

Adrian, Tobias; Boyarchenko, Nina; Shin, Hyun-Song

Working Paper

The cyclical of leverage

Staff Report, No. 743

Provided in Cooperation with:
Federal Reserve Bank of New York

Suggested Citation: Adrian, Tobias; Boyarchenko, Nina; Shin, Hyun-Song (2015) : The cyclical of leverage, Staff Report, No. 743, Federal Reserve Bank of New York, New York, NY

This Version is available at:
<https://hdl.handle.net/10419/130630>

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Federal Reserve Bank of New York
Staff Reports

The Cyclicalities of Leverage

Tobias Adrian
Nina Boyarchenko
Hyun Song Shin

Staff Report No. 743
October 2015



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The Cyclicity of Leverage

Tobias Adrian, Nina Boyarchenko, and Hyun Song Shin
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October 2015
JEL classification: E02, E32, G00, G28

Abstract

This paper studies the question of the economic scale of financial institutions. We show that banks actively smooth book equity by adjusting payouts to achieve a desired trajectory of book equity. The countercyclical nature of net payouts of financial institutions leads to procyclical book leverage, while market leverage is nearly entirely reflective of movements in book-to-market ratios. There is an apparent structural break after the 2008 crisis, indicated by the banking sector's subdued growth rate relative to pre-crisis levels. Market volatility dampens the intermediary leverage cycle. We draw conclusions for theories of financial intermediation and for capital regulation.

Key words: financial intermediation, market volatility, macro-finance

Adrian, Boyarchenko: Federal Reserve Bank of New York (e-mail: tobias.adrian@ny.frb.org, nina.boyarchenko@ny.frb.org). Shin: Bank for International Settlements (e-mail: hyunsong.shin@bis.org). The authors thank Daniel Stackman for excellent research assistance. The views expressed in this paper are those of the authors and do not necessarily reflect the position of the Bank for International Settlements, the Federal Reserve Bank of New York, or the Federal Reserve System.

1 Introduction

Recent theoretical literature has come to recognize the importance of financial intermediation in macroeconomic fluctuations. Within dynamic equilibrium models, financial intermediation has been shown to matter for asset pricing, systemic risk, monetary policy, and macroprudential policy.¹ The recent literature builds on earlier papers by [Bernanke and Gertler \(1989\)](#) and [Kiyotaki and Moore \(1997\)](#) by applying financial frictions that amplify macroeconomics fluctuations to the intermediary sector.

In the macro-finance literature with financial intermediation, a key state variable is the evolution of intermediary leverage. While some theories feature procyclical leverage, others result in countercyclical leverage. The importance of the leverage cycle for aggregate fluctuations was first pointed out by [Geanakoplos \(2003\)](#) and [Fostel and Geanakoplos \(2008\)](#). In their theory, heterogeneous agents are subject to collateral constraints, giving rise to an inherently procyclical leverage cycle: booms are fueled by loosening collateral requirements, while busts feature contractions in leverage. Such procyclicality of leverage has also been a key amplification mechanism in models with value-at-risk constraints, as shown by [Brunnermeier and Pedersen \(2009\)](#), [Danielsson, Shin, and Zigrand \(2011\)](#), [Adrian and Shin \(2014\)](#), and [Adrian and Boyarchenko \(2012\)](#). Value-at-risk constraints loosen in booms when volatility is low, enabling higher leverage, and tighten in downturns when volatility increases. In addition, [Gertler and Kiyotaki \(2012\)](#) introduce accounting frictions that fuel procyclical leverage. In contrast, [He and Krishnamurthy \(2012b, 2013\)](#), and [Brunnermeier and Sannikov \(2014, 2011\)](#) feature countercyclical leverage, driven by the intuition that equity is run down in bad times, leading to an involuntary increase in leverage.

Empirically, leverage can be measured using book values or using market values. The definition of book leverage is the ratio of total assets to book equity, while the definition of market equity is the ratio of enterprise value to market equity (enterprise value is the sum of total liabilities and

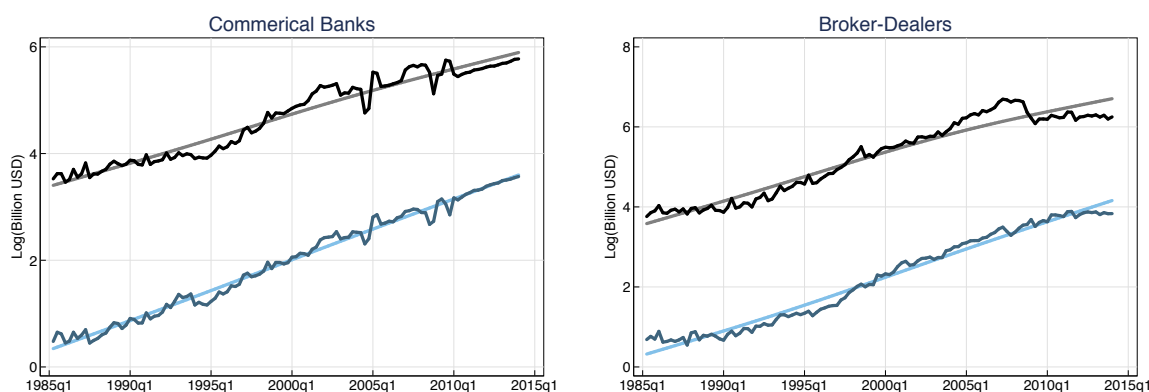
¹[He and Krishnamurthy \(2013\)](#) examine assets pricing implications, [He and Krishnamurthy \(2012b,a\)](#), [Brunnermeier and Sannikov \(2014\)](#), [Gertler and Kiyotaki \(2012\)](#) analyze systemic risk, [Brunnermeier and Sannikov \(2011\)](#) investigate monetary policy, and [Goodhart, Kashyap, Tsomocos, and Vardoulakis \(2012\)](#), [Angelini, Neri, and Panetta \(2011\)](#), [Angeloni and Faia \(2013\)](#), [Korinek \(2011\)](#), [Bianchi and Mendoza \(2011\)](#) examine macro prudential policy.

market equity). [Adrian and Shin \(2014\)](#) document that book leverage is procyclical while market leverage is countercyclical. These facts raise the question whether the relevant empirical measure of leverage is at book or at market values.

Book values figure prominently in both financial firms’ discussions of what they do, as well as in the regulations that govern banks. For example, the annual reports of major US banking organizations commonly present their targets for return on equity—a measure of performance at book value—and they report the evolution of leverage at book values. Regulations are typically built around ratios related to book leverage, not market leverage. In particular, the Basel bank capital regulations all refer to measures of capital at book value. In addition, US and European stress tests measure capital adequacy in terms of the book value of equity.

The purpose of our paper is to delve further into the book leverage and document empirically that banks base their balance sheet management around book equity and book leverage. Market leverage also plays a role in the banks’ balance sheet management, but that role is secondary, and turns out to matter at shorter horizons. Furthermore, we present evidence that balance sheet management of intermediaries is linked to market risk. Market risk directly impacts firms’ ability to take on leverage, either via explicitly value at risk constraints, via regulatory risk weights, or as funding costs tend to increase with risk.

Figure 1. Equity and Assets of Banks and Dealers over Time



This figure plots total assets (in black) and book equity (in blue) for the commercial bank sector and the broker-dealer sector over time. The trend is from a Hodrick-Prescott filter. Total assets and book equity are from Compustat.

Figure 1 presents the long sweep of the evolution of total assets and book equity of the US commercial bank sector and the US broker-dealer sector from 1980, where we have superimposed the trend lines generated by a Hodrick-Prescott (HP) filter of the total asset series. We note three features. First, the broker-dealer sector has grown at a slightly faster pace than the commercial bank sector over this period, and has operated at a higher book leverage than the commercial bank sector, as indicated by the wider tram-lines between the total assets and book equity trend series.

Second, the book equity series displays a smoother path over time than total assets, suggesting that banks actively smooth book equity. We will see shortly that this is indeed the case, and banks adjust payouts to achieve a desired trajectory of book equity. We document the evidence both through the determinants of book equity, but also through dynamic impulse responses from a panel vector autoregression (VAR) of a large cross-section of banks and how they manage their balance sheets.

Third, there is an apparent structural break after the 2008 crisis, whereby the growth of both sectors, but the broker-dealer sector in particular, has been subdued. The current total assets and book equity of the broker-dealer sector remains substantially below the HP trend line.

