DO NOISY FAIR VALUES OF DERIVATIVES DISTORT BANK CAPITAL ADEQUACY RATIOS?

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ABSTRACT

This study examines how noise in the reported fair market values of derivatives owned by banks affects bank capital adequacy ratios. Monte Carlo simulation is used to generate new balance sheet data to identify noise and subsequently determine its impact on the capital ratios. Noise in fair market values is found to significantly impact the probability of a type I error with regards to the Tier 1 Leverage ratio at the well capitalized benchmark. Banks who suffered from a type I error during the 2008 financial crisis would have been required to pay higher FDIC insurance premiums, get approval of all brokered deposits, and would have faced challenges in obtaining approval for acquisitions.

INTRODUCTION

This study examines how noise in the reported fair market values of derivatives affects bank capital adequacy ratios. Noise is defined as a component of the measurement of a derivative asset or liability that is not related to its fundamental value, where fundamental values represent an agreed-upon price between a willing buyer and a willing seller in a competitive liquid market. It is common to refer to measurement error in fair values as noise. These terms are used interchangeably throughout the text.

The study is unique in that it isolates the effects of changes in fair market values of derivative-type instruments from such changes in fair values of all financial instruments that banks own. Further, the use of a simulation methodology allows for the measurement of the noise component in fair market values of derivatives and their ultimate effect on capital adequacy ratios. Tier 1 capital, total capital, and tier 1 leverage are the three capital ratios that are impacted by changes in the fair values of financial derivative contracts. Using these ratios, three bank capital adequacy benchmarks are examined: 1) well capitalized; 2) adequately capitalized; and 3) significantly undercapitalized.

A Monte Carlo simulation is used to generate new balance sheet data for 48 banks with nonzero derivative assets to identify noise in fair market values. The Monte Carlo simulation is performed using the RISK AMP simulation software package. The noise component in fair values has the potential to distort the determination of the true capital adequacy of a bank. This novel simulation approach allows for gaining insight as to how noise in fair market values of derivatives ultimately affects capital adequacy ratios.

The results show that noise in fair market values of derivatives significantly impacts the probability of a type I error with regards to the Tier 1 Leverage ratio at the well capitalized benchmark. Banks who suffered from a type I error during the 2008 financial crisis would have been required to pay higher FDIC insurance premiums, get approval of all brokered deposits, and would have faced challenges in obtaining approval for acquisitions.

Prior research by Valencia, Smith, and Ang (2013) examines the overall effect of noise in fair values on bank capital adequacy ratios during the 2008 financial crisis. It is important to note that their study presents results based on the combined effect of noise in the fair market values of all financial instruments owned by banks. While measuring the combined effect of noise, the authors give useful insights. Current debates over derivatives and the relaxation of certain Dodd-Frank banking regulations warrant an investigation on the noise component of fair values exclusive to derivatives. This paper concentrates on derivatives, because these instruments often involve an increased use of level 3 fair market valuation models, which can exacerbate the noise component of market value estimates.

Derivatives have been the source of controversy since the financial crisis of 2007-2009. Many believe that these instruments contributed to the crisis due to the manner in which they were valued and reported (e.g. Emm and Ince, 2011). Since this time, both the Financial Accounting Standards Board (FASB) and the International Accounting Standards Board (IASB) have stated that fair market values are the best option for fair valuation (Securities and Exchange Commission [SEC], 2008). However, both boards are examining the use of fair values, because they believe that there are still some weaknesses in measurement and reporting processes that need to be addressed (FASB, 2021; IASB, 2021).

Many derivative contracts are relatively straightforward to value because they are traded in liquid markets with many participants. As these contracts get more complicated and are structured around a specific set of circumstances, they become very difficult or impossible to trade and extremely illiquid. The users of these complex derivatives are often unable to find direct comparables or other valuation platforms. Thus, fair valuation or performing suitable mark-to-market computations for these contracts is often difficult (Schmidt, 2016).

International (IASB, 2021) and US (FASB, 2020) financial accounting standards require that all financial instruments, except those carried at amortized cost, be reported at fair value in financial statements. Those accounting standards use a fair value hierarchy ranging from level 1 (best evidence) to level 3 (least reliable evidence). Level 1 fair market valuations use available quotes for identical assets or liabilities in active markets. Level 2 values use available quotes for similar assets and liabilities in active markets. Level 3 valuations use assumptions determined by management as inputs to complex financial valuation models to derive fair values. Thus, level 3 derivative instruments are measured using mark-to-model processes that may create doubts in the minds of the users of financial statements as to their reliability in investment decisions (Power, 2010).

