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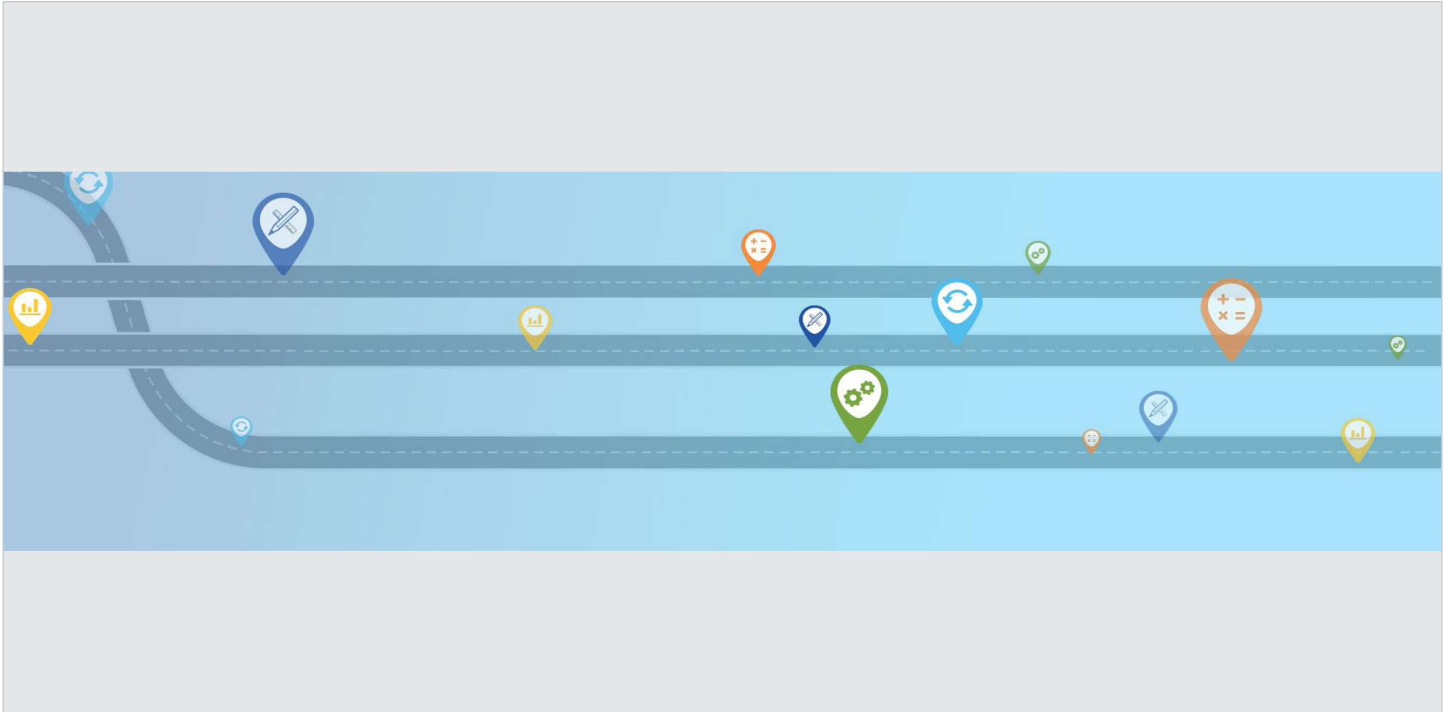

Article

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Earnings Volatility, Share Price Performance, and Portfolio Management

In this paper, we study how earnings volatility induced by credit risk can impact share price performance for financial institutions under CECL and IFRS 9, and we quantify the benefit of an active credit risk management practice. Our study uses empirical data to show that a 1.0% increase in earnings volatility leads to a 15.6 bps decrease in equity value.

When we look at the earnings volatility components, we find that a 1.0% increase in the volatility of change in the loss allowance leads to a 6.0% bps decrease in equity value, while a 1.0% increase in the volatility of net charge-offs plus write-downs leads to a 10.5 bps decrease in equity value. This finding suggests that credit risk managers who diversify holdings and reduce earnings volatility without lowering profitability can increase shareholder value.

To quantify the benefit of having a sound credit risk management practice, we evaluate the historical performance of loan origination strategies that aim to minimize a credit portfolio's credit earnings volatility via diversification. We perform backtesting using Moody's proprietary Credit Research Database (CRD) data, which contains empirical, name-level financial information, including credit quality (Moody's Analytics EDF™ (Expected Default Frequency) credit measures) associated with each name and whether and when a name defaults.

When assessing performance against market benchmarks, we find that reasonably parsimonious loan origination diversification strategies can reduce the volatility of change in loss allowance by up to 67% (implying a 4.0% increase in equity value) and the volatility of net charge-offs plus write-downs by up to 63% (implying a 6.6% increase in equity value), which can boost equity value by a total of 10.6%.

1. Introduction

In this paper, we investigate the relationship between accounting rules, credit earnings volatility, credit portfolio management, and share price performance. We explore the mechanisms through which accounting rules can affect a financial firm's valuation. While this research is motivated, in part, by the volatility generated when using the forward-looking allowance under IFRS 9 and CECL, the value of active credit portfolio management is more broadly demonstrated by the impact of charge-off volatility on valuation. Our research aims to quantify the relationship between share price performance and the volatility in changes in allowance and net charge-offs plus write-downs. In addition, we demonstrate how credit portfolio management tools can help design portfolio strategies that minimize a credit portfolio's credit earnings volatility through diversification, directly improving share price.

We first look at the relevance of earnings volatility. A number of factors come in to play. First, earnings feed into capital surplus; and high earnings volatility is associated with a higher likelihood of insolvency. Second, high earnings volatility can indicate questionable business practices and portfolio composition. We saw this trait during the 2007–2009 financial crisis, as the market reacted very negatively to news of concentrated portfolio composition and uncertainty. In some cases, there was a question as to whether organizations entered distress because of liquidity constraints, in part due to this issue. We argue that ultimately, volatility leads to higher capital costs, limited business opportunities, and lower valuation.

Our empirical analysis follows Rountree, Weston, and Allayannis (2008) who study the impact of earnings volatility on non-financial firms and conclude that a 1.0% increase in cash-flow volatility leads to a 15 bps decrease in firm value. We evaluate whether we can observe this dynamic within financial institutions, which differ fundamentally from non-financial firms with regard to the magnitude and role of allowance. To address this question, we examine credit earnings (i.e., earnings generated by a credit portfolio) and its components (including net charge-offs plus write-downs and change in allowance) using the Y-9C reports of U.S. public bank holding companies from 2000–2017.

