Global Market Shock and Large Counterparty Default Study

Recommendations for Reforms Based on a Statistical Analysis of Stress Testing Scenarios

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Contents

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Introduction

To promote the stability of the financial system, the Federal Reserve Board (FRB) is responsible for regulating and supervising various financial entities. One of the tools the FRB uses to fulfill its mandate is stress testing of financial institutions.

The FRB has adopted a formal standard that, the severely adverse scenario of the Comprehensive Capital Analysis and Review (CCAR) program, the Global Market Shock (GMS) component should consider "hypothetical but plausible outcomes."[1] Unlike the macroeconomic component of CCAR, where the FRB has adopted formal unemployment rate and house price decline quantitative targets for the severely adverse scenario, the FRB has not adopted any quantitative thresholds for determining what severely adverse scenario shocks are "plausible" in the GMS component. The Study attempts to answer a simple question: does the available evidence indicate that GMS and Large Counterparty Default (LCD) shocks from recent CCAR cycles are plausible?

To answer this question, the Study evaluated the probability of various GMS/LCD shocks from the past several years. In many cases, the statistical probability of a GMS/LCD shock is extremely low. For example, as summarized in the pages that follow, the statistical probability of 2019 GMS spreads for certain corporate bonds occurring is 0.001%. The Study begs the question: should a one-in-one hundred thousand probability be deemed to be "plausible" within the meaning of the FRB's scenario design standard?

The Study does not propose a formal quantitative threshold for determining what GMS/LCD shocks should be deemed plausible. However, for reference, it is worth keeping in mind that the FRB modeled the Macroeconomic component's unemployment rate and house price decline quantitative targets on observed economic data from recent severe recessions. the 10 percent unemployment rate target, for example, is "the average level to which it has increased in the most recent three severe recessions."[2] The FRB's approach to calibrating severity in the macroeconomic component suggests that "plausible" shocks under the GMS should align with observed stress market conditions from recent severe recessions.

The Study concludes that, in a number of significant areas, GMS/LCD shocks are not reasonably plausible. In many areas, GMS/LCD shocks do not replicate, or approximate levels of severity observed in recent severe recessions, and in some key areas effectively impose double counting that exaggerates loss assumptions well beyond historic experience. In other cases, the assumptions that govern GMS/LCD shocks appear to be illogical, resulting in exaggerated stress loss estimates that do not align with plausible assessments of market or counterparty risk. Reasonably plausible GMS shocks are critical to the GMS and LCD components of the stress test, as they are the single tool that the FRB uses to size the test's severity. Unnecessarily severe calibration of shocks results in excessive capital requirements relative to potential risk,

[1] 12 C.F.R. § 252 Appendix A Section 5.2.3(c).
[2] 12 C.F.R. § 252 Appendix A Section 4.2.2.

which create uneconomic outcomes for firms, their clients and the market. These exaggerated stress loss estimates include instances where particular trading assets are subject to multiple, unreconciled stress loss assumptions, which can result in capital requirements that exceed trading assets' carrying value or other double counting that are analytically unsupported. The effect of implausible or illogical GMS/LCD shock calibrations and assumptions should be assessed not only in isolation, but also cumulatively; the coherence and risk management value of the GMS component are weakened if the GMS is not grounded in a reasonable assessment of banking institutions' actual vulnerabilities.

The Study provides detailed calculations in support of its conclusions, with the objective that open, transparent engagement will result in future GMS/LCD shocks that more clearly meet the FRB's stated objective of "hypothetical but plausible outcomes." In time, with further data analysis, we believe that the formal standards governing the GMS component could evolve to include quantitative targets analogous to the unemployment and house price decline ratios, thereby improving the coherence of CCAR stress loss analysis and strengthening its utility in risk management.

Executive Summary

To support the FRB's recent effort to review and improve the transparency, coherence and volatility of the CCAR program,[3] SIFMA[4] performed an analysis of the GMS and LCD components of CCAR. These efforts are described in this paper as: "Global Market Shock and Large Counterparty Default Study," or the "Study".

The primary goals of the Study were to understand and analyze the:

- Assumptions underlying the GMS, including its severity, plausibility, stability and degree of conservatism;
- Calibration and correlation assumptions embedded in the GMS;
- Coherence of incorporating the GMS in the LCD; and
- Transparency and coherence of the overarching CCAR framework.

The Study's empirical and statistical analysis reviewed the range of GMS shocks individually and collectively from the inception of CCAR through CCAR 2019. It also attempted where possible to understand and consider the impact of the new GMS approaches announced in February 2019 pursuant to which future scenarios would derive from historical, hypothetical and hybrid sources. The analytical approaches that the Study used to perform an assessment and draw conclusions included:

- Estimating the probability and severity of a subset of material GMS shocks using historical data, and assuming a conservative fat-tailed distribution;
- Evaluating the plausibility of the GMS shocks occurring simultaneously based on historical data;
- Analyzing the severity of GMS shocks individually against historical factor activity;
- Assessing trading volume data as a proxy for asset class liquidity during the crisis period;
- Examining regulatory approaches to estimating market dislocation duration; and
- Evaluating the use of GMS factor shocks on the LCD component's outcome.

[3] Although supervisory stress testing exists independently from CCAR, and the paper's comments focus on the FRB's supervisory stress testing more generally, this paper refers to CCAR and the FRB's supervisory stress testing framework interchangeably for convenience.
[4] The thoughts expressed in the document are that of SIFMA, however, BlackRock Financial Market Advisory assisted with the quantitative analysis and Debevoise & Plimpton LLP assisted in the preparation of this document.

Material Conclusions

- The severity of single-factor GMS shocks -- including their extended calibration -- are not considered reasonably plausible based on empirical analysis and unlike the macroeconomic scenario, do not appear closely tied to a detailed scenario;
- The correlation assumptions underlying the construct of annual GMS shocks cannot be empirically justified as reasonably plausible;
- The use of GMS factor shocks to size losses in the LCD component is not appropriate because of the factor shocks' severity, calibration and correlation assumptions;
- The use of the GMS and LCD components and the pre-provision net revenue (PPNR) framework to estimate losses leads to an inherent overestimation of losses and underestimation of available capital; and
- The limited transparency and disclosure regarding the assumptions which underly the GMS and LCD components impede public study and improvements in methodology.

Each of the material conclusions including the approach is briefly summarized below.

The severity of single-factor GMS shocks -- including their extended calibration -- are not considered reasonably plausible based on empirical analysis

To assess the calibration and the plausibility of individual GMS factor shocks, the Study used several analytical and statistical tests, including by evaluating the:

- Severity of a sub-population of material shocks based on historical factor activity;
- Relationships between shock factor moves;
- Probability of factor shocks occurring based on historical and crisis data;
- Trading volumes for a sample of asset classes across the crisis period as a proxy for market receptivity; and
- Access and capacity of specific markets to execute transactions following a material market event.

The Study found that the probability of a 2019 GMS factor shock occurring on a single day were extremely remote. For instance, the probability of market movements assumed by the 2019 GMS spreads for A/BBB/B- corporate bonds, single A rated Credit Card ABS, GBP/USD and EUR/USD were less than or equal to 0.001%. Similarly, the probability of the 2019 GMS S&P 500 Index shock occurring on a single day estimated using a historical time series was 0.002%. Estimating the same probability using only crisis data (126 trading days of the second half of 2008) and assuming a crisis occurs every 10 years, the probability that the S&P index would move 20.3% in one day was similarly low, implying a frequency of once in every four crisis periods. As further discussed below, the severity of the GMS shocks is compounded when applied simultaneously. Although stress test shocks should be severe, the extent of any such severity should not be so extreme as to be implausible. Introducing discipline into these assumptions would increase the comparability of CCAR results year-over-year and support more robust risk analysis and conservative capital management.

The study also employed a historical analysis to assess the plausibility of the severity of GMS shocks. Specifically, the study compared the most adverse GMS factor shocks used since 2013 with the most adverse performance for 10 asset classes. The analysis indicated that GMS factor shocks were more severe than the actual most adverse six-month period for five of the ten asset classes sampled. When reviewing the most adverse three-month period, the Study found that the GMS factor shocks were more severe than the most adverse three-month period for six of the ten asset classes reviewed. Finally, when reviewing the most adverse ten-day periods, the GMS factor shocks were more severe than the most adverse ten-day period for seven out of the ten asset classes sampled. These results underscore the severe calibration of the GMS shocks across the 10-day, three month and six-month time periods.

Lastly, the Study examined the market receptivity of certain asset classes immediately following a large- scale adverse event (such as the Lehman default, AIG bailout and Brexit). Using volume as a proxy for market receptivity, the Study found that U.S. Treasuries, corporate bonds, and FX pairs exhibited reasonable, and arguably even healthy, volumes immediately preceding and following the studied event. To test this hypothesis further, the Study used a Transaction Cost Model to test market capacity and depth. Ultimately, the analysis revealed that the markets in these asset classes were deep enough to support execution of large transactions, suggesting that certain asset classes should not be subject to the most severe calibrations.

Taking into account the results of the single factor analysis, the plausibility of historical GMS shock versus observed experience and our market function analysis, the Study concluded that the severity and calibration of many GMS shock factors were not plausible. Based on this finding, the FRB should more actively consider plausibility and consistency when calibrating the severity of the GMS shocks. An empirically supported range of severity and calibration metric would increase the credibility of CCAR's GMS and LCD components, and moreover, result in outcomes that support capital and risk management.

The correlation assumptions underlying the construct of annual GMS shocks cannot be empirically justified as reasonably plausible.

As currently constructed, the GMS assumes that multiple, if not most, asset classes will experience their most adverse or near-most adverse performance *simultaneously*. To assess the plausibility of this assumption, the Study conducted various correlation assessments including:

- Cross-factor relationship historical analysis of largest one-day and six-month movements across a subset of asset classes;
- Three-month rolling historical correlation analysis between select factor pairs; and
- Statistical analysis of the relative probabilities of joint tail events for correlated variables.

The Study demonstrated that simultaneously applying the GMS shocks would require a set of market movements that have never been experienced together in history. Moreover, the FRB's underlying assumption that extreme events for various asset classes are highly correlated was not supported by historical statistical evidence and more importantly was not empirically supported.

The Study found no material evidence of simultaneous shifts in asset class performance in the magnitude represented by the 2019 GMS scenario in a cross factor historical correlation analysis of one-day and six-month periods. While the Study identified positive correlations between certain asset classes, such correlations were never of the same magnitude as implied by the GMS shocks, and never occurred on the same date. On a six-month basis, the Study revealed some increased positive correlations among certain asset classes versus the one-day cross factor historical analysis, but, again, such correlations were not nearly of the same magnitude implied by the relevant asset class GMS shock tested.

Another test for correlation produced similar results. In an analysis of rolling historical factor pairs, the Study revealed that the existence of some positive correlation depended on the asset classes in question. For example, over a 20-year historical time series, the analysis revealed very low correlation between the S&P 500 and the 10-year U.S. Treasury notes (roughly 0.29 on average). Moreover, the degree or direction of correlation was not constant over time. While the GBP/USD and the EUR/USD demonstrated higher correlation (0.63 on average), the correlation relationship similarly varied significantly over time. For both asset class comparisons, the variation in correlation suggests the magnitude of any positive and negative correlation is bounded at levels much lower than suggested in the GMS. Consequently, the high correlations assumptions found in the GMS factor shocks are significantly overstated.

Lastly, the Study estimated the relative likelihood of different extreme events occurring simultaneously based on the correlations between those extreme events (using perfect correlation as a benchmark). The Study found that correlation across factors would need to exceed 0.85 before the relatively likelihood of joint extreme events would reach at least 50%, suggesting that the correlation assumptions underlying the GMS factors are implausible. This analysis again supports the conclusion that the correlation assumptions underlying the application of the most severe GMS factors across most asset classes are overstated and empirically remote.

Given the implausibility of the correlation assumptions embedded in the GMS factor shocks and the impact that these assumptions have on the severity of the overall outcome, the FRB should establish explicit, reasonable bounds on these correlation assumptions. Using more empirically grounded correlation assumptions in sizing GMS shocks would result in more precise and credible outcomes.

The use of GMS factor shocks to size losses in the LCD component is not suitable, because of the implausible calibration and correlation assumptions embedded in the GMS.

The use of the GMS to size losses in the LCD component implies a margin period of risk (MPOR) that is considerably longer than both recognized market practice and applicable regulatory requirements, even in extreme market conditions. To assess the reasonableness of the MPOR implied by GMS factor shocks, the Study reviewed market practice and regulatory requirements, and estimated the cost and speed of the liquidation of a large hypothetical portfolio of "typical" collateral. Although the Study was unable to assess the speed to rebalance positions following a large counterparty default, market feedback indicated that the largest counterparty exposures typically are rates and FX derivative contracts, and firms would be able to access exchanges to initiate risk and loss mitigating hedges as typical during events in 2008 and 2009.

The analysis indicated that the MPOR implied by the GMS factor shock calibration can be as extreme as 120 business days. While an extended MPOR may be appropriate for certain transaction or collateral types as outlined in point in time capital rules (ranging from 10 to 20 days in general), the MPOR implied by the GMS factor shocks can be six to twelve times greater than applicable MPOR point-in-time regulatory requirements. Moreover, the extended MPOR calibration implied by the GMS calibration is considerably outside of market observation Additionally, the transaction cost analysis estimated that, under a 99% confidence interval, a firm could liquidate a large pool of typical collateral within five days and within the applied haircuts, even if the pool of collateral included relatively illiquid securities within a given asset class.

Based on these studies, the FRB should revise the LCD component to increase its risk sensitivity and more closely mirror established market practices around liquidation of collateral. At a minimum, the FRB should support an estimation of LCD losses based on extreme-but-plausible price moves over conservatively defined closeout periods, but not as draconian as those implied in many of the GMS shocks. Calibrating the LCD based on a new set of price shocks defined independently of the GMS, or by applying scalars that adjust the GMS down to closeout periods appropriate for counterparty default exposures are potential alternatives that would be appropriately risk sensitive and reflect market practice.

The Study's findings regarding calibration of the GMS shocks and its use in LCD lend additional support to an FRB review of other aspects of the GMS and LCD where concerns have been noted. These other aspects include the impact of using both the GMS and LCD components and the PPNR process, and the lack of transparency of GMS and LCD compared to other elements of CCAR testing.

The use of both the GMS and LCD components and the PPNR framework leads to overestimation of losses and underestimation of available capital.

The requirement to apply both the GMS and PPNR components to many of the same assets results in overestimation of losses and underestimation of available capital through double counting of losses for those assets. Many of the same trading assets that are written down under the GMS are then subject to additional losses as part of the PPNR forecasting requirement, which the Study indicates can have severe impacts. The impacts are further exacerbated by the treatment of deductions for certain asset classes.

Accordingly, the FRB should revise the GMS and/or PPNR approaches to eliminate any such double counting either by developing a supervisory workaround, or by “zeroing out” the GMS and LCD component results in the first quarter of the PPNR. Further, the FRB should implement a max loss cap (losses and deductions) to avoid capital requirements that could exceed the current value of securities and investments. With regards to the CCAR treatment of non-SSFA assets that require a capital deduction, firms are required to employ pre-stress assets values when calculating post-stress loss capital. The Study concluded it is more appropriate to calculate deductions in post-stress loss capital ratios using post-stress loss asset values.

The limited transparency and disclosure regarding the GMS and LCD components, including assumptions, and the lack of a coherent scenario type approach impede public study and improvements in methodology.

A continued disparity in transparency and disclosure exists between the GMS and LCD components and other elements of CCAR such as scenario design, loss-modeling and PPNR. This opacity impedes public study of approaches and outcomes and consequently hinders process and approach improvements. Greater openness on the part of the FRB to share the justification for its approaches also could help preserve and promote its independence.

Currently, GMS factor shocks are simply provided by asset class without regard to the events the GMS factor shocks have been sized to capture. Providing transparency around the broader scenario like how the macroeconomic scenario provides context to the banking book and PPNR components would promote better understanding of potential risk and capital needs. Linking the GMS factor shocks to a detailed “scenario” or event type would support the year-on-year analysis and potentially limited back testing of results.

For these reasons, the FRB should continue to promote transparency and, moreover, apply the same level of transparency and disclosure employed in other aspects of CCAR to the GMS and LCD components. Moreover, the heightened transparency recently applied to the macroeconomic scenario design process and the development of controls and metrics to guide annual volatility should be applied to the GMS shock development and evaluation.

Policy Commentary and Recommendations

SIFMA supports stress testing as a valuable capital planning and risk management tool. It also appreciates the goals of CCAR, including the incorporation of fire sale risk as a critical consideration of the GMS and LCD. However, the Study's empirical and historical analysis, coupled with the related conclusions regarding the plausibility of assumptions underlying the GMS and LCD, warrant further FRB consideration. Important improvements could be made to the GMS and LCD to support their continued creditability, appropriateness and precision. Moreover, it is particularly appropriate to improve the precision of the GMS and LCD components given the anticipated implementation of the Stress Capital Buffer (SCB). This sequencing is important because reducing unnecessary and unwarranted severity in the GMS and LCD will promote more appropriate inputs to the CCAR framework and, in turn, the size of the SCB.

