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Leverage asset pricing

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Leverage Asset Pricing

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Emanuel Moench
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Staff Report No. 625
August 2013

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Leverage Asset Pricing

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Abstract

We investigate intermediary asset pricing theories empirically and find strong support for models that have intermediary leverage as the relevant state variable. A parsimonious model that uses detrended dealer leverage as a price-of-risk variable, and innovations to dealer leverage as a 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 specifications of intermediary pricing models that use intermediary net worth as a state variable, and it performs well in comparison to benchmark asset pricing models. We draw implications for macroeconomic modeling.

Key words: return predictability, cross-sectional asset pricing, financial intermediation, macro-finance

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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. 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 state variable is net worth or leverage, defined as the ratio of assets to equity. 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 a 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 hence the reduced capacity to borrow.

Given the contrasting perspectives on the importance of net worth and leverage, we investigate empirically which matters more for asset pricing. We find that it is leverage, which is key. To the extent that net worth matters for asset pricing, it enters with the opposite sign from that predicted by the theory.

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 this second question, we find that it is leverage in terms of book equity that matters for asset pricing (total assets to book equity), not leverage in terms of market capitalization (enterprise value to market cap). We interpret our finding as a reaffirmation of the importance of credit supply conditions for asset pricing. Enterprise value is about *how much the bank is worth*, while book assets are about *how much the bank lends*. Our findings suggest that credit supply matters for asset pricing. For instance, hedge funds that rely on prime brokers to construct leveraged positions will care about lending conditions and their returns will depend sensitively on how easily they can construct leveraged positions.

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 broker-dealers ("dealers") predicts excess returns significantly and with the right sign, while other variables are

either insignificant or have the wrong sign. In particular, dealer book leverage forecasts the market return and BAA-rated credit return with a negative sign, consistent with theories that leverage is procyclical. Market leverage, or market capitalization, on the other hand, do not forecast returns.

In cross sectional regressions, only the dealer book leverage variable has a positive and significant price of risk, a finding that is consistent with Adrian, Etula, Muir (2012). In contrast, we do not find significant prices of risk for any of the other intermediary variables in the cross sectional regressions.

For the forecasting tests, we demonstrate that our measure of dealer (book) leverage has strong predictive power for equity and credit returns. This result is robust across sub-periods, as well as to the inclusion of standard return forecasting variables. When controlling for typical return forecasting variables 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 dealer leverage variable tends to increase. We do not find such robust forecasting performance for alternative intermediary variables. In fact, to the extent that net worth has significant effects, it appears with the *opposite sign* to that predicted by the theory.

When considered together, our findings from time series and cross sectional tests suggest that a parsimonious asset pricing model with two key features perform well empirically. First, the model has dealer book leverage that tracks the pricing of risk. Second, innovations to 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 also 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 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, but that higher leverage growth forecasts lower future returns. In contrast to the large literature that emphasizes the role of *net worth* as the state variable, our model features *leverage* as the key quantity.

There are broader implications of our finding. 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 used in the empirical tests, and we explain the conceptual difference between book leverage and leverage computed form market capitalization. In Section 4, we present empirical evidence that helps to discriminate among alternative intermediary asset pricing theories. We further present predictive regressions which show that 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 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 for the empirical investigation that aims at discriminating between alternative theoretical approaches, we compare the predictions from recent intermediary asset pricing theories.

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 wealth 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

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

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

This asset pricing kernel 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, with a constant price of risk. In addition to that specification, Model 1 allows the price of risk to vary as a function of the level of intermediary equity. In particular, the model implies:

- $\lambda\left(w\right) > 0$, i.e. the price of risk of intermediary wealth should be positive
- $\lambda'\left(w\right) < 0$ 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) and Kiyotaki and Moore (1997). While these authors have focused on the net worth of borrowers such as non-financial corporations 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) that was mentioned earlier. 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 margin constraints. The pricing factor is the market return, and the price of risk is the Lagrange multiplier on margin constraints. Garleanu and Pedersen (2010) is a recent exponent of such an approach. Empirically, the tightness of the margin constraint is not observable directly, but Adrian and Etula (2010) discuss how theories with margin constraints compare to models that use intermediary leverage as state variable. A reduced form asset pricing restriction takes the following form:

$$E_t\left[R^i_{t+1}\right] = \beta^i_{R^M}\lambda\left(Lev_t\right). \qquad \text{(Model 2)}$$

The pricing factor is therefore the market return R^M_{t+1}, while the price of risk variable is intermediary leverage.