We calculate the volatility of each item using a three-year rolling window and then analyze the impact these measures have on the market-to-book equity value using panel regressions. We find that a 1.0% increase in a portfolio's credit earnings volatility leads to a 15.6 bps decrease in shareholder value. When we decompose credit earnings into net interest income, net charge-offs plus write-downs, and change in allowance, we find that the volatility of both net charge-offs plus write-downs and change in loss allowance have a statistically significant, negative impact on firm valuation. More specifically, a 1.0% increase in volatility of net charge-off plus write-downs leads to a 10.5 bps decrease in equity value, and a 1.0% increase in the volatility of change in loss allowance leads to an additional 6.0 bps decrease in equity value.

Our empirical research suggests that investors value smooth performance, and they care a great deal about banks' earnings volatility. This finding has important implications for credit portfolio management. Given commercial banks can experience a significant increase in allowance and, therefore, earnings volatility in the face of IFRS 9 and CECL, the idea of using active credit portfolio management to help negate the impact of CECL and IFRS 9 on earnings volatility is more relevant now than ever.

The second half of the paper proposes a portfolio loan-origination strategy and studies its effectiveness in reducing earnings volatility and increasing shareholder value. The strategy allocates funds to newly originated assets across segments in a way that minimizes ex-ante portfolio earnings volatility through diversification while maintaining a target level of profitability. We backtest the performance against both U.S. and European loan portfolios and find the strategies can materially increase equity value.

More specifically, to study the effectiveness of a volatility-reducing strategy in the U.S., we evaluate the performance of portfolios constructed under the above-mentioned loan origination strategy (i.e., optimized portfolios) over time and compare that against the performance of actual U.S. banks' portfolios from Moody's CRD/LAS loan consortium database. We find that, on average, such loan origination strategies can reduce realized portfolio earnings volatility by 32%, implying a 4.9% increase in shareholder value. For European banks, we construct portfolios using Moody's CreditEdge™ data, where we use the debt of publicly traded firms to represent the credit market. In this case, we find we can reduce the volatility of net charge-off plus write-downs and the change in loss allowance by 59% and 35%, respectively, using the optimized strategy, which translates to a total increase in shareholder value of 8.3%.

We organize the remainder of this paper as follows: Section 2 describes the empirical analysis of credit earnings volatility's impact on share price performance. Section 3 discusses the portfolio strategy and presents backtesting results for U.S. and European portfolios. Section 4 concludes.

2. The Impact of Earnings Volatility on Share Price Performance

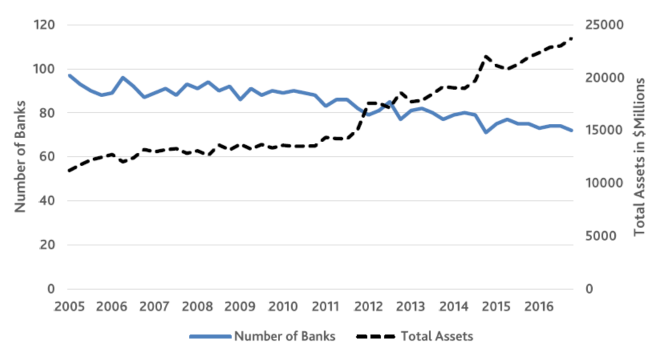
2.1 Data Description

Our initial sample includes all public U.S. bank holding companies with FR Y-9C reports from 2000–2017. We exclude private banks due to the lack of information on shareholder values. Due to the increase in the asset-size threshold for filing FR Y-9Creports from $150 million to $500 million, many smaller banks that filed reports between 2000–2005 stopped doing so after 2006. To make sure our sample remains consistent across time in terms of asset size, for the period 2000–2005, we only include banks that continued to file reports in 2006.

Observed discontinuities or jumps in data resulting from M&A activities are another complication of the Y-9C data. For example, if a reporting bank acquires assets from another bank, we observe a sharp rise in reported Y-9C line items, such as asset size and earnings of the acquiring bank, artificially increasing its earnings growth and volatility. To eliminate M&A effects, for each merger or acquisition, we retroactively transfer the appropriate dollar amount from the line items of the selling entity to those of the buying entity. This adjustment makes it as if the acquiring bank has always owned the acquired bank, so that the adjusted Y-9C line items are more representative of each bank's organic growth, rather than exhibiting jumps due to M&A activities.

Finally, to estimate the volatility of line items such as earnings from the quarterly income statement, we only include banks that have at least three years of consecutive quarterly observations from 2000–2017. Our final sample consists of 8,717 total bank-quarter observations, roughly 200 public U.S. banks in each period. Figure 1 presents the number of banks available in our final sample and their total asset values across time.

Figure 1 Number of banks and average asset size.



We supplement data from Y-9C reports with data from Moody's CreditEdge database, which contains information on each bank's market value of equity, Moody's Analytics EDF (Expected Default Frequency) credit measure, and GCorr™ Corporate RSQs and asset returns. Expected Default Frequency is a measure of default risk, and GCorr Corporate RSQ is a measure of firms' exposure to systematic risk, similar in spirit to the beta coefficient in a CAPM framework.

Table 1 reports summary statistics of the final data. The bank holding companies in the sample have a mean asset value of $15,677 million USD and a mean equity value of $2,341 million USD. The average debt-to-assets ratio is 89.6%. Our main earnings' measure is earnings before extraordinary items and taxes. As shown in Table 1, the mean quarterly earnings are approximately $56 million. We calculate credit earnings as net interest income minus provisions.[1] They have a mean of $101 million in our sample. The primary reason credit earnings are higher than earnings is that the former do not account for any non-credit related expense items, such as employee salaries. Provisions are important components of credit earnings, and they are calculated as change in allowance plus net charge-offs plus write-downs, where change in allowance is equal to the difference between the balance of allowance at the end and at the beginning of the quarter.[2] Given earnings level can differ due to differences in bank size, we normalize earnings-related variables by using banks' book value of assets.[3]

TABLE 1

Summary Statistics Panel A (millions USD)

