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Investment Decisions and Risk-Based Capital Allocation Under Stress Testing Requirements

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Abstract

During recent years, higher capital standards imposed by new stress testing requirements have forced organizations to address how to better manage capital to meet regulatory constraints. While maintaining higher capital levels is indeed mandatory, simply satisfying the requirement does not necessarily align with stakeholders' preferences for optimal capital deployment and investment decisions. CCAR-style stress tests are requirements that organizations must adhere to; however, these exercises likely do not reflect how stakeholders actually trade off risk and return.

Required economic capital (EC) accounts for economic risks such as diversification and concentration effects. When used in measures such as return on risk-adjusted capital (RORAC), EC can provide useful insights that allow institutions to optimize risk-return profiles and to facilitate strategic planning and limit setting, as well as quantify risk appetite.

Given these observations, both EC and regulatory stress tests should influence decision-making. After all, a deal with lower sensitivity to the stressed scenario but the same EC is favorable, and a deal with lower EC but the same sensitivity to the stressed scenario is also favorable.

In this paper, we formalize risk measures that help organizations make optimal investment decisions and capital deployment under CCAR or DFAST-style stress testing requirements.

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1. Introduction

During recent years, organizations have faced increasing pressure to better measure risk-return tradeoffs and to manage capital under increasingly higher regulatory capital standards. While maintaining required Regulatory Capital (RegC) levels is necessary, and indeed mandatory, simply satisfying the requirement does not necessarily align with stakeholders' preferences for optimal capital deployment and investment decisions. This discrepancy can occur because typical measures related to RegC are not as risk-sensitive as traditional risk measures, such as Economic Capital (EC). For example, the Risk-Weighted Asset (RWA) measured under the Basel advanced IRB approach does not capture concentration and diversification effects on risk. Consequently, such measures do not differentiate across, say, an energy bond and a loan lent to a tech company, so far as the underlying obligors have similar default risks, regardless of the composition of the current portfolio held by the organization.

To address the shortcomings of simple RegC measures, Levy, Kaplin, Meng, and Zhang (2012) proposed the concept of integrating RegC and EC. They introduced RegC-Adjusted RORAC — a measure of risk-return tradeoff that accounts for both RegC requirements and the full spectrum of economic risk. Xu and Levy (2015) applied the same model framework to design a capital allocation measure called Composite Capital Measure (CCM), which specified optimal capital deployment under various regulatory requirements.

Regulations such as the Dodd-Frank Act (DFA) require financial institutions to conduct CCAR-style stress tests. These tests stipulate that organizations maintain a sufficient capital buffer throughout a hypothetical, severe economic downturn scenario. In this paper, we show that a CCAR-style stress testing requirement can be incorporated into the Levy, Kaplin, Meng, and Zhang (2012) framework by considering the stressed expected loss and capital requirements in the horizon being stressed. The approach provides direction for optimal business decisions under various stress testing requirements using CCM and RegC-Adjusted RORAC.

The remainder of this paper is organized as follows:

» Section 2 proposes the conversion of a CCAR-style stress testing requirement into a static Basel-style capital requirement.

» Section 3 discusses CCM under stress testing requirements.

» Section 4 studies RegC-Adjusted RORAC under stress testing requirements.

» Section 5 concludes.

» The Appendix describes the sample portfolio used in our exercise.

2. Stress Testing Requirements

2.1 Effective RWC

Basel-style regulatory capital requirements place limits on the degree to which an organization can leverage its balance sheet. While the exact rule may differ with the calculation method of Risk Weighted Asset (RWA), or the difference in the definition of capital, the requirement can be generalized into a static capital constraint for the organization:

$$Book\ Equity_t \geq \sum_i N_{i,t} RWC_{i,t} \tag{1}$$

where $N_{i,t}$ is the holding amount of asset i at time t; and $RWC_{i,t}$ represents Risk Weighted Capital, which measures the required regulatory capitalization rate (i.e. the ratio between required RegC and the nominal amount of the asset) of asset i at time t. As suggested by the name, RWC is closely connected with RWA via the following relationship:

$$RWC = RWA \times Capital\ Adequacy\ Ratio \times \frac{EAD}{Nominal\ Amt.} \tag{2}$$

Both RWA and the Capital Adequacy Ratio (risk-based) are determined by capital regulations. For example, under the standardized Basel III approach, RWA is typically 100% for a commercial loan. The adequacy ratio for total capital is 8%.

Levy, Kaplin, Meng, and Zhang (2012) augmented the traditional RORAC measure by incorporating the capital constraint specified in Equation (1). The resulting RegC-Adjusted RORAC measure — a function of RWC among other inputs — accounts for both economic risk and the regulatory capital requirement associated with the underlying investment. Xu and Levy (2015) applied the same concept and constructed the Composite Capital Measure (CCM), which specifies optimal capital allocation in a way that accounts for both RegC and EC.