Along similar lines, Danielsson, Shin, and Zigrand (2010) 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, and hence on 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. Importantly, leverage—not wealth—is the key measure of the marginal value of wealth in these models.

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 $\phi_{t+1} \approx a - b \ln (Lev_{t+1})$, 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:

$$E_t \left[R^i_{t+1} \right] = \beta^i_{Lev} \lambda. \qquad \text{(Model 3)}$$

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 (2010) 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, prices 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:

$$E_t \left[R^i_{t+1} \right] = \beta^i_{Lev} \lambda_{Lev} \left(Lev_t, \omega_t \right) + \beta^i_y \lambda_y \left(Lev_t, \omega_t \right). \qquad \text{(Model 4)}$$

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.

While the model of Adrian and Boyarchenko (2012) has highly non-linear prices of risk, in the empirical applications, we are restricting ourselves to linear specifications. Furthermore, we are only using Lev as state variable and use the return to the equity market portfolio instead of output growth. The reduced form version of Model 4 is then

$$E_t\left[R^i_{t+1}\right] = \beta^i_{Lev}\left(\lambda_0 + \lambda_{1,Lev} Lev_t\right) + \beta^i_{R^M}\left(\lambda_0 + \lambda_{1,R^M} Lev_t\right). \qquad \text{(Model 4A)}$$

The leverage of dealers thus acts both as a pricing factor and a price of risk variable. The second pricing factor is the market return. 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 dealer leverage themselves carry a significant positive price of risk in the cross-section of equity and bond portfolios.

To summarize, the brief survey of the extant literature on financial intermediary asset pricing theory in this section has shown that different theories vary along several dimensions regarding the mechanics of how financial frictions affect asset prices. In what follows, we will use asset pricing tests to differentiate empirically between the various theories.

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 treasury 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 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 results with respect to alternative detrending methods in Section B in the appendix. We use the following naming convention: the annual growth rates of dealer book equity and leverage are labeled $yBDbeg$ and $yBDblevg$; similarly, 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 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 for the aggregate value-weighted market portfolio from CRSP (BM), the log consumption-wealth ratio from Martin Lettau's website (CAY), as well as the Cochrane and Piazzesi (2005) Treasury return forecasting factor which we updated with recent data from CRSP.

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

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 (2009) 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?" 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 2 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 dealers in

