VALUING TOXIC ASSETS:

AN ANALYSIS OF CDO EQUITY

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Abstract. How does the market value complex structured-credit securities? This issue is central to understanding the current financial crisis and identifying effective policy measures. We study this issue from a novel perspective by contrasting the valuation of CDO equity with that of bank stocks. This is possible because both CDO equity and bank stock represent levered first-loss residual claims on an underlying portfolio of debt. There are strong similarities in the two types of equity investments. Using an extensive data set of CDX index tranche prices, we find that the discount rates applied by the market to bank and CDO equity are very comparable. In addition, a single factor explains more than 64 percent of the variation in bank and CDO equity returns. Although banks are presumably active credit-portfolio managers, we find that bank alphas are significantly negative during the sample period and comparable in magnitude to those of more-passively-managed CDO equity. Both banks and CDO equity display significant sensitivity to "shadow banking" factors such as counterparty credit risk, the availability of collateralized financing for debt securities, and the liquidity of the derivatives market. A key implication is that we may be able to value "toxic" assets using readily-available stock market information.

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1. INTRODUCTION

Much of the innovation in financial markets during the past decade has focused on the creation of structured or synthetic investment vehicles that parallel the ownership of actual financial assets and securities. Examples include collateralized debt obligations (CDOs), collateralized loan obligations (CLOs), structured investment vehicles (SIVs), and conduits that synthesize highly-rated debt instruments from portfolios of high-yield bonds or subprime loans, collateralized fund obligations (CFOs) that create leveraged hedge-fund-like structures, and total rate of return swaps (TRORS) that parallel the ownership of stock without the use of the balance sheet. This sector of the financial markets is sometimes termed the "shadow-banking" system because these structures are typically complex, opaque, and largely unregulated.

Structured or securitized credit, in particular, has played a prominent role in the current crisis in the international financial markets. Beginning with the meltdown in the subprime home-equity asset-backed CDO and SIV markets in late 2007, the crisis quickly spread to other sectors such as commercial mortgage-backed securities, securitized student loans and credit-card receivables, auto leasing and financing, asset-backed commercial paper, collateralized short-term repo financing by investment dealers and hedge funds, auction-rate securities, and short-term municipal finance markets.

Much of the debate about the role of securitized credit in the current crisis focuses on the issue of how these structured or synthetic types of securities are valued in the financial markets. For example, many argue that the complexity and lack of transparency of these instruments allowed them to be issued as highly-rated investment-grade securities at premium valuations.[1] On the other hand, a key premise behind many of the recent troubled-asset programs implemented by the Treasury and the Federal Reserve was that these "toxic" securitized-credit investments were being discounted in the market at illiquid fire-sale prices far below their intrinsic worth.[2] Thus, securitized-credit investments are viewed as having

[1]From an October 31, 2008 speech by Federal Reserve Board Chairman Ben S. Bernanke, "As subsequent events demonstrated, however, the boom in subprime mortgage lending was only a part of a much broader credit boom characterized by an underpricing of risk, excessive leverage, and the creation of complex and opaque financial instruments that proved fragile under stress."

[2]From a September 19, 2008 speech by Treasury Secretary Henry M. Paulson, Jr., "These troubled loans are now parked, or frozen, on the balance sheets of banks and other financial institutions, preventing them from financing productive loans. The inability to determine their worth has fostered uncertainty about mortgage assets,

alternated between being overvalued and undervalued by the financial markets.

In an effort to shed light on these important issues, this paper studies the valuation of CDO equity in the financial markets. We focus on CDO equity because of the unique role that it plays in the securitized-credit markets since it represents the most-junior first-loss position in a CDO capital structure. Thus, CDO equity is the most "toxic" of all CDO tranches, often trading at prices requiring a payment of \$95 or more up front to buy credit protection for a tranche with a notional amount of \$100.

From a research perspective, studying the valuation of CDO equity is interesting for a number of reasons. First, there is a direct parallel between CDO equity and bank stock. The key insight here is that the balance sheet of a typical CDO closely resembles that of a commercial bank. Specifically, the asset side of both balance sheets consists of a portfolio of loans, while the liability side consists of senior, regular, and junior debt, along with a residual equity claim which is first in line to absorb credit losses. Thus, comparing the pricing of CDO equity to that of bank stock can provide insight about how the market values structured credit. Second, by viewing a CDO structure as a passively-managed "synthetic" bank, it is natural to contrast CDO equity return performance with that of actively-managed commercial banks to identify the value that the active management of their credit portfolios actually adds. Third, since CDO equity is a creation of the shadow-banking system, we can examine how the unique risks present in this sector, such as counterparty credit risk and the availability of leveraged financing, affect the pricing of derivative securities.

The empirical analysis is based on an extensive sample of traded tranche prices on both the CDX investment grade (IG) and high yield (HY) indexes for the five-year period from January 2004 to February 2009. We compare the valuation and returns of CDO equity constructed from these tranches with those for several portfolios formed from the commercial banks in the Russell 1000 index.

Three important sets of results emerge from this analysis. First, we find that the market tends to value bank stock and CDO equity similarly. In particular, we estimate the discount rates used by the market in valuing banks' dividend cash flows and find that they parallel those implicit in the valuation of CDO equity. Bank and CDO equity returns display very similar properties during the sample period and appear to be driven by common factors. In fact, a principal components analysis shows that more than 64 percent of the variation in bank and CDO equity returns is due to a common first factor.

Second, we risk adjust CDO equity and bank stock returns via the Fama-

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and even about the financial condition of the institutions that own them."

French three-factor model and find that the two types of equity have similar risk characteristics. Furthermore, the alphas generated by CDO equity are comparable in magnitude to those from bank stocks. These results are surprising since, as discussed above, banks can be viewed as active credit portfolio managers while CDO structures are essentially passively-managed portfolios. Thus, there is little evidence that commercial banks were able to add incremental value on a risk-adjusted basis. In fact, the significant negative alpha generated by the largest banks in the sample is equivalent to their shareholders absorbing a management fee of 157.3 basis points per year on the banks' total assets.

Third, complex structured securities may also be subject to additional types of systemic risk inherent in the shadow banking system such as counterparty credit risk, shifts in the availability of collateralized financing for leveraged positions, and liquidity/supply shocks in the derivatives market. Accordingly, we examine the sensitivity of risk-adjusted bank and CDO equity returns to measures of these systematic factors. The results indicate that both CDO equity and bank equity are significantly affected by the shadow-banking factors. These counterparty credit risk, financing availability, and liquidity measures, however, explain a much larger fraction of the variation in bank returns than they do for CDO equity returns.

These results have a number of important implications. For example, the similarities in the pricing of bank and CDO equity suggest we may be able to value a wide variety of illiquid toxic assets using stock valuation information. In addition, these results provide some surprising new perspectives on the role and valued added by traditional financial institutions relative to the shadow-banking system. Finally, our results imply that policies targeted toward the recapitalization of the banking sector via the purchase of troubled assets may have economic costs similar to the direct injection of equity capital into banks.

This paper contributes to the rapidly growing literature on securitized credit. Recent papers in this area include Duffie and Gârleanu (2001), Hull and White (2004), Giesecke (2004), DeMarzo (2005), Berd, Engle, and Voronov (2007), Longstaff and Rajan (2008), and Bhansali, Gingrich, and Longstaff (2008) who present models for valuing CDO tranches. Brennan, Hein, and Poon (2008), Benmelech and Dlugosz (2008), and Westerfield (2008) consider the relation between credit ratings and the CDO market. Franke and Krahnen (2005), Krahnen and Wilde (2006), and Longstaff (2008) consider the effects of risk transfer between securitized-credit markets and other financial institutions and markets. In an important recent paper, Coval, Jurek, and Stafford (2008a) model the prices of senior CDO tranches in terms of deep out-of-the-money stock index put options and conclude that these senior tranches are overvalued relative to their economic risks. This paper both complements Coval, Jurek, and Stafford and extends the literature by linking the valuation of structured-credit equity tranches to the values of commercial bank stocks.

The remainder of the paper is organized as follows. Section 2 provides an introduction to CDO equity and the securitized-credit market. Section 3 describes the data. Section 4 estimates the discount rates applied to bank stock and explores their implications for CDO equity discount rates. Section 5 examines the returns on bank stock and CDO equity. Section 6 studies the properties of these returns on a risk-adjusted basis. Section 7 summarizes the results and presents concluding remarks.

2. CDO EQUITY

In this section, we provide a simple introduction to CDO equity. First, we briefly describe the securitized-credit market, focusing specifically on CDO structures and CDO equity. We then discuss the widely-used CDX indexes and the tranches traded in the market based on the CDX indexes. Finally, we consider the parallels between CDO equity and bank stock.

2.1 Collateralized Debt Obligations

One of the most-important types of securitized-credit structures in the financial markets during the past decade has been the collateralized debt or loan obligation. Until the subprime crisis of 2007, CDO issuance exceeded $100 billion per year. Assets that have been securitized by CDOs included investment-grade bonds, high-yield bonds, emerging-market debt, leveraged loans, middle-market loans, trust preferred securities, credit-card receivables, prime and subprime home equity mortgages, asset-backed securities, commercial mortgages, and even previously issued CDO tranches.[3]

To illustrate how a CDO works, we will consider a simple example based on a diversified portfolio of corporate loans. Imagine that a bank has a portfolio of 100 loans on its balance sheet that it wishes to securitize. Each loan has a face amount of $1 million, is worth par, and has a ten-year maturity. In addition, each loan is to a different corporate borrower. The total value of the loan portfolio is $100 million. To sell the portfolio, the bank could sell the entire portfolio to a single buyer as a whole, or sell the portfolio in tranches as a CDO to multiple buyers.[4]

[3]For more details about the structure of the CDO market, see Duffie and Gârleanu (2001), Rajan, McDermott, and Roy (2007), and Coval, Jurek, and Stafford (2008b).

[4]This example parallels Longstaff and Rajan (2008). Also see the illustration of a subprime home-equity asset-backed CDO structure in Longstaff (2008).

To sell the portfolio as a CDO, the bank might structure the transaction in the following way. First, the bank would create an equity tranche with a total notional amount of, say, ten percent of the total value of the portfolio ($10 million). By definition, this tranche absorbs the first ten percent of any defaults on the entire portfolio. Thus, this equity tranche is said to have a thickness of ten percent. In exchange for bearing this first-loss credit risk, the tranche will receive a coupon rate of, say, 500 basis points above Treasuries. If there are no defaults, the buyer of the equity tranche earns a high coupon rate for ten years and then receives back his $10 million notional investment. If, say, four of the firms default (and assuming that there is zero recovery in the event of default), the equity tranche absorbs the $4 million loss to the portfolio and the notional amount of the equity tranche is reduced to $6 million. Going forward, the equity tranche investor receives the 500 basis point coupon spread as before, only now on the $6 million notional. If six or more additional firms default, the equity tranche absorbs additional losses of $6 million, the notional amount of the equity tranche investor's position is completely wiped out, and the investor receives neither coupons nor principal going forward. Because a 10-percent loss in the portfolio translates into a 100-percent loss for the equity tranche investor, the equity tranche investor is leveraged 10 to 1.