It is critical that the GMS and LCD are appropriately calibrated, because these components have a significant measurable impact on banks' capital allocation and business strategy, which in turn affect the health, capacity and effectiveness of the U.S. capital markets. The effect of any revisions to the GMS and LCD should be to increase the value of the GMS and LCD components as capital planning and risk management tools, to apply the lessons learned from previous GMS and LCD reviews, and to improve the precision and credibility of the framework's outcomes.

> "I believe it is prudent to review all our practices to ensure that they are as efficient and transparent as possible and that they remain appropriate in light of changes in the industry that have been achieved."
>
> **Randal K. Quarles**
> Vice Chair for Supervision, FRB
> July 2019

List of Findings and Recommendations

This report segments the key findings and recommendations from the analysis into three distinct areas where the FRB should concentrate on potential enhancements:

Section 1: Global Market Shock

Key Findings	Recommendations
• The severity of any single GMS factor shock is an extreme, low-probability event when compared to historical observations and empirical estimations.	• **Recommendation 1:** GMS factor shocks should be tailored to reflect the liquidity and price stability characteristics of particular asset classes.
• The correlation assumptions underlying the GMS factor shocks are not empirically or historically supported, and do not meet the FRB's "severe but plausible" standard.	• **Recommendation 2:** Correlation assumptions need to be rationalized and validated based on empirical analysis and historical observation in order to meet the "severe but plausible" standard.
• The extent of volatility in prior GMS shocks - in terms of severity and direction - conflicts with the FRB's embedded assumption of near-perfect correlation and hinders capital planning.	• **Recommendation 3**: Year-over-year changes in stress testing should explore salient emerging risks and avoid unexpected, extreme or random swings do not facilitate capital risk identification and management.
• GMS assumptions regarding the duration of market dislocation for certain asset classes are not supported by empirical analysis or historical observation, conflict with other U.S. and Basel Committee on Banking Supervision (BCBS) standards (*e.g.*, the LCR and the Fundamental Review of the Trading Book) and do not pass a "severe but plausible" test.	• **Recommendation 4:** Replace the blunt three- to six-month GMS with a framework that accounts for the liquidity and price stability of assets. Assets with high price stability and liquidity should be calibrated towards historical observation, at a maximum of 30 days or fewer.

Section 2: Large Counterparty Default (LCD)

Key Findings	Recommendations
• The use of GMS shocks to estimate LCD losses leads to an overstatement of risk, particularly for the most liquid and easiest-to-hedge exposures. • As recognized in multiple U.S. regulatory frameworks, the typical closeout period for counterparty default exposures is far shorter than the multi-month timeframe implicit in the GMS. • Other jurisdictions have evolved their LCD components to more closely mirror risks, counterparty vulnerability and market behaviors.	• **Recommendation 5:** Review and justify the LCD component to improve risk sensitivity and more closely mirror market practice. • **Recommendation 6:** At a minimum, estimate LCD losses on the basis of extreme-but-plausible price moves over conservatively defined closeout periods, either by basing the LCD on a new set of price shocks defined independently of the GMS, or by applying scalars that adjust the GMS shocks down to closeout periods appropriate for counterparty default exposures.
• The FRB's supervisory approaches to recovery rate modeling, including its assumptions, data and calibration, are not transparent. Specifically, the recovery rates that are employed in the annual test are not disclosed. This contrasts to the increased transparency of loss estimation models and annual loss rates.	• **Recommendation 7:** Increase the transparency and disclosure regarding recovery rate modeling, assumptions and data including empirical support. Recovery rates used in CCAR should be disclosed annually.

Section 3: CCAR Framework and Approach

Key Findings	Recommendations
• The FRB does not provide disclosure regarding how the GMS shocks are sized, including how calibration and correlation are considered, other than they are based on a "principle of conservatism" and a "severe but plausible" standard. • The opacity in how the GMS shocks are constructed impedes the FRB's ability to analyze and learn from these tests, and to improve upon its current supervisory approach. • The process surrounding the GMS and LCD components and their administration lacks the structure, transparency and consistency that exists in other parts of CCAR.	• **Recommendation 8:** Apply similar transparency to the determination of GMS shocks as is currently applied to the FRB's macroeconomic scenarios. Additionally, employ controls or "guardrails" on GMS factor severity, correlation, volatility and calibration similar to what the FRB implemented with respect to House Price Index (HPI) and unemployment. Moreover, apply the same process type controls to the administration and communication of the GMS and LCD components' annual process.
• The requirement to employ both GMS and PPNR modelling results in overestimation of losses and underestimation of available capital through double counting of losses and the instructions for calculation of pro forma capital. • The GMS captures some assets that do not demonstrate the characteristics of more traditional trading exposures. Given the underlying objectives of the GMS, the impact on some asset classes is inappropriate and may over or understate losses.	• **Recommendation 9:** Revise the GMS and LCD components and PPNR framework to eliminate the double counting issue either by a developing a transparent supervisory workaround, or by zeroing out the GMS and LCD components results in the first quarter of the PPNR. Simultaneously, address the underestimation of available capital by implementing a max loss cap (losses and deductions) to avoid capital requirements that could exceed the current value of securities and investments, and allow firms to calculate deductions in post-stress loss capital ratios using post-stress loss asset values. • **Recommendation 10:** Omit non trading-centric asset types from the GMS, as is currently the case with the carve-out of fair value non-trading loans. These assets would remain subject to PPNR modelling.

Overview of the Study Methodology

This Study reflects the views of the firms' subject to the GMS and/or LCD components. The impetus for producing this analysis, report and recommendations was not to reduce capital needs or to arrive at a pre-ordained outcome, but rather to identify areas for improvement. Specifically, the study looked to justify the FRB's approaches, including the assumptions regarding calibration and correlation that drive the severity. The study also looked to reinforce the FRB's CCAR goals of transparency, simplicity and stability, and framed its recommendations around those objectives where possible.

To support the analytical aspects of the study, SIFMA engaged BlackRock Financial Management to perform a series of analytical evaluations. Overall the scope of review included:

1) Estimating the probability and severity of a subset of material GMS shocks using historical data, and assuming a conservative fat-tailed distribution;
2) Evaluating the plausibility of the GMS shocks occurring simultaneously based on historical data;
3) Analyzing the severity of GMS shocks individually against historical factor activity;
4) Assessing trading volume data as a proxy for asset class liquidity during the crisis period;
5) Examining regulatory approaches to estimating market dislocation duration; and
6) Evaluating the use of GMS factor shocks on the LCD component outcome.

The following table identifies the data type, the data source and the time series used to produce the analytical work.

GMS Historical Time Series Range and Sources

Factor	Historical Data Range	Source
A-rated Corporate Bond	4/13/1999 - 4/26/2019	BBG-Barclays Indices
BBB-rated Corporate Bond	4/13/1999 - 4/26/2019	BBG-Barclays Indices
B-rated Corporate Bond	4/13/1999 - 4/26/2019	BBG-Barclays Indices
Credit Card ABS (AA)	4/13/1999 - 4/26/2019	BBG-Barclays Indices
TBAs	4/13/1999 - 4/26/2019	BlackRock
U.S. Equities (S&P 500)	1/2/1945 - 4/26/2019	Bloomberg
GBP/USD	1/4/1971 - 4/26/2019	Bloomberg
EUR/USD	1/2/1975 - 4/26/2019	Bloomberg
U.S. TSY 2Y	10/21/1992 - 4/26/2019	Bloomberg
U.S. TSY 10Y	12/11/1979 - 4/26/2019	Bloomberg

Section 1: Global Market Shock Framework

The FRB requires firms with significant trading activity to apply the GMS component to their trading books. This approach requires a firm to apply each GMS factor shock to their trading books as an instantaneous shock. The GMS shocks are also used to size counterparty losses under the LCD component. GMS shocks are applied as of a specified date, with losses and associated capital impacts included in the first quarter of the nine-quarter planning horizon. Those losses are *in addition* to the revenue and capital impact derived from the PPNR projected under the nine-quarter macroeconomic scenarios.

Each year the FRB provides individual asset class shocks, which collectively are used to simulate a severe market dislocation. One of the reoccurring observations of the GMS shocks is that their severity is calibrated greater than any historical one-day movement, and for many asset classes outside of a 10-day, 30-day and six-month historical period. In general, the Study found that the GMS shocks are generally calibrated over a three- to six-month time horizon. This extended calibration is based on the aggregate of price movements over that extended period. As a practical matter, the GMS shock is simply the sum of the price movements based on this calibration and because it is applied as a onetime shock it precludes any risk mitigating activities such as sales or hedging. For many asset classes, this disregards the historical observations that certain markets generally were available to execute hedging or sale transactions during or soon after a material event. Specifically, the Study noted that despite the extended calibration for asset classes such as spot foreign exchange (FX), U.S. treasuries and agencies and corporate bonds, there was reasonable market access during and after a material event. These observations contradict the assumption implied by the calibration: that many of these asset class markets were "frozen" for the extent of the calibration period.

One of the significant findings of the Study was that the severity of the correlation assumptions underlying the application of the asset shocks across a trading portfolio is not plausible based on historical experience. Although one might be able to theoretically justify applying a shock based on a six-month calibration to select high risk portfolios, empirically it is difficult to plausibly justify applying the most adverse shocks (calibrated at a three to six-month level) *across all* portfolios simultaneously. The analysis demonstrates that this correlation assumption, which applies the most adverse shocks simultaneously, does not credibly pass a plausibility test. In particular, the empirical data show that cross-asset market shocks of this magnitude simply do not occur and certainly never occur within the same periods (*i.e.*, the joint probability of such shocks is extremely low).

The analysis demonstrates that when the shocks are applied simultaneously, the probability of the GMS scenario shocks becomes extremely remote and does not credibly pass a plausibility test. In particular, the empirical data show that cross-asset market shocks of this magnitude simply do not occur and certainly never occur within the same periods.

We understand that the FRB may have sought to address these extreme and unsupportable calibration and correlation assumptions in the new GMS shock approach published in February 2019; however, the FRB did not disclose how severity, including calibration and correlation, would be addressed. Moreover, the approach is equally opaque as to how the FRB will evaluate conservatism and plausibility when selecting individual and collective GMS shocks. The analysis supports the idea of implementing guardrails for the GMS factor shock development, like those that have recently been applied in the context of macroeconomic scenario development. Guardrails in the form of metrics that place bounds around severity, calibration and correlation would increase the credibility of the test, support stronger analysis of the output by firms and the public, and support strong risk identification.

Description of Analytical Approaches to Evaluate the GMS's Plausibility

The Study incorporated numerous approaches to determine the plausibility of the GMS shocks individually and collectively, and the use of GMS shocks in the LCD framework. The scope of analysis included the following:

- Estimating the probability of occurrence for each shock based on historical data (*i.e.*, observed experience) and assuming a conservative fat-tailed distribution (*i.e.*, higher likelihood of extreme adverse events).
- Evaluating the plausibility of 2019 GMS scenario shocks occurring simultaneously relative to historical movements. These assertions were supported using a copula-based correlation framework, which measured the joint probability of extreme adverse events occurring across multiple independent factors. Put differently, the analysis measured the likelihood (or remoteness) of several extremely adverse trading shocks occurring simultaneously.
- Assessing the severity of the shock levels individually against historical factor activity, considering each factor separately. The Study compared the GMS scenario shocks to the largest historical movements for various factors across different trading periods (*i.e.*, one-day, 10-day, three-month and six-month) to understand the historical trading period implied by each shock level. The Study also reviewed year-over-year changes to the GMS scenario shocks themselves to confirm that the 2019 GMS scenario we analyzed represented a more severe joint shock than had been implemented in prior CCAR cycles.
- Studying volume data as a proxy for asset class liquidity during historical stress periods.
- Examining regulatory approaches to determining reasonable estimations of severe market dislocations by asset class.
- Reviewing the embedded assumptions in the GMS and its calibration, and the impact of these assumptions on the LCD framework given market protocols and regulatory requirements.

The Severity of a Single GMS Factors Were Generally Unfounded Empirically and Were Not Reasonably Plausible

Key Finding

- The severity of any single GMS factor shock is an extreme, low-probability event when compared to historical observations and empirical estimations.

Recommendation

- **Recommendation 1:** GMS factor shocks should be tailored to reflect the liquidity and price stability characteristics of particular asset classes.

Using the 2019 GMS shocks, the Study estimated the probability of any such GMS shock occurring using historical distributions of the various factors. The analysis demonstrated that each individual factor shock represented an extremely low-probability event relative to historical and crisis data series. Figure 1 illustrates an estimation of the probability of individual shocks occurring in isolation. The Study analyzed these key factor shocks using historical time series data assuming a t-distribution with four degrees of freedom. Using a t-distribution with a low number of degrees of freedom (*e.g.*, four) was a conservative assumption, as this distribution has considerably "fatter" tails (*i.e.*, a higher probability of tail events) than a normal distribution. In other words, extreme (or tail) events are more frequently observed in a t-distribution.

The analysis shows that even assuming a conservative t-distribution, individual market movements implied by the GMS scenario are very low-probability events. For instance, when examining one-day historical trading periods, spread and FX factors, excluding TBAs, indicated probabilities of less than 0.001% (or one approximately 400 calendar years), with rates, which have the highest likelihood across factors, indicating only 0.1%-0.3% probabilities of occurring (or one in 1,000 trading days and three in 1,000 trading days, respectively).

To illustrate the issues with the severity and likelihood assumptions, the Study more closely assessed the GMS shocks for BBB corporate bond spreads, the S&P 500 Index and the 2-year U.S. Treasury note. As indicated in Figure 1, the 2019 GMS BBB corporate bond spread shock was 436 bps. Using a full historical time series, the probability of BBB corporate bond spreads moving the applied GMS shock of 436 bps in one day was less than 0.001%, *i.e.* one occurrence every 100,000 trading days (approximately 400 years). Using only crisis period data, the probability of occurrence is still less than 0.001%. Assuming the crisis period of 126 trading days were to occur every 20 years, the probability that BBB corporate spreads would move 436 bps is approximately 0.00625%, *i.e.*, approximately one occurrence every 16,000 years (800 crises). Using the same crisis period time series, assuming that the "crisis" is calibrated to a one-day event (similar to how the shocks are applied) and a crisis occurs every 10 years, the GMS BBB corporate spread shock would occur once every one-million years. This extreme infrequency underscores the severity of the GMS BBB spread shock used in 2019. Notably, the GMS BBB corporate spread shock employed in 2019 was significantly less severe than what was used in 2015, when the spread shock was 640.3 bps.

To expand the analysis to other asset classes, the Study examined the 2019 GMS S&P 500 shock of 20.3%. Using the full historical time series, the probability of the S&P 500 index moving the equivalent of the 2019 GMS shock of 20.3% was 0.002%, *i.e.*, one occurrence in 50,000 trading days. Using only crisis period data, the probability of occurrence is still 0.195%. Assuming the crisis period of 126 trading days were to occur every 10 years, the S&P index would move 20.3% approximately once every four crises. Using the same crisis period time series, assuming the "crisis" is calibrated to a one-day event (similar to how the shocks are applied) and a crisis occurs every 10 years, the S&P 500 GMS would occur approximately once every 5 thousand years.

In contrast to the BBB corporate spread and S&P 500 shocks, the analysis indicated the 2019 GMS 2-year U.S. Treasury note rate shock of 42.50 bps had a higher probability of occurrence albeit still remote because the 2019 GMS 2-year U.S. Treasury note rate shock was considerably less severe compared to the other 2019 GMS factor shocks and far less severe than prior GMS 2-year U.S. Treasury note rate shocks. Using the full historical time series, the probability of a 2-year U.S. Treasury note rate moving the equivalent of the 2019 GMS shock of 42.5 bps was 0.069%, *i.e.*, one occurrence in 1,449 days (approximately six years). Using only crisis period data, the probability of occurrence increases to 0.895%. Assuming the crisis period of 126 trading days were to occur every 10 years, the 2-year U.S. Treasury note rate would move 42.50 bps approximately once every nine years. Using the same crisis period time series, assuming the "crisis" is calibrated to a one day event (similar to how the shocks are applied) and a crisis occurs every 10 years, the 2-year U.S. Treasury note rate GMS shock would occur would be one in approximately 1,100 years.

The Study also employed a "Rolling Max" analysis at the bottom of Figure 1 to understand correlation. Using this method, the Study assumed that the most volatile three-month rolling time period for each factor represents the worst stressed period for that factor. Even in such a scenario, the estimates remain well below 1%, except for rates, which indicated a 1.76% probability for the 2-year U.S. Treasury note rate and 7.75% for the 10-year U.S. Treasury note rate.

The results indicate that, while some of the individual GMS scenario shocks have been observed across different trading periods in history, most shocks represent an extremely low-probability market move. The GMS scenario calibration appears even less plausible when considering these shocks simultaneously, as described in the next section.