During the financial crisis, it became a serious concern when fair valuations of financial derivatives indicated significant losses and trading in these instruments almost came to a halt, leading to inactive markets. As a result, level 3 valuations became increasingly important in determining balance sheet values of these instruments, leading to further cessation of trade and creating a downward spiral (Pozen, 2009).

Schmidt (2016) notes that Dodd-Frank regulations increased the accuracy of fair value measures and decreased the noise they introduce into financial reports by improving the liquidity and transparency of capital markets. Subsequently, the comparability of the measures of derivative instruments, such as credit default swaps (CDSs) improved (see below for a discussion of CDSs). With the recent loosening of the Dodd-Frank regulations, which will allow well-capitalized banks to take on more risk, it is important to examine the consequences of less regulatory rigor that existed during the crisis. For example, Bear Sterns, the first victim of the 2008 financial crisis, failed because of significant losses resulting from speculative real estate investment derivatives. Thus, any change in these regulations that increases the use of derivatives also injects noise into the financial information reported by banks, as the use of fair valuations increases in tandem (Office of the Comptroller of the Currency, 2017).

In summary, the use of derivatives during the financial crisis has been the subject of much controversy. At the core of the debates has been the issue of valuation. The use of fair market values to measure derivatives and the complexity of determining these amounts leads to the use of level 3 valuation approaches which, in turn, introduce noise in the reported fair market values. In the following sections, the purpose and major findings are first discussed, followed by a short background on derivatives. Next, the hypothesis development and the research methodology are presented. Finally, research results and their limitations and implications for future studies are discussed.

PURPOSE AND SUMMARY RESULTS

Following the methodology used by Valencia, Smith, and Ang (2013), this study uses a simulation approach in order to investigate the effect of noise resulting solely from the valuation of derivatives on the capital adequacy of banks at December 31, 2007. Tier 1 capital, total capital, and tier 1 leverage are the three primary ratios that are impacted the most by changes in the fair values of financial derivative contracts. Using these ratios, three bank capital adequacy benchmarks are examined: 1) well capitalized; 2) adequately capitalized; and 3) significantly undercapitalized.

Minimum bank capital requirements were set in place to prevent banks from taking on excessive risk (Wagster, 1996). During the decade leading to the financial crisis, banks circumvented these regulations by buying certain derivatives that allowed them to take on risk without the need of holding an adequate amount of capital to cover possible losses (Puwalski, 2003). During the financial crisis, poorly capitalized banks were more likely to use CDSs than those banks that were adequately capitalized (Office of the Comptroller of the Currency, 2009). For example, at the time that Lehman Brothers went bankrupt and defaulted on its bonds, AIG (which had sold CDSs for Lehman Brothers) did not have enough money to repay the companies that bought the swaps. While AIG was classified as adequately capitalized, a true measure of adequacy that included derivatives may have shown that AIG was undercapitalized.

Using data from the average balance sheets of 48 banks with nonzero derivatives as of December 31, 2007, a Monte Carlo simulation is used to create new balance sheet values. This information is used to determine the effect of noise in the fair values of derivatives on capital adequacy ratios. The results show that there is a significant probability of a type I error regarding the tier 1 leverage ratio at the well capitalized bank benchmark. Banks that experienced a type I error during the crisis period would have been charged higher FDIC insurance premiums, been required to obtain approval for brokered deposits, and had a difficult time getting approval for acquisitions. The difficulty in acquiring other banks is especially troubling because the process of consolidation was used during the financial crisis period to protect bank depositors and minimize economic damage (Slifer, 2008).

BACKGROUND ON DERIVATIVES

Derivatives are contracts between two or more parties that help reduce risk by trading one form of risk for another. Their value is based on, or derived from, underlying financial assets, such as stocks, bonds, interest rates, commodities, etc. The most common derivative contract types are swaps, forwards, futures, and option contracts (see Bodie, Kane, and Marcus, 2019, for more information).

Swaps

A swap is a private contract used to exchange periodic cash flows over a future period and are long term relative to other derivatives, such as futures and options. Because swaps are private, there is very little regulation on them, unless one of the traders is considered a swap dealer. Financial institutions that engage in more than $8 billion in swaps during a year are required to trade swaps through a clearinghouse. In these cases, market information is readily available for level 1 fair values. For institutions that do not trade swaps through a clearinghouse, assumptions and models must be used to value swaps, resulting in level 3 valuations. The classification will also be affected by the complexity of the swap. If swaps are buyer-seller specific, it will be difficult to determine comparables and level 3 valuation models must be used.