Now imagine that the bank also creates a junior mezzanine tranche with a total notional amount of five percent of the total value of the portfolio ($5 million). This tranche absorbs up to five percent of the total losses on the entire portfolio after the equity tranche has absorbed the first ten percent of losses. For this reason, this tranche would be designated the 10−15 percent tranche. In exchange for absorbing these losses, this tranche may receive a coupon rate of, say, 200 basis points above Treasuries. If total credit losses are less than ten percent during the ten-year horizon of the portfolio, then the 10−15 percent investor earns the coupon rate for ten years and then receives back his $5 million notional investment. If total credit losses are greater than or equal to 15 percent of the portfolio, the total notional amount for the 10−15 percent investor is wiped out. The bank follows a similar process in creating additional mezzanine, senior mezzanine, and even super-senior tranches. A set of tranches might include the 0−10 percent equity tranche, and 10−15, 15−20, 20−25, 25−30, and 30−100 percent tranches. The initial levels 10, 15, 20, 25, and 30 percent at which losses begin to accrue for the respective tranches are called attachment points or subordination levels. Note that the total notional valuation of all the tranches equals the $100 million notional of the original portfolio of corporate bonds.

In this example, the CDO is based on a portfolio of debt securities. This type of a CDO is referred to as a cash CDO. To take advantage of the wide availability of credit derivatives, however, credit markets have recently introduced CDO structures known as synthetic CDOs. A synthetic CDO is economically similar to a cash CDO, but rather than there being an actual portfolio of corporate debt on which tranches are based, the underlying portfolio is a basket of credit default swap (CDS) contracts. If there is a default on the underlying reference debt security (which can be either a bond or a loan) during that period, however, then the buyer of protection is able to put the defaulted bond or loan to the protection seller and receive par (the full face value of the loan or the bond). Thus, for the purposes of this paper, the two types of CDOs are economically equivalent.

2.2 CDO Equity Tranches

By absorbing the first credit losses on the underlying portfolio, the equity tranche has a key role in the CDO capital structure as the most-junior or residual claim on the underlying credit portfolio. Thus, despite being typically viewed as a fixed-income security, the designation of this tranche as equity is actually a very apt description in the usual stock-market sense.

Even though the equity tranche in the example above has a thickness of ten percent, it is important to recognize that equity tranches with different thicknesses can be constructed by combining the equity tranche with tranches that are more senior in the capital structure. For example, an investor could construct a $0-15$ percent equity tranche by buying both the $0-10$ percent equity tranche and the $10-15$ percent junior mezzanine tranche. This is because the investor would absorb the first 15 percent of credit losses (the first 10 percent via the equity tranche, and the next 5 percent via the junior mezzanine tranche). Similarly, the investor could construct a $0-20$ percent equity tranche by buying the $0-10$, $10-15$, and $15-20$ percent tranches, and so forth.

2.3 The CDX Index and CDX Index Tranches

In this study, we focus on CDO equity with cash flows tied to the most liquid U.S. corporate credit derivative indexes, the CDX North American Investment Grade (CDX IG) and High Yield (CDX HY) Indexes. These indexes are managed by Dow Jones and are based on liquid baskets of CDS contracts for 125 U.S firms with investment-grade debt for the CDX IG index, and for 100 U.S. firms with high-yield debt for the CDX HY index. The CDX indexes themselves trade like a single-name CDS contract, with a defined premium based on the equally-weighted basket of its constituents.

The individual firms included in the CDX basket are updated and revised ("rolled") every six months in March and September, with a few downgraded and illiquid names being dropped and new ones taking their places. CDX indexes are numbered sequentially. While there is considerable overlap between successive CDX indexes, there can occasionally be minor changes across index rolls. For example, the CDX IG 4 index (beginning in March 2005) includes Ford and General Motors while the CDX IG 5 index (beginning in September 2005) does not since the debt for these firms dropped below investment grade in May 2005.

Index CDO tranches have also been issued, each tied to a specific CDX index. For the CDX IG indexes, the attachment points of these CDO tranches are standardized at 3, 7, 10, 15, and 30 percent. For the CDX HY indexes, the attachment points of these CDO tranches are standardized at 10, 15, 25, and 35 percent. From these tranches, we can construct 0−3, 0−7, 0−10, 0−15, and 0−30 percent CDO equity tranches for the CDX IG index, and 0−10, 0−15, 0−25, and 0−35 percent CDO equity tranches for the CDX HY index. We will designate these tranches by IG_3, IG_7, IG_{10}, IG_{15}, IG_{30}, HY_{10}, HY_{15}, HY_{25}, and HY_{35}.

2.4 Synthetic Bank Equity

At an intuitive level, the parallels between CDO equity and bank stock are easily understood. Both pay a stream of cash flows over time, but also absorb the first losses on a leveraged credit portfolio. In the case of CDX equity, the underlying portfolio consists of corporate debt. In the case of bank stock, the underlying portfolio also includes loans to corporations (but may also include other types of loans). From an accounting perspective, the balance sheet for a CDO structure is essentially identical to that of a commercial bank.

This intuition can be made a little more formal by considering a very stylized bank with total assets of \$1 and a book value of equity of L. Imagine that in steady state, the bank pays a gross dividend of ρL each period. To maintain that level of dividends, however, the bank must replenish its capital whenever it experiences credit losses of $x_t \leq L$. If we view the required injection of capital as a "negative dividend," then the bank's net dividend is simply $\rho L - x_t$ each period. In the event that $x_t > L$ at some point in time, however, the book value of equity becomes negative and the bank is liquidated.

The stream of cash flows from this stylized bank can be replicated by combining a par Treasury bond with notional amount L with a one-period synthetic equity tranche of thickness L and spread s on a credit portfolio essentially identical to that of the bank.[5] In particular, this portfolio generates a cash flow of $(c+s)L - x_t$ over time, where c is the par coupon rate on the Treasury bond. A simple arbitrage argument shows that $c + s$ must equal ρ. This one-period portfolio is continually rolled over until $x_t > L$. Thus, this simple portfolio of Treasury bonds and CDO equity can be viewed as creating a "synthetic" type of bank equity.

This stylized example is admittedly very simplistic and is intended only to

[5]In this stylized one-period example, the premium leg of the synthetic equity tranche is assumed to pay a fixed spread on the original notional amount of the tranche at the end of the period.

introduce the notion of synthetic bank equity and to illustrate that the parallels between bank stock and CDO equity are more than purely superficial. In the Appendix, we present a more-extensive example of a stylized bank in which the bank's dividends grow randomly over time, but can be replicated by a dynamically-managed portfolio of CDO equity and Treasury bonds.

3. THE DATA

In this section, we first describe the CDX tranche data used in the study. We then provide some descriptive statistics for the composition of the CDX IG and HY indexes. Finally, we describe the three bank return indexes that will be used in the empirical analysis later in the paper.

3.1 The CDO Data

The CDO data include daily closing values for the 0−3, 3−7, 7−10, 10−15, and 15−30 percent tranches on the ten-year CDX IG index for the period January 2, 2004 to February 20, 2009. As discussed earlier, the underlying basket of 125 firms in the index is revised every March and September. Thus, the data are for the 11 individual indexes denoted CDX IG i, $i = 1, 2, 3, 4, 5, 6, 7, 8, 9,$ 10, and 11. In addition, we have daily closing values for the 0−10, 10−15, 15−25, and 25−35 percent tranches on the five-year CDX HY index for the period from December 29, 2004 to February 20, 2009. These data are for the CDX HY i, $i = 3, 4, 5, 6, 7, 8, 9, 10,$ and 11 indexes.

The market convention is to quote CDX index equity tranches in terms of points up front. Specifically, the CDX IG 0−3 percent and the CDX HY 0−10 and 10−15 percent tranches are quoted in terms of points up front. To illustrate, the price of the CDX HY 0−10 percent equity tranche was 98.5 points up front on February 20, 2009. This means that a seller of protection on this tranche would be paid 98.5 at time zero in exchange for bearing the first 10 percent of credit losses over the next five years (up to a maximum of 100) on a credit portfolio with notional amount of 1000. Thus, given the time value of money, this price implies not only that the 0−10 percent tranche is expected to be essentially wiped out, but that the losses will occur in the very near term.

To be consistent throughout, we will express all of the prices of CDO equity tranches in terms of points up front. For the equity tranches that are not already quoted in terms of points up front, this requires a simple conversion from the prices quoted in terms of running spreads on the notional amount.[6]

[6]To do this, we assume that firms default on the basis of the realization of a Poisson process of intensity λ, and that when a default occurs, the recovery rate is 50

Table 1 provides summary statistics for the points-up-front prices of the CDO equity tranches. As shown, the required points up front can be very substantial, particularly for the thinner equity tranches. The average number of required points up front is nearly 80 percent of the notional amount for the IG_3 tranche, and declines to 18.5 percent of the notional amount for the IG_{30} tranche. The average number of required points up front is roughly 83 percent of the notional amount for the HY_{10} HY tranche, and declines to 37 percent of the notional amount for the HY_{35} tranche. Interestingly, the volatilities of the tranche prices are not necessarily monotonic with leverage or the thickness of the tranche. Specifically, the most volatile IG tranche is the IG_{10}, and the HY_{25} and HY_{35} tranches are about equally volatile. Intuitively, the reason for this is that the number of points up front required for the thinner or more-leveraged tranches is so high, that there is much less percentage variation in their price over time; the credit gamma for the deep in-the-money or deep out-of-the-money tranches is not as high as for the at-the-money tranches.[7] Figure 1 plots the time series of points-up-front prices for the equity tranches. As illustrated, these prices have increased substantially during the past year as the financial crisis has unfolded.

3.2 The Composition of the CDX Index

To provide some perspective on the CDX indexes, Table 2 reports summary statistics for the composition of the CDX indexes. The first part of the table provides summary statistics for the CDX IG index; the second part of the table provides summary statistics for the CDX HY index. For each index, we report the percentage composition of the index components by industry based on their Fama-French 12-industry classifications, the percentage composition by Standard and Poor's credit rating (as of the date of formation of each index), and the percentage of each index that turns over relative to the previous index. Recall that since the CDX indexes are reconstituted every six months, a firm that appears in CDX $n-1$ may not appear in CDX n if the firm defaults, if its credit rating drops below investment grade, or even if the liquidity of CDS contracts of that firm declines. For example, Ford and General Motors both appeared in CDX IG 1 through 3, but were dropped from CDX IG 4 and later indexes because their debt was downgraded below investment grade in May of 2005 (see Acharya, Schaefer, and Zhang (2008)). Summary statistics reported in Table 2 are based on the composition of each CDX index at the time the respective indexes are constructed.

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percent. For each CDO equity tranche and each date in the sample period, we solve for the value of λ that sets the present value of payments to be received equal to the present value of payments to be made. Once λ is determined, the price in terms of points up front is given by a simple calculation.

[7] See Longstaff and Rajan (2008) for a discussion of the relation between CDO tranches and options on the realized losses on the underlying credit portfolio.