As for market leverage, we show that virtually all the cyclical variation of market leverage is driven by fluctuations in the book-to-market ratio, reflecting the valuation changes of free cash flows generated by the bank. Nevertheless, there are important links between market leverage and shifts in the book leverage of the bank. At short horizons, an increase in market leverage (reflecting the higher valuations of intangible income) has a similar effect as a decline in the implicit haircut paid by the bank to borrow.

Crucially, just as we observe a structural break in the total assets and book equity series around the financial crisis, we also observe a structural break in the relationship between market leverage and the book-to-market ratio; in particular, the slope of the relationship between the two undergoes a structural shift, so that the book-to-market ratio for any given market leverage is significantly lower after the crisis. In other words, both book leverage and market leverage undergo a structural shift post-crisis.

The remainder of the paper is organized as follows. Section 2 shows the procyclicality of book leverage and countercyclicality of market leverage for commercial banks and broker-dealers, documenting that the degree of cyclicality is exacerbated when risk or uncertainty are low. Section 3 shows that book leverage is actively managed via changes to payout that impact the equity cushion of firms, while market leverage is largely a function of fluctuations in market to book values. Section 4 links leverage management to the scale of banking by showing that net payout is a function of the equity gap—the difference between book equity and its long term trend. Finally, Section 5 concludes by discussing implications for macro-finance theories that feature endogenous risk and actively managed financial intermediaries.

2 Cyclicity of Book Leverage and Market Leverage

In this Section, we study the behavior of leverage over the business cycle, and the determinants of the evolution of leverage. Previous work (see [Adrian and Shin, 2014](#)) has established the importance of distinguishing between book and market values of equity and leverage. We follow this work in defining book equity as the difference between total assets and total debt, and market equity as market capitalization. Similarly, book leverage is defined as the ratio of total assets to book equity, while market leverage is defined as the ratio of enterprise value (total assets - book equity + market equity) to market equity. Maintaining the distinction between these different concepts of equity and leverage is important, as they have distinct interpretations and display disparate behavior both across sectors and over the business cycle.

The enterprise value of a bank addresses how much the bank is worth to its stakeholders. A bank's enterprise value is the theoretical sum of money that would be needed to buy out the shareholders and debt holders. In contrast, the total assets of the bank measure how much the bank lends, either directly as loans or through other claims. Both of these valuation concepts are economically meaningful and capture different facets of how financial institutions manage their balance sheets.

Figure 3 shows the procyclicality of book leverage for broker-dealers, bank holding companies, and five of the largest US banks (JP Morgan, Citibank, Bank of America, Goldman Sachs, and Morgan Stanley). For each cut of the data, book leverage is procyclical, while market leverage is countercyclical, as noted by [Adrian and Shin \(2014\)](#). That is, book leverage is high when total assets are large, but market value leverage is low when enterprise value is high. This result illustrates the fundamental difference between book and market leverage: while financial institutions can actively manage the behavior of book leverage, market leverage is determined primarily by market forces. The procyclicality of book leverage derives from banks reducing lending by reducing their debt – that is, by deleveraging. Hence, book leverage is low during downturns and high during booms. The countercyclicality of market leverage comes from the fact that more of the value of the bank is in the hands of the debt holders during downturns, as the share price of the bank falls. Thus, market leverage is high during downturns.

To delve further into the difference between book leverage and market leverage, it is helpful to consider the relationship of leverage with book-to-market values, reported in Figure 4. The top four panels show that market leverage moves almost one-for-one with the book-to-market ratio. In contrast, book leverage exhibits very low correlation with the book-to-market ratio (lower four panels). It is worth emphasizing that the countercyclicality of market leverage is not simply about the marking-to-market of balance sheets and the potentially stale nature of accounting values. Broker-dealers mark their whole balance sheet to market, while commercial banks use historical cost accounting for their loan book. However, Figures 3 and 4 show that the behavior of leverage and of the book-to-market ratio is qualitatively very similar when comparing broker-dealers and commercial banks. This suggests that accounting is an unlikely driver of the different cyclicality using book and market values, as dealers are fully marking to market their balance sheets, while banks use historical cost accounting.

This observation brings us to the importance of intangible assets in accounting for the difference between book equity and market capitalization. Market capitalization is the discounted value of free cash flows, and those cash flows can be generated by intangible assets. For example, the re-

relationships that firms have with their clients, or the human capital of their workforce are important determinants of future profitability, but those assets are not visible on the balance sheet, and hence do not count towards book equity. An important reason for fluctuations in book-to-market values for financial firms therefore consist in fluctuations of the value of future cashflows from intangible assets.

Fluctuations in the book-to-market ratio due to variations in the discounted future value of intangible assets are distinct from leverage management. Active leverage management of financial intermediaries reflects asset sales and purchases, lending decisions, market making, and other financial transactions. The intangible assets of intermediaries, on the other hand, are related to fee income from investment banking and similar activities. Such activities need little, if any, balance sheet. These considerations thus establish that the countercyclicality of market leverage is primarily related to fluctuations in value not directly related to financial assets and liabilities on the balance sheets of intermediaries.

The cyclicity of book and market leverage can also be seen from Table 1. Columns (1) and (2) report the regression of quarterly (book) asset growth on quarterly book leverage growth using fixed effects and time effects, respectively, while columns (5) and (6) show the regressions of quarterly enterprise value growth on quarterly market leverage growth, again using fixed effects and time effects, respectively. Columns (1) and (2) show that the procyclicality of leverage holds both in the time series (using fixed effects) and in the cross section (using time effects). In contrast, for market leverage, the time series relationship is negative, but the cross-sectional relationship is actually positive.

We also study the impact of risk on the cyclicity of leverage. We measure risk as total volatility of the market equity return computed from daily data within each quarter for each firm. Previous work by [Adrian and Shin \(2014\)](#) suggests that volatility might impact the cyclicity of leverage due to its impact on the tightness of value-at-risk constraints. As can be seen from columns (3) and (4) of Table 1, procyclicality of book leverage tends to be dampened by risk. Higher risk is associated with lower asset growth. Furthermore, the interaction between volatility

and book leverage growth is significantly negative, albeit with economically small coefficients.

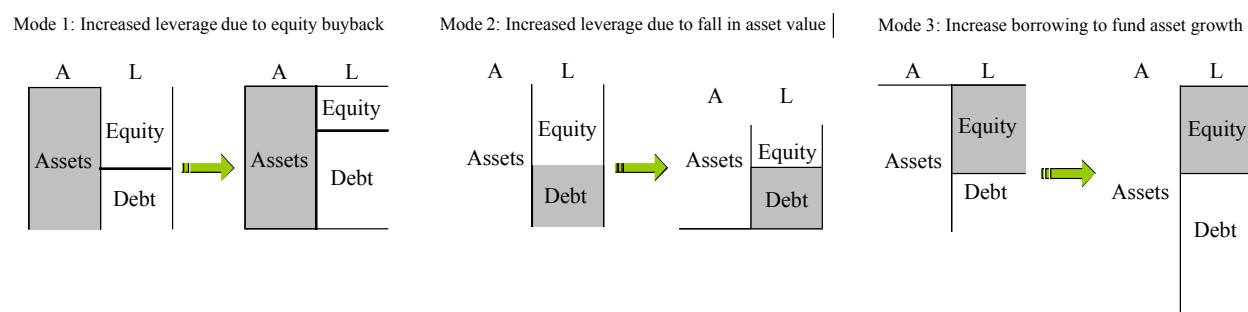
The countercyclicality of leverage is rendered insignificant by the inclusion of risk, as can be seen in columns (7) and (8) of Table 1. While the fixed effect specification of column (5) exhibited a significantly negative relationship between asset growth and leverage growth, the relationship is insignificant when the interaction with volatility is included. Furthermore, the volatility term is more highly significant than the interaction term, indicating that countercyclicality of market leverage is essentially captured by market volatility.

It is noteworthy that the R^2 statistics for the book leverage regressions is sizable, ranging from 18.4 to 23 percent depending on the specification (Columns (1)-(4) of Table 1) while the R^2 statistics for the market leverage regressions are much smaller.

