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Liquidity and leverage ☆

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ABSTRACT

In a financial system in which balance sheets are continuously marked to market, asset price changes appear immediately as changes in net worth, and eliciting responses from financial intermediaries who adjust the size of their balance sheets. We document evidence that marked-to-market leverage is strongly procyclical. Such behavior has aggregate consequences. Changes in dealer repos – the primary margin of adjustment for the aggregate balance sheets of intermediaries – forecast changes in financial market risk as measured by the innovations in the Chicago Board Options Exchange Volatility Index VIX index. Aggregate liquidity can be seen as the rate of change of the aggregate balance sheet of the financial intermediaries.

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1. Introduction

In a financial system where balance sheets are continuously marked to market, changes in asset prices show up immediately on balance sheets, and have an instant impact on the net worth of all constituents of the financial system. The net worth of financial intermediaries are especially sensitive to fluctuations in asset prices given the highly leveraged nature of such intermediaries' balance sheets.

Our focus in this paper is on the reactions of the financial intermediaries to changes in their net worth, and the market-wide consequences of such reactions. If financial intermediaries were passive

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and did not adjust their balance sheets to changes in net worth, then leverage would fall when total assets rise. Change in leverage and change in balance sheet size would then be negatively related.

However, as we will see below, the evidence points to a strongly *positive* relationship between changes in leverage and changes in balance sheet size. Far from being passive, the evidence points to financial intermediaries adjusting their balance sheets actively, and doing so in such a way that leverage is high during booms and low during busts. That is, leverage is procyclical.

Procyclical leverage can be seen as a consequence of the active management of balance sheets by financial intermediaries who respond to changes in prices and measured risk. For financial intermediaries, their models of risk and economic capital dictate active management of their overall Value-at-Risk (VaR) through adjustments of their balance sheets.

From the point of view of each institution, decision rules that result in procyclical leverage are readily understandable. However, there are aggregate consequences of such behavior for the financial system as a whole that might not be taken into consideration by individual institutions. We exhibit evidence that procyclical leverage affects aggregate volatility and particularly the price of risk.

Our paper has two main objectives. Our first objective is to document the relationship between balance sheet size and leverage for security broker dealers – financial intermediaries that operate primarily through the capital markets, and which included the major Wall Street investment banks. We show that leverage is strongly procyclical for these institutions and show that the margin of adjustment on the balance sheet is through repos and reverse repos. The first version of our paper was written in June 2007, just prior to the eruption of the financial crisis of 2007–2009. Since then, the five major US investments banks that we analyze in the remainder of the paper have all left the broker dealer sector. Three of them – Bear Stearns, Lehman Brothers and Merrill Lynch were either taken over under distressed conditions or declared bankruptcy. The remaining two – Goldman Sachs and Morgan Stanley – converted to bank holding companies. Thus, in the short time period since the first version of this paper was written, the era of stand alone Wall Street investment banks has come to an end. Our paper represents a contemporaneous record of the last months of the once illustrious Wall Street investment banks.

Our second objective is to pursue the aggregate consequences of procyclical leverage and document evidence that expansions and contractions of balance sheets have asset pricing consequences through shifts in risk appetite. In particular, we show that changes in collateralized borrowing and lending on intermediary's balance sheet are significant forecasting variables for innovations in market-wide risk as measured by the VIX index of implied volatility in the stock market. We also decompose VIX innovations into changes of stock market volatility and changes of the difference between implied volatility and actual volatility (the volatility risk premium). We find that dealer balance sheet changes primarily forecast changes in the volatility risk premium, which has a natural interpretation as the price of risk.

Previous work has shown that innovations in market volatility are important cross-sectional pricing factors (see Ang et al. (2006), and Adrian and Rosenberg (2008)), and that the volatility risk premium forecasts future equity returns (Bollerslev and Zhou (2007)). Our finding that fluctuations of the balance sheets of broker dealers forecast volatility innovations shows that intermediary balance sheets matter for the pricing of risk. In this way, our empirical results provide some backing to recent theoretical work on liquidity and asset pricing. Gromb and Vayanos (2002) draw on the theme in Shleifer and Vishny (1997) on the importance of collateral constraints for leveraged traders. Brunnermeier and Pedersen (2009) coined the term "margin spiral" where increased margins and falling prices reinforce market distress. He and Krishnamurthy (2008) show how intermediary capital matters in a dynamic asset pricing model. Our empirical results provide some context for this literature.

Our findings also shed light on the concept of "liquidity" as used in common discourse about financial market conditions. In the financial press and other market commentary, asset price booms are sometimes attributed to "excess liquidity" in the financial system. Financial commentators are fond of using the associated metaphors, such as the financial markets being "awash with liquidity", or liquidity "sloshing around". However, the precise sense in which "liquidity" is being used in such contexts is often left unspecified.

Our empirical findings suggest that financial market liquidity can be understood as the rate of growth of aggregate balance sheets. In response to increases in prices on the asset side of intermedi-

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