While both the RegC-Adjusted RORAC and CCM measures are initially designed for organizations under a Basel-style regulatory capital requirement, they can be extended to the case where a CCAR-style stress testing requirement is present. The approach incorporates the forward-looking CCAR-style capital constraint into the form of Equation (1). Recall, CCAR requires institutions to maintain adequate capitalization under hypothetical, severe economic downturns. This regulation boils down to a required capital buffer that adheres to RWC, while accounting for erosion due to stressed expected losses, conditioned on the downturn scenario. Mathematically, the CCAR constraint can be approximated as:

$$Book\ Equity_t \geq \sum_i N_{i,t} RWC_{i,t} + \sum_i N_{i,t} EL_{i,t} = \sum_i N_{i,t} RWC_{i,t}^* \tag{3}$$

where $EL_{i,t}$ is the expected loss of instrument i during the worst CCAR scenario. We reference the sum of EL and the regular RWC as the *Effective RWC*. The intuition behind Equation (3) is that, if an organization can maintain its capitalization rate in order to maintain Effective RWC, it can expect to absorb portfolio losses using its capital under a severe economic downturn and still retain enough capital to meet the minimum future capital requirements. Since Equation (3) has the same form as Equation (1), we can compute CCM or RegC-Adjusted RORAC under CCAR stress testing requirement by replacing regular RWC with Effective RWC in the corresponding formula.[1]

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[1] See Levy, Kaplin, Meng, and Zhang (2012) and Xu and Levy (2015) for the mathematical formula of RegC-Adjusted RORAC and CCM.
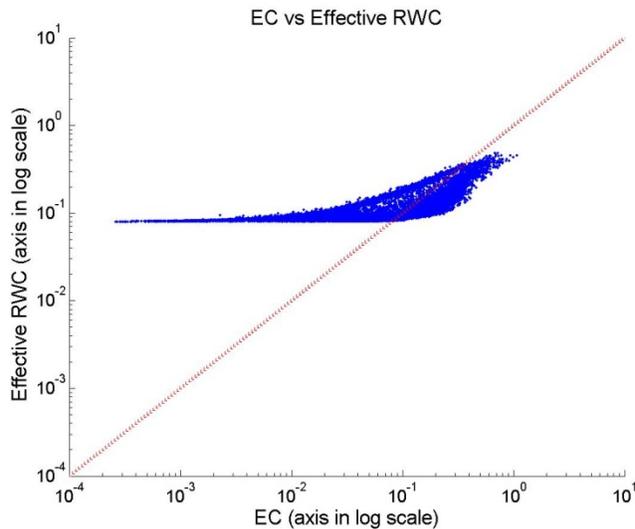
Figure 1   EC vs. Effective RWC

Figure 1 presents the relationship between EC and Effective RWC for a sample portfolio.[2] The instrument EL component of the Effective RWC is computed as the nine-quarter cumulative expected loss under the CCAR 2015 Severely Adverse Scenario. RWC is set at 8%, corresponding to 100% RWA under Basel standardized approach. Three important patterns stand out in the figure. First, Effective RWC generally increases as EC does. This increase occurs because riskier instruments tend to have higher losses during a stress scenario. Second, the value of Effective RWC is bound below by 8%. The boundary reflects the required minimum capitalization rate, 8%. Finally, as EC increases, Effective RWC does not increase as fast, in general. This finding occurs because Effective RWC only accounts for default risk in the form of EL. It does not capture diversification or concentration risk as reflected in EC; concentration does not impact Effective RWC.

2.2 Calibration

Both the RegC-Adjusted RORAC and CCM measures are functions of two inputs, in addition to the economic risk and return associated with the instrument: the regulatory capital burden on the specific instrument, and the degree to which an organization is capital-constrained. The former is measured by RWC or Effective RWC, as discussed in the previous section. The latter input is portfolio-specific and must be calibrated. Xu, Levy, Meng, and Kaplin (2015) link the degree to which an organization is capital-constrained with its deleverage ratio—how much an organization must deleverage in order to meet its regulatory capital standard. They show two general ways of estimating the deleverage ratio: the historic deleverage pattern or the target capitalization method. Under the first method, the deleverage ratio is calculated so that U.S. banks have an average deleverage ratio of approximately 15% since 2004, when Basel II was first introduced. The second method estimates the deleverage ratio according to the ratio between economic capital and RegC. Both methods are applicable to cases where the capital requirement is in the form of CCAR stress testing. Using the second method, the deleverage ratio for the sample portfolio is approximately 20% under the CCAR 2015 requirement. In light of this result, we set the deleverage ratio as 20% in all examples in this paper.

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[2] See the Appendix for a description of the sample portfolio.