3 Balance Sheet Management over Short and Long Run

We now examine the role of book equity in banks' lending decisions and how banks adjust their balance sheets over the short and long run. Figure 2 from Adrian and Shin (2014) shows three ways that a firm (financial or otherwise) can increase its leverage. In each case, the grey shaded area represents the balance sheet component that does not change.

Figure 2. Three Modes of Leveraging Up



Mode 1 is through an equity buyback through a debt issue. Mode 2 is through a dividend financed by asset sale. Mode 3 is through increased borrowing to fund new assets. In each case the shaded area indicates the balance sheet component that is held fixed.

Mode 1 on the left is the case typically dealt with in corporate finance textbooks. The set of

positive net present value (NPV) projects is taken as given, with the implication that the size of the balance sheet is not part of the firm's decision. Instead, attention falls on how the firm's assets are financed. The left hand panel of Figure 2 depicts a financial operation where the firm issues debt and buys back equity financed with the proceeds of the debt issue. The assets of the firm are unchanged. This is the way, for instance, that a private equity fund would finance the acquisition of a target firm.

Mode 2 depicts the consequences of a drop in the value of assets of the firm – say, through a dividend paid to shareholders financed by an asset sale. The leverage goes up because the notional debt remains unchanged, but the firm's assets shrink in value. The shrinking of the asset value could alternatively just reflect market value changes, with notional amounts held fixed. The middle panel is closest to the way that leverage fluctuates in the Merton (1974) model of long-term debt, where leverage fluctuates due to changes in the value of assets, with notional debt held fixed.

For banks, Adrian and Shin (2014) show that neither Mode 1 nor Mode 2 turns out to be the right picture over short horizons - say over one quarter. Banks adjust their leverage as in Mode 3, where new assets are financed by issuing new debt, with the relationship between assets and book equity being flat.

On the other hand, we know from the long-term trends in assets and equity given in Figure 1 that over long horizons of several years, there is a proportional relationship between book equity and total assets. Thus, whereas short-run changes in assets are driven by shifts in leverage taking book equity as given, long-run growth in assets mirror the growth of book equity. Equivalently, the long-run elasticity of book equity with respect to total assets is 1, but the short-run elasticity of book equity with respect to total assets is much smaller.

Figure 6 presents the scatter charts of the growth of book equity against growth of assets at the quarterly frequency for the broker-dealer sector (left panel) and the commercial bank sector (right panel). We see that at the quarterly horizon, asset growth has only a weak relationship with book equity growth. At longer horizons, however, we know from Figure 1 that there is a proportional relationship between book equity and total assets. In this sense, the short-run elasticity of total

assets with respect to book equity is small, but the long-run elasticity is close to 1.

The short-run relationship between lending and book equity is reflected in the market leverage of the bank. Figure 3 shows that book equity growth at short horizons of one quarter is only weakly related to asset growth, while enterprise value growth is strongly positively related to market equity.

The panels on the relationship between market equity growth and market leverage growth in Figure 5 is particularly striking, as they demonstrate that market equity growth is strongly negatively related to market leverage growth. To a first approximation, market leverage is entirely determined by the valuation of equity: the R^2 is 90 percent for broker-dealers, and 97 percent for commercial banks. For book equity and market leverage the R^2 is only slightly lower for the case of commercial banks, at 71 percent, but considerably lower for the broker-dealers (18 percent).

4 Book Equity and the Scale of the Bank

The scale of a firm is given by its total assets. In corporate finance textbooks, the assets of a firm are determined exogenously by the set of positive net present value projects available to the firm. When the firm happens to be a bank, we have seen that the bank's book equity plays an important role in defining the scale of the firm. The long-run scale of the bank is determined by the book equity of the bank, and any short-run fluctuations in total assets take place around a fixed book equity base. In other words, it is the book equity of the bank that takes the role of the scaling variable for the firm.

Additional evidence that book equity is the right scale variable for the bank comes from the active management of the size of the bank's book equity through dividend payouts by the bank. The evidence is that banks tend to adjust net payouts so as to target a fixed trend level of book equity. Figure 1 shows that book equity evolves very smoothly over the long-run, and much more so than total assets.

The payout policy of banks in achieving such a smooth trajectory of book equity can be obtained from Figure 7, which shows the cross-correlograms between net payouts, book equity

growth and book leverage growth. The top left hand panel of Figure 7 shows that net payouts precede increases in book leverage for the banks. In other words, when net payouts have been high, book leverage tends to increase. The middle panel of the first column in Figure 7 shows that net payouts increase following strong book equity growth. In other words, when book equity growth has been strong in the recent past (4 or 5 quarters ago), net payouts increase significantly, thereby dissipating the book equity of the bank. Taken together, the evidence is that banks actively manage the size of their book equity, paying down book equity with higher payouts when it has been growing strongly.

The evidence in the cross-correlograms on the active management of book equity by the banks is confirmed in the impulse response charts in Figure 8 obtained from a panel VAR where the variables in the VAR are ordered from left to right in the order depicted in Figure 8. The estimates of the panel VAR are reported in Table 2. We focus in particular on the panel showing the response of book leverage to a payout shock and the response of payouts to a book equity shock. Regarding the former, we see that book leverage tends to increase after a payout, showing that payouts are one way for the bank to keep book leverage high. For the response of payouts to a book equity shocks, we see first that there is an instantaneous negative relationship between payouts and book equity—a mechanical relationship—but there is a more interesting effect at a longer horizon of around 5 quarters in which payout increases significantly when book equity increases. This response of payouts to an equity shock indicates that the bank is actively managing book equity and trying to keep book equity along a smooth path. Indeed, the open chart in Figure 1 showed how smooth book equity was, and the VAR evidence supports the hypothesis of active management of book equity.

Table 3 reports the results of a panel regression for net payouts of the bank as a function of the de-trended book equity of the bank, defined as the deviation of book equity from its HP trend line plotted in Figure 1. We see that the coefficient on detrended book equity 4 quarters-lagged is strongly positive, implying that the bank pays down book equity if it has recently (over the year) seen strong growth in book equity. Conversely, if the bank has suffered losses and has seen an

erosion of book equity, the bank takes action to rebuild book equity.

The fact that banks pay down book equity during the upswing is especially noteworthy. Since book equity growth reflects strong profitability of banks, the period of rapid book equity growth coincides with periods of buoyant economic conditions and strong credit growth. The question is why banks choose to finance the growth in credit through debt, even while they erode the size of their book equity through increased payouts.

Another way to pose the question is to ask whether the banks' operations have constant returns to scale. If the banking business had constant returns to scale, the bank could refrain from dividend payouts by retaining the profit as book equity and replicate their existing operations based on a larger book equity foundation. To the extent that the bank's shareholders are reluctant to issue new equity due to the dilution of incumbent shareholders' claims, the shadow value of book equity is bigger than one. That is, one dollar in book equity is worth more to the shareholders than one dollar in cash. However, to the extent that banks' shareholders are also willing to pay out cash dividends suggests that the shadow value of book equity cannot be strictly larger than 1.

We need to reconcile (1) cash dividends that dissipate book equity and (2) reluctance of shareholders to be diluted by issuing new shares. One way to reconcile these two features would be the existence of an optimal scale of the bank as given by an optimal size of its book equity K^* . The optimal size of the book equity determines the shadow value of book equity, so that the shadow value of book equity is larger than one when book equity K is below this optimal scale ($K < K^*$), but the shadow value is less than 1 when $K > K^*$. Moreover, we may hypothesize that the optimal scale K^* is a slow-moving variable. The existence of such an optimal scale K^* for the bank reconciles the long-run unit elasticity of book equity with respect to total assets (Figure 1) with the payout behavior of banks targeting a level of book equity.

Around the long-term trend for book equity, the bank's lending behavior in the short-run is determined by its leverage decision, which in turn is closely related to the market conditions that tie down the bank's market capitalization and the book-to-market ratio of the bank.

One question raised by our finding that the bank appears to have an optimal scale given its

book equity K^* raises a more fundamental question about the scalability of the bank's operation. In particular, does the bank operate according to constant returns to scale? In other words, if the bank could simply replicate its existing business by expanding its balance sheet in exact proportion, what would happen to the overall value of the bank? Under constant returns to scale, the bank's value would be proportional to the size of its balance sheet, and the shadow value of the bank's book equity would be constant. If the shadow value is strictly larger than 1, this implies that the bank's shareholders value one dollar of book equity higher than one dollar of cash. Under constant returns to scale, then, the bank would never pay a cash dividend. Instead, the bank would retain the profit and expand the bank's business by replicating the bank's existing balance sheet. The fact that the bank appears to have an optimal scale of book equity and actively manages it suggests that the bank's business is not perfectly scaleable. Its intangible assets, such as its workforce, relationships with clients would be very difficult to replicate.

