Krishnamurthy 2012, 2013; Brunnermeier and Sannikov 2014; Kondor and Vayanos 2015). Different from the traditional asset pricing models, the above mentioned studies typically do not rely on a representative investor to price assets. Rather, asset price is jointly determined by multiple agents with different degrees of sophistication and capital constraints. Our major contribution is two-fold. We first propose that margin requirements could contain both a market component and a firm-specific component. We then provide an explicit proxy of funding constraint to explore the impact of margin or funding risk on the cross-section of stock returns.

To the best of our knowledge, we are the first to construct funding risk measures based on explicit margin information in the equity market that have both stock-level and time-series variations. Our proxy, therefore, also extends the effort of the existing empirical literature in constructing and examining the impact of funding risk measures (e.g., Gupta and Subrahmanyam 2000; Adrian and Shin 2010; Ang, Gorovyy, and Van Inwegen 2011; Fontaine and Garcia 2012; Asness, Moskowitz, and Pedersen 2013; Lee 2013; Adrian, Etula, and Muir 2014; He, Kelly, and Manela 2015; Chen and Lu 2015; Fontaine, Garcia, and Gungor 2015).

Thirdly, we contribute to the literature on short-sellers' behavior. The focus in this literature has always been on predictability and informativenss of short-sellers (e.g., Cohen, Diether and Malloy, 2007, Boehmer, Jones and Zhang, 2008, Diether, Lee and Werner, 2009, Engelberg, Reed and Ringgenberg, 2012). We contribute by focusing on the constraints that limit the use of such information. By doing so, we also contribute to the literature on the impact of short-sellers' behavior on stock prices. The focus has been on the showing that short-sellers improve market liquidity and market efficiency (Boehmer, Jones and Zhang, 2008, Saffi and Sigurdsson, 2011, Boehmer and Wu, 2013). We contribute by providing evidence on the sources of the constraints that limit their impact.

The remainder of the paper is organized as follows. Section II discusses the theoretical background of our analysis. Section III presents the data that we employ and the main variables constructed for the analysis. Section IV describes the main empirical tests at the stock level and at the portfolio level. Section V presents additional tests and robustness tests, and a brief conclusion follows.

II. Asset Pricing with Co-margins

The motivation of our test can be easily demonstrated relying on the model of Garleanu and Pederson (2011). More specifically, Garleanu and Pederson (2011) propose the following margin-based asset pricing model (their Proposition 3):

$$\underbrace{u_{it} - r_{Ct}}_{\substack{Expected\ excess\ return \\ of\ risky\ asset\ i}} = \underbrace{\beta_{it} \times \lambda_t}_{\substack{CAPM\ risk\ exposure \\ and\ risk\ premium}} + \underbrace{m_{it} \times \varphi_t}_{\substack{Margin\ (haircut)\ times \\ margin\ premium}}, \quad (1)$$

where the required return of the assets differs from the one based on a standard CAPM model by the last term, in which m_{it} is the margin requirement of asset i, measured as the fraction of investments that must be financed by an agent's own capital (i.e., haircut), and φ_t is the margin premium, measured as the shadow cost of funding for the risk-tolerant agents multiplied by the relative importance of these agents.

The impact of margins is introduced through the margin constraint as follows:

$$\sum_i m_{it} \times |\theta_i| + \eta_u \leq 1, \quad (2)$$

where θ_i is the proportion of wealth of an agent invested in risky asset i, and η_u is the investment weight in an uncollateralized riskless money-market asset.[8] Equation (2) basically says that, aside from the uncollateralized riskless money-market asset, an agent can tie up in his capital in margins for long or short positions in all risky assets: the summation of all his capital in these margin account should be less than 100% of his total wealth.

We focus on the time-varying property of the margin requirement to demonstrate the asset pricing impact of funding risk. Our key intuition is that, in general, stock-level margin requirements can be attributed to two components with different economic rationales: a "*co-margin*" component which captures the impact of market-wide margin requirements on individual stocks and an idiosyncratic part which reflects some special properties of the underlining stock on its own.

It is reasonable to think that the margin requirement of an asset can both contain a market-wide component and be affected by some firm-specific characteristics. Brunnermeier and Pedersen (2009), for instance, show that margins can be affected by the market liquidity of the securities which, as demonstrated in Acharya and Pedersen (2005), has exhibited strong co-movement. Some more recent empirical studies also show that shocks to primary dealers' leverage and capital ratio may play an important role in affecting asset price through the funding risk of financial intermediaries (Adrian, Etula, and Muir, 2014; He, Kelly, and Manela, 2015). On the other hand, asset-specific institutional frictions, such as those in the over-the-counter search markets (e.g., Duffie, Garleanu, and Pedersen, 2005, 2007; Vayanos and Weill 2008), can also affect margins.

[8] The model assumes the existence of two riskless money-market assets, one collateralized and the other uncollateralized; the agent will invest rest of his money in a collateralized riskless asset

In particular, we can define the margin requirement of m_{it} as::

$$m_{it} = a_i + \beta_i^m \times m_t + \epsilon_{it}\ , \quad (3)$$

where m_t is the average margin requirement of the market across all the assets, β_i^m is the exposure of asset i to the margin requirement of the market (i.e., "co-margin"), a_i is the unconditional asset-specific margin requirement, and ϵ_{it} is the individual margin requirement with an *i.i.d.* normal distribution.

The way the two components of margins affect returns, however, are totally different. As margin requirement is priced in equilibrium when capital is constrained, so will be its co-movement part. Indeed, capital is now constrained in Equation (2) by co-margin according to $\sum_i \beta_i^m \times m_t \times |\theta_i|$. Consequently, the expected asset return of an asset will be affected by co-margin and margin premium according to Equation (1), i.e., $u_{it} - r_{Ct} \sim \beta_i^m \times m_t \times \varphi_t$. In this case, the unconditional asset return will be proportional to β_i^m, because asset return can be written as $E[u_{it} - r_{Ct}] \sim \beta_i^m \times E[m_t \times \varphi_t] = \beta_i^m \times \bar{\varphi}$, where $\bar{\varphi} = E[m_t \times \varphi_t]$ is the unconditional margin premium associated with the average margin requirement of the market.[9] The idiosyncratic movement of the funding risk, by contrast, will be diversified away when the agent invests in a diversified manner (i.e., $\sum_i \epsilon_{it} \times |\theta_i| = 0$) and, consequently, has little impact on asset return. Overall, when the margins contain both a co-margin component and a firm-specific component, the first component should be associated with positive stock return.

We rely on this intuition and we construct an explicit proxy for co-margin that allows us to test the above asset pricing implications. Since the literature lacks good proxies for funding liquidity especially at the stock level, we propose to use the collateral information in the short selling market to construct such a proxy.

The short selling market is ideal not only because it is allows a very rare glimpse on the funding conditions of stocks (as we will discuss shortly in the data section), but also because it fits the above theoretical arguments well. In particular, the funding constraint as described in Equation (2) involves the absolute-value operator (i.e., $\sum_i m_{it} \times |\theta_i|$) which, as pointed out by Garleanu and Pederson (2011), implies that short selling ties up capital (by contrast, a linear constraint without the absolute-value operator implies that short selling frees up capital). This property, together with the assumption of risk tolerant agents, tightly capture the characteristics of real world short-sellers in terms of their sophistication and use of leverage (Cohen, Diether and Malloy, 2007, Boehmer, Jones and Zhang, 2008, Diether, Lee and Werner, 2009, Engelberg, Reed and Ringgenberg, 2012), as well as their role in affecting liquidity (e.g., Boehmer, Jones and Zhang, 2008, Saffi and Sigurdsson, 2011, Boehmer and Wu, 2013). The separation between co-margin and idiosyncratic margin also fits well with the

[9] Here we assume that co-margin is independent of the show cost of capital of the agent. The potential mutual influence between the two goes beyond the scope of this paper.

institutional frictions observed in the short selling market (e.g., Duffie, Garleanu, and Pedersen, 2002). Restrictions on the funding conditions of shorts, therefore, provide a powerful test to the asset pricing implications of funding constraints as discussed above.

Before we move on to data, it is worth pointing out that, although we use the model of Garleanu and Pederson (2011) to demonstrate the impact of co-margin, the intuition is consistent with quite general a list of models on intermediary asset pricing and funding liquidity (e.g., Kyle and Xiong 2001, Geanokoplos and Fostel 2008, Brunnermeier and Pedersen 2009, Garleanu and Pederson 2011, He and Krishnamurthy 2012, 2013; Brunnermeier and Sannikov 2014). By increasing the scarcity of intermediary capital, for instance, co-margin will also contribute to risk premium in the framework of He and Krishnamurthy (2012, 2013).

III. Data and Main Variables

This section explains how to use cash-collateral information from the short selling market to construct an explicit proxy for co-margin. When there is no confusion, we will label our proxy "co-collateral" following the spirit of the previous section.

A. Data and Variables

We use data from many sources. Equity lending data come from DataExplorers, a privately owned company that supplies financial benchmarking information to the securities lending industry and short-side intelligence to the investment management community. Information detailed at the stock level is available from May 2002 onwards.[10] The dataset has the unique feature that it provides information on not only the value of shares that are on loan but also the margin information of loaned shares, which is important for the purposes of this paper. In our study, we focus on the sample period beginning from July 2006 till June 2010, when Data Explorer covers *daily* information for the short selling market, which allows us to construct co-collateral measures. We focus on the US sample and verify that short-selling information is available for approximately 84% of the firms in our sample period, which is similar to the figure reported in Saffi and Sigurdsson (2011). For firms covered in the short-selling data, we retrieve stock market data from CRSP and balance sheet data from Compustat to compute market capitalization and book-to-market ratios (we include only common shares, i.e., when CRSP share code = 11 or 12). We also employ data on analyst coverage (I/B/E/S), and institutional ownership (Thompson Reuters 13f filings). To be included in the sample, we require that each firm must have at least 50 weekly return observations, price larger than $5, and more than 8

[10] A more detailed description of the data can be found in Saffi and Sigurdsson (2011) and Jain et al. (2012). In the United States, equity transactions are settled after three trading days, while equity loans are settled immediately. Accordingly, a short-seller does not need to borrow a stock until 3 days after taking his or her short position. Therefore, we compute the amount of shorted stocks on a day using the shares on loan at t+3 following Geczy, Musto and Reed (2002) and Thornock (2013).

monthly lending observations in a year. The sample period is from July 2006 to August 2010. The final combined data have an average of 1,708 stocks per month.

We now describe our main variables. From the short-selling database, we mainly retrieve three types of information: cash collateral ratio of a stock, short interest, and the utilisation ratio of lendable shares. Among the three, cash collateral ratio is related to the margin requirement in the short selling market which, as explained in Duffie, Garleanu, and Pedersen (2002), is as follows. When short sellers borrow shares of domestic securities, they typically pass cash collateral of 102% of the value of the borrowed shares to the lenders. SEC Regulation T further asks the retail customers of brokers to post an additional margin requirement of 50% of the market value of the stock as collateral—this additional collateral can be posted in Treasury Bills. Based on the above margin requirements, DataExplorers reports the total value of stock on loan, which allows us to define the Cash collateral ratio of a stock (*Col*) as the value of stock on loan collateralized by cash divided by total value of stock on loan. We can then define change in cash collateral ratio (*ΔCol*) as the cash collateral ratio at period t minus cash collateral ratio at period $t-1$. Here, *Col* and *ΔCol* can be defined both on the monthly frequency and on the daily basis. We will report the distribution of monthly collateral variables in this section, together with other monthly variables that we will use to conduct empirical tests. Daily collateral information, by contrast, is mainly used to define measures of co-collateral and idiosyncratic collateral risk in the next section.

