Leverage Asset Pricing*

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Abstract

We investigate intermediary asset pricing theories empirically and find strong support for intermediary book leverage as the relevant state variable. A parsimonious dynamic pricing model that uses detrended broker-dealer leverage as a price of risk variable, and innovations to broker-dealer leverage as pricing factor is shown to perform well in time series and cross sectional tests of a wide variety of equity and bond portfolios. The model outperforms alternative intermediary pricing specifications that use intermediary net worth as state variables, and performs well in comparison to benchmark asset pricing models. We draw implications for macroeconomic theories.

Keywords: return predictability, cross sectional asset pricing, financial intermediation, macro-finance
JEL classification: G10, G12

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1 Introduction

Financial frictions have been the subject of intensive study as economists have refined their theoretical models to capture key aspects of the recent crisis and its aftermath. Although the building blocks used in this literature share many common elements, a systematic study of the comparative *empirical* impact of financial frictions is still in its early stages. Our paper is an attempt to redress the balance by exploring the empirical implications of financial frictions in an asset pricing context.

There are several dimensions to the debate on how best to model financial frictions and how they impact the economy and the financial system.

The first is whether the key state variable is net worth or leverage, where leverage is defined as the ratio of assets to net worth. The importance of net worth as the determinant of credit availability has a long tradition, encompassing the work of Bernanke and Gertler (1989), Holmstrom and Tirole (1997) and Kiyotaki and Moore (1997). These early insights have been developed in the asset pricing context by Gromb and Vayanos (2002), Brunnermeier and Sannikov (2012) and He and Krishnamurthy (2012).

In contrast, Geanakoplos (2010) and Fostel and Geanakoplos (2012) have emphasized the role of leverage as the determinant of financial conditions, rather than net worth itself. They emphasize how leverage falls during downturns, mirroring the increased collateral requirements (increased "haircuts") imposed by lenders, and how the risk bearing capacity of the financial system fluctuates with changes in collateral requirements. Similarly, Gorton (2010) and Gorton and Metrick (2012) have explored the analogy between classical bank runs and the modern run in capital markets driven by increased collateral requirements and the reduced capacity to borrow that comes from a reduction in permitted leverage.

Given the contrasting perspectives on the importance of net worth and leverage from theories, we investigate empirically which matters more for asset pricing. Our tests strongly suggest that it is leverage, not net worth, which is key. Surprisingly, to the extent that net worth matters for asset pricing at all, it enters with the opposite sign from that predicted by theories.

The key to understanding the importance of leverage lies in a second debate about how financial frictions operate. This second dimension of debate is whether net worth should be measured as the market capitalization of the intermediary or as its book equity. This second debate is important irrespective of the outcome of the first debate between net worth and leverage, as leverage itself pre-supposes a measure of net worth.

It is a common practice in macro models to assume that banks hold real assets rather than extending loans to borrowers, so that banks and borrowers are consolidated into one sector. Brunnermeier and Sannikov (2012) and He and Krishnamurthy (2012) are examples of this approach. The advantage of this approach is modeling simplicity, as the relationship between the bank and the borrower can be neglected. Instead, the focus is on the enterprise value of the bank - the sum of its market capitalization and the market value of its debt - rather than the bank's total assets.

When we investigate the answer to the second question on whether leverage should be measured in terms of book equity or market capitalization, we find that it is leverage in terms of book equity that matters empirically, not leverage in terms of market capitalization. In other words, the definition of leverage that matters for asset pricing is the ratio of total assets to book equity, rather than the ratio of enterprise value to market capitalization.

We interpret our finding as a reaffirmation of the importance of credit supply conditions for asset pricing. For instance, hedge funds that rely on their prime brokers to construct leveraged positions will care about lending conditions, and their returns will depend on the terms of the credit offered by their prime brokers. High book leverage of broker-dealers reflects easier credit conditions for leveraged investors, signalling low risk premiums and low future returns. In contrast, enterprise value is about *how much the bank is worth*, rather than *how much the bank lends*. Adrian and Shin (2013) explore this distinction in detail.

Our conclusions on the importance of leverage and its measurement in terms of book equity come from a detailed study of both cross-section and time series tests of asset pricing using a broad class of assets that includes size, book-to-market, and momentum sorted equity portfolios; credit returns sorted by ratings and industries, and Treasury returns sorted by maturity.

In the time series, we find that only book leverage of security brokers and dealers ("broker-dealers") predicts excess returns significantly and with the correct sign. Other variables are either insignificant or have the wrong sign. In particular, broker-dealer book leverage forecasts equity market and credit returns with a negative sign, consistent with theories that leverage is procyclical. Market leverage, defined in terms of market capitalization, on the other hand, does not predict returns.

In cross sectional regressions, only the broker-dealer book leverage variable has a positive and significant price of risk, a finding that is consistent with Adrian, Etula, and Muir (2013). In contrast, we do not find significant prices of risk for any of the other intermediary variables in the cross sectional regressions.

Our finding that book leverage matters in the cross-section as well as in the time series, is indicative of the differential sensitivity of trading portfolios to fluctuations in broker-dealer credit provision. A shock to broker-dealer leverage is a shock to credit availability to leveraged investors, such as hedge funds. To the extent that hedge fund trading portfolios differ in their reliance on prime broker credit, shocks to broker-dealer leverage will have a differential impact on portfolio returns in the cross-section.

We find that broker-dealer book leverage has strong predictive power for equity and credit returns, and this result is robust across sub-periods, as well as to the inclusion of standard return forecasting variables. Moreover, when we control for return forecasting variables used in previous asset pricing studies (such as the dividend yield, the term spread, the credit spread, the book-to-market ratio of the market portfolio, the equity share in new issues or the consumption-wealth ratio), the significance of the broker-dealer leverage variable tends to increase rather than diminish.

When considered together, our findings from time series and cross sectional tests suggest that a parsimonious dynamic asset pricing model with two key features performs well empirically. First, the model has broker-dealer book leverage that tracks the pricing of risk. Second, innovations to broker-dealer leverage take the role of a pricing factor that prices the cross-section of assets. Following theoretical arguments by Adrian and Boyarchenko (2012), we use the equity market return as an additional pricing factor. These features are combined in a dynamic asset pricing model that allows for prices of risk which vary over time as a function of a subset of the state variables (see Adrian, Crump, and Moench (2013)). We show that this parsimonious model performs well in pricing both the time series and the cross section of a wide variety of equity and bond portfolios, and does well in comparison to benchmark asset pricing models. Consistent with the theory, we find that the price of risk associated with exposure to leverage shocks is positive, and that higher leverage growth forecasts lower future returns. Both of these findings reflect the procyclicality of leverage. The price of risk is positive as unexpectedly large leverage shocks correspond to states of the world when the marginal value of wealth is high. Leverage forecasts returns negatively as high leverage is associated with asset price booms, when expected returns are compressed. In contrast to the large literature that emphasizes the role of *net worth* as the state variable, our empirical findings thus favor *leverage* as the key quantity.

There are broader implications of our findings. Our evidence suggests that credit supply conditions are important for asset pricing. Among other things, this implies that the common practice of consolidating the borrowers and banks into one sector may be missing important elements that shed light on financing conditions. To the extent that macro outcomes are determined by such conditions, our findings also hold implications for the broader exercise of incorporating financial frictions into macroeconomics.

The remainder of the paper is organized as follows. In Section 2, we provide a brief summary of alternative intermediary asset pricing theories. In Section 3, we describe the data that is used in the empirical tests, and we explain the conceptual difference between book leverage and leverage computed from market capitalization. In Section 4, we present empirical evidence that helps to discriminate between alternative intermediary asset pricing theories. We further present predictive regressions which show that broker-dealer leverage is a powerful forecasting variable for equity and bond returns, in contrast to other measures of intermediary balance sheets. In Section 5, we present a parsimonious dynamic asset pricing model with detrended broker-dealer leverage as pricing factor. Section 6 discusses implications for macro finance models, and Section 7 concludes.

2 Alternative Intermediary Asset Pricing Approaches

As a background to our empirical investigation, we outline a framework where alternative intermediary asset pricing theories can be nested and compared. In what follows, we use "net worth" and "equity" interchangeably. Also, in line with common usage in the asset pricing literature, we also use "wealth" to mean "equity".

The asset pricing approach that rests on net worth can be described in the following terms. The net worth approach places emphasis on the intermediary's equity, w_{t+1}, as the key variable in the pricing kernel. Formally, denote the growth rate of intermediary equity R^w_{t+1} and $\lambda(w_t)$ the price of risk of intermediary wealth, which is allowed to vary as a function of wealth. Expected excess returns are

$$E_t\left[R^i_{t+1}\right] - R^f_t = \beta^i_w \lambda\left(w_t\right), \qquad \text{(Model 1)}$$

where β^i_w is the risk factor exposure of asset i relative to the return to intermediary wealth R^w_{t+1} and R^f_t denotes the risk free rate. Model 1 implies a one factor asset pricing model where intermediary wealth is the price of risk variable, and the price of risk $\lambda(w_t)$ depends on the level of intermediary equity w_t.

This asset pricing prediction is a generalization of the theory of He and Krishnamurthy (2012). In their theory, the growth rate of intermediary equity represents the asset pricing factor. Model 1 also allows the price of risk to vary as a function of the level of intermediary equity. Intermediary asset pricing theory predicts:

- $\lambda(w) > 0$, i.e. the price of risk of intermediary wealth should be positive,
- $\lambda'(w) < 0$ implying that high intermediary equity is associated with low expected returns.

The assumption of net worth as the key state variable has a long tradition starting with the seminal papers by Bernanke and Gertler (1989), Holmstrom and Tirole (1997) and Kiyotaki and Moore (1997). While these early papers focused on the net worth of borrowers (typically non-financial firms or households), the more recent literature has emphasized the net worth of financial intermediaries. Intermediary asset pricing papers that follow the net worth approach include Gromb and Vayanos (2002) and Brunnermeier and Sannikov (2012), in addition to the work by He and Krishnamurthy (2012) mentioned above. The common thread among these theories is that the pricing of risk depends directly on intermediary equity, with the prediction that intermediary equity is a procyclical variable.