CDS are a type of swap largely used around the 2008 crisis. CDSs are derivatives that act as insurance by requiring the buyer to pay a periodic premium for insuring against default or the decline in value of the underlying asset. If default occurs, CDS owners receive a lump sum payment. The opportunity for profit, if no default occurs, can be significant if the seller of the CDS is able to gather enough information on the creditworthiness of the reference entity and establish an adequate premium fee. In addition, an institution can buy a CDS on a security that they do not actually own, which is equivalent to buying insurance for someone else's property (Levy and Post, 2005).

The market for CDSs predominantly includes large financial institutions, because these firms can easily gather the counterparty's creditworthiness information. CDSs are often used for mortgage-backed securities, and during the crisis, they were not regulated and mostly traded over the counter. Prior to Dodd-Frank, since there were no strict regulations on trading swaps, companies may have been purchasing them without having the ability to pay the amount of the loss in the event of default (e.g., the AIG debacle). CDSs gained their popularity at a time of economic prosperity because defaults were less common, and it was a great opportunity to make a profit. However, during the crisis, massive write-downs resulted from the use of credit derivatives, because the default rates on subprime mortgages were soaring. Fuller, et al. (2018) even find that firms with CDSs trading on their debt have greater equity issuance with higher risk.

Under the Commodities Futures Modernization Act of 2000, there were no central clearing houses to intervene when one of the members of a CDS contract was unable to perform its obligations. Companies selling protection at this time were not required to set aside capital to cover their obligations, so it became difficult to fully understand the financial position of these institutions. Moreno, et al (2014) state that companies classify these instruments as swaps instead of insurance because it allows them to circumvent the bank capital requirements. Stulz (2009) believes that CDSs contributed to the financial crisis, because no one could be sure of the financial position of another party. Due to this uncertainty, the credit markets froze up and AIG, with as much as $440 billion of mortgage-backed securities under contract, realized that it did not have enough capital to cover them, leading it to seek help from the government.

Forward Contracts

Forward contracts give firms and investors the chance to hedge against changes in future prices. These contracts usually allow for the exchange of a commodity (agriculture or oil) or financial asset (Treasury bills, currencies, stock indexes) at a future date. Forward contracts are traded over the counter with terms tailored specific to the buyer and seller. Thus, trading in forwards is often a difficult task, because the original contract requires that any subsequent buyer has to agree to the original terms, which makes forward markets illiquid. Forward contracts are not standardized and not traded on regulated exchanges, leading to higher credit risk. In addition, there is risk of default, called counterparty risk, because these contracts rely on other parties to fulfill their obligations (Levy and Post, 2005). Thus, investors require relatively high returns for forward contracts and many often use trading strategies to help increase these returns (Turkington and Yazdani, 2020). To try to mitigate this risk, firms encounter information costs to make decisions on the creditworthiness of the potential counterparty.

Futures Contracts

Futures contracts differ from forward contracts in that they are traded on exchanges, are standardized, and specify the quantity to be delivered at settlement. Futures can be more attractive than forwards to investors because they are liquid and there is less counterparty risk and information costs. The counterparty risk is lower because the exchange that futures trade on is a clearinghouse that acts as the counterparty for each transaction (see Bodie, Kane and Marcus, 2019). The market for futures contracts is very large with many participants, allowing these instruments to be recorded in the level 1 fair market value hierarchy. Futures are regulated by the Commodity Futures Trading Commission who monitors any price manipulation and the conduct of these exchanges. Since futures are exchange traded, if a buyer wishes to hold a position for a relatively long period of time, this position must be "rolled", where the buyer sells out of one contract and purchases another with a later expiration date (Bessembinder, 2018).

Options

Options are derivative contracts that give the buyer the right to buy or sell an underlying asset at a prespecified price during a specific period of time in exchange for a premium. Having a call (put) option gives the buyer the right, but not the obligation, to buy (sell) the underlying asset at the price specified in the contract until the option expires (Bodie, Kane, and Marcus, 2019).

Options act like insurance, which results in the buyer paying the seller a premium for the right to trade the underlying asset. Options can be traded over the counter or on exchanges, providing level 1 fair values. The actual purchase or sell of the underlying asset on option contracts only happens when an option is exercised, so there are less fluctuations of capital with options than with other derivatives. The buyer of an option pays the premium because options protect the buyers from losses by limiting their loss to the cost of the option. The seller of the option does not have the same limit on losses. Given that buyers of options have limited losses, large options trading volume is often associated with more market information (Blanco and Wehrheim, 2017). Trading in options sends signals to market participants where the value of a call option increases as the market price increases and the value of a put option increases as the market price decreases.