Table 4 reports the panel regressions of leverage on payout and equity. Higher payout increases book leverage, as it leads to a compressed equity cushion for a given level of assets. Consequently, net payout is highly significantly related to book leverage. However, it has low explanatory power. Book equity, on the other hand, is strongly negatively correlated with book leverage, yielding a 32 percent R^2 . Market equity growth, and book-to-market growth have very low explanatory power for book leverage. When all indicators are used jointly (Column (5)), only book equity growth appears significant. Hence we conclude that net payout and equity valuations matter for book leverage only to the extent to which they have an impact on book equity growth.

For market leverage the panel regressions give R^2 s of 87 and 83 percent, respectively, when market leverage growth is regressed on market equity or the book-to-market ratio (columns (8) and (9) of Table 4). Net payout and book leverage, on the other hand, have barely any explanatory power for market leverage, with R^2 s below 1 percent. These findings are consistent with the notion that market leverage growth rates are largely outside of the control of firms, and are instead moved by exogenous variations in valuations. This contrasts with book leverage, which is pinned down by book equity, which is directly in control of the firms, via retained earnings and net payout.

Table 5 reproduces Table 4, but adding interactions with volatility. The interaction with market volatility strengthens the relationship between book leverage and book equity. For market leverage, while the interaction with market volatility is significant, there is no increase in R^2 by adding those variables as interaction terms.

4.1 Points of Contact with Asset Pricing Literature

We have seen that, although book equity and total assets are accounting constructs, rather than market variables, they nevertheless hold important information on market conditions, as book equity and book leverage determine the supply of credit to the economy, including to the financial system. To the extent that asset prices are sensitive to credit conditions through, for instance, the ease with which financial market participants can obtain leverage, the combination of book equity and book leverage will hold important information that is relevant for asset returns.

The recent asset-pricing literature has explored the impact of book leverage on asset returns. [Adrian, Etula, and Muir \(2014\)](#) use shocks to the leverage of broker-dealers to construct an intermediary SDF. Intuitively, deteriorating funding conditions are associated with deleveraging and high marginal value of wealth. The single-factor model of [Adrian, Etula, and Muir \(2014\)](#) prices size, book-to-market, momentum, and bond portfolios with an R^2 of 77 percent and an average annual pricing error of 1 percent. The model performs as well as standard multi-factor benchmarks designed to price these assets. The findings support the hypothesis that financial intermediaries trade frequently in many markets using sophisticated models. Building on [Adrian, Etula, and Muir \(2014\)](#), [Adrian, Moench, and Shin \(2014\)](#) investigate predictions from alternative intermediary asset pricing theories which distinguish themselves in their use of intermediary equity or leverage as pricing factors or forecasting variables. [Adrian, Moench, and Shin \(2014\)](#) find strong support for a parsimonious dynamic pricing model based on broker-dealer leverage as the return forecasting variable and shocks to broker-dealer leverage as a cross-sectional pricing factor. The model performs well in comparison to other intermediary asset pricing models as well as benchmark pricing models. [Adrian, Moench, and Shin \(2014\)](#) in turn extends results by [Adrian, Moench, and Shin](#)

(2010) who document that broker-dealer leverage growth contains strong predictive power for excess returns on a broad set of equity and corporate bond portfolios. [Adrian, Friedman, and Muir \(2015\)](#) build a model for the cost of equity capital of financial intermediaries that absorbs the common variation of financial sector equity returns in both the cross section and time series. [Adrian, Friedman, and Muir \(2015\)](#) construct risk factors from the cross-section of intermediary returns, including a leverage and a return on equity factor, and a financial sector excess return. Despite apparent overlap, the return factors have surprisingly low correlation with standard benchmark pricing factors that are not specifically constructed for the financial sector, and these benchmark pricing models fail to price financial sector portfolio returns. [Adrian, Friedman, and Muir \(2015\)](#) relate the leverage factor to the balance sheet expansion of intermediaries which predicts low future returns, in sharp contrast to non-financials. The model is used to estimate the time-series for the cost of capital of the financial sector.

5 Lessons and Conclusions

Banking organizations manage payout and leverage in order to achieve a scale of operation that is best captured by its book equity. The long-run leverage of the bank is then built on the trend book equity.

In the short-run, however, the bank's total assets can fluctuate considerably depending on market conditions, especially on those same forces that determine the book-to-market ratio of the bank. Qualitatively, the book-to-market ratio behaves similarly to the implied volatility of the bank's share price, which is known to be closely linked with the Value-at-Risk (VaR) and the haircut variables that banks are subject to ([Adrian and Shin, 2014](#)). Net payout is high in booms, and issuance only occurs in severe financial crisis. Furthermore, book leverage is managed in a strongly procyclical manner. Market leverage, on the other hand, appears to be primarily linked to the market to book ratio, which is largely determined by fluctuations in valuations.

Intriguingly, we have documented a structural break with the onset of the 2008 financial crisis

that has subdued both the market leverage of the bank but also its book equity growth. Post-crisis, the trend growth of the book equity of the banking sector (but especially the broker dealer sector) has been on a flatter trajectory. At the same time, the book-to-market ratio of the banks have also undergone a step decline, to the extent that the book value of equity has exceeded the market value in aggregate since the crisis. The relationship between market leverage and the book-to-market ratio lies on a different line altogether after the crisis.

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A Data

Firm-level data are from CRSP and the merged CRSP-Compustat databases. Daily and monthly returns, and monthly prices and shares outstanding from CRSP are merged with quarterly accounting data from Compustat. Following much of the asset pricing literature, we only retain common stocks. Firm characteristics are winsorized at the 5% and 95% levels. Additionally, firms' balance sheets and market values are adjusted for mergers, and an analysis of the merger-adjusted sample is presented in the appendix as a robustness check. The sample period is 1985:1-2014:1. We winsorize at the 95 and 5 percent levels in both levels and growth rates.

A.1 The universe of firms

Our full sample includes any firm with a SIC code between 6000 and 6799, which we take to be the CRSP universe of all financial firms. This universe includes banks, dealers, real estate, and insurance, as well as a variety of smaller lenders, investment advisors, and holding offices. However, only banks and dealers are retained for analysis. We define commercial banks broadly, as firms with SIC codes less than 6200. This includes all commercial banks, from small community banks to large financial conglomerates², as well as credit unions, and a few government-sponsored entities (e.g., Fannie and Freddie). We define broker-dealers as firms with SIC codes between 6200 and 6300, and 6712. Our sample of dealers is much smaller than our sample of commercial banks, and is dominated by a few big firms (Bear Sterns, Goldman Sachs, Lehman Brothers, Merrill Lynch, and Morgan Stanley). Finally, we drop any firms whose total assets fall below \$2 billion and any firm that has zero observations for assets, book equity, or market equity over the whole sample.

A.2 Merger adjustment

Mergers and acquisitions create discontinuities in the time series of firm characteristics. Therefore, we use the delisting file from CRSP to merger-adjust the raw data. Given firms A, B, and C, where B *acquires* A and is *acquired by* C, merger adjustment is simply the process of consolidating the balance sheets of A, B, and C over the whole sample period. Additive variables, such as assets and equity, are simply summed up, while for non-additive variables, such as returns and return volatility, we take a (lagged) market equity weighted average across the firms. Ratios (e.g. ROE) and growth rates are then re-calculated for the merger-adjusted entity. Merger adjusting has the advantage of removing irrelevant (for our purposes) discontinuities in the data, but has several drawbacks. Most importantly, two out of the five large U.S. broker-dealers are folded into the balance sheets of commercial banks (Bear into JPMorgan, and Merrill into Bank of America). Therefore, we opt to focus on our analysis of the unadjusted firms.

²While we categorize Bank of America, Citibank, and JPMorgan Chase as commercial banks, we often distinguish between these three firms and the rest of the commercial banks, due to the fact that they each have large broker-dealer subsidiaries.