Next, we define short interest ratio (*SIR*) as the total value of stock on loan, as reported in DataExplorers, divided by total market capitalization of the stock, and monthly change in short interest (*ΔSIR*) as the average*SIR* in month t minus that in month $t-1$. Finally, DataExplorers also reports the utilization ratio of lendable shares (i.e., the value of stock on loan from lenders divided by the total lendable value), based upon which we define the monthly change in utilisation (*ΔUtili*) as the average utilisation ratio in month t minus that in month $t-1$.

The literature also suggests that certain firm characteristics may affect the incentives for insider trades. For instance, insiders trade more actively in large stocks, in low book-to-market firms, and following positive past returns (e.g., Lakonishok and Lee, 2001; Ke et al., 2003; and Rozeff and Zaman 1998). We confirm and control for these effects by explicitly employing a set of control variables: *Market size*, defined as the market capitalization of the firm; *Book to market*, defined as the book value of equity divided by market capitalization; *Momentum*, defined as past 12-month aggregated return of the stock; *IO* is institutional ownership, which is defined as institutional ownership shares divided by adjusted shares outstanding; *Volume* is calculated as the logarithm of trading volume of the stock; *Freefloat* is the proportion of a stock's market capitalization available to ordinary investor; *Zero*, defined as the proportion of zero-return weeks in a given year, where zero-return is defined as return within ± 0.1bps; *Illiq* is the Amihud (2002) illiquidity measure calculated as the average absolute daily return per dollar volume over the past 12 months. All the control variables are winsorized at the 99% and 1% levels.

The recent literature also documents the existence of a wide range of asset pricing anomalies, or firm level characteristics, which could be linked to asset returns. In our main tests, we will explicitly control for value, size, and momentum. In our robustness checks, we will further control for a list of more recently documented anomalies, including the ratio of gross profit to assets (Novy-Marx, 2013), operating profit (Fama and French, 2015), asset growth (Cooper et al., 2008), investment-to-asset (Hou, Xue, and Zhang, 2015), net stock issuance (Xing, 2008), accruals (Fama and French, 2008), and the logarithm of net operating assets (Hirshleifer, Hou, Teoh, and Zhang, 2004). Appendix 1 provides detailed definition of each variable.

In Table 1, we report summary statistics for the above variables except the construction and summary statics of co-collateral variables, which we will discuss in the next section. In Table 1, we report the number of observations, mean, standard deviation, and percentile distributions of short-selling variables, stock return, risk and controls for our sample of 3,023 U.S stocks at stock-month level. The average firm in the sample has a market capitalization of 1.6 billion USD, a book-to-market ratio of 0.5, and 23% institutional ownership. The values of stock returns and control variables are consistent with that of the literature. Most interestingly, we see that in the short selling market in the U.S., majorities of loaned shares are collateralized against cash, which the level of cash collateral to be as high as 93.96% in our sample period. However, cash collateral has significant cross section and time series variations, evident by the standard deviation of cash collateral ratio itself (10% in the full sample) and the standard deviation of monthly changes in cash collateral (5.6% in the full sample). Variations at such a big degree imply that margin requirements in the short selling market vary significantly in the cross section. Our next section, therefore, continue to use collateral information to construct co-collateral for future tests.

B. The Construction of Co-Collateral Measures

Before we construct co-collateral, we want to first report more properties of the margin requirement in the short selling market that is not directly observable from Table 1. Especially, we want to examine the general correlation between collateral changes (i.e., ΔCol) and known risk factors as well as existing proxies of funding risk in the literature. Table 2 achieves this goal by regressing monthly ΔCol on 1) the list of five factors proposed by Fama and French (1993), Carhart (1997) and Pastor and Stambaugh (2003) and the 2) the list of existing funding risk proxies, including the TED spread (Gupta and Subrahmanyam 2000), broker-dealers' asset growth (Adrian and Shin 2010), financial sector leverage, major investment banks' CDS spread, hedge fund leverage, investment bank excess returns, 3-month LIBOR rate, the term spread, and the VIX (Ang, Gorovyy, and Van Inwegen 2011), Treasury security-based funding liquidity (Fontaine and Garcia 2012; Fontaine, Garcia, and Gungor

2015), the swap spread (Asness, Moskowitz, and Pedersen 2013), percentage of loan officers tightening credit standards for commercial and industrial loans (Lee 2013), broker-dealers' leverage factor and credit spread (Adrian, Etula, and Muir 2014).

The multivariable regression results are reported in Panel A of Table 2, column (1) for the five-factor model and column (2) for the list of 14 funding risk measures (to save space, the univariate regression results are reported in the Internet Appendix). Column (1) shows that positive changes in cash collateral requirements reduces liquidity (significant at the 5% level), but are uncorrelated with the traditional Fama-French-Carhart risk factors. Hence, consistent with the arguments of margin-based asset pricing models such as Garleanu and Pederson (2011), margin requirements are unrelated to traditional asset pricing factors. In other words, any potential pricing impact of margin requirements in the short selling market is likely to be in addition to the risk premium proposed in traditional asset pricing models. The relationship between margin requirements and the Pastor and Stambaugh liquidity measure indicates that margins can indeed affect or be affected by the market liquidity conditions as pointed out by Brunnermeier and Pedersen (2009). More specifically, column (2) illustrates that margin requirements in the short selling market could be related to credit spread, Libor rate, and TED spread (significant at the 10%, 5%, and 10% level, respectively). However, if we look at the R-square of both columns, we fine that neither list of factors explain the variations in ΔCol very well: majority time-series variations in ΔCol is actually NOT explained by these two lists of variables. The inability of existing factors, especially existing funding risk proxies, in explaining ΔCol is heuristic: these variables are constructed either on the basis of market-wide information or relying on information outside of the equity market, which limit their ability in describing stock-level margin requirements as observed in the equity market. This inability motivates us to further explore the asset pricing impact of stock-level margin requirements.

In order to conduct the asset pricing tests, in spirit of Equation (3), we now decompose stock margin requirements into the co-movement part as well as the idiosyncratic part. More specifically, in each month t, we estimate the following regression using daily data for each stock *i*:

$$\Delta Col_{i,d} = \alpha_{i,m} + \beta_{i,t}^{Col} \times \Delta col_{MKT,d} + \varepsilon_{i,d}^{Col}, \quad (4)$$

where $\Delta Col_{i,d}$ is the daily change (i.e., from date $d-1$ to date d) in cash collateral ratio for stock i, $\Delta col_{MKT,d}$ is the value-weighted average change in cash collateral ratio of all stocks in the market excluding stock i, $\beta_{i,t}^{Col}$ is the regression coefficient, and $\varepsilon_{i,d}$ is the regression residual. Following the literature convention, we refer to $\beta_{i,t}^{Col}$ as *co-collateral beta* of stock i in month t and $\sigma_{i,t}^{Col}$, the standard deviation of $\varepsilon_{i,d}$ in the same month, as *idiosyncratic collateral volatility*. To obtain stable estimations, we use a rolling window of three months (from month $t-2$ to month t) to estimate Equation (4) in our main analysis—i.e., we include all daily observations in the three-month period including month t to estimate co-collateral beta for month t—our results are robust to this time convention as we will discuss in Internet Appendix.

In Panel B of Table 2, we report the summary statistics of *co-collateral beta* and *idiosyncratic collateral volatility*. Interestingly, the mean value of co-collateral beta is about 0.2, confirming the existence of co-movements in margin requirement changes in the short selling market. The standard deviation of co-collateral beta is around 0.6, suggesting the existence of significant variations in asset co-collateral movements. Idiosyncratic collateral volatility also has significant variations in data. In Figure 1, Panels A, B, C further virsualize the average values as well as the 95% confidence interval for ΔCol, $\beta_{i,t}^{Col}$, and $\sigma_{i,t}^{Col}$, respectively. We can see that both co-collateral beta and idiosyncratic collateral volatility have significant time-series variations as well. Both, for instance, increases in the last quarter of 2008, revealing the potential impact of Lehman on the margin requirements in the short selling market.

Panel C represents the Spearman correlation matrix. We see that co-collateral beta and idiosyncratic collateral volatility are correlated positively and negatively with respect to DGTW-adjusted returns, respectively. The positive correlation between co-collateral beta and stock return is consistent with the existence of a positive margin premium. Of course, this evidence is very preliminary, as many stock characteristics are not control for. Our next section, therefore, move on to multivariate regressions to formally assess the asset pricing impact of co-collateral.

IV. Collateral Risk and Stock Return

We now zoom in on the main proxy of co-margin requirements, i.e., co-collateral beta, and relate it to the stock price.

A. A Stock-based Analysis

We start with a stock-based analysis. We regress future stock returns on the co-collateral beta. Specifically, we estimate:

$$AbnRet_{i,t+1} = \alpha + \lambda_1 \times \beta_{i,t}^{Col} + \lambda_2 \times \sigma_{i,t}^{Col} + C \times M_{i,t} + \varepsilon_{i,t}, \quad (5)$$

where $AbnRet_{i,t+1}$ is the one-month ahead DGTW-adjusted stock return (by size, book-to-market ratio and past 12 months return), $\beta_{i,t}^{Col}$ and $\sigma_{i,t}^{Col}$ and co-collateral beta and idiosyncratic collateral risk estimated from Equation (4) for month t (with λ_1 and λ_2 being their associated risk premium, respectively), and $M_{i,t}$ stacks a set of control variables including stock size, book-to-market ratio, past 12 month return, institutional ownership, trading volume, free float, zero return weeks and Amihud's illiquidity. Appendix 1 provides detailed definition of each variable.

We report the results in Table 3. In Model (1) to (3), the coefficients are estimated using a Fama-Macbeth specification with Newey-West robust standard errors (include 12 month lags). In Model (4) to (6), we run a panel specification that includes firm and calendar month dummies and the standard errors are clustered at firm and month level.

We find a strong and positive correlation between co-collateral beta and stock returns. If we focus on the Fama MacBeth (Panel) specification in Models (3) and (6), a one-standard-deviation increase in co-collateral beta is related to 2.16% higher expected return per year.[11] Although idiosyncratic collateral volatility also predicts returns in Models (2) and (5) on its own, its prediction power is weakened, if not totally absorbed, by co-collateral beta in Models (3) and (6).

In the Internet Appendix, we further control for short selling demand and supply shocks following Cohen, Diether and Malloy (2007). Our results remain similar, suggesting that the return predictability of collateral risk is not related to the forecasting power of the short-sellers.

Table 4 further examine the pricing implication of co-collateral by using various factor models to adjust stock return. More specifically, in Models (1) to (4) of Table 4, we conduct Fama-Macbeth regressions similar to that of Model (3) in Table 3, except that the dependent variables become the out-of-sample excess stock return $R\text{-}R_f$, CAPM 1-factor alpha, Fama-French 3-factor alpha, Carhart 4-factor alpha, and the Pastor-Stambaugh 5-factor alpha, respectively. Models (5) to (8) conduct panel regressions on these variables following Model (6) of Table 3. When a factor-model is used, the abnormal return of a stock in month t is constructed as the return of the stock in the month minus the product between the realized factor returns in month t and the exposure of the stock with respect to the factors estimated from a three-year rolling window from $t - 36\ months$ to $t - 1\ month.$

Table 4 further confirms the strong and positive relations between co-collateral beta and out-of-sample asset returns. Idiosyncratic collateral volatility, by contrast, does not exhibit a similar return predicative power. Especially, in Panel specifications, it loses explanatory power in all proxies of returns.