Figure 1. GMS Shock Comparison Using a Fat-Tailed Distribution[5]

		Spreads					Equity	FX		Rates	
		A-rated Corporate Bond	BBB-rated Corporate Bond	B-rated Corporate Bond	Credit Card ABS (AA)	TBAs	US Equities (S&P 500)	GBP/USD	EUR/USD	US TSY 2Y	US TSY 10Y
2019 GMS Shock		330.000	436.000	1478.000	-1280.000	45.000	-20.300%	-15.100%	-17.400%	-42.500	-40.000
One-Day											
Full Historical Series	Stdev	3.104	3.604	11.687	22.997	2.990	1.054%	0.599%	0.618%	5.363	7.501
	T-distribution (df = 4) Probability	<0.001%	<0.001%	<0.001%	<0.001%	0.006%	0.002%	0.001%	<0.001%	0.069%	0.298%
Crisis Period	Stdev	12.724	9.739	35.431	91.787	9.107	3.385%	1.107%	1.085%	10.966	10.060
	T-distribution (df = 4) Probability	0.001%	<0.001%	<0.001%	0.008%	0.390%	0.195%	0.008%	0.004%	0.895%	0.823%
Three-Month											
Rolling Max	Stdev	17.490	12.962	46.863	137.157	11.321	4.568%	1.597%	1.398%	13.591	22.864
	T-distribution (df = 4) Probability	0.002%	<0.001%	<0.001%	0.037%	0.823%	0.565%	0.035%	0.012%	1.764%	7.756%

Correlation of GMS Shocks Occurring Simultaneously Does Not Pass the “Severe but Plausible” Test

Key Finding

- The correlation assumptions underlying the GMS factor shocks are not empirically or historically supported and do not meet the FRB’s "severe but plausible" standard.

Recommendation

- **Recommendation 2:** Correlation assumptions need to be rationalized and validated based on empirical analysis and historical observation in order to meet the “severe but plausible” standard.

Despite the actualization of low-probability events for certain individual factors using a six-month calibration, the analysis demonstrates these events do not occur simultaneously as contemplated by the GMS scenario. In fact, the data suggest that the simultaneous set of shocks that comprise the GMS scenario represent a set of market movements that have never

[5] The analysis compares the key factor shocks using historical time series data assuming a t-distribution with four degrees of freedom. The time series were analyzed across three different periods: 1) the entire available time series (“Full Historical Series”), 2) the second half of 2008 (“Crisis Period”) and 3) the most volatile three-month period for each series (“Rolling Max”). For each period, the figure shows the standard deviation of the time series for that period, as well as the probability, assuming a t-distribution with four degrees of freedom, of the GMS shock occurring.

been experienced together in history. Moreover, the FRB's underlying assumption that all extreme events are highly correlated is not supportable by statistical and historical analysis.

To demonstrate the strong improbability of multiple GMS factor shocks occurring simultaneously, the Study performed a cross factor historical analysis and a correlation analysis of extreme events.

Cross-Factor Historical Analysis

To demonstrate the improbability of multiple asset classes simultaneously exhibiting adverse market movements at exactly the same time at historically high levels, the Study examined the market movements of a set of asset classes over a period of time, assuming that each such asset class experienced its most historically adverse market movements during that period of time. The results, which are illustrated in Figures 2 and 3, present this analysis under one-day and six-month historical trading periods (*i.e.*, a six-month calibration). The results are depicted as values and percentiles of each movement within a given time period.

The analysis indicated that asset class performance has never resulted in a simultaneous shift in value as severe as prescribed in the 2019 GMS scenario. In fact, history has demonstrated that individual performance for certain asset classes can be negatively correlated with other asset classes under severely adverse conditions, *i.e.*, certain asset classes perform well during times of stress.

A review of the largest one-day moves in Figure 2, and corresponding moves for other asset classes on that same date, demonstrate that factors do not necessarily move together, in the same magnitude or even in the same direction. Across the A-, BBB-, and B-rated asset classes, the largest adverse moves occurred in three different years, (2008, 2002, and 2001, respectively) with the BBB- and B-rated spread factors occurring outside of the most recent crisis period. Critically, when evaluating the largest adverse moves that did occur during the financial crisis, none of the movements occurred on the same day, or even within several days of each other. For instance, the most adverse A-rated corporate bond spread movement occurred in September 2008, while the largest spread movements for TBAs occurred in January 2008. Importantly, any time gap between shocks would allow firms to react and mitigate risk across the specific asset classes or across all asset classes.

The analysis also revealed that a very large or the largest market movement in one factor type may correspond to only a small or modest move in another risk factor. For example, the most adverse BBB corporate bond spread movement on 7/1/2002 of 70.128 bps corresponded to 40.9 and 49.7 percentile moves in the GBP/USD and EUR/USD factors, respectively and 25.13 and 45.34 percentile moves in the 2-year and 10-year Treasury note rate factors, respectively. A similar result also emerged when comparing the most adverse one-day TBA move on 1/24/2008 of 20 bps to each of the corresponding corporate bond spread movements. Although each spread factor showed a move in the 3rd percentile or lower, these movements were relatively small compared to their respective "most adverse" movements. For example, the credit card ABS factor at the 0.3th percentile had a value of -87.54 bps, still substantially smaller that its most adverse move of -841.2 bps.

Figure 2. Cross-Factor Historical Analysis One-Day Market Moves[6,7]

Yellow highlight denotes figures described above	GMS Shock	Largest Adverse Move	Largest Adverse Move Date	Spreads					Equity	FX		Rates	
				A-rated Corporate Bond	BBB-rated Corporate Bond	B-rated Corporate Bond	Credit Card ABS (AA)	TBAs	US Equities (S&P 500)	GBP/USD	EUR/USD	US TSY 2Y	US TSY 10Y
Observed One-Day Moves													
A-rated Corporates	330	68.18	9/15/2008		15.35	59.51	110.60	-2.60	-4.71%	0.39%	0.14%	-40.30	-21.50
BBB-rated Corporates	436	70.128	7/1/2002	37.92		-2.08	8.43	1.40	-2.14%	-0.07%	0.00%	-2.40	-0.90
B-rated Corporates	1,478	197.02	9/17/2001				79.70	-6.10	-4.92%	0.62%	3.01%	-51.60	-18.00
Credit Card ABS (AA)	-1,280	-841.2	10/20/2008	4.70	2.66	-34.74		-18.70	4.77%	-0.75%	-0.52%	5.40	-5.90
TBAs	45	20.30	1/24/2008	-3.87	-3.90	-32.50	-87.54		1.01%	1.13%	0.89%	21.10	20.50
US Equities	-20.3	-20.5	10/19/1987							0.90%	1.54%		-8.00
GBP/USD	-15.1	-8.065	6/24/2016	8.30	9.76	30.22	36.58	-2.50	-3.59%		-2.37%	-12.40	-16.50
EUR/USD	-17.4	-4.96%	11/1/1978						3.97%	-0.94%			
US TSY 2Y	-42.5	-51.60	09/17/2001			197.02	79.7	-6.10	-4.92%	0.62%	3.01%		-18.00
US TSY 10Y	-40.0	-75.00	10/20/1987						5.33%	-1.50%	-1.77%		
Observed One-Day Moves (pct)													
A-rated Corporates	330	68.18	9/15/2008		99.60%	99.76%	99.84%	10.28%	0.21%	80.28%	61.24%	0.03%	0.89%
BBB-rated Corporates	436	70.128	7/1/2002	99.92%		39.09%	72.71%	77.73%	2.28%	40.91%	49.67%	25.13%	45.34%
B-rated Corporates	1,478	197.026	9/17/2001				99.66%	1.90%	0.18%	88.44%	99.94%	0.01%	1.41%
Credit Card ABS (AA)	-1,280	-841.2	10/20/2008	97.60%	93.95%	0.67%		0.14%	99.85%	8.18%	16.27%	89.56%	15.93%
TBAs	45	20.30	1/24/2008	2.52%	3.25%	0.79%	0.30%		87.82%	96.96%	93.43%	99.72%	98.87%
US Equities	-20.3	-20.5	10/19/1987							94.3%	98.7%		9.4%
GBP/USD	-15.1	-8.065	6/24/2016	98.97%	99.19%	98.69%	97.60%	11.12%	0.44%		0.19%	1.89%	1.94%
EUR/USD	-17.4	-4.96%	11/1/1978						99.6%	5.1%			
US TSY 2Y	-42.5	-51.60	09/17/2001			100.00%	99.66%	1.90%	0.18%	88.44%	99.94%		1.41%
US TSY 10Y	-40.0	-75.00	10/20/1987						99.9%	1.5%	0.70%		

[6] The analysis compares the largest historical adverse one-day moves for each factor to one-day moves in other factors on the same date. For example, the largest A-rated corporate bond spread one-day move was a 68.18 bp widening on 9/15/2008. On that same day, BBB-rated corporate bond spreads widened 15.35 bp. This move falls in the 99.6th percentile (shown in the bottom half of the table) of all one-day moves for BBB-rated corporate bond spreads over the historically available data series.

[7] Cells are left blank in cases where historical data is not available.

Figure 3. Cross-Factor Historical Analysis Six-Month Market Moves[8,9]

Yellow highlight denotes figures described above	GMS Shock	Largest Adverse Move	Largest Adverse Move Date	Spreads					Equity	FX		Rates	
				A-rated Corporate Bond	BBB-rated Corporate Bond	B-rated Corporate Bond	Credit Card ABS (AA)	TBAs	US Equities (S&P 500)	GBP/USD	EUR/USD	US TSY 2Y	US TSY 10Y
Observed Six-Month Moves (values)													
A-rated Corporates	330	374.95	10/20/2008		394.10	991.33	-1228.00	-78.90	-36.97%	-15.05%	-16.31%	-160.90	92.70
BBB-rated Corporates	436	524.90	12/16/2008	365.80		1311.94	-1340.90	-85.30	-43.97%	-26.82%	-21.89%	-247.20	-174.10
B-rated Corporates	1,478	1,325.80	12/12/2008	367.73	520.64		-1340.90	-85.30	-44.30%	-26.82%	-21.89%	-228.90	-157.40
TBAs	45	123.30	3/6/2008	139.75	159.03	447.33	623.50		-16.66%	-7.87%	12.34%	-265.70	-107.10
U.S. Equities	-20.3%	-46.64%	11/20/2008	368.07	473.38	1205.72	-1340.90	-79.70		-26.57%	-21.89%	-217.40	114.10
GBP/USD	-15.10	-30.79	1/23/2009	311.59	484.01	1199.98	-1256.38	-85.30	-42.36%		-20.90%	-217.80	-220.10
U.S. TSY 2Y	-42.5	-290.90	03/17/2008	173.13	201.97	549.92	5.98	1.23	-18.64%	-7.87%	13.41		-109.6
U.S. TSY 10Y	-40.0	-437.00	10/13/1982						33.48%	-8.38%	-12.52%		
Observed Six-Month Moves (pct)													
A-rated Corporates	330	374.95	10/20/2008		97.87%	97.93%	2.03%	2.72%	0.95%	6.33%	4.85%	9.32%	74.89%
BBB-rated Corporates	436	524.90	12/16/2008	99.19%		99.98%	0.47%	1.65%	0.25%	0.54%	0.15%	0.93%	9.28%
B-rated Corporates	1,478	1,325.80	12/12/2008	99.34%	99.92%		0.47%	1.65%	0.25%	0.54%	0.15%	1.71%	12.54%
TBAs	45	123.30	3/6/2008	96.47%	96.27%	94.71%	88.61%		12.74%	27.97%	81.62%	0.63%	24.32%
U.S. Equities	-20.3%	-46.64%	11/20/2008	99.51%	98.85%	99.21%	0.47%	2.46%		0.64%	0.15%	2.48%	81.52%
GBP/USD	-15.1	-30.79	1/23/2009	98.55%	99.17%	99.18%	1.22%	1.65%	0.52%		0.76%	2.40%	5.75%
U.S. TSY 2Y	-42.5	-290.90	03/17/2008	97.15%	97.18%	97.29%	87.42%	99.91%	9.84%	27.97%	84.60%		23.23%
U.S. TSY 10Y	-40.0	-437.00	10/13/1982						97.47%	25.97%	12.50%		

Figure 3 above represents a comparison of GMS factor shocks that are applied instantaneously but reflect the aggregate of up to six months of price movements with the most adverse six month period by asset class. The analysis demonstrates

[8] The analysis compares the largest adverse six-month moves for each factor to six-month moves in other factors over the same time period. As an example, the largest six-month A-rated corporate bond spread move was a 374.95 bp widening for the six-month period ending 10/20/2008. Over that same six-month period, the BBB-rated corporate spread widened by 394.10 bp. This number falls in the 97.87th percentile of all BBB-rated corporate bond six-month spread moves observed over the historical data series.

[9] Cells are left blank in cases where historical data is not available

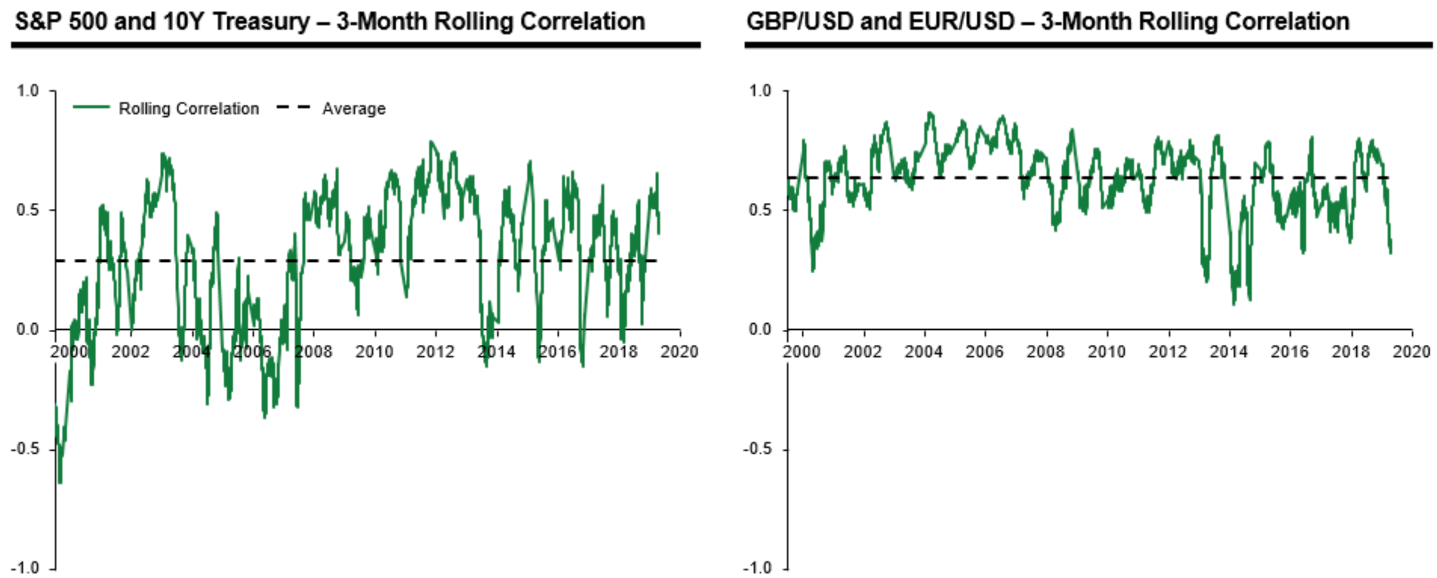
that some of the most adverse historical movements occurred during the recent financial crisis. Notably, however, these adverse movements occurred on different dates during the crisis. As indicated by the highlighted cells, most of the periods of largest adverse moves began in either the latter half of 2008 or the beginning of 2009, *but there are sometimes considerable gaps between these dates*. Further despite some overlap or closeness in dates. it is critical to acknowledge that markets for certain asset classes as we discuss later in this paper were available for risk mitigating actions such as sale or hedging activities.

The extreme severity of correlation embedded in the GMS shock scenario can be seen in the following examples.

- The most adverse TBA move corresponds with higher percentile corporate bond spread moves (96.47, 96.27 and 94.72 for AAA, BBB, and B-rated corporate bonds, respectively), but the values of those moves (139.75, 159.03, and 447.33 bps, respectively) are small compared to the largest adverse or 100th percentile moves for those factors (374.95, 524.90, and 1,325.80 bps respectively).
- The most adverse move across all factors did not correspond with significant moves in the 10 year U.S. Treasury note rate both in terms of value (between -220.10 bps and 114.10 bps compared to the largest adverse 10 year U.S. Treasury note rate move of -437.00 bps) and on a percentile basis (between 5.75th and 81.52th percentile) as highlighted along in the right-most column in the table

Finally, the proposition that large historical factor moves do not occur simultaneously is further evidenced by observing historical correlations between factor pairs. To illustrate this point, two sets of factor pairs were selected (Figure 4 below): the S&P 500 and 10-year U.S. Treasury note rate (on the left) and the GBP/USD and EUR/USD exchange rates (on the right).