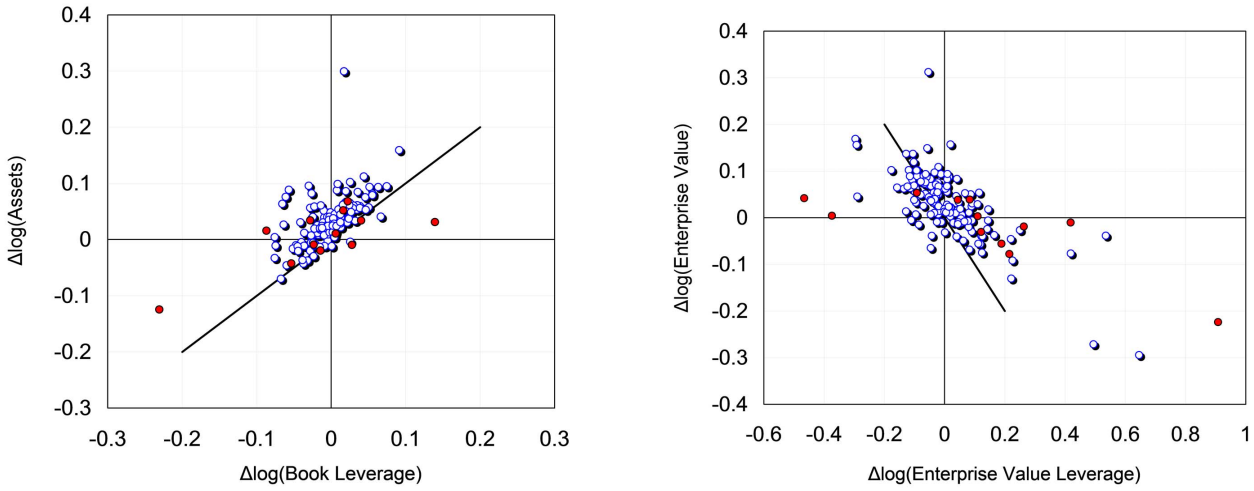

Figure 1: The left panel shows the scatter chart of the asset-weighted growth in book leverage and total assets for the eight largest US dealers and banks. The right panel is the scatter chart for the asset-weighted growth in enterprise value leverage and enterprise value. Enterprise value is the sum 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 instutions are Bank of America, Citibank, JP Morgan, Bear Stearns, Goldman Sachs, Lehman Brothers, Merrill Lynch and Morgan Stanley (Source: SEC 10Q filings) .

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. Institutions that we do not consider in the analysis are the foreign banks, some of which also own substantial trading operations in the US.

The left hand panel of Figure 2 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 2 is the corresponding

[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.

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 2 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 and let 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 therefore 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. Although the Flow of Funds also includes a series for book equity of the broker dealer sector, this series is measured at the end of the quarter after any recapitalization has taken place. By defining 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 US 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 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 credit as well as the constraints that are placed on the equity of the bank. Indeed, we may interpret that new equity raising is an endogenous response to such funding challenges.

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 different intermediary balance sheet indicators. As we will see, the results show that dealer book leverage is the only significant explanatory variable for both the time series and the cross-sectional variation of a wide range of equity and bond returns. We then go on to discuss the robustness of the dealer book leverage.

4.1 Evaluating Alternative Intermediary Pricing Kernels

We turn to the empirical evidence to help us discriminate between the various intermediary asset pricing predictions in Table 1. 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

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

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 BAA rated corporate bond portfolio from Barclays, and the 10 year zero coupon constant maturity Treasury return. The sample period is 1975Q1-2012Q4. The upper panel of Table 1 shows that 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 our hypothesis that tighter (looser) balance sheet constraints result in higher (lower) risk premia. The predictive coefficient of the investment grade corporate bond portfolio is also negative, albeit not statistically different from zero. The coefficient of the ten-year Treasury return is also insignificant. The interpretation of these results in terms of the availability of credit to market participants again fits the narrative well, since leveraged market players would not typically figure as the primary holders of investment grade or treasury bonds.

Comparing the predictive power of 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 dealer book equity growth from the Flow-of-Funds shows strong predictive power for the S&P 500 index, the slope coefficient has a positive sign. This empirical finding is in contrast to the theories of 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, 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:

$$\begin{aligned} R_{i,t+1} &= \beta_i'\lambda_0 + \beta_i' v_{t+1} + e_{i,t+1} \\ X_{t+1} &= \mu + \Phi X_t + v_{t+1} \end{aligned}$$

where v_{t+1}^X denotes the shock to the pricing factor, and e^i 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 various balance sheet indicators considered, only dealer book leverage growth features a significant price of risk. This finding is consistent with the findings in Adrian, Etula, and Muir (2012) who use innovations to seasonally-adjusted dealer book leverage as a pricing factor in similar cross-sectional tests. The positive sign of the estimated price of dealer book leverage is consistent with the theories of Brunnermeier-Pedersen (2009) and Adrian-Boyarchenko (2012). Interestingly, none of the other balance sheet indicators are associated with significant prices of risk.

Our result that the market capitalization of 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, there are two main reasons for this 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 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 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, Brggemann, and Daske (2011) discuss how illiquid assets gave rise to "stale" book values when fair value reporting requirements were suspended temporarily at the height of the crisis. In contrast, dealers mark their assets and liabilities to market.

A second reason for the relatively better performance of the dealer sector might be that 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 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 have shown that dealer book leverage growth

is a very good predictor of excess equity and bond returns and also represents a priced risk factor in the cross section of risky assets. In the next section, we study this variable's ability to predict excess returns over different subsamples, and relative to typical return-predictor variables.