B Tables and Figures

Table 1: Asset Growth and Leverage Growth

This table displays estimates from panel regressions of total asset (enterprise value) growth on book (market) leverage growth. Enterprise value is the sum of total debt and market equity; book (market) leverage is the ratio of total assets (enterprise value) to book (market) equity. Total volatility, measured as the standard deviation of returns over the quarter is included in levels and interacted with leverage growth. Balance sheet data are quarterly from Compustat, and returns are daily from CRSP. Growth rates are quarterly, and expressed as percentages. The sample period is 1985:1 - 2014:1. *** ** and * denote significance at the 1%, 5%, and 10% levels, respectively. Robust standard errors, clustered by PERMNO, in parentheses.

	Asset Growth			Enterprise Value Growth		
	(1)	(2)	(3)	(4)	(5)	(6)
Book Leverage Growth	0.367*** (0.021)	0.361*** (0.021)	0.439*** (0.023)			
_____ × Volatility			-0.022*** (0.006)			
Market Leverage Growth				-0.025*** (0.005)	0.010 (0.006)	0.004 (0.008)
_____ × Volatility						-0.004** (0.002)
Return Volatility			-0.499*** (0.054)			-0.688*** (0.061)
Firm FE	Yes	No	Yes	Yes	No	Yes
Time FE	No	Yes	No	No	Yes	No
Observations	11678	11678	11536	11674	11674	11536
Adjusted R^2	0.184	0.228	0.208	0.006	0.101	0.041

Table 2: Vector Autoregression

This table reports the panel vector autoregression of annual growth rates of equity volatility, market-to-book, book equity, book leverage, and net payout. Data on book values are quarterly from Compustat, data on market equity are monthly from CRSP, and returns are daily from CRSP. Growth rates are quarterly, and expressed as percentages. The sample period is 1985:1 - 2014:1. ***, ** and * denote significance at the 1%, 5%, and 10% levels, respectively.

	Return Volatility	Market- to-Book	Book Equity	Book Leverage	Book Payout
Return Volatility (1Q lag)	0.620*** (28.607)	-0.110*** (-9.309)	0.011* (1.831)	-0.014*** (-2.734)	-0.014** (-2.271)
Market-to-Book (1Q lag)	-0.258*** (-6.158)	0.702*** (25.210)	0.009 (0.896)	0.001 (0.060)	-0.011 (-1.023)
Book Equity (1Q lag)	-0.048 (-0.616)	-0.115** (-2.093)	0.850*** (20.669)	-0.038 (-1.393)	0.003 (0.155)
Book Leverage (1Q lag)	0.389*** (4.747)	-0.188*** (-3.533)	0.077* (1.900)	0.644*** (19.556)	-0.023 (-1.067)
Payout (1Q lag)	-0.115 (-1.109)	0.298** (2.555)	-0.041 (-1.085)	0.057** (2.332)	0.505** (2.406)
Return Volatility (2Q lag)	0.043** (2.098)	0.007 (0.639)	-0.001 (-0.179)	0.006 (1.199)	-0.001 (-0.451)
Market-to-Book (2Q lag)	0.305*** (7.342)	-0.085*** (-3.117)	-0.007 (-0.679)	0.010 (0.982)	0.018* (1.785)
Book Equity (2Q lag)	0.153* (1.886)	0.088 (1.483)	-0.084*** (-2.576)	0.026 (0.914)	0.015 (0.645)
Book Leverage (2Q lag)	-0.066 (-0.825)	0.123** (2.144)	-0.035 (-1.041)	0.012 (0.385)	-0.000 (-0.003)
Payout (2Q lag)	-0.006 (-0.068)	-0.168 (-1.039)	-0.077** (-2.064)	-0.001 (-0.066)	0.173 (1.416)

Table 3: Payouts and the Equity Gap

This table displays the estimates of panel regressions of net payouts on HP detrended book equity. Data on book values are quarterly from Compustat, data on market equity are monthly from CRSP, and returns are daily from CRSP. Growth rates are quarterly, and expressed as percentages. The sample period is 1985:1 - 2014:1. *** ** and * denote significance at the 1%, 5%, and 10% levels, respectively. Robust standard errors, clustered by PERMNO, in parentheses.

	Net Payouts, normalized by:							
	Contemporaneous Assets				Lagged Assets			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Detrended Book Equity (4Q lag)	0.013*** (0.004)	0.012*** (0.004)	0.010*** (0.003)	0.009*** (0.003)	0.014** (0.006)	0.012** (0.006)	0.011** (0.004)	0.010** (0.004)
Return Volatility (4Q lag)		-0.001 (0.000)	-0.000 (0.000)	-0.000 (0.000)		-0.000 (0.000)	-0.000 (0.001)	-0.000 (0.001)
Market/Book (4Q lag)			-0.002 (0.001)	-0.002 (0.001)			-0.001 (0.002)	-0.001 (0.002)
Book Leverage (4Q lag)				-0.000** (0.000)				-0.000* (0.000)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	3749	3614	3601	3601	3737	3602	3601	3601
Adjusted R^2	0.068	0.073	0.073	0.075	0.039	0.038	0.039	0.041

Table 4: What is Driving Leverage?

This table displays estimates from panel regressions of book and market leverage growth on net payouts, book equity growth, market equity growth, and Book/Market growth. Data on book values are quarterly from Compustat, and data on market values are monthly from CRSP. Net payouts are in billions of US dollars. Growth rates are quarterly, and expressed as percentages. The sample period is 1985:1 - 2014:1. *** ** and * denote significance at the 1%, 5%, and 10% levels, respectively. Robust standard errors, clustered by PERMNO, in parentheses.

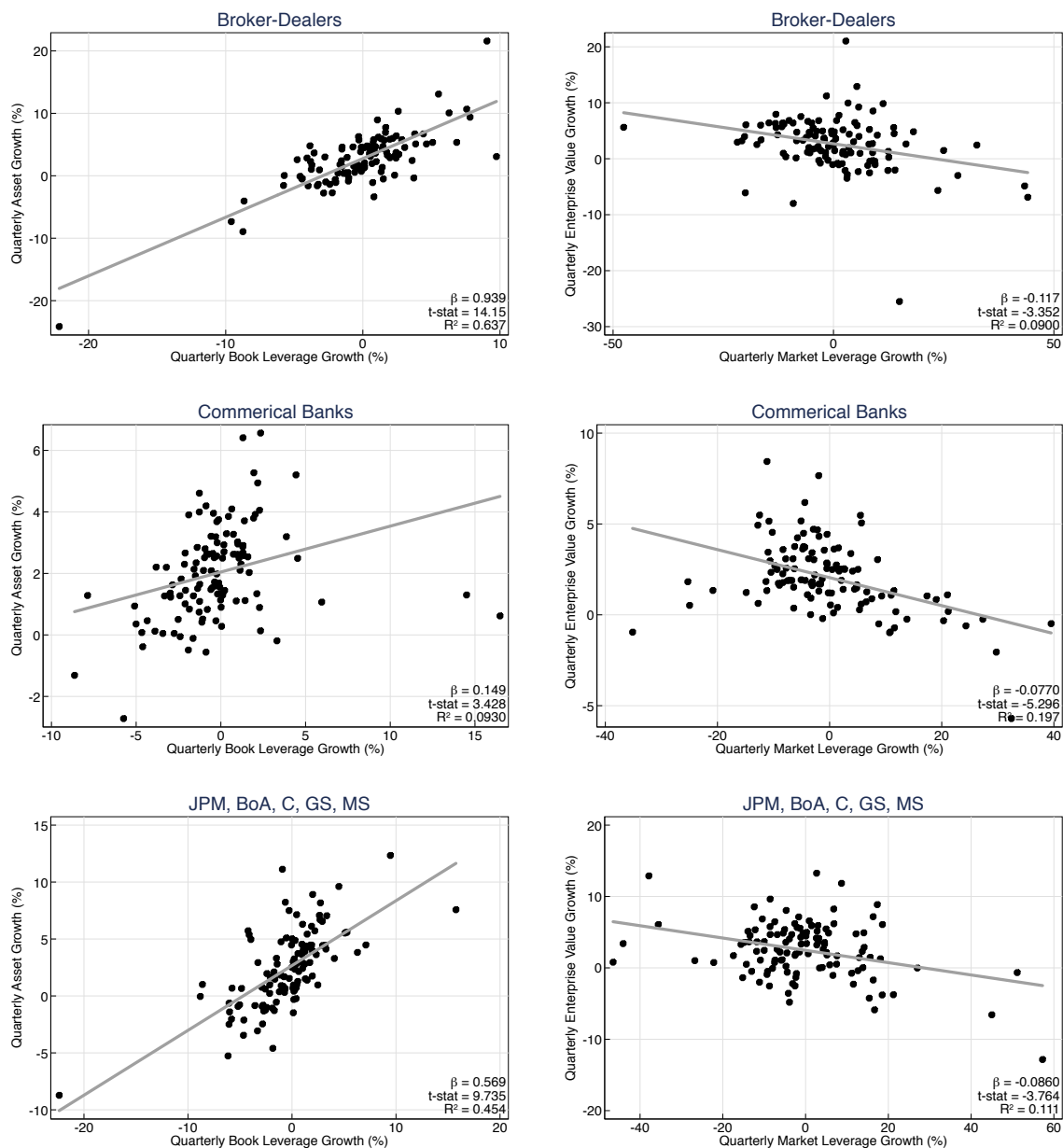
	Book Leverage Growth					Market Leverage Growth				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Net Payouts	0.271*** (0.077)				0.090* (0.050)	-0.463** (0.231)				0.037 (0.074)
Book Equity Growth		-0.604*** (0.024)			-0.749*** (0.045)		-0.237*** (0.051)			-0.163** (0.070)
Market Equity Growth			-0.036*** (0.006)		0.029 (0.042)			-0.866*** (0.007)		-0.528*** (0.068)
Book/Market Growth				-0.028*** (0.006)	0.008 (0.043)				0.853*** (0.008)	0.327*** (0.066)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	4201	11678	11674	11674	4201	4201	11674	11674	11674	4201
Adjusted R^2	0.011	0.324	0.012	0.007	0.400	0.005	0.006	0.868	0.835	0.871

