A Conceptual Framework for Examining the Impact of Basel 2.5 on Market Risk Capital

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Abstract

This study presents a conceptual framework that highlights the overreaching impact of Basel 2.5 on market risk capital. The Basel accords provide the basis for the calculation of the minimum capital that banks should maintain to fully absorb their credit, market, and operational risks. In Basel 2.5, the calculation of market risk capital is enhanced by the inclusion of *stressed value-at-risk*, a new metric designed to account for future periods of extreme market volatility. As this study demonstrates, however, the use of this additional risk estimator often leads to the unintended consequence of excessive and costly capital charge, especially when the stressed period is overshadowed by more recent but less turbulent market events.

I. Introduction

The provision of market risk capital in financial risk management is designed to ensure that the size of capital held by a bank is in line with its market risk exposure. Months after the 2008 global financial crisis ended, many large banks in the United States and Europe faced continuing financial stress. Among the factors responsible for the persisting uncertainty were the slow recovery of the U.S. housing sector, high delinquency rates among residential and consumer loan customers, and excessive European sovereign debt. Because systemic bank failures undermine the safety and soundness of the financial system, banks have a regulatory mandate to maintain sufficient economic capital to fully absorb their risk losses.

In determining their capital adequacy, banks first endeavor to incorporate expected losses into the cost of their services. Losses beyond this level are then estimated and included in their capital provision. Under the regulatory guideline of the Basel Committee on Banking Supervision, more than one half of the total required capital should be in the form of common equity, also referred to as core tier one capital. In any event, minimum capital must be at least eight percent of the financial institution's risk-weighted assets.

The three types of risks considered by the Basel Committee are credit, market and operational risks. Credit risk is the risk of loan default and is the preeminent risk faced by banks, since most of their assets are held as loans. Market risk arises from a bank's exposure to fluctuations in equity prices, foreign exchange rates, interest rates, credit spreads, commodity prices, and the prices of derivatives in which they hold positions. Operational risk consists of a host of nonfinancial risks that nevertheless result in a financial loss to the institution. Examples are theft, natural hazards, IT security breaches, product and work safety problems, and various environmental hazards.

The first of the Basel Accords, referred to as Basel 1, was published in 1988. This initial accord prescribes the minimum capital requirement for credit risk. The 1996 amendment to this accord specified additional capital charge for market risk. It was this amendment that required

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banks to measure and hold capital to cover their market risk losses from all transactions in their trading book, including off-balance sheet items. Basel 2, which came into effect in 2007, introduced operational risk into the mix of minimum capital calculation.

In September 2010, the Basel Committee published Basel 3, which contains tougher capital requirements for credit risk. This latest accord raised the amount of tier one equity capital for credit risk losses. It also includes a provision for liquidity requirements for banks. These new standards were introduced in response to observed deficiencies in financial regulations following the 2008 global financial crisis.

Earlier, in July 2009, the Basel Committee introduced a revision to the standards for calculating market risk capital, called Basel 2.5. The revised regulation was developed in response to large market risk losses that occurred at the peak of the financial crises. The Committee discovered that a significant amount of the losses that initially appeared as credit risk losses, were in fact the result of the market risk exposure of the financial institutions. Examples were changes in credit ratings, widening credit spreads, and declining liquidity in the bank's tradable assets. As a result, Basel 2.5 introduced a revised method for calculating value-at-risk (VaR) referred to as "stressed VaR."

Value-at-risk is the key metric for determining the minimum capital requirement for market risk losses. It calculates the maximum loss that can occur within a defined period at a given confidence level. Stressed VaR (sVaR) strengthens the bank's capital provision for market risk by incorporating empirical data from a past period of extreme market volatility. Thus, in revising the basis upon which VaR is calculated, Basel 2.5 aims to strengthen the capital requirement for market risk so as to better prepare banks to cope with future periods of extreme market volatility. In view of this, this study is designed to determine if sVaR is in fact an improvement over previous risk measures in estimating market risk capital. This is done with the use of equity market data for internationally active banks.