	MEAN	STD.	25%	MEDIAN	75%
Total assets	15,677.0	41,660.9	1,202.2	3,147.5	9,339.0
Total liabilities	12,657.2	33,678.3	1,036.6	2,489.9	6,886.9
Equity market value	2,341.4	7,480.1	114.1	354.2	1,392.8
Earnings	56.0	248.5	2.4	8.2	29.8
Credit earnings	101.2	260.7	9.2	22.2	59.7
Provisions	23.7	117.4	0.4	1.6	6.4
Net interest income	125.8	337.8	11.4	27.5	68.8
Change in allowance	0.8	38.4	-0.4	0.1	0.9
Net charge-off plus write-down	22.0	84.0	0.2	1.4	5.4
PANEL B: NORMALIZED	MEAN	STD.	25%	MEDIAN	75%
Earnings	0.46%	1.56%	0.20%	0.33%	0.45%
Credit earnings	1.18%	2.71%	0.64%	0.81%	1.05%
Provisions	0.15%	0.35%	0.02%	0.05%	0.14%
Net interest income	1.33%	2.81%	0.76%	0.93%	1.17%
Change in allowance	0.02%	0.18%	-0.01%	0.01%	0.03%
Net charge-off plus write-down	0.13%	0.30%	0.01%	0.04%	0.12%
PANEL C	MEAN	STD.	25%	MEDIAN	75%
Return on assets	0.46%	1.56%	0.20%	0.33%	0.45%
Volatility of credit earnings	0.24%	0.31%	0.06%	0.13%	0.30%
Volatility of earnings	0.27%	0.43%	0.06%	0.10%	0.26%
Volatility of change in allowance	0.08%	0.14%	0.02%	0.04%	0.08%
Volatility of net charge-off plus write-down	0.11%	0.19%	0.02%	0.04%	0.11%
Volatility of net interest income	0.17%	0.26%	0.05%	0.08%	0.17%
Asset growth	1.94%	2.27%	0.58%	1.54%	2.88%
Debt-to-assets ratio	89.57%	6.03%	88.60%	90.08%	91.48%
Market-to-book equity value ratio	1.38	0.73	0.92	1.28	1.72

Based on the normalized earnings-related variables (summary statistic reported in Panel B), we construct their volatilities at each time as the standard deviation of the corresponding variable's three-year trailing observations.[4] For example, the credit earnings volatility of bank i at the end of Q4 2014 is the standard deviation of the quarterly credit earnings per book value of assets over the previous 12 quarterly observations (including Q4 2014) during years 2012–2014. We understand that at each time point, what matters significantly in evaluating a bank's current value is the expectation of its future earnings. However, without knowing how investors form their expectations exactly, we assume they consult banks' recent past performance for guidance.[5] We measure asset growth as the three-year rolling average of the quarterly asset growth rate. The average asset growth of the sample is about 1.9%. We use the market-to-book equity value ratio as a proxy for bank equity value.[6] The sample's mean value is 1.38.

2.2 Regression Analysis

This section examines whether the volatility in earnings due to credit risk affects a bank's share price performance. Specifically, we estimate the change in a bank's equity value (again, measured as market-to-book equity value) due to an increase in the volatilities of credit earnings, change in loss allowance and net charge-offs plus write-downs. Following Rountree, Weston, and Allayannies (2008), we control for other factors that can potentially impact banks' market values, such as (1) bank size, measured by total assets; (2) capital structure, measured by debt-to-assets ratio; (3) systematic risk, calculated as the variance of a bank's asset return due to systematic factors; and (4) financial performance, measured by return on assets (ROA). While Rountree, Weston, and Allayannies (2008) use sales growth to capture the growth level for non-financial firms, we use asset growth rate for banks. In addition, we control for banks' non-performing assets, an indicator of bank asset quality and financial health.

Given the significant skewness present in many of the variables, we use the log transformation of market-to-book equity values, book value of assets, and volatility measures. This technique reduces the potential impact of outliers on the analysis. Furthermore, under this transformation, we can easily interpret the coefficients in the regression results as measuring the percentage change in a bank's equity value due to a one-percent increase in earnings volatility.

We begin by testing whether credit earnings volatility negatively affects a bank's equity value and then further investigate how each component of credit earnings volatility incrementally contributes to the impact. Specifically, we perform a panel regression of log-transformed market-to-book equity values on the variables mentioned above with time-fixed effects. We add time-fixed effects to remove potential bias caused by market factors that impact both components of credit earnings volatility and equity value. For example, an oil price shock can decrease bank earnings with high exposure to the oil sector, resulting in banks' higher earnings volatility. In the meantime, a sharp decrease in oil prices can also cause negative market sentiment that depresses equity value. Without controlling for these types of market factors, the effect of credit earnings volatility on equity value is likely overestimated. Table 2 presents results of the panel regression with time-fixed effects.

TABLE 2

Market-to-Book Equity Ratio and Credit Earnings Volatility (with time-fixed effects)

DEPENDENT VARIABLE: LN(EQUITY VALUE)	(1)	(2)
Ln(Volatility of credit earnings)	-0.156*** (0.015)	
Ln(Volatility of net interest income)		-0.041** (0.019)
Ln(Volatility of change in allowance)		-0.060*** (0.019)
Ln(Volatility of net charge-off plus write-down)		-0.105*** (0.017)
Ln(Total assets)	-0.065*** (0.013)	-0.064*** (0.012)
Assets growth	2.547*** (0.535)	0.481 (0.718)
Debt-to-asset ratio	-0.306* (0.186)	-0.279* (0.165)
Return on assets	6.698*** (1.162)	6.902*** (1.085)
Ln(Systematic risk)	0.323*** (0.026)	0.289*** (0.026)
Ln(Non-Performing Assets)	-0.011** (0.005)	-0.011** (0.005)

***significance at 1.0%; **significance at 5.0%; *significance at 10.0%

Column (1) in Table 2 summarizes the regression of market-to-book equity value on credit earnings volatility, controlling for a wide range of factors that generally affect valuation. Credit earnings volatility has a statistically significant negative impact on market-to-book equity value, with a 1.0% increase in credit earnings volatility associated with a 15.6 bps decrease in equity value. Intuitively, earnings feed into capital surplus, and, thus, high earnings volatility is associated with high insolvency uncertainty and lower value. In addition, high earnings volatility is indicative of questionable business practices and portfolio composition, which can generate market concerns that lower market valuation.The estimated effects of the other control variables we use are reasonable and consistent with the existing literature. We find that larger banks with higher total assets and smaller asset growth rates tend to have relatively lower equity values. As expected, higher return on assets (ROA) is associated with higher equity values. Higher debt-to-asset ratios can increase firms' likelihood of bankruptcy and, thus, is associated with lower equity values. Systematic risk impacts equity value positively, consistent with Rountree, Weston, and Allayannis (2008). Finally, a larger percentage of non-performing assets indicates poorer financial health, leading to lower equity values.To understand how different components of credit earnings affect a bank's equity value, we decompose credit earnings into net interest income, change in loss allowance and net charge-offs plus write-downs and re-run the regression on these variables. Column (2) in Table 2 shows that volatilities of these variables all have statistically and economically-significant, negative impacts on equity value. Intuitively, higher volatilities can be the result of a poorly diversified portfolio, highly sensitive to the credit environment. They can also indicate the bank's lack of reasonable, expected loan loss forecasts and a lack of understanding of their portfolio risk. Finally, higher volatilities may suggest that a bank frequently changes its portfolio's risk profile. These issues can cause investor concerns that drive down the equity value. Specifically, we estimate that a 1.0% increase in the volatility of net interest income decreases equity value by 4.1 bps. This finding suggests that asset liability management that effectively lowers the volatility of net interest income can increase shareholder value. Our regression analysis also shows that a 1.0% increase in the volatility of net charge-offs plus write-downs leads to a 10.5 bps decrease in equity value, and a 1.0% increase in the volatility of change in loss allowance leads to a 6.0 bps decrease in equity value.