Table 5: Leverage and Volatility

This table displays the estimates from panel regressions analogous to those presented in Table 2 above, augmented by the inclusion of return volatility in levels and interactions. Growth rates are quarterly, and expressed as percentages. The sample period is 1985:1 - 2014:1. *** ** and * denote significance at the 1%, 5%, and 10% levels, respectively. Robust standard errors, clustered by PERMNO, in parentheses.

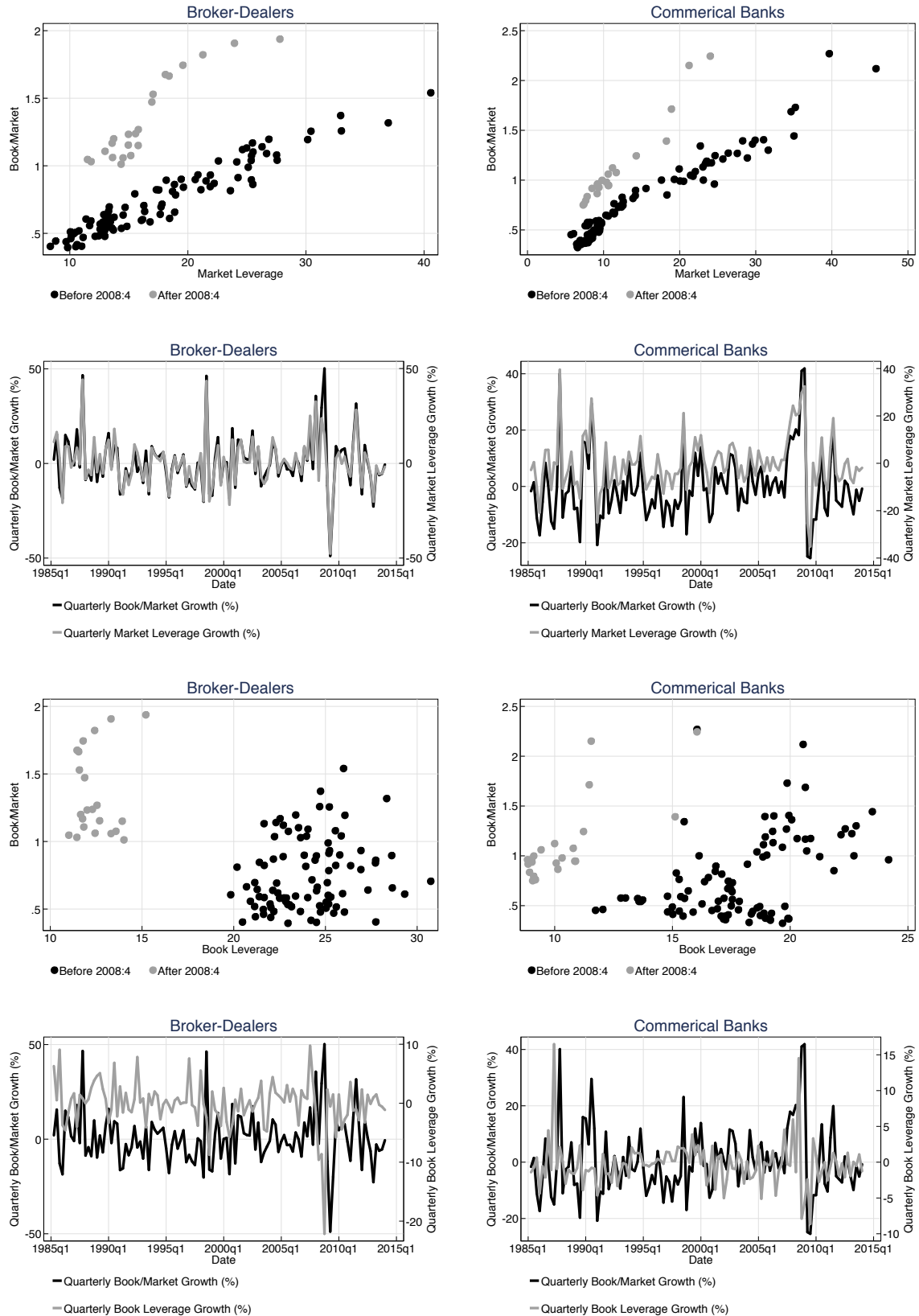
	Book Leverage Growth	Market Leverage Growth
	(1)	(2)
Net Payouts	0.158** (0.073)	-0.007 (0.128)
_____ × Volatility	-0.017** (0.007)	-0.002 (0.012)
Book Equity Growth	-0.525*** (0.065)	-0.114 (0.096)
_____ × Volatility	-0.045*** (0.012)	-0.012 (0.019)
Market Equity Growth	-0.082 (0.055)	-0.499*** (0.081)
_____ × Volatility	0.019 (0.012)	-0.007 (0.018)
Book/Market Growth	-0.101* (0.056)	0.320*** (0.081)
_____ × Volatility	0.020 (0.012)	0.002 (0.018)
Return Volatility	-0.177*** (0.064)	-0.444*** (0.072)
Firm FE	Yes	Yes
Observations	4072	4072
Adjusted R^2	0.412	0.880