3. Composite Capital Measure Under Stress Testing Requirements

As highlighted by Xu and Levy (2015), finding the optimal capital deployment under Basel-style capital constraint is challenging, given the measure does not account for diversification and concentration effects. This scenario is also true for capital requirements in the form of CCAR-style stress testing; stressed EL also does not account for diversification or concentration (seen in Figure 1). To address this issue, Xu and Levy proposed a capital allocation measure called CCM, which integrates regulatory capital with economic capital. At the aggregate level, portfolio CCM equals the organization's top-of-the-house target capitalization rate, set to be the portfolio Effective RWC in our examples. At the individual instrument level, CCM resembles a combination of instrument Effective RWC and EC, the latter of which accounts for the full spectrum of economic risk. The measure can be interpreted as RegC adjusted for economic diversification effects or as EC adjusted for RegC.

Figure 2   CCM under the Stress Testing requirement.

CCM vs EC   CCM vs Effective RWC
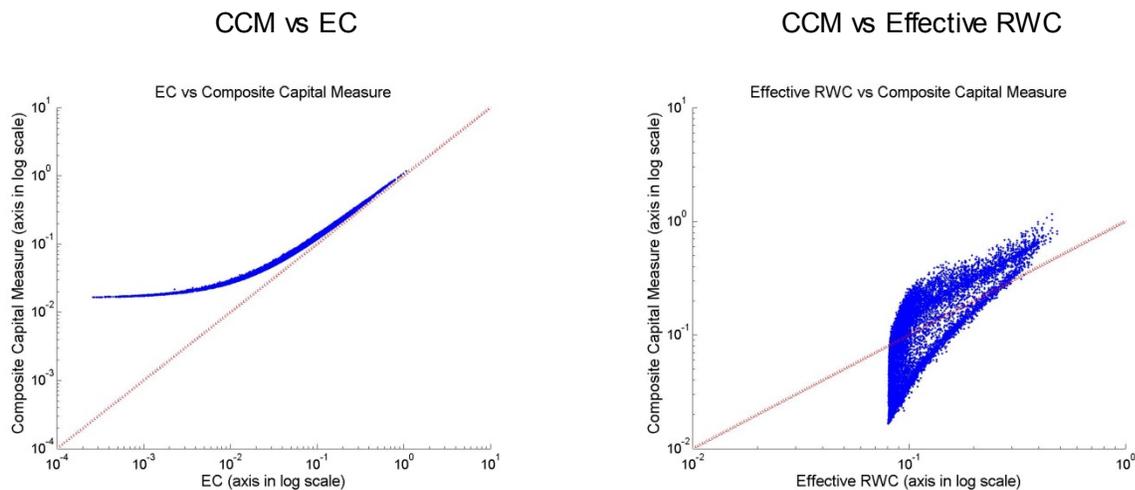
The left-hand graph in Figure 2 presents instrument CCM (under the CCAR 2015 stress testing requirement) against EC. We see that CCM converges with EC as EC increases to a high level, and CMM flattens to 8% as EC decreases. This pattern is the same as Xu and Levy's (2015) observation, within the context of the Basel II capital requirement. The finding reflects CCM's abilities to ensure a sufficient capitalization rate that meets regulatory requirements, as well as to account for diversification and concentration risks as captured by EC.

The right-hand graph in Figure 2 plots instrument CCM against Effective RWC. While CCM has an overall positive correlation with Effective RWC, the two capital measures can differ significantly at the instrument level. For example, as the value of Effective RWC is close to the 8% floor — this typically occurs for instruments with low default risk — the value a specific instrument's CMM can be either significantly higher or significantly lower than Effective RWC. Variation is mostly driven by the instrument's level of diversification and concentration risks. In general, instruments with higher such risks have relatively higher CCM when compared to Effective RWC, and vice-versa.

Table 1 and Table 2 further illustrate the differences in CCM's ability to capture diversification when compared to RegC, and they present average CCM and Effective RWC among instruments within EDF™ (Expected Default Frequency) values and RSQ buckets. The RSQ variable measures how much default risk of an instrument is attributed to systemic risk. [3] Therefore, the RSQ variable can be viewed as a proxy for the diversification risk of the instrument — the higher the RSQ, the lower the diversification benefit the instrument brings to the portfolio and, thus, the higher the diversification risk. Table 1 shows that, when controlling for the instrument's EDF value, CCM has high positive correlation with RSQ. It confirms that the composite measure captures diversification risk as expected. In contrast, Table 2 shows that a simple RegC measure, such as Effective RWC, is not nearly as sensitive to RSQ. While high-RSQ entities are more sensitive to macro scenarios, the diversification effect that EC captures is much more substantial.

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[3] See "Modeling Credit Portfolios," Moody's Analytics Quantitative Research Group, 2015.

TABLE 1

Average CCM in each RSQxEDF Bucket

	VERY HIGH RSQ	HIGH RSQ	MEDIUM RSQ	LOW RSQ	VERY LOW RSQ
VERY HIGH EDF	47.7%	36.8%	31.4%	28.5%	28.2%
HIGH EDF	19.2%	15.2%	12.6%	10.6%	10.0%
MEDIUM EDF	12.6%	9.7%	8.3%	6.8%	6.1%
LOW EDF	8.7%	6.7%	5.7%	4.7%	4.2%
VERY LOW EDF	5.1%	4.2%	3.7%	3.3%	2.8%

All 13,494 instruments in the sample portfolio are divided into five RSQ quintiles and five EDF quintiles of an equal number of instruments. Table 1 reports the simple average value of instrument CCM within each cross bucket. The range of RSQ and EDF within each bucket is reported below.