A second approach to intermediary asset pricing emphasizes the role of leverage. Danielsson, Shin, and Zigrand (2012) consider risk-neutral financial intermediaries that are subject to a value at risk (VaR) constraint. The intermediaries' demand for risky assets depends on the Lagrange multiplier of the VaR constraint that reflects effective risk aversion. In equilibrium, asset prices depend on the level of effective risk aversion, which determines the leverage of the intermediaries—times of low intermediary leverage are times when effective risk aversion is high. As a result, financial intermediary leverage directly enters the equilibrium SDF. The reduced form asset pricing restriction takes the following form:

$$E_t\left[R_{t+1}^i\right] - R_t^f = \beta_{R^M}^i \lambda\left(Lev_t\right). \tag{Model 2}$$

The pricing factor is therefore the market return R_{t+1}^M, while the price of risk depends on intermediary leverage, reflecting the time varying effective risk aversion of intermediaries.

Importantly, leverage—not wealth—is the key measure of the marginal value of wealth in these models.

A pricing kernel similar to the one of Model 2 also emerges in equilibrium pricing theories of margin constraints. The pricing factor is the market return, and the price of risk is the Lagrange multiplier on margin constraints. Garleanu and Pedersen (2011) is a recent exposition of such an approach. Empirically, the tightness of the margin constraint is not observable directly, but Adrian and Etula (2011) discuss how theories with margin constraints compare to models that use intermediary leverage as state variable.

A related theory is presented in Brunnermeier and Pedersen (2009) who propose a model where the pricing kernel consists of the financial intermediary's Lagrange multiplier on its leverage constraint ϕ_{t+1}. A specification that is consistent with Brunnermeier and Pedersen (2009) is to proxy $\phi_{t+1} \approx a - b \ln \left(Lev_{t+1} \right)$, such that lower leverage corresponds to tighter funding constraints. Using such an approximation, we can write the reduced form pricing model implied by their theory as follows:

$$E_t \left[R_{t+1}^i \right] - R_t^f = \beta_{Lev}^i \lambda. \qquad \text{(Model 3)}$$

In this setup, the risk factor is the growth rate of intermediary leverage, while the price of risk is assumed to be constant.

Adrian, Etula, and Muir (2013) test this model in the cross section of asset returns. When funding constraints tighten, intermediaries are forced to deleverage by selling off assets they can no longer finance. A drawback of this model is its static nature; the theory does not have any time series predictions, but instead generates a constant price of risk. In order to capture asset price dynamics, the price of risk needs to be explicitly modeled as time-varying.

A pricing kernel in which the pricing of risk varies as a function of leverage over time, and in which shocks to leverage are cross sectional pricing factors, can be motivated from the equilibrium asset pricing model of Adrian and Boyarchenko (2012), who study an economy in which financial intermediaries have risk based leverage requirements, forcing them to deleverage when volatility increases. Volatility endogenously increases when intermediaries deleverage, thus generating a feedback mechanism. In equilibrium, the price of risk can be expressed as varying as a function of leverage as well as the wealth share of financial intermediaries, while the model implies that the relevant risk factors are shocks to intermediary leverage and aggregate output:

$$E_t\left[R_{t+1}^i\right] - R_t^f = \beta_{Lev}^i \lambda_{Lev}\left(Lev_t, \omega_t\right) + \beta_y^i \lambda_y\left(Lev_t, \omega_t\right). \qquad \text{(Model 4)}$$

Adrian and Boyarchenko (2012) show that the price of risk of leverage is always positive $\lambda_{Lev}\left(Lev_t, \omega_t\right) > 0$, while the price of risk of aggregate output $\lambda_y\left(Lev_t, \omega_t\right)$ fluctuates generically between positive and negative. Moreover, intermediary equity is countercyclical in their model. The linear specification of this model where the return to the equity market portfolio is a proxy for output growth gives the following reduced form version of Model 4:

$$E_t\left[R_{t+1}^i\right] - R_t^f = \beta_{Lev}^i\left(\lambda_{0,Lev} + \lambda_{1,Lev} Lev_t\right) + \beta_{R^M}^i\left(\lambda_{0,R^M} + \lambda_{1,R^M} Lev_t\right). \qquad \text{(Model 4A)}$$

The leverage of broker-dealers thus acts both as a pricing factor and a price of risk variable. We will see that Model 4A has the best pricing performance, both in the time series and in the cross section. Leverage is highly significant in explaining the time variation of the market price of risk. Moreover, innovations to broker-dealer leverage carry a significant positive price of risk in the cross-section of equity and bond portfolios.

3 Data

We draw on three types of data for our empirical exercise in this paper. The first are excess returns for equities, Treasury and corporate bond portfolios. The equity returns are decile portfolios sorted on book-to-market, market cap, and momentum, respectively, and have been obtained from Ken French's website. The Treasury returns are the constant maturity returns for maturities $n = 1, 2, 5, 7, 10, 20, 30$ years which we obtain from CRSP. The corporate bond returns are Barclays total return series for benchmark indices for investment grade industrials, utilities and financials, as well as for AAA, AA, A, and BAA rated bonds.

We collect intermediary balance sheet data from various sources. We obtain book equity and book leverage for Securities Brokers and Dealers ("broker-dealers") from the Federal Reserve Flow of Funds series (Table L.127). We obtain broker-dealer market equity and leverage from Compustat-CRSP by aggregating individual firm data with SIC codes 6712 or 6211. We also use Compustat-CRSP to construct market equity and leverage for commercial banks using individual firm data with SIC codes from 6000 through 6099. Finally, we obtain book equity and leverage series for commercial banks by aggregating the individual CALL report data obtained from the Federal Deposit Insurance Corporation (FDIC).[1]

We detrend all balance sheet indicators by computing annual growth rates and check the robustness of our main results with respect to alternative detrending methods in Section B in the appendix. We use the following naming convention: the annual growth rates of broker-dealer book equity and leverage are labeled $yBDbeg$ and $yBDblevg$; similarly, broker-dealer market equity and leverage growth are named $yBDmeg$ and $yBDmlevg$. The corresponding quantities for commercial banks are $yCBbeg$, $yCBblevg$, $yCBmeg$, and $yCBmlevg$.

We compare the predictive power of the balance sheet indicators with benchmark return forecasting factors that have been used in the literature. These are the dividend yield (dy) for the S&P500 from Haver Analytics, the term spread ($TERM$) calculated as the difference between the ten-year constant maturity Treasury yield and the three-month Treasury bill rate, both from the Federal Reserve's H.15 release, the default spread (DEF), calculated as the difference between Moody's Aaa and Baa yields also from the

[1] A detailed discussion of how these aggregates have been constructed is provided in Appendix A.

H.15 release, the equity share in new issues (ES) from Baker and Wurgler (2000) which we updated with recent data, the book-to-market ratio (BM) for the aggregate value-weighted market portfolio from CRSP, the log consumption-wealth ratio from Martin Lettau's website (CAY), as well as the Cochrane and Piazzesi (2005) Treasury return forecasting factor (CP) which we updated with recent data from CRSP.

3.1 Measuring Net Worth and Leverage

The literature uses two distinct measures of intermediary net worth, either the book equity or the market capitalization. Book equity is the owner's own stake in the portfolio, and is exemplified by the haircut applied to a repurchase agreement (repo). A repo haircut of 5 percent means that 5 cents of each dollar's worth of securities must be funded by the owner's stake, so that maximum achievable leverage is 20. For securities that are traded in liquid markets, the repo haircut gives an accurate marked-to-market snapshot of book equity and hence of book leverage. A rise in collateral requirements (increased haircuts) is the mirror image of decreased leverage, and Geanakoplos (2010) and Gorton and Metrick (2012) have examined how the risk bearing capacity of the financial system can be severely diminished when leverage falls through an increase in collateral requirements. Leverage is thus procyclical—leverage is high during booms and low during busts (Adrian and Shin (2010, 2013)).

An alternative notion of equity is market capitalization, which is the discounted value of all future free cash flows. Market capitalization is a natural counterpart to the *enterprise value* of the bank, which is defined as

$$\text{Enterprise value} = \text{market capitalization} + \text{debt}$$

For a financial intermediary (called a "bank" for simplicity), enterprise value addresses the question "how much is the bank worth?" In contrast, total assets address the question "how much does the bank lend?" The two can diverge - for instance when one bank has a higher fee income than another even when they hold identical portfolios of loans and securities. Enterprise value is the correct notion when the focus is on capital budgeting, corporate takeovers or the sale of new ownership stakes.

Figure 1 from Adrian and Shin (2013) presents side by side the scatter charts for the growth of total assets and enterprise value for the eight largest banks and broker-dealers in the US.[2] Although commercial banks have assets that are not marked to market (such as loans), they also have substantial holdings of marketable securities.[3] They have also absorbed some of the largest formerly independent investment banks (Citibank acquired Salomon Brothers in 1998, Chase acquired JP Morgan in 2000 and Bear Stearns in 2008, and Bank of America acquired Merrill Lynch in 2008), and their book equity reflects valuation changes, albeit imperfectly.

The left hand panel of Figure 1 is the scatter chart for the relationship between the asset-weighted growth (quarterly log difference) in book leverage against the asset-weighted growth in total assets. The right hand panel of Figure 1 is the corresponding scatter chart where we use enterprise value instead of total assets and use market capitalization instead of book equity. The left hand panel shows the upward-sloping scatter chart associated with procyclical book leverage as discussed in Adrian and Shin (2010). In contrast, the right hand panel of Figure 1 shows that when leverage is defined as the ratio of enterprise value to market cap, the scatter chart is *negatively* sloped, so that leverage is high when enterprise value is low. In other words, enterprise value leverage is *countercyclical*. The interpretation is that during downturns when the value of the bank is low, a greater proportion of the bank's value is held by the creditors, rather than the equity holders.

In what follows, we take an agnostic stance on which matters for asset pricing and let

[2]The eight firms include the securities firms Goldman Sachs, Morgan Stanley, Lehman Brothers, Merrill Lynch, and Bear Stearns and the three commercial banks with the largest trading operations (JP Morgan Chase, Citibank, and Bank of America). All eight of these institutions have been primary dealers of the Federal Reserve.

[3]Ball, Jayaraman and Shivakumar (2012) report the findings of a detailed investigation of the securities holdings of commercial banks, and find that banks with larger holding of trading securities are associated with share prices with larger bid-ask spreads.

the data speak. It will turn out, however, that it is *book leverage* which is more informative concerning asset pricing relationships, both for the predictive exercise of forecasting returns, and also in cross-sectional asset pricing tests. Market capitalization and the associated enterprise value leverage tell us much less, as we will see. Our results indeed suggest that the availability of credit to traders and other intermediaries is a crucial component of the asset pricing relationship and that such information on the availability of credit will be useful for predictive and cross-sectional asset pricing exercises.