HYPOTHESIS DEVELOPMENT

Proponents of derivatives believe that these instruments increase cash flows and reduce risk in the financial system (e.g., Ryan, 2007). Opponents believe that they are risky and have the potential to result in significant damage to those dealing in them (e.g., Keenan and Snow, 2010).

The Office of the Comptroller of the Currency (2009) states that derivatives are important to the financial markets and the world economy, because they provide a means for companies to separate and trade various kinds of risks. If derivatives did not exist, investors would be less likely to engage in the same number of investments as they now do, decreasing the overall liquidity of the financial system, making it harder for firms to borrow, and slowing down economic growth (Campbell et al, 2019). One purpose of derivatives is to hedge against market uncertainty or payment default. Prior research concerning noise in financial information focused on CDSs because many believed that they provided the best opportunity for banks to manipulate their capital requirements (Alnassar and Chin, 2015). Futures and listed options are traded on exchanges so it can be assumed that the noise factor in information provided is smaller than those provided by forwards and CDSs.

Many believe that fair market values, specifically with regards to subprime loans and CDSs, had nothing to do with the crisis, and that the change in values simply communicated the effects of bad decisions made by management (Ryan, 2007). In Congressional testimonies, the members of the FASB repeatedly stated that the use of fair values helped with the recovery from the crisis in that they provided information that investors needed in order to be comfortable in recapitalizing troubled firms. Additionally, only financial instruments that are held in trading and available for sale portfolios are measured at fair value. According to a study by the SEC (2008), assets valued at fair values accounted for 31% of bank assets at the time of the crisis, with reported losses decreasing regulatory capital by 22%. Even if fair market values did differ from fundamental values, the impact on a bank's health would have been temporary.

On the other hand, opponents have expressed their concern over the use of derivatives. Stiglitz (2009) states that complex financial derivatives are time bombs that may damage both the parties that deal in them and the economic system. These accusations are based on concerns where there is a lack of market information to determine accurate fair values, an absence of regulation, and a high counterparty risk when a clearinghouse is not used (Eichengreen et al, 2012).

Power (2010) examines the connection between fair market values and the financial crisis and concludes that accounting used to record derivatives provided a platform and catalyst for demands to expand the use of fair market values to all financial instruments. While the use of fair market values may be the best option for valuing derivatives, net realizable values (NRVs) can differ substantially from estimated values, especially for risky financial instruments such as residual interests from securitizations and complex derivatives (Ryan, 2007).

During the financial crisis, most capital markets became inactive casting doubt on the fair values obtained from analyzing trades and prices. To mitigate this problem, the FASB promulgated revisions to the fair valuation standards that allowed companies to transfer level 2 assets to level 3 and use mark-to-model processes. However, banks were not required to disclose the worst-case scenario losses on derivatives and the assumptions used for obtaining level 3 amounts, leaving investors in the dark when trying to determine fundamental values for these instruments (Ferrara and Nezzamoddini, 2013).

Given the opposing views on the use of derivatives and the fact that existent literature has not provided conclusive findings on this matter, we hypothesize (stated in the null form):

> *H1: Noise in fair market values of derivatives will not affect the determination of bank capital adequacy ratios and the subsequent bank capital adequacy classifications.*

DATA AND METHODOLOGY

Data: Sources and Justification

The study focuses on three capital adequacy ratios: 1) tier 1 capital; 2) total capital; and 3) tier 1 leverage. The capital adequacy ratios were introduced in 1988 by the Basel Accord to provide standardized measures for all banks. Each ratio is computed by dividing components of equity or debt by a measure of risk-weighted assets. For example, tier 1 capital ratio is computed by dividing tier 1 capital by weighted average assets. The total capital ratio is computed by dividing tier 1 plus tier 2 capital by weighted average assets. Finally, the tier 1 leverage ratio is computed by dividing tier 1 capital by unweighted average assets. Using these ratios, the study categorizes banks under three benchmarks: 1) well capitalized; 2) adequately capitalized; and 3) significantly undercapitalized. Failure to comply with these requirements can lead to punitive actions by regulatory bodies, forcing a bank to recapitalize, stop growing, or go into receivership.