4.2 Broker Dealer Book Leverage: Further Time Series Tests

In the previous section, we have shown that among the various intermediary balance sheet indicators, 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 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 dealer book leverage variable as a significant predictor of excess returns. Specifically, we run predictive return 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. To the extent that high book leverage of dealers indicates greater availability of credit to investors and other intermediaries, our prediction is that high dealer book 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 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 dealer leverage growth. For robustness, we also report "coeff-Stambaugh" which provide the Stambaugh-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 dealer book leverage variable is a strong predictor of subsequent returns for risky assets. The interpretation is that high book leverage of the dealers indicates lower risk premiums due to the greater availability of credit to leveraged investors. The coefficients on the lagged dealer leverage growth term is negative and highly significant for the stock returns (MKT, SPX) as well as the BAA-rated bonds (BAA) for all sub-periods. The results for the investment grade bonds (IG) hold only in the period beginning in 1986, with the results being strongest for the most recent period. However, 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. One hypothesis for the lack of predictive power for Treasuries is that leveraged investors typically do not hold large long positions in risk-free government bonds. Therefore, there is less strong a relationship between risk premiums in the economy and the size of the dealer sector's treasury holdings.

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 dealer leverage growth. The rolling estimation window is for 60-quarters. 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.

Figure 2 shows that the explanatory power of the dealer leverage growth variable has increased over time. Until 1990, the point estimate of the coefficient on the 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 dealer book leverage variable, Table presents the results of robustness exercises where we compare the performance of 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 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-Ludvigson (2001), the equity share in new issuance ("ES") from Baker-Wurgler (2000), 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. All the standard errors are Newey-West with a maximum lag length of 4 quarters.

We see from Table 3 that our dealer leverage variable has incremental predictive value even in the presence of all of the other pricing factors. In fact, the dealer leverage variable

is the only variable 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 dealer leverage variable. We take the results in Table 3 as confirmation of the dealer leverage term as conveying important information on the risk premium 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 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 (2005) Treasury return forecasting factor ("CP") which has been updated to include more recent data.

Again, we see the predictive role of the dealer leverage variable in all sub-periods. 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, dealer leverage is significant at the 1 percent level.

5 Dynamic Leverage Asset Pricing

In the previous sections we have seen that 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:

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

$$X_{t+1} = \mu + \phi X_t + v_{t+1}. \tag{3}$$

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. 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 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 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 dealer leverage growth. This is in line with the evidence in Section 4.2 that higher dealer leverage growth is associated with lower future excess returns. Precisely, a one-standard deviation increase of 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 dealer leverage growth, in line with the cross-sectional asset pricing results in Section 4.1. In particular, one unit of exposure to 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 Boyachenko (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 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-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.

We see from Figure 3 that our favored two factor asset pricing model using 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 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 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 dealer equity growth with a significant coefficient in two subsamples. Hence, in line with the predictive regressions and cross-sectional analysis, 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

The availability of credit and how credit varies over the business cycle is a central topic in macroeconomics. We have seen that book leverage is an important pricing factor for a wide range of assets, implying that the risk premiums that affect real economic activity will similarly be influenced by the fluctuations in (book) leverage of financial 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.

For firms with access to the bond market, the decline in bank lending was largely made up through increased borrowing in the bond market. However, the cost of credit rose steeply, whether for direct or intermediated credit, suggesting that the demand curve for bond financing shifted out as a response to the inward shift in the bank credit supply curve. The substitution from bank financing to bond financing echoes the earlier by Kashyap, Stein and Wilcox (1993), who pointed to the importance of shocks to the supply of intermediated credit as a key driver of financial frictions.

Our findings suggest that a promising lead to pursue is the procyclicality of credit supply as a consequence of how financial intermediaries manage their leverage in reaction to changing economic conditions.