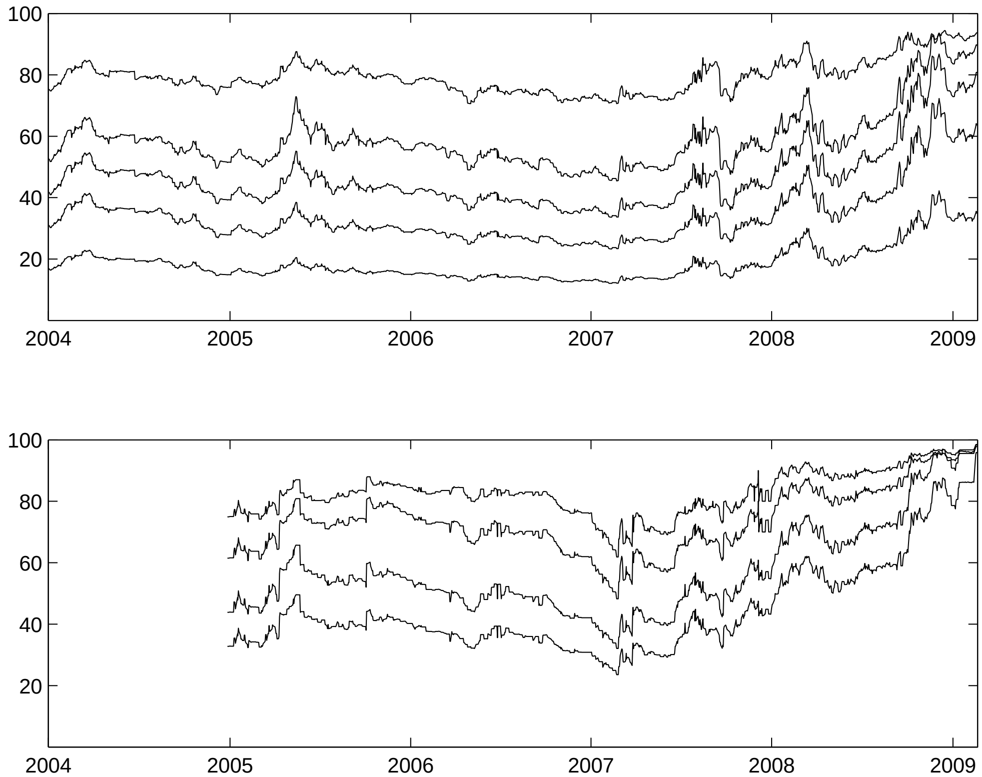

Figure 1. Points-up-Front Prices for CDX IG and HY Equity Tranches. The upper panel plots the points-up-front prices (as a fraction of par) for the IG_3, IG_7, IG_{10}, IG_{15}, and IG_{30} equity tranches (in order from largest to smallest). The lower panel plots the points-up-front prices (as a fraction of par) for the HY_{10}, HY_{15}, HY_{25}, and HY_{35} equity tranches (in order from smallest to largest).

As shown, the CDX IG portfolio is broadly diversified across most major industries. The finance industry represents roughly 20 percent of the index, while the manufacturing, wholesale and retail, and other industries each represent about 10 to 14 percent of the index. Table 2 also shows that while the CDX index consists of investment grade firms, the majority of the firms in the index are rated BBB. Furthermore, less than ten percent of the 125 firms in the CDX index are rated AAA and AA. Table 2 also shows that there is some turnover in the index each period. Typically, however, there are fewer than six to eight firms that turn over each time the index is reconstituted.

The industry composition of the CDX HY portfolio is also broadly diversified. The primary difference is that this index includes fewer financial firms than the CDX IG index. Since the index is based on average credit ratings across ratings agencies, there are actually a number of BBB-rated firms (as rated by Standard and Poor's) in the indexes. In general, however, the majority of firms in the index are rated BB by Standard and Poor's. The CDX HY index also experiences some turnover each time the index is reconstituted.

3.3 The Bank Equity Data

It is important to acknowledge that it is probably not possible to obtain a sample of banks with asset portfolios that *exactly* match the CDX composition of the CDX portfolio. Our approach, therefore, will be to focus on sets of banks with asset compositions and loan portfolios that are most likely to approximate the CDX index portfolios. Given that the firms in the CDX IG and HY indexes tend to be among the largest in the financial markets, it seems appropriate to focus specifically on banks that lend primarily to large firms.

Specifically, we focus on the firms in the Russell 1000 index that are designated as commercial banks based on their two-digit SIC classifications as depository institutions. There are a total of 89 banks that were included in the Russell 1000 at some point during the sample period. From these banks, we construct three bank indexes based on the average asset size of the banks while they are in the Russell 1000. The Bank_1 index consists of the banks with an average asset size in excess of \$100 billion. The Bank_2 index consists of the banks with an average asset size between \$20 billion and \$100 billion. The Bank_3 index consists of the banks with an average asset size of less than \$20 billion. Table 3 reports summary statistics for the three bank indexes. The data for this table are obtained from the Bloomberg system.

4. IMPLIED LOSS RATES

In studying the valuation of CDO equity, our first task is to compare the discount rate applied to CDO equity cash flows with the discount rate applied to bank dividend streams. This is difficult to do directly, of course, since the two discount rates are not directly observable. In light of this, our approach will be to solve for the implied CDO loss rate that would set the two discount rates equal, and then evaluate how the implied loss rate compares with historical loss rates. This indirect approach indicates that CDO equity discount rates tend to be very similar or slightly lower than bank discount rates.

To define terms, let P be the current or time-zero price of a security, and let CF_t denote its risky cash flow at time t. Standard textbook present-value theory implies that the price of the security can be represented as the sum of the present values of its expected cash flows,

$$P = \sum_{t=1}^{\infty} \frac{E[\ CF_t\ ]}{(1+R)^t}, \tag{1}$$

where R is the discount rate, and the expectations are taken with respect to the actual (not risk-neutral) probability measure.

4.1 Bank Stock

In general, measuring the *ex ante* expected return or discount rate R of a security is difficult because expected cash flows are not readily observable. In special cases, however, it may be possible to estimate these expected cash flows. One such situation is when the well-known Gordon Growth model can be applied to stock valuation. Specifically, if the expected dividend to be paid by a share of stock grows at a constant rate of g, then Equation (1) implies

$$P = \sum_{t=1}^{\infty} \frac{D(1+g)^{t-1}}{(1+R)^t} = \frac{D}{R-g}, \tag{2}$$

where D is the next dividend for the stock. Rearranging this expression allows us to represent the discount rate of the stock as $R = d + g$, where d is the dividend yield of the stock.

To keep things simple, we will adopt this approach to estimating the discount rate for bank stock indexes. As the estimate of the time series of dividend yields for a bank, we use the dividend yields reported in the Bloomberg system. The dividend yield is defined by Bloomberg as the most-recently-announced gross dividend, annualized based on the dividend frequency, divided by the current market price for the bank's stock (the Bloomberg dividend indicated yield). The dividend growth rate is the estimated long-term dividend per share growth rate as reported by IBES. In cases where analysts forecasts for dividend growth are not available, earnings per share forecasts are used. Table 3 reports the average dividend yield and dividend growth rate for the three indexes. Figure 2 plots the times series of the average discount rate (taken over all three indexes).

4.2 CDO Equity

Because CDO equity is a fixed income instrument, it is straightforward to calculate its internal rate of return (IRR) or yield to maturity. It is important to observe, however, that an IRR is not the same as a discount rate. Intuitively, this is because the IRR is based on *promised* cash flows while the discount rate is based on *expected* cash flows. Thus, when expected credit losses are greater than zero, the discount rate will be less than the IRR.

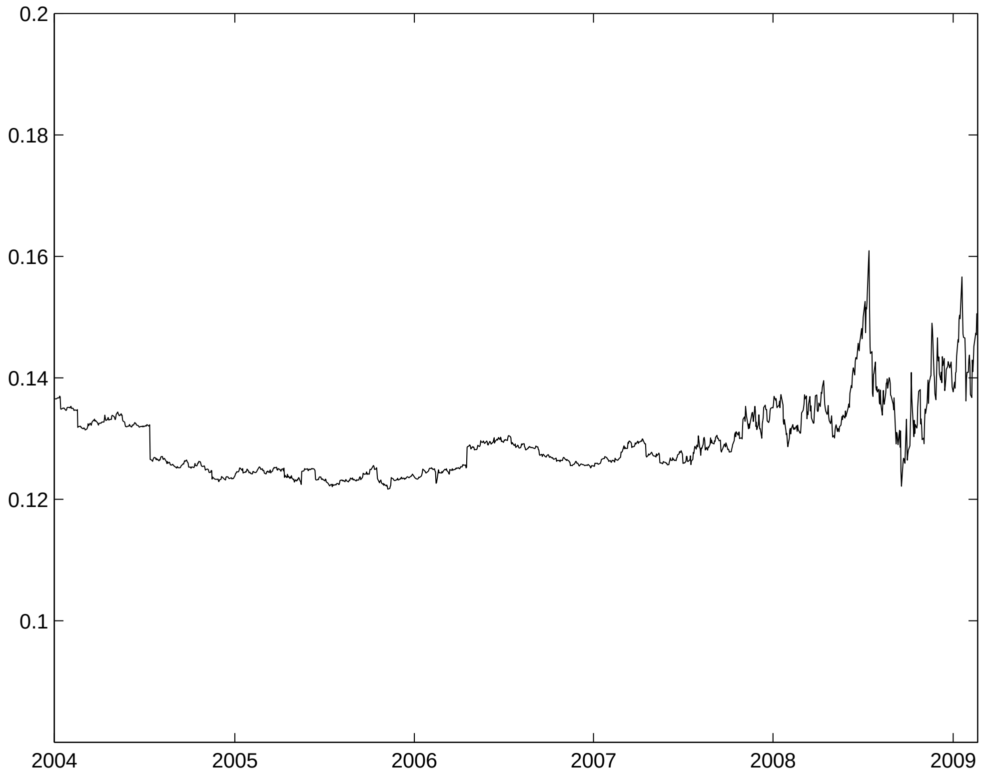

Figure 2. Average Discount Rate for Bank Equity. This graph plots the average discount rate for the banks in the Russell 1000 index.

Since the synthetic CDX tranches are structured as swaps, their initial value is zero. Thus, for computing returns and studying their valuation, it will be more convenient to translate them into their cash (funded) equivalents. To illustrate how this is done, consider the case where an equity tranche has thickness of L and maturity T. We invest L in a riskless floating-rate note with the same maturity and paying coupon r_t. In exchange for bearing the first L of credit losses, the portfolio receives pL points up front. Thus, the net investment in the portfolio is $(1-p)L$. As losses of x_t are realized over time, they are covered by liquidating the amount x_t of the floating-rate notes until the notional amount is reduced to zero. As the notional is reduced, the amount of coupon income from the floating-rate note is reduced accordingly. This strategy maps the synthetic CDX equity tranches into the much more intuitive equivalent of a cash CDO with an initial notional amount L and price $(1-p)L$, and which pays a coupon rate of r_t on its remaining notional balance. We will adopt this simple pricing convention throughout the remainder of the paper.