Overall, our analysis suggests that bank investors value smooth performance, even after controlling for time-fixed effects and other factors such as risk, size, operating performance, leverage, and financial performance, etc.

2.3 Robustness Tests

In our baseline regressions above, we only control for time-fixed effects. This means that the variation in credit earnings volatility comes primarily from cross-sectional differences between banks. Intuitively, different levels of credit earnings volatility mainly reflect differences in banks' credit portfolio management practices. As a result, the effect of credit earnings volatility on equity value estimated using the specification with time-fixed effects helps answer the question of how different credit portfolio strategies or credit portfolio management practices that reduce earnings volatility influence equity value, our key research question.However, it is also possible that the cross-sectional difference in earnings volatility is driven heavily by unobserved bank characteristics that directly affect both a bank's earnings volatility and its equity value. Such a possibility prevents us from claiming that our estimated coefficients in front of volatility variables measure the true causal effect of earnings volatility on share price performance.To address this concern, we perform a set of panel regressions with both bank- and time-fixed effects. Columns (1) and (2) in Table 3 report the estimated coefficients of these regressions. We see that the effects of the volatility variables remain statistically and economically significant. Specifically, a 1.0% decrease in credit earnings volatility leads to a 10.3 bps increase in equity value, while a 1.0% decrease in the volatilities of loss allowance or net charge-offs plus write-downs increases equity value by 6.0 bps and 8.9 bps, respectively. Compared to the baseline regressions, the estimated effects of credit earnings volatility and volatility of net charge-offs plus write-downs are only slightly smaller. These findings support our hypothesis that earnings volatility has a causal effect on banks' shareholder value.

TABLE 3

Market-to-Book Equity Ratio and Credit Earnings Volatility

DEPENDENT VARIABLE: LN(EQUITY VALUE)	(1)	(2)	(3)
Ln(Volatility of credit earnings)	-0.103*** (0.013)		
Ln(Volatility of net interest income)		-0.015 (0.015)	-0.078*** (0.021)
Ln(Volatility of change in allowance)		-0.060*** (0.015)	-0.046* (0.026)
Ln(Volatility of net charge-off plus write-down)		-0.089*** (0.015)	-0.124*** (0.022)
Ln(Total assets)	-0.318*** (0.049)	-0.279*** (0.049)	-0.078*** (0.014)
Assets growth	2.740*** (0.614)	0.702 (0.709)	-0.997 (0.919)
Debt-to-asset ratio	0.089 (0.720)	-0.104 (0.713)	-0.413* (0.224)
Return on assets	15.006*** (2.457)	13.697*** (2.247)	6.907*** (1.121)
Ln(Systematic risk)	0.183*** (0.046)	0.154*** (0.046)	0.346*** (0.028)
Ln(Non-Performing Assets)	0.001 (0.004)	-0.001 (0.004)	-0.004 (0.006)

***significance at 1.0%; **significance at 5.0%; *significance at 10.0%

By using both time- and bank-fixed effects in the regression, we force the variation in credit earnings volatility to come only from the change in each bank's credit earnings volatility over time. But credit earnings volatility for most banks exhibits small variation over time in the data, likely because most banks did not change their credit risk management practice materially during our sample period. Consequently, the estimated coefficients reported in Columns (1) and (2) of Table 3 may be influenced heavily by a few outlier banks. For this reason, we choose not to present the regression results controlling for both time- and bank-fixed effects as our primary findings.

Another concern in our baseline regression is the definition of volatility variables, which we calculate using a three-year trailing window. It is possible that our estimated coefficients are highly dependent on the choice of window size. To address this concern, we perform additional regressions using volatility variables calculated under a five-year trailing window. Column (3) in Table 3 shows the results of the regression using the same specifications as in Column (2) in Table 2, differing only in the way we calculate the volatility variables. In the baseline regressions presented in Table 2, we calculate all of the volatility variables and the asset growth variable using a three-year trailing window. For the regression in Column (3) of Table 3, we calculate the variables using a five-year trailing window. As the results suggest, the rolling window size shows a limited impact on the magnitude of the effects of volatility variables. Specifically, the coefficients for volatility of change in loss allowance and volatility of net charge-offs plus write-downs are -0.046 and -0.124 when using a five-year trailing window, compared to -0.06 and -0.105 when using a three-year trailing window. Volatility of net interest income is also statistically significant at 7.8 bps.Overall, our robustness tests lend support to the conclusion in the baseline specification, that the increase in the volatility of net interest income, net charge-offs plus write-downs, and change in allowance has a significant negative causal effect on equity valuation.

2.4 Cyclical Impact of Earnings Volatility on Share Price

The panel regression in the previous section explores the average relationship between banks' credit earnings volatility and their share prices over a very long period. In this section, we investigate how the impact of earnings volatility on share price changes over time. Specifically, for each quarter, we perform a cross-sectional regression across all banks within that quarter following specification (1) in Table 2. We then compare the coefficients for credit earnings volatility across time.

In Figure 2, the solid blue line plots the estimated coefficients of credit earnings volatility from the cross-sectional regressions in each quarter. We find that this coefficient has a clear cyclical pattern — it shows the largest magnitude during crises but becomes very small during benign periods. This pattern suggests that bank investors place a significantly higher premium on smoother performance during economic downturns.

Figure 2 Sensitivity of equity value to volatility versus standard deviation of credit earnings volatility.

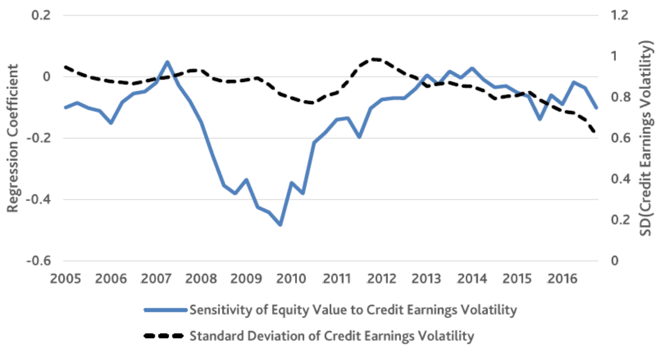
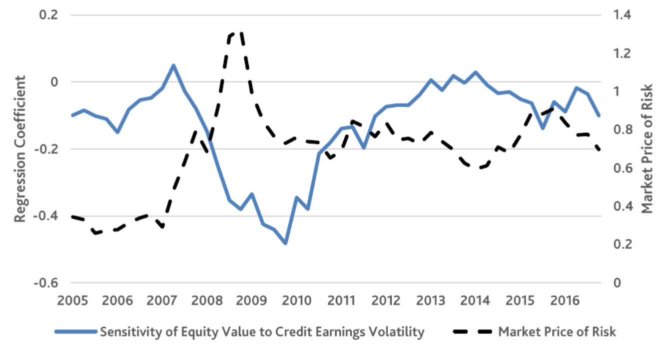


Figure 3 Sensitivity of equity value to credit earnings volatility versus market Sharpe ratio.