B. Two Portfolio Analyses

We now conduct two portfolio analyses with different purposes. The first analysis aims to ask whether co-collateral is also priced in the known 25 size and book-to-market sorted Fama-French portfolios. In the second analysis, we explore ten portfolios sorted by co-collateral beta to assess the magnitude of the asset pricing impact of margin requirements.

[11] For instance, the regression coefficient of Model (3) is 0.29. We then estimate the economic magnitude as $0.29 \times 0.615 = 0.178\%$ per month, where 0.615 is the standard deviation of $\beta_{i,t}^{Col}$ in the sample. We then compute the annualized return impact as $(1 + 0.178\%)^{12} - 1 = 2.16\%$.

To explore the first question, we aggregate co-collateral betas of individual stocks (as well as their betas to other factors) at the portfolio level, and examine how portfolio beta predicts stock return in the following month together. More specifically, for each stock in month t, we estimate co-collateral beta based on the rolling period from $t-2$ and t as specified in Equation (5). In a similar manner, we calculate the risk-exposure of individual stocks for Fama-French-Carhart factors. Next, we construct the portfolio beta as the equal-weighted average of the above estimated betas across all the stocks in it. Finally, we estimate the risk premium associated with co-collateral beta and other risk factors by regressing the out-of-sample monthly excess return of the 25 portfolios on the corresponding portfolio betas. The final step employs a Fama-Macbeth specification with Newey-West robust standard errors (include 12 month lags).

The results are tabulated in Table 5. In Model (1), only co-collateral beta is included as the independent variable to explain out-of-sample portfolio return. Models (2) to (4) include the market factor, the Fama and French's (1993) three factors, as well as the Carhart's (1997) momentum factor. The results are consistent with the previous ones and show that collateral risk is priced at the portfolio level. A one-standard-deviation increase in co-collateral beta is related to 2.04% higher annualized return. Note that this result holds even when we control for the standard risk factors, suggesting that the impact of margin goes beyond what traditional asset pricing factors can describe.

Since the first portfolio test confirm that co-collateral risk is priced at the portfolio level, we now move on to the second portfolio analysis in which we construct our own mimicking portfolios based on exposure to co-collateral risk—i.e., co-collateral betas. We then calculate the calendar-time abnormal returns of portfolios sorted on the basis of co-collateral beta.

We proceed as follows. At the beginning of every month, all sample stocks are ranked in ascending order on the basis of their co-collateral beta in the previous month, and the ranked stocks are assigned to ten decile portfolios respectively. Stocks with the lowest past month $\beta_{i,t}^{Col}$ comprise decile 1 and stocks with the highest $\beta_{i,t}^{Col}$ comprise decile 10. Within a given portfolio, all stocks are equally weighted. The portfolios are rebalanced every month to maintain equal weights. We then obtain the long-term return of these ten decile-based portfolios and compute their monthly excess return, DGTW-adjusted return, as well as their risk-adjusted alphas based on the CAPM model, Fama-French three-factor model, Carhart four-factor model and Pastor-Stambaugh five-factor model. We also construct long-short portfolios (L/S) as the zero-cost portfolio that holds the stocks with top 10% co-collateral betas and sells short the stocks with the bottom 10% co-collateral betas in the previous month.

We report the results in Table 6. We find that, consistent with our stock-level analysis, decile 10 portfolio delivers significant risk-adjusted return, whereas decile 1 portfolio has insignificant performance. Furthermore, the long-short strategy of buying/selling stocks in the top/bottom deciles can deliver a DGTW-adjusted long-term performance of 6% per year, which is both statistically significant and economically relevant. Likewise, the long-short strategy delivers 4.8%, 6.2%, 5.8%, and 5.8% risk-adjusted return per year when stock return are adjusted by the CAMP model, the Fama-French 3-factor model, the Fama-French-Carhart 4-factor model, and the Pastor-Stambaugh 5-factor model, respectively.

V. Additional Tests and Robustness Checks

A. The Economic Mechanism

The previous tests establish a fundamental relationship between co-collateral risk and stock returns. We further conduct a list of additional tests to shed more lights on the economic mechanism behind the scene. First of all, we have argued that co-collateral imposes a funding constraint on short-selling. We want to provide evidence in this section to validate this assumption.

We notice that, if co-collateral imposes margin constraints on short selling, it should also be associated with less short selling activities. To test this implication, we investigate how co-collateral beta affects the future borrowing by short sellers (i.e., the fraction of outstanding shares that are "on loan") as well as the utilization ratio of lendable shares (i.e., the fraction of lendable shares that are borrowed by short sellers). The empirical specification follows Equation (5), except that monthly change in short interest (*ΔSIR*) and monthly change in utilization (*ΔUtili*) are used as the left-side variables. The results are reported in Table 7, columns 1, 2, 5, and 6. In Models 1 and 2, the coefficients are estimated by the Fama-Macbeth Method with Newey-West robust standard errors (include 12 month lags), while in model 5 and 6, we run panel regression include firm and calendar month dummies and the standard errors are clustered at firm and month level. We find a significant negative correlation between short-selling and collateral risk, both in the case of utilization and in the case of stocks on loans. Indeed, in Fama-MacBeth (panel) specifications, a one-standard-deviation increase in co-collateral beta is related to a reduction of short interest by 0.02% (0.01%) and a reduction of utilization ratio by 0.06% (0.04%) in the following month, confirming that co-collateral risk put funding constraints on short selling activities.

Next, we test whether margin requirement increases the total volatility of assets in addition to asset returns. Garleanu and Pederson (2011) show that the impact on volatility is also an important property of margin requirements. To examine this implication, we explore the relationship between co-collateral beta and total volatility of stocks in Fama-MacBeth specifications in Model 3 of Table 7 and Panel specifications in Model (7) of the same table. We indeed find that co-collateral beta enhances total volatility: a one-standard-deviation increase in co-collateral beta is associated with 0.03% (0.02%) higher stock volatility.

In the third additional test, we notice that co-collateral may also affect asset price by imposing a stricter short sale constraint when investors have dispersed opinions (e.g., Miller 1977; Hong and Stein 2003). To explore whether the impact of co-collateral is more related to margin or more through the channel of differences in opinion, we focus on one prediction of Hong and Stain (2003) that enhanced short selling constraints should lead to more crashes when investors have different opinions. Hence, we examine the relationship between skewness (market crash leads to negative skewness) and co-collateral beta.

The tests are conducted in Fama-MacBeth specifications, as reported in Model (4) of Table 7, and Panel specifications, as reported in Model (8) of the same table. We find that co-collateral beta actually enhances skewness. Indeed, a one-standard-deviation increase in co-collateral beta is associated with 0.03% (0.02%) higher skewness, suggesting that dispersed opinions is not the major mechanism behind our findings.

B. Robustness Checks

We now carry out some robustness checks. In the first set of checks, we control for anomalies. We have already controlled for value premium, the size premium, and momentum in our main specification. We therefore re-estimate the main results of Table 3 and 4, controlling for a set of more recently documented anomalies associated with the ratio of gross profit to assets (Novy-Marx, 2013), operating profit (Fama and French, 2015), asset growth (Cooper et al., 2008), investment-to-asset (Hou, Xue, and Zhang, 2015), net stock issuance (Xing, 2008), accruals (Fama and French, 2008), and the logarithm of net operating assets (Hirshleifer, Hou, Teoh, and Zhang, 2004).

The results for DGTW-adjusted abnormal return are reported in Table 8. In Models (1) to (8), we add anomalies independently. In Model (9), all anomalies are included. We can see that for both the FamaMacBeth specification (Panel A) and the Panel specification (Panel B), there is a positive relation between co-collateral beta and DGTW return, regardless of the type of anomaly we control for. Table 9 further confirms that co-collateral beta is positively and significantly related to net-of-risk returns in presence all above anomalies.

Our last robustness check examines whether our results are robust to a change in the sampling frequency. We therefore re-estimate Table 3, using a regression based on quarterly frequency. As reported in Table 10, the results are consistent with the previous ones and deliver a robust and economically significant correlation between collateral risk and DGTW-adjusted returns.

Conclusion

In this paper, we propose a novel measure of stock-level margin constraints to study the impact of funding risk on the cross-section of stock returns. More specifically, we use daily cash collateral information collected from the short selling market to construct the measure, and decompose it into two components reflecting either co-movements in margin requirements (co-collateral risk) or idiosyncratic variations. Since co-collateral risk tightens margin constraints faced by major traders, it is expected to be associated with positive return premium when funding risk is priced in the cross section of stock returns.

We indeed find a significantly positive relationship between co-collateral risk and out-of-sample stock returns in our empirical tests. By contrast, idiosyncratic collateral risk is not priced. At the portfolio level, we find that co-collateral risk is priced in the 25 Fama-French portfolio. Mimicking portfolios constructed based on co-collateral beta further confirm a fundamental link between co-collateral and asset return: the strategy of buying/shorting stocks with top/bottom 10% co-collateral betas can deliver a DGTW-adjusted return of as high as 6% per year. Our additional tests further confirm that co-collateral beta imposes constraints on short-selling activities. We further rule out a few alternative explanations based on asset pricing anomalies or dispersion of opinions.

Overall, our results provides important evidence regarding the importance of funding risk in the equity market. This evidence has important normative and policy implications for regulators. Among others, it suggests that policies affecting margin conditions in the short selling market may also affect asset pricing and market efficiency through the channel of funding risk. Our findings, therefore, call for more research on the join impact of funding risk and the short selling market.