Very Low RSQ: [10.0% −10.6%]; Low RSQ: [10.6%−16.2%]; Medium RSQ: [16.2%−22.5%]; High RSQ: [22.5%−30.6%]; Very High RSQ: [30.6%−65%]

Very Low EDF: [0.010% −0.050%]; Low EDF: [0.050%−0.176%]; Medium EDF: [0.176%−0.376%]; High EDF: [0.376%−1.587%]; Very High EDF: [1.587%−19.988%]

TABLE 2

Average Effective RWC in each RSQxEDF Bucket

	VERY HIGH RSQ	HIGH RSQ	MEDIUM RSQ	LOW RSQ	VERY LOW RSQ
VERY HIGH EDF	26.8%	23.0%	21.4%	21.3%	22.3%
HIGH EDF	13.1%	11.9%	11.0%	10.8%	10.8%
MEDIUM EDF	10.0%	9.6%	9.3%	9.1%	9.1%
LOW EDF	9.0%	8.7%	8.6%	8.5%	8.5%
VERY LOW EDF	8.3%	8.2%	8.2%	8.2%	8.2%

All 13,494 instruments in the sample portfolio are divided into five RSQ quintiles and five EDF quintiles of an equal number of instruments. Table 2 reports the simple average value of instrument Effective RWC within each cross bucket. The range of RSQ and EDF within each bucket is reported below.

Very Low RSQ: [10.0%−10.6%]; Low RSQ: [10.6%−16.2%]; Medium RSQ: [16.2%−22.5%]; High RSQ: [22.5%−30.6%]; Very High RSQ: [30.6%−65%]

Very Low EDF: [0.010%−0.050%]; Low EDF: [0.050%−0.176%]; Medium EDF: [0.176%−0.376%]; High EDF: [0.376%−1.587%]; Very High EDF: [1.587%−19.988%]

4. RegC-Adjusted RORAC Under Stress Testing Requirements

In general, an organization makes investment decisions by weighing the risk-return tradeoff of the underlying assets. While CCM helps an organization determine optimal capital deployment, it only addresses the risk aspect of a typical investment decision. To measure the risk-return tradeoff of an instrument, we require a metric such as Sharpe Ratio or RORAC. Under a Basel-style regulatory capital requirement, Levy, Kaplin, Meng, and Zhang (2012) show that RegC-Adjusted RORAC — a traditional RORAC measure adjusted by the implicit cost of regulatory capital constraint — can serve as a decision-making variable for the optimal investment choice. As discussed previously, this measure is also applicable for organizations under CCAR-style stress testing requirements, with the Effective RWC for each instrument representing its regulatory capital requirement.

Figure 3 compares RegC-Adjusted RORAC under CCAR requirement against other RORAC measures. In the left-hand graph, instrument RegC-Adjusted RORAC is plotted against traditional RORAC, where the capital is measured by EC. We can see that little correlation exists between the two measures — a phenomenon previously observed by Xu, Levy, Meng, and Kaplin (2015). This lack of correlation results from the fact that the 8% regular RWC, which is one of the components of Effective RWC, does not differentiate instruments with low credit risks from those with high credit risks. Consequently, the CCAR stress testing requirement is relatively more taxing on safer instruments than on riskier ones. Many safe instruments tend to have very small ES but high traditional RORAC. However, once the relatively high cost of the regulatory capital requirement is taken into consideration, the risk-return tradeoff of these instruments becomes very poor, as RegC-Adjusted returns often become negative. This ultimately results in low overall correlation between RegC-Adjusted RORAC and traditional EC RORAC. The higher regulatory capital cost on safer instruments is better visualized in the right-hand graph of Figure 3, where we compare RegC-Adjusted RORAC against the rate of return on Effective RWC. [4] We can see that instruments with the lowest returns on Effective RWC — typically those with very low default risk and small ES — all have very negative RegC-Adjusted RORAC.