One possible issue that undermines this argument is that earnings volatility may vary across banks more during crisis periods and less during other periods. Consequently, a regression analysis may have a hard time picking up the effects of earnings volatility during an economic boom than during a crisis, simply due to the lack of cross-sectional variation in the explanatory variables during the former period. However, in Figure 2, the dashed line shows that the standard deviation of banks' earnings volatility stays relatively constant over time without a clear cyclical pattern, suggesting that the variation of earnings volatility across banks is, in fact, quite stable throughout time. Another potential explanation of the cyclical nature of the impact of earnings volatility is that the risk premium for uncertainty in earnings is higher during crises, driven by generally higher risk aversion levels in the market. To test this hypothesis, in Figure 3, we plot the estimated coefficients in front of credit earnings volatility against the market price of risk estimated by Moody's CreditEdge and find a strong negative relationship. The evidence suggests that the market discounts earnings volatility more aggressively during periods where the market price of systematic risk is high.

3. Can Credit Portfolio Risk Management Be a Profit Center? Case Studies Using U.S. and European Portfolios

The empirical findings in Section 2 suggest that bank investors do value smooth performance, and, thus, portfolio strategies that can effectively reduce credit earnings volatility help increase shareholder value. Various studies (for example, Levy, et al. [2017] and Levy and Zhang [2018]) show that earnings volatility can increase significantly under CECL and IFRS 9 compared to incurred loss. This impact highlights the necessity of taking into account earnings volatility for credit portfolio management. However, can a portfolio management strategy reduce credit earnings volatility without hampering profitability? In addition, if it can, to what degree does such a practice raise the bank's value?To answer these questions, we design a portfolio management strategy where, over time, newly originated loans minimize ex-ante portfolio credit earnings volatility while maintaining expected target profitability. The bank then holds each loan throughout its maturity or default. Proceeds, including coupon and principal payments, along with default recoveries, constitute the funding budget for the next period's loan origination. We benchmark performance against either a portfolio from a bank consortium or a benchmark intended to resemble the overall corporate debt market.Section 3.1 presents a case study using U.S. banks' actual portfolios in the Moody's CRD/LAS dataset as the benchmark portfolios. Section 3.2 presents a case study using a synthetic European portfolio constructed using data from Moody's CreditEdge as the benchmark portfolio.3.1 Case Study Using Portfolios of U.S. Banks in Moody's CRD Data

For the case study of U.S. banks, we use Loan Accounting System (CRD/LAS) data extracted from Moody's Analytics Credit Research Database. The CRD/LAS data includes loan-level variables such as loan type, loan origination and maturity dates, interest charged and outstanding balance, as well as borrower-level information such as industry, credit rating, and size. The data covers a large number of U.S. banks. In our study, we also complement the CRD/LAS dataset with Moody's CRD default dataset. This dataset contains loan-level default information: whether a loan defaults and, if it does, the time of the default. This dataset allows us to track the default loss of our portfolios.Seven banks have C&I portfolio data from 2005–2016, covering periods both before and after the Great Recession. We use each bank's portfolio time series as one of the benchmark portfolios.[7] We then attempt to answer the following question: How does portfolio performance for each bank compare to the following new loan origination strategy?

- At the beginning of each year, set the universe of available new loans to be the observed new loan origination of the benchmark portfolio.
- Divide this universe into segments, each containing 10 otherwise random loans in the same industry.[8] The relative weight of each new loan in a segment remains the same as that in the benchmark.

Once we finish the segmentation, we allocate the total origination-funding budget across the new loan segments to minimize the overall portfolio's ex-ante earnings volatility, while targeting the benchmark portfolio's expected income. In each period, we calculate earnings as follows:

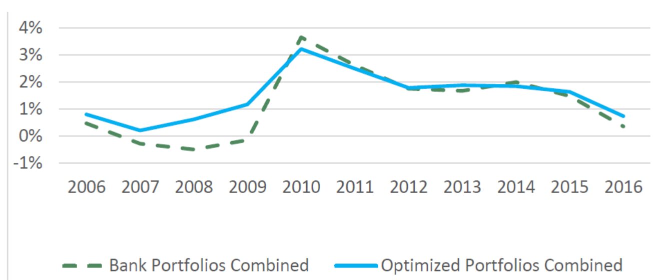
$$Earnings_{t,t+1} = Interest\ Income_{t,t+1} - Default\ Loss_{t,t+1} - Change\ in\ Loss\ Allownce_{t,t+1} \quad (1)$$

Beginning at time t (ex-ante), we project an earnings distribution for time t + 1, which accounts for instruments' default risk, credit migration risk, as well as the correlation between instruments' changes in credit qualities. We then calculate the ex-ante earnings volatility based on the projected earnings distribution.It is worth pointing out that we only allow optimization over the newly originated instruments from the benchmark and keep the holding amounts for existing instruments unchanged. We also assume no capital injection or depletion for the optimized portfolios. The total portfolio holding of the optimized portfolio evolves as follows:

$$Portfolio\ Holding_{t+1} = Portfolio\ Holding_t + Interest\ Income_{t,t+1} - Default\ Loss_{t,t+1} \quad (2)$$

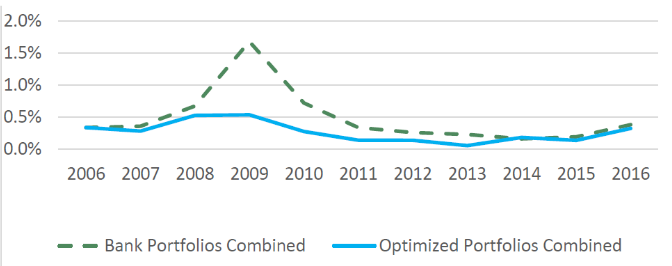
Calculation of realized earnings still follows Equation (1), but in this case, we stand at time t + 1, when we can observe the actual default and changes in credit qualities of the instruments from time tto t + 1. We then calculate realized earnings volatility as the time series volatility of the realized earnings.Figure 4 presents realized earnings (after interest expense) of the benchmark and optimized portfolios aggregated across banks.[9]The optimized portfolios have smoother performance, primarily due to a smaller decrease in earnings during the 2007–2009 crisis period. Specifically, realized earnings volatility for the benchmark portfolio is 1.21%, while the volatility of the optimized portfolios is only 0.79%, indicating a 32% decrease, and, thus, a 4.9% increase in equity value according to the empirical analysis presented in Section 2. In addition, average earnings for the optimized portfolios is 1.49%, slightly higher than that of the benchmark portfolios at 1.19%.