For our empirical asset pricing exercise, the book equity variable that we use is the difference between the financial assets and total liabilities from the Flow of Funds. Although the underlying data of the Flow of Funds also includes a series for book equity, this series is measured at the end of the quarter after any recapitalization has taken place. By defining broker-dealer book equity as the difference between the financial assets and total liabilities, we manage to strip out the FDI component in the equity series in the Flow of Funds that represent the injection of equity by foreign investors. As such, our book equity series is closer to the book equity prior to the recapitalizations. To the extent that equity injections have played an important role during the crisis (for instance, by sovereign wealth funds who took stakes in the US broker-dealer sector), our measure of book equity manages to bring book equity closer to the marked-to-market value of the book equity *before* the injection of new equity. In this way, the leverage series may capture both the availability of credit as well as the constraints that are placed on the equity of the bank.

4 Empirical Results

In this section, we bring the various intermediary asset pricing theories to the data and examine empirically their reduced-form implications. We start by comparing the predictive power and cross-sectional pricing performance of intermediary balance sheet indicators.

4.1 Evaluating Alternative Intermediary Pricing Kernels

Table 1 helps us adjudicate between the various competing intermediary asset pricing predictions. The top panel presents time series tests of the alternative pricing predictions, while the bottom panel presents the cross sectional evidence. We use intermediary net worth and intermediary leverage growth in both types of tests. Net worth and leverage can be measured using book values or market values (market capitalization), giving four combinations (book value of leverage and net worth, and market value of leverage and net worth). In addition, we measure each of those four variables for two types of institutions: security brokers and dealers, and commercial banks. Those eight alternative variables are reported in the eight columns of Table 1.

To test the time series implications of the various models we estimate one quarter ahead predictive return regressions of the form

$$R^i_{t+1} - R^f_t = a^i + b^i X_t + \varepsilon^i_{t+1} \tag{1}$$

where the X_t variables are measures of intermediary wealth or leverage. The time series regressions test the prediction of the intermediary pricing theories that the pricing of risk varies over time as a function of the intermediary variables.

As dependent variables we use the equity market return from CRSP, the return on the BAA rated corporate bond portfolio from Barclays, and the ten-year zero coupon constant maturity Treasury return. The sample period is 1975Q1-2012Q4. The upper panel of Table 1 shows that broker-dealer book leverage growth from the Flow of Funds strongly predicts the excess returns on the CRSP equity market portfolio as well as the portfolio of BAA rated corporate bonds. In both cases, the estimated predictive slope coefficients are negative, in line with the prediction of Model 2 and Model 4 that tighter (looser) balance sheet constraints result in higher (lower) risk premia. The predictive coefficient of the BAA corporate bond portfolio is also negative and statistically different from zero. The coefficient of the ten-year Treasury return is insignificant. The interpretation of these results in terms of the availability of credit to market participants fits the narrative well, since leveraged market players would typically figure as the primary holders of risky assets such as equities and credit, but not of less risky assets such as Treasury bonds.

Comparing the predictive power of broker-dealer book leverage from the Flow-of-Funds with that of alternative balance sheet indicators, we see that none predicts excess returns as consistently. While broker-dealer book equity growth from the Flow-of-Funds shows predictive power for the quarterly excess return on the S&P 500 index, the slope coefficient has a positive sign and is only statistically significant at the 10 percent level. This empirical finding is in contrast to the theories underlying Model 1, but is consistent with Model 4 which generates countercyclical intermediary net worth in equilibrium.

Interestingly, none of the commercial bank variables appear significant in the predictive return regressions. Furthermore, none of the leverage or net worth variables measured at market value show significant predictive power for equity or bond returns. In summary, broker-dealer book equity as obtained from the Flow-of-funds shows the strongest predictive performance for risky asset returns.

In the second exercise we estimate the unconditional prices of risk associated with exposure to various intermediary asset pricing factors. In other words, we test how well these intermediary balance sheet indicators fare in explaining the cross-section of asset returns. In this exercise, our prediction would be that those assets or portfolios that rely most on the availability of credit from financial intermediaries would load most on the cross-sectional pricing factor. Moreover, exposure to intermediary balance sheet risk should be a priced factor in the cross-section of risky assets. Specifically, we estimate the following reduced-form asset pricing model:

$$\begin{aligned} R^i_{t+1} - R^f_t &= \beta_i' \lambda_0 + \beta_i' v_{t+1} + e^i_{t+1} \\ X_{t+1} &= \mu + \Phi X_t + v_{t+1} \end{aligned}$$

where v^X_{t+1} denotes the AR(1) innovation to the pricing factor, and e^i_{t+1} denotes the cross sectional pricing error. We apply the standard two pass Fama-MacBeth estimator and assess the significance of the estimates using standard errors as in Shanken (1992).

The lower panel of Table 1 provides cross-sectional estimates of the market price of risk associated with exposure to the various intermediary balance sheet indicators. The results show that among the balance sheet indicators considered, only broker-dealer book leverage growth features a significant price of risk. This result is consistent with the findings in Adrian, Etula, and Muir (2013) who use innovations to seasonally-adjusted broker-dealer book leverage as a pricing factor in similar cross-sectional tests. The positive sign of the estimated price of broker-dealer book leverage is consistent with the theories of Brunnermeier and Pedersen (2009) and Adrian and Boyarchenko (2012). Interestingly, none of the other balance sheet indicators are associated with significant prices of risk.

Our result that the market capitalization of broker-dealers do not significantly forecast asset returns and do not appear to be priced risk-factors in the cross-section suggests that book values are the more appropriate measures for financial conditions for asset pricing. The finding that the book leverage is significant while market leverage is not can be related to the debate concerning the measurement of balance sheet quantities. In intermediary asset pricing theories, all assets and liabilities are assumed to be marked to market, and there is thus no distinction between book and market equity. Put differently, the market to book ratio always equals one in those theories. Empirically, however, there are two main reasons for time variation of the market to book ratio. One is that not all financial institutions mark their balance sheets to markets. Another is that market equity measures not just the residual value of financial assets, but also of intangible assets. Intermediary asset pricing theories typically do not model such intangible assets, resulting in the equality of market and book values. The problem that not all assets are marked to market is particularly important for commercial banks, whose loan books are typically held at historical accounting values. In contrast, for security broker-dealers, all assets and liabilities are typically accounted at fair value. As a result, for those institutions, the difference between market and book equity can be viewed as a pure measure of intangible assets.

Another notable finding from Table 1 is that the balance sheets of broker-dealers are more informative about asset price dynamics than the balance sheets of commercial banks. This finding is likely due to two reasons. First, the inertia in accounting values of commercial bank assets might mask true financial condition. Bischof, Brüggemann, and Daske (2011) discuss how illiquid assets gave rise to “stale” book values when fair value reporting requirements were changed temporarily at the height of the crisis. In contrast, broker-dealers mark their assets and liabilities to market.

A second reason for the relatively better performance of the broker-dealer sector might be that broker-dealers provide a better proxy for the marginal investor in traded assets. Our asset pricing tests are conducted on equity and bond portfolios, for which broker-dealers are the market makers. In contrast, commercial bank balance sheets primarily contain non-traded loans, for which we cannot conduct asset pricing tests. We thus interpret our results not as evidence against the importance of commercial banks for pricing and economic activity more generally, but rather as evidence of the degree to which their balance sheet fluctuations mask conditions in credit markets.

In summary, the results in this section show that broker-dealer book leverage growth is strong predictor of excess equity and bond returns and also represents a priced risk factor in the cross section of risky assets.

4.2 Broker-dealer Book Leverage: Further Time Series Tests

Thus far, we have shown that among the various intermediary balance sheet indicators, broker-dealer book leverage growth is the only variable that both predicts excess returns on stocks and bonds as well as acts as a significant cross-sectional pricing factor. The latter result is in line with the findings of Adrian, Etula, and Muir (2012), who carry out a number of robustness checks. They find that broker-dealer book leverage growth computed from Flow of Funds data is a strongly significant cross-sectional pricing factor across different subsamples, as well as controlling for various other cross-sectional pricing factors and accounting for statistical uncertainties regarding the two-pass regression estimates.

In this subsection, we examine the robustness of the broker-dealer book leverage variable as a significant predictor of excess returns. Specifically, we run simple predictive regressions where we use the book leverage factor as a predictor for subsequent returns over different sample periods, and controlling for the most commonly used return predictor variables. As a reminder, among the theories considered in Section 4.1 which feature time varying prices of risk, Model 2 and Model 4 predict that high intermediary leverage is associated with lower risk premiums, and hence lower subsequent returns for all risky assets.

We expand our set of dependent variables and use the quarterly return in excess of the three-month Treasury bill for five benchmark assets: the excess return on the CRSP market portfolio (MKT), the excess return on the S&P500 index (SPX), the excess return on an investment grade corporate bond portfolio (IG), the excess return on a portfolio of BAA rated corporate bonds (BAA), and finally the excess return on a constant maturity ten-year Treasury portfolio ($CMT10$).

Table 2 reports the results for one quarter ahead predictive return regressions where we use the annual broker-dealer leverage growth from the Flow-of-funds as the predictor variable for five alternative risky assets whose returns are used as the dependent variable. The first panel shows results for the sample period $1975Q1 - 2012Q4$, the second panel the sample period $1986Q1 - 2012Q4$, and the last the sample period $1986Q1 - 2008Q2$. The rows labeled “cst” provide the regression intercept term, and the rows labeled “coeff” are the focus of Table 1, and show the OLS regression coefficient on lagged broker-dealer leverage growth. For robustness, we also report “coeff-Stambaugh” which provide the Stambaugh (1999) bias adjusted regression coefficients. In all panels, t-statistics are provided in square brackets below, and all standard errors are Newey-West adjusted with a maximum lag length of 4 quarters.

The results confirm our main finding that the broker-dealer book leverage variable is a strong predictor of subsequent excess returns on risky assets. The interpretation is that high book leverage of the broker-dealers indicates lower risk premiums due to the greater availability of credit to leveraged investors. The coefficients on the lagged broker-dealer leverage growth term is negative and highly significant for stock returns (MKT, SPX) as well as the BAA-rated bond portfolio (BAA) for all sub-periods. The predictive relationship between broker-dealer leverage and one-quarter ahead excess return on equity market and credit portfolios is also economically significant: a one-standard deviation increase in annual broker-dealer leverage growth translates into a two percent decline in next quarter's excess stock market returns and a reduction of a little less than one percent in quarterly excess returns on the BAA-rated bond portfolio for the 1975-2012 sample period.