Figure 4. Examples of Three-Month Rolling Correlation for Selected Factor Pairs[10]



Using a rolling three-month window over 20 years of historical data, the correlation between the FX pairs (0.63 average correlation coefficient) is stronger than the correlation between the S&P 500 and 10-year U.S. Treasury note rate (0.29 average correlation coefficient), but wide fluctuations in correlations can be observed in both pairs. In other words, these pairs (particularly the S&P 500 and 10-year U.S. Treasury note rate pair) do not exhibit high correlation. Both tables therefore suggest that factors incorporated into the GMS scenario shocks are not highly correlated and therefore do not experience extreme movements simultaneously.

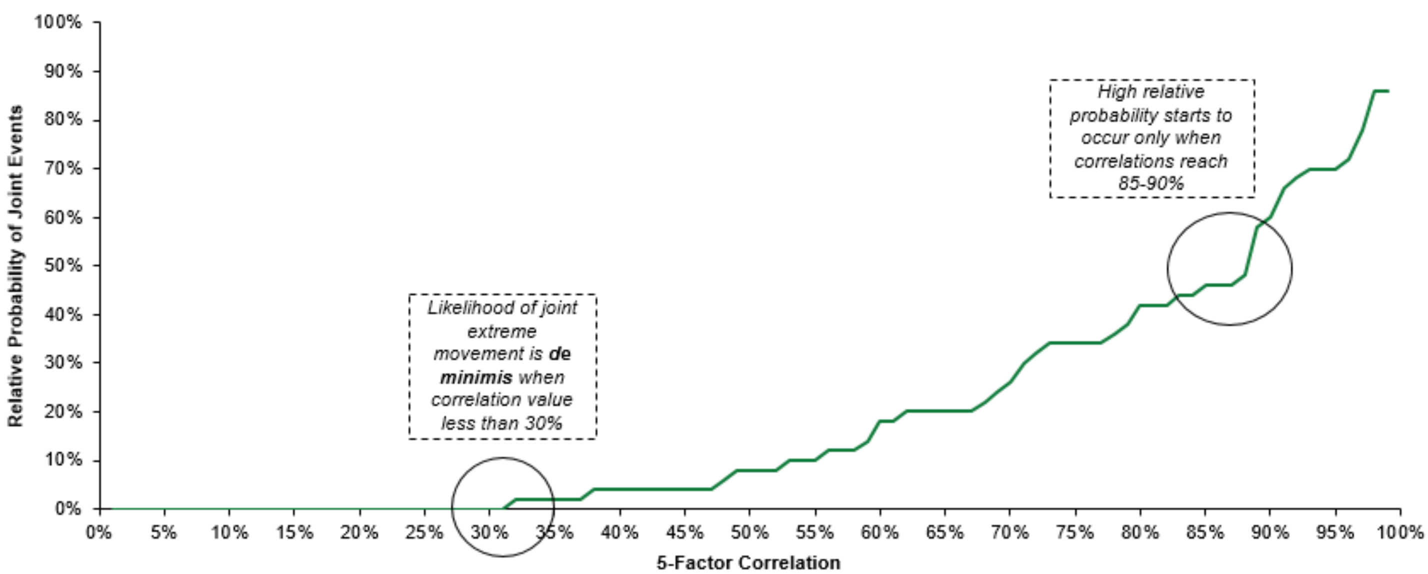
To analyze correlation among GMS factor shocks from a different perspective, the Study employed statistical correlation analysis. When extreme events *are nearly perfectly correlated*, which is implicitly assumed in many of the GMS scenarios (or a at a minimum across a number of GMS shocks within a given CCAR cycle), the occurrence of one extreme event will result in the simultaneous occurrence of all other extreme events (*e.g.*, if equity markets fall precipitously, then credit spreads will widen rapidly; interest rates will decrease substantially, etc. all simultaneously). However, the analysis demonstrates that, to-date, during extreme events, particular factors *were not highly correlated* across factors. Furthermore, *the analysis demonstrates that the probability of simultaneous occurrence decreases significantly as the correlations across factors goes down*. Given these observations, the Study concludes that the FRB's assumption of extremely high correlations across factors goes far beyond any conservative, severe or plausible standard. Moreover, the FRB has not provided any

[10] The analysis illustrates the three-month historical rolling correlation for two different pairs of factors: (1) S&P 500 and 10 year Treasury note and (2) GBP/USD and EUR/USD. A correlation value of 1 or -1 represents a perfect linear relationship between two factors while a correlation value of 0 represents no linear relationship. The dashed line represents the average historical correlation between each pair of factors.

justification, insight or guidance as to the appropriateness of such an assumption and why it is plausible, or any theoretical or developmental evidence supporting such an approach.

The analysis estimated the relative likelihood of different extreme events (*i.e.*, large movements in factors) occurring simultaneously based on the correlation between those extreme events (using perfect correlation as the benchmark) using a t-distribution analysis, which produces a "fatter" tail (*i.e.*, a higher likelihood of extreme events) than a normal distribution. The chart below, Figure 5, illustrates the relative likelihood of extreme events occurring simultaneously (represented in the Y-axis of Figure 5) across five factors at different levels of correlation (represented along the X-axis of Figure 5).

Figure 5. Relative Probability of Joint Tail Events for Correlated Variables[11]



As highlighted in the graph above, when the 5-factor correlation is less than 0.30, the relative likelihood of a joint extreme event is essentially *de minimis*. The level of correlations across factors each would need to reach 0.85-0.9, or "near perfect correlation," before the relative likelihood of joint extreme events occurring would reach 50% or greater of the benchmark likelihood of joint occurrence (with perfect correlation). Consequently, the GMS's reliance on a near-perfect correlation assumption for such extreme adverse shocks occurring simultaneously is so remote it is implausible.

[11] The analysis illustrates the likelihood of joint extreme movement occurring across five factors assuming different correlations between the factors. The correlation among the five extreme events (rho) is represented on the horizontal axis. The vertical axis is the probability of a joint event, conditional on one factor experiencing an event. Specifically, the vertical axis is the ratio of the probability of all five factors experiencing a 99.9^{th} percentile move to the probability of one factor experiencing a 99.9^{th} percentile move (i.e. 0.1%).

While Volatility Has Been Addressed in Other Areas of CCAR -It Has Not Been Addressed for GMS Shocks

Key Finding

- The extent of volatility in prior GMS shocks – in terms of severity and direction – conflicts with the FRB's embedded assumption of near-perfect correlation and hinders capital planning.

Recommendation

- **Recommendation 3:** Year-over-year shock volatility should not be extreme or random, but rather should reflect a more gradual adjustments to emerging views of risk that are linked to feedback from the prior years' analysis.

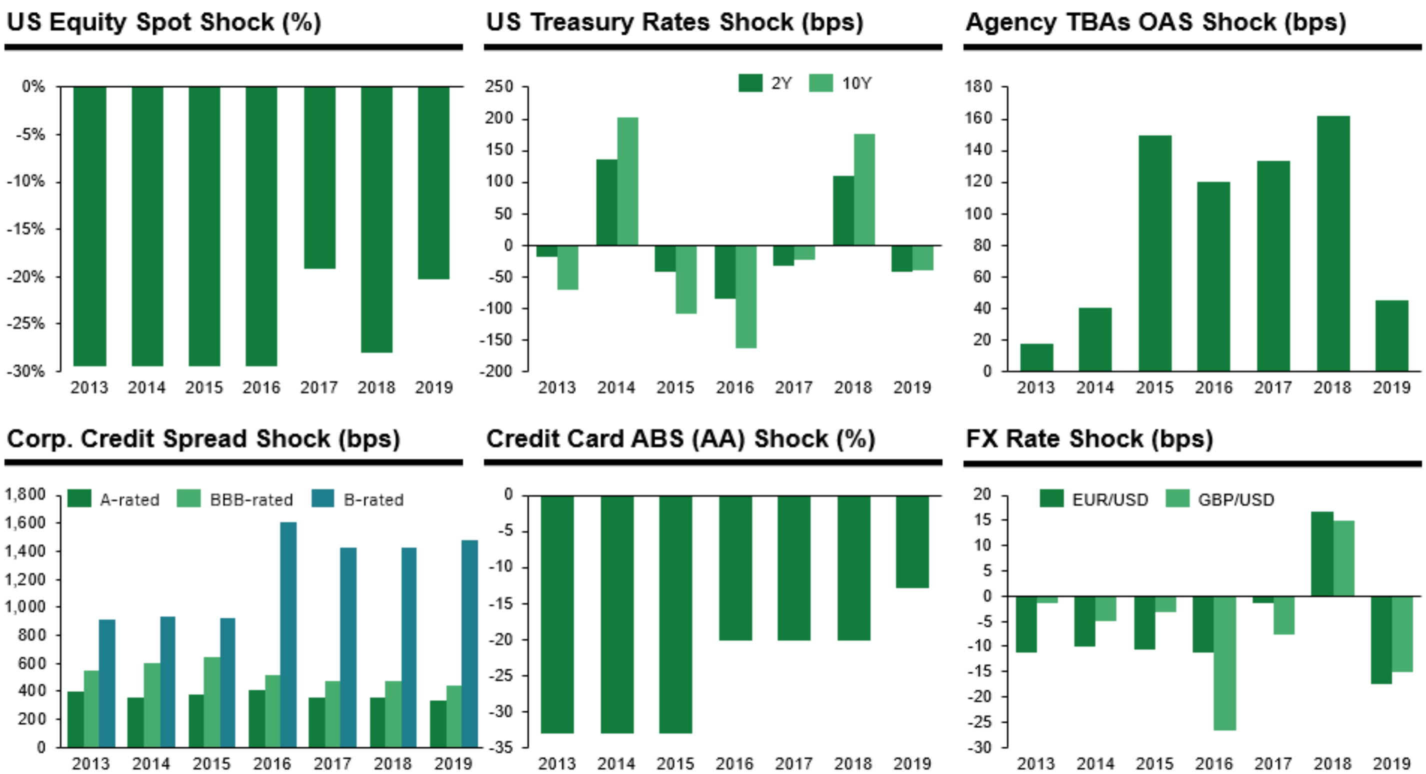
Vice Chair Quarles has acknowledged repeatedly, most recently on July 9th, 2019, that excess volatility in CCAR hampers capital planning.

> "When I think about volatility in stress testing, I want to distinguish what I consider to be useful variation in the tests, in the form of exploration of salient risks, from what I consider to be less useful variation, in the form of unexpected swings in capital requirements that don't have any particular relationship to changing risks at individual firms. In addition, one source of volatility in the tests comes from the fact that banks are forced to do their capital planning before they get the results of our tests"

To that end, the FRB has already addressed some of the issues with volatility by implementing controls regarding some of the factors that drive the macroeconomic scenario design, specifically, the House Pricing Index (HPI) and the Unemployment Rate (UR). However, similar improvements have not yet been made to the GMS where there is, and has been, significant volatility in the magnitude and direction of GMS shocks. Some degree of variability is a key feature of any credible stress test; however, extensive volatility in terms of severity, direction and magnitude for specific asset classes is counterproductive for capital planning and related governance, especially without a rationale for such extreme movements. Given the GMS is a significant driver of losses in CCAR (and for certain banks, the LCD component), this extreme volatility is meaningful for a subset of the very largest banks and should at least be rationalized year-to-year. To ameliorate this excessive or unintended volatility, the FRB should extend the types of controls applied to the HPI and the UR to the GMS factor shocks.

To demonstrate the extent of volatility within the GMS shocks over time, the Study sampled and analyzed a number of key shocks since 2013. Figure 6, below, illustrates that GMS shocks varied in terms of direction and magnitude, many times significantly. This volatility was not necessarily anchored in a specific historical scenario particularly as it applied across asset classes, and the determination of magnitude or direction was not justified or explained.

Figure 6. 2019 CCAR GMS Shocks vs. Previous CCAR Cycles



Analysis of the Severity of Individual GMS Shocks

The chart above in Figure 6 illustrates the range of GMS shocks the FRB has applied to the largest trading firms since 2013, including the 2019 shock (which was somewhat less severe compared to previous shocks). Interestingly, while some shocks are held somewhat constant, *e.g.*, the U.S. equity and AA credit card ABS shocks from 2013-2015, other asset classes demonstrate directional flips, *e.g.*, U.S. Treasuries and FX rates multiple times. Again, the Study concluded that although some variability in GMS shocks is necessary as a part of a robust stress testing framework, the magnitude of the changes should fall within some reasonable band and form part of a larger, coherent scenario in order to support a more predictable capital planning process that will facilitate advances in risk management.

Analysis of Most Severe GMS Shock and Historical Comparison

Figure 7 illustrates the most severe asset class shocks across the prior 6 CCAR cycles and identifies the most adverse experience (and the date of that experience) across one-, 10-, 90- and 180-day intervals. The analysis demonstrated there was considerable volatility year-over-year in individual asset classes, and that collective severity was most draconian in 2016.

Figure 7. Largest Adverse GMS Shocks in CCAR History Compared to Largest Adverse Market Moves Across Historical Trading Periods[12]

	Spreads					Equity	FX		Rates	
	A-rated Corporate Bond	BBB-rated Corporate Bond	B-rated Corporate Bond	Credit Card ABS (AA)	TBAs	U.S. Equities (S&P 500)	GBP/USD	EUR/USD	U.S. TSY 2Y	U.S. TSY 10Y
Largest Adverse GMS Shock	**414.00**	**640.30**	**1,604.00**	**-3,310.00**	**161.60**	**-29.40%**	**-26.70%**	**-17.40%**	**-85.20**	**-164.20**
Largest Adverse GMS Shock Year	2016	2015	2016	2013-2015	2018	2013-2016	2016	2019	2016	2016
One-Day										
Largest Adverse Move	68.18	70.13	197.02	-841.15	20.30	-20.47%	-8.06%	-4.96%	-51.60	-75.00
Largest Adverse Move Date	09/15/2008	07/01/2002	09/17/2001	10/20/2008	01/24/2008	10/19/1987	06/24/2016	11/01/1978	09/17/2001	10/20/1987
10-Day										
Largest Adverse Move	134.03	178.85	452.68	-906.86	55.30	-29.57%	-14.86%	-8.99%	-94.80	-215.00
Largest Adverse Move Date	09/18/2008	10/16/2008	10/10/2008	10/20/2008	03/06/2008	10/19/1987	09/21/1992	09/16/1992	09/19/2001	11/09/1981
Three-Month										
Largest Adverse Move	312.44	451.57	1,074.41	-1256.38	110.20	-42.15%	-24.58%	-19.94%	-199.50	-385.00
Largest Adverse Move Date	10/20/2008	12/04/2008	12/05/2008	10/31/2008	03/06/2008	11/20/2008	11/09/1992	10/27/2008	03/17/2008	05/06/1980
Six-Month										
Largest Adverse Move	374.95	524.90	1,325.80	-1340.90	123.30	-46.64%	-30.79%	-21.89%	-290.90	-437.00
Largest Adverse Move Date	10/20/2008	12/16/2008	12/12/2008	10/31/2008	03/06/2008	03/09/2009	01/23/2009	11/20/2008	03/17/2008	10/13/1982

The highlighted yellow boxes indicate where a GMS shock exceeds the historical most adverse performance for that asset class. Across the board, *all GMS shocks exceeded* the most adverse 1-day performance, with *70% of the GMS shocks*

[12] The analysis compares the most severe GMS shock in any CCAR cycle to the largest adverse historical moves across different trading periods for a subset of typical factor shocks associated with trading banks. The "largest adverse move date" for the 10-day, three-month, and six-month trading period refers to the last date of the largest historical factor move over the corresponding trading period.

exceeding the most severe historical 10-day experience. Interestingly, for the asset classes where historical 10-day performance was greater than the associated GMS factor shock, such performance was in each case exhibited outside of the “great recession.” Similarly, the GMS shocks were higher than the most adverse three-month period for 60% of asset classes sampled and were higher than the most adverse six-month experience for 50% of asset classes sampled. As discussed earlier in the paper, the six-month calibrated shock assumes that all price movements that occurred over the six-month period happen over one day, which precludes any risk mitigating activity. This single factor historical analysis clearly demonstrates that the FRB regularly employs GMS shocks that are in excess of historical observation and that are sometimes more severe than have been experienced in the post war economy. This is contrary to the Policy Statement on the Scenario Design Framework for Stress Testing where the FRB has stated that “The severely adverse scenario will consist of a set of economic and financial conditions that reflect the conditions of post-war U.S. recessions”.

The analysis of 2019 GMS shocks shown in Figure 8, shows that, on a *six-month timeline*, almost all of the 2019 GMS factor shocks were within historical experience. In one regard, the 2019 GMS shocks were among the more benign GMS shocks since 2013. However, as stated earlier in the paper, the six-month calibration implies the full impact of price movements for the 126-day crisis period occur on a single day and without any ability to mitigate risk, which did not occur during the “great recession”. Looking to the future, there is no assurance that GMS shocks will be as benign as they were in 2019. In particular, without any metrics to bound the calibration of severity or measure of plausibility, shocks could be more volatile in the future.