Figure 4 Realized earnings after interest expense.



To better understand the main drivers, we look into the earnings components — default loss and change in loss allowance. Figure 5 demonstrates realized default loss is much lower for the optimized portfolios compared with the benchmark portfolios during the crisis period.[10] The volatility of default loss for the optimized portfolios is only 37% (with volatility at 0.16%) for the benchmark portfolio (with volatility at 0.43%), which implies a 6.6% increase in equity value based on our empirical study.

Figure 5 Default loss.



The other important component contributing to earnings volatility is change in loss allowance. Figure 6 presents the level of loss allowance at the end of each year, and Figure 7 plots the change in loss allowance.

Figure 6 Loss allowance.

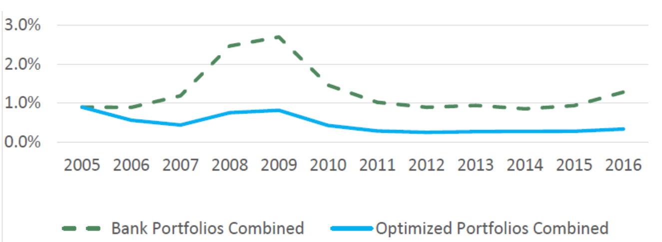
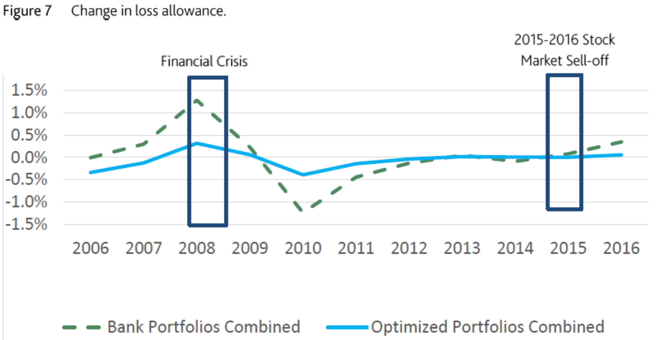


Figure 7 Change in loss allowance.



For the benchmark portfolios, although loss allowance peaked at the end of 2009, the largest increase in allowance occurred during 2008 (i.e., the large difference between loss allowance on 2008/12/31 and 2007/12/31) due to a significant deterioration in credit qualities during that period. A large increase in allowance contributes to the low level of earnings for the benchmark portfolios during 2008. Although optimized portfolios follow a similar trend as the benchmark portfolios, their changes in loss allowance are less sensitive during the cycle and show much lower volatility. In particular, volatility of change in loss allowance for the benchmark portfolio is 0.60%, while the volatility for the optimized portfolios is only 0.20%, a 67% decrease from the benchmark portfolio, indicating a 4.0% increase in equity value.Figures 8 and 9 compare portfolio characteristics between the bank portfolios and the optimized portfolios. The optimized portfolios tend to favor instruments with lower probability of default and shorter maturities. We expect this finding, given we calculate loss allowance as the lifetime expected loss under CECL, and, thus, shorter maturity implies lower volatility, keeping everything else constant.

Figure 8 Probability of default.

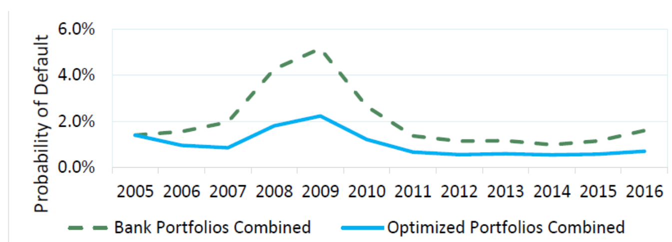
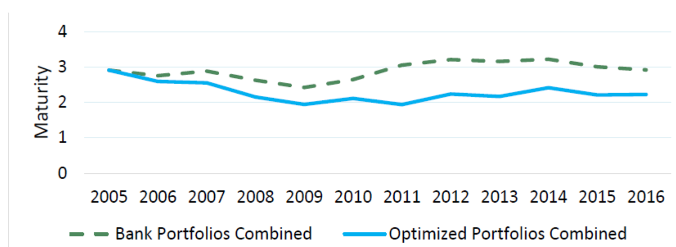


Figure 9 Average maturity.



Tables 4–7 summarize the results at the individual bank level. Tables 4 and 5 show that, for all banks, optimized portfolios have lower earnings volatility, slightly higher average earnings (after interest expense), and higher

earnings Sharpe ratios. Tables 6 and 7 show that volatilities for default loss and change in loss allowance are also always lower for the optimized portfolios. We observe that the improvement level from the optimization can differ significantly across portfolios. For example, as Table 4 shows, the volatility of earnings decreases by 56% for Bank 2 under optimization, while it only decreases by 16% for Bank 7. One of the reasons for the difference is that the maturities of instruments are much lower and have less differentiation in Bank 7's portfolio.

Under CECL, the reduction in volatility by optimization is achieved primarily by shifting allocation from instruments with longer maturities and higher PD to instruments with shorter maturities and lower PD (without lowering profitability). In this case, a portfolio starting with a high proportion of short-maturity instruments has less room for volatility reduction.

TABLE 4
Earnings Volatility

BANK	BENCHMARK	OPTIMIZATION INDUSTRY SUBGROUP	IMPLIED INCREASE IN EQUITY VALUE
Bank 1	1.14%	0.78% (32% ↓)	5.0%
Bank 2	1.50%	0.66% (56% ↓)	8.7%
Bank 3	2.16%	1.21% (44% ↓)	6.9%
Bank 4	1.48%	1.03% (30% ↓)	4.7%
Bank 5	1.60%	1.21% (24% ↓)	3.7%
Bank 6	1.45%	1.01% (30% ↓)	4.7%
Bank 7	1.24%	1.04% (16% ↓)	2.5%

TABLE 5
Average Earnings and Earnings Sharpe Ratio

AVERAGE EARNINGS			EARNINGS SHARPE RATIO		
BANK	BENCHMARK	OPTIMIZATION INDUSTRY SUBGROUP	BANK	BENCHMARK	OPTIMIZATION INDUSTRY SUBGROUP
Bank 1	1.00%	1.30%	Bank 1	0.91	1.61
Bank 2	2.21%	2.55%	Bank 2	1.49	3.79
Bank 3	0.37%	0.43%	Bank 3	0.19	0.31
Bank 4	0.53%	0.91%	Bank 4	0.37	0.83
Bank 5	1.59%	1.89%	Bank 5	1.00	1.50
Bank 6	1.23%	1.51%	Bank 6	0.91	1.46
Bank 7	1.08%	1.29%	Bank 7	0.89	1.22