While broker-dealer book leverage is a significant predictor of returns on investment grade bonds (IG) in the subsamples starting in 1986, the treasury portfolio ($CMT10$) is the conspicuous exception. The broker-dealer book leverage term has no role in predicting excess returns on Treasuries in any of the subsamples considered.

Figure 2 provides the graphical counterpart to Table 2, where we have plotted the rolling window regression coefficients and corresponding two standard error bands for the coefficients on MKT and BAA on one quarter lagged broker-dealer leverage growth. The rolling estimation window is for 60 quarters. The initial sample period is from $1968Q1 - 1982Q4$ and the final regression window is for the sample $1998Q1 - 2012Q4$. Standard errors are Newey-West adjusted with a maximum lag length of 4 quarters.

Figure 2 shows that the explanatory power of the broker-dealer leverage growth variable has increased over time. Until 1990, the point estimate of the coefficient on the broker-dealer leverage growth term is actually of the "wrong" sign, but starting from the mid-1990s, the estimate becomes more and more negative, so that the most recent period from the early 2000s has the coefficient estimate being two standard errors or more below zero. This time series pattern is consistent with the increased role of market-based intermediaries in the economy, as they supplant the traditional role of commercial banks as the primary financial intermediary (see Adrian and Shin (2010)).

As a further check on the predictive power of our broker-dealer book leverage variable, Table 3 presents the results of robustness exercises where we compare the performance of broker-dealer book leverage growth with other variables that have been considered in the asset pricing literature. Table 3 reports results for one quarter-ahead predictive return regressions using the excess return on the CRSP market portfolio (MKT) as the dependent variable. As predictor variables, we consider our broker-dealer leverage growth variable together with the following commonly used equity return forecasting factors. They are the log dividend yield ("dy"), the log consumption-wealth-ratio, ("CAY") from Lettau and Ludvigson (2001), the equity share in new issuance ("ES") from Baker and Wurgler (2000), the market portfolio's book-to-market ratio ("B2M"), the term spread between the ten-year Treasury yield and the three-month Treasury bill yield ("TERM"), and the default spread between the yields on Moody's benchmark BAA-rated and AAA-rated corporate bonds. The first panel shows results for the sample period $1975Q1 - 2012Q4$, the second panel the sample period $1986Q1 - 2012Q4$, and the last the sample period $1986Q1 - 2008Q2$. The rows labeled "coeff" show the OLS regression coefficient and t-statistics are provided in brackets. All the standard errors are Newey-West with a maximum lag length of 4 quarters.

We see from Table 3 that our broker-dealer leverage variable has incremental predictive value even in the presence of all of the typical return predictor variables. In fact, the broker-dealer leverage variable is the only one that appears consistently as a predictor variable, and in all cases with statistical significance at the 1% level. Indeed, we see from the lowest panel that in the period between 1986 and 2008, all other pricing factors are knocked out when we include our broker-dealer leverage variable. We take the results in Table 3 as confirmation of broker-dealer leverage as conveying important information on the risk premiums for risky assets.

Table 4 reports the results of a similar exercise as in Table 3, except that we examine the excess return on the BAA-rated bonds (BAA) instead of the CRSP market portfolio. The predictor variables are annual broker-dealer leverage growth as well as a few commonly used bond return forecasting factors. These are the term spread between the ten-year Treasury yield and the three-month Treasury bill yield ("TERM"), the default spread between the yields on Moody's benchmark BAA-rated and AAA-rated corporate bonds, and the Cochrane-Piazzesi Treasury return forecasting factor ("CP") which has been updated to include more recent data.

Again, we see the predictive role of the broker-dealer leverage variable in all subperiods. It is the only variable that appears consistently in all panels. The significance level in the earlier period from 1975 is somewhat lower than for equities. However, we see that from 1986 onwards, broker-dealer leverage is significant at the 1 percent level.

5 Dynamic Leverage Asset Pricing

In the previous sections we have seen that broker-dealer book leverage growth both acts as a strong predictor for excess returns on risky assets and as a significant cross-sectional risk factor. In this section, we combine these times series and cross-sectional results to arrive at a dynamic asset pricing model which captures both features of the data. Specifically, the model is of the form:

$$R^i_{t+1} - R^f_t = \beta\left(\lambda_0 + \lambda_1 X_t + v_{t+1}\right) + \varepsilon^i_{t+1} \quad (2)$$

$$X_{t+1} = \mu + \phi X_t + v_{t+1}. \quad (3)$$

In such a model, the pricing factors X_t are predictive variables that drive time variation in risk premia. At the same time, the innovations to the pricing factors, v_{t+1}, act as cross-sectional pricing factors (Adrian, Crump, and Moench (2013) provide an econometric treatment of the dynamic asset pricing estimation and its economic interpretation). By using different combinations of the market return and the balance sheet variables, and by imposing certain restrictions on the dynamic price of risk parameters λ_1 we can obtain the intermediary pricing models 1-4A.

Table 5 provides results for a two-factor dynamic asset pricing model. The two factors are the excess return on the CRSP market portfolio (MKT) and annual broker-dealer book leverage growth ($yBDblevg$). The prices of risk of both pricing factors are time-varying and depend linearly on one-quarter lagged broker-dealer leverage growth. Estimation is done using the QMLE estimator of Adrian, Crump, and Moench (2013). The column labeled λ_0 provides the constant elements of the factors' prices of risk, while the column labeled "yBDblevg" provides the coefficients of the price of risk on one-quarter lagged broker-dealer leverage growth. The three panels report estimates for the three subsamples $1975Q1 - 2012Q4$, $1986Q1 - 2012Q4$, and $1975Q1 - 2008Q2$, respectively.

The table documents that the price of market risk has a strongly significant constant component in all three subsamples, which is estimated to range from about 2.4 percent per quarter in the subsample excluding the recent financial crisis to 2.7 percent per quarter for the full sample from $1975Q1 - 2012Q4$. However, the price of market risk is also estimated to be strongly time varying except in the subsample ending in 2008, as captured by the coefficient on lagged broker-dealer leverage growth. This is in line with the evidence in Section 4.2 that higher broker-dealer leverage growth is associated with lower future excess returns. Precisely, a one-standard deviation increase of broker-dealer leverage growth is estimated to reduce the market risk premium by a little more than 2 percent per quarter in the full sample from 1975 through 2012. Combined the unconditional price of market risk is estimated to be a statistically significant 2 percent per quarter in all subsamples.

The model also has a role for exposure to broker-dealer leverage growth, in line with the cross-sectional asset pricing results in Section 4.1. In particular, one unit of exposure to broker-dealer leverage growth is estimated to be associated with a statistically significant quarterly excess return of about 1.1 percent both in the full sample and in the sample ending in 2008. While the estimated price of leverage risk is considerably larger at 2 per cent in the sample from 1986Q1-2012Q4, its standard error is also larger and thus statistically not significant for that sample. Interestingly, there is no evidence that the price of leverage risk is time-varying, as indicated by the insignificant coefficient on lagged leverage in all subsamples. This is consistent with the model by Adrian and Boyarchenko (2012) which implies a positive price of leverage risk, but a price of market risk that can fluctuate between positive and negative values.

The key chart of our dynamic asset pricing tests is Figure 3, which provides plots of observed versus model-implied average excess returns on the set of test assets for various model specifications. All excess returns are stated in quarterly percentage terms. The test assets are ten size sorted stock decile portfolios (ME1 ... MEe10), ten book-to-market sorted decile portfolios, and ten momentum sorted decile portfolios (all from Ken French's website), as well as constant maturity Treasury returns for maturities ranging from 1 through 30 years (cmt1 ... cmt30), obtained from CRSP, and Barclay's benchmark corporate credit portfolios for various ratings classes and industries. The plots are based on the sample period $1975Q1 - 2012Q4$.

The crucial panel for us is the one on the lower right-hand side, labeled "LCAPM", which plots the results for the two-factor leverage capital asset pricing model which uses MKT and broker-dealer leverage growth ("yBDblevg") as pricing factors and allows for prices of risk to vary as a function of lagged broker-dealer leverage growth. The other three panels are for comparison. The upper-left panel reports results based on the static CAPM where the excess return on the market portfolio (MKT) is the only risk factor; the upper-right panel shows the unconditional fit for the Fama-French (1993) three factor model using MKT, SMB, and HML as pricing factors and assuming constant prices of risk. The lower-left panel shows results for a five-factor model that augments the Fama and French (1993) three-factor model with a momentum factor and the level of the Treasury yield curve. The latter is computed as the first principal component of the CRSP Fama-Bliss discount bond yields for maturities from one year through five years.

We see from Figure 3 that our favored two factor asset pricing model using broker-dealer leverage performs extremely well compared to the other models as it implies average excess returns that line up very well with actual observed excess returns. This is in stark contrast to the CAPM and the Fama-French three-factor model which are provided in the upper two panels. Moreover, the lower two panels show that our two-factor model does as well as the five-factor model that augments the Fama-French three-factor model with a momentum factor and the level of the Treasury yield curve and has thus been tailored to fit the large cross-section of equity and bond portfolios that represents our set of test assets.

The results presented in this section have shown that a parsimonious two-factor dynamic asset pricing model with broker-dealer leverage as the relevant risk factor fits the cross-section of equity and bond return portfolios well and implies significant price of risk coefficients that have the correct sign. Table 6 provides results for a similar two-factor dynamic asset pricing model where we replace broker-dealer book leverage growth with book equity growth. Estimation is done using the same estimator of Adrian, Crump, and Moench (2013), and the three panels report estimates for the same three subsamples as before. The estimates reinforce our earlier findings: innovations to broker-dealer book equity growth are associated with a negative price of risk that is significantly different from zero at least at the 10% level in all three considered sample periods. In addition, the market price of MKT risk is estimated to positively depend on lagged broker-dealer equity growth with a significant coefficient in two subsamples. Hence, in line with the predictive regressions and cross-sectional analysis, broker-dealer equity growth is estimated to behave as a countercyclical variable also in a dynamic asset pricing model. This is inconsistent with the implications of Model 1 but is in line with the predictions of Model 4.

6 Macro Implications

In this paper, we have highlighted the importance of intermediary book leverage as the key pricing factor for financial assets. To the extent that financial risk premiums affect discount rates for consumption and investment, we may conjecture that real economic activity will similarly be influenced by the fluctuations in (book) leverage of financial intermediaries. Our results therefore hold potentially important implications for macroeconomics.