II. Motivation

Under the 1996 Amendment of the Basel Accords, market risk capital (MRC) calculation is based on a 10-day, 99 percent confidence VaR. The more commonly used approach for determining MRC is the Internal Models Approach in which the capital charge is the greater of the previous day's VaR or the average VaR over the last 60 business days, as follows.[1]

$$MRC_t^{IMA} = Max\left(k\frac{1}{60}\sum_{i=1}^{60} VAR_{t-i}, VaR_{t-1} \right) + SRC_t, (1)$$

Where k = a multiplicative factor determined by regulators, not to be less than 3; SRC = specific risk charge, which may be added depending on the performance of the model.

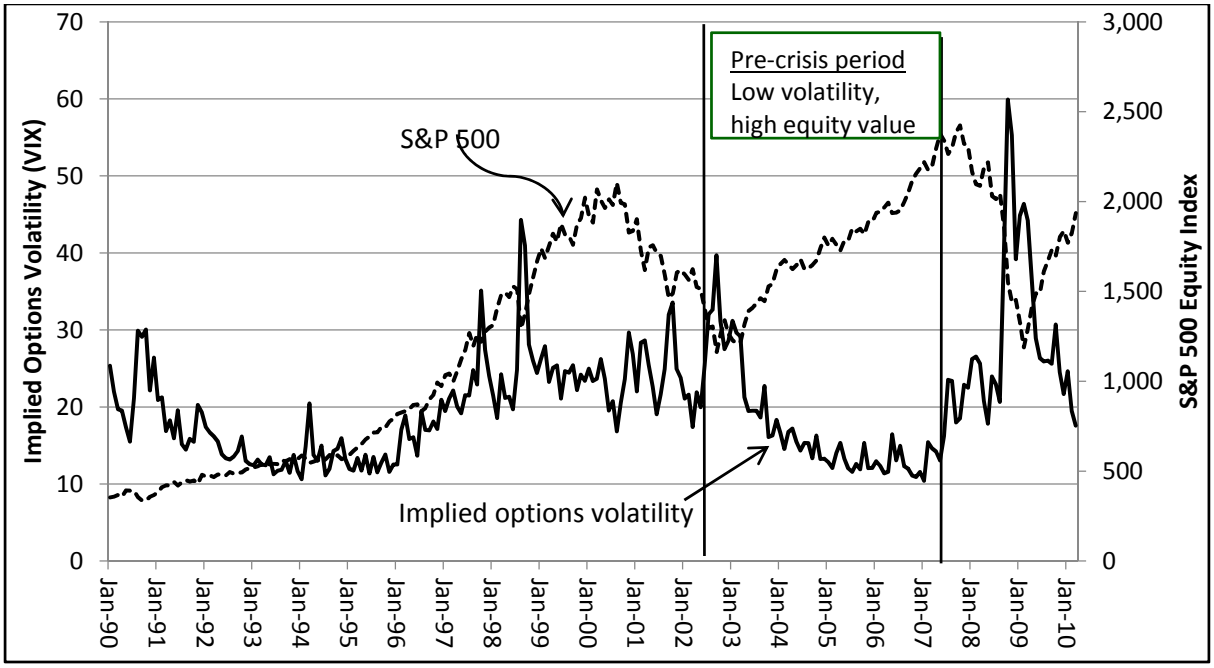
One of the two methods that are typically used to calculate VaR is the variance-covariance approach. This method assumes that investment returns are normally distributed.

[1] "An Internal Model-Based Approach to Market Risk Capital Requirements," Bank for International Settlements, April 1995. www.bis.org/publ/bcbsc224.pdf. (Retrieved on March 24, 2013).

Thus, for the 99 percent confidence level, VaR is determined at 2.326 standard deviations below the mean return. The other and more commonly used approach is historical simulations, which assumes that the next day's market performance will be similar to the market condition in the period from which the data was generated. With daily data, the 1-day 99 percent VaR is determined as the first percentile of the distribution.

As it later became evident, market volatility between 2002 and 2006 was too low to realistically estimate VaR for the subsequent turbulent period of 2007-2009. The evidence presented in Figure 1 shows that implied volatility, a broad measure of expected market risk often referred to as the investor fear gauge, actually declined in the pre-crisis period. This behavior shows that the equity market failed to incorporate the rising financial risk indicated by the widening credit spreads at that time. Expected market risk is measured by VIX, calculated by the Chicago Board Options Exchange as the implied options volatility on the broad S&P 500 stock index. This metric tends to rise as investor anxiety rises and declines as the market stabilizes.