TABLE 6
Default Loss Volatility

BANK	BENCHMARK	OPTIMIZATION INDUSTRY SUBGROUP	IMPLIED INCREASE IN EQUITY VALUE
Bank 1	0.53%	0.20% (63% ↓)	6.6%
Bank 2	0.36%	0.13% (64% ↓)	6.7%
Bank 3	0.42%	0.41% (2.4% ↓)	0.3%
Bank 4	0.77%	0.47% (39% ↓)	4.1%
Bank 5	0.34%	0.20% (41% ↓)	4.3%
Bank 6	0.26%	0.15% (42% ↓)	4.4%
Bank 7	0.38%	0.17% (55% ↓)	5.8%

TABLE 7
Change in Loss Allowance Volatility

BANK	BENCHMARK	OPTIMIZATION INDUSTRY SUBGROUP	IMPLIED INCREASE IN EQUITY VALUE
Bank 1	0.48%	0.14% (71% ↓)	4.3%
Bank 2	0.93%	0.27% (71% ↓)	4.3%
Bank 3	1.08%	0.37% (66% ↓)	4.0%
Bank 4	0.62%	0.25% (60% ↓)	3.6%
Bank 5	0.69%	0.32% (54% ↓)	3.2%
Bank 6	0.73%	0.25% (66% ↓)	4.0%
Bank 7	0.47%	0.17% (64% ↓)	3.8%

3.2 Case Study Using a Synthetic European Portfolio

This section presents backtesting results for the minimum variance strategy applied to a synthetic European portfolio. We create the benchmark portfolio using quarterly data of public European firms in CreditEdge January 1, 2000–December 31, 2017.To construct the initial portfolio, we include all counterparties with liabilities exceeding $10 million USD, and assume one newly originated floating rate term loan for each counterparty, with maturity determined by a weighted average[11] of one and seven years (representing current and long-term liabilities), and spread equal to the implied par spread. The reference rate is the three-month LIBOR rate. We determine the probability of default for each instrument using Moody's Analytics EDF credit measures, and we set loss given default at 50%.Once originated, an instrument is held until maturity unless the counterparty defaults or the counterparty drops out of the database. If the counterparty defaults, we use recovery for funding during the following period. If the counterparty leaves the database (without indication of default), we assume the loan sold at face value with cash returned for reinvestment. If an instrument matures, we assume a new loan originates from the same counterparty with updated maturity and spread information, if the counterparty continues to exist in the database. Another source of newly originated loans is the addition of new counterparties. Whenever a new counterparty enters the database, we assume a newly originated loan from that counterparty. We assume both the benchmark and optimized portfolios begin with the same initial composition, with holdings of instruments proportion to the liability of their counterparties. In any case, portfolio growth only comes from free cash flow with no external cash infusions or depletion. We calculate free cash flow during each quarter as the sum of interest income, recovery from default, cash from matured loans, and loans sold.For the benchmark portfolio, free cash flow is reinvested proportionally to the liability of the counterparties of the newly originated loans (i.e., proportional to the available credit in the market). For the optimized portfolio, we allocate free cash flow so that it minimizes the overall portfolio ex-ante earnings volatility, while maintaining the same level of expected earnings as the benchmark portfolio during that quarter. We conduct optimization at the country- and industry-level.Loss allowance calculation under IFRS 9 is more complicated. Under CECL for U.S. portfolios, loss allowance is always calculated as lifetime expected loss, while under IFRS 9 for the European portfolio, loss allowance is calculated as one-year or lifetime expected loss according to the instruments' stages. For our study, we use the following rule for determining an instrument's stage:[12] We categorize an instrument as Stage 2 if it satisfies either (1), the current PD to maturity exceeds 130% of the origination PD to maturity, and the absolute PD level to maturity exceeds 0.66%; or (2), its PD level to maturity exceeds 2.5%.Figure 10 shows the realized loss allowance for the two portfolios at the beginning of each quarter 2000–2017. The loss allowance of the optimized portfolio is always lower than that of the benchmark portfolio. It is also less volatile. The level of loss allowance increases for both portfolios during the periods of the dot-com crisis, the financial crisis, and the European debt crisis. While we see an increase in the loss allowance for the benchmark portfolio during the stock market sell-off during 2015–2016, the loss allowance for the optimized portfolio is not impacted.

Figure 10 Realized loss allowance under IFRS 9.

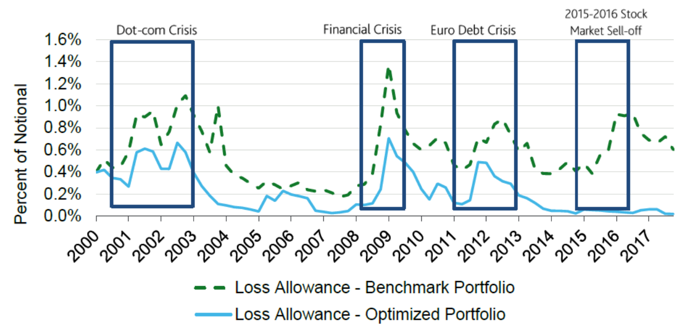


Figure 11 shows the change in loss allowance for the two portfolios. Similar to the case for U.S. portfolios, the optimized portfolio shows much smaller volatility of change in loss allowance at 0.11%, a 35% decrease from the benchmark portfolio at 0.17%. This decrease, in turn, translates to a 2.1% increase in equity value.

Figure 11 Change in realized loss allowance under IFRS 9.

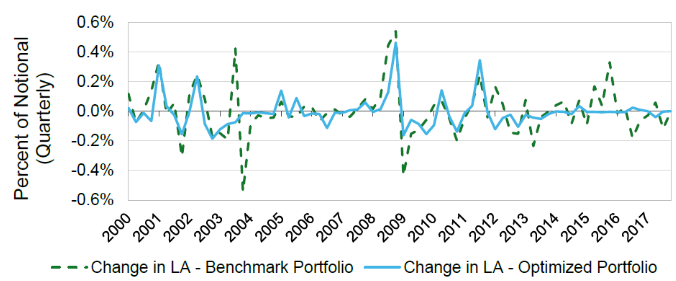
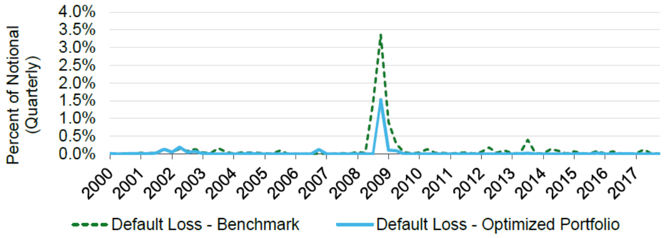


Figure 12 shows the realized default loss for the two portfolios. As shown, default loss is significantly lower for the optimized portfolio during the crisis period as well as the post-crisis period. Volatility of default loss for the benchmark portfolio is 0.44%, while the volatility for the optimized portfolio is only 0.18%, a 59% decrease, implying a 6.2% increase in equity value.