If the expected credit losses for CDO equity were observable, then the expected cash flows $E[\,CF_t\,]$ would be given by taking the promised cash flows and subtracting the expected credit losses. The discount rate could then be determined by solving for the R in Equation (1) that sets the present value of the expected cash flows equal to the initial price of the CDO equity tranche. Rather than doing this, however, our approach will be to solve the inverse problem. Specifically, we will set R equal to the value estimated for the bank index, and then invert Equation (1) for the expected losses for the tranche.

In doing this, we assume that the percentage of losses y_t on the underlying CDX portfolio follows a simple lognormal process

$$d\,y = \sigma \;\; y\,dZ, \tag{3}$$

where the initial value of y is to be determined and where $\sigma = 0.20$.[8] For a given initial value of y, we estimate the expected cash flows from the CDO equity tranche by simulating 10,000 paths of the loss process and then taking the average value of the loss process over all paths. This simulation approach is necessary since the cash flows from the synthetic equity portfolio are not linear in the losses of the underlying portfolio. This follows from the fact that the losses on the tranches can be modeled in terms of options on the losses of the underlying portfolio.[9] From these expected cash flows, we use Equation (1) to solve for the discount rate associated with the synthetic portfolio. After discounting the expected cash flows at the bank equity discount rate, we compare the resulting price for the CDO equity tranche with its actual price, and then iterate over initial values of y until convergence is achieved.[10] This process is repeated for each date during the sample period.

4.3 Estimated Loss Rates

To keep things simple, we will base our results on a single equally-weighted bank index formed from all of the banks in the three bank indexes described earlier. The average leverage ratio for the banks in this composite index is 0.0935. Accordingly,

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[8]The value of 0.20 for σ is motivated based on the annual absolute changes in the default rates for investment grade bonds over the 1920-2007 period (reported in *Moody's Corporate Default and Recovery Rates, 1920-2007*, February 2008.) divided by the average default rate. We observe that using other values for σ resulted in very similar estimates of the loss rate.

[9]See Longstaff and Rajan (2008) for a discussion of the economics of CDO tranches.

[10]For convenience, we also make the assumption that the riskless bond included in the funded CDO equity strategy pays the par Treasury coupon rate corresponding to the horizon of the CDO equity tranche.

we will solve for the implied loss rates for the IG_{10} and HY_{10} tranches since these are the most comparable in terms of their implicit leverage.

Table 4 reports summary statistics for the estimated loss rates. Figure 3 plots the time series of estimated loss rates. As shown, the average implied loss rate for IG equity is only about 2 basis points per year during the sample period. This number is very similar to the historical realized loss rate for a portfolio of bonds with similar credit ratings to those included in the CDX IG portfolio. Specifically, the historical one-year loss rates on corporate bonds reported by Moody's for the 1982-2007 period are percent 0.000 for Aaa-, and Aa-rated bonds, 0.012 percent for A-rated bonds, 0.103 percent for Baa-rated bonds, 0.677 percent for Ba-rated bonds, 2.908 percent for B-rated bonds, and 11.145 percent for Caa- to C-rated bonds.[11] Applying these loss ratios to the distribution of CDX IG index credit ratings in Table 2 implies that an expected one-year loss rate for the portfolio would be on the order of six basis points per year. Thus, the implied loss ratio is only slightly less than the historical one-year loss rate; the difference between the two is insignificant once the serial correlation of the implied losses is taken into account.

Similarly, Table 4 shows that the average loss rate for HY equity is about 171 basis points per year during the sample period. Again, applying the historical loss rates to the distribution of credit ratings for the CDX HY index reported in Table 2 implies an expected one-year loss rate for the portfolio of roughly 170 to 195 basis points. These two loss rates are statistically and economically indistinguishable.

Taken together, these results imply that the assumption that CDO equity discount rates are equal to bank discount rates leads to implied loss rates that are very consistent with the historical evidence. These results provide indirect support for the hypothesis that the market values bank equity in manner similar to CDO equity with comparable leverage ratios. It is important, however, to raise the caveat that these results are based on a comparison of implied loss rates to historical one-year loss rates. In actuality, historical multi-year loss rates tend to be somewhat higher than historical one-year loss rates. Thus, it probably more accurate to say that the results suggest that CDO equity discount rates are equal to, or slightly less than, bank discount rates.

5. CDO EQUITY RETURNS

In this section, we compare the properties of CDO equity returns and contrast them with those for the three bank indexes. Specifically, we focus on weekly returns

[11]These values are from Exhibit 11 of Moody's Investor Services *Corporate Default and Recovery Rates, 1920-2007*, February 2008.

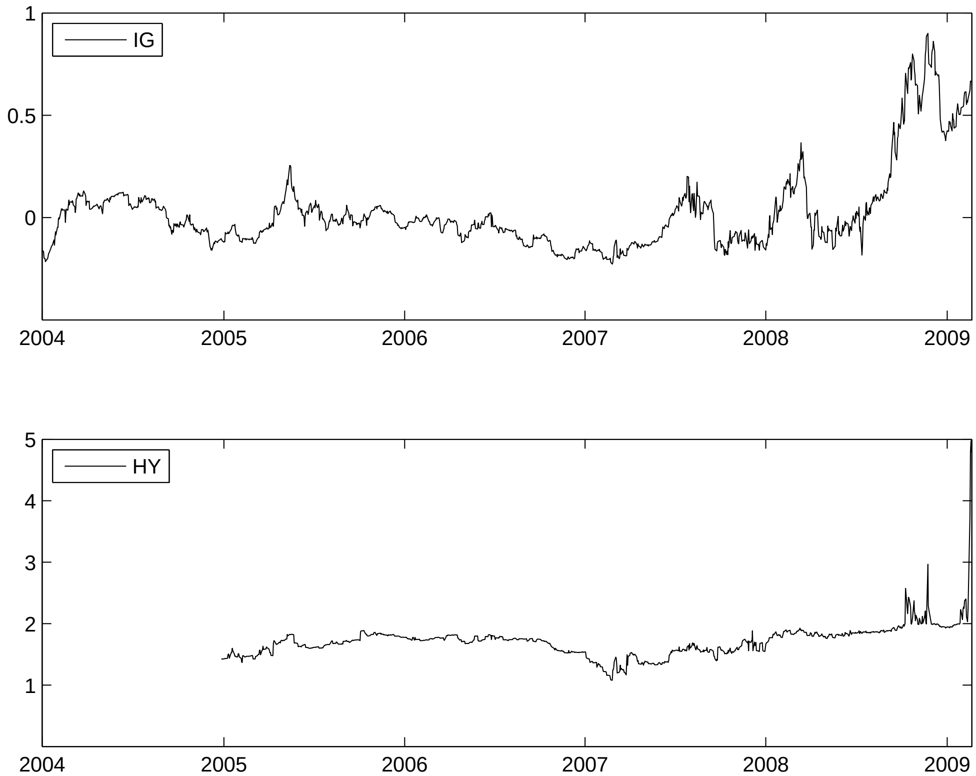

Figure 3. Implied Loss Rates for CDO Equity. The upper panel plots the implied loss rate obtained by setting the discount rate for the IG_{10} equity tranche equal to the discount rate for the index bank stocks and solving for the implied discount rate. The lower panel plots the corresponding implied loss rate for the HY_{10} equity tranche.

throughout the analysis, where the returns are based on Wednesday data (Tuesday when market data for Wednesday is not available). We begin by describing how the IG and HY equity returns are computed and presenting basic summary statistics. We then conduct a principal components analysis of the bank and CDO equity returns.

5.1 Computing CDO Equity Returns

Given the points-up-front price for the CDO equity tranches, computing weekly returns is straightforward. Let p_t be the points-up-front price of a CDO tranche with thickness L. At time t, we construct a funded CDO equity position by buying a riskless floating-rate note with coupon r_t and notional amount 1, and receiving an up-front payment of p_t for bearing the first credit losses on the underlying credit portfolio. Thus, the initial cost of the portfolio is $(1 - p_t)$. At time $t + 1$, the portfolio is liquidated at current market prices. Specifically, the cash generated by liquidation is the sum of $r_t/52$ and $(1-p_{t+1})(1-x_{t+1}/L)$, where the first term is the accrued interest on the floating-rate note and the second term is the cash generated by liquidating the floating-rate note and credit protection leg (taking into account the impact of any realized credit losses x_{t+1} on the CDX index during the return period).[12]

5.2 Return Properties

Table 5 reports summary statistics for the weekly returns for the bank stock indexes and for the IG and HY CDO equity portfolios. As shown, the realized returns for both bank and CDO equity are significantly negative for the slightly longer than five-year sample period (four-year sample period for HY equity). The realized returns are much lower for the large banks in the sample and increase monotonically with the size of the banks included in the indexes.

In terms of leverage, IG_{10} and HY_{10} CDO equity are the most comparable to the bank indexes. The average returns for these tranches are −32.3 and −16.3 basis points, respectively. These values essentially bracket the average return of −24.9 basis points for the index of the largest banks. Thus, the returns for leverage-matched CDO equity appear to be most closely related to those for large banks. The volatility of CDO equity returns is generally larger than that of the bank index returns. The volatility of weekly returns for the bank indexes ranges from about 3.1 to 4.5 percent. In contrast, the volatilities of weekly returns for IG_{10} and HY_{10} are 6.1 and 9.7 percent, respectively. Returns for CDO equity are also less serially correlated than are bank index returns. This provides some evidence that the market prices are not merely reflecting stale or illiquid prices since these types of data problems would induce serial correlation into returns.

Table 6 presents the correlation matrix for the bank and CDO equity returns. Not surprisingly, the three bank indexes are highly correlated with each other. Interestingly, however, there is a substantial amount of correlation between the bank indexes and the different CDO equity returns. The correlation between the returns for the $Bank_1$ index and the IG equity tranches ranges from roughly 37 to 45 percent. The correlations between the returns for the $Bank_1$ index and the HY equity tranches ranges from about 27 to 35 percent. The correlations between the other bank index returns and the CDO equity returns are slightly lower, but still relatively high. Again, this suggests that CDO equity returns are most closely related to the returns on the larger banks included in the first bank index.

[12]There were a number of firms included in the on-the-run CDX IG and HY indexes that defaulted during the sample period including Fannie Mae, Freddie Mac, Collins Aikman, Delphi, Calpine, Tribune, and Smurfit Stone.

Table 6 also shows that the returns on IG CDO equity are very highly correlated with the returns on HY CDO equity. For example, the correlations between the returns for the IG_{10} equity tranche and the returns for the four HY equity tranches range from about 57 to 67 percent. These relatively large correlations across the different types of equity returns suggests the possibility of significant commonality in the structure of returns. We explore this possibility in the next section.

5.3 Principal Components Analysis

We conduct a standard principal components analysis on the correlation matrix of weekly bank and CDO equity returns. Table 7 reports the results from this analysis.

The results confirm that there is a high level of commonality in the return data. Specifically, the first principal component explains more than 64 percent of the variation in the correlation matrix, while the first three principal components explain more than 90 percent.