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Appendix 1. Variable Definition

Variable	*Definition*
Cash Collateral	
Col	Cash collateral ratio, value of stock on loan collateralized by cash divided by total value of stock on loan.
ΔCol	Monthly change in cash collateral ratio, which equals cash collateral ratio at month t minus cash collateral ratio at month $t-1$.
β_{Col}	Collateral beta, measured by the sensitivity of change in stock i's cash collateral ratio to the change in market aggregate cash collateral ratio; each month t we run time-series regression from a rolling strategy using daily data for each stock i over month t and its preceding two months $t-1$ and $t-2$: $\Delta col_{i,d} = \alpha + \beta_i \Delta col_{m,d} + \varepsilon_{i,d}$, where $\Delta col_{i,d}$ is the daily change in cash colalteral ratio for stock i, $\Delta col_{m,d}$ is the value-weighted average change in cash collateral ratio of all stocks in the market excluding stock i, and we refer to β_i as collateral beta.
σ_{Col}	Idiosyncratic collateral risk, the standard deviation of residual change in stock i's cash collateral ratio; each month t we run time-series regression from a rolling strategy using daily data for each stock i over month t and its preceding two months $t-1$ and $t-2$: $\Delta col_{i,d} = \alpha + \beta_i \Delta col_{m,d} + \varepsilon_{i,d}$, where $\Delta col_{i,d}$ is the daily change in cash colalteral ratio for stock i, $\Delta col_{m,d}$ is the value-weighted average change in cash collateral ratio of all stocks in the market excluding stock i, and we refer to the standard deviation of $\varepsilon_{i,d}$ as idiosyncratic collateral risk.
Lending Supply, Demand and Others	
ΔLoan	Monthly change in short interest, which equals loan at month t minus loan at month $t-1$; loan is the total value of stock on loan divided by total market capitalization of the stock.
ΔUtili	Monthly change in utilisation, which equals utilisation at month t minus utilisation at month $t-1$; utilisation is the value of stock on loan from lenders divided by the total lendable value.
DIN	Dummy variable equals 1 if the stock experienced at least a lending demand shift in (both change in fee and change in short interest are less than 30th percentile), 0 otherwise.
DOUT	Dummy variable equals 1 if the stock experienced at least a lending demand shift out (both change in fee and change in short interest are greater than 70th percentile), 0 otherwise.
SIN	Dummy variable equals 1 if the stock experienced at least a lending supply shift in (change in fee is greater than 70th percentile and change in short interest is less than 30th percentile), 0 otherwise.
SOUT	Dummy variable equals 1 if the stock experienced at least a lending supply shift out (change in fee is less than 30th percentile and change in short interest is greater than 70th percentile), 0 otherwise
DSHIFT	DSHIFT=DOUT-DIN
SSHIFT	SSHIFT=SOUT-SIN
Stock Return & Risk	
$R-R_f$	Stock return minus risk-free rate.
Ret^{dgtw}	DGTW adjusted stock return by stock size and book-to-market ratio and past 12 months return.
1-Factor α	Stock alpha from a regression of monthly excess return on market return, using 3-year rolling strategy.
3-Factor α	Stock alpha from a regression of monthly excess return on Fama and French (1993)

	three factor, using 3-year rolling strategy.
4-Factor α	Stock alpha from a regression of monthly excess return on Fama and French (1993) three factors and Carhart (1997) momentum factor, using 3-year rolling strategy.
5-Factor α	Stock alpha from a regression of monthly excess return on Fama and French (1993) three factors, Carhart (1997) momentum factor and Pastor and Stambaugh (2003) liquidity factor, using 3-year rolling strategy.
Vol	The monthly standard deviation of daily excess returns.
Down Risk	The monthly standard deviation of below-average daily returns.
Stock-Level Controls	
Size	Logarithm of market capitalization of the stock in million US dollars.
BM	Book-to-market ratio of the stock.
Mom	Past 12 month aggregated return of the stock.
IO	The fraction of shares outstanding that is owned by mutual funds globally lagged one quarter.
Volume	Logarithm of trading volume of the stock.
Freefloat	The proportion of a stock's market capitalization available to ordinary investor.
Zero	The proportion of zero-return weeks in a given year, where zero-return is defined as return within ± 0.1bps.
Illiq	Amihud (2002) illiquidity measure as the average absolute daily return per dollar volume over the past 12 months.
Anomalies	
GrossP/A	Gross profit-to-assets measured as gross profits scaled by assets.
EBIT	Operating profit measured by earnings before interest and tax.
Grow(A)	Asset growth, growth rate of total assets in the previous fiscal year.
I/A	Investment-to-assets, measured as annual change in gross property, plant, and equipment plus the annual change in inventories scaled by the lagged book value of assets.
Issue	Net stock issuance measured by growth rate of the split-adjusted shares outstanding in the previous fiscal year.
Accrual	Total accruals measured as changes in noncash working capital minus depreciation expenses scaled by average total assets for the previous two fiscal years.
NetOPA	Net operating assets, measured as the logarithm of difference on the balance sheet between all operating assets and all operating liabilities.
ROA	Return on assets, the ratio of quarterly earnings to last quarter's assets

Appendix 2. Cash Collateral Ratio and Collateral Beta by Month

This table presents the monthly cross-sectional mean and standard deviation of cash collateral ratio, change in cash collateral ratio and collateral beta. The sample period is from September 2006 to August 2010.

Month	Col		ΔCol		β_{Col}		Month	Col		ΔCol		β_{Col}	
	Mean	Std.	Mean	Std.	Mean	Std.		Mean	Std.	Mean	Std.	Mean	Std.
2006Sep	93.93%	11.93%	-0.18%	7.13%	0.176	0.65	2008Sep	92.60%	11.12%	-0.03%	4.75%	0.253	0.58
2006Oct	94.33%	11.04%	0.21%	6.56%	0.194	0.65	2008Oct	93.36%	10.03%	0.88%	6.08%	0.385	0.60
2006Nov	93.53%	12.55%	-0.95%	7.35%	0.231	0.69	2008Nov	94.38%	10.48%	0.51%	5.70%	0.315	0.52
2006Dec	93.87%	12.04%	0.18%	7.66%	0.432	0.96	2008Dec	95.27%	8.51%	0.41%	5.99%	0.352	0.57
2007Jan	94.48%	10.88%	0.49%	7.08%	0.392	0.92	2009Jan	95.35%	7.55%	-0.18%	4.75%	0.159	0.47
2007Feb	93.66%	12.52%	-0.81%	6.41%	0.367	0.89	2009Feb	95.05%	8.96%	-0.27%	4.89%	0.154	0.47
2007Mar	93.86%	11.90%	0.09%	7.38%	0.260	0.75	2009Mar	96.07%	7.11%	0.36%	3.81%	0.148	0.46
2007Apr	93.83%	12.09%	0.08%	6.92%	0.223	0.60	2009Apr	96.20%	6.20%	0.05%	3.68%	0.149	0.47
2007May	93.97%	11.50%	-0.81%	6.30%	0.201	0.55	2009May	95.89%	6.82%	-0.19%	3.95%	0.159	0.51
2007Jun	93.37%	11.31%	-0.65%	6.75%	0.203	0.60	2009Jun	95.74%	6.54%	-0.23%	4.34%	0.127	0.66
2007Jul	93.80%	10.73%	0.17%	5.86%	0.218	0.62	2009Jul	95.39%	6.82%	-0.32%	4.18%	0.105	0.63
2007Aug	94.18%	9.49%	0.28%	5.65%	0.210	0.58	2009Aug	94.98%	7.97%	-0.41%	3.87%	0.121	0.69
2007Sep	93.89%	9.65%	-0.15%	4.58%	0.213	0.57	2009Sep	95.09%	7.09%	-0.03%	4.75%	0.173	0.62
2007Oct	93.77%	10.08%	-0.22%	4.96%	0.265	0.57	2009Oct	93.91%	8.84%	-1.16%	5.21%	0.147	0.64
2007Nov	93.62%	9.91%	-0.14%	4.80%	0.271	0.64	2009Nov	93.86%	9.35%	-0.27%	4.81%	0.098	0.58
2007Dec	93.60%	9.91%	0.03%	5.07%	0.280	0.61	2009Dec	93.52%	9.51%	-0.46%	5.98%	0.091	0.58
2008Jan	93.74%	9.78%	0.17%	4.51%	0.201	0.57	2010Jan	93.57%	9.50%	-0.07%	4.65%	0.088	0.57
2008Feb	94.06%	9.71%	0.16%	4.11%	0.193	0.57	2010Feb	94.20%	8.80%	0.62%	4.80%	0.131	0.56
2008Mar	94.14%	9.14%	0.11%	5.17%	0.189	0.53	2010Mar	94.10%	8.73%	-0.32%	5.48%	0.140	0.54
2008Apr	93.67%	10.48%	-0.48%	5.97%	0.182	0.53	2010Apr	93.37%	9.22%	-0.91%	5.17%	0.171	0.53
2008May	92.66%	11.77%	-0.91%	5.10%	0.178	0.53	2010May	93.22%	9.62%	-0.22%	5.31%	0.158	0.60
2008Jun	92.47%	10.88%	-0.38%	5.41%	0.194	0.57	2010Jun	93.86%	8.84%	0.04%	4.97%	0.154	0.53
2008Jul	92.74%	10.24%	0.02%	5.28%	0.207	0.56	2010Jul	93.85%	8.42%	-0.19%	5.24%	0.118	0.52
2008Aug	92.59%	11.00%	-0.12%	5.27%	0.220	0.58	2010Aug	93.88%	8.36%	0.07%	4.09%	0.108	0.50

Table 1. Summary Statistics

This table shows summary statistics for the existing variables used in this paper. We report the number of observations, mean, standard deviation, and percentile distributions of short-selling variables, stock return, risk and controls for our sample of 3,023 U.S stocks at stock-month level. To be included in the sample, we require that each firm must have at least 50 weekly return observations, price larger than $5, and more than 8 monthly lending observations in a year. The sample period if from September 2006 to August 2010. Appendix 1 provides detailed definition of each variable.

				Percentile Distribution				
Variable	N	Mean	Std Dev	5%	25%	50%	75%	95%
Lending Supply, Demand and Others								
ΔLoan (%)	83714	0.046	1.475	-2.586	-0.596	0.015	0.686	2.770
ΔUtili (%)	83714	-0.071	4.887	-7.472	-2.063	-0.090	1.902	7.407
DSHIFT	83714	-0.001	0.498	-1.000	0.000	0.000	0.000	1.000
SSHIFT	83714	-0.001	0.394	-1.000	0.000	0.000	0.000	1.000
Stock Return & Risk								
$R-R_f$ (%)	83359	0.469	13.117	-41.140	-6.530	0.266	6.931	21.339
Ret^{dgtw} (%)	77978	0.381	10.893	-37.828	-5.450	-0.145	5.459	18.244
1-Factor α (%)	80711	0.468	11.810	-40.397	-5.711	-0.065	5.851	19.896
3-Factor α (%)	80711	0.480	12.382	-43.958	-6.057	0.045	6.300	20.708
4-Factor α (%)	80711	0.488	12.899	-46.587	-6.144	0.106	6.489	21.318
5-Factor α (%)	80711	0.493	13.384	-49.228	-6.416	0.112	6.707	22.040
Vol	83636	0.028	0.019	0.010	0.016	0.023	0.034	0.062
Down Risk	83635	0.017	0.013	0.005	0.009	0.014	0.020	0.040
Stock-Level Controls								
Size	83714	7.406	1.480	5.347	6.320	7.213	8.269	10.172
BM	83714	0.545	0.404	0.072	0.274	0.464	0.719	1.283
Mom	83714	0.100	0.512	-0.569	-0.213	0.029	0.296	1.028
IO	82873	0.236	0.147	0.000	0.123	0.262	0.376	0.411
Volume	83714	9.566	1.491	7.221	8.584	9.506	10.549	12.029
Freefloat	83450	0.785	0.170	0.420	0.710	0.820	0.910	1.000
Zero	83714	0.020	0.026	0.000	0.000	0.019	0.038	0.058
Illiq	82873	0.011	0.061	0.000	0.000	0.001	0.005	0.035
Anomalies								
GrossP/A	76856	0.313	0.257	0.017	0.137	0.287	0.444	0.785
EBIT	76601	2.967	4.755	-0.451	0.294	1.060	3.254	15.892
Grow(A)	76761	0.179	0.499	-0.169	-0.007	0.075	0.199	0.775
I/A	66987	0.074	0.159	-0.054	0.007	0.040	0.095	0.317
Issue	77834	0.072	0.258	-0.081	-0.012	0.008	0.035	0.549
Accrual	65795	-0.031	0.170	-0.245	-0.093	-0.040	0.009	0.201
NetOPA	75393	6.574	1.546	4.027	5.533	6.596	7.644	9.291
ROA	76768	0.008	0.039	-0.048	0.002	0.011	0.023	0.052

Table 2. Market Level Collateral Risk and Stock Wide Exposure to It

This table reports the market aggregate collateral risk and stock-level exposure to it. In Panel A, we examine the relationship between the market aggregate change in cash collateral ratio and risk/funding factors. In Model (1), we run time-series regression $\Delta Col_{m,t} = \alpha + \boldsymbol{Risk}_t + \varepsilon_t$, where ***Risk*** is a set of risk factors including Fama and French (1993) three factors, Carhart (1997) momentum factor and Pastor and Stambaugh (2003) liquidity factor. In Model (2) we run time-series regression $\Delta Col_{m,t} = \alpha + \boldsymbol{Funding}_t + \varepsilon_t$, where ***Funding*** is a set of market-based funding factors in Chen and Lu (2015). In Panel B, we present the summary statistics of stock-level cash collateral ratio, its monthly innovation, collateral beta and idiosyncratic collateral risk. Specifically, each month t we run time-series regression from a rolling strategy using daily data for each stock i over month t and its proceeding two months $t-1$ and $t-2$: $\Delta col_{i,d} = \alpha + \beta_i \Delta col_{m,d} + \varepsilon_{i,d}$, where $\Delta col_{i,d}$ is the daily change in cash collateral ratio for stock i, $\Delta col_{m,d}$ is the value-weighted average change in cash collateral ratio of all stocks in the market excluding stock i, and we refer to β_i as collateral beta and the standard deviation of $\varepsilon_{i,d}$ as idiosyncratic collateral risk. In Panel C, we represent the correlation matrix. ***, **, * denote significant at the 1%, 5%, 10% level respectively. The sample period is from September 2006 to August 2010.