Figure 3   RegC-Adjusted RORAC

EC RORAC vs RegC-Adjusted RORAC

Return on Effective RWC vs RegC-Adjusted RORAC
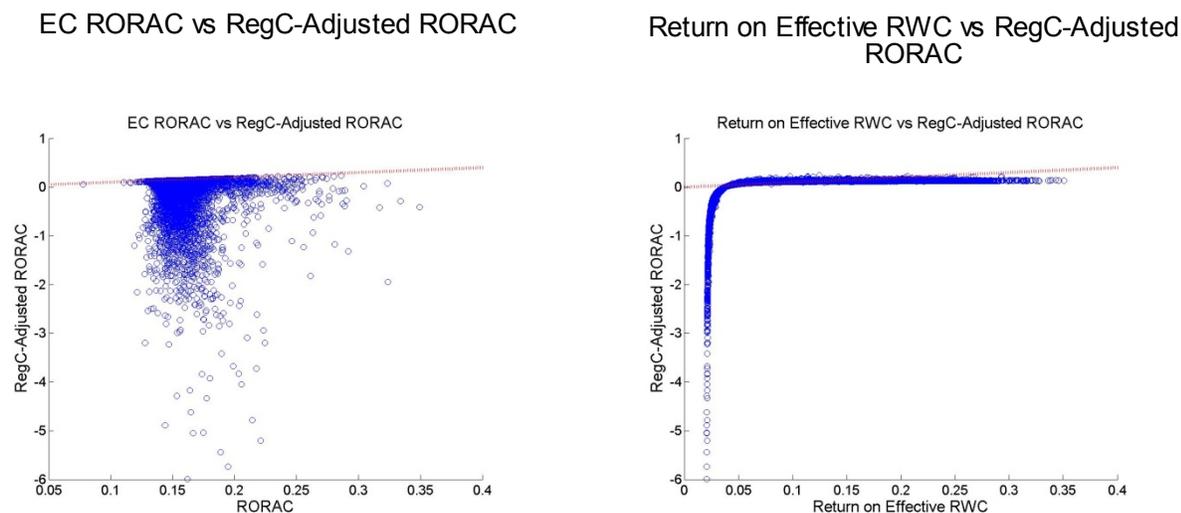
The RegC-Adjusted RORAC measure reflects the intuition that regulatory capital requirements such as CCAR tests add an implicit cost to each investment. After adjusting the investment return by this implicit cost, the resulting RORAC measure represents an appropriate investment decision rule that properly accounts for the tradeoffs associated with risk, return, and capital constraints. An alternative representation of the decision rule incorporates the regulatory capital requirement as an additional capital burden and adjusts the required capital instead. Indeed, this method was introduced with CCM, a RegC-Adjusted capital allocation measure. Xu and Levy (2015) showed that the investment's rate of return on each unit of CCM (specified in Equation (4)) implies the same investment decisions as with the RegC-Adjusted RORAC.

$$CCM\ RORAC = \frac{ES}{CCM} + riskfree\ rate \tag{4}$$

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[4] The formula of return on Effective RWC is analogous to that of RORAC: $Return\ on\ Effective\ RWC = \frac{ES}{Effective\ RWC} + riskfree\ rate$.

At the aggregate level, portfolio CCM RORAC is equal to the portfolio rate of return on Effective RWC, which follows from the fact that portfolio CCM is equal to Effective RWC.

Figure 4 compares CCM RORAC against EC RORAC and return on Effective RWC. First notice that CCM RORAC is positive, which follows from positive ES and CCM, and it is consistent with traditional RORAC measures. In addition, CCM RORAC is smaller than EC RORAC. This finding is expected, as RegC requirements make all investment opportunities less attractive on an absolute basis. Finally, CCM RORAC is higher than the return on Effective RWC for instruments with very low return on Effective RWC, and vice-versa. This finding indicates that, while CCM RORAC accounts for the regulatory capital requirement, it does not penalize safe instruments as much as the rate of return on Effective RWC does.

Figure 4   CCM RORAC
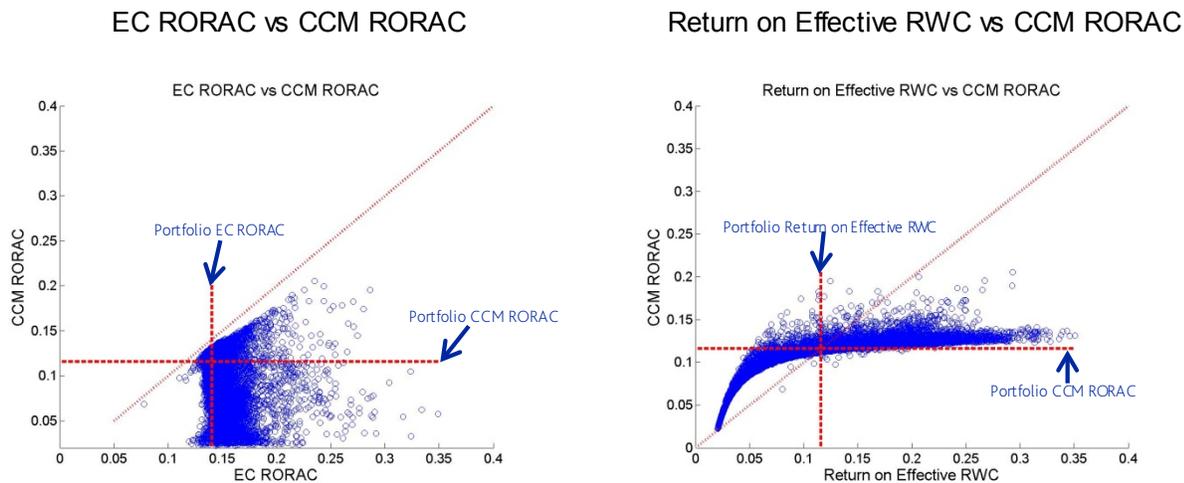
The application of RegC-Adjusted RORAC or CCM RORAC under CCAR stress testing requirements is the same as under Basel-style requirements. The organization can rank order all instruments within a portfolio according to RegC-Adjusted RORAC or CCM RORAC. It can then reduce exposures to those with low rankings and increase exposures to those with high rankings. Table 3 lists the top-ten instruments with the highest RegC-Adjusted RORAC ranking in the sample portfolio of 13,494 instruments. A common feature of these instruments is very low RSQ, an indication of low diversification risk. Since Effective RWC does not capture diversification risk, the return per unit of Effective RWC of these instruments is not high. For example, the instrument with highest RegC-Adjusted RORAC only ranks 5,201 by the rate of return on Effective RWC. In contrast, the top-ten instruments with the highest return per unit of Effective RWC all have relatively high RSQ, as shown in Table 4.