The Study indicated that the timing of many of these six-month shocks differed throughout the course of 2008 (as well as during other market dislocations). As previously mentioned, the markets for many of the shocked asset classes remained robust, or otherwise experienced periods of liquidity that allowed firms to readjust their risk profiles. The periods of time between troughs is indeed critical, as CCAR is designed to test capital sufficiency under a severe, but plausible framework. In this regard, Figure 8 illustrates that, apart from the 10-year U.S. Treasury note rate, these shocks began as early as March 2008, and continued through October, November, and December 2008, as well as in the beginning of 2009. These timing differences demonstrate that these six-month factor shocks were not perfectly correlated – unlike in the design of the GMS scenario, which implies high correlation among these extreme factor shocks.

Figure 8. 2019 GMS Shock Compared to Largest Adverse Market Moves Across Historical Trading Periods[13]

	Spreads					Equity	FX		Rates	
	A-rated Corporate Bond	BBB-rated Corporate Bond	B-rated Corporate Bond	Credit Card ABS (AA)	TBAs	US Equities (S&P 500)	GBP/USD	EUR/USD	US TSY 2Y	US TSY 10Y
2019 GMS Shock	330.00	436.00	1478.00	-1280.00	45.00	-20.30%	-15.10%	-17.40%	-42.50	-40.00
One-Day										
Largest Adverse Move	68.18	70.13	197.02	-841.15	20.30	-20.47%	-8.06%	-4.96%	-51.60	-75.00
Largest Adverse Move Date	09/15/2008	07/01/2002	09/17/2001	10/20/2008	01/24/2008	10/19/1987	06/24/2016	11/1/1978	09/17/2001	10/20/1987
10-Day										
Largest Adverse Move	134.03	178.85	452.68	-906.86	55.30	-29.57%	-14.86%	-8.99%	-94.80	-215.00
Largest Adverse Move Date	09/18/2008	10/16/2008	10/10/2008	10/20/2008	03/06/2008	10/19/1987	09/21/1992	9/16/1992	09/19/2001	11/09/1981
Three-Month										
Largest Adverse Move	312.44	451.57	1,074.41	-1256.38	110.20	-42.15%	-24.58%	-19.94%	-199.50	-385.00
Largest Adverse Move Date	10/20/2008	12/04/2008	12/05/2008	10/31/2008	03/06/2008	11/20/2008	11/09/1992	10/27/2008	03/17/2008	05/06/1980
Six-Month										
Largest Adverse Move	374.95	524.90	1,325.80	-1340.90	123.30	-46.64%	-30.79%	-21.89%	-290.90	-437.00
Largest Adverse Move Date	10/20/2008	12/16/2008	12/12/2008	10/31/2008	03/06/2008	03/09/2009	01/23/2009	11/20/2008	03/17/2008	10/13/1982

The yellow shading indicates the GMS shock is in excess of historical periods

Consequently, the GMS scenario is likely implausible given historical experience, both in terms of the magnitude of the shocks and in timing. This timing and magnitude mismatch imply capital markets become frozen for an extended period (*i.e.*, up to six months) across all major markets affected by the GMS scenario. To prove whether the assumption that all asset classes remained in a period of prolonged market dislocation was appropriate, the Study explored market access for certain asset classes, as explained in the following section.

[13] The analysis compares the GMS shock in the 2019 CCAR cycle to the largest adverse historical moves across different trading periods for a subset of typical factor shocks associated with trading banks. The "largest adverse move date" for the 10-day, three-month, and six-month trading period refers to the last date of the largest historical factor move over the corresponding trading period.

GMS Assumption Regarding Duration of Market Dislocation Not Supported by Empirical Analysis or Historical Observation

Key Finding

- GMS assumptions regarding the duration of market dislocation for certain asset classes are not supported by empirical analysis or historical observation, conflict with other U.S. and BCBS standards (*e.g.*, the LCR and the Fundamental Review of the Trading Book) and do not pass a "severe but plausible" test.

Recommendation

- **Recommendation 4:** Replace the blunt 3- to 6-month GMS with a framework that accounts for the liquidity and price stability of assets. Assets with high price stability and liquidity should be calibrated towards historical observation, at a maximum 30 days or fewer.

One of the assumptions driving the severity of the GMS shock calibration is that a market dislocation could last three months, six months or more. This Study clearly notes that certain asset classes that are captured in the GMS exhibited less liquidity during times of stress, or only experienced normalization following implementation of special programs by the FRB, U.S. Department of the Treasury or the Federal Deposit Insurance Corporation. Nonetheless, the Study pursued additional analysis to determine whether it was appropriate to assign market dislocation assumptions of three or six months or more for all asset classes. The Study identified key markets that were not beneficiaries of "special programs" to encourage normalization of the market. U.S. treasuries, corporate bonds, U.S. agency MBS and Foreign Exchange were identified as a sample population. The Study also assumed that volume for all asset classes was the indication of reasonable market function.

To test the FRB's assumption regarding market dislocation, the study evaluated:

- Historical experience during the crisis period, including market volumes across several asset classes an indicator of market functionality;
- Market capacity to sell portfolio of securities within reasonable bands on costs and time using a transaction cost model, and
- Assumptions in other regulatory frameworks published by the FRB and the BCBS regarding market function and dislocation.

Volume Analysis

The Study used the financial crisis as the period of analysis for core bond markets U.S. Treasuries, U.S. agency MBS, investment grade corporate bonds and non-investment grade corporate bonds. Data was obtained from SIFMA on the monthly average of daily volumes. To ensure the FX analysis captured a period of market turbulence, the announcement of the Brexit referendum was chosen. The FX data was sourced from CLS and is presented in monthly average of daily volumes.

Volume Analysis for Bond Asset Classes

During the crisis, trading volumes across three core bond markets (U.S. Treasuries, U.S. agency MBS and Corporates) clearly demonstrated volatility; however, the volume data did not indicate a strong correlation with material market events. In fact, volume for some asset classes increased during and after event occurrence for certain asset classes. The study reviewed data for U.S. Treasuries, investment grade and non-investment grade corporate bonds and U.S. agency MBS, which are presented and discussed below.

While the study did review U.S. Treasuries across the curve, there was concern that the data may be distorted by other factors such as rate moves, global coordinated interest rate cuts and quantitative easing. Nonetheless, the analysis did yield some interesting data points regarding the January 2007 to June 2010 period. This review is presented in Figure 9 below. Across all maturities, the lowest point in volume did not occur at the time of the Lehman Default (September 2008) or immediately following. In fact, September and October 2008 for some U.S. treasury segments (U.S. Treasury Bills, Treasuries due in less than three years and Treasuries due between three and six years) witnessed the highest or near highest volumes. Conversely, the lowest volume of trading for two of the five U.S. Treasury segments occurred in December 2008, but both rebounded significantly in January 2008. This suggests that the reduction in volume was disconnected from the market event related to the Lehman default or the most severe part of the crisis. Separately, low volume months were noted for longer dated treasuries a full 15 months prior to the most extreme crisis period, again suggesting that UST markets remained sufficiently accessible as indicated by volume in the second half of 2008.

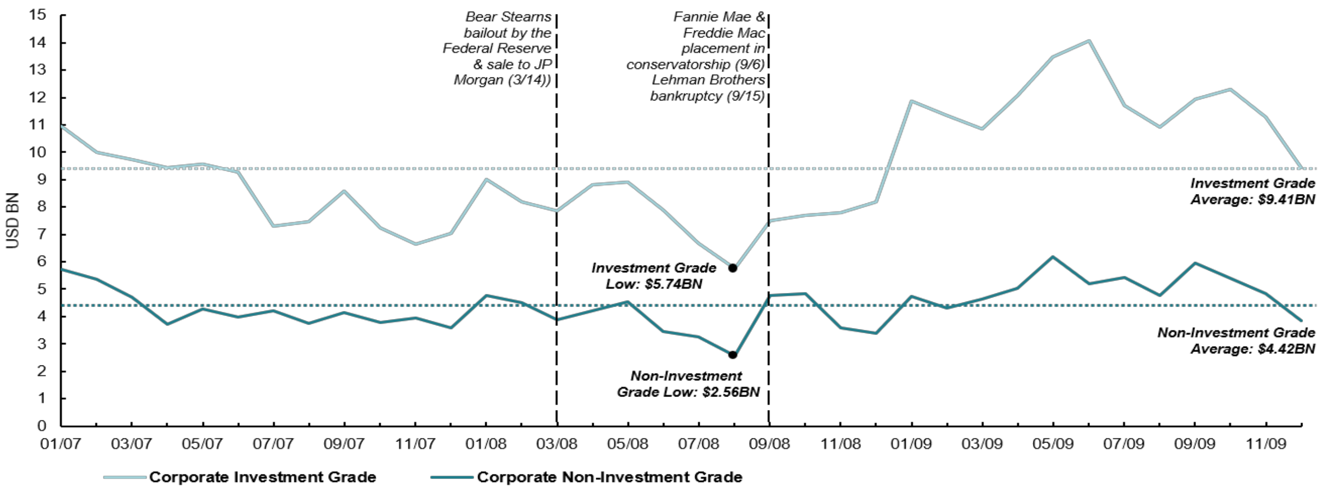
Figure 9. Select U.S. Treasury Volume Analysis

Abridged UST Volume Analysis					
	U.S. Treasury Bills	U.S. Treasuries due ≤ 3 years	U.S Treasuries due 3 years <6 years	U.S Treasuries due 6 years <11 years	U.S Treasuries due 11 years >
9/08 Volume	99.5	225.0	195.1	133.7	35.2
10/08 Volume	132.5	160.4	129.5	96.6	29.2
1/09 Volume	75.0	114.0	70.5	71.0	21.5

Similar to the outcome of the analysis of U.S. treasuries, the analysis revealed that both investment grade and non-investment grade corporate bonds demonstrated reasonable volumes during the latter half of 2008 including September and October 2008.

In Figure 10 below, considering the period of January 2007 through December 2009 revealed that the lowest volume for both investment and non-investment grade corporate bonds occurred in August 2008 and may have been due to seasonal flows. However, both asset classes showed significant rebound in September and October 2008. The upward sloping trend continued for investment grade corporates through the end of the data series. While non-investment grade corporates volumes dipped again in November and December 2008, volume remained significantly above the August 2008 low. The upward trend in volume for non-investment grade corporates picked up in January 2009.

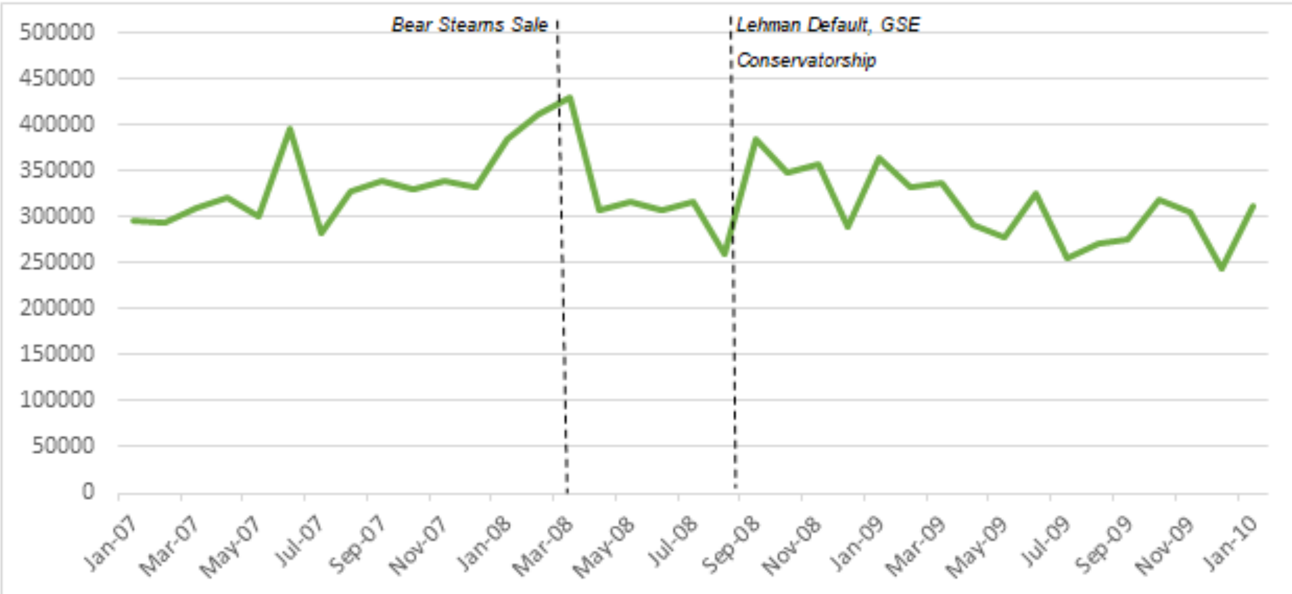
Figure 10. Avg. Daily Trading Volume During the Crisis Investment Grade and Non-Investment Grade Corporates[14]



The last bond asset class reviewed was U.S. Agency MBS. Here, the study found similar results for U.S. agency MBS for the time series between January 2007 and January 2010. The results of the analysis are found in Figure 11. The study concluded that there was reasonable volume in September and October of 2008, largely because volume data for those months were much closer to the volume noted at the top of the time series in March 2008 than to the lowest volume in the data series, which occurred in August 2008.

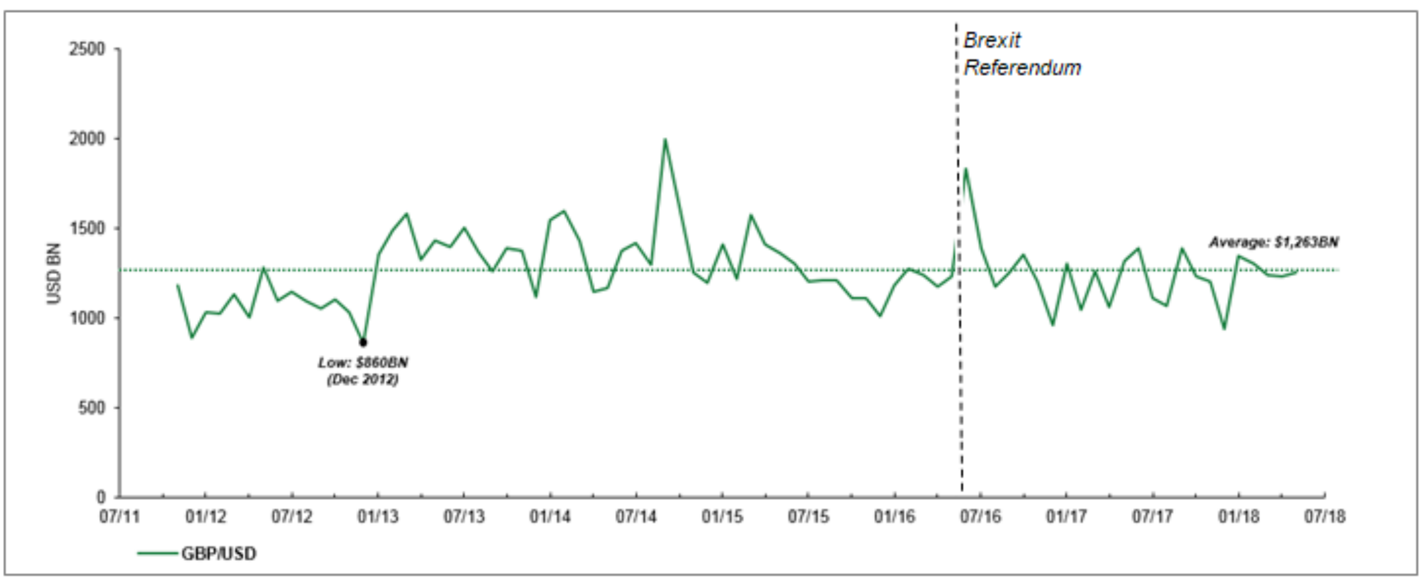
14 Source: SIFMA; CLS.

Figure 11. Daily Trading Volume of U.S. Agency MBS



Turning to the FX analysis, the data demonstrates that periods of stress or volatility result in volume spikes. This is displayed in Figure 12 below. Following the Brexit referendum on June 23, 2016, while the GBP/USD exchange rate fell by 8.1%, from 1.49 to 1.37, the largest single day movement in the currency pair since 1945, trading volumes spiked substantially. This is depicted in Figure 12 below.

Figure 12. Avg. Daily GBP/USD Trading Volume



In conclusion, the study found when volume is used as the primary indicator of market access, all of the bond market products reviewed (U.S. treasuries, U.S. agencies, and corporate bonds) demonstrated market access at the time of a material event and immediately following that event, at a minimum. The same conclusions were also drawn regarding the FX markets, indicating that sufficient access remained in the market at time of considerable market turbulence. Consequently, the study was unable to support one of the FRB's tenets regarding the draconian calibration of certain GMS shocks. The FRB's assumption that all markets are frozen post an event is unsupportable for all asset classes. Moreover, the study demonstrated that for the asset classes reviewed, the opposite in fact was supported: market access was reasonable during and after the event.