The data used in the simulation is based on the average reported values of the December 31, 2007 balance sheet amounts of the 48 banks included in the sample. The sample includes banks that reported non-zero derivative balances, which are also the largest banks by size of assets. This information is publicly available through the Board of Governors of the Federal Reserve System in Form FR Y-9C. The average starting balances as of December 31, 2007 were chosen because this date precedes the crisis period. The average balances on December 31, 2007 are assumed to be fundamental values and are used to determine if simulated changes in periods going forward are fundamental (without noise) or non-fundamental (noise component).

While the Dodd-Frank Act increased regulatory oversight of derivatives, recent efforts to loosen these rules makes it important to examine a period of lessened oversight (such as the crisis period) in an effort to inform what could reoccur as regulations are relaxed (Rajoo, 2017). During the crisis period, most derivatives were unregulated and valued using mark-to-model processes. These level 3 valuations included various assumptions and estimations instead of market derived quotations, possibly increasing the noise content of the information.

The difference in the popularity of derivatives and level 3 asset valuations between 2008 and 2016 is another reason for further investigation. In the first quarter of 2008, notional amounts of derivatives peaked at $200.4 trillion. This amount has declined to $165.2 trillion in 2016, with only 39% being centrally cleared as level 1 assets. Bank level 3 assets peaked at $204.1 billion in the fourth quarter of 2008 and have declined since the crisis down to $33.8 billion in the fourth quarter of 2016 (Office of the Comptroller of the Currency, 2017). This 84% decline is most likely due to the increased regulation and more readily available market information.

Alnassar and Chin (2015) examine the reasons that banks use credit derivatives for risk management. They find that the decision on the use of certain derivatives as hedging instruments was positively and consistently associated with the size of banks, costs of financial distress, and the level of exposure to risk and was negatively associated with the capital positions of the banks. Accordingly, certain derivatives were only used by bigger banks and had higher costs. This is consistent with the characteristics of the sample of larger banks used in this study and shows that the financial distress may have been more significant for banks with particular derivatives. Additionally, banks using these derivatives had lower capital adequacy positions.

Table 1 shows the data and descriptive statistics of the average bank balance sheet at December 31, 2007. Total assets equal $233 billion, of which 25.3 percent ($59 billion) are carried at fair market value. Derivative assets carried at fair market values represent 6.1% of all assets carried at fair market values. Total liabilities equal $215 billion, of which 5.3 percent ($12 billion) are carried at fair market value. Derivative liabilities carried at fair market values represent 44.5% of all liabilities carried at fair market values. The sample average bank tier 1 ratio is 8.1 percent. Further decomposing this ratio shows that the sample average bank total capital ratio is 11.2 percent, and the leverage capital ratio is 6.7 percent.

Table 1
DESCRIPTIVE STATISTICS OF THE AVERAGE BANK BALANCE SHEET AS OF DECEMBER 31, 2007 ($ in thousands; N = 48)

Variable	Mean
Total Assets	$ 233,094,415
Total Liabilities	215,476,916
Total Owners Equity	17,617,499
Assets at Fair Market Value (AFV)	58,974,650
AFV / Total Assets	25.3%
Derivative Assets at Fair Market Value (DAFV)	3,597,691
DAFV/AFV	6.1%
Liabilities at Fair Market Value (LFV)	12,248,025
LFV / Total Assets	5.3%
Derivative Liabilities at Fair Market Value (DLFV)	5,457,113
DLFV/LFV	44.5%
Tier 1 Capital ratio	8.1%
Total Capital ratio	11.2%
Tier 1 Leverage ratio	6.7%

Methodology

The use of a Monte Carlo simulation allows us to explore the effect of noise in fair values on capital adequacy ratios. This methodology allows for the estimation of the capital effects of both fundamental (without noise) and non-fundamental changes (noise due to measurement error) in reported fair values. To obtain the values shown in Table 2, a total of 10,000 simulated runs are estimated, each one hypothetically representing one fiscal period end. When each simulation is run, hypothetical index values are estimated for the fair market value calculations. The Monte Carlo simulation assumes a normal distribution and randomly generates a new set of values for all indices at once. These simulated index values are constrained by both the historical distributional properties for each index (mean and standard deviation), and the historical cross correlation between all indices (correlation matrix), which are based on quarterly changes in values from 1972 to 2008. Data is gathered from the Federal Reserve, the National Bureau of Economic Research, the office of the Chief Economist, and the Center of Research in Security Prices.