Panel A. Market Level Collateral Risk			
Dependent Variable: $\Delta Col_{m,t}$			
(1)		(2)	
MKT_t	-0.0144	Broker-dealers' asset growth rate	0.0000
	(-1.51)		(0.04)
SMB_t	-0.0114	Bond liquidity	-0.0017
	(-0.39)		(-1.13)
HML_t	-0.0216	CDS spread	0.0000
	(-0.84)		(-0.95)
UMD_t	-0.0068	Credit spread	-0.0037
	(-1.00)		(-1.86)*
LIQ_t	-0.0303	Financial leverage	-0.0008
	(-2.50)**		(-1.04)
		Hedge fund leverage	0.0000
			(0.68)
		Investment banks' excess return	0.0002
			(1.48)
		Broker-dealers' leverage factor	-0.0009
			(-0.22)
		LIBOR rate	0.0054
			(2.10)**
		Loan Tighten %	0.0000
			(0.16)
		Swap spread	0.0060
			(0.93)
		TED spread	-0.0062
			(-1.71)*
		Term spread	0.0021
			(1.09)
		VIX	0.0000
			(0.13)
Constant	-0.0012	Constant	-0.0015
	(-1.97)*		(-1.90)*
Obs.	49	Obs.	49
R2	0.17	R2	0.39

Table 2. Cont.

Panel B. Stock Wide Exposure to Cash Collateral Risk								
				Percentile Distribution				
Variable	N	Mean	Std Dev	5%	25%	50%	75%	95%
Cash Collateral								
Col (%)	83714	93.96	10.01	74.51	93.22	97.56	99.42	99.97
Δcol (%)	83714	-0.139	5.558	-6.591	-0.845	-0.023	0.547	6.078
β_{Col}	79829	0.205	0.615	-0.468	-0.020	0.036	0.266	1.540
σ_{Col}	80542	0.009	0.011	0.000	0.002	0.005	0.012	0.034

Table 2. Cont.

Panel C. Correlation Matrix (Spearman for upper-right part; Pearson for bottom-left part)

	Col	Δcol	β_{Col}	σ_{Col}	DSHIFT	SSHIFT	Ret^{dgtw}	Size	BM	Mom	IO	Volume	Freefloat	Zero	Illiq
Col	1.000	0.215	-0.295	-0.772	0.010	0.028	0.013	-0.439	0.069	-0.073	-0.082	-0.393	-0.157	-0.044	0.438
	-	<.0001	<.0001	<.0001	0.002	<.0001	0.000	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
Δcol	0.284	1.000	-0.002	-0.014	-0.051	0.132	0.013	-0.002	0.000	-0.039	-0.003	0.013	0.004	-0.009	-0.011
	<.0001	-	0.644	0.000	<.0001	<.0001	0.000	0.487	0.921	<.0001	0.367	0.000	0.271	0.014	0.002
β_{Col}	-0.405	0.012	1.000	0.318	-0.012	0.004	0.002	0.230	-0.045	-0.003	0.002	0.212	0.090	0.041	-0.246
	<.0001	0.001	-	<.0001	0.001	0.300	0.618	<.0001	<.0001	0.385	0.643	<.0001	<.0001	<.0001	<.0001
σ_{Col}	-0.754	0.031	0.458	1.000	-0.029	0.013	-0.002	0.494	-0.065	0.055	0.012	0.439	0.212	0.074	-0.483
	<.0001	<.0001	<.0001	-	<.0001	0.000	0.541	<.0001	<.0001	<.0001	0.001	<.0001	<.0001	<.0001	<.0001
DSHIFT	-0.003	-0.119	-0.013	-0.026	1.000	0.000	-0.057	-0.025	0.002	-0.018	-0.012	-0.002	-0.001	-0.010	0.017
	0.424	<.0001	0.000	<.0001	-	0.998	<.0001	<.0001	0.574	<.0001	0.001	0.595	0.752	0.004	<.0001
SSHIFT	0.030	0.088	0.002	0.015	0.000	1.000	-0.059	0.004	-0.020	0.039	-0.010	0.005	-0.001	-0.001	0.006
	<.0001	<.0001	0.550	<.0001	0.999	-	<.0001	0.290	<.0001	<.0001	0.003	0.179	0.784	0.881	0.074
Ret^{dgtw}	0.020	0.010	-0.002	-0.008	-0.067	-0.068	1.000	0.045	-0.096	-0.021	-0.015	0.002	-0.005	0.012	0.017
	<.0001	0.005	0.644	0.034	<.0001	<.0001	-	<.0001	<.0001	<.0001	<.0001	0.562	0.176	0.001	<.0001
Size	-0.509	0.001	0.353	0.581	-0.028	0.003	0.020	1.000	-0.235	0.198	0.115	0.757	0.280	0.141	-0.918
	<.0001	0.714	<.0001	<.0001	<.0001	0.459	<.0001	-	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
BM	0.069	0.002	-0.054	-0.062	0.007	-0.017	-0.082	-0.239	1.000	-0.264	0.076	-0.147	0.009	-0.050	0.207
	<.0001	0.486	<.0001	<.0001	0.052	<.0001	<.0001	<.0001	-	<.0001	<.0001	<.0001	0.008	<.0001	<.0001
Mom	-0.020	-0.019	-0.016	0.009	-0.009	0.045	-0.038	0.110	-0.228	1.000	0.011	0.036	0.044	0.071	-0.072
	<.0001	<.0001	<.0001	0.012	0.012	<.0001	<.0001	<.0001	<.0001	-	0.001	<.0001	<.0001	<.0001	<.0001
IO	-0.018	0.003	0.004	0.008	-0.011	-0.009	-0.022	0.122	0.052	0.009	1.000	0.115	-0.025	-0.081	-0.132
	<.0001	0.381	0.269	0.017	0.001	0.012	<.0001	<.0001	<.0001	0.014	-	<.0001	<.0001	<.0001	<.0001
Volume	-0.368	0.011	0.272	0.439	-0.003	0.006	0.001	0.749	-0.118	0.041	0.146	1.000	0.264	0.007	-0.798
	<.0001	0.002	<.0001	<.0001	0.437	0.093	0.820	<.0001	<.0001	<.0001	<.0001	-	<.0001	0.050	<.0001
Freefloat	-0.177	0.001	0.122	0.229	-0.002	-0.002	-0.010	0.250	0.001	0.027	0.057	0.256	1.000	0.065	-0.297
	<.0001	0.790	<.0001	<.0001	0.554	0.612	0.004	<.0001	0.872	<.0001	<.0001	<.0001	-	<.0001	<.0001
Zero	-0.067	-0.006	0.044	0.090	-0.017	-0.005	0.012	0.117	-0.071	0.047	-0.123	-0.005	0.057	1.000	-0.127
	<.0001	0.084	<.0001	<.0001	<.0001	0.138	0.001	<.0001	<.0001	<.0001	<.0001	0.113	<.0001	-	<.0001
Illiq	0.009	0.003	-0.042	-0.018	0.006	0.011	0.049	-0.233	0.055	0.059	-0.130	-0.250	-0.069	0.019	1.000
	0.009	0.409	<.0001	<.0001	0.113	0.001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	-

Table 3. Collateral Beta and Future DGTW-Adjusted Stock Returns

This table presents the results of the regressions relating cash collateral beta and future DGTW-adjusted stock return. We start with the basic regression $Ret^{dgtw}{}_{i,d} = \alpha + \beta_i \beta_{col\,i,d} + \gamma Ctrls_{i,d} + \varepsilon_{i,d}$, where Ret^{dgtw} is monthly DGTW-adjusted stock return (by size, book-to-market ratio and past 12 months return), β_{Col} is collateral beta and $Ctrls$ is a set of control variables including stock size, book-to-market ratio, past 12 month return, institutional ownership, trading volume, free float, zero return weeks and Amihud's illiquidity. We then add σ_{Col}, the idiosyncratic collateral risk into the model, replacing or together with β_{Col}. Finally, we also control for short-selling demand and supply shift, where DSHIFT is net short-selling demand shift on the stock; SSHIFT is net short-selling supply shift on the stock. Appendix 1 provides detailed definition of each variable. In Model (1) to (4), coefficients are estimated by the Fama-Macbeth Method with Newey-West robust standard errors (include 12 month lags). In Model (5) to (8), we run panel regression include firm and calendar month dummies and the standard errors are clustered at firm and month level. t-statistics are reported in parenthesis. ***, **, * denote significant at the 1%, 5%, 10% level respectively. The sample period is from September 2006 to August 2010.