Analysis of market access for Certain Market under Extreme Events

To further test asset class markets functionality during or shortly after a shock event, an analysis using the transaction cost model was performed. The goal was to test whether large portfolios under stressed conditions could be sold without sizeable price movement and in a period of 5 days. The transaction cost model estimated the cost of selling portfolios of securities assuming different transaction sizes and market conditions. The model was created using marketplace data (benchmark pricing data, dealers runs, transaction volumes sourced from pricing vendors, etc.) and is widely used by financial market participants for trading, portfolio management and risk management purposes.

Figure 13 compares the sum of three representative portfolios' Value-at-Risk (VaR) analysis and their estimated transaction costs versus repo and discount window haircuts.[15] Each representative portfolio consisted of the least-liquid Treasuries, agency MBS, and investment grade corporate bonds (note: 75% percentile illiquid securities were used for investment grade corporates) across a range of maturity or product and tenor buckets to simulate a portfolio of relatively illiquid securities for each asset class. Next, using the transaction cost model, the cost to sell each portfolio under stressed conditions was estimated as well as the five-day, 99% VaR for each portfolio. The VaR output and transaction costs were summed to understand the total economic cost.

Collateral haircuts were used as a benchmark of cost. By verifying that standard haircuts were less than the sum of the representative portfolios' VaR and transaction costs, the analysis illustrates that a counterparty could liquidate the collateral resulted from a large counterparty default at values higher than their implied haircuts within five days.

Therefore, it is reasonable to assume that during an extreme market disruption, sufficient market access would exist in these specific asset classes to sustain continued trading and hedging. This analysis further supports the implausibility of a six-month liquidity horizon implied by the GMS scenario for many asset classes.

[15] The Treasury data uses discount window margins while the agency MBS uses the median tri-party repo haircut as reported by the Federal Reserve Bank of New York

Figure 13. Transaction Cost Model Results of Representative Treasury, Agency MBS, and Investment Grade (IG) Corporate Portfolios[16]

Modeling Assumptions					
Liquidation Period	5 days				
Confidence Level	99%				
Portfolio Assumptions					
	Treasury		**Agency MBS**		**IG Corporate**
Discount Window / Repo Haircut	2.41%		3.00%		5.00%
Portfolio Size	$10BN	$30BN	$10BN	$30BN	$275MM
Analytical Output					
Portfolio Analytical VaR	**111.30bps**		**181.10bps**		**298.38bps**
Portfolio Transaction Cost	9.81bps	16.71bps	23.69bps	40.63bps	201.60bps
Total Market Value Reduction	1.21%	1.28%	2.05%	2.22%	5.00%
MV Reduction within Haircut?	✓	✓	✓	✓	✓

Market Dislocation as Estimated in Regulatory Framework Evaluations

Regulatory framework comparisons can be useful for identifying areas of alignment or divergence around specific topics, particularly as these may impact firms that operate across regions. In this regard, several FRB and BCBS capital and liquidity frameworks assume or imply extended periods of market illiquidity or dislocation. The GMS scenario calibration period is an outlier compared these other frameworks; the trading period contemplated by the GMS is longer than those assumed under the FRTB, the FRB's market risk capital rule (MRR), and FRB's and BCBS's LCRs.

In 1996, the BCBS introduced the "Minimum capital requirements for market risk," which provided firms with a framework to calculate a minimum level of regulatory capital required to absorb losses related to trading activities. In the first version of the framework, firms were required to calculate VaR, defined as an estimate of the maximum expected loss on a portfolio as a result of market movements over a stated time period and within a stated confidence interval. Following the financial

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[16] The analysis demonstrates the ability to sell large portfolios under stressed conditions in a 5-day period. The Figure compares the expected market value reduction under stressed conditions for representative U.S. Treasury, agency MBS, and investment grade corporate portfolios against their respective haircuts. The market value reduction of each portfolio is calculated as the combination of the portfolio analytical value-at-risk (VaR) and the portfolio transaction cost, estimated based on the portfolio size, assumed liquidation period, 99% confidence level assumption.

crisis of 2007-2009, the Committee published a revised framework (Basel 2.5) in 2009. Among other revisions, Basel 2.5 amended the prior iteration's VaR calculation by requiring it to be calibrated to a stressed period. In both the first iteration published in 1996 and the revision published in 2009, the framework prescribed a static 10-day horizon for calculating VaR.

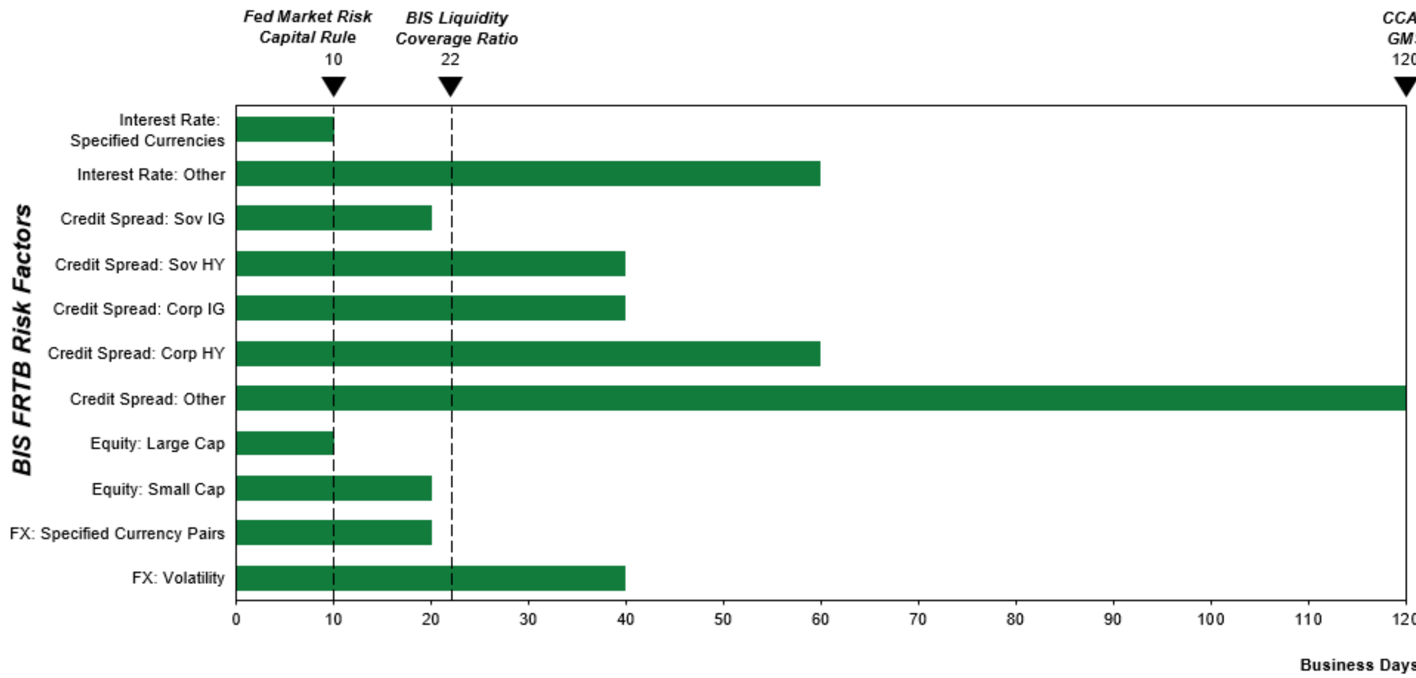
Following Basel 2.5, the U.S. federal banking agencies, including the FRB, introduced the MRR in 2011, which went into effect in 2013. The MRR adopted the stressed VaR-based measure from Basel 2.5, requiring firms to calculate VaR using a 10-day holding period, calibrated to a one-tail, 99% confidence level.

The BCBS has continued to develop the market risk standards via the FRTB. The revised "Minimum capital requirements for market risk" published in 2016 and finalized in early 2019 replaces the static 10-day horizon for calculating VaR with tailored liquidity horizons for different asset classes. Per BCBS standards, the FRTB is set to go into effect in 2022.

The BCBS's LCR is yet another standard that seeks to address issues related to liquidity deterioration observed in certain markets during the crisis. The LCR is intended to ensure that firms hold a sufficient supply of high-quality liquid assets (HQLA) to cover net cash outflows during a liquidity stress period. HQLA is defined as assets that, during a market dislocation, can still be converted into cash without significant loss of value. Calibrating outflow rates to prescribe how much HQLA a firm is required to hold requires the BCBS/FRB to conduct a cash flow stress test based on the assumption of a 30-calendar day (22 business day) liquidity stress period. The study concluded that the BCBS and the FRB both acknowledge that certain asset classes largely those considered to be HQLA maintain reasonably strong price stability and reasonable market function during periods of market dislocation.

Figure 14 compares the implied liquidity horizon from the GMS scenario with the horizons contemplated by the three rules described above. Thought of another way, the chart provides context as to the expected period of a marketplace dislocation by product type. Given that FRTB prescribes the most granular horizons, an illustrative set of risk factors is shown on the y-axis. The number of days prescribed by MRR, LCR, and the GMS is marked along the x-axis. FRTB distinguishes holding periods by perceived risk factor liquidity; the most liquid factors, such as equity large caps and certain interest rates, have a liquidity horizon of 10 days, while the least liquid factors have liquidity horizons of 60 to 120 days. In contrast, the MRR, the LCR, and the GMS do not distinguish asset classes by market liquidity.

Figure 14. A Comparison of the GMS with Stressed Periods for Other Regulatory Frameworks[17]



These calibration periods demonstrate a degree of variation in how regulators think about a reasonable liquidity horizon for estimating market risk of trading positions. Despite the differences between the frameworks, only one of the calibration periods is close to the 120-day assumption implicitly incorporated into the GMS scenario related to certain illiquid credit spread positions in FRTB.

The liquidity horizons that MRR, FRTB and LCR incorporate generally reflect the appropriate liquidity horizons for these asset classes and shows that the GMS is unnecessarily severe.

[17] The Figure compares implied liquidity horizons across FRTB, the Market Risk Capital Rule, the Liquidity Coverage Ratio and the GMS. The vertical axis shows illustrative set of risk factors prescribed by FRTB. The horizontal axis indicates the liquidity horizon prescribed to each risk factor. The liquidity horizon for the Fed Market Risk Capital Rule, the BCBS Liquidity Coverage Ratio, and the CCAR GMS are 10, 22, and 120 days, respectively and are represented by dashed lines.

Section 2: Large Counterparty Default

The LCD is designed to measure potential losses and related effects on capital associated with the instantaneous and unexpected default of a firm's largest counterparty. A firm's largest counterparty is the counterparty whose failure would result in the largest "net stressed loss" to the firm, estimated by revaluing default exposures and collateral using the GMS factor shocks.

To evaluate the appropriateness of using the GMS factor shocks as part of the LCD component, the analysis focused on assessing the validity of the embedded MPOR assumptions as derived from the GMS factor shocks.. Additionally, the analysis estimated a firm's market access by assessing its ability to liquidate a hypothetical collateral portfolio following a large counterparty default during a crisis. The evaluation also included a review of alternative LCD approaches and the FRB's recovery rate approaches.

The analysis supports the hypothesis that the LCD framework has foundational weaknesses. Essentially, the use of the GMS factor shocks given their calibration and correlation assumptions create unsupported distortions in the LCD results because the GMS factor shock calibration results in extreme assumptions regarding the closeout period or the MPOR. Moreover, the LCD lacks any consideration of risk sensitivity, and has not evolved since its inception. These factors limit the value of the LCD component as a risk management or capital planning tool for firms and supervisors.

The Study also found that the FRB's recovery rate estimation model(s), assumptions and data are not sufficiently transparent to the industry. Additionally, the recovery rate assumption of 10% disclosed in 2018 implies that the FRB does not differentiate recovery rate expectations by counterparty type. Disclosures regarding the FRB's approaches to recovery rate modeling would promote better analysis of firms' recovery rate modeling and promote improvement across the industry.

The LCD Overstates Counterparty Default Losses Because It Does Not Reflect the Short Duration of Defaulted Exposures and Overestimates Underlying Collateral Losses

Key Finding

- The use of GMS shocks to estimate LCD losses leads to an overstatement of risk, particularly for the most liquid and easiest-to-hedge exposures.
- As recognized in multiple regulatory frameworks, the typical closeout period for counterparty default exposures is far shorter than the multi-month timeframe implicit in the GMS.
- Other jurisdictions have evolved their LCD approaches to more closely mirror risks, counterparty vulnerability and market behaviors.

Recommendation

- **Recommendation 5**: Review and justify the LCD component to improve risk sensitivity and more closely mirror market practice.
- **Recommendation 6:** At a minimum, estimate LCD losses on the basis of extreme-but-plausible price moves over conservatively defined closeout periods, either by basing the LCD on a new set of price shocks defined independently of the GMS, or by applying scalars that adjust the GMS shocks down to closeout periods appropriate for counterparty default exposures.

Estimating potential counterparty default losses requires an estimate of the amount of time that would be needed to hedge and liquidate the exposures that result from the default. Yet as currently constructed, the LCD's estimate of counterparty default losses is based on the price moves reflected in the GMS shocks. This leads to a substantial overstatement of risk, since the multi-month timeframe implicit in the GMS is often well in excess of the amount of time required to close out counterparty default exposures, even during a severe market dislocation.

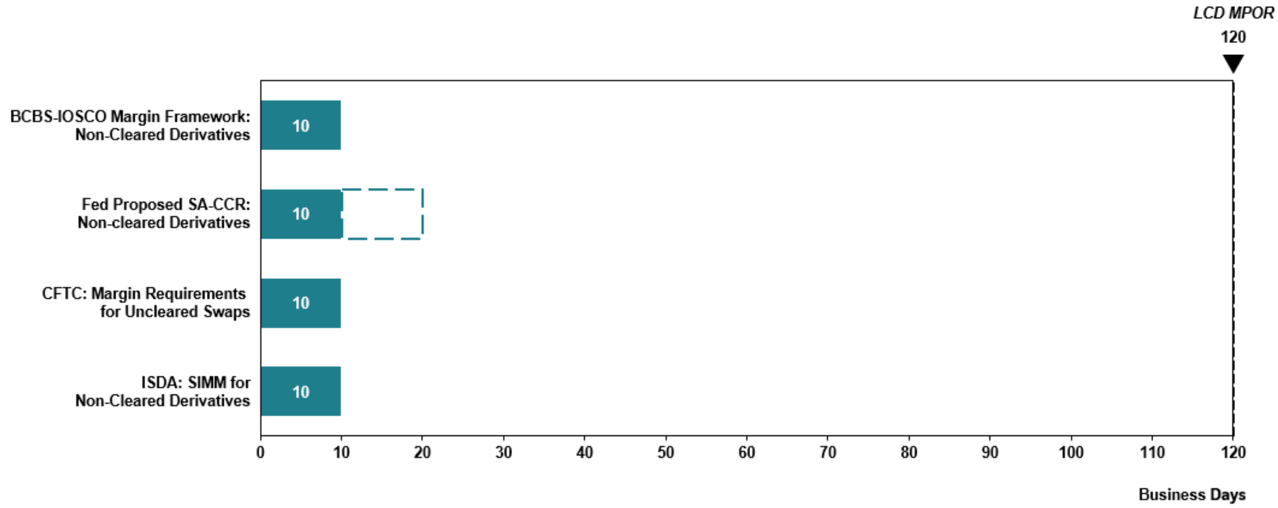
As stated earlier in this Study, the analysis suggests that many GMS shocks are calibrated over a three to six month severely adverse timeframe. The FRB's CCAR Policy Statement explains that "market shocks that might typically be observed over an extended period (i.e., 6 months) are assumed to be an instantaneous event which immediately affects the market values of the companies' trading assets and liabilities."[18] Referring to the GMS, former FRB Governor Daniel Tarullo explained that "we add a market shock scenario that incorporates market turbulence of severity similar to that of the latter half of 2008."[19]

[18] 78 FR 71435 (November 29, 2013), at 71442
[19] Daniel K. Tarullo (2014), "Stress Testing after Five Years," speech delivered at the Federal Reserve Third Annual Stress Test Modeling Symposium, Boston, MA, June 25.

Though the amount of time needed to close out default exposures will depend on the exposure, closeout periods (MPOR) are generally measured in days or weeks, not months. A firm that is faced with a counterparty default is incentivized to take immediate action to limit losses. In this respect, there is an important difference between the considerations relevant to the timing assumptions embedded in the GMS and the objectives of the LCD. Whereas the core activities of market makers may require firms to maintain securities inventory and derivative positions through stress, firms that experience a counterparty default do not need or desire to maintain the default exposures in order to continue their normal activities. To the contrary, promptly hedging default exposure is a core risk management practice reflected in internal policies, workout experience, and supervisory expectations.