The simulated indices are then used to estimate new fair values for all derivatives. After using the data to calculate fair market values of derivatives, adjusted balance sheets are obtained and new capital adequacy ratios are calculated. Using data from each of the 10,000 runs, two separate sets of balance sheets are created. First, the balance sheet showing the fundamental changes (without noise) in fair market values of derivative assets and liabilities is obtained.

Next, a second set is obtained that shows fundamental and non-fundamental changes in fair market values, with non-fundamental changes indicating the noise in measurement error component. The example below illustrates how the new balance sheet values are computed.

Table 2
DISTRIBUTIONAL PROPERTIES OF EACH INDEX AND THE FAIR-VALUED ASSETS/LIABILITIES USED FOR EACH INDEX

Index	Term (months)	Mean[a]	Standard Deviation[a]	Asset/Liability Values
3 month Treasury Bill rate	3	0.058	0.030	U.S. Treasury and State Securities
Fixed rate first mortgages	360	0.091	0.028	Mortgage-backed securities and real estate loans
Personal loans rate	24	0.140	0.017	Credit Card, Auto, and Consumer Loans
Moody's BAA bond rate	120	0.095		Commercial and Industrial Loans
S&P 500 index	3	0.018	0.069	Investment in Mutual Funds and Short Positions
Federal Funds rate	1/30	0.065	0.035	Federal Funds
Freddie Mac Home Price index	5	0.057	0.063	Real Estate

a. The means and standard deviations are based on the historical changes in the quarterly values of the indices during the period 1972-2008
NOTE: This table contains the same information that was used by Valencia, Smith, and Ang (2013)

Consider one simulated change to the S&P 500 index. A hypothetical quarterly return for the S&P 500 is generated by the Monte Carlo simulation software based on both (1) the historical distributional properties (from Table 2: mean of 1.8 percent and standard deviation of 6.9 percent) of the quarterly S&P 500 returns, and (2) the historical cross-correlation between the S&P 500 and all other indices for the period 1972–2008 (untabulated). Assume that a derivative value based on the underlying value of equity securities is valued as an asset for $100 at period t. Further, assume that one of the 10,000 runs generates a simulated S&P 500 return of 5 percent for period t+1. Based on this data, we revalue the equity securities at $105 for period t+1. The difference between the carrying value at t and the new value on t+1 ($5) is considered a gain that flows to owner's equity (which affects capital values on the ratios). We assume that the gain of $5 is based on fundamental changes in fair values.

The next step involves the introduction of noise (measurement error). This is necessary in order to investigate the effects of noise in fair values on bank capital. Our approach allows us to estimate new index values in a way to allow noise to either have an amplifying or dampening effect on each index. Noise is modeled based on a second set of independent simulated runs of the index based on N (0, historical sigma of S&P 500 index). Continuing with the equity securities example above, assume that a second independent simulated run (representing noise) generates an S&P 500 return of 1.2 percent. The noise component (1.2 percent) is added to the first simulated index value (5 percent). The revised S&P 500 return of 6.2 percent reflects both fundamental (5 percent) and non-fundamental (1.2 percent) components. This procedure results in a new value for the equity securities of $106.20 ($100 original value * 6.2%), comprised of a

$5 gain due to fundamental changes in value ($105-$100), and a $1.20 gain due to non-fundamental changes in value ($106.20- $105). The simulation approach used to model noise allows us to generate measurement error that is not only naturally scaled by the distributional properties of each index, but is also able to have either an amplifying or dampening effect on fair values.

Each simulation run results in two balance sheets: (1) one reporting fundamental values in fair market values; and (2) the other one reporting both fundamental and non-fundamental changes (noise) in fair market values. We compute new capital ratios based on each balance sheet. After simulating 10,000 runs, we generate a probability distribution of the ending values for each capital adequacy ratio based on: (1) only fundamental changes (without noise) in fair market values; and (2) both fundamental and non-fundamental changes (noise) in fair market values. Next, the distributional properties from each scenario are examined to see if noise leads to the occurrence of either type I or type II errors around each of the three capital adequacy benchmarks.

Type I errors arise when the computed capital ratio with noise is higher than the fundamental capital ratio. This unwanted effect can cause regulators to misidentify a fundamentally healthy bank as troubled and result in additional unwarranted monitoring and compliance costs to the bank. A type II error arises when the computed capital ratio with noise is lower than the fundamental capital ratio. This undesirable effect can lead regulators to misclassify a fundamentally troubled bank as healthy. This could result in erroneously allowing a bank to continue to operate without the proper oversight.