The fact that book leverage of intermediaries matters for financial risk premiums reinforces the case for keeping track of credit supply conditions in the economy, especially the credit supplied through intermediaries. Adrian, Colla, and Shin (2012) argue that the evidence during the 2007-9 crisis points overwhelmingly to a shock in the supply of intermediated credit, driven by a contraction in the lending by banks and other intermediaries, while firms that had access to direct credit through the bond market took advantage of their access and tapped the bond market in large quantities. Although large firms with access to the bond market compensated for the loss of bank financing by tapping the bond market, the cost of credit rose steeply, both for direct and intermediated credit. The evidence in Adrian, Colla, and Shin (2012) points to upward pressure on market risk premiums in order to induce non-bank investors to enter the market for risky corporate debt and take on a larger exposure to the credit risk of non-financial firms. The sharp increase in spreads during financial crises would be consistent with such a mechanism. The recent work of Gilchrist, Yankov, and Zakrajšek (2009) and Gilchrist and Zakrajšek (2011) point to the importance of the credit risk premium as measured by the "excess bond spreads" (EBP) (i.e. spreads in excess of firm fundamentals) as an important predictor of future economic activity.

Since the financial crisis, a new batch of dynamic, general equilibrium macro models that incorporate financial frictions have been developed.[4] The evidence in our study

[4] Brunnermeier, Eisenbach, and Sannikov (2012) and Quadrini (2011) offer more comprehensive surveys of the literature on general equilibrium macroeconomic models with financial frictions.

presents an empirical challenge to many of these models, as we point to a very specific stylized facts, with tight implications for the modeling of financial frictions. The challenge for the theory is to capture the empirical regularities that we document; namely, 1) the market price of risk varies with intermediary leverage, where an increase in leverage corresponds to a compression of expected returns, and 2) shocks to intermediary leverage are a priced risk factor with a positive price of risk.

Our finding that intermediary book leverage is the key state variable for risk premiums also suggests that macro models need to take explicit account of credit supply relationships between intermediaries and borrowers, rather than consolidating banks and borrowers into one sector, and assuming that banks hold real assets directly. Our results suggest that macro models should not neglect the book value of intermediary assets, as book value of assets hold information on how much the bank lends. To the extent that credit supply matters, book values also matter. Bank leverage is then procyclical and reflects the fluctuations of lending conditions over the cycle. Nuño and Thomas (2013) presents a promising analysis that incorporates the procyclicality of leverage explicitly.

Perhaps the most important lesson from our paper is that macro models need to be able to encompass the narrative where the economy is more vulnerable to a downturn and the downturn is more severe when it is followed by a long period of expansion of lending by intermediaries. Work at central banks have done much to extend the boundary along these dimensions. The recent work by Boissay, Collard, and Smets (2012) on booms and systemic banking crises is an important step in addressing the period in the run-up to the crisis, rather than focusing exclusively on the propagation and amplification of the shock that hits an otherwise normally functioning economy.

7 Conclusion

Asset pricing theories in which financial intermediaries, not representative consumers, are the marginal investor, have attracted increasing attention since the financial crisis of 2007-2009. The theories differ along key dimensions. While many emphasize the role of intermediary net worth as the key, procyclical variable, other theories put more emphasis on intermediary leverage or margins. We have used time series and cross sectional asset pricing test to discriminate between alternative approaches.

We have seen that intermediary leverage measured using book values is the best performing variable in both cross sectional and time series asset pricing tests. Intermediary leverage is procyclical in both tests; it has a positive price of risk in the cross section of asset returns, and high leverage growth predicts low future returns. In contrast, net worth fails in the empirical tests. Intermediary net worth tends to predict higher returns in the future, indicating the countercyclicality of that variable. The latter finding is consistent with the notion that intermediaries pay out in booms, and issue equity in busts.

We have shown that the time series and cross sectional evidence can be summarized in a parsimonious dynamic asset pricing model that uses broker-dealer leverage and the market equity return as cross sectional pricing factors, and broker-dealer leverage as a price of risk factor. That model performs well in pricing the time series and cross section of a wide variety of equity and bond portfolios in comparison to benchmark models.

For macroeconomic modeling, our results imply that intermediary leverage should emerge endogenously as a procyclical variable. This is the case in theories with risk-based leverage constraints, such as Adrian and Boyarchenko (2012), Adrian and Shin (2013) or Danielsson, Shin, and Zigrand (2012). The comparison of the asset pricing model with intermediary state variables to more traditional state variables suggests that intermediaries are central to the pricing of risk from a quantitative point of view. The asset pricing facts presented in this paper suggest a central role for intermediaries in the pricing of risk, and therefore in macroeconomic dynamics.

References

ADRIAN, T., AND N. BOYARCHENKO (2012): "Intermediary Leverage Cycles and Financial Stability," *Federal Reserve Bank of New York Staff Report*, 567.

ADRIAN, T., P. COLLA, AND H. S. SHIN (2012): "Which Financial Frictions? Parsing the Evidence from the Financial Crisis of 2007-9," in *NBER Macroeconomics Annual 2012, Volume 27*. University of Chicago Press.

ADRIAN, T., R. K. CRUMP, AND E. MOENCH (2013): "Efficient Regression Based Estimation of Dynamic Asset Pricing Models," *Federal Reserve Bank of New York Staff Report*, 493.

ADRIAN, T., AND E. ETULA (2011): "Comment on" Two Monetary Tools: Interest Rates and Haircuts"," in *NBER Macroeconomics Annual 2010, Volume 25*, pp. 181–191. University of Chicago Press.

ADRIAN, T., E. ETULA, AND T. MUIR (2013): "Financial intermediaries and the cross-section of asset returns," *Journal of Finance*, forthcoming.

ADRIAN, T., AND H. S. SHIN (2010): "Liquidity and leverage," *Journal of Financial Intermediation*, 19(3), 418–437.

——— (2013): "Procyclical leverage and value-at-risk," *Review of Financial Studies*, forthcoming.

BAKER, M., AND J. WURGLER (2000): "The equity share in new issues and aggregate stock returns," *Journal of Finance*, 55(5), 2219–2257.

BERNANKE, B., AND M. GERTLER (1989): "Agency Costs, Net Worth, and Business Fluctuations," *American Economic Review*, 79(1), 14–31.

BISCHOF, J., U. BRÜGGEMANN, AND H. DASKE (2011): "Fair value reclassifications of financial assets during the financial crisis," Discussion paper, University of Mannheim.

BOISSAY, F., F. COLLARD, AND F. SMETS (2012): "Booms and systemic banking crises," *ECB Working Paper*, 1514.

BRUNNERMEIER, M., AND Y. SANNIKOV (2012): "A macroeconomic model with a financial sector," *American Economic Review*, forthcoming.

BRUNNERMEIER, M. K., T. M. EISENBACH, AND Y. SANNIKOV (2012): "Macroeconomics with financial frictions: A survey," Discussion paper, National Bureau of Economic Research.

BRUNNERMEIER, M. K., AND L. H. PEDERSEN (2009): "Market liquidity and funding liquidity," *Review of Financial studies*, 22(6), 2201–2238.

COCHRANE, J., AND M. PIAZZESI (2005): "Bond Risk Premia," *American Economic Review*, 95, 138–160.

Danielsson, J., H. S. Shin, and J.-P. Zigrand (2012): "Procyclical Leverage and Endogenous Risk," Discussion paper, London School of Economics.

Fama, E. F., and K. R. French (1993): "Common risk factors in the returns on stocks and bonds," *Journal of Financial Economics*, 33(1), 3–56.

Fostel, A., and J. Geanakoplos (2012): "Endogenous Leverage in a Binomial Economy: The Irrelevance of Actual Default," Discussion paper, Cowles Foundation.

Garleanu, N., and L. H. Pedersen (2011): "Margin-based asset pricing and deviations from the law of one price," *Review of Financial Studies*, 24(6), 1980–2022.

Geanakoplos, J. (2010): "The leverage cycle," in *NBER Macroeconomics Annual 2009, Volume 24*, pp. 1–65. University of Chicago Press.

Gilchrist, S., V. Yankov, and E. Zakrajšek (2009): "Credit market shocks and economic fluctuations: Evidence from corporate bond and stock markets," *Journal of Monetary Economics*, 56(4), 471–493.

Gilchrist, S., and E. Zakrajšek (2011): "Credit spreads and business cycle fluctuations," *American Economic Review*, forthcoming.

Gorton, G., and A. Metrick (2012): "Securitized banking and the run on repo," *Journal of Financial Economics*, 104(3), 425–451.

Gorton, G. B. (2010): *Slapped by the Invisible Hand: The Panic of 2007*. Oxford University Press.

Gromb, D., and D. Vayanos (2002): "Equilibrium and welfare in markets with financially constrained arbitrageurs," *Journal of Financial Economics*, 66(2), 361–407.

He, Z., and A. Krishnamurthy (2012): "Intermediary asset pricing," *American Economic Review*, 103(2), 732–770.

Holmstrom, B., and J. Tirole (1997): "Financial intermediation, loanable funds, and the real sector," *Quarterly Journal of economics*, 112(3), 663–691.

Kiyotaki, N., and J. Moore (1997): "Credit Cycles," *Journal of Political Economy*, 105(2), 211–248.

Lettau, M., and S. Ludvigson (2001): "Consumption, aggregate wealth, and expected stock returns," *Journal of Finance*, 56(3), 815–849.

Nuño, G., and C. Thomas (2013): "Bank leverage cycles," *ECB Working Paper*, 1524.

Quadrini, V. (2011): "Financial frictions in macroeconomic fluctuations," *FRB Richmond Economic Quarterly*, 97(3), 209–254.

Shanken, J. (1992): "On the estimation of beta-pricing models," *Review of Financial Studies*, 5(1), 1–55.

Stambaugh, R. F. (1999): "Predictive regressions," *Journal of Financial Economics*, 54(3), 375–421.

