Cross-Sectional Dispersion and Expected Aggregate Loan Losses

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ABSTRACT: Debt holders face a concave payoff function. Well-performing borrowers pay back predetermined interest and principal, while poor-performing borrowers may cause losses. Consequently, the losses on a portfolio of loans or bonds depend not only on the mean performance but also on the cross-sectional dispersion in borrowers' performance. Higher dispersion suggests higher losses due to a larger number of defaulting borrowers and higher loss given default. Thus, for debt holders, aggregate economic conditions should be redefined as a function of both the mean and the cross-sectional dispersion in borrowers' performance. Empirical analysis of loan and bond portfolio performance confirms our hypotheses.

Keywords: debt cycle, loan, bond, dispersion, loss.

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1. INTRODUCTION

Studies on financial markets have demonstrated that debt and equity asset values are linked to business cycles. The relation between asset values and business cycles is robust and holds for measures of real activity (e.g., Fama and French 1989; Fama 1990; Schwert 1990), as well as measures of aggregate corporate earnings (e.g., Sadka 2007; Sadka and Sadka 2009; Gkougkousi 2014). The literature that examines the cyclicality of debt markets, however, does not fully account for the concave payoff function faced by debt holders. Debt holders are more sensitive to downside risks than the upside potential. Thus, the relation between debt markets and business cycles should be affected by the debt holders' asymmetric payoff function. In this paper, we argue that the definition of aggregate business conditions for debt securities should be redefined to account for debt holders' asymmetric payoff function.

Consider, for example, an economy with two firms that earn \$10 each. Compare this economy to another economy where one firm earns \$25 and the other firm earns $-$\$5 (i.e., a loss of \$5). Note that in both economies, aggregate profits are the same and equal to \$20. A debt holder earns interest (assume \$2 interest payment) if the firm performs well, but loses her investment if the firm incurs a loss. In the first scenario, where both firms earn \$10, a debt holder earns \$4 in interest. In the second scenario, however, the debt holder collects \$2 from the profitable firm and loses \$5 on her investment in the losing firm (overall loss is $-$\$3). Thus, even though aggregate performance is the same in both economies, debt holders' earnings are not the same.

The simple example above illustrates that debt holders are not only interested in the average performance of the firms in their portfolio, but also in the cross-sectional dispersion in performance. Debt holders' payoffs and pricing depend on realized and expected losses, respectively, and realized and expected losses depend on the realized and expected cross-sectional dispersion in borrowers' performance. The reason is that debt holders are more sensitive to downside risk, and cannot fully diversify away the effect of loss firms by lending to more firms.

Consequently, all else equal, higher dispersion results in a larger proportion of defaulting firms and a higher loss given default. Thus, higher dispersion results in higher losses for debt holders. As a result, the definition of business cycles for debt markets should incorporate both the mean and the cross-sectional dispersion of borrowers' performance, rather than solely focusing on the aggregate and/or mean performance.

The intuition underlying the example above is examined analytically by assuming that the cross-section of asset values is log-normally distributed. The expected loss is given by the mean asset values below a threshold asset value. Our analysis shows that the expected loss is a function of both the mean and the cross-sectional dispersion of asset values. In particular, we show that the expected loss is decreasing at a decreasing rate with the mean, i.e., the sensitivity of the expected loss to changes in the mean is small when asset values are large. Intuitively, when the mean asset values are large, the proportion of assets that are likely to fall below the threshold value is lower than when the mean asset values are small. Thus, the expected loss is affected less by the mean asset values for large mean asset values than small mean asset values. That is, the sensitivity of expected loss to mean asset values decreases in mean asset values. This result suggests that in developed economies such as the U.S., where the mean asset values are sufficiently high, the expected loss is not likely to be very sensitive to changes in the mean asset values.

We also show analytically that the expected loss is increasing at a decreasing rate with the cross-sectional dispersion in asset values. The intuition for this result stems in a straightforward fashion from the debt holders' exposure to downside risk with limited upside potential. As such, when the cross-sectional dispersion increases, the expected loss also increases. More importantly, comparing the sensitivity of the expected loss to the mean and the cross-sectional dispersion in asset values, we show that the expected loss is more sensitive to the cross-sectional dispersion than the mean asset values. The effect of the cross-sectional dispersion on expected loss is more pronounced than that of the mean asset value because the debt holder is exposed to downside risks, but not to the upside potential. Accordingly, the intuition embedded in the example above is made analytically precise.