Perhaps the three best-known workhorse models of financial frictions used in macroeconomics are Bernanke and Gertler (1989), Kiyotaki and Moore (1997) and Holmström and Tirole (1997). However, in the benchmark versions of these models, the lending sector is competitive and the focus of the attention is on the *borrower's* net worth instead. The results from the benchmark versions of these models should be contrasted with the approach that places the borrowing constraints on *the lender* (i.e. the bank) as in Gertler and Kiyotaki (2010). The explicit recognition of the role of financial intermediaries holds

some promise in explaining the economic impact of financial frictions. When intermediaries curtail lending, directly granted credit (such as bond financing) must substitute for bank credit, and market risk premiums must rise 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 subsequent economic activity as measured by industrial production or employment.

Since the financial crisis, a new wave of dynamic, general equilibrium macro models that incorporate financial frictions have been developed.[4] The evidence in our study presents a challenge to many of these models, as we point to a very specific set of empirical facts, with tight implications for the modeling of financial frictions. The challenge for the theory is to capture the stylized facts that we documented earlier: 1) the market price of risk varies with intermediary leverage, with increases in leverage corresponding to a compression of expected returns; 2) shocks to intermediary leverage are a priced risk factor with a positive price of risk.

There is also a recent literature that extends the standard DSGE models to include a banking sector. Gertler and Karadi (2011) present a parsimonious DSGE model with a banking sector, production, and sticky prices, allowing them to study monetary policy. The model again captures increases in spreads during crisis, but does not produce a substitution between loans and bonds. In addition, the paper does not feature the procyclicality of the banking sector that we documented earlier. Christiano, Motto, Rostagno (2009) offer a rich quantitative DSGE model with three production sectors, and a banking sector. Curdia and Woodford (2009) incorporate banks that intermediate between households.

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

Nevertheless, the relative size of the banking sector is not well addressed in these papers, where all credit is intermediated credit.

To the extent that banking sector behavior is a key driver of the observed outcomes, capturing procyclical leverage seems crucial. Imposing additional constraints on banks so that their lending contracts would be one way to bring the model closer to observed behavior, but such an approach implies constraints that bind only in the downturn, rather than binding all the time. On this score, it would be fair to say that existing macro models of financial frictions are still some way off from being fully satisfactory. Nuño and Thomas (2011) is an exception in the macro literature which takes seriously the procyclicality of leverage and show that they derive quantitative conclusions that are closer to the empirical evidence. Adrian and Boyarchenko (2012) present an equilibrium model that is closest to capturing the stylized facts presented earlier. In their setting, intermediaries are subject to risk based capital constraints, giving rise to time varying effective risk aversion of intermediaries. When market volatility is endogenously low, the leverage constraint on intermediaries is loose, and their effective risk aversion is low. In equilibrium, the pricing of risk is endogenously low. At the same time, shocks to intermediary leverage represent systematic risk, and Adrian and Boyarchenko (2012) show that the equilibrium pricing kernel can be represented as a function of shocks to leverage and shocks to output, where the price of risk of leverage is always positive. Adrian and Boyarchenko (2012) capture the pro cyclical leverage of intermediaries documented by Adrian and Shin (2010, 2013), the pro cyclical share of financial intermediation documented by Adrian, Colla, Shin (2012), as well as the counter cyclicality of intermediary net worth that was emerged from Table 1.

Perhaps the most important lesson 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. Work at central banks have done much to extend the boundary along these dimensions. The recent work by Boissay, Collard and Smets (2013) 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 aggregate consumers, are the marginal investor, have experienced intense attention since the financial crisis of 2007-2009. Various theories differ along important dimensions. While most of the theories emphasize the role of institutions' net worth as the key, procyclical variable, other theories put more emphasis on intermediary leverage or margins. Time series and cross sectional asset pricing test allow us to discriminate among those alternative approaches.

We present evidence that intermediary leverage measured at book values is the best performing variable in both cross sectional and time series asset pricing tests. The intermediary leverage variable is found to be procyclical in both forms of 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, intermediary equity tends to predict higher returns in the future, indicating countercyclicality of that variable. The latter finding is consistent with the notion that intermediaries pay out in booms, and issue equity in busts.