Figure 3. Balance Sheets Size and Leverage



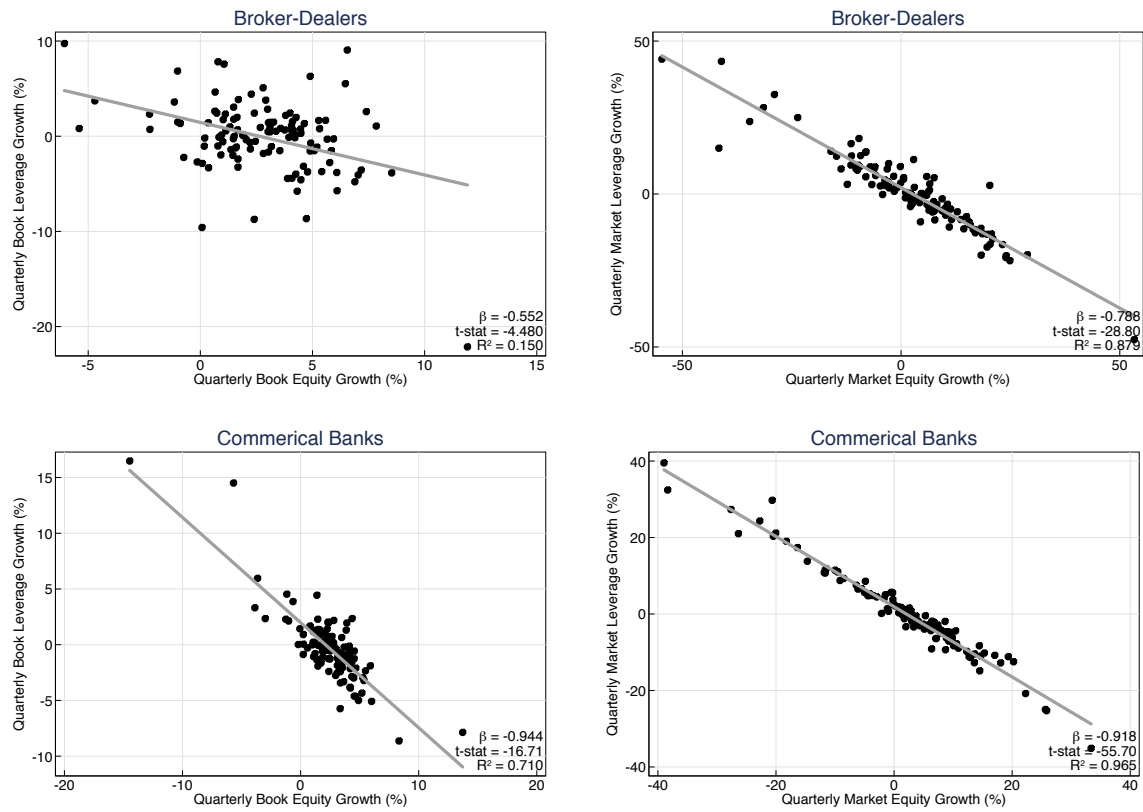
Growth rates in log-differences; reported in percentage terms. The sample period is 1985:1 – 2014:1. Source: Compustat and CRSP.

Figure 4. Leverage and the Book-to-Market Ratio



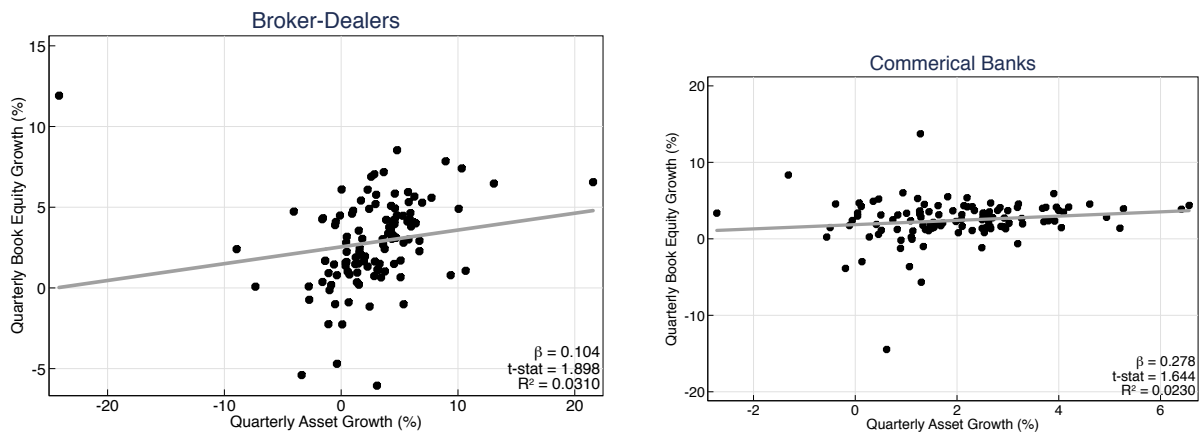
Growth rates in log-differences; reported in percentage terms. The sample period is 1985:1 – 2014:1. Source: Compustat and CRSP.

Figure 5. Equity and Leverage



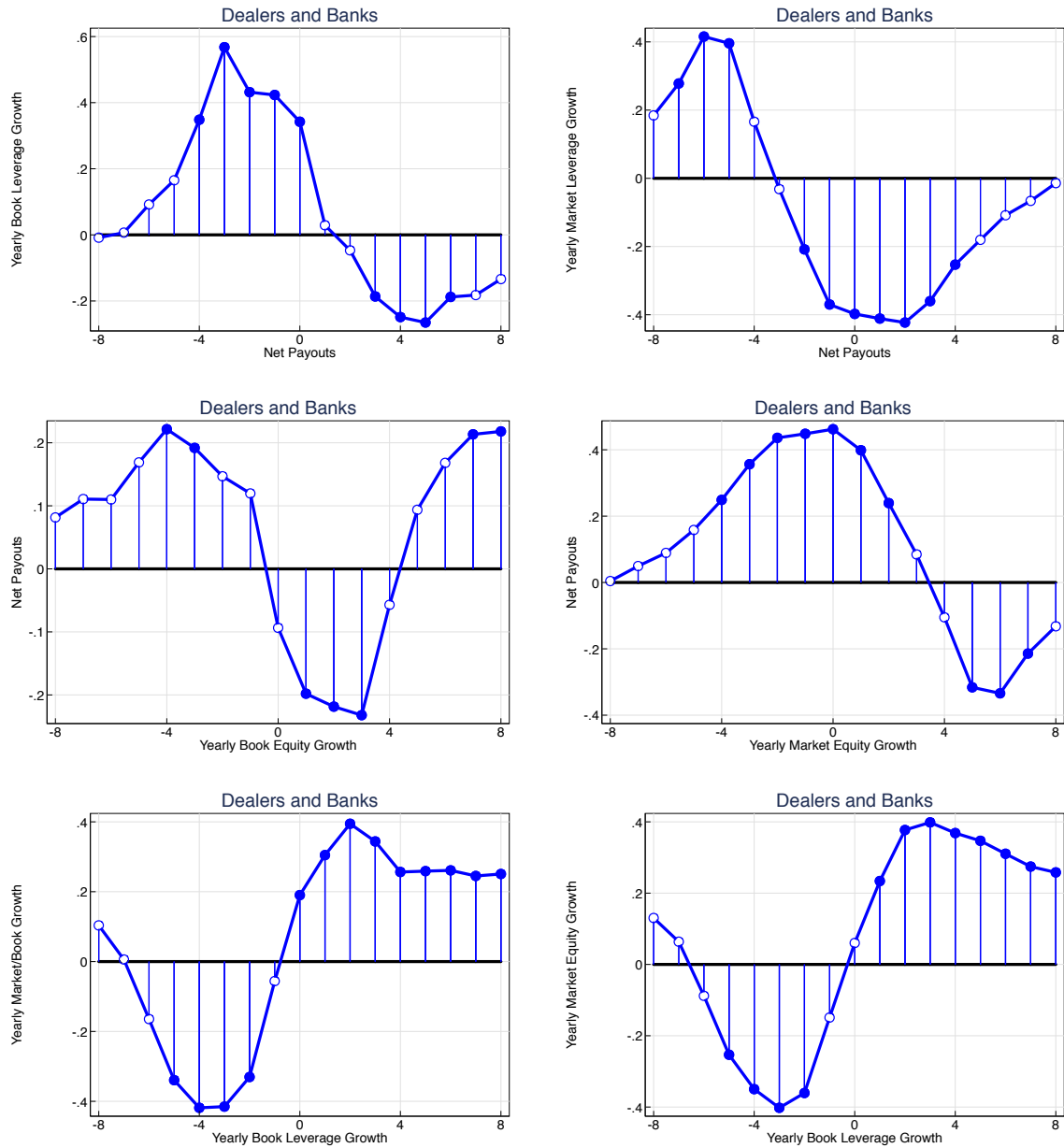
Growth rates in log-differences; reported in percentage terms. The sample period is 1985:1 – 2014:1. Source: Compustat and CRSP.