	Dependent Variable: Ret^{dgtw}_{t+1}							
	Fama-Macbeth Regression				Panel Regression			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\beta_{Col\ t}$	0.3457		0.2898	0.2935	0.3063		0.2446	0.2442
	(3.50)***		(3.66)***	(3.56)***	(4.13)***		(3.77)***	(3.76)***
$\sigma_{Col\ t}$		17.6651	10.6069	10.4398		18.4631	13.1302	13.3105
		(2.91)***	(1.93)*	(1.85)*		(1.77)*	(1.24)	(1.25)
$DSHIFT_t$				0.0382				-0.0709
				(0.50)				(-0.64)
$SSHIFT_t$				-0.1502				-0.1851
				(-2.55)**				(-1.35)
$Size_t$	-0.8182	-0.8547	-0.8687	-0.8680	-0.6522	-0.6920	-0.7048	-0.7078
	(-2.54)**	(-2.63)**	(-2.66)**	(-2.64)**	(-5.68)***	(-5.14)***	(-5.24)***	(-5.23)***
BM_t	-1.5638	-1.5602	-1.5643	-1.5648	-1.0735	-1.0927	-1.0935	-1.0943
	(-4.36)***	(-4.31)***	(-4.33)***	(-4.42)***	(-2.17)**	(-2.20)**	(-2.20)**	(-2.21)**
Mom_t	-1.4068	-1.3688	-1.3593	-1.3564	-0.6642	-0.6606	-0.6548	-0.6489
	(-1.41)	(-1.39)	(-1.38)	(-1.37)	(-1.96)*	(-1.94)*	(-1.93)*	(-1.92)*
IO_t	-1.1546	-1.1032	-1.1150	-1.0871	-1.1091	-1.0641	-1.0631	-1.0682
	(-6.08)***	(-6.06)***	(-5.93)***	(-5.78)***	(-2.58)**	(-2.47)**	(-2.47)**	(-2.48)**
$Volume_t$	0.5145	0.5138	0.5129	0.5133	0.4002	0.4031	0.4012	0.4033
	(1.79)*	(1.81)*	(1.81)*	(1.81)*	(2.71)***	(2.73)***	(2.72)***	(2.72)***
$Freefloat_t$	-0.5604	-0.6365	-0.6386	-0.6238	-0.1912	-0.2481	-0.2534	-0.2527
	(-0.99)	(-1.10)	(-1.11)	(-1.09)	(-0.51)	(-0.66)	(-0.67)	(-0.67)
$Zero_t$	12.8616	12.6162	12.6284	12.6397	11.1302	10.9833	11.0344	11.0053
	(3.92)***	(3.93)***	(3.94)***	(3.98)***	(4.63)***	(4.56)***	(4.58)***	(4.56)***
$Illiq_t$	8.6568	7.7677	7.7696	7.7046	1.6196	1.2890	1.2464	1.2684
	(2.47)**	(2.35)**	(2.34)**	(2.34)**	(0.87)	(0.67)	(0.65)	(0.66)
Constant	2.1572	2.4052	2.5249	2.4983	2.1035	2.3227	2.4348	2.4359
	(2.80)***	(2.94)***	(3.01)***	(2.94)***	(2.52)**	(2.70)***	(2.82)***	(2.82)***
Obs.	71037	71037	71037	71037	71037	71037	71037	71037
R^2	0.04	0.04	0.04	0.05	0.01	0.01	0.01	0.01

Table 4. Collateral Beta and Future Factor-Based Stock Returns

This table presents the results of the regressions relating cash collateral beta and future factor-based stock return. We start with the regression $alpha_{i,d} = \alpha + \beta_{1i}\beta_{col_{i,d}} + \beta_{2i}\sigma_{Col_{i,d}} + \gamma Ctrls_{i,d} + \varepsilon_{i,d}$, where $alpha$ include excess stock return $R\text{-}R_f$, CAPM 1-factor alpha, Fama-French 3-factor alpha, Carhart 4-factor alpha and Pastor-Stambaugh 5-factor alpha, β_{Col} is collateral beta, σ_{Col} is idiosyncratic collateral risk, and $Ctrls$ is a set of control variables including stock size, book-to-market ratio, past 12 month return, institutional ownership, trading volume, free float, zero return weeks and Amihud's illiquidity. We further control for short-selling demand and supply shift, where DSHIFT is net short-selling demand shift on the stock; SSHIFT is net short-selling supply shift on the stock. Appendix 1 provides detailed definition of each variable. In Panel A, coefficients are estimated by the Fama-Macbeth Method with Newey-West robust standard errors (include 12 month lags). In Panel B, we run panel regression include firm and calendar month dummies and the standard errors are clustered at firm and month level. t-statistics are reported in parenthesis. ***, **, * denote significant at the 1%, 5%, 10% level respectively. The sample period is from September 2006 to August 2010.

Panel A. Fama-Macbeth Regression

	$R\text{-}R_{f\ t+1}$		1-Factor α_{t+1}		3-Factor α_{t+1}		4-Factor α_{t+1}		5-Factor α_{t+1}	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
$\beta_{Col\ t}$	0.2967	0.2975	0.2761	0.2787	0.2553	0.2513	0.2910	0.2907	0.2685	0.2630
	(2.83)***	(2.76)***	(3.21)***	(3.08)***	(3.00)***	(2.98)***	(2.63)***	(2.64)***	(2.18)**	(2.17)**
$\sigma_{Col\ t}$	8.4613	8.5913	13.9844	13.9663	6.4986	7.6488	19.3695	19.9701	21.0384	22.1153
	(1.53)	(1.52)	(1.87)*	(1.93)*	(1.10)	(1.29)	(2.59)***	(2.61)***	(2.74)***	(2.74)***
$DSHIFT_t$		0.0815		0.1425		0.1760		0.3063		0.2220
		(0.88)		(1.25)		(2.27)**		(2.27)**		(2.29)**
$SSHIFT_t$		-0.1108		-0.1824		-0.0349		0.0722		0.1106
		(-2.17)**		(-1.91)*		(-0.58)		(1.03)		(1.14)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	1.7788	1.7816	2.5247	2.5254	1.9606	1.9497	2.0254	2.0332	2.5720	2.5792
	(2.78)***	(2.77)***	(2.36)**	(2.32)**	(2.50)**	(2.46)**	(2.61)**	(2.55)**	(2.74)***	(2.69)***
Obs.	74927	74927	73461	73461	73461	73461	73461	73461	73461	73461
R^2	0.06	0.06	0.06	0.07	0.05	0.05	0.04	0.04	0.04	0.04

Table 4. Cont.

Panel B. Panel Regression

	$R-R_{f\ t+1}$		1-Factor α_{t+1}		3-Factor α_{t+1}		4-Factor α_{t+1}		5-Factor α_{t+1}	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
$\beta_{Col\ t}$	0.2497	0.2493	0.2259	0.2254	0.1959	0.1956	0.2339	0.2338	0.2007	0.2007
	(3.19)***	(3.18)***	(3.09)***	(3.08)***	(2.65)**	(2.65)**	(2.89)***	(2.90)***	(2.52)**	(2.52)**
$\sigma_{Col\ t}$	10.9562	11.1345	18.3972	18.6700	5.9595	6.1041	15.4016	15.4879	17.6286	17.6449
	(0.99)	(1.01)	(1.41)	(1.43)	(0.63)	(0.64)	(1.34)	(1.34)	(1.54)	(1.53)
$DSHIFT_t$		-0.0093		0.0396		0.0563		0.1665		0.1075
		(-0.08)		(0.31)		(0.39)		(1.10)		(0.56)
$SSHIFT_t$		-0.1562		-0.2336		-0.1124		-0.0241		0.0199
		(-1.07)		(-1.35)		(-0.78)		(-0.15)		(0.12)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	1.2852	1.2879	2.2207	2.2238	1.5850	1.5870	1.6157	1.6179	2.0328	2.0339
	(1.17)	(1.17)	(2.07)**	(2.07)**	(1.54)	(1.54)	(1.75)*	(1.75)*	(2.26)**	(2.27)**
Obs.	74927	74927	73461	73461	73461	73461	73461	73461	73461	73461
R^2	0.20	0.20	0.03	0.03	0.01	0.01	0.01	0.01	0.01	0.01

Table 5. Fama-French 25 Equity Portfolios: Price of Collateral Beta

This table presents the pricing results for the 25 size and book-to-market portfolios. For each portfolio, the portfolio β_{Col} is calculated as the equal-weighted average β_{Col} across all the stocks in it, and the βs for the three Fama-French factors and Carhart momentum factor are calculated (from a rolling strategy) in a regression of daily stock return on daily factors in the past three months for all the stocks in the portfolio. Then we estimate the price of the cash collateral risk and other risk factors as $E[R - R_{f\ t+1,n}] = \boldsymbol{\lambda} \times \boldsymbol{\beta}_{t,n}$, where n denotes the 25 portfolios, $R - R_f$ is excess portfolio return, $\boldsymbol{\beta}$ denotes β_{Col} and (or) the βs for other risk factors. We report the price of the risks, $\boldsymbol{\lambda}$. Coefficients are estimated by the Fama-Macbeth Method with Newey-West robust standard errors (include 12 month lags). ***, **, * denote significant at the 1%, 5%, 10% level respectively. The sample period is from September 2006 to August 2010.

	Dependent Var: $R\text{-}R_{f\ t+1}$			
	(1)	(2)	(3)	(4)
$\beta_{Col\ t}$	0.7086	0.6138	0.6625	0.3045
	(3.05)***	(2.51)**	(2.94)***	(1.96)**
β_MKT_t		-2.8819	-2.7978	-1.3493
		(-2.12)**	(-2.53)**	(-1.18)
β_SMB_t			-1.4997	-1.8055
			(-9.36)***	(-6.87)***
β_HML_t			-2.0533	-1.4436
			(-3.90)***	(-4.49)***
β_UMD_t				3.0625
				(5.98)***
Constant	-0.2112	-0.0286	0.2120	0.3468
	(-0.21)	(-0.03)	(0.20)	(0.49)
R^2	0.11	0.20	0.38	0.57
F-statitics	9.34	5.38	10.09	17.38
P-value	0.004	0.008	0.000	0.000

Note: The standard deviation for the portfolio β_{Col} is 0.24.

Table 6. Portfolio Returns Based on Collateral Beta

This table shows calendar-time portfolio abnormal returns sorted on collateral beta. At the beginning of every month, all sample stocks are ranked in ascending order on the basis of their β_{Col} in the previous month, and the ranked stocks are assigned to ten decile portfolios respectively. Stocks with the lowest past month β_{Col} comprise decile 1 and stocks with the highest comprise decile 10. Within a given portfolio, all stocks are equally weighted. The portfolios are rebalanced every month to maintain equal weights. $R\text{-}R_f$ is the monthly excess return of the decile portfolio. 1-factor alpha, 3-factor alpha, 4-factor alpha and 5-factor alpha are the intercept on a regression of monthly excess portfolio return using CAPM model, Fama-French three-factor model, Carhart four-factor model and Pastor-Stambaugh five-factor model. Ret^{dgtw} is the DGTW-adjusted portfolio return (by size and book-to-market ratio). L/S is the alpha of zero-cost portfolio that holds the stocks with top 10% β_{Col} and sells short the stocks with the bottom 10% β_{Col} in the previous month. t-statistics are reported in parenthesis. ***, **, * denote significant at the 1%, 5%, 10% level respectively. The sample period is from September 2006 to August 2010.