We show that the time series and cross sectional evidence can be summarized in a parsimonious dynamic asset pricing model that uses dealer leverage and the market equity return as cross sectional pricing factors, and 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 endogenously emerge as a procyclical variable. This is the case in theories with risk based capital constraints, such as Adrian and Boyarchenko (2012) or Danielson, Shin and Zigrand (2012). The evidence also suggests that intermediary equity should be a

countercyclical variable, a fact that only few theories currently embed (see Adrian and Boyarchneko (2012) for an exception). Finally, 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 play a central role for intermediaries in the pricing of risk, and therefore in macroeconomic dynamics.

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A Data Appendix

A.1 Compustat-CRSP

We construct aggregate market equity and leverage for the Commercial Banks 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 Dealer Leverage

So far we have shown that the annual growth rate of dealer book leverage is a strong predictor of excess returns on risky assets and that innovations of 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 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 dealer leverage: annual 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 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 dealer book leverage growth from the Flow-of-Funds, $yBDblevg(ff)$; dealer market leverage growth from Compustat-CRSP, $yBDmlevg(cc)$; dealer book equity growth from the Flow-of-Funds, $yBDbeg(ff)$; dealer market equity growth from Compustat-CRSP, $yBDmeg(cc)$; commercial bank book leverage growth from CALL report data, $yCBblevg(cr)$; commercial bank market leverage growth from Compustat-CRSP, $yCBmlevg(cc)$; commercial bank book equity growth from CALL report data, $yBDbeg(ff)$; and commercial bank market equity growth from Compustat-CRSP, $yCBmeg(cc)$. 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 $1977Q1 - 2012Q4$. 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***	0.012	0.044*	-0.009	-0.276	0.027	0.051	-0.018
	[-2.857]	[0.342]	[1.761]	[-0.268]	[-1.377]	[0.658]	[0.254]	[-0.540]
BAA	-0.026**	0.014	0.014	-0.021	-0.159	0.020	-0.098	-0.017
	[-2.122]	[0.819]	[1.086]	[-1.216]	[-1.595]	[0.992]	[-0.988]	[-1.008]
CMT10	0.008	0.006	-0.006	-0.006	-0.137	0.001	-0.002	-0.000
	[0.593]	[0.312]	[-0.475]	[-0.329]	[-1.277]	[0.049]	[-0.017]	[-0.004]
Cross-Sectional Fama-MacBeth Regressions								
λ_0	0.716***	-0.301	0.218	0.255	-0.462	-0.240	0.815	0.253
	[2.905]	[-1.335]	[0.768]	[1.320]	[-0.757]	[-1.400]	[0.947]	[1.437]

Table 2: **Predictive Return Regressions**

This table provides results for one quarter ahead predictive return regressions using annual 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 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
			1986Q1 - 2008Q2		
coeff	-0.046**	-0.035**	-0.023**	-0.019*	-0.015
	[-2.297]	[-1.992]	[-2.186]	[-1.766]	[-0.970]
coeff-Stambaugh	-0.045**	-0.034*	-0.023**	-0.020*	-0.016
	[-2.241]	[-1.934]	[-2.190]	[-1.776]	[-0.991]
R^2	0.026	0.033	0.074	0.052	0.014
N obs	89.000	89.000	89.000	89.000	89.000

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 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.