Figure 4 plots the first four principal components. As shown, the first principal component represents a nearly uniform effect across all of the return series. Thus, bank stock and CDO equity appear to be driven by an important common factor. This provides strong support for the basic premise of the paper that bank stock and CDO equity have many similarities, despite the fact that equity markets and fixed-income markets are traditionally viewed as being very different in nature. The second principal component is clearly a bank equity factor since it primarily affects the three bank indexes. The third principal component appears to be a contrast between IG and HY equity. The fourth principal component is particularly interesting since it loads largely on the thinnest or most-leveraged equity tranches. Thus, this factor appears to be a leverage-related factor.

6. RISK-ADJUSTED RETURNS

In this section, we compare the returns from bank stock with those from CDO equity on a risk-adjusted basis. First, using the Fama-French three-factor model to control for risk, we contrast the alphas and risk exposures of the two types of equity returns. We then examine the extent to which risk-adjusted excess returns of CDO equity and bank stock are affected by shadow-banking factors such as counterparty credit risk, the availability of financing for security positions, and the liquidity in the derivatives market.

6.1 Alphas and Risk Exposure

As described earlier, both bank stocks and CDO equity represent residual claims to the cash flows of an underlying leveraged portfolio of debt and/or loans. In the

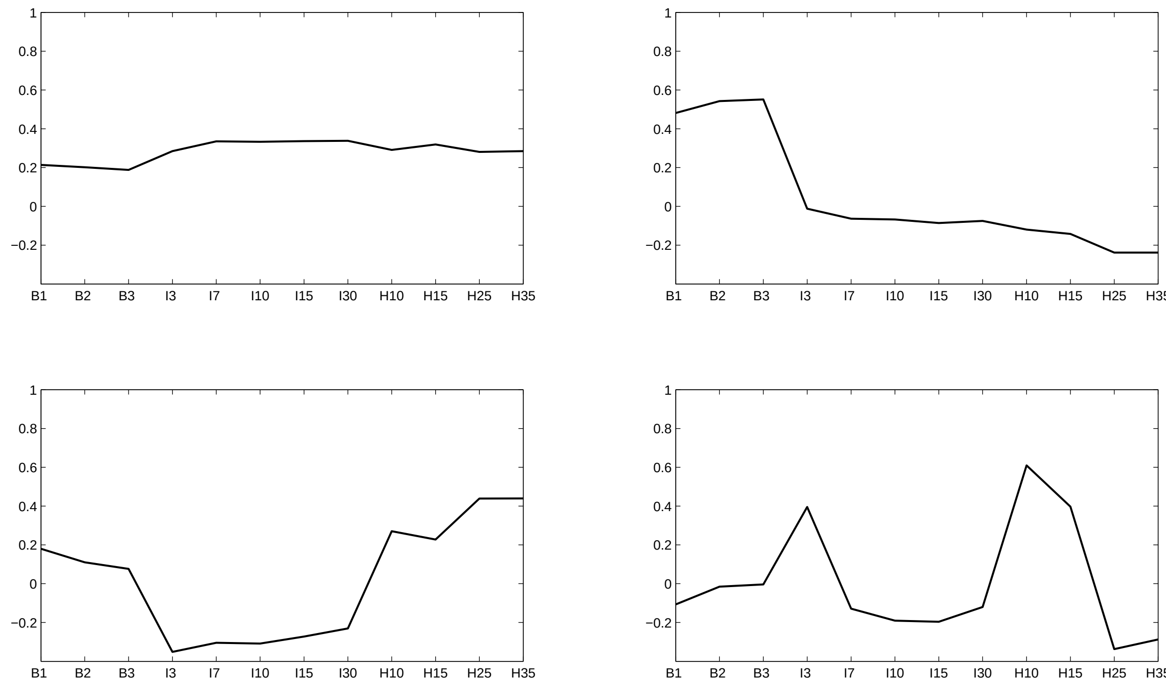

Figure 4. Principal Components for Bank Stock and CDO Equity Returns. This plots shows the first four principal components of the correlation matrix of returns on the three bank stock indexes and the nine IG and HY equity tranches. The upper left panel is the first principal component, the upper right is the second, the lower left is the third, and the lower right is the fourth.

case of commercial banks, the underlying portfolio can be viewed as an actively-managed fixed income portfolio. In contrast, the underlying portfolios for the CDX indexes are essentially static or passively-managed fixed income portfolios. From this portfolio management perspective, it is then very natural to raise the issue of whether the active management by banks or the passive management of CDOs are able to deliver excess returns on a risk-adjusted basis.

To explore this issue, we adopt the standard approach of regressing excess returns on a vector of market factors and examining the alpha from this regression. In doing this, we use the standard three Fama-French factors: the excess return on the market and the SMB and HML factors. Table 8 reports the results from the regressions.

Table 8 shows that the alphas for the bank stock indexes are all negative. The alpha for the largest banks is −32.7 basis points per week and is significant at the five-percent level. The alpha for the large regional banks is −20.7 basis points per week and is significant at the ten-percent level. The alpha for the smaller regional banks is −9.6 basis points per week but is not statistically significant. To put these large negative alphas into perspective, it is useful to translate them into the equivalent of management fees for the underlying fixed income portfolios. Given the average capital ratios for the bank indexes, these negative alphas are equivalent to the banks charging an annualized management fee of 159.0, 100.6, and 46.7 basis points, respectively. Viewed from this perspective, the banks in at least the top two indexes appear to have functioned as relatively expensive fixed income portfolio managers during this period.[13]

The CDO equity alphas are likewise all negative and on the same order of magnitude as the bank index alphas. None of these alphas, however, are statistically significant. Since the IG_{10} and HY_{10} portfolios most closely match the leverage ratios of the banks, their alphas are particularly relevant. Table 8 shows that the alphas for these two tranches are −31.0 and −7.1 basis points, respectively. The first is very comparable to the alpha for the $Bank_1$ index; the second is very comparable to the $Bank_3$ index.

As a robustness check, we also reestimate these regressions using the Fama-French three-factor model plus the excess returns on the Fama-French real estate and construction portfolios. The results this regression and the estimates of the alphas for the bank indexes and CDO equity portfolios are very similar to those shown in Table 8, and are, therefore, not reported. As a further robustness check, we estimate the regression for an index of all the bank stocks in the Russell 1000 using monthly excess returns for the January 1984 to November 2004 period prior to the sample period used in this study. The alpha for this index of bank stocks is only −13.9 basis points per month with a t-statistic of −0.63. Thus, these results suggest that the significantly negative alphas for the bank indexes reported in Table 8 are not simply due to a misspecified risk-adjustment model since the Fama-French three-factor model appears to explain the excess returns on bank stocks relatively well over the previous 20-year period.

Table 8 shows that the bank indexes tend to have significant exposure to the market and HML factors. The coefficients for the market and HML factors are all highly significant for each of the bank indexes. Consistent with the premise of this paper that CDO equity parallels bank equity, the regressions indicate that CDO equity has a similar risk profile to that of the bank indexes. Specifically, the

[13]Discussions with several fixed income portfolio managers suggests that management fees for an actively-managed portfolio of loans might be on the order of 100 basis points per year or less.

market betas for the IG equity portfolios range from 1.81 to 0.32 and are all highly significant. The market betas for the HY equity portfolios range from 1.26 to 0.40 and are also all statistically significant. The IG and HY equity betas with respect to the HML factor are all positive and similar in magnitude to those for the bank indexes, and many of these betas are significant at the ten-percent level. The IG and HY equity betas with respect to the SMB factor are all positive and comparable in magnitude to those for the bank indexes, although none are significant.

In summary, the results suggest that the alphas and risk exposures of the CDO equity portfolios are very comparable to those for the commercial banks. This lends support to the notion that valuation information for bank equity may be useful in valuing synthetic types of investment structures that are often termed "toxic assets" in the financial press.

6.2 Shadow-Banking Factors

We next take the analysis of risk-adjusted returns one step further by exploring the extent to which banks and CDO equity are affected by additional influences in the markets. What additional factors should affect equity returns after risk adjusting for their exposure to the Fama-French factors? In the case of the bank returns, there is very little in the way of theoretical guidance as to possible additional factors, particularly since these factors appear to explain the excess returns of banks over long horizons.

In contrast, a number of possible economic factors influencing the returns of securities or contracts in the shadow-banking sector are suggested by the literature. First and foremost among these is the risk of counterparty default. Specifically, since synthetic CDOs are contracts in which the protection seller has a large contingent liability, the risk that the protection seller cannot perform may affect the pricing of synthetic bank equity. Examples of papers that consider the valuation effects of counterparty credit risk include Cooper and Mello (1991), Sorensen and Bollier (1994), Duffie and Huang (1996), Duffie (1999), and Jarrow and Yu (2001). DeMarzo (2005) considers the potential adverse-selection effects on tranche prices of informational asymmetries between counterparties.

Another major factor which might affect the valuation of synthetic securities and contracts is the availability of financing to leveraged investors such as hedge funds, SIVs, conduits, etc. Recent papers addressing the role of financing availability on security values include Brunnermeier and Pedersen (2008) and Longstaff and Wang (2008).

A third category of factors potentially affecting the valuation of synthetic securities and contracts is the liquidity of the shadow-banking system. The role that liquidity plays in determining market values for derivative contracts is considered in many recent papers such as Longstaff (2004), Longstaff, Mithal, and Neis (2005) Brunnermeier and Pedersen (2008), and Longstaff (2009).

Based on this literature, three hypotheses about the properties of risk-adjusted excess returns suggest themselves.

Hypothesis 1. *The risk-adjusted returns of CDO equity should be more sensitive to counterparty credit risk than are the risk-adjusted returns of bank equity.*

Hypothesis 2. *The risk-adjusted returns of CDO equity should be more sensitive to the availability of security financing than are the risk-adjusted returns of bank equity.*

Hypothesis 3. *The risk-adjusted returns of CDO equity should be more sensitive to the liquidity of derivatives markets than are the risk-adjusted returns of bank equity.*

To examine these hypotheses, we regress the risk-adjusted excess returns, as measured by the residuals from the Fama-French three-factor model in the regression reported in Table 8, on a number of explanatory variables proxying for counterparty credit risk, the availability of security financing, and the liquidity of the derivatives market. These variables are described below.

To capture the potential effects of variation in systemic counterparty credit risk in the financial market, we include three variables in the analysis. First, we collect data on the average CDS spread for a subset of Wall Street dealers that make active markets for CDS contracts, but are not explicitly commercial banks during the sample period.[14] Changes in this average spread should reflect the variation in creditworthiness of major counterparties in the CDS markets. The CDS data are obtained from the Bloomberg system. Second, we include changes in the VIX index in the analysis since this important index is widely viewed as a key indicator of the perceived level of systemic risk in the financial markets. Also, increases in uncertainty may increase the risk of informational asymmetries among tranche market participants of the type discussed by DeMarzo (2005). The VIX data are also obtained from the Bloomberg system. Third, as a measure of market disruptions and operational distress, we use the aggregate weekly dollar amount of settlement failures (failures to deliver and failures to receive) by primary dealers in the Treasury, agency, mortgage, and corporate bond markets. Settlement failures

[14]We considered several different subsets of Wall Street firms, but converged on the average CDS spread for Morgan Stanley and Goldman Sachs as being the most representative. We note that the CDS spreads of major Wall Street firms are highly correlated.

can occur for a variety of reasons, but are likely to be more pronounced in periods when there is greater risk of counterparty defaults. This data is obtained from the Federal Reserve Bank of New York's website.