Decile (β_{Col})	$R\text{-}R_f$	1-Factor α	3-Factor α	4-Factor α	5-Factor α	Ret^{dgtw}
1	-0.04%	0.35%	0.14%	0.09%	0.06%	-0.09%
	(-0.04)	(1.23)	(0.77)	(0.52)	(0.37)	(-0.68)
2	0.41%	0.82%	0.56%	0.46%	0.50%	0.30%
	(0.38)	(2.21)**	(2.49)**	(2.71)***	(2.99)***	(1.73)*
3	0.24%	0.66%	0.42%	0.31%	0.33%	0.28%
	(0.22)	(1.59)	(1.60)	(1.51)	(1.62)	(1.38)
4	0.72%	1.14%	0.37%	0.81%	0.82%	0.44%
	(0.64)	(2.58)***	(2.60)***	(2.66)***	(2.61)***	(2.41)**
5	0.58%	1.03%	0.75%	0.65%	0.69%	0.66%
	(0.50)	(2.47)**	(3.22)***	(3.54)***	(3.87)***	(3.53)***
6	0.39%	0.82%	0.55%	0.47%	0.49%	0.46%
	(0.34)	(1.90)*	(2.23)**	(2.13)**	(2.25)**	(1.97)*
7	0.55%	0.99%	0.76%	0.64%	0.66%	0.32%
	(0.49)	(2.56)**	(2.66)***	(2.84)***	(2.93)***	(1.64)
8	0.24%	0.65%	0.46%	0.37%	0.35%	0.22%
	(0.22)	(2.08)**	(2.11)**	(2.11)**	(1.97)*	(1.72)*
9	0.38%	0.79%	0.59%	0.48%	0.47%	0.32%
	(0.37)	(2.57)**	(2.56)**	(2.84)***	(2.73)***	(1.84)*
10	0.35%	0.75%	0.66%	0.57%	0.55%	0.41%
	(0.35)	(2.93)***	(2.70)***	(2.76)***	(2.64)***	(2.17)**
L/S	0.39%	0.40%	0.52%	0.48%	0.49%	0.50%
	(1.69)*	(1.75)*	(2.70)***	(2.56)**	(2.55)**	(3.00)***

Table 7. The Impact of Collateral Beta on Short Interest and Risk

This table presents the results examining the impact of collateral beta on short interest and stock risk. We start with the regression $\Delta ShortInterst_{i,t+1} = \alpha + \beta_{1i}\beta_{col_{i,d}} + \beta_{2i}\sigma_{Col_{i,d}} + \gamma Ctrls_{i,d} + \varepsilon_{i,d}$, where we use two variables to proxy for change in short interest $\Delta ShortInterst$: ΔLoan is monthly change in stock on loan divided by total market capitalization of the stock.; ΔUtili is monthly change in utilisation of lendable shares; $Ctrls$ is a set of control variables including stock size, book-to-market ratio, past 12 month return, institutional ownership, trading volume, free float, zero return weeks and Amihud's illiquidity. We then run the regression $Risk_{i,t+1} = \alpha + \beta_{1i}\beta_{col_{i,d}} + \beta_{2i}\sigma_{Col_{i,d}} + \gamma Ctrls_{i,d} + \varepsilon_{i,d}$, where $Risk$ is measured by Vol, total return volatility, calculated as the monthly standard deviation of daily excess returns and Down Risk, downside risk, calculated as the monthly standard deviation of below-average daily returns. Appendix 1 provides detailed definition of each variable. In Model (1) to (4), coefficients are estimated by the Fama-Macbeth Method with Newey-West robust standard errors (include 12 month lags). In Model (5) to (8), we run panel regression include firm and calendar month dummies and the standard errors are clustered at firm and month level. t-statistics are reported in parenthesis. ***, **, * denote significant at the 1%, 5%, 10% level respectively. The sample period is from September 2006 to August 2010.

	Fama-Macbeth Regression				Panel Regression			
Dependent Variable:	ΔLoan $_{t+1}$	ΔUtili $_{t+1}$	Vol $_{t+1}$	Skew $_{t+1}$	ΔLoan $_{t+1}$	ΔUtili $_{t+1}$	Vol $_{t+1}$	Skew $_{t+1}$
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\beta_{Col\ t}$	-0.0004	-0.0010	0.0005	0.0127	-0.0002	-0.0007	0.0004	0.0104
	(-2.12)**	(-3.11)***	(3.37)***	(3.22)***	(-2.30)**	(-2.40)**	(4.31)***	(1.67)*
$\sigma_{Col\ t}$	0.0405	0.2322	0.0084	0.1971	0.0404	0.2567	0.0164	0.6526
	(1.42)	(3.38)***	(0.51)	(0.69)	(6.14)***	(12.15)***	(2.61)***	(1.55)
Size $_t$	0.0001	-0.0007	-0.0055	-0.0599	-0.0001	-0.0014	-0.0053	-0.0666
	(0.17)	(-0.97)	(-9.36)***	(-9.44)***	(-2.10)**	(-6.76)***	(-85.68)***	(-15.89)***
BM $_t$	-0.0004	0.0002	0.0020	-0.0884	-0.0006	0.0002	0.0036	-0.0669
	(-1.62)	(0.20)	(1.56)	(-3.13)***	(-4.14)***	-0.5000	(25.60)***	(-7.14)***
Mom $_t$	-0.0003	-0.0018	0.0001	-0.0489	0.0000	-0.0016	0.0018	-0.0270
	(-0.99)	(-1.16)	(0.06)	(-2.54)**	(-0.05)	(-3.93)***	(14.34)***	(-3.29)***
IO $_t$	-0.0005	0.0008	-0.0042	-0.1228	-0.0006	0.0009	-0.0038	-0.1333
	(-0.47)	(0.45)	(-3.02)***	(-3.87)***	(-1.60)	-0.7100	(-10.22)***	(-5.36)***
Volume $_t$	0.0000	0.0003	0.0037	0.0338	0.0000	0.0005	0.0037	0.0398
	(-0.37)	(0.70)	(6.13)***	(5.03)***	(0.86)	(2.94)***	(68.14)***	(10.95)***
Freefloat $_t$	0.0010	0.0057	-0.0060	-0.0630	0.0008	0.0052	-0.0058	-0.0727
	(4.48)***	(5.70)***	(-7.75)***	(-3.06)***	(2.50)**	(4.93)***	(-18.42)***	(-3.45)***
Zero $_t$	-0.0104	-0.0184	-0.0537	0.7711	-0.0128	-0.0206	-0.0463	0.8058
	(-2.94)***	(-1.60)	(-4.77)***	(5.30)***	(-5.90)***	(-2.95)***	(-22.31)***	(5.78)***
Illiq $_t$	0.0016	0.0071	0.0201	0.2058	0.0023	-0.0006	0.0164	0.1167
	(0.84)	(1.26)	(4.63)***	(2.57)**	(2.17)**	(-0.18)	(16.12)***	(1.71)*
Constant	0.0000	-0.0040	0.0375	0.3539	0.0006	-0.0014	0.0364	0.3558
	(-0.02)	(-0.36)	(17.72)***	(10.29)***	(1.37)	(-0.96)	(83.32)***	(12.13)***
Obs.	75115	75115	75115	75115	75115	75115	75115	75115
R^2	0.03	0.03	0.25	0. 02	0.06	0.05	0.47	0.03

Table 8. Robustness: Collateral Beta and Future DGTW-Adjusted Stock Returns Controlling for Anomalies

This table presents the results of robustness check for Table 3 controlling for a set of anomalies. Appendix 1 provide detailed definition of each anomaly variable.

Panel A. Fama-Macbeth Regression

	Dependent Variable: Ret^{dgtw}_{t+1}								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$\beta_{Col\ t}$	0.3382	0.3108	0.3316	0.2517	0.3142	0.2750	0.3180	0.3379	0.1802
	(5.60)***	(5.64)***	(5.68)***	(5.53)***	(5.05)***	(4.38)***	(6.05)***	(5.66)***	(4.25)***
$\sigma_{Col\ t}$	7.1860	-3.1336	6.8987	3.9986	8.1725	4.8820	6.3108	7.2312	-3.9586
	(1.35)	(-0.56)	(1.32)	(0.57)	(1.54)	(0.87)	(1.30)	(1.36)	(-0.73)
GrossP/A $_t$	-0.1899								-0.0168
	(-0.42)								(-0.02)
EBIT $_t$		0.1143							0.0949
		(2.91)***							(4.42)***
Grow(A) $_t$			-0.3766						-0.0487
			(-1.90)*						(-0.21)
I/A $_t$				-0.3234					-0.6940
				(-0.38)					(-0.71)
Issue $_t$					-0.1145				0.3440
					(-0.45)				(1.97)*
Accrual $_t$						-0.3192			-0.4596
						(-1.33)			(-1.75)*
NetOPA $_t$							0.6328		0.7371
							(7.52)***		(4.45)***
ROA $_t$								-1.0947	1.4595
								(-0.44)	(0.44)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	2.8684	4.9134	2.8376	2.7337	2.6897	2.3694	3.8297	2.7836	5.7034
	(2.65)**	(4.34)***	(3.03)***	(3.09)***	(2.94)***	(2.98)***	(4.69)***	(3.03)***	(7.06)***
Obs.	65414	65175	65382	56793	67731	56005	64498	65366	53601
R^2	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.07

Table 8. Cont.

Panel B. Panel Regression

	Dependent Variable: Ret^{dgtw}_{t+1}								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$\beta_{Col\ t}$	0.2824	0.2463	0.2801	0.2133	0.2501	0.2230	0.2743	0.2788	0.1569
	(3.28)***	(2.86)***	(3.26)***	(2.31)**	(2.98)***	(2.41)**	(3.18)***	(3.24)***	(1.66)*
$\sigma_{Col\ t}$	9.1400	-1.1234	8.4789	7.5471	10.3043	8.0351	7.4846	9.1876	-2.9797
	(1.63)	(-0.19)	(1.51)	(1.24)	(1.88)*	(1.32)	(1.33)	(1.63)	(-0.47)
$GrossP/A_t$	-0.2777								-0.2181
	(-1.53)								(-0.96)
$EBIT_t$		0.1077							0.1023
		(7.30)***							(5.89)***
$Grow(A)_t$			-0.2712						-0.2473
			(-2.49)**						(-1.63)
I/A_t				0.0741					-0.0740
				(0.22)					(-0.18)
$Issue_t$					0.2521				0.5436
					(1.50)				(2.73)***
$Accrual_t$						-0.2513			-0.1529
						(-0.81)			(-0.46)
$NetOPA_t$							0.6127		0.6799
							(10.75)***		(10.13)***
ROA_t								-1.2430	0.2391
								(-0.97)	(0.16)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	2.8026	4.5571	2.6678	2.9646	2.6659	2.8046	3.6689	2.6354	6.1757
	(6.84)***	(9.61)***	(6.73)***	(6.80)***	(6.85)***	(6.34)***	(8.93)***	(6.64)***	(10.97)***
Obs.	65414	65175	65382	56793	67731	56005	64498	65366	53601
R^2	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01

Table 9. Robustness: Collateral Beta and Future Factor-Based Stock Returns Controlling for Anomalies

This table presents the results of robustness check for Table 4 controlling for a set of anomalies. Appendix 1 provide detailed definition of each anomaly variable.