A Data Appendix

A.1 Compustat-CRSP

We construct aggregate market equity and leverage for the commercial bank and broker-dealer sectors using the monthly stock file from CRSP. In order to account for the changing ownership of institutions, a merger adjustment is performed. This entails using the new CRSP permno (nwperm), and assigning to each firm the ultimate acquirer, i.e. if firm A is acquired by B and B is acquired by C, a variable acquirer is created whose value is equal to the permno of C for the entire lives of A, B, and C. Before collapsing by acquirer, a quarterly dataset is generated by compounding end of month returns to the quarterly frequency. Then, the dataset is collapsed by acquirer-quarter, summing up total market equity and computing a value-weighted average return. This gives a historical time series of effective market equity and returns of merger-adjusted entities. We then merge the permno-acquirer link generated by the CRSP data to the Compustat Fundamentals Quarterly File and apply the same merger adjustment summing up total assets (atq) and liabilities (ltq) by acquirer-quarter. Finally, the merger adjusted CRSP and Compustat data are merged together by acquirer-quarter where acquirer is now taken to be permno. We assign to the entire history of each merger adjusted firm the most recently available SIC code from CRSP and the most recently available permco from Compustat. The universe of broker-dealers is defined to be firms with SIC codes 6712 or 6211. Using the FRBNYs permco-rssd link, the universe of Commercial Banks is defined to be those firms with institution type Commercial Bank or Bank Holding Company. For each firm, quarterly (annualized) and annual growth rates of assets, liabilities, book and market equity, and book and market leverage, are calculated. Within each quarter, growth rates less than the 5% and greater than the 95% percentiles are dropped. Aggregate growth rates are then calculated by taking lagged asset-weighted averages within the two universes already defined.

A.2 FDIC

We construct book equity and leverage for commercial banks by compiling the raw data from historical Call Reports of all FDIC-insured Banks. Book assets and liabilities are simply aggregated across firms, and equity and book leverage is then calculated for the entire sector.

B Alternative Detrending of Broker-dealer Leverage

So far we have shown that the annual growth rate of broker-dealer book leverage is a strong predictor of excess returns on risky assets and that innovations of broker-dealer leverage is a priced factor in the cross-section of assets. However, the theories discussed in Section 2 provide a role for the level of leverage rather than its growth rate. Leverage might be subject to secular trends due to changing financial system and regulatory frameworks. It is therefore advisable to use measures of detrended leverage in empirical tests. The annual growth rates is a convenient way of detrending leverage or other variables.

In this appendix, we provide evidence that corroborates these claims. In particular, we show that other methods of detrending broker-dealer book leverage yield very similar results as our preferred variable $yBDblevg(ff)$. Figure 4 shows this variable along with two alternative measures of detrended book leverage. The first is "MA4" which is the the difference between current quarter log leverage and its past four quarter moving average. The second is "HP" which is the cyclical component of a one-sided HP-filter applied to log broker-dealer leverage with a penalty parameter of 1600. The sample period is 1975Q1-2012Q4.

The performance of each detrended variables is presented in Table 7, together with results for the raw series. The results are for the one quarter-ahead predictive return regressions using the excess return on the CRSP market portfolio (MKT) and the excess return on a portfolio of BAA rated corporate bonds (BAA) as dependent variables. The predictor variables are three different measures of detrended broker-dealer leverage: annual broker-dealer leverage growth ("yBDblevg "), the MA4 variable and the HP variable. The first panel shows results for the sample period $1975Q1-2012Q4$, the second panel for the sample period $1986Q1-2012Q4$, and the last for the sample period $1986Q1-2008Q2$.

We see from Table 7 that when the dependent variable in SPX, both detrended variables perform well, and do as well as (and sometimes better) than the raw broker-dealer leverage series itself. There is a slight advantage to the MA4 variable, but the differences are small. However, when the dependent variable is the CRSP MKT variable, the results are less consistent. Although the smoothed variables perform well for some sub-periods, they do less well in the period 1986 - 2008. In particular, in the lowest panel, we see that only the HP variable is significant while the MA4 variable ceases to be so. The results highlight potential sensitivities of the asset pricing results depending on the particular risky asset return used. More research would be useful in ascertaining some of the underlying reasons for the differences.

Tables and Figures

Table 1: **Comparing the Predictive and Cross-Sectional Pricing Power of Alternative Measures of Intermediary Leverage and Equity**

This table provides results comparing the predictive and cross-sectional pricing power of alternative measures of intermediary leverage and equity. The explanatory variables are the annual growth rates of broker-dealer book leverage growth from the Flow-of-Funds, $yBDblevg$; broker-dealer market leverage growth from Compustat-CRSP, $yBDmlevg$; broker-dealer book equity growth from the Flow-of-Funds, $yBDbeg$; broker-dealer market equity growth from Compustat-CRSP, $yBDmeg$; commercial bank book leverage growth from CALL report data, $yCBblevg$; commercial bank market leverage growth from Compustat-CRSP, $yCBmlevg$; commercial bank book equity growth from CALL report data, $yBDbeg$; and commercial bank market equity growth from Compustat-CRSP, $yCBmeg$. The upper panel shows results for univariate one quarter ahead predictive return regressions using as dependent variables the excess return on the CRSP market portfolio (MKT), the excess return on a portfolio of BAA rated corporate bonds (BAA), as well as the excess return on a constant maturity ten-year Treasury portfolio ($CMT10$). The lower panel shows estimates of factor risk premia obtained from Fama-MacBeth regressions using the innovation from an AR(1) of the respective balance sheet variable as pricing factors. The test assets are ten size sorted stock decile portfolios (ME1 ... ME10), ten book-to-market sorted decile portfolios, and ten momentum sorted decile portfolios (all from Ken French's website), as well as constant maturity Treasury returns for maturities ranging from 1 through 30 years (cmt1 ... cmt30), obtained from CRSP, and Barclay's benchmark corporate credit portfolios for various ratings classes and industries. The sample period is $1975Q1 - 2012Q4$. t-statistics are shown in brackets. The standard errors for the predictive coefficients are Newey-West adjusted with a maximum lag length of 4 quarters. The standard errors for the Fama-MacBeth regressions are computed as in Stambaugh (1992). ***, *, and * denote statistical significance at the 1%, 5%, and 10% level.

	$yBDblevg$	$yBDmlevg$	$yBDbeg$	$yBDmeg$	$yCBblevg$	$yCBmlevg$	$yCBbeg$	$yCBmeg$
Predictive Time Series Regressions								
MKT	-0.070***	0.018	0.047*	-0.016	-0.276	0.039	0.051	-0.027
	[-2.975]	[0.477]	[1.862]	[-0.369]	[-1.346]	[0.917]	[0.379]	[-0.682]
BAA	-0.025**	0.015	0.015	-0.022	-0.159**	0.021	-0.098	-0.019
	[-2.122]	[0.915]	[1.542]	[-1.288]	[-2.316]	[1.038]	[-1.607]	[-1.065]
CMT10	0.009	0.005	-0.007	-0.006	-0.137*	-0.001	-0.002	0.001
	[0.561]	[0.308]	[-0.555]	[-0.346]	[-1.733]	[-0.042]	[-0.026]	[0.058]
Cross-Sectional Fama-MacBeth Regressions								
λ_0	0.939***	-0.336	0.235	0.278	-0.477	-0.273	0.813	0.281
	[3.395]	[-1.500]	[0.819]	[1.449]	[-0.777]	[-1.581]	[0.944]	[1.587]

Table 2: **Predictive Return Regressions**

This table provides results for one quarter ahead predictive return regressions using annual broker-dealer leverage growth as the predictor variable. The dependent variables are the excess return on the CRSP market portfolio (MKT), the excess return on the S&P500 index (SPX), the excess return on an investment grade corporate bond portfolio (IG), the excess return on a portfolio of BAA rated corporate bonds (BAA) as well as the excess return on a constant maturity ten-year Treasury portfolio ($CMT10$). The first panel shows results for the sample period $1975Q1 - 2012Q4$, the second panel the sample period $1986Q1 - 2012Q4$, and the last the sample period $1986Q1 - 2008Q2$. The rows labeled "cst" provide the point estimates for the regression intercept, the rows labeled "coeff" show the OLS regression coefficient on lagged broker-dealer leverage growth, and "coeff-Stambaugh" show the Stambaugh-bias adjusted regression coefficients. t-statistics are provided in brackets below. All standard errors are Newey-West with a maximum lag length of 4 quarters. ***, *, and * denote statistical significance at the 1%, 5%, and 10% level.

	MKT	SPX	BAA	IG	$CMT10$
			1975Q1 - 2012Q4		
coeff	-0.070***	-0.065**	-0.025**	-0.014	0.009
	[-2.975]	[-2.542]	[-2.122]	[-1.281]	[0.561]
coeff-Stambaugh	-0.070***	-0.064**	-0.025**	-0.013	0.009
	[-2.960]	[-2.527]	[-2.117]	[-1.264]	[0.572]
R^2	0.056	0.089	0.029	0.009	0.003
N obs	151.000	151.000	151.000	151.000	151.000
			1986Q1 - 2012Q4		
coeff	-0.078***	-0.073***	-0.034***	-0.022**	0.005
	[-3.021]	[-2.647]	[-3.511]	[-2.421]	[0.279]
coeff-Stambaugh	-0.077***	-0.072***	-0.035***	-0.022**	0.005
	[-2.998]	[-2.628]	[-3.514]	[-2.397]	[0.294]
R^2	0.081	0.133	0.156	0.064	0.002
N obs	107.000	107.000	107.000	107.000	107.000
			1975Q1 - 2008Q2		
coeff	-0.042**	-0.030*	-0.012	-0.008	-0.006
	[-2.394]	[-1.911]	[-0.941]	[-0.631]	[-0.368]
coeff-Stambaugh	-0.042**	-0.029*	-0.012	-0.008	-0.006
	[-2.364]	[-1.873]	[-0.931]	[-0.626]	[-0.373]
R^2	0.018	0.019	0.006	0.003	0.001
N obs	133.000	133.000	133.000	133.000	133.000

Table 3: **Predictive Return Regressions for the Equity Market Return**

This table provides results for one quarter ahead predictive return regressions using the excess return on the CRSP market portfolio (MKT) as dependent variable. The predictor variables are annual broker-dealer leverage growth as well as the following a variety of commonly used equity return forecasting factors. These are the log dividend yield ("dy"), the log consumption-wealth-ration ("CAY") from Lettau-Ludvigson, the equity share in new issuance ("ES") from Baker-Wurgler, the market portfolio's book-to-market ration ("B2M"), the term spread between the ten-year Treasury yield and the three-month Treasury bill yield ("TERM"), and the default spread between the yields on Moody's benchmark BAA-rated and AAA-rated corporate bonds. The first panel shows results for the sample period $1975Q1-2012Q4$, the second panel the sample period $1986Q1-2012Q4$, and the last the sample period $1986Q1-2008Q2$. The rows labeled "coeff" show the OLS regression coefficient and t-statistics are provided in brackets below. All standard errors are Newey-West with a maximum lag length of 4 quarters. ***, *, and * denote statistical significance at the 1%, 5%, and 10% level.