Figure I. Stock Market Performance Before, During and After the 2008 Financial Crisis



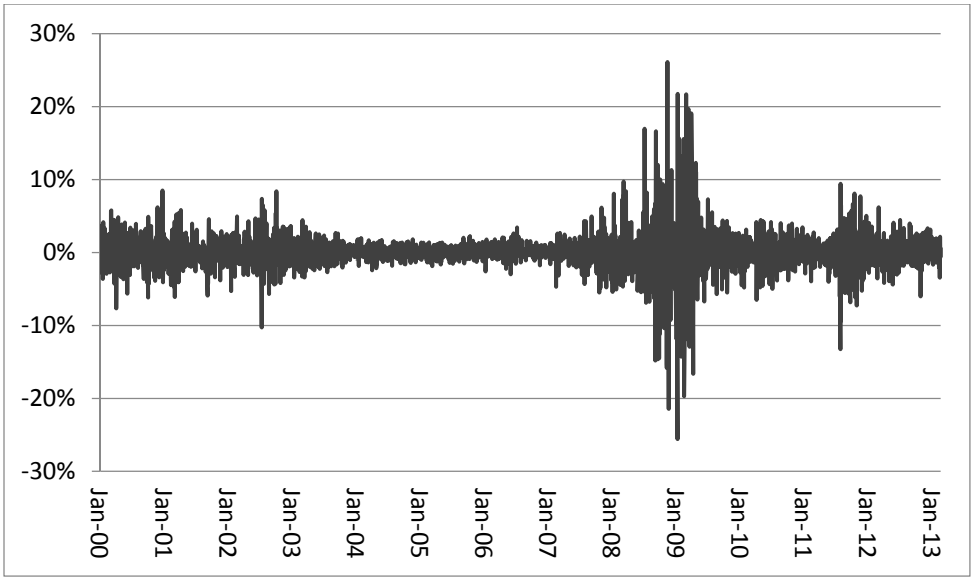
This pre-crisis disconnect between the equity market and implied volatility, initially pointed out by Obi, Lerner, and Sil (2010), largely explains why the stock market rose markedly during that period. Basel 2.5 attempts to overcome this estimation oversight by requiring the inclusion of data from a recent 250-day period in which market conditions were particularly turbulent.

The pattern of daily equity returns of the largest U.S. and European banks, shown in Figure 2, illustrates why the standards of Basel 2.5 may be seen as particularly consequential. As the chart shows, there is a tendency for market volatility to cluster at specific periods. For example, U.S. bank stocks exhibited much higher volatility both during the early 2000s when the dot com bubble was at its peak as well as during the 2007-2009 financial crisis. This volatility persistence, known as generalized autoregressive conditional heteroscedasticity or GARCH

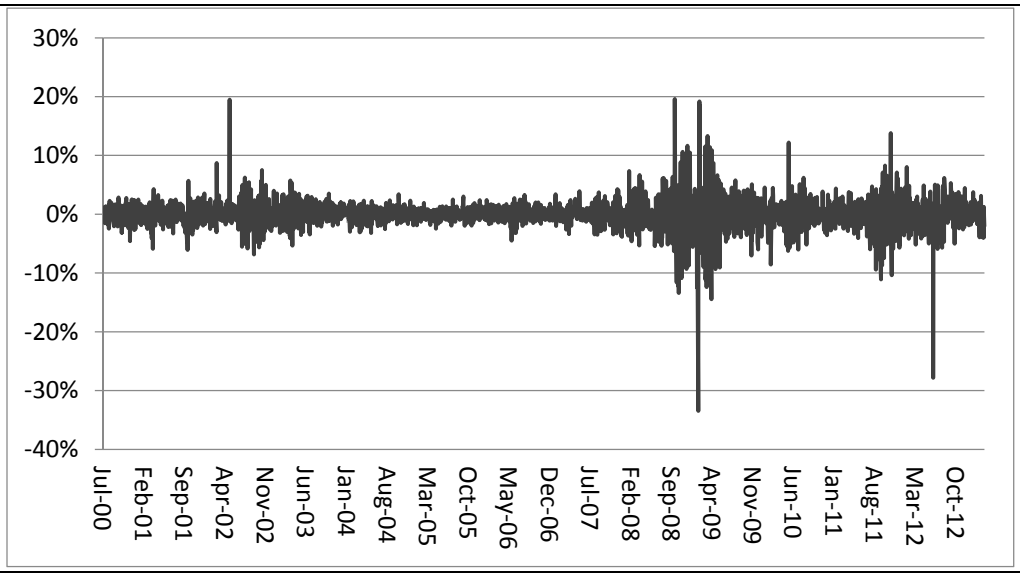
(Bollerslev, 1986), suggests that any VaR calculations for 2007 and beyond with data from the preceding period, would have significantly underestimated the worst-case loss. This also means that the size of economic capital capable of fully absorbing the huge losses that occurred in the turbulent months that followed, would also have been underestimated.