	Fama-Macbeth Regression					Panel Regression				
Dependent Var:	$R\text{-}R_{f\ t+1}$	1-Factor α_{t+1}	3-Factor α_{t+1}	4-Factor α_{t+1}	5-Factor α_{t+1}	$R\text{-}R_{f\ t+1}$	1-Factor α_{t+1}	3-Factor α_{t+1}	4-Factor α_{t+1}	5-Factor α_{t+1}
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
$\beta_{Col\ t}$	0.2392	0.2456	0.2872	0.2859	0.2676	0.2422	0.2169	0.1783	0.2349	0.1886
	(4.26)***	(3.93)***	(4.16)***	(4.53)***	(3.58)***	(2.74)***	(2.64)***	(2.02)**	(2.46)**	(2.09)**
$\sigma_{Col\ t}$	-8.1725	-0.8852	-5.9777	2.4441	1.9944	-7.7947	-0.0035	-9.8464	-1.9314	-0.2614
	(-1.03)	(-0.13)	(-0.79)	(0.37)	(0.29)	(-0.70)	(-0.00)	(-0.94)	(-0.17)	(-0.02)
GrossP/A $_t$	-0.1119	-0.2802	0.0450	-0.2450	-0.1433	-0.0928	-0.2527	-0.0874	-0.0239	0.0566
	(-0.12)	(-0.30)	(0.04)	(-0.38)	(-0.21)	(-0.14)	(-0.37)	(-0.13)	(-0.04)	(0.09)
EBIT $_t$	0.0937	0.0660	0.0964	0.1285	0.1376	0.0901	0.0769	0.1058	0.1223	0.1238
	(2.03)**	(2.37)**	(2.45)**	(2.03)**	(1.86)*	(3.03)***	(2.84)***	(3.95)***	(3.58)***	(3.53)***
Grow(A) $_t$	-0.2403	-0.0358	-0.0728	-0.0931	-0.1225	-0.4184	-0.1478	-0.1352	-0.1808	-0.1849
	(-1.02)	(-0.14)	(-0.32)	(-0.38)	(-0.48)	(-1.65)	(-0.66)	(-0.53)	(-0.63)	(-0.58)
I/A $_t$	-0.7453	-0.8318	-0.4121	-0.0339	-0.4903	-0.1783	-0.3655	-0.0350	-0.2717	-0.7671
	(-0.78)	(-0.85)	(-0.35)	(-0.04)	(-0.61)	(-0.17)	(-0.35)	(-0.03)	(-0.21)	(-0.72)
Issue $_t$	0.3080	0.4381	0.5058	0.7873	0.6625	0.4942	0.7904	0.9253	0.8831	0.6865
	(1.36)	(1.67)*	(1.42)	(1.96)*	(1.70)*	(1.97)*	(3.70)***	(3.39)***	(3.07)***	(2.06)**
Accrual $_t$	-0.5714	-0.4149	-0.3452	-0.4853	-0.4083	-0.2894	-0.1834	-0.1262	-0.3121	-0.2493
	(-2.18)**	(-1.42)	(-0.89)	(-1.03)	(-0.88)	(-0.67)	(-0.46)	(-0.27)	(-0.68)	(-0.50)
NetOPA $_t$	0.8201	0.7193	0.6860	0.6860	0.7606	0.8587	0.7391	0.6652	0.7670	0.7993
	(4.30)***	(4.56)***	(4.18)***	(8.61)***	(8.76)***	(4.73)***	(3.57)***	(3.22)***	(3.83)***	(4.11)***
ROA $_t$	1.1010	4.0664	2.9390	4.2460	3.7202	-0.6784	3.7244	2.2917	4.5457	3.7741
	(0.23)	(0.99)	(0.50)	(0.86)	(0.66)	(-0.18)	(1.10)	(0.60)	(1.20)	(0.93)
Controls	4.6391	4.9949	4.5231	5.1478	6.0830	4.6419	5.1842	4.7932	5.0521	5.6986
Constant	(5.00)***	(5.15)***	(4.11)***	(4.10)***	(3.75)***	(2.74)***	(3.34)***	(3.02)***	(3.28)***	(4.24)***
	55724	55354	55354	55354	55354	55724	55354	55354	55354	55354
Obs.	0.09	0.09	0.08	0.07	0.07	0.21	0.03	0.01	0.01	0.01

Table 10. Robustness: Collateral Beta and Future DGTW-Adjusted Stock Returns Based on Quarterly Regression

This table reports the results of robustness test for Table 3 based on quarterly regression. ${Ret^{dgtw}}_t$ is the accumulated DGTW-adjusted stock return over the three months in quarter t. $\beta_{Col\,t}$ is calculated in a regression using daily data from quarter t: $\Delta col_{i,d} = \alpha + \beta_i \Delta col_{m,d} + \varepsilon_{i,d}$, where $\Delta col_{i,d}$ is the daily change in cash colalteral ratio for stock i, $\Delta col_{m,d}$ is the value-weighted average change in cash collateral ratio of all stocks in the market excluding stock i. $\sigma_{Col\,t}$ is the standard deviation of $\varepsilon_{i,d}$ from quarter t regression. All other control variables are aggregated to quarterly level.

	Dependent Variable: ${Ret^{dgtw}}_{t+1}$							
	Fama-Macbeth Regression				Panel Regression			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\beta_{Col\,t}$	0.5491		0.4657	0.4588	0.4880		0.4500	0.4469
	(3.58)***		(4.04)***	(3.87)***	(3.28)***		(2.56)**	(2.52)**
$\sigma_{Col\,t}$		28.7819	15.6584	12.0359		21.0116	10.0632	7.0396
		(1.82)*	(1.09)	(0.90)		(0.64)	(0.29)	(0.20)
$DSHIFT_t$				-1.1202				-1.3372
				(-6.66)***				(-2.65)**
$SSHIFT_t$				-0.5323				-0.4167
				(-3.61)***				(-1.35)
$Size_t$	-1.5836	-1.6317	-1.6592	-1.6610	-1.3924	-1.4034	-1.4326	-1.4446
	(-5.02)***	(-5.06)***	(-5.12)***	(-5.24)***	(-3.43)***	(-2.80)**	(-2.88)**	(-2.97)**
BM_t	2.5511	2.5056	2.5007	2.5434	3.9128	3.9014	3.8976	3.9130
	(2.96)**	(2.91)**	(2.91)**	(2.93)**	(3.44)***	(3.35)***	(3.35)***	(3.35)***
Mom_t	-2.8376	-2.8533	-2.8334	-2.8437	-1.2343	-1.2388	-1.2270	-1.3001
	(-1.58)	(-1.58)	(-1.57)	(-1.58)	(-0.99)	(-0.98)	(-0.97)	(-1.03)
IO_t	-3.7182	-3.6626	-3.6934	-3.7708	-3.4712	-3.4461	-3.4421	-3.4993
	(-6.68)***	(-6.31)***	(-6.37)***	(-6.37)***	(-2.71)**	(-2.69)**	(-2.69)**	(-2.68)**
$Volume_t$	1.0830	1.0967	1.0967	1.1169	1.0001	1.0049	1.0005	1.0330
	(2.99)**	(3.05)***	(3.04)***	(3.21)***	(1.96)*	(1.97)*	(1.96)*	(2.02)*
$Freefloat_t$	-0.9669	-1.0479	-1.0573	-0.9971	-0.2077	-0.2355	-0.2508	-0.1845
	(-1.11)	(-1.24)	(-1.25)	(-1.17)	(-0.17)	(-0.18)	(-0.19)	(-0.14)
$Zero_t$	25.0464	24.5199	24.4911	23.8720	26.7849	26.5612	26.6884	26.1457
	(4.25)***	(4.28)***	(4.28)***	(4.28)***	(3.32)***	(3.21)***	(3.23)***	(3.15)***
$Illiq_t$	-11.6703	-11.8943	-12.1764	-11.0940	-10.2836	-10.3542	-10.5174	-10.1662
	(-3.69)***	(-3.39)***	(-3.40)***	(-3.14)***	(-1.84)*	(-1.86)*	(-1.88)*	(-1.68)
Constant	0.6583	0.8494	1.0749	0.8877	0.0800	0.0704	0.3351	0.1179
	(0.35)	(0.40)	(0.51)	(0.42)	(0.05)	(0.04)	(0.17)	(0.06)
Obs.	22791	22791	22791	22768	22791	22791	22791	22768
R2	0.05	0.05	0.05	0.05	0.02	0.02	0.02	0.02

Figure 1. Innovation in Collateral Ratio Over Time: This Figure shows the time series (monthly mean with 95% confidence interval) of innovation in cash collateral ratio, ΔCol, collateral beta β_{Col}, and idiosyncratic collateral risk σ_{Col}, for our sample from September 2006 to August 2010.

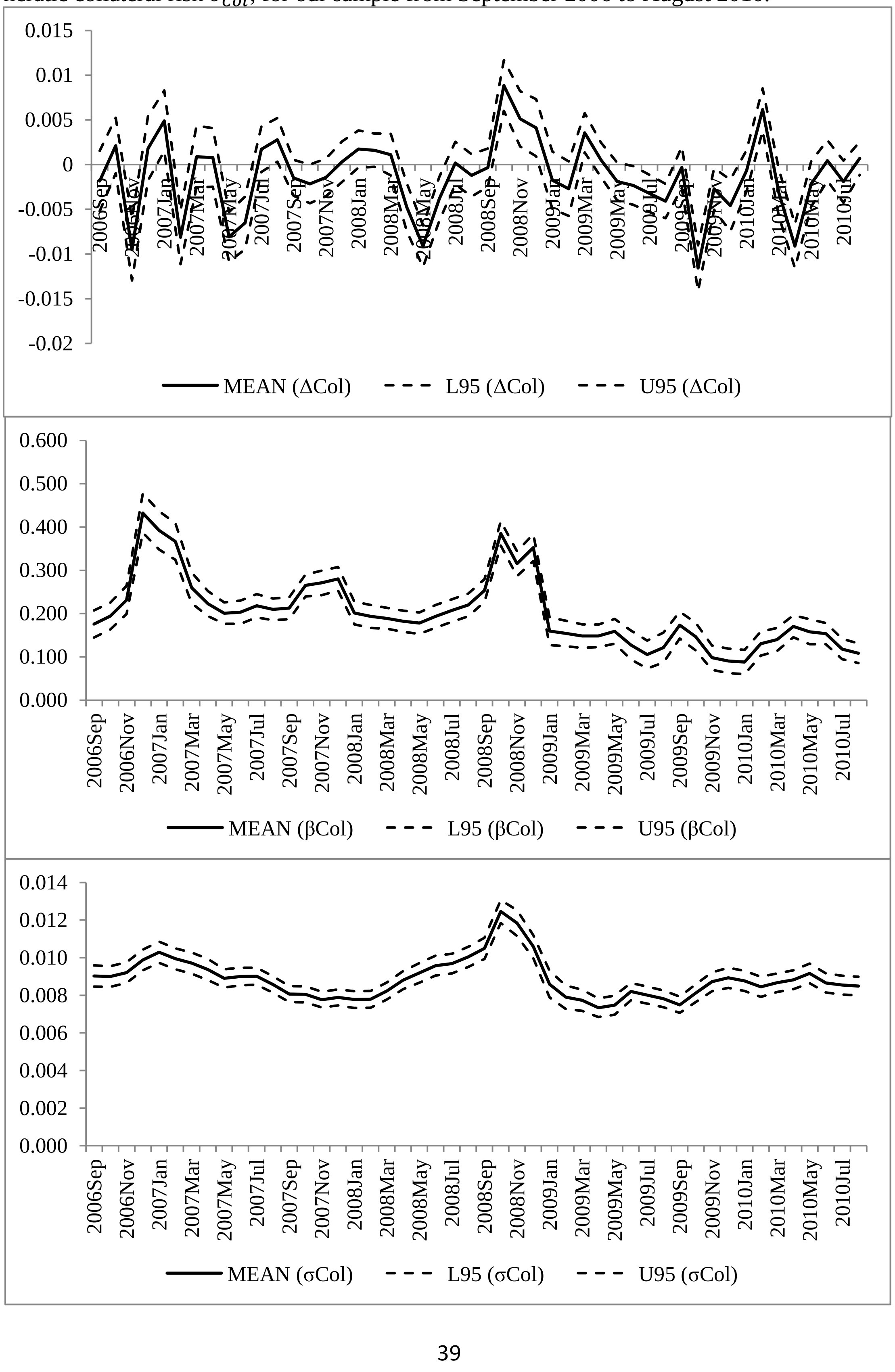

Figure 2. Realized versus Predicted mean returns: Cash Collateral Risk

This figure plots the realized mean excess returns of 25 size and book-to-market portfolios against the mean excess returns predicted by our single-factor collateral beta model (model 1 in Table 10), $E[R - R_{f\ t+1,n}] = \lambda_{col} \times \beta_{col_{t,n}}$. The sample period is from September 2006 to August 2010.