We include three different measures of financing availability. First, we include the weekly change in the outstanding amount of asset-backed commercial paper in the financial markets (both overnight and term commercial paper). Asset-backed commercial paper is an important source of debt for many leveraged structures in the shadow-banking system. These data are obtained from the Federal Reserve Board's website. Second, we include the difference between general collateral mortgage and Treasury overnight repo rates. Changes in this spread reflect variation in the relative ability of market participants to finance non-Treasury debt securities; when financing is readily available, the two repo rates are close to each other, and vice versa. These data are obtained from the Bloomberg system. Third, we include the net volume of overnight repurchase and reverse repurchase agreements (repurchase − reverse repurchase) entered into by primary dealers which is also reported by the Federal Reserve Bank of New York.

We use two measures of the liquidity of the leveraged derivatives markets. First is the total amount of corporate debt transactions by primary dealers in the financial markets. These data are reported by the Federal Reserve Bank of New York. Second, we collect data on the total value of dollar-denominated CDOs issued each week during the sample period. This measure is intended to capture the potential effects of changes in CDO supply on existing CDO prices. These data are collected from the Bloomberg system.

Table 9 summarizes the regression results. Focusing first on the counterparty credit risk variables, changes in broker spreads are significantly negatively related to the excess returns for the first two bank indexes and for three of the five IG equity portfolios. The negative sign of the coefficient indicates that increases in broker credit risk are associated with negative excess returns. Changes in the VIX are negatively related to bank and IG equity returns, but are only marginally significant for two of the IG equity portfolios. The FAIL variable is marginally significant for the third bank index but has a positive sign. The FAIL variable is also marginally significant for two of the HY portfolios but with the expected negative sign.

Turning to the financing variables, Table 9 shows that changes in the amount of asset-backed commercial paper is not significantly related to any of the excess returns. In contrast, the repo financing spread is highly positive and significant for the three bank indexes, but is not significant for any of the CDO equity portfolios. The net amount of repo financing is negative and significant for all three bank indexes, and is positive and significant for most of the IG equity portfolios.

Finally, the corporate transaction liquidity proxy is significant for nearly all of the excess returns. The sign of the coefficient is negative for all of the bank indexes, and is uniformly positive for all of the CDO equity excess returns. The amount of CDO issuance is significantly negatively related to the excess returns for the two thickest HY tranches.

In summary, both bank equity and CDO equity appear to be significantly affected by counterparty credit risk. Since the effects do not appear to be stronger for CDO equity than for bank stocks, Hypothesis 1 does not receive much support from the empirical results. In contrast, bank equity is very significantly related to two of the financing variables, while one of these variables is related to CDO equity. Thus, the evidence suggests that banks are more affected by financing availability and costs than are the CDO equity portfolios, implying that Hypothesis 2 is not supported by the results. Finally, bank stocks and CDO equity are about equally affected by the derivative's market liquidity variables, again implying that Hypothesis 3 is not supported.

Taken together, these results indicate that the excess returns for the bank indexes are at least as sensitive to the shadow-banking factors as are the excess returns for the CDO equity portfolios. In fact, the adjusted R^2s for the regressions confirm this impression. The adjusted R^2s for the bank indexes are all in the range from 12 to 21 percent, while the adjusted R^2s for the CDO equity tranches are generally much lower than 10 percent. These results raise intriguing questions about whether the actual banking system and the shadow-banking system are all that different from a fundamental economic perspective.

7. CONCLUSION

This issue of how the market values complex, opaque, credit-related securities has become of fundamental importance in light of their macroeconomic impact in the current financial crisis. This paper studies this issue from a novel perspective by contrasting bank equity returns with returns on CDO equity tranches.

The results suggest that the market values bank and CDO equity in a similar manner. In particular, the discount rates applied to bank dividend streams closely parallel those applied to CDO equity. Furthermore, a principal components analysis of bank and CDO equity returns indicates that more than 64 percent of their variation is explained by a common factor. This strong commonality is particularly striking given that the two securities trade in very different markets, CDO equity in fixed-income markets and bank equity in the stock market.

At a more fundamental level, commercial banks can be viewed as active credit portfolio managers while CDO structures are typically passive credit portfolios. We contrast the returns of bank and CDO equity on a risk-adjusted basis. We find that both banks and CDO equity generated significant negative alpha of similar magnitude over the recent past. Thus, there is no evidence that banks generate incremental risk-adjusted returns relative to synthetic bank or CDO structures.

Furthermore, the results also suggest that bank stocks are driven by factors inherent in the shadow-banking system such as swap counterparty credit risk, the availability of collateralized financing for debt securities, and liquidity in the corporate debt markets. Surprisingly, bank equity appears to be more sensitive to these types of factors than is CDO equity. These results have many potential implications for the current debate about the viability of banks and policy initiatives to recapitalize banks directly or through the purchase of troubled assets.

Finally, our analysis has focused primarily on CDO equity based on corporate credit portfolios. An interesting issue for future research is how these results would extend to CDO equity based on other types of underlying debt portfolios such as mortgage, consumer, or asset-backed loans.

APPENDIX

In this Appendix, we present another illustration of how CDO equity can be used to create a portfolio with cash flows that parallel those from bank stock. To make the intuition as clear as possible, we focus on a particularly simple example of a stylized bank. Assume that a new commercial bank is formed at time t. This new bank raises both equity and debt capital through stock and by issuing one-period bonds. To fix notation, let E_t denote the amount of equity capital raised. Let L denote the bank's capital ratio, defined as the ratio of the book value of the bank's equity to the book value of the bank's assets. We assume that the bank is required to maintain its capital ratio at L at all times. Given the initial equity capital E_t and the required capital ratio, the initial size of the bank's assets is simply $A_t = E_t/L$. Thus, the bank has total assets of A_t which are financed by LA_t of equity and $(1 - L)A_t$ of debt. Let c denote the coupon rate on the bank's debt.

The bank invests its capital by making one-period simple-interest loans to its clients, where d is the interest rate charged by the bank on its loans. We assume throughout that the loan portfolio of the bank is similar in all material respects to the composition of the portfolio of debt underlying the CDX index. The bank incurs general administrative and business expenses of kA_t.

At the end of the period, the loan portfolio comes due and the bank learns what its credit losses x_{t+1} are. We assume that any credit losses are borne entirely by the common stockholders of the bank; that a credit loss of \$1 reduces the book value of the equity by \$1 (until the equity is reduced to zero). Thus, the bank's shareholders are clearly the residual claimants to the bank's cash flows and bear the first L percent of credit losses on the loan portfolio.

To operationalize this, we assume that when the bank has credit losses, one of two possibilities occur. If credit losses are less than the book value of equity E_t, then the bank's dividends are reduced by the amount of the credit losses. In this situation, credit losses are analogous to a "negative dividend" which must be paid back to the bank to restore its equity capital to its previous levels before the bank can continue operating. On the other hand, if credit losses exceed the book value of equity, $x_t > L$, then the bank is liquidated and the bank's bonds default.

Specifically, let V_{t+1} denote the bank's net income from operations (excluding credit losses),

$$V_{t+1} = (c - k - (1 - L)d)\ A_t \equiv \phi\ A_t. \tag{A1}$$

For simplicity, we assume that this amount is positive, although this is not essential. We will also ignore corporate taxes in this stylized example. Corporate taxes, however, could easily be incorporated into this framework. The dividends D_{t+1} paid by the bank are assumed to be

$$D_{t+1} = \rho \; V_{t+1} - x_{t+1} \; A_t \; I_{t+1}, \qquad (A2)$$

where ρ is the fraction of total operating income paid out, and I_{t+1} is an indicator function that takes value zero if liquidation is (or has previously been) triggered, and one otherwise. Given this dividend payout policy, the value of the bank's equity becomes

$$E_{t+1} = E_t \; I_{t+1} + (1-\rho) \; V_{t+1} \; I_{t+1}. \qquad (A3)$$

Thus, provided that liquidation does not occur, the bank's equity increases through the retained earnings.

Going forward, the bank now repeats the process of issuing one-year bonds and using its capital to make one-year loans. The increase in the bank's capital likewise allows the bank's assets to increase. Holding fixed the capital ratio at L, the bank's total assets becomes $A_{t+1} = E_{t+1}/L$, or equivalently,

$$A_{t+1} = A_t \; I_{t+1} + (1-\rho) \; \frac{V_{t+1}}{L} \; I_{t+1}. \qquad (A4)$$

As before, this implies that the bank has assets of A_{t+1} which are financed by equity of LA_{t+1} and debt of $(1-L)A_{t+1}$. At the end of the period, the firm's operating income, dividends, equity capital, and new asset size are given by simply updating the time subscripts in Equations (A1) through (A4).

This entire process then repeats itself each period *ad infinitum* unless a liquidation occurs at some point. Specifically, if at some point in time $t+N$, the bank's credit loss percentage x_{t+N} exceeds the capital ratio L, we assume that the bank first pays the interest it owes to the bondholders, but then pays out all of the current operating income to the shareholders as a final dividend. The shareholders then walk away from the bank, leaving the debtholders to absorb the difference between the value of the loan portfolio $(1-x_{t+N})A_{t+N-1}$ and the notional amount of the bonds $(1-L)A_{t+N-1}$ as a loss.

To illustrate the bank's cash flows more clearly, the top panel of Table A1 summarizes the cash flows resulting from an equity investment in the bank. For expositional clarity, we assume in Table A1 that the credit loss percentage does not exceed L until time $t+N$, where $N > 3$. As shown, the dividend stream is proportional to the total asset size of the bank at each period (where we have substituted out the the operating income term in Equation (A2) using Equation (A1)). The bank's asset size grows over time because of the bank's retained earnings. The growth in the bank's assets is given by the recursive relation in Equation (A4).

Although very simple, the bank in this example captures a number of realistic features. For example, the bank generates a stochastic stream of dividends over time which is driven by realized credit losses. Thus, this model is consistent with a single-factor model of bank equity returns in which the primary driving factor is credit related. In addition, the bank's dividend is expected to grow over time in this example, consistent with the usual Gordon growth model intuition.

We now illustrate how the dividend stream generated by the stylized bank described above can be replicated using CDO tranches and other fixed income instruments. To do this, we need to structure the replicating portfolio so that it bears the first L percent of credit losses in the same way as the bank's equityholders. Let s be the spread on a one-year synthetic index equity tranche that bears the first L percent of credit losses (has thickness L) on a portfolio of one-year loans equivalent to that owned by the bank. Let x_t denote the credit loss percentage on that portfolio.