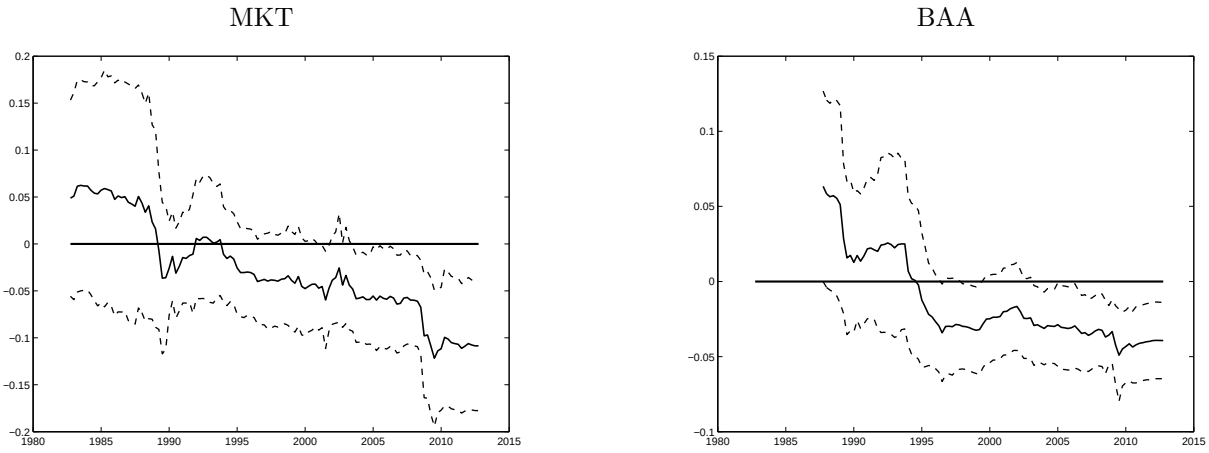

Table 3: **Predictive Return Regressions for the Equity Market Return**

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 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 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 dealer book leverage growth ($yBDblevg$). The prices of risk of both pricing factors are time-varying and depend linearly on one-quarter lagged 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 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 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 dealer book equity growth ($yBDbeg$). The prices of risk of both pricing factors are time-varying and depend linearly on one-quarter lagged 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 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]

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 dealer leverage growth ("yBDblevg") as pricing factors allowing for prices of risk to vary as a function of lagged 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.