Figure II. U.S. and European Bank Stocks Daily Returns

Panel A. U.S. Bank Stocks: Daily Returns



Panel B. European Bank Stocks: Daily Returns (in USD)



This study begins by first demonstrating the application of sVaR, as described in Basel 2.5, which is accomplished by the utilization of VaR estimates from a 250-day period of intense market disturbance. With this approach, the calculated value-at-risk is believed to be less likely to underestimate the worst case market risk loss and thus, the amount of capital that can fully

absorb that loss. Finally, the misestimating anomaly of this approach is demonstrated using equity market data for both the U.S. and European banking sectors.

III. Literature

One of the initial studies to critique the regulatory burden of Basel 2.5 is by Moosa (2012), who observes that the new guideline is unnecessarily complex and costly. Moosa notes, in particular, that the guideline fails to address the key regulatory problem in Basel 1 and Basel 2, which is the calculation of regulatory capital with risk-weighted assets. The challenges of bank capital adequacy were also the focus of a study by da Veiga, Chan, and McAleer (2012). They explain that while high capital provisions are intended to mitigate costly bank failures, striking a balance between the low risk benefit of a high capital charge and the opportunity cost associated with it is a struggle that many banks continue to face.

Prorokowski and Prorokowski (2014) discuss how banks are coping with the regulatory challenges of stressed value-at-risk. In a survey of European banks, the authors find that the lack of regulatory guidance and inadequate market data pose the greatest hindrances in coming up with realistic risk measures. The authors also find that majority of the banks utilize historical simulations, the same method used in this study. Driven by the lack of industry consensus on the Internal Models approach for Basel 2.5, Wilkens et al (2013) provide a working example of VaR calculations using two alternate methods: Incremental Risk Charge and Comprehensive Risk Measure. Unfortunately, their use of selected risk factor models to derive simulation-based loss distributions may be biased since they lack uniformity across banks.

In an empirical study that accounts for the effects of time-varying volatility, McAleer, Jiménez-Martín, and Pérez-Amaral (2013) show that the median point forecast of value-at-risk (VaR) is still robust even in times of financial crisis. As such, VaR enhancements, as indicated in Basel 2.5, may lead to an overestimation of market risk capital. A similar critique is posed by Masood and Fry (2012) in a survey of risk managers in the developing economies. Masood and Fry find that the implementation of the new rules is fraught with problems due to limited expertise. Given the circumstance, the authors conclude that these recent and more complex models described in Basel 2.5 and Basel 3 may never be successfully implemented by these banks.

Bhowmik and Tewari (2010) wonder if the disproportionate emphasis on credit risk in the Basel Accords might have contributed to the overall poor risk management in many emerging economy banks – like those in India. In a case study of the failed Global Trust Bank of India, they find that the disregard for operational risk was chiefly to blame for the bank's woes. Their analysis employed the CAMELS model, which was the precursor to the Basel's risk-weighted capital framework.[2] Supporting this view, Rippel and Teplý (2011) show that models which combine historical loss events and scenario analysis provide the best estimates for operational risk capital. In a rejoinder, Kravitt (2012) argues that in spite of their flaws, recent financial regulations have helped overcome many of the regulatory lapses exposed by the 2008 financial crisis. Kravitt's study was based on an examination of the regulatory effects of all four Basel Accords (Basel 1, 2, 2.5, and 3) as well as the U.S. Dodd-Frank Act of 2010.