Based on such considerations, existing regulatory standards, market conventions, and internal risk management frameworks have all acknowledged the short duration of exposures that result from a counterparty default. For example, the Basel III capital charges for counterparty default exposure are based on MPORs that extend from five to 10 days depending, *inter alia*, on instrument and collateral liquidity, and extend out to 20 to 40 days in the event of a history of collateral disputes. The FRB's Single-Counterparty Credit Limits rely on the same MPORs as the Basel capital rules. Similarly, the BCBS-IOSCO standard on margin requirements for non-centrally cleared derivatives states initial margin requirements for such derivatives should be based on potential price movements over a 10-day time horizon. Industry standard risk management practices have evolved to match similar timeframes. Methodologies used by CCPs to set initial margin and default fund requirements are based on estimates of the amount of time the CCP would require to unwind positions with failed clearing members – timeframes as short as 3 days. Firms' internal potential future exposure models, scenario analyses, and economic capital models are based on similar timeframes for counterparty default exposures. Figure 15 visually depicts the MPOR required across a select subset of regulatory frameworks.

Figure 15 Margin Period of Risk described in Various Regulatory Policies[20]



Given the very different timeframes contemplated by the GMS and the LCD, using the GMS to estimate LCD losses has the potential to vastly overstate counterparty default losses, especially for counterparty exposures that are the most liquid and easiest to hedge. This is problematic for several reasons:

- it is in tension with the goal of risk-sensitivity in CCAR, as well as with the basic structure of the GMS itself, which is highly granular and based on shocks to over 35,000 specified risk factors;
- it drives a wedge between the view of counterparty credit risk reflected in CCAR, on the one hand, and a firm's internal assessment of risk, on the other hand, which limits CCAR's usefulness as a risk management tool; and
- the LCD as currently constructed fails to differentiate between counterparty exposures based on liquidity, thereby placing an excessive regulatory tax on "plain vanilla" forms of financial intermediation compared to other activities, which could unnecessarily disrupt market functioning in some areas while encouraging firms to take more risk in others.

To avoid these consequences, the FRB should restructure the LCD so that the estimate of counterparty default losses reflects extreme-but-plausible price movements over a conservatively defined closeout period. One approach could be to base the LCD on a new set of price shocks that are defined independently of the GMS, on the grounds that the LCD and the GMS operate on fundamentally different timeframes. Alternatively, the FRB could maintain the link between the LCD and the GMS but apply "scalars" to adjust how the GMS is incorporated in the LCD in recognition of the shorter duration of counterparty default exposures. Different closeout periods should be used for different categories of default exposure, which

[20] The Figure shows the implied margin period of risk (MPOR) prescribed by the BCBS-IOSCO Margin Framework for Non-Cleared Derivatives, the Fed Proposed SA-CCR for Non-Cleared Derivatives, the CFTC Margin Requirements for Uncleared Swaps, the ISDA SIMM for Non-Cleared Derivatives, compared to the implied MPOR prescribed by LCD.

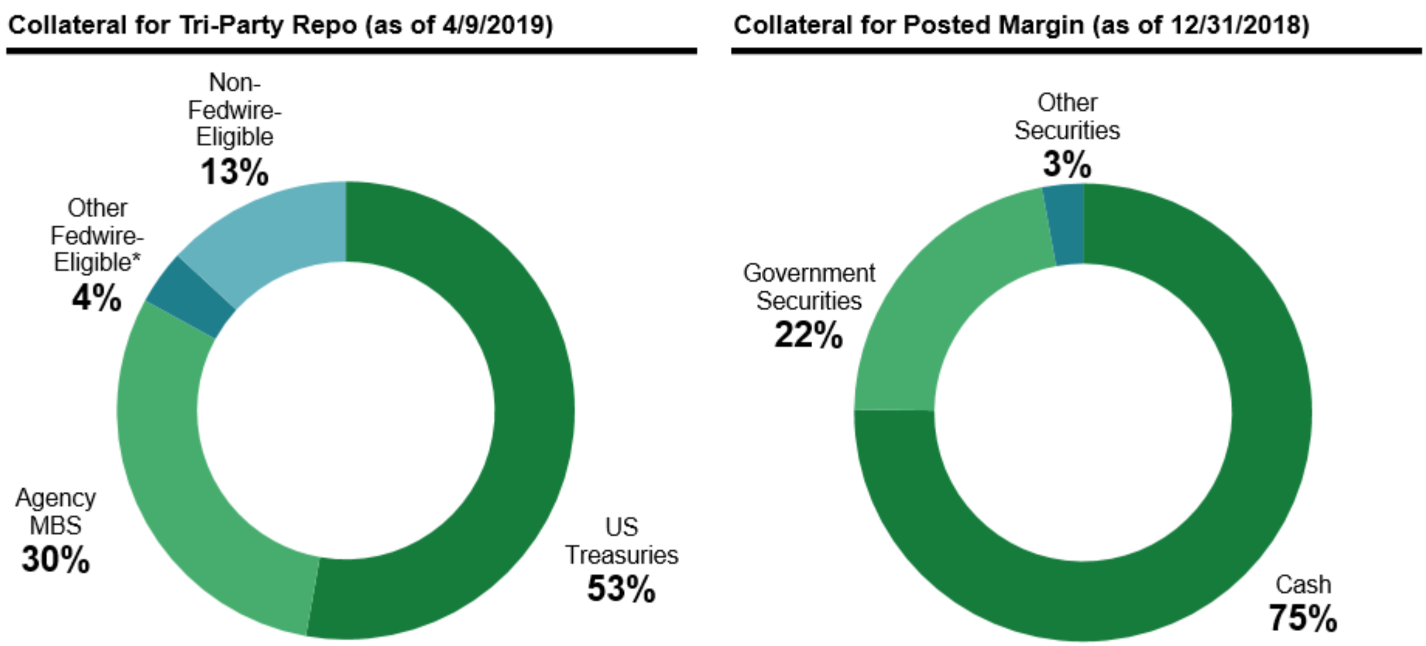
could be defined coarsely at the asset class level or using a more fine-grained methodology such as the one incorporated in the Basel III capital rules.

GMS impact on Collateral Values

To analyze the impact of GMS shocks on collateral supporting a counterparty exposure, the Study reviewed the composition of typical collateral and the impact of the GMS shocks on collateral underlying counterparty exposure.

As expected, U.S. Treasuries and agency MBS– along with cash – make up a significant portion of collateral received as margin for counterparty exposures. Figure 16 shows the breakdowns of collateral used for posted margin and tri-party repo. For posted margin, cash is widely used as collateral (approximately 75% of total margin posted) with government securities contributing another 22%, for a combined total of 97%. For tri-party repo, U.S. Treasuries and agency MBS are responsible for over 80% of the total.

Figure 16. Composition of Collateral for Posted Margin and Tri-Party Repo [21,22]



Once the typical composition of counterparty collateral was established, the Study estimated the time to liquidate and price give-up for a hypothetical counterparty collateral portfolio during a market dislocation. The below transaction cost analysis

[21] ISDA Margin Survey Year-End 2018. Available at: https://www.isda.org/a/nIeME/ISDA-Margin-Survey-Year-End-2018.pdf
[22] Federal Reserve Bank of New York. Available at: https://www.newyorkfed.org/data-and-statistics/data-visualization/tri-party-repo#interactive/volume/collateral_value

table (Figure 17) contains a subset of the previous Figure 13 for the representative U.S. Treasury and agency MBS portfolios, which were used to support the collateral liquidation analysis.

Figure 17. Transaction Cost Model Results of Representative Treasury, Agency MBS, and Investment Grade (IG) Corporate Portfolios[23]

Modeling Assumptions				
Liquidation Period	5 days			
Confidence Level	99%			
Portfolio Assumptions				
	Treasury		**Agency MBS**	
Discount Window / Repo Haircut	2.41%		3.00%	
Portfolio Size	$10BN	$30BN	$10BN	$30BN
Analytical Output				
Portfolio Analytical VaR	**111.30bps**		**181.10bps**	
Portfolio Transaction Cost	9.81bps	16.71bps	23.69bps	40.63bps
Total Market Value Reduction	1.21%	1.28%	2.05%	2.22%
MV Reduction within Haircut?	✓	✓	✓	✓

The table above (Figure 17) compares the sum of two representative collateral portfolios that are comprised *of the least-liquid Treasuries and agency MBS* across a range of maturity or product and tenor buckets. As an indication of risk, the Study estimated the five-day, 99% VaR for each portfolio. The transaction cost model was used to estimate the market value impact of liquidation under stressed conditions. The analysis found that in all cases, market value reduction was less than the haircut and within a short period of time. This analysis further underscores the inappropriateness of using the GMS shocks to sizes collateral losses.

[23] The analysis demonstrates the ability to sell large portfolios under stressed conditions in a 5-day period. Figure compares the expected market value reduction under stressed conditions for representative U.S. treasury and agency MBS portfolios against their respective haircuts. The market value reduction of each portfolio is calculated as the sum of the portfolio analytical value-at-risk (VaR) and the portfolio transaction cost, estimated based on the portfolio size, assumed liquidation period, and 99% confidence level assumption.

Comparison of Counterparty Default Designs

Inclusion of a counterparty default scenario is reasonable in a stress test framework. An LCD approach is most valuable when it is structured to support improvements in risk identification, management and assumptions and reflects market standards, and less helpful if it becomes an exercise in loss creation and capital need (*e.g.*, as the LCD is currently constructed). To provide perspective on the current LCD component, the Study reviewed how other jurisdictions approach large counterparty default scenarios. Figure 18 presents a comparison of the key features of the FRB, European Banking Authority (EBA) and the Bank of England's Prudential Regulation Authority (PRA) counterparty default approaches.[24, 25] The PRA appears to have made the most progress in nuancing their LCD approach. In particular, the PRA approach distinguishes approaches for collateralized and uncollateralized exposures, and fine tunes the approach to determining vulnerability.

[24] 2018 EU-Wide Stress Test: Methodological Note. Available at: https://eba.europa.eu/risk-analysis-and-data/eu-wide-stress-testing

[25] Stress testing the UK banking system: Key elements of the 2019 annual cyclical scenario. Available at: https://www.bankofengland.co.uk/news/2019/march/key-elements-of-the-2019-stress-test

Figure 18. Comparison of FRB, EBA, and PRA Counterparty Default Design

Approach Requirements	Federal Reserve Board	Prudential Regulatory Authority	European Banking Authority
Exposure Shock	Apply GMS shock to all margined and unmargined counterparty exposures	• For uncollateralized exposures, apply market risk factors • For collateralized exposures, assess time to close out all open positions, then apply market shocks based on identified closeout periods	• Apply risk factor shocks to all uncollateralized and collateralized exposures
Default Selection	Default largest counterparty of stressed exposures	• Default a total of 7 of the most vulnerable counterparties • 2 uncollateralized counterparties from bank's top 10 Asia and emerging market economies • 3 from bank's uncollateralized counterparties from UK/U.S. and Euro Area • 2 from bank's top 30 collateralized counterparties	• Default the two "most vulnerable" of the top 10 largest counterparties
Determination Drivers	None	• Banks should consider creditworthiness, among other factors, and exercise expert judgment	• Banks consider creditworthiness, among other factors, and exercise expert judgment

Recovery Rate Model Approaches and Assumptions Are Not Transparent

Key Findings

- The FRB's supervisory approaches to recovery rate modeling, including assumptions, data and calibration are not sufficiently transparent. This contrasts to the increased transparency of loss estimation models and annual loss rates. The recovery rate disclosure in 2018 of 10% suggests that the FRB does not differentiate recovery based on counterparty type.

Recommendations

- **Recommendation 7: Increase the transparency and disclosure regarding recovery rate modeling, assumptions and data, and seek to implement more risk sensitive recovery rate models that consider the risk of counterparty types.**

The modeling approaches, assumptions and data the FRB employs to estimate recovery rates under CCAR are not transparent to CCAR filers or the public. Greater disclosure regarding recovery rate modeling would be informative for the industry to support analysis of approaches, assumptions, and for self-assessment. Moreover, the lack of transparency regarding the evolution of recovery rate models and assumptions, particularly given post-crisis reforms and their impacts on the resilience of financial counterparties, hampers the industry's ability to further evolve models. This is another example of where the GMS and LCD components have not been provided the same level of transparency as the other elements of the CCAR/DFAST process. In light of the FRB's recent commitment to "publish disclosures about two additional models in 2020 and each year thereafter until we have provided transparency about all our stress test models", it is incumbent that the FRB apply the same expectations to the models in the GMS and LCD components as they are applied to the banking book models particularly with respect to disclosure.

The recovery rate disclosure in 2018 suggests that the FRB does not differentiate recovery rates by counterparty type. Academic and industry studies clearly provide evidence that counterparty types influence recovery rate experience. The use of blanket assumptions regarding recovery rates can over or underestimate the potential experience. Furthermore, because recovery rates have a direct impact on loss estimates and the outcome of the LCD component, precision where possible is important to the credibility and reasonableness of the outcome. Similar to the commitment to continuous improvement of banking book models, it is reasonable to expect that the same efforts would be dedicated to recovery rate modeling for the LCD component.

Section 3: CCAR Framework and Appoach Observation

Limited Transparency into the Determination of Severity Undermines the Plausibility of the Approach

Key Findings

- The FRB does not provide disclosure regarding how the GMS shocks are sized, including how calibration and correlation are considered, other than they are based on a "principle of conservatism" and a "severe but plausible" standard.
- The opacity in how the GMS shocks are constructed impedes the FRB's ability to analyze and learn from these tests, and to improve upon its current supervisory approach.
- The process surrounding the GMS AND LCD components and their administration lacks the structure, transparency and consistency that exists in other parts of CCAR.

Recommendation

- **Recommendation 8:** Apply similar transparency to the determination of GMS shocks as is currently applied to the FRB's macroeconomic scenarios. Additionally, employ controls or "guardrails" on GMS factor severity, correlation, volatility and calibration similar to what the FRB implemented with respect to HPI and unemployment. Moreover, apply the same process type controls to the administration and communication of the GMS and LCD components' annual process.

Needed Transparency Regarding "Severe but Plausible"

Despite some recently-provided insight into the FRB's CCAR and scenario design processes, including models and loss rates,[26] the FRB's process and rubric for (i) the calibration and correlation of market shocks, (ii) the parameters that guide those decisions, and (iii) how the FRB evaluates the degree of intended variability in GMS shocks, continues to be opaque. The FRB recently published principles to guide the development of macroeconomic scenarios, including application of controls regarding the HPI and the unemployment rate. It also has substantially enhanced its disclosure regarding some of its banking book models. Nevertheless, that transparency has not expanded to the construction of GMS shocks, their calibration or correlation, or specifically to how the "principle of conservatism" and the "severe but plausible" standards apply to the GMS shocks. A measurable, transparent standard to guide the development of annual GMS shock levels would

[26] FRB, Dodd-Frank Act Stress Test 2019: Supervisory Stress Test Methodology (April 9, 2019); 84 Fed. Reg. 6651 (Feb. 28, 2019) (Amendments to Policy Statement on the Scenario Design Framework for Stress Testing); 84 Fed. Reg. 6784 (Feb. 28, 2019) (Enhanced Disclosure of the Models Used in the Federal Reserve's Supervisory Stress Test); 84 Fed. Reg. 6664 (Feb. 27, 2019) (Stress Testing Policy Statement).

reduce the inconsistency of the framework over time and allow the public to understand and study how the severity and calibration of the GMS impact risk profiles. More transparency would also promote the credibility of the test and the framework.

Currently, GMS factor shocks are simply provided by asset class without regard to the events the GMS factor shocks have been sized to capture. Providing transparency around the broader scenario similar to how the macroeconomic scenario provides context to the banking book loss estimates and PPNR approach would promote better understanding of potential risk and capital needs. Linking the GMS factor shocks to a "scenario" or event type would support the year on year analysis and potentially limited back testing of results.

The new FRB policy statement on the Scenario Design Framework for Stress Testing describes a future framework for shock development that employs a more "scenario type approach," with individual shocks determined based on a historical scenario, multiple historical scenarios, hypothetical scenarios or a hybrid approach. However, the policy statement does not provide insight into how shocks will be calibrated, or what correlation assumptions the FRB will use. The policy framework therefore introduces additional variability and complexity without any greater transparency, which runs counter to the FRB's stated objective of increased transparency in the CCAR process. Under the policy framework, the current, flawed process will be partially replaced with an even more opaque, qualitatively driven and complex approach. Of note, the policy statement does not appear to consider the changes in the financial system or lessons learned from the financial crisis as driving a need to revisit its scenario design framework. Given the advent of a newer approach to the GMS, it is an appropriate time for the FRB to develop guardrails to guide the GMS scenario development, including with respect to severity, correlation and calibration.

It is incumbent upon the FRB to ensure consistency in the GMS AND LCD components approach and expectations with other parts of CCAR, including the new controls implemented around the development of macroeconomic scenarios. In particular, the GMS calibration should be grounded in an economically supportable and repeatable framework that is subject to the same oversight and review as the macroeconomic scenario development process.

GMS and LCD Components Process Transparency

The FRB has looked to increase some of the communication and disclosure regarding CCAR process and some elements of the GMS and LCD components process and execution timelines. Much of the communication regarding GMS and LCD components remains "non-standard" and opaque to the public when compared with other aspects of CCAR. For example:

- The FRB communicates market shocks separately from its macroeconomic scenarios and does not indicate when any such communication may be expected other than by providing a deadline.
- Templates that are not part of the FR Y-14 reporting often are introduced without explanation and close to the submission deadline, *e.g.*, one month.
- FRB guidance continues to be brief and does not convey to the public its approach and expectations in a meaningful way.