Furthermore, we examine the combined conditional effect of mean and dispersion on debt holders' expected loss. We characterize the various states of the economy in terms of mean borrowers' performance and cross-sectional dispersion in borrowers' performance, and we examine how expected losses change as mean and dispersion change. Higher (lower) mean performance and lower (higher) dispersion in borrowers' performance characterize better (worse) states of the economy. We show that expected losses increase at a decreasing rate when moving from better to worse economic states. This result implies that the expected loss is more sensitive to changes in the economy when the economy moves from a good to a mediocre state, than when the economy moves from a mediocre to a bad state. When the state of the economy is good, the mean asset value is high and the cross-sectional dispersion is low, and both the high mean and the low dispersion contribute to a low proportion of assets being below the threshold value. Moving from the good to the mediocre state of the economy, the lower mean and the higher cross-sectional dispersion combine to increase the proportion of assets that fall below the threshold value considerably. However, moving from a mediocre to a bad state, most of the assets are already below the threshold value and as such, the additional increase in expected loss is muted. This non-linearity in the sensitivity of expected loss to the state of the economy demonstrates the importance of considering both the mean and the cross-sectional dispersion in asset values for debt markets.

Collectively, our analytical framework provides the following empirically testable predictions: (a) the expected loss is positively related to the cross-sectional dispersion of asset values; (b) the expected loss is negatively related to the mean asset values; and (c) the expected loss is more sensitive to the cross-sectional dispersion of asset values than the mean asset values.

We proceed to empirically test our predictions. While our model is based on asset values, our empirical analysis employs shocks to performance. Our performance measure is the equal-weighted average of firm-specific earnings growth, and our dispersion measure is the cross-sectional standard deviation of firm-specific earnings growth in each year (e.g., Jorgensen et al. 2012; Kalay et al. 2016; Nallareddy and Ogneva 2017). We use earnings as a proxy for asset values in our analysis because earnings is the primary summary indicator of firms' performance, earnings figures are routinely used in debt contracts, and earnings data is widely available.

We measure losses on loan portfolios using aggregate loan loss provisions (LLP), aggregate net charge-offs (NCO), and aggregate non-performing loans (NPL). Loan loss provisions are charges to income for uncertain yet probable credit losses, net charge-offs are debt write-downs minus recoveries of previous write-downs, and non-performing loans are loans that are in default or close to being in default (e.g., loans 90 days past due). We measure the performance of bond portfolios using high-yield corporate bond market returns. Our main analysis is conducted at the annual frequency to avoid issues related to serial correlations of quarterly data and fourth-quarter effects, which are prominent in accounting-based variables.

Consistent with our predictions, we find that aggregate bank loan loss provisions, net charge-offs, and non-performing loans are increasing with dispersion and decreasing with aggregate earnings growth. Our empirical results suggest that dispersion explains a larger proportion of the variation in aggregate loan loss provisions, net charge-offs, and non-performing loans compared to aggregate earnings growth. We find similar results using returns on publicly-traded bond portfolios. Earnings dispersion alone can explain as much as 35 percent of the variation in annual corporate bond market returns and bank loan portfolio performance.

We conduct two additional tests for bond portfolios. First, we sort bonds into portfolios based on their maturity. Our hypothesis implies that bonds with longer maturities should be more sensitive to dispersion. Second, we sort bonds into portfolios based on their credit ratings. We expect the sensitivity of bonds to dispersion to be higher for low-rated compared to high-rated bonds. Our findings are consistent with our expectations. The association between bond returns and dispersion is negative and rises monotonically in absolute magnitude as the bond maturity increases and the bond credit ratings decrease. These findings further highlight the importance of dispersion for the pricing of portfolios of debt securities.

Next, we examine the combined effect of earnings dispersion and aggregate earnings growth on loan and bond portfolio performance. We define good (bad) economic state as the state of the economy with low (high) dispersion and high (low) aggregate earnings growth, and find that losses increase at a decreasing rate when moving from good to bad economic states. The reason for this non-linear relation between the state of the economy and loan and bond portfolio performance is that the sensitivity of performance to earnings dispersion increases at a decreasing rate as aggregate earnings growth decreases.

Finally, we examine whether cross-sectional earnings dispersion predicts the performance of banks' loan portfolio. Cross-sectional earnings dispersion can predict future loan portfolio performance when there is a delay between the time a borrower becomes financially constrained/ distressed and the time the loss on the loan portfolio is recognized by the lender. However, we do not expect dispersion to have predictive power in the long run. Our results are in line with our expectations—cross-sectional earnings dispersion predicts aggregate loan loss provisions, net charge-offs, and non-performing loans for up to two quarters ahead. Our empirical results are robust to a number of alternative specifications.