In a micro study of the risks in a bank-firm relationship, Gama and Geraldes (2012) find that smaller firms and firms with just one bank relationship are more likely to default on their

[2] CAMELS is an acronym, defined as follows: C - Capital adequacy; A - Asset quality; M - Management quality; E – Earnings; L – Liquidity; S - Sensitivity to Market Risk.

loans. Smaller firms are characteristically riskier with lower asset correlations. More than seeking to implement the regulatory model described in the Basel accords, Gama and Geraldes suggest that banks can more effectively manage their overall risk exposure by utilizing both financial and qualitative data in measuring their credit risk. In such cases, they suggest, market and operational risks are diminutive.

IV. The Methodology

In its practical application, market risk capital is based on the risk characteristics of the assets held in the bank's trading book. Nevertheless, because in an efficient market, stock performance is believed to reflect the risk characteristics of the firm's investments, this study uses the equity market data of the banks in the sample to demonstrate the impact of Basel 2.5 on market risk capital. Pursuant to this, two bank equity portfolios are constructed using daily stock price data from January 2000 to March 2013. One portfolio consists of the five largest banks in the United States while the other contains the seven largest European Union banks. Bank size is measured by asset size as published by *Global Finance* in 2012.

The selection of the largest banks in the U.S. and E.U. is deliberate. These banks have been widely cited in regulatory reforms – such as the Dodd-Frank Act of 2010 – as too-big-to-fail in that their performance is inextricably linked to the stability of the global economy. The largest bank in the working sample is Deutsche Bank, with asset size of almost $3 trillion. Goldman Sachs, with asset size of about $1 trillion, is the smallest bank in the working sample. In all, the total asset value of the U.S banks in the final sample is $8.5 trillion while that of the European banks is twice as much, approximately $17 trillion.

The two portfolios are equally weighted and each is evaluated based on a hypothetical investment of $10 million. Non-U.S. stock prices are first converted to U.S. dollars using the corresponding daily exchange rates published by Oanda. Daily returns, r_t, are then calculated for each of the stocks using the first logarithmic difference, as follows:

$$r_t = \ell n(P_t / P_{t-1}) \quad (2)$$

Where P_t and P_{t-1} are the current day's close and the previous day's close, respectively. For each day, the returns are averaged across all firms in the sample to find the daily portfolio return.

Although the U.S. stock market peaked in October 2008, both the U.S. and European bank stocks attained their highest levels much earlier, in May 2007. Thereafter, bank stocks began their descent following news that New Century Financial Corporation, a leading subprime mortgage lender, had filed for bankruptcy protection a month earlier.

As Figure 3 shows, U.S. bank stocks began their turnaround in January 2009 when the initial effects of the so-called Wall Street Bailout became visible. The same is true for European bank stocks, although their performance remained flat in the several months that followed. For this reason, the *in-sample* period of this study is from January 2000 to December 2011. This period includes the benign pre-crisis period of 2002 to 2006, the crisis period of 2007 to 2009, and the recovery period ending in 2011. The post-crisis recovery period is when the U.S. economy began to show signs of slow but sustained recovery.

Figure III. U.S. Bank Stocks: Average Daily Price

4.1 Calculating VaR using historical simulation

The in-sample period yields the data with which VaR is calculated. Pursuant to common practice, the estimation period is typically one to four years. For this study, however, the one-year in-sample period terminating on December 30, 2011, is used as the starting point to estimate next day's VaR and with that, market risk capital. To operationalize the risk calculation, the one-year daily returns in the last year of in-sample (January 2011 to December 2011) are used to find the first percentile return and the one-day VaR.

In line with Basel 2.5, stressed VaR (sVaR) is calculated using data from 2009. This in-sample period was identified in the study as the stressed period of 250 days. It was in this period that the U.S. financial markets and economy suffered their greatest decline. Accordingly, the two types of VaR are then combined to calculate the capital charge for market risk. This is derived by modifying Equation (1) to include sVaR, as follows:

$$MRC_t^{IMA,STRESSED} = Max\left(k_T \frac{1}{60}\sum_{i=1}^{60} VAR_{t-i}, VaR_{t-1}\right) + Max\left(k_S \frac{1}{60}\sum_{i=1}^{60} sVAR_{t-i}, sVaR_{t-1}\right), (3)$$

where

VaR_{t-1} and $sVaR_{t-1}$ = Regular VaR and stressed VaR, respectively

k_T and k_S = Multiplicative factors determined by bank regulators, with the constraint $k \geq 3$