				1975Q1 - 2012Q4				
	$yBDblevg$	dy	CAY	ES	$B2M$	$TERM$	DEF	$\bar{R}^2$
Coeff	-0.07***							0.05
t-stat	[-2.97]							
Coeff		-1.34	0.96**	-18.09***	20.35**	0.08	0.71	0.06
t-stat		[-0.76]	[2.06]	[-2.63]	[1.99]	[0.14]	[0.28]	
Coeff	-0.07***	-1.17	1.03**	-17.04***	18.72*	-0.00	-0.07	0.10
t-stat	[-3.07]	[-0.74]	[2.42]	[-3.21]	[1.95]	[-0.01]	[-0.03]	
				1986Q1 - 2012Q4				
	$yBDblevg_ff$	dy	CAY	ES	$B2M$	$TERM$	DEF	$\bar{R}^2$
Coeff	-0.08***							0.07
t-stat	[-3.02]							
Coeff		-1.15	0.65	-26.65*	24.62**	-0.25	-3.01	0.06
t-stat		[-0.57]	[1.28]	[-1.85]	[2.43]	[-0.26]	[-1.04]	
Coeff	-0.08***	-0.89	0.73	-19.49**	23.99***	-0.87	-4.05*	0.13
t-stat	[-3.91]	[-0.46]	[1.61]	[-2.17]	[2.75]	[-1.01]	[-1.73]	
				1986Q1 - 2008Q2				
	$yBDblevg_ff$	dy	CAY	ES	$B2M$	$TERM$	DEF	$\bar{R}^2$
Coeff	-0.05**							0.01
t-stat	[-2.30]							
Coeff		0.61	0.80	-39.24*	5.41	-0.16	-2.25	0.03
t-stat		[0.27]	[1.52]	[-1.75]	[0.38]	[-0.16]	[-0.48]	
Coeff	-0.06***	0.74	0.76	-34.68	7.66	-0.44	-4.44	0.05
t-stat	[-2.90]	[0.36]	[1.55]	[-1.63]	[0.58]	[-0.48]	[-1.02]	

Table 4: **Predictive Return Regressions for the BAA Credit Return**

This table provides results for one quarter ahead predictive return regressions using the excess return on the CRSP market portfolio (MKT) as dependent variable. The predictor variables are annual broker-dealer leverage growth as well as the following a variety of commonly used bond return forecasting factors. These are the term spread between the ten-year Treasury yield and the three-month Treasury bill yield ("TERM"), and the default spread between the yields on Moody's benchmark BAA-rated and AAA-rated corporate bonds, and the Cochrane-Piazzesi (2005) Treasury return forecasting factor which has been updated to include more recent data. The first panel shows results for the sample period $1975Q1-2012Q4$, the second panel the sample period $1986Q1-2012Q4$, and the last the sample period $1986Q1-2008Q2$. The rows labeled "coeff" show the OLS regression coefficient and t-statistics are provided in brackets below. All standard errors are Newey-West with a maximum lag length of 4 quarters. ***, *, and * denote statistical significance at the 1%, 5%, and 10% level.

			1975Q1 - 2012Q4		
	$yBDblevg$	$TERM$	DEF	CP	$\bar{R}^2$
Coeff	-0.03**				0.02
t-stat	[-2.12]				
Coeff		0.77**	1.09	0.27	0.08
t-stat		[2.34]	[1.21]	[1.03]	
Coeff	-0.02*	0.73**	0.82	0.31	0.09
t-stat	[-1.65]	[2.20]	[0.89]	[1.12]	
			1986Q1 - 2012Q4		
	$yBDblevg_ff$	$TERM$	DEF	CP	$\bar{R}^2$
Coeff	-0.03***				0.15
t-stat	[-3.51]				
Coeff		0.53***	1.35	0.08	0.08
t-stat		[2.70]	[1.41]	[0.44]	
Coeff	-0.03***	0.36*	0.92	0.14	0.18
t-stat	[-2.81]	[1.73]	[1.10]	[0.63]	
			1986Q1 - 2008Q2		
	$yBDblevg_ff$	$TERM$	DEF	CP	$\bar{R}^2$
Coeff	-0.02**				0.06
t-stat	[-2.19]				
Coeff		0.31	-1.13	0.59**	0.05
t-stat		[1.35]	[-1.17]	[2.13]	
Coeff	-0.03***	0.08	-2.29***	1.00***	0.14
t-stat	[-2.72]	[0.33]	[-3.09]	[2.93]	

Table 5: **Dynamic Asset Pricing with Intermediary Leverage**

This table provides results for a two-factor dynamic asset pricing model. The two factors are the excess return on the CRSP market portoflio (MKT) and annual broker-dealer book leverage growth ($yBDblevg$). The prices of risk of both pricing factors are time-varying and depend linearly on one-quarter lagged broker-dealer leverage growth. Estimation is done using the QMLE estimator of Adrian, Crump, and Moench (2013). The first panel shows results for the sample period $1975Q1-2012Q4$, the second panel the sample period $1986Q1-2012Q4$, and the last the sample period $1975Q1-2008Q2$. The column labeled λ_0 provides the constant elements of the factor risk prices. The column labeled "yBDblevg" provide the coefficient of the price of risk on one-quarter lagged broker-dealer leverage growth. t-statistics are provided in brackets below. All standard errors are robust to heteroskedasticity. ***, *, and * denote statistical significance at the 1%, 5%, and 10% level.

		1975Q1 - 2012Q4	
	λ_0	yBDlevg	$\bar{\lambda}$
MKT	2.681***	-2.190***	2.102***
	[3.575]	[-3.121]	[2.701]
$yBDblevg$	1.153*	0.572	1.304*
	[1.886]	[1.214]	[1.865]
		1986Q1 - 2012Q4	
	λ_0	yBDblevg	$\bar{\lambda}$
MKT	2.565**	-2.771***	1.810*
	[2.530]	[-3.302]	[1.648]
$yBDblevg$	2.170	0.416	2.283
	[1.199]	[0.577]	[1.192]
		1975Q1 - 2008Q2	
	λ_0	yBDblevg	$\bar{\lambda}$
MKT	2.390***	-1.086	2.011***
	[3.027]	[-1.502]	[2.639]
$yBDblevg$	1.048**	0.091	1.080**
	[2.427]	[0.388]	[2.457]

Table 6: **Dynamic Asset Pricing Model with Broker-Dealer Book Equity**

This table provides results for a two-factor dynamic asset pricing model. The two factors are the excess return on the CRSP market portoflio (MKT) and annual broker-dealer book equity growth ($yBDbeg$). The prices of risk of both pricing factors are time-varying and depend linearly on one-quarter lagged broker-dealer leverage growth. Estimation is done using the QMLE estimator of Adrian, Crump, and Moench (2013). The first panel shows results for the sample period $1975Q1-2012Q4$, the second panel the sample period $1986Q1-2012Q4$, and the last the sample period $1975Q1-2008Q2$. The column labeled λ_0 provides the constant elements of the factor risk prices. The column labeled "yBDbeg" provide the coefficient of the price of risk on one-quarter lagged broker-dealer equity growth. t-statistics are provided in brackets below. All standard errors are robust to heteroskedasticity. ***, *, and * denote statistical significance at the 1%, 5%, and 10% level.

		1975Q1 - 2012Q4	
	λ_0	yBDbeg	$\bar{\lambda}$
MKT	1.902**	1.272*	2.467***
	[2.426]	[1.827]	[3.035]
$yBDbeg$	-0.851***	0.166	-0.777***
	[-2.713]	[1.029]	[-2.623]
		1986Q1 - 2012Q4	
	λ_0	yBDbeg	$\bar{\lambda}$
MKT	1.530*	1.743**	2.142**
	[1.707]	[2.096]	[2.153]
$yBDbeg$	-0.507**	0.028	-0.498**
	[-2.246]	[0.192]	[-2.286]
		1975Q1 - 2008Q2	
	λ_0	yBDbeg	$\bar{\lambda}$
MKT	1.653*	0.803	2.124**
	[1.660]	[1.091]	[2.300]
$yBDbeg$	-2.152*	0.315	-1.968*
	[-1.687]	[0.801]	[-1.675]

Table 7: **Predicting Returns with Alternative Broker-Dealer Leverage**

This table provides results for one quarter ahead predictive return regressions using the excess return on the CRSP market portfolio (MKT) and the excess return on a portfolio of BAA rated corporate bonds (BAA) as dependent variables. The predictor variables are three different measures of detrended broker-dealer leverage: annual broker-dealer leverage growth ("yBDblevg'), the difference between current quarter log leverage and its past four quarter moving average ("MA4"), and the cyclical component of log broker-dealer leverage extracted using a one-sided HP-filter ("HP"). The first panel shows results for the sample period $1975Q1 - 2012Q4$, the second panel for the sample period $1986Q1 - 2012Q4$, and the last for the sample period $1986Q1 - 2008Q2$. The column labeled "t" provides the t-statistics of the OLS regression coefficient with OLS standard errors, the column "t-NW" provides the t-statistics of the OLS regression coefficient with Newey-West adjusted standard errors, and the column labeled "t-Stambaugh" provides t-statistics for Stambaugh-bias adjusted regression coefficients with Newey-West standard errors. The column R^2 shows predictive R-squared. ***, *, and * denote statistical significance at the 1%, 5%, and 10% level.

	MKT				SPX			
	t	t-NW	t-Stambaugh	R^2	t	t-NW	t-Stambaugh	R^2
				1975Q1 - 2012Q4				
yBDblevg	-2.98***	-2.97***	-2.96***	0.06	-2.10**	-2.12**	-2.12**	0.03
MA4	-3.27***	-5.63***	-5.60***	0.07	-3.30***	-5.50***	-5.49***	0.07
HP	-3.32***	-4.60***	-4.57***	0.07	-3.11***	-5.45***	-5.43***	0.06
				1986Q1 - 2012Q4				
yBDblevg	-3.04***	-3.02***	-3.00***	0.08	-4.40***	-3.51***	-3.51***	0.16
MA4	-3.29***	-5.84***	-5.80***	0.09	-5.72***	-5.60***	-5.58***	0.24
HP	-3.37***	-4.82***	-4.78***	0.10	-5.34***	-5.76***	-5.74***	0.21
				1986Q1 - 2008Q2				
yBDblevg	-1.52	-2.30**	-2.24**	0.03	-2.63***	-2.19**	-2.19**	0.07
MA4	-1.19	-1.35	-1.29	0.02	-3.07***	-2.50**	-2.48**	0.10
HP	-1.65*	-2.39**	-2.30**	0.03	-2.81***	-2.59***	-2.59***	0.08

Figure 1: **Book Leverage and Market Leverage**

The left panel shows the scatter chart of the asset-weighted growth in book leverage and total assets for the eight largest US dealers and banks. The right panel is the scatter chart for the asset-weighted growth in enterprise value leverage and enterprise value. Enterprise value is the sum of market capitalization and debt, and enterprise value leverage is the ratio of enterprise value to market capitalization. The dark dots are for 2007 - 2009. The eight institutions are Bank of America, Citibank, JP Morgan, Bear Stearns, Goldman Sachs, Lehman Brothers, Merrill Lynch and Morgan Stanley (Source: SEC 10Q filings).