TABLE 3

Top-Ten Instruments with Highest RegC-Adj. RORAC

ID	RORAC	RET. ON RWC	REGC-ADJ. RORAC	EC RORAC RANKING	RET. ON RWC RANKING	REGC-ADJ. RORAC RANKING	1-YR EDF	RSQ	LGD	MATURITY
M_369730	0.29	0.12	0.24	13	5201	1	0.021	0.10	0.43	1.3
M_N22452	0.24	0.21	0.23	64	1332	2	0.135	0.10	0.45	1.2
M_C10710	0.24	0.29	0.22	89	57	3	0.166	0.10	0.48	4.6
M_N20733	0.27	0.11	0.22	22	5728	4	0.024	0.10	0.41	1.2
M_N04159	0.28	0.10	0.22	16	6577	5	0.009	0.17	0.40	1.3
M_N01858	0.26	0.11	0.22	35	5712	6	0.018	0.10	0.42	1.4
M_N08046	0.23	0.27	0.21	116	183	7	0.063	0.10	0.50	4.4
M_N20682	0.24	0.14	0.21	65	4394	8	0.043	0.10	0.43	1.3
M_N23402	0.25	0.12	0.21	44	5480	9	0.021	0.10	0.43	1.4
M_N22354	0.23	0.17	0.21	99	3242	10	0.046	0.15	0.43	1.5
Top-ten instruments (out of 13,494) with the highest RegC-Adjusted RORAC under the CCAR 2015 stress testing requirement.										

TABLE 4

Top-Ten Instruments with Highest Rate of Return on Effective RWC

ID	RORAC	RET. ON RWC	REGC-ADJ. RORAC	EC RORAC RANKING	RET. ON RWC RANKING	REGC-ADJ. RORAC RANKING	1-YR EDF	RSQ	LGD	MATURITY
L_N06357	0.14	0.35	0.14	9536	1	1034	0.004	0.65	0.36	7.0
L_N07529	0.14	0.35	0.13	9717	2	1076	0.005	0.65	0.37	7.0
L_867914	0.15	0.34	0.14	6061	3	485	0.003	0.63	0.35	7.0
M_208464	0.15	0.34	0.14	6278	4	511	0.004	0.59	0.36	6.7
L_208464	0.14	0.34	0.14	8835	5	922	0.004	0.59	0.36	7.0
L_534187	0.14	0.34	0.13	12184	6	1705	0.004	0.62	0.37	7.0
L_125569	0.13	0.33	0.13	13409	7	2890	0.006	0.42	0.53	7.0
L_131237	0.14	0.33	0.14	9209	8	1039	0.009	0.32	0.47	7.0
L_163722	0.14	0.33	0.14	7011	9	611	0.003	0.58	0.35	7.0
L_617446	0.14	0.32	0.13	12552	10	1903	0.004	0.65	0.35	7.0

Top-ten instruments (out of 13,494) with the highest rate of return on Effective RWC under the CCAR 2015 stress testing requirement.

To further illustrate the application of RegC-Adjusted RORAC, we design an algorithm to reweight the sample portfolio by trading instruments with relatively low RegC-Adjusted RORAC for those with relatively high RegC-Adjusted RORAC, while keeping the portfolio Effective RWC constant. This step ensures that the new portfolio still passes the CCAR test. Table 5 shows that even modest portfolio turnover can increase the risk-return attractiveness of the portfolio notably. For instance, the portfolio rate of return on Effective RWC increases by 60 bps with only a 2.5% portfolio turnover rate. In addition, the EC RORAC also increases by 30 bps.