The calculation of VaR_{t-1} and $sVaR_{t-1}$ are based on a 10-day time horizon and 99 percent confidence level, calculated on the previous trading day. Likewise, average VaR and average stressed VaR are based on a 10-day horizon and 99 percent confidence level. However, these are calculated over the preceding 60 days. The adjustment for 10-day VaR is made by multiplying the 1-day VaR by the square root of 10. To find the average VaR, 1-day VaR is first calculated for each day in the estimation (in-sample) period using one-year daily data. The VaRs are then averaged over the relevant 60-day period.

The 1-day VaR, based on the 99 percent confidence level, is the 1st percentile of the returns distribution when the returns are ranked from the smallest to the largest. Alternatively, it is the rate of return below which lies the worst one percent of the returns series. Given this amount of loss, the bank can be 99 percent confident that it will not incur a daily loss larger than that amount. Going forward, for each day in the out-of-sample (forecast) period, the next day VaR (VaR_{t+1}) is then calculated by updating the input data by one day at a time and then dropping off the earliest observation in the one-year in-sample period. In this way, the number of observations yielding the VaR remains unchanged, at approximately 250 trading days.

V. Results

Table 1 summarizes the VaR results and the estimates of capital requirements for both portfolios. The results show that if the next trading day is expected to reflect the general market conditions of the preceding one year, the maximum one day loss on the U.S. portfolio will be $121,964 while that on the European portfolio is estimated to be $133,186. When evaluated on a 10-day trading period, pursuant to Basel 2, the 99 percent VaR for the U.S. portfolio is $385,682, which is about nine percent less than the corresponding value for the European portfolio.

Table 1. Basel 2.5 Results Summary

	U.S. Portfolio	**European Portfolio**
Regular VaR (In-sample: Jan 2008-Dec 2011)		
1-day VaR at t-1 +	$121,964	$133,186
10-day VaR at t-1: VaR_{t-1}	**$385,682**	**$421,170**
10-day average VaR: VaR_{avg}	**$378,705**	**$410,961**
t-stat (p-value) for paired comparison	24.47 (0.0000)*	
Largest one-day portfolio loss in 2011	$251,415	$153,766
Stressed VaR (Jan 2009 - Dec 2009)		
1-day VaR at t-1	$319,378	$223,246
10-day sVaR at t-1: $sVaR_{t-1}$	**$1,009,962**	**$705,967**
10-day sVaR-avg: $sVaR_{avg}$	**$1,412,783**	**$757,808**
t-stat (p-value) for paired comparison	16.18 (0.0000)*	
Largest 1-day portfolio loss in stressed period	$548,467	$592,916
Total capital charge for market risk (k = 3)	**$5,374,464**	**$3,506,306**
Portfolio value at beginning of in-sample period (January 2008)	$10,000,000	$10,000,000
Portfolio value at end of in-sample period (December 2011)	$1,448,112	$1,084,093

+ Data from January 2011 - December 2011

* Significant at the 0.01 level

The 10-day average VaR for the U.S. portfolio is $378,705 and the corresponding value for the European portfolio is $410,961. The VaRs with which these averages are calculated were obtained from the 60-day period ending on the last trading day of December 2011. When the daily VaRs during this period are paired for the two portfolios, the test of significance shows that the market risk loss for the European portfolio is significantly larger than that of the U.S. portfolio. The t statistic of 24.47 indicates that the null hypothesis of equal daily market risk losses is rejected at the 0.01 level. This suggests that prior to Basel 2.5, European banks, would have needed to set aside a larger market risk capital than their U.S. counterparts, on average.

Interestingly, when the daily portfolio losses were examined, it was found that the largest one day U.S. portfolio loss (of $251,415) is about 1.5 times larger than that of the European portfolio. This outcome reveals a certain weakness of value-at-risk in its original construct. It does not identify the magnitude of loss if the 99 percent maximum threshold is breached. This weakness is, in part, what the stressed VaR attempts to overcome.