At time t, we invest LA_t in a one-period riskless par bond with coupon rate r. We also sell protection on the one-year synthetic equity tranche with thickness L in the notional amount of A_t. As with interest rate swaps, there are no initial cash flows associated with synthetic index tranches. At time $t+1$, this portfolio generates the cash flow,

$$(1+r)\ L\ A_t + sL\ A_t - x_{t+1}\ A_t. \tag{A5}$$

The first term in this expression represents the principal and coupons from the maturing riskless bond. The second term represents the spread earned from the CDO equity position. The third term represents the credit losses that must be paid out on the synthetic CDO equity tranche.

To roll the portfolio forward at time $t+1$, assuming that the credit losses are less than the capital ratio L, we now invest LA_{t+1} in a one-period riskless bond. From Equations (A1) and (A4), LA_{t+1} can also be expressed as $(L+(1-\rho)\phi)A_t$. In addition, we sell protection on the one-year synthetic equity tranche with thickness L in the notional amount A_{t+1}. Adding the cash flows from rolling over the portfolio at time $t+1$ to the other cash flows in Equation (A5) implies that the total cash flows generated by the strategy at time $t+1$ can be expressed as

$$\big[(r+s)L - \phi + \rho\phi - x_{t+1}\big]A_t. \tag{A6}$$

As before, this process can be repeated *ad infinitum* (assuming that credit losses do not exceed L), each time resulting in the net cash flow shown in Equation (A6) (updated with the appropriate time subscripts).

If at some point $t+N$ realized credit losses exceed L, then the portfolio is no longer rolled over. In this case the cash flow at time $t+N$ is simply given by Equation (A5), but with one slight modification. Specifically, since the maximum credit loss that the seller of an equity tranche of thickness L is required to absorb is LA_{t+N-1}, the cash flow at time $t+N$ becomes,

$$(1+r)\ L\ A_{t+N-1} + sL\ A_{t+N-1} - L\ A_{t+N-1}, \qquad (A7)$$

which is simply

$$(r+s)L\ A_{t+N-1}. \qquad (A8)$$

To illustrate the cash flows generated by this synthetic equity strategy, the lower panel of Table A1 summarizes the cash flows for the same scenario as for the bank equity.

Comparing the two panels in Table A1 shows that the two cash flow streams have a similar structure. In particular, both the bank equity and synthetic bank equity strategies generate cash flows that are given by an affine function of the credit loss percentage times the asset size. In fact, the two cash flow streams are not only similar, they must be equal in order to avoid an arbitrage situation. To see this, observe from Table A1 that if $(r+s)L = \phi$, the two cash flow streams are equal. Thus, if the market does not set the spread s of the equity tranche in a way such that $(r+s)L = \phi$, then taking a long position in bank equity and a short position in the synthetic bank equity is easily shown to costlessly generate a nonstochastic annuity, implying arbitrage. Thus, $(r+s)L$ must equal ϕ, implying that the two strategies have identical cash flows through time.

In summary, we have shown that cash flows from an equity position in a stylized bank can be replicated by a portfolio including CDO equity. This is the sense in which we can view the replicating portfolio as being the synthetic analogue of bank equity. Since this example is intended only as an illustration, we have focused on the simplest case in which the bank's loans, the bank's bonds, and the synthetic CDO equity included in the replicating portfolio have a one-year horizon. Much more complex and realistic examples could be constructed in which the bank's asset and funding horizons were longer, the bank's revenues and funding costs were linked to a floating rate such as Libor, or additional risk factors were introduced. For most of these examples, however, a synthetic counterpart could again be constructed using CDO equity, futures contracts, interest rate swaps, etc. In summary, the key takeaway from this Appendix is that even fundamental types of securities such as bank stock can be approximated by synthetic structures created using securitized versions of the same portfolio of assets held by the bank.

Table A1

Cash Flows from the Stylized Bank and from the Replicating Synthetic Bank Equity Strategy. This table shows the cash flow generated each period from the indicated positions. L denotes the bank's leverage ratio, A_t denotes the bank's assets, and x_t denotes the default loss rate on the underlying credit portfolio. The bank's operating income is ϕA_t and the bank pays out a fraction ρ of its operating income as dividends. The term r denotes the riskless one-period interest rate and s denotes the spread on a one-period synthetic CDO equity tranche, where the spread is paid on the notional amount LA_t.

Strategy	t	$t+1$	$t+2$	$t+3$	...	$t+N$
Bank Equity						
Buy Stock	$-LA_t$					
Dividends		$(\rho\phi - x_{t+1})A_t$	$(\rho\phi - x_{t+2})A_{t+1}$	$(\rho\phi - x_{t+3})A_{t+2}$	...	ϕA_{t+N-1}
Synthetic Bank Equity						
Buy Riskless Bonds	$-LA_t$	$-(L + (1-\rho)\phi)A_t$	$-(L + (1-\rho)\phi)A_{t+1}$	$-(L + (1-\rho)\phi)A_{t+2}$	...	
Principal and Coupon		$(1+r)LA_t$	$(1+r)LA_{t+1}$	$(1+r)LA_{t+2}$	...	$(1+r)LA_{t+N-1}$
Equity Tranche, Notional A_t	0					
Equity Tranche, Notional A_{t+1}		0				
Equity Tranche, Notional A_{t+2}			0			
Equity Tranche, Notional A_{t+3}				0	...	
⋮					...	
Spread from Tranche		sLA_t	sLA_{t+1}	sLA_{t+2}	...	sLA_{t+N-1}
Tranche Credit Losses		$-x_{t+1}A_t$	$-x_{t+2}A_{t+1}$	$-x_{t+3}A_{t+2}$	...	$-LA_{t+N-1}$
Total Cash Flow	$-LA_t$	$\big[(r+s)L - \phi$ $+\rho\phi - x_{t+1}\big]A_t$	$\big[(r+s)L - \phi$ $+\rho\phi - x_{t+2}\big]A_{t+1}$	$\big[(r+s)L - \phi$ $+\rho\phi - x_{t+3}\big]A_{t+2}$	... ...	$(r+s)LA_{t+N-1}$

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Table 1

Summary Statistics for the Ten-Year CDX IG Equity and Five-Year CDX HY Equity Points-Up-Front Prices. This table reports summary statistics for the points-up-front prices of the indicated CDX equity tranches. Results are reported for the combined on-the-run time series. The CDX IG sample period is from January 2, 2004 to February 20, 2009. The CDX HY sample period is from December 29, 2004 to February 20, 2009.

	Mean	Standard Deviation	Minimum	Median	Maximum	Serial Correlation	N
IG_3	0.7952	0.0549	0.7060	0.7904	0.9445	0.992	1288
IG_7	0.5892	0.0966	0.4546	0.5739	0.9331	0.994	1288
IG_{10}	0.4649	0.1047	0.3363	0.4359	0.8677	0.996	1288
IG_{15}	0.3391	0.0928	0.2329	0.3116	0.7229	0.996	1288
IG_{30}	0.1850	0.0567	0.1205	0.1687	0.4222	0.996	1288
HY_{10}	0.8274	0.0729	0.6188	0.8275	0.9850	0.991	1039
HY_{15}	0.7345	0.1041	0.4825	0.7283	0.9783	0.994	1039
HY_{25}	0.5700	0.1480	0.3206	0.5297	0.9834	0.997	1039
HY_{35}	0.4445	0.1475	0.2353	0.3928	0.9592	0.997	1039

Table 2

Summary Statistics for the Composition of the CDX Credit Portfolios. The first panel reports the percentage composition of the firms in the CDX IG indexes by industry based on their Fama-French 12-industry classifications, the percentage compositions of the firms in the CDX IG indexes by Standard and Poor's credit rating, and the percentage turnover of firms in the index when the index is reconstituted at the next roll date. The second panel reports the same information for the CDX HY indexes.

CDX IG Index	1	2	3	4	5	6	7	8	9	10	11
Industry											
Consumer Nondurables	7.2	7.2	7.2	7.2	8.8	9.6	7.2	8.0	9.6	8.8	8.8
Consumer Durables	4.8	4.0	4.0	4.8	2.4	1.6	1.6	1.6	1.6	2.4	2.4
Manufacturing	12.0	12.0	12.0	12.0	11.2	12.0	12.8	12.8	12.8	14.4	12.8
Oil, Gas, and Coal	5.6	5.6	5.6	5.6	4.8	4.8	4.8	4.8	4.8	4.8	5.6
Chemicals	3.2	3.2	3.2	3.2	3.2	3.2	4.0	4.0	3.2	3.2	2.4
Business Equipment	6.4	4.8	4.0	4.0	4.0	4.0	4.0	4.8	4.0	4.0	4.0
Telecommunications	9.6	11.2	8.8	8.8	9.6	8.8	9.6	8.8	8.0	8.0	8.0
Utilities	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6
Wholesale, Retail	10.4	11.2	13.6	12.8	13.6	14.4	12.8	12.0	13.6	14.4	16.0
Healthcare	3.2	3.2	3.2	3.2	3.2	3.2	3.2	4.8	4.0	4.0	4.0
Finance	20.8	20.8	20.8	20.0	19.2	19.2	20.0	20.0	20.0	19.2	16.8
Other	11.2	11.2	12.0	12.8	14.4	13.6	14.4	12.8	12.8	11.2	13.6
Credit Rating											
AAA	4.0	4.0	4.0	4.0	3.2	3.2	3.2	3.2	3.2	3.2	1.6
AA	4.0	4.0	4.0	4.0	4.0	3.2	3.2	3.2	3.2	3.2	2.4
A	32.8	33.6	33.6	34.4	34.4	36.0	37.6	39.2	39.2	37.6	39.2
BBB	59.2	58.4	58.4	57.6	58.4	57.6	56.0	54.4	54.4	56.0	56.8
Percentage Turnover	0.0	4.8	8.0	2.4	7.2	4.0	4.8	4.8	6.4	6.4	8.0

Table 2 Continued

CDX HY Index	1	2	3	4	5	6	7	8	9	10	11
Industry											
Consumer Nondurables	9.0	7.0	7.0	7.0	6.0	6.0	7.0	6.0	6.0	7.0	8.0
Consumer Durables	4.0	3.0	4.0	6.0	9.0	8.0	7.0	7.0	7.0	7.0	7.0
Manufacturing	14.0	14.0	15.0	16.0	15.0	16.0	16.0	12.0	12.0	10.0	10.0
Oil, Gas, and Coal	5.0	7.0	7.0	7.0	6.0	6.0	6.0	6.0	5.0	5.0	5.0
Chemicals	5.0	6.0	6.0	5.0	5.0	5.0	5.0	5.0	4.0	4.0	4.0
Business Equipment	9.0	9.0	8.0	9.0	10.0	10.0	11.0	12.0	11.0	11.0	11.0
Telecommunications	14.0	13.0	13.0	13.0	12.0	11.0	12.0	12.0	13.0	14.0	14.0
Utilities	8.0	8.0	8.0	9.0	9.0	9.0	9.0	10.0	10.0	9.0	8.0
Wholesale, Retail	11.0	10.0	10.0	9.0	9.0	9.0	8.0	10.0	9.0	9.0	7.0
Healthcare	1.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Finance	4.0	4.0	6.0	5.0	5.0	4.0	3.0	2.0	4.0	4.0	5.0
Other	16.0	16.0	13.0	11.0	11.0	13.0	13.0	15.0	16.0	17.0	18.0
Credit Rating											
BBB	5.0	3.0	3.0	4.0	4.0	4.0	3.0	3.0	5.0	4.0	2.0
BB	59.0	57.0	56.0	55.0	54.0	51.0	48.0	50.0	45.0	40.0	45.0
B	33.0	36.0	36.0	36.0	37.0	41.0	44.0	45.0	49.0	52.0	48.0
CCC	2.0	3.0	4.0	4.0	4.0	4.0	5.0	2.0	1.0	4.0	5.0
CC	1.0	1.0	1.0	1.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0
Percentage Turnover	0.0	8.0	8.0	6.0	7.0	10.0	5.0	9.0	6.0	4.0	5.0