Figure 6. Equity and Balance Sheet Size



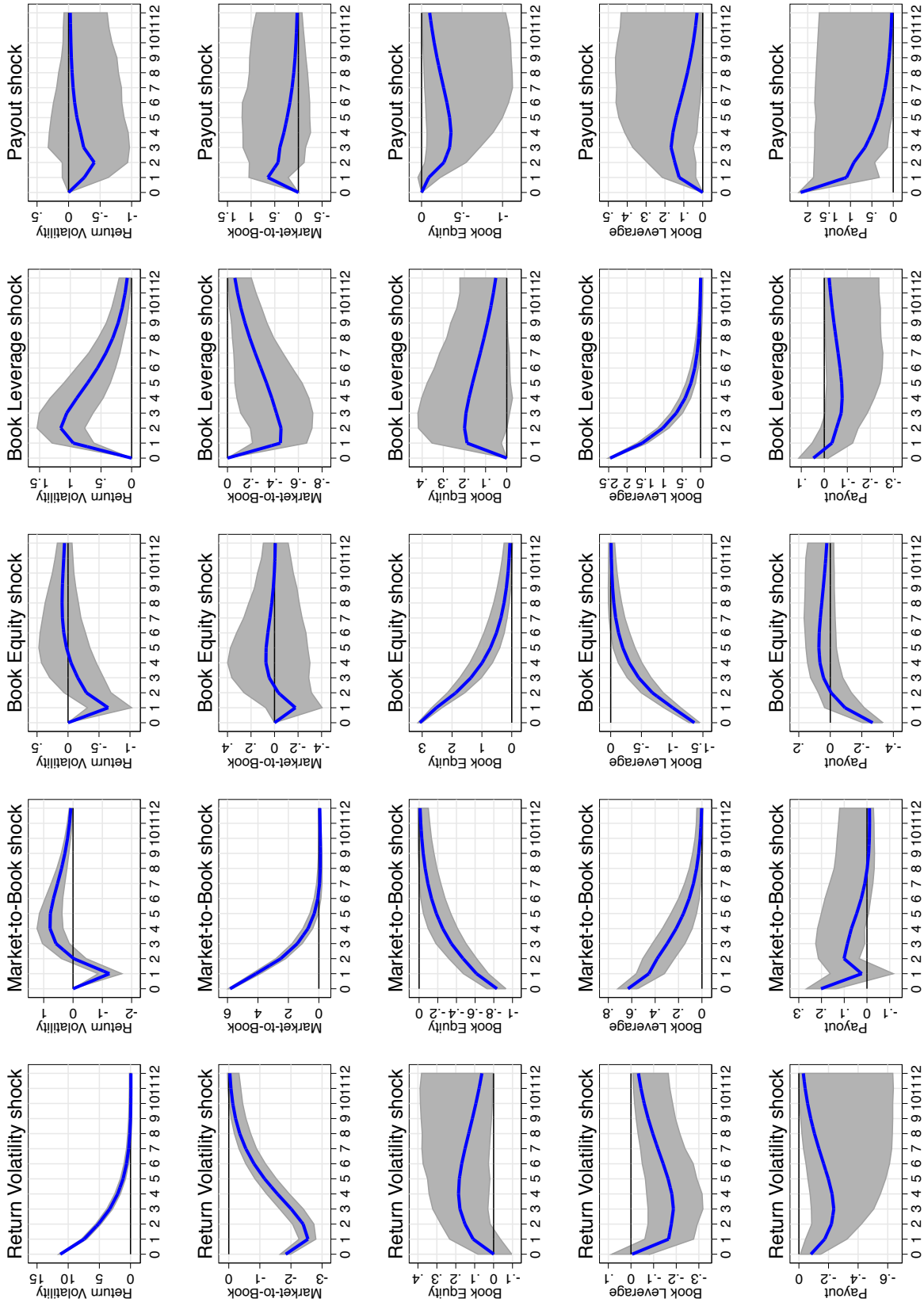
The left hand panel is the scatter chart of the growth of book equity and growth of total assets at quarterly frequency for broker-dealers. The right panel is the equivalent scatter for the commercial banks. Growth rates in log-differences; reported in percentage terms. The sample period is 1985:1 – 2014:1. Source: Compustat and CRSP.

Figure 7. Net Payout, Leverage, and Market-to-Book: Cross-Correlation



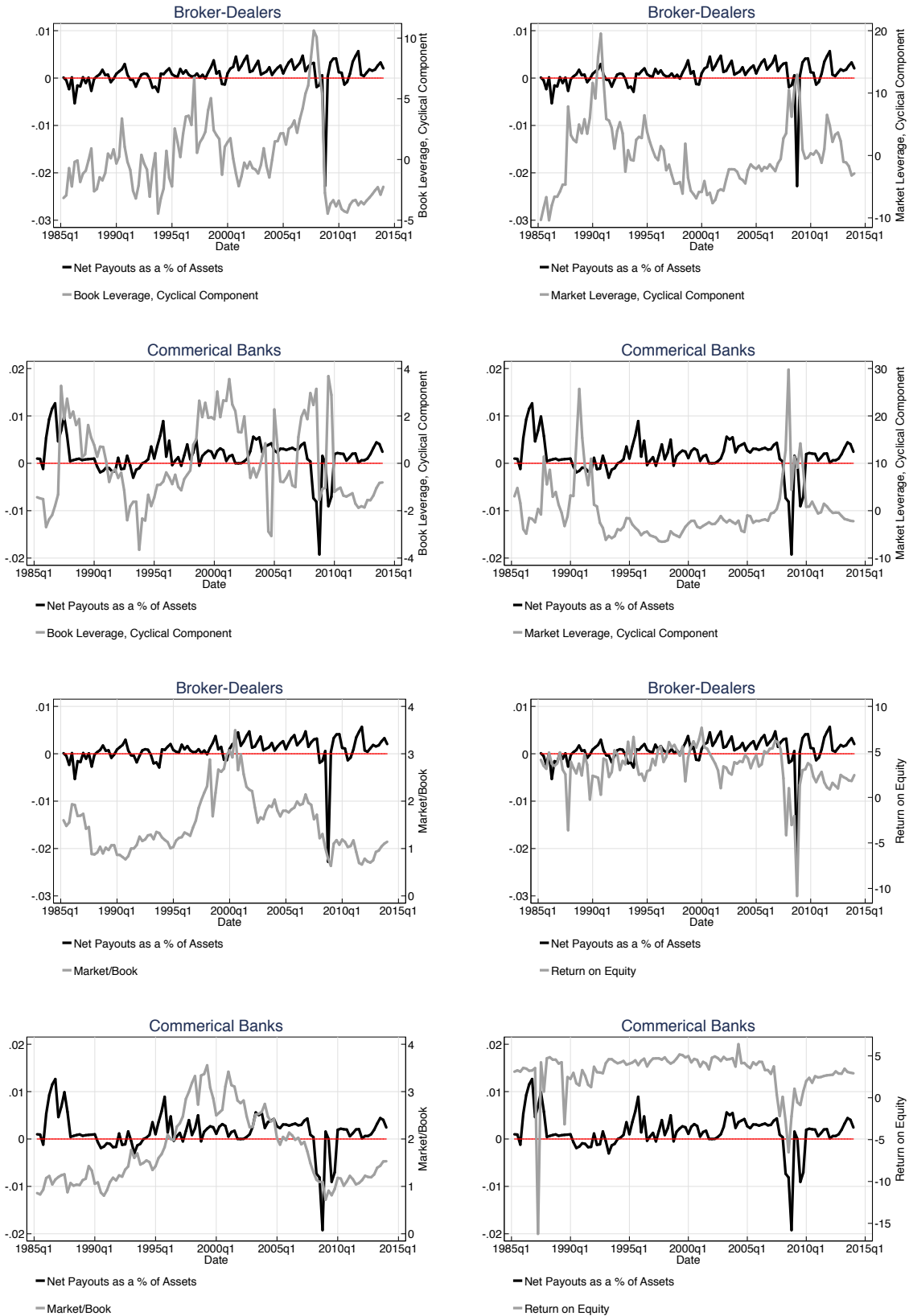
Filled in points indicate statistical significance at the 5% level. Net payouts are measured as total dividends plus total share repurchases minus total share issuance. Growth rates in log-differences; reported in percentage terms. The sample period is 1985:1 – 2014:1. Source: Compustat and CRSP.

Figure 8. Impulse Response Functions from the Panel Vector Autoregression



Estimated impulse response functions (in blue) from a panel vector autoregression (VAR) and the 5% confidence bands for a one standard deviation shock. Impulses responses reported in percentage differences relative to the baseline. Return volatility, market-to-book, book equity and book leverage are all in quarterly log growth terms; payout is net payout normalized by assets. Shocks are ordered according to the order of columns in the figure. The sample period is 1985:1 – 2014:1. Source: Compustat and CRSP.

Figure 9. Net Payout over Time



Deviations from a Hodrick-Prescott filtered trend and returns reported in percentage terms. The sample period is 1985:1 – 2014:1. Source: Compustat and CRSP.