Figure 12 Realized default loss.



Figures 13 and 14 compare the average PD to maturity and average maturity between the two portfolios. Similar to the case for U.S. portfolios under CECL, the optimized portfolio favors safer instruments with generally lower PDs. However, the differences between the maturities of the two European portfolios under IFRS 9 are not as significant as seen for the case under CECL in Figure 9. In fact, under IFRS 9, safe instruments with long maturities are very attractive, because their incomes are higher due to longer maturities. However, they exhibit sensitivity to credit migration roughly equivalent to instruments with one-year remaining maturity (i.e., allowance is calculated as the one-year expected loss).

Figure 13 One-year probability of default.

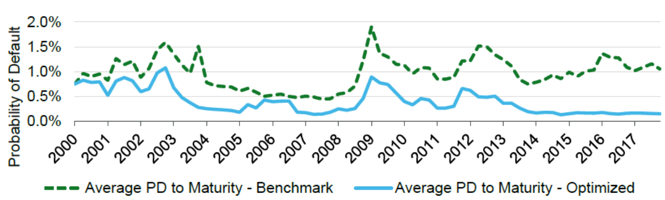


Figure 14 Average maturity.

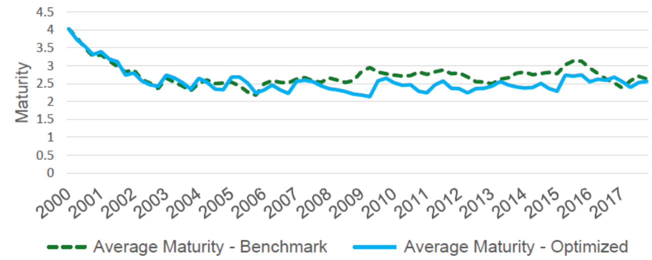
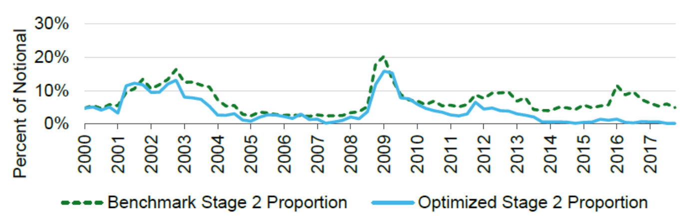


Figure 15 calculates the notional-based proportion of Stage 2 assets at each time point. As expected, the optimized portfolio contains a smaller proportion of Stage 2 instruments, given their propensity to exhibit higher earnings volatility. This difference is a primary driver for the optimized portfolio's large reduction in earnings volatility. The difference in proportion of Stage 2 assets between the two portfolios is largest during the post-crisis period. Worth noting, there are a few notable periods where the optimized portfolio has a larger proportion of Stage 2 instruments. These occur primarily because the instruments' changes of staging after loan origination and the inability to change loan holding amount after origination.

Figure 15 Proportion of notional in Stage 2.



4. Summary

Our research shows how credit earnings volatility can impact share price performance for financial institutions. Results demonstrate that a 1.0% increase in credit earnings volatility is associated with a 15.6 bps decrease in equity value. When exploring earnings volatility components, we find that a 1.0% increase in the volatility of change in loss allowance leads to a 6.0 bps decrease in equity value, while a 1.0% increase in the volatility of net charge-offs plus write-downs leads to a 10.5 bps decrease in equity value. These findings suggest that credit portfolio risk management strategies can effectively reduce credit earnings volatility without decreasing income, helping to increase shareholder value. Studies show that earnings volatility can increase significantly under CECL and IFRS 9, which makes this research and conclusions very pertinent.

Our portfolio strategy minimizes ex-ante portfolio earnings volatility while targeting expected income at the benchmark level. We test the effectiveness of the strategy using both U.S. and European portfolios. For the U.S. portfolios, we use historical bank portfolio data from Moody's CRD database as benchmarks. We find that the optimized portfolios constructed under the strategy can reduce the realized earnings volatility by 32% on average. In addition, the volatility of default loss and loss allowance are both much smaller for the optimized portfolios. Specifically, the realized volatility of default loss is reduced by 63%, and the realized volatility of change in loss allowance is reduced by 67%, suggesting an increase in equity value of 6.6% and 4.0%, respectively. For the European portfolios, we construct the benchmark portfolio using data from public European firms in Moody's CreditEdge database. The optimized portfolio constructed under the portfolio strategy effectively reduces the volatility of default loss and loss allowance by 59% and 35%, respectively, implying an increase of 6.2% and 2.1% in equity value.

Our findings illustrate that these specific credit risk management strategies add value, helping to achieve stable performance. The value generated can be significant.

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[1] Net interest income calculated as interest income minus interest expense.[2] There may be some adjustment due to amended reports. For more detailed information, please refer to "Consolidated Financial Statements for Holding Companies—FR Y-9C."[3] Rountree, Weston, and Allayannies (2008) normalize earnings using number of outstanding shares (adjusted for stock splits) and, thus, use earnings per share to calculate earnings volatility. Under their method, one firm with a smaller number of shares will have larger earnings volatility than another firm, even if the two firms remain the same in all other aspects. In contrast, we expect our earnings volatility measure to reflect the healthiness of a bank's portfolio composition, or, in other words, the effectiveness of banks' credit portfolio management. Therefore, we construct our normalized earnings in a way that abstracts from the impact of the number of shares.[4] The existing literature commonly uses a five-year rolling window (as in Rountree, Weston, and Allayannies [2008]). Essentially, we want the rolling window to incorporate long enough earnings dynamics, so that the calculated earnings volatility is meaningful, but not too long, so that the volatility constructed still reflects current/relevant information at each time point. We use both a three-year and a five-year window, and results are not sensitive to the final time period used. For completeness, we report both results (with results of the five-year rolling window reported in the alternative specifications).[5] Some of the literature assumes perfect foresight and, thus, uses future volatility. However, this assumption could be too strong to hold in reality.

[6] The literature uses the market-to-book asset value ratio as a proxy for firm value. In this paper, we use market-to-book equity value as our dependent variable, because we focus on the impact of earnings volatility on share price performance, rather than on firm value.[7] For the benchmark portfolios, we only include term loans and revolvers that have bank-provided coupon rates and probability of default values generated by Moody's RiskCalc™ (using firms' financial statement information).

[8] In cases where a sector's total number of loans is not a multiple of 10, one segment of the sector has fewer than 10 loans.[9] Due to confidentiality, we cannot present times series results for individual banks. We can interpret aggregate results as those of one large portfolio containing seven sub-portfolios optimized separately.

[10] In the empirical section, default loss corresponds to net charge-offs plus write-downs.

[11] The weight used for one year equals current liability over the sum of current and long-term liabilities.

[12] Numbers calibrated based on historical data.