To calculate stressed VaR, historical volatilities for each of the years in the in-sample period were first examined. The outcome showed that 2009 was easily the most stressed period in the equity markets between 2000 and 2011. Therefore, stressed VaR results, presented in the mid-section of Table 1, are calculated with daily data from that year.

As it turns out, stressed VaR results are the opposite of those of the regular VaR – in terms of their impact on capital requirement. Specifically, the 10-day stressed VaR for the U.S. portfolio is $1,009,962, which is larger than that of the European portfolio by as much as $304,000. Similarly, the average VaR, calculated over the regulatory 60-day period, is much larger for the U.S. than for the European portfolio. In fact, the t statistic for the paired comparison of the daily VaRs during this period is 16.18, which is significant at any conventional level. Thus, while regular VaR results show a riskier European portfolio, the stressed VaR results show the U.S. bank portfolio is in fact much riskier, when viewed as of the end of 2011.

The evidence presented by the stressed VaR confirms the intensity of the U.S. credit crisis, which marked the beginning of the global financial crisis in 2008. Based on the specification of Basel 2.5, the market risk capital for U.S. banks, going into the out-of-sample period, is estimated to be $5,374,464 while that of the European banks is only $3,506,306. These results are shown in the bottom section of Table 1. Unfortunately, the effects of the financial crisis took a heavy toll on the market value of bank portfolios which, by the end of the observation period, had lost close to 90 percent of their values.

The European debt crisis intensified in the years after 2011. In addition to the huge sovereign debt of a number of E.U. countries, many French and German banks were particularly exposed to Greece's huge public debt, which, at the time was estimated to be 160 percent of GDP. The intensity of the financial crisis slowed economic growth and in some cases, forced many E.U. countries back into a recession. At the same time, the U.S. economy steadily improved. It is therefore paradoxical that the Basel 2.5 analysis in this study suggests that U.S. banks should have maintained a much higher core tier one capital than their European counterparts during this particularly turbulent period for the European economy.

VI. Conclusions

With a conceptual framework that utilizes stock market data, this study examined the impact of Basel 2.5 on the market risk capital adequacy of banks. Under this new standard, banks are expected to strengthen their market risk capital by incorporating data from a recent period of high market turbulence in the calculation of *stressed* value-at-risk (VaR). Using this approach, it is believed that the bank's economic capital would be better able to absorb the worst possible market risk losses. Unfortunately, as this study has shown, this enhanced estimation approach has the potential to significantly misestimate the bank's capital requirement.

The outcome of this study is important for two reasons. First, and in keeping with the tenets of Basel 2.5, it highlights the benefit of accounting for periods of high market stress in the estimation of market risk capital. For this reason, the calculated VaR for U.S. banks in 2010 was shown to be greater than that of the European banks, in recognition of the widespread market risk losses that U.S. banks incurred in the period leading up to the 2008 financial crisis. This outcome is an obvious reminder of the fact that the banking crisis that eventually spread to Europe and other parts of the world in 2008 had its roots in the U.S. housing market.

The second and perhaps more important implication may be viewed as an overreach on bank capital requirement. By elevating market data from a stressed period in the VaR calculation, the model tends to underrate the impact of ongoing market events, regardless of how extreme or benign they may be. The European debt crisis, which intensified after the global financial crisis ended in late 2009, is a case in point. In calculating the next day's market risk capital at the end of this period, it is reasonable to expect that more recent events should have a greater impact in the VaR calculation than much older market shocks. For this reason, the lower capital charge calculated for European banks over the course of the European debt crisis obviously underestimated the huge market losses that emerged in the several months that followed.

While post-crisis U.S. bank reforms, such as the Dodd–Frank Wall Street Reform and Consumer Protection Act of 2010, helped strengthen the balance sheets of U.S. banks, European banks remained exposed to the persisting uncertainty caused by the debt crises in Spain, Ireland, Portugal, Italy, and especially, Greece. For this reason, the use of stressed VaR, as stipulated in Basel 2.5, is unlikely to provide superior estimates of market risk capital; the reason being that it downgrades the impact of recent market shocks, as this study has amply demonstrated. Perhaps a remedy to this overreach is to assign a greater risk weight to more recent market events in the VaR calculation. In this way, the model would not only reflect the intensity of recent market stress but also the greater relevance of current market shocks.

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