TABLE 5

Improved Portfolio Composition Using RegC-Adjusted RORAC

TURNOVER*	ES	EFFECTIVE RWC	EC	RETURN ON EFFECTIVE RWC	EC RORAC
0.0%	0.94%	9.79%	7.79%	11.6%	14.0%
2.5%	1.00%	9.79%	8.11%	12.2%	14.3%
5.0%	1.03%	9.79%	8.30%	12.5%	14.4%
7.5%	1.07%	9.79%	8.57%	12.9%	14.5%
10.0%	1.10%	9.79%	8.75%	13.3%	14.6%

*Portfolio turnover is defined as the percentage of portfolio rebalanced (sold and reinvested) in terms of notional amount.

5.   Summary

This paper presents an approach for organizations facing CCAR-style stress testing requirements to make optimal investment decisions and deploy capital using RegC-Adjusted RORAC and CCM. We find that CCM under CCAR assigns more regulatory capital to instruments with high diversification and concentration risk, even though the CCAR test does not account for these risks. For example, for instruments with similar default risk, those with higher RSQ tend to have larger CCM. We also discuss CCM RORAC, which is an alternative representation of RegC-Adjusted RORAC. The investment decision rule based on CCM RORAC results in the same optimal portfolio as the RegC-Adjusted RORAC rule. CCM RORAC has some intuitive properties, including being equal to the rate of return on required RegC at the portfolio level and always being positive at the instrument level. Finally, we illustrate a practical example of how an organization facing a CCAR test can improve portfolio risk-return tradeoff using RegC-Adjusted RORAC. This example shows that portfolio rebalancing based on RegC-Adjusted RORAC increases portfolio return on both Effective RWC and EC, while ensuring the organization passes the CCAR test.

Appendix

PORTFOLIO OVERVIEW

We create a sample portfolio of floating rate term loans lent to 30,799 obligors across 72 countries and 61 industry sectors, defined by Moody's. In this portfolio, each obligor is assigned three loans: one with a one-year maturity, one with a seven-year maturity, and a third with a maturity randomly assigned (with a uniform distribution) between one and seven years. The total commitment amount of the portfolio is $150 billion USD, with one-year and seven-year loans accounting for approximately $50 billion each.

This paper uses the U.S. sub-portfolio in all analyses. The U.S. portfolio includes loans lent to 4,498 U.S. obligors across 61 industry sectors. The total commitment amount is $37 billion USD, with one-year and seven-year loans accounting for 28% and 39% of the total amount, respectively.

OBLIGOR SELECTION FOR THE GLOBAL PORTFOLIO

The 32,157 obligors are selected as the entire universe of public companies in the CreditEdge™ dataset, as of 03/31/2014, excluding the following:

» Obligors whose total liability as of 03/31/2014 is less than $10 million USD.

» Obligors whose one-year EDF value (EDF9) as of 03/31/2015 exceeds 20%.

» Obligors whose RSQ values are not available in Moody's Analytics GCorr™ 2014 universe.

COMMITMENT AMOUNT

In general, the commitment amount for a one-year loan is proportional to the underlying obligor's current liability, while the commitment amount for a seven-year loan is proportional to the obligor's long-term liability. [5, 6] The third loan, whose maturity is in between one and seven years, has a commitment amount equal to 50% of the total commitment amount of the one-year and seven-year loans. The current and long-term liabilities are obtained as the actual values for each obligor as of 03/31/2014, with the following adjustments for different industries:

» Banks and S&L (NDY: N06); Insurance Companies (NDY: N29, N30): current and total liabilities are reduced by 90% of total liabilities to account for non-debt liabilities, such as deposits and insurance claims.

» Security Brokers and Dealers (NDY: N48): current and total liabilities is reduced by 60% of total liability to account for non-debt liabilities such as deposits.

» For all obligors, both current and long-term liabilities are floored below by $5 million USD.

» For obligors with adjusted total liabilities above $50 billion USD, the current and long-term liabilities are scaled down proportionally such that the total liability is capped at $50 billion USD.

INDUSTRY/COUNTRY WEIGHT AND RSQ SELECTION

We use GCorr 2014 values.

PIT PD AND TTC PD

We use the EDF9 values of the underlying obligor as the instrument point-in-time (PIT) PD. We convert the PIT PD to a Moody's rating using the EDF9 to Moody's rating mapping table, as of 03/31/2015. We can convert the Moody's rating to a TTC PD using a mapping table based on a historical rating transition matrix estimated by Tsaig, Levy, and Wang (2010). Specifically, for any rating category, we take the transition probability from that rating to default as the TTC PD associated with the rating.

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[5] The scaling factor used to convert the liability to commitment amount is selected, such that, the total portfolio commitment amount equals $150 billion USD.

[6] The intuition behind this practice is that the average composition of the credit portfolios held by all banks should mimic the overall composition of liability.