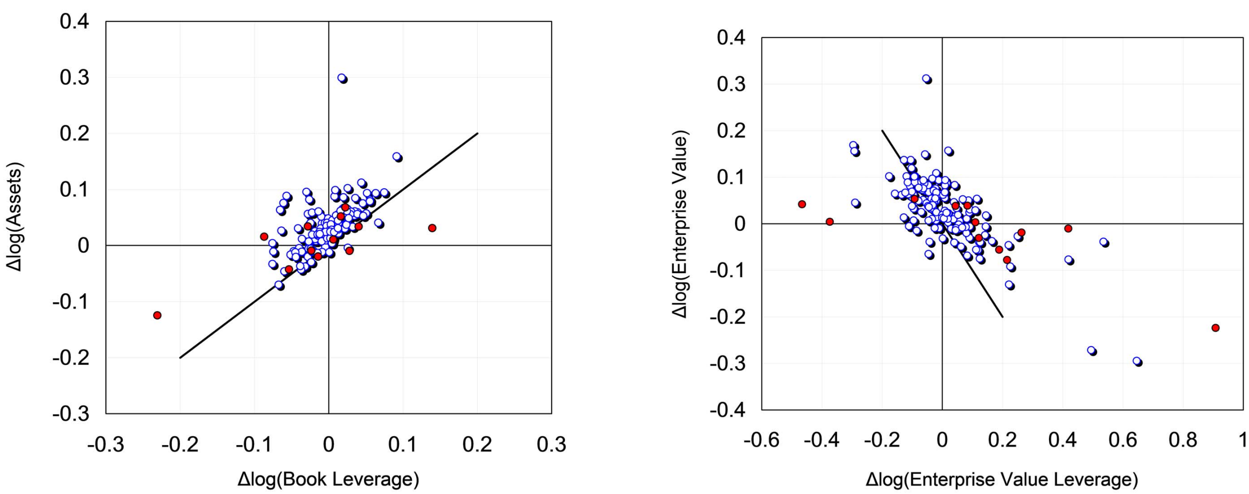

Figure 2: **Rolling Forecasting Coefficients**

This figure provides the estimated regression coefficient and corresponding two standard error bands for the regressions of MKT and BAA on one quarter lagged broker-dealer leverage growth using a 60-quarter rolling estimation window. The initial sample period is from 1968Q1-1967Q4 and the final regression window is for the sample $2003Q1 - 2012Q4$. Standard errors are Newey-West adjusted with a maximum lag length of 4 quarters.

MKT BAA

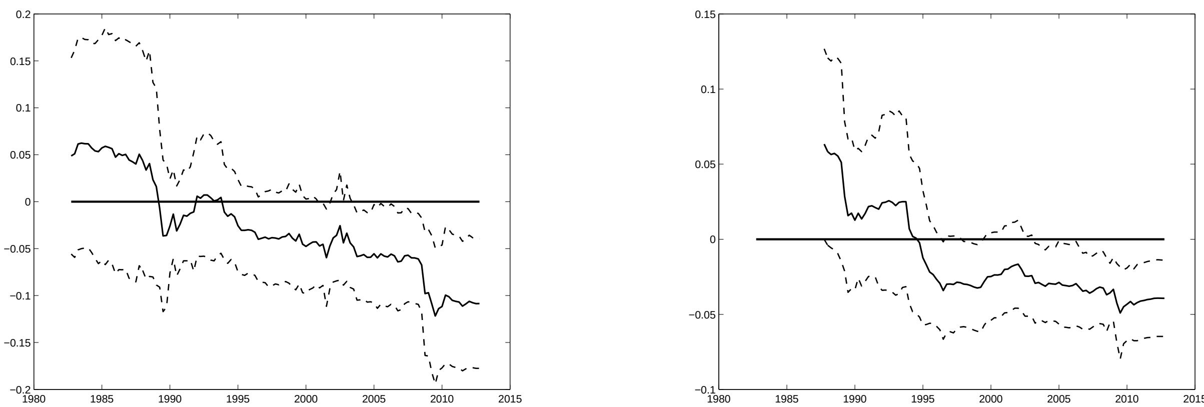

Figure 3: **Cross-Sectional Pricing Performance**

This figure provides plots of observed versus model-implied average excess returns on the set of test assets for various model specifications. The upper-left panel reports results based on the static CAPM where the excess return on the market portfolio (MKT) is the only risk factor; the upper-right panel shows the unconditional fit for the Fama-French three factor model using MKT, SMB, and HML as pricing factors and assuming constant prices of risk. The lower-left panel shows results for a five-factor model that augments the Fama-French three-factor model with a momentum factor and the level of the Treasury yield curve. The latter is computed as the first principal component of the CRSP Fama-Bliss discount bond yields for maturities from one year through five years. The lower right panel provides results for the two-factor leverage capital asset pricing model which uses MKT and broker-dealer leverage growth ("yBDblevg") as pricing factors allowing for prices of risk to vary as a function of lagged broker-dealer leverage growth. All excess returns are stated in quarterly percentage terms. The test assets are ten size sorted stock decile portfolios (ME1 . . . MEe10), ten book-to-market sorted decile portfolios, and ten momentum sorted decile portfolios (all from Ken French's website), as well as constant maturity Treasury returns for maturities ranging from 1 through 30 years (cmt1 . . . cmt30), obtained from CRSP, and Barclay's benchmark corporate credit portfolios for various ratings classes and industries. The plots are based on the MLE estimates of the model. The sample period is 1975Q1 - 2012Q4.

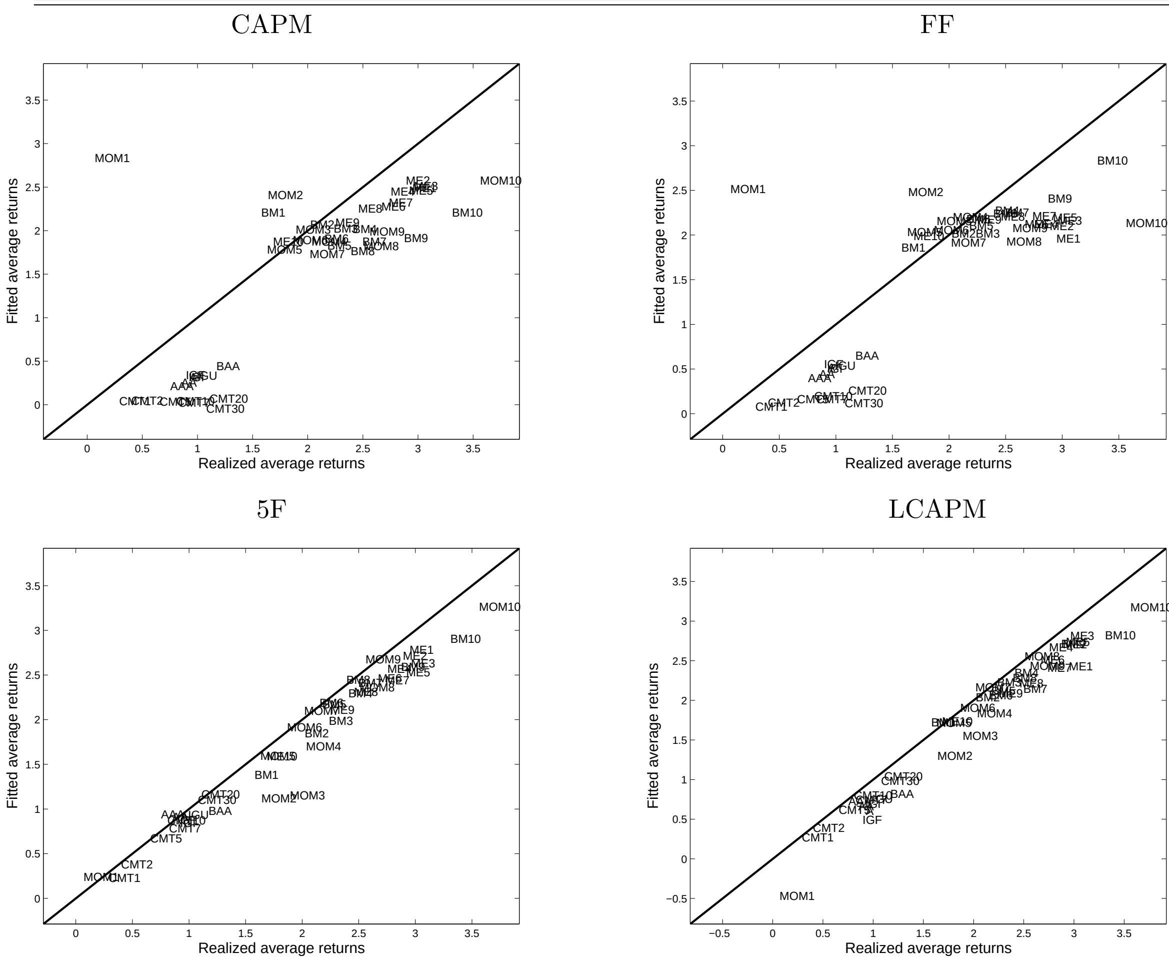

Figure 4: **Broker-Dealer Leverage using Alternative Detrending Methods**

This figure shows the annual growth rate of broker-dealer book leverage growth ($yBDblegv$) along with two alternative measures of detrended book leverage: "MA4" denotes the difference between current quarter log leverage and its past four quarter moving average. "HP" denotes the cyclical component of a one-sided HP-filter applied to log broker-dealer leverage with a penalty parameter of 1600. The sample period is 1975Q1-2012Q4.