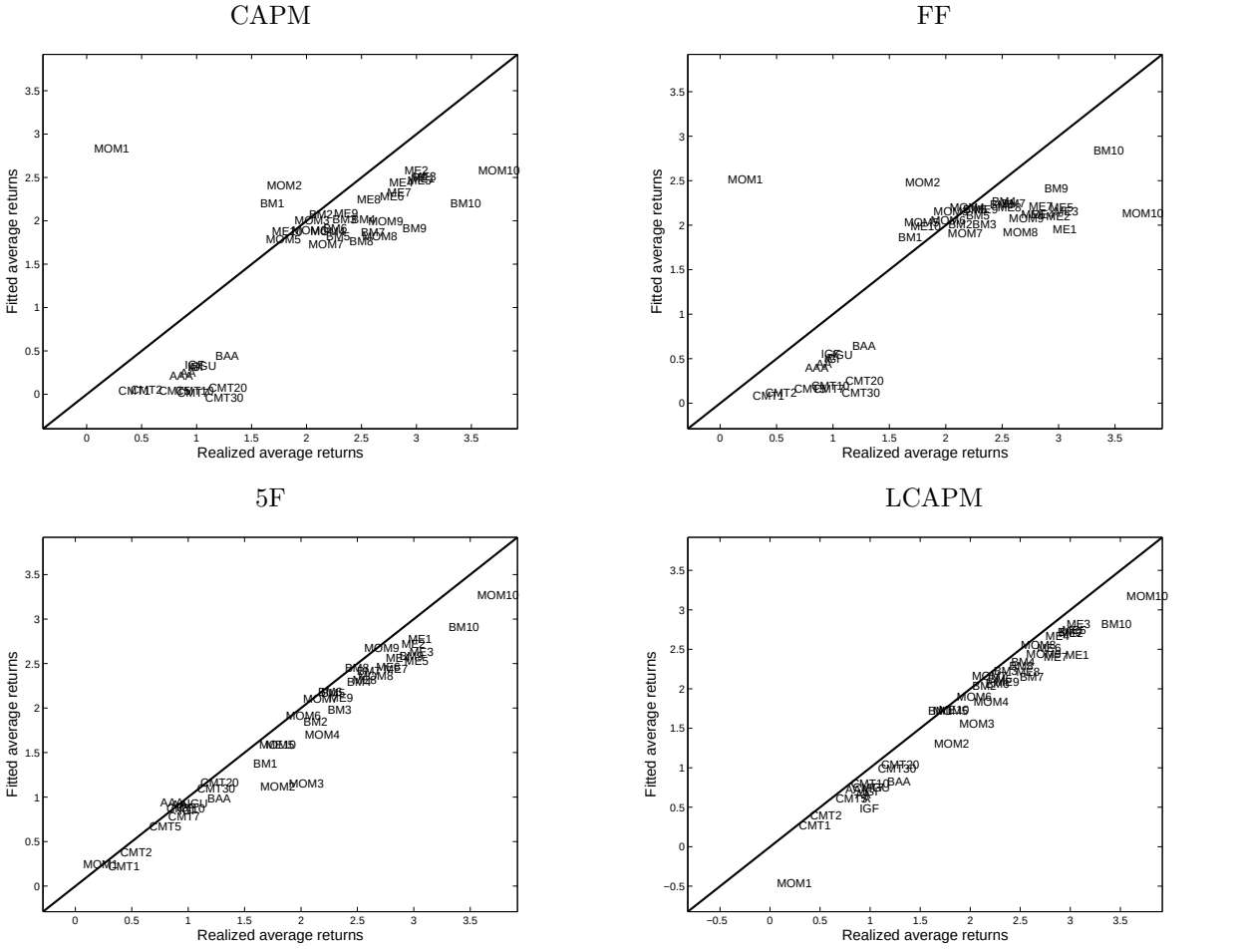

Figure 4: **Dealer Leverage Growth using Alternative Detrending Methods**

This figure shows the annual growth rate of 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.

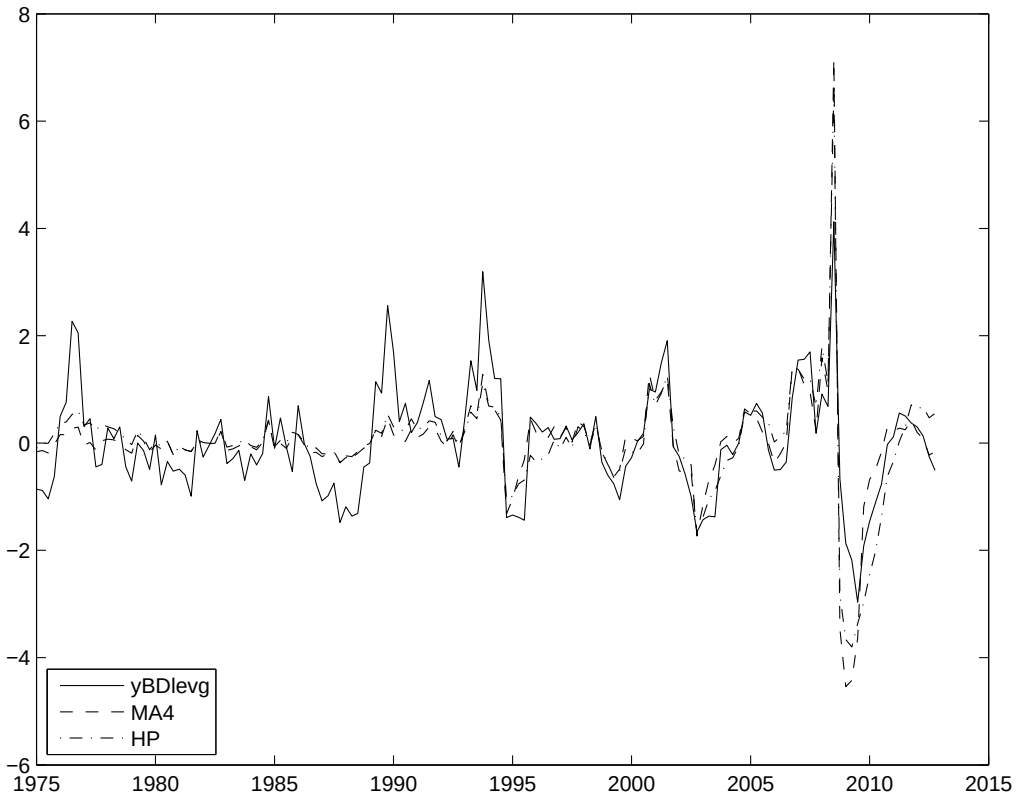

Table 7: **Predicting Returns With Measures of Detrended Dealer Leverage**

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 dealer leverage: annual 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 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