TABLE 6

Rating to TTC PD Mapping

RATINGS	TTC PD (%)
Aaa	0.01
Aa1	0.02
Aa2	0.02
Aa3	0.02
A1	0.03
A2	0.03
A3	0.03
Baa1	0.18
Baa2	0.18
Baa3	0.18
Ba1	1.20
Ba2	1.20
Ba3	1.20
B1	5.00
B2	5.00
B3	5.00
Caa1	19.23
Caa2	19.23
Caa3	19.23
Ca	19.23
C	19.23

Ratings to TTC PD mapping. Extracted from Table 1 in Tsaig, Levy, and Wang (2010).

LGD, DOWNTURN LGD, AND LGD VARIANCE PARAMETER SELECTION

LGD, downturn LGD, and LGD variance parameter for most obligors are extracted from Moody's LossCalc™ 3.0, as of 03/31/2015, under the assumption that instruments are senior unsecured loans. LGD-related information of a small number of obligors (around 100) is not available in LossCalc 3.0. In these cases, we use the average values computed based on corresponding variables of all other obligors.

INTEREST SPREAD

We use the marked-to-par spread over the ZeroEDF rate with annual coupon payment. The ZeroEDF rate is assumed to be 2%, with a constant term structure. We set the risk-aversion parameter λ as 0.6.

GLOBAL PORTFOLIO SUMMARY STATISTICS

TABLE 7

Summary Statistics for Top Industry Exposures in the Global Portfolio

INDUSTRY CODE	INDUSTRY NAME	WEIGHT	1-YR EDF	LGD	MATURITY	RSQ
N06	BANKS AND S&LS	12.8%	0.75%	55%	4.4	55%
N59	UTILITIES, ELECTRIC	5.9%	0.88%	44%	4.9	33%
N13	CONSTRUCTION	4.8%	1.99%	53%	3.4	36%
N51	TELEPHONE	4.1%	0.90%	51%	4.3	33%
N40	OIL, GAS & COAL EXPL/PROD	3.7%	1.55%	53%	4.5	42%
N29	INSURANCE - LIFE	3.1%	0.46%	52%	3.0	57%
N05	AUTOMOTIVE	3.1%	0.41%	52%	3.7	40%
N09	BUSINESS SERVICES	3.1%	0.67%	51%	3.7	30%
N46	REAL ESTATE	3.0%	0.83%	52%	4.5	34%
N25	FOOD & BEVERAGE	2.7%	0.45%	49%	3.9	31%
Portfolio Overall		**100%**	**0.83%**	**51%**	**4.0**	**39%**

Summary statistics of the top-ten industries (by total commitment) in the portfolio. EDF, LGD, Maturity, and RSQ are average values weighted by commitment amount.

TABLE 8

Summary Statistics for Top Country Exposures in the Global Portfolio

COUNTRY	WEIGHT	1-YR EDF	LGD	MATURITY	RSQ
USA	24.8%	0.35%	37%	4.3	36%
JPN	11.9%	0.46%	58%	3.6	43%
CHN	9.5%	1.78%	52%	3.1	41%
GBR	5.4%	0.42%	59%	4.0	38%
FRA	5.1%	0.31%	59%	3.8	39%
DEU	3.7%	0.35%	58%	4.1	36%
KOR	3.4%	1.87%	39%	3.7	39%
CAN	3.2%	0.42%	50%	4.2	41%
HKG	2.7%	1.58%	37%	3.7	35%
IND	2.6%	2.67%	59%	4.0	41%
Portfolio Overall	**100%**	**0.83%**	**51%**	**4.0**	**39%**

Summary statistics of the top-ten countries (by total commitment) in the portfolio. EDF, LGD, Maturity, and RSQ are average values weighted by commitment amount.

U.S. PORTFOLIO SUMMARY STATISTICS

TABLE 9

Summary Statistics for Top Industry Exposures in the U.S. Portfolio

INDUSTRY CODE	INDUSTRY NAME	WEIGHT	1-YR EDF	LGD	MATURITY	RSQ
N47	REAL ESTATE INVESTMENT TRUSTS	7.0%	0.34%	36%	3.8	35%
N59	UTILITIES, ELECTRIC	6.4%	0.04%	26%	5.2	32%
N06	BANKS AND S&LS	5.1%	0.25%	35%	4.9	49%
N40	OIL, GAS & COAL EXPL/PROD	5.1%	0.95%	46%	4.8	41%
N23	FINANCE COMPANIES	4.4%	0.29%	36%	3.5	40%
N18	CONSUMER PRODUCTS RETL/WHSL	4.2%	0.67%	36%	3.6	29%
N09	BUSINESS SERVICES	3.6%	0.36%	38%	3.9	31%
N42	PHARMACEUTICALS	3.1%	0.10%	39%	4.5	30%
N25	FOOD & BEVERAGE	3.0%	0.03%	36%	4.5	33%
N51	TELEPHONE	2.8%	0.45%	37%	5.2	33%
Portfolio Overall		**100%**	**0.35%**	**37%**	**4.3**	**36%**

Summary statistics of the top-ten industries (by total commitment) in the portfolio. EDF, LGD, Maturity, and RSQ are average values weighted by commitment amount.

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