RESULTS

Table 3 shows descriptive statistics for the cumulative probability distributions of capital ratios reflecting changes in fundamental values only versus changes in fundamental and non-fundamental values (columns A and B, respectively). Results indicate that the mean tier 1 (total) [leverage] capital ratios that include non-fundamental values or noise are 0.089 (0.133) [0.049], respectively. These ratios are almost identical to those without noise of 0.088 (0.132) [0.049], respectively. These results suggest that noise in derivative fair values plays a very small role in these capital ratios, as predicted by the SEC (2008) study which demonstrated that fair valuations lowered regulatory capital 22%, with the impact lasting for a brief period.

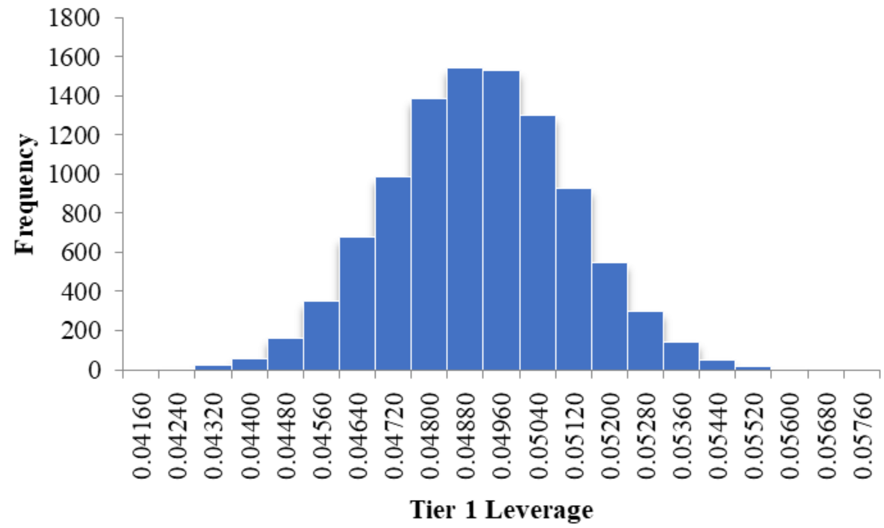
Despite noise appearing to play a small role in the capital ratios, we find that noise leads to categorization errors in one capital ratio. More specifically, the study finds that there is a 26% higher probability of identifying a fundamentally well capitalized bank as adequately capitalized because of noise (type I error). In other words, out of the estimated 10,000 simulated runs, approximately 2,600 simulation runs show that noise makes the Tier 1 Leverage ratio fall below 5% even though fundamentally the bank's Tier 1 Leverage ratio is above 5%. To be considered well capitalized, a bank needs to report a minimum of 5% for the Tier 1 Leverage ratio. This is an example of a type I error for the Tier 1 leverage ratio. Figure 1 and Figure 2 illustrate the histograms of the Tier 1 Leverage ratio for changes in (A) fundamental values and (B) changes in fundamental and non-fundamental values, respectively, for the 10,000 simulated runs. While a visual inspection of the histograms may not appear as if noise in fair values biases the Tier 1 Leverage ratio downward, the occurrence of the aforementioned type 1 error is of economic significance to banks.

Banks that appear to be adequately capitalized due to noise, as opposed to fundamentally well capitalized, may encounter additional costs or miss out on profitable opportunities that are only available to well capitalized banks. A well-capitalized bank will pay lower premiums for Federal Deposit Insurance, be audited less frequently by regulatory bodies, and will be subject to less invasive regulatory actions. Once a bank falls below well capitalized, it must obtain approval in order to make brokered deposits. Finally, adequately capitalized banks will also have a more difficult time getting approvals for acquisitions of other banks and have restrictions on the interest rate that they can pay on deposits. The latter restriction is very important because the crisis period provided a unique opportunity for banks to increase exponentially in size through acquisitions. Acquisitions helped stabilize the banking industry by preserving both customer and shareholder wealth. Thus, restrictions placed on fundamentally well capitalized banks that were misidentified as adequately capitalized may have hampered the stabilization of the banking industry and prolonged the crisis.

Table 3
DISTRIBUTIONAL PROPERTIES OF THE CAPITAL ADEQUACY RATIOS UNDER TWO SIMULATED BALANCE SHEETS:
(A) changes in fundamental values only; (B) changes in fundamental and non-fundamental values.