Table 3

Summary Statistics for the Commercial Bank Indexes. This table reports summary statistics for the indicated indexes of commercial banks. The $Bank_1$ index consists of the banks in the Russell 1000 index with an average asset size in excess of \$100 billion. The $Bank_2$ index consists of the banks in the Russell 1000 index with an average asset size between \$20 billion and \$100 billion. The $Bank_3$ index consists of the remaining banks in the Russell 100 index. Averages reported are equally weighted across banks in each index and based on average month-end values for the sample period. Asset size is in \$billions. Market to book is the average ratio of the market value of equity to book value. Leverage ratio is the ratio of the book value of equity to the book value of assets. Dividend yield is the ratio of the most-recently-announced dividend divided by the current market price of the stock. Dividend growth is the long-term dividend per share growth rate reported by IBES. Discount rate is the sum of dividend yield and dividend growth. Credit Rating is the Standard & Poor's rating as of the end of 2008.

Bank Index	Asset Size	Market to Book	Leverage Ratio	Dividend Yield	Dividend Growth	Discount Rate	Credit Rating
$Bank_1$	530.00	1.21	0.0891	0.0391	0.0928	0.1319	A/A+
$Bank_2$	48.92	1.33	0.0932	0.0355	0.0980	0.1335	BBB+
$Bank_3$	11.62	1.40	0.0952	0.0342	0.0941	0.1283	BBB+

Table 4

Summary Statistics for the Implied Credit Losses Embedded in CDO Equity Prices. This table reports summary statistics for percentage credit losses implied from CDO equity prices. These implied credit losses are identified by setting the CDO equity discount rate equal to that of the bank index and iteratively solving for the current loss rate that sets the present value of future cash flows equal to the current CDO equity value. Results are reported for the combined on-the-run time series.

	Mean	Standard Deviation	Minimum	Median	Maximum	Serial Correlation	N
IG_{10}	0.0228	0.1973	−0.2274	−0.0228	0.9004	0.991	1228
HY_{10}	1.7080	0.2752	1.0775	1.7293	4.9753	0.954	1039

Table 5

Summary Statistics for Weekly Bank Stock and CDO Equity Returns. This table reports summary statistics for weekly returns of the bank stock indexes and the CDO equity tranches.

	Mean	Standard Deviation	Minimum	Median	Maximum	Serial Correlation	N
Bank_1	−0.00249	0.04486	−0.25229	0.00033	0.22946	−0.143	264
Bank_2	−0.00165	0.03343	−0.17862	−0.00062	0.15378	−0.147	264
Bank_3	−0.00057	0.03104	−0.16000	0.00063	0.12590	−0.189	264
IG_3	−0.00469	0.08829	−0.40256	0.00184	0.30290	−0.025	264
IG_7	−0.00489	0.08444	−0.62794	0.00017	0.40800	0.012	264
IG_{10}	−0.00323	0.06122	−0.44963	0.00113	0.31870	0.025	264
IG_{15}	−0.00167	0.03661	−0.25199	0.00087	0.19753	0.026	264
IG_{30}	−0.00030	0.01578	−0.09003	0.00070	0.08164	−0.015	264
HY_{10}	−0.00163	0.09740	−0.32100	0.00402	0.34194	−0.089	213
HY_{15}	−0.00294	0.08257	−0.31195	0.00312	0.25222	−0.002	213
HY_{25}	−0.00804	0.10915	−0.73024	0.00178	0.68518	0.118	213
HY_{35}	−0.00436	0.06131	−0.41720	0.00167	0.34040	0.075	213

Table 6

Correlation of Weekly Bank Stock and CDO Equity Returns. This table reports the correlations of weekly returns for the bank indexes and CDO equity tranches. The number of weekly observations used in computing correlations is 264 (except for correlations with the HY tranches which are based on 213 weekly observations).

	$Bank_1$	$Bank_2$	$Bank_3$	IG_3	IG_7	IG_{10}	IG_{15}	IG_{30}	HY_{10}	HY_{15}	HY_{25}	HY_{35}
$Bank_1$	1.000											
$Bank_2$	0.875	1.000										
$Bank_3$	0.825	0.940	1.000									
IG_3	0.373	0.403	0.364	1.000								
IG_7	0.454	0.417	0.376	0.792	1.000							
IG_{10}	0.442	0.408	0.377	0.744	0.989	1.000						
IG_{15}	0.427	0.392	0.373	0.741	0.969	0.989	1.000					
IG_{30}	0.439	0.407	0.398	0.769	0.934	0.949	0.977	1.000				
HY_{10}	0.327	0.297	0.271	0.570	0.586	0.573	0.592	0.620	1.000			
HY_{15}	0.354	0.312	0.281	0.616	0.675	0.666	0.687	0.708	0.949	1.000		
HY_{25}	0.267	0.194	0.148	0.416	0.584	0.583	0.614	0.620	0.671	0.765	1.000	
HY_{35}	0.268	0.201	0.153	0.435	0.586	0.583	0.618	0.633	0.691	0.790	0.991	1.000

Table 7

Principal Components Analysis Results. This table reports summary statistics for the principal components analysis of the correlation matrix of weekly returns for the bank indexes and the CDO equity tranches. The correlation matrix is computed using all available overlapping observations for each pairwise correlation.

Principal Component	Percentage Explained	Cumulative Percentage Explained
First	64.28	64.28
Second	17.92	82.20
Third	7.89	90.09
Fourth	4.70	94.79

Table 8

Regression Tests for Risk-Adjusted Excess Returns. This table reports the coefficients and t-statistics from the following regressions of weekly excess bank and CDO equity returns on the Fama-French factors.

$$ER_t = \alpha + \gamma_1 MKT_t + \gamma_2 SMB_t + \gamma_3 HML_t + \epsilon_t$$

	Coefficient				t-Statistic					
ER	α	MKT	SMB	HML	α	MKT	SMB	HML	Adj. R^2	N
$Bank_1$	−0.00327	1.11	−0.44	1.78	−2.12	15.37	−2.87	12.86	0.687	264
$Bank_2$	−0.00207	0.92	0.10	0.93	−1.75	16.82	0.88	8.75	0.672	264
$Bank_3$	−0.00096	0.80	0.42	0.72	−0.81	14.63	3.64	6.84	0.621	264
IG_3	−0.00429	1.70	0.39	0.43	−0.90	7.68	0.84	1.01	0.234	264
IG_7	−0.00466	1.81	0.17	0.85	−1.07	8.95	0.40	2.19	0.305	264
IG_{10}	−0.00310	1.36	0.11	0.48	−0.99	9.35	0.35	1.69	0.313	264
IG_{15}	−0.00182	0.78	0.15	0.24	−0.96	8.83	0.82	1.42	0.293	264
IG_{30}	−0.00070	0.32	0.08	0.12	−0.85	8.31	0.94	1.56	0.273	264
HY_{10}	−0.00071	1.26	0.54	0.65	−0.11	4.68	0.90	1.22	0.132	213
HY_{15}	−0.00214	1.20	0.48	0.75	−0.41	5.42	0.97	1.70	0.178	213
HY_{25}	−0.00817	0.65	0.76	1.52	−1.12	2.09	1.09	2.45	0.067	213
HY_{35}	−0.00466	0.40	0.45	0.83	−1.15	2.28	1.16	2.40	0.073	213

Table 9

Regression of Risk-Adjusted Excess Returns on Counterparty Credit Risk, Financing Availability, and Liquidity Variables. This table reports the t-statistics from the following regression of weekly risk-adjusted excess returns *RAER* on the indicated variables. *CDS* denotes the change in the index of dealer CDS spreads. *VIX* denotes the change in the VIX index. *FAIL* denotes the total value of Treasury, agency, mortgage, and corporate bonds settlement failures by primary dealers. *CP* denotes the change in the aggregate amount of asset-backed commercial paper outstanding. *SPRD* denotes the spread between the overnight mortgage repo rate and the overnight Treasury repo rate. *REPO* denotes the difference between the aggregate amount of primary dealers' overnight repurchase agreements and their reverse repurchase agreements. *CTRN* denotes the aggregate amount of primary dealers' corporate transactions. *CDO* denotes the notional amount of dollar-denominated CDO issuance during the week.

$$RAER_t = \gamma_0 + \gamma_1 CDS_t + \gamma_2 VIX_t + \gamma_3 FAIL_t + \gamma_4 CP_t + \gamma_5 SPRD_t + \gamma_6 REPO_t + \gamma_7 CTRN_t + \gamma_8 CDO_t + \epsilon_t$$

	t-Statistics										
RAER	γ_0	*CDS*	*VIX*	*FAIL*	*CP*	*SPRD*	*REPO*	*CTRN*	*CDO*	Adj. R^2	N
Bank_1	1.59	−3.54	−0.58	1.30	0.27	4.45	−2.54	−1.63	0.22	0.121	256
Bank_2	2.03	−2.44	−0.04	0.91	0.07	6.12	−2.35	−2.38	1.01	0.148	256
Bank_3	2.60	−0.20	−1.61	1.81	0.05	7.60	−2.73	−3.21	1.27	0.208	256
IG_3	−1.44	−5.76	−0.30	1.18	−0.75	0.64	0.78	1.22	1.03	0.125	256
IG_7	−2.62	−2.30	−1.38	−0.41	−0.51	−0.38	2.23	2.52	0.60	0.038	256
IG_{10}	−2.73	−1.21	−1.78	−0.26	−0.44	−0.99	2.37	2.62	0.59	0.030	256
IG_{15}	−2.72	−0.66	−1.78	0.15	−0.16	−1.13	2.34	2.57	0.58	0.023	256
IG_{30}	−2.28	−2.20	−1.54	0.65	0.28	−0.16	1.87	2.05	0.61	0.030	256
HY_{10}	−1.46	−1.33	0.30	0.45	−1.03	0.17	−0.23	1.64	−0.59	−0.005	205
HY_{15}	−1.84	−1.23	0.28	−0.17	−0.75	−0.73	0.16	2.12	−0.90	−0.003	205
HY_{25}	−2.76	−1.18	1.53	−2.03	−0.66	−1.32	0.28	3.55	−2.87	0.075	205
HY_{35}	−2.45	−1.29	1.56	−1.73	−0.70	−1.32	0.18	3.21	−2.76	0.063	205