Collectively, these shortcomings undercut the FRB's goal of simplicity by adding needless complexity and opacity. As a practical matter, the unpredictable nature of the process makes deadlines and personnel management unnecessarily difficult, creating inefficiencies and costs that could be avoided.

> "Stress testing must never become static. As the financial system evolves, with the creation of new products and new correlations among asset price movements, the supervisory model must account for these changes."
>
> **Daniel K. Tarullo**
> Former FRB Governor
> April 2017

Application of GMS and PPNR Undermines the Value of CCAR as a Risk Management Tool

Key Findings

- The requirement to employ both GMS and PPNR modelling results in overestimation of losses and underestimation of available capital through double counting of losses and the instructions for calculation of proforma capital.
- The GMS captures some assets that do not demonstrate the characteristics of more traditional trading exposures. Given the underlying objectives of the GMS, the impact on some asset classes is inappropriate and may over or understate losses.

Recommendations

- **Recommendation 9***:* Revise the GMS/PPNR approach to eliminate the double counting issue either by developing a transparent supervisory workaround or by zeroing out the GMS and LCD components results in the first quarter of the PPNR. Simultaneously, address the underestimation of available capital by implementing a max loss cap (losses and deductions) to avoid capital requirements that could exceed the current value of securities and investments and allow firms to calculate deductions in post-stress loss capital ratios using post-stress loss asset values.
- **Recommendation 10:** Omit non trading-centric asset types from the GMS, as is currently the case with the carve-out of fair value non-trading loans. These assets would remain subject to PPNR modelling.

Overestimation of Losses (Double Counting) and Underestimation of Capital (Proforma Instructions)

Large trading firms subject to the GMS are also required to model and project PPNR on their trading book assets based on the FRB's macroeconomic scenarios. These two requirements are at odds with each other, including with respect to methodology, timing of losses and objectives. Subjecting large trading firms to both requirements results in calculating losses twice on certain trading book assets.

To explain, the GMS scenario of CCAR requires an immediate recognition of loss on a particular date, which is typically a different date the starting date for the PPNR modelling. If, however, a firm holds a particular asset on the GMS reference date *and on* the first date of PPNR modelling, that asset would be subject to both the GMS and PPNR components for modeling losses. As a result, the asset will be subject to a loss calculation based on a prescribed market shock (under GMS) and a separate, duplicative loss calculation under the FRB's macroeconomic scenarios as a part of PPNR modeling.

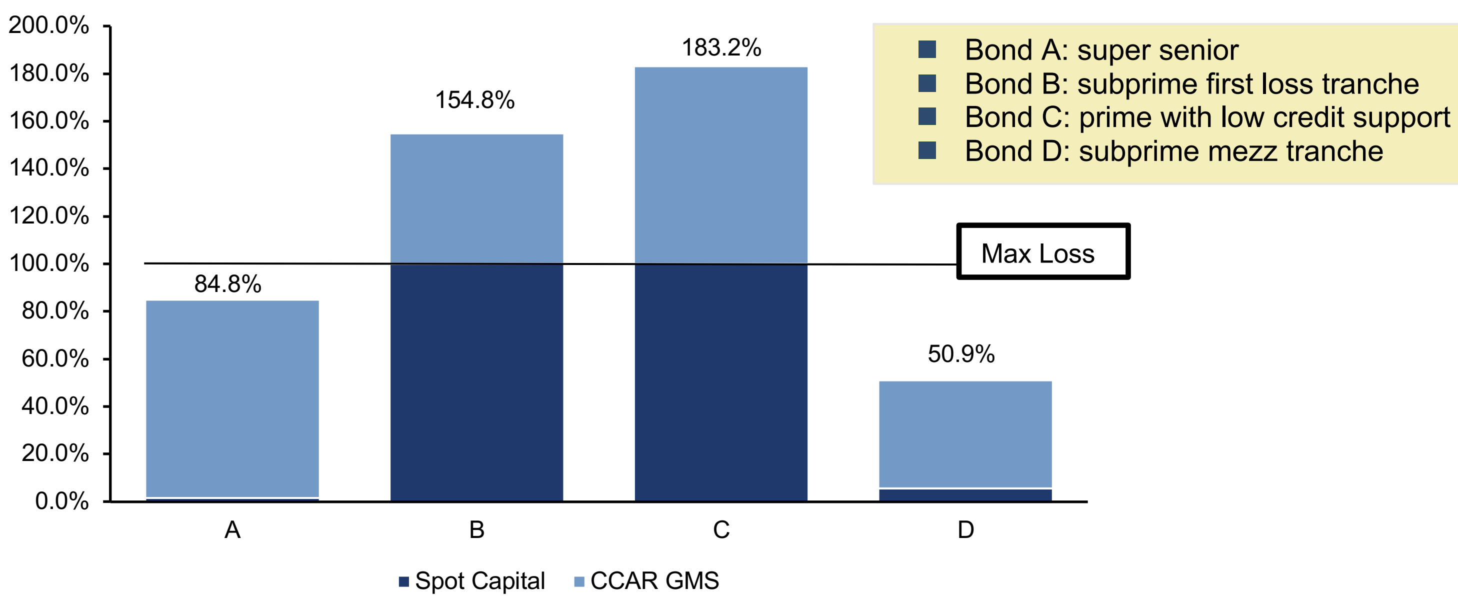
The greater the overlap of trading assets held on the GMS reference date and day one of the PPNR projections, the greater the double counting of losses. While the FRB outlines a process for a firm to eliminate the double count, it is overwhelmingly complex as the impact of the GMS and the PPNR needs to be performed at the transaction level. Moreover, there is no explanation as to how the FRB eliminates the double count in their calculation. The double count issue is an approach flaw that needs to be addressed. The FRB could consider a review of a firm's own estimates of double-count losses or by eliminating the GMS impact in the PPNR Q1 projection period. Moreover, the FRB should consider developing a more strategic solution by modeling PPNR on the trading book using similar techniques as firms — *i.e.*, by segmenting by business and modeling volumes, bid-offer, mark-to-market, and carry.

Double Count in Proforma Capital Calculations

The double count issue is also problematic in the pro forma capital calculation with respect to assets that are subject to the simplified supervisory formula approach (SSFA) or a capital deduction.

With respect to securitization exposures that are subject to the SSFA, the total capital required for such exposures under CCAR can be greater than the current market value of the exposure. In particular, a large trading firm subject to both the GMS and PPNR losses with respect to a securitization exposure also would be required to reflect losses when applying the SSFA approach in its RWA calculations, potentially implying a capital requirement for the asset that is higher than the current market value of the asset. Figure 19 below illustrates this impact.

Figure 19. Comparison of Spot and Stress Capital Requirements for Exposures Subject to the SSFA

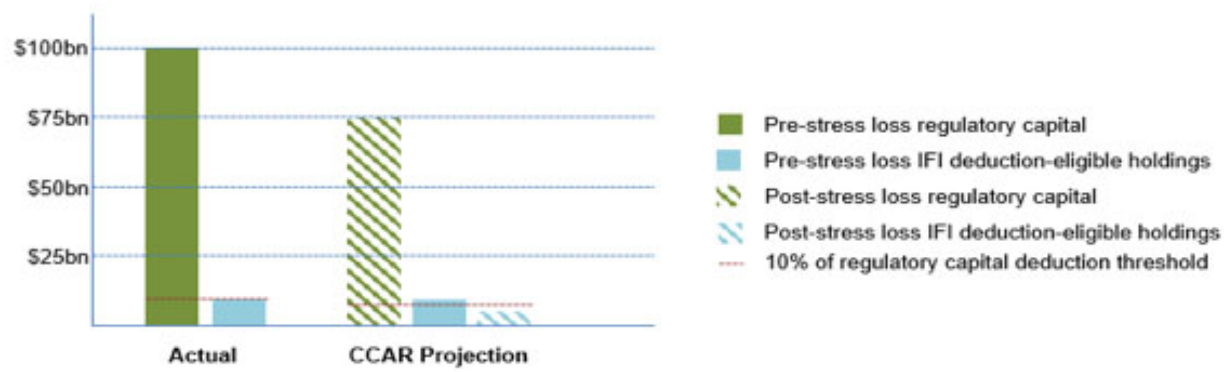


With regards to the CCAR treatment of non-SSFA assets that require a capital deduction, firms are required to employ pre-stress assets values when calculating post-stress loss capital. This introduces a disconnect between stress loss analysis and pro forma capital calculations. The Study recommends that, as part of the second step of the stress loss analysis, firms be required to calculate deductions in post-stress loss capital ratios using post-stress loss asset values.

These issues go well beyond the SSFA example summarized in Figure 19, and implicate basic methodology questions for post-stress loss capital projections. For example, assume a firm has pre-stress loss regulatory capital of $100 billion and $9 billion of unconsolidated investments in financial institutions (IFI) that are eligible for deduction. In this example, the firm's IFI positions do not exceed 10 percent of the firm's regulatory capital, meaning that no IFI-related deduction would apply.

In the CCAR stress loss analysis, assume that the firm recognizes $25 billion of losses, reducing its regulatory capital from $100 billion to $75 billion. Further assume that, of the $25 billion of losses, $4 billion relate to IFI holdings, meaning that the firm's post-stress loss IFI holdings are now $5 billion, or $4 billion less than the original $9 billion IFI position. These illustrative figures are summarized in Figure 20.

Figure 20. Post-stress loss capital deduction analysis



The critical issue in this example is what reference value of IFI deduction-eligible assets is used for CCAR projection purposes. The firm's post-stress loss regulatory capital of $75 billion results in a 10 percent deduction threshold of $7.5 billion. If this deduction threshold is measured against the firm's post-stress loss IFI deduction-eligible assets of $5 billion, no deduction would apply. This outcome is logical, since the IFI deduction-eligible assets have already lost 45% of their value through the stress loss analysis.

If, however, the $9 billion *pre*-stress loss value of IFI deduction-eligible assets is applied to the firm's *post*-stress loss regulatory capital, these assets exceed the $7.5 billion deduction threshold by $1.5 billion, resulting an additional capital cost in the form of a deduction that is additive to the original $4 billion of stress losses. By combining pre- and post-stress loss values together in this manner, regulatory capital stress losses rise from the original $4 billion to $5.5 billion.

This outcome is punitive, and also illogical. In the above example, the firm's post-stress loss regulatory capital results in a lower threshold; it is apples-to-oranges to apply the larger, pre-stress loss IFI deduction-eligible asset values. Applying post-stress loss regulatory capital values and post-stress loss deduction-eligible asset values would ensure that a coherent set of assumptions and principles governs the process.

GMS Coverage

The GMS attaches to some assets that do not necessarily display the same characteristics of more traditional trading book exposures – specifically those assets held short term with the intent of resale. In the past, the FRB recognized certain asset classes that, while part of the "trading book" for GMS purposes, are not reasonably or appropriately "tested" by the GMS. The FRB in the past has recognized this concern and provided a carve out for fair value, non-traded loans. This Study strongly suggests that the FRB consider what other assets classes may be better suited to the PPNR approach (as opposed to the GMS) to improve the appropriateness of results.

Conclusion: Important to Revisit Key Aspects of CCAR

The FRB's CCAR framework as applied to trading book exposures has not been revised since adoption over ten years ago and, as a result, is unsophisticated relative to the significant advancements in the prudential regulatory framework and risk management practices that have been made since that time. SIFMA stands ready to facilitate a dialogue between the industry and the FRB and other policy makers to help ensure that the CCAR process evolves and advances in a way that supports its relevance to risk management practices.

Based on the Study and analysis described above, SIFMA makes the following observations:

- Post-crisis regulations have led to significant changes in market structure and practices, reducing the likelihood and impact of potential vulnerabilities in the financial system. The new regulatory framework has required financial institutions to decrease their risk appetite and risk profiles. Further, supervisors have implemented additional regulations with similar goals as the GMS and LCD. The FRB should account for these changes when structuring the GMS and LCD components of CCAR. To date, however, the GMS and LCD have not evolved in tandem with these other changes.
- Over the past decade, regulators have become more proficient at modeling approaches, which is particularly relevant to projecting PPNR for the trading book. Experience with model performance and more robust data should drive better results and less reliance on extraneous drivers of loss disconnected from the macroeconomic scenarios.
- Many of the foundational assumptions underlying the GMS scenario calibration are excessive and not plausible; they are out of line with empirical analysis and historical observations when combined with the PPNR modelling requirements. The continued overestimation of potential market shocks, particularly for certain product types, is not justifiable and, in fact, is detrimental to market performance, pricing and liquidity.
- The LCD approach, which is driven by the severity of the GMS, is not useful or credible for risk management purposes given the lack of consideration given to counterparty vulnerability and the margin period of risk historically observed during LCD events.
- The GMS and LCD continue to be less transparent than other aspects of CCAR. The FRB should increase transparency regarding how it evaluates what is plausibly severe in a repeatable and empirically supportable manner.

The recommendations made in this paper recognize that a well-designed, robust supervisory stress testing framework needs to be severe and conservative, but at the same time demonstrate plausibility under the FRB's own standards. The plausibility element is critical to the credibility of the results, which is crucial to maintaining confidence in financial institutions and the financial system; (b) the usefulness as a risk management tool for financial institutions; (c) ensuring that supervisors are not somewhat arbitrarily picking winners and losers from specific business models or markets; and (d) the effectiveness for supervisors in monitoring potential stress points in the financial system.

For the foregoing reasons and based on the analysis described in this paper, we urge the FRB to act promptly to revise the GMS and LCD components of the CCAR program.

Appendix

Summary Recommendations

Recommendation 1	GMS factor shocks should be tailored to reflect the liquidity and price stability characteristics of particular asset classes.
Recommendation 2	Correlation assumptions need to be rationalized and validated based on empirical analysis and historical observation in order to meet the “severe but plausible” standard.
Recommendation 3	Year-over-year shock volatility should not be extreme or random, but rather should reflect more gradual adjustments to emerging views of risk that are linked to feedback from the prior years' analysis.
Recommendation 4	Replace the blunt three- to six-month GMS with a framework that accounts for the liquidity and price stability of assets. Assets with high price stability and liquidity should be calibrated towards historical observation, at a maximum 30 days or fewer.
Recommendation 5	Review and justify the LCD component to improve risk sensitivity and more closely mirror market practice.
Recommendation 6	At a minimum, estimate LCD losses on the basis of extreme-but-plausible price moves over conservatively defined closeout periods, either by basing the LCD on a new set of price shocks defined independently of the GMS, or by applying scalars that adjust the GMS shocks down to closeout periods appropriate for counterparty default exposures.
Recommendation 7	Increase the transparency and disclosure regarding recovery rate modeling, assumptions and data including empirical support. Recovery rates used in CCAR should be disclosed annually.
Recommendation 8	Apply similar transparency to the determination of GMS shocks as is currently applied to the FRB’s macroeconomic scenarios. Additionally, employ controls or “guardrails” on GMS factor severity, correlation, volatility and calibration similar to what the FRB implemented with respect to House Price Index (HPI) and unemployment. Moreover, apply the same process type controls to the administration and communication of the GMS AND LCD components’ annual process.
Recommendation 9	Revise the GMS and LCD components and the PPNR framework to eliminate the double counting issue either by a developing a transparent supervisory workaround, or by zeroing out the GMS AND LCD components results in the first quarter of the PPNR. Simultaneously, address the underestimation of available capital by implementing a max loss cap (losses and deductions) to avoid capital requirements that could exceed the current value of securities and investments, and allow firms to calculate deductions in post-stress loss capital ratios using post-stress loss asset values.
Recommendation 10	Omit non trading-centric asset types from the GMS, as is currently the case with the carve-out of fair value non-trading loans. These assets would remain subject to PPNR modelling.

Definitions (Figure 22)

Term	Definition
t-distribution	t-distribution (Student's t-distribution) is a probability distribution that is used to estimate population parameters when the sample size is small and/or when the population variance is unknown. t-distribution is often used in statistical analyses on certain data sets that are not appropriate for analysis using the normal distribution.
Copula	Copula (probability theory) is a statistical measure representing a multivariate uniform distribution, which examines the association or dependence between many variables. Copula works with skewed or asymmetric distributions and is often used in place of correlation coefficient, which only works well with normal distribution.
Degrees of Freedom (df)	The number of values or observations that can vary in an analysis when estimating statistical parameters. In the context of a t-distribution, degrees of freedom equal to $n - 1$, where n is the sample size.
Confidence Interval	A range of values, calculated from a given set of data, which will contain an unknown population parameter at a specified probability.
Value-at-Risk (VaR)	The potential loss in value of an investment given a defined period of time and confidence interval.
Margin Period of Risk (MPOR)	The time period from the last exchange of collateral covering a netting set of transactions with a defaulting counterpart until that counterpart is closed out and the resulting market risk is re-hedged.