	Tier 1 Capital Ratio		Total Capital Ratio		Tier 1 Leverage Ratio	
	A	B	A	B	A	B
Mean	0.088	0.089	0.132	0.133	0.049	0.049
Number of Trials	10,000	10,000	10,000	10,000	10,000	10,000
Standard error	0.000036	0.000003	0.000036	0.000002	0.000020	0.000002
Minimum	0.073	0.088	0.117	0.132	0.041	0.048
Maximum	0.101	0.090	0.144	0.133	0.056	0.050
Median	0.088	0.089	0.132	0.133	0.049	0.049
Range	0.028	0.002	0.028	0.002	0.015	0.002
Std. Deviation	0.0036	0.0003	0.0036	0.0002	0.0020	0.0002
Variance	0.00001314	0.00000007	0.00001314	0.00000006	0.00000403	0.00000002
Skewness	0.048	-0.015	0.048	-0.015	0.048	-0.014
Kurtosis	2.958	2.892	2.958	2.892	2.957	2.892

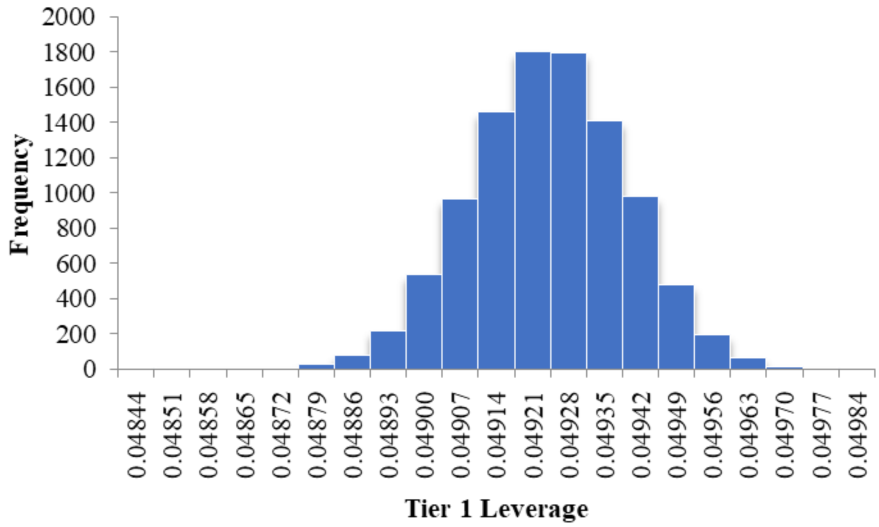
Figure 1
Histogram of Tier 1 Leverage (Scenario A)



CONCLUSIONS AND IMPLICATIONS FOR FUTURE RESEARCH

This study focuses on the impact of noise in the fair values of derivatives on the incidence of type I and type II errors surrounding bank capital adequacy ratios. By separating the simulated calculations into fundamental and non-fundamental changes, the study finds that fair valuation of derivatives results in misclassifications of banks for one ratio. Out of the three widely used capital adequacy ratios, only the tier 1 leverage ratio was affected by noise in the fair market values of derivatives where the study shows that there was a 26% higher probability of a type I error surrounding the well capitalized benchmark. These banks would have experienced both monetary and opportunity costs due to such misidentification.

Figure 2
Histogram of Tier 1 Leverage (Scenario B)



A limitation of this study is the use of simulated data that may not perfectly represent reality. Although the simulation is based on historical trends and correlations among indices over a 26-year period, the results should be carefully considered. Another limitation is the use of the December 31, 2007 average bank balance sheet values as the starting point for the simulation where it is assumed that these amounts exclude noise. In addition, the simulations do not indicate if a misclassification is due to measurement error or due to the nature of the derivative. Finally, the analyses are based on the information reported by only 48 banks, limiting the generalizability of the findings.

This study offers opportunities for future research that may take a more granular approach and examine specific types of derivatives. Due to a lack of data availability, this study could only measure noise based on a sum of all derivatives with positive values (assets) and a sum of all derivatives with negative values (liabilities). If values for each type of derivative (i.e., CDSs, forwards, futures, and options) were available, it would have been interesting to determine if there was a particular type of derivative that was noisier than others. Such narrow focus would allow investors and regulators to get a better understanding of the potential impact of noise on specific derivatives. Finally, future research may determine how the current drive to relax the Dodd-Frank act will affect noise associated with derivatives. Recently, the act has been amended to allow for less stringent regulations, which significantly reduced noise in fair valuations. Analyzing the consequences of the initial increase in regulation may enable the researchers to determine the potential for opposite results.

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