Our hypotheses and analyses do not consider additional potential implications of dispersion for aggregate economic activity. A number of studies link dispersion to macroeconomic activity. First, Lilien (1982) shows that higher dispersion is related to higher unemployment due to sectoral shifts—that is, employees migrating from less to more efficient sectors (see also, Lucas and Prescott 1974; Abraham and Katz 1986; Hosios 1994). Second, Foster et al. (2006) employ establishment-level data in the retail sector and show that dispersion in establishment productivity generates reallocation from less productive to more productive establishments. Finally, Bloom (2009) suggests that higher dispersion implies higher firm-level uncertainty, which reduces investments and lowers economic activity (see also, Bernanke 1983; Bloom et al. 2007; Bordo et al. 2016; Balke et al. 2017). Thus, we caution that the empirical relation between dispersion and debt market performance documented in this paper may also be attributable to these other effects.

We contribute to the literature in the following ways. First, our findings highlight the importance of accounting for cross-sectional dispersion in asset values when modeling debt cycles. Prior literature focuses on the impact of mean asset values on business cycles (e.g., Fama and French 1989). Our analytical and empirical findings show that cross-sectional dispersion is as important, if not more important, than the mean of asset values in characterizing debt cycles. Second, we provide an alternative explanation for the relation between dispersion and the economy documented in prior literature (e.g., Baker and Bloom 2013). Prior literature links dispersion to uncertainty, while we argue that dispersion in asset values can be negatively related to the performance of loan and bond portfolios regardless of the level of uncertainty, because dispersion is positively related to loan and bond portfolio losses. Third, we contribute to literature that examines the information content of aggregate accounting dispersion (e.g., Jorgensen et al. 2012; Kalay et al. 2016; Nallareddy and Ogneva 2017) by providing evidence of a link between cross-sectional earnings dispersion and losses on loan and bond portfolios.

The remainder of the paper is organized as follows. Section 2. develops our predictions, Section 3. describes the research design, Section 4. presents the results of our empirical analysis, Section 5. describes our robustness tests, and Section 6. concludes.

2. ILLUSTRATION

Consider that the debt asset value in the lenders' portfolio, x is log-normally distributed, i.e., $\log(x) \sim N(\mu, \sigma)$. Assets below a threshold value of k are to be written-off because they are uncollectible. The expected loss, $L(.)$ is the expected asset value below the threshold value

k and is given by:

$$L(\mu,\sigma,k) = E[x|x \leq k]Pr(x \leq k) = \int_0^k \left[\frac{1}{\sigma\sqrt{2\pi}}\right] \exp\left\{-\frac{1}{2}\left(\frac{log(x)-\mu}{\sigma}\right)^2 dx\right\} \\ = \exp\{d_1\}N(d_2) \tag{1}$$

where $E[.]$ is the expectations operator, Pr(.) denotes the probability, $d_1 = \mu + (\frac{\sigma^2}{2})$, $d_2 = \left[\frac{\log(k)-(\mu+\sigma^2)}{\sigma}\right]$ and $N(.)$ is the cdf of the standard normal distribution. We assume that $k < \mu$ such that $d_2 < 0$, since we are considering the asset value that is to be written-off.

The debt asset values are related to business cycles. To gain insights into the impact of the business cycles characterized by the mean, μ and the dispersion, σ of the asset values, we examine how $L(.)$ changes when μ and σ change. Differentiating $L(.)$ with respect to μ, denoting the pdf of the standard normal distribution by $n(.)$ and using $\frac{\partial d_1}{\partial \mu} = 1$ and $\frac{\partial d_2}{\partial \mu} = -(\frac{1}{\sigma})$ we get:

$$\frac{dL(.)}{d\mu} = \exp\{d_1\}\left[\frac{\partial d_1}{\partial \mu}\right]N(d_2) + \exp\{d_1\}n(d_2)\left[\frac{\partial d_2}{\partial \mu}\right] = \exp\{d_1\}N(d_2)\left[1-\left(\frac{n(d_2)}{\sigma N(d_2)}\right)\right] \\ = L(.)Y(.) \tag{2}$$

where $Y = [1-Z_1]$, $Z_1 = \left(\frac{n(d_2)}{\sigma N(d_2)}\right)$. The $sign(\frac{dL(.)}{d\mu}) = sign(Y)$. In general, the $sign(Y)$ can be either positive or negative. Since $N(d_2)$ does not have a closed form, it can be numerically verified that a necessary condition for $\sigma Z_1 > 1$ is for $d_2 < 0$. It follows that $Y < 0$ and thus, $\left[\frac{dL(.)}{d\mu}\right] < 0$ over the domain where σ is sufficiently small.

Figure 1 provides the $L(.)$ for $k = 1.5$, $\sigma = 1$, and $\sigma = 1.5$ when μ is varied from 2 to 5. In both cases, it can be observed that as the mean asset value becomes larger, the expected loss becomes less sensitive to the mean asset value. With $d_2 < 0$ and σ sufficiently small, it can be shown that $[\frac{d^2L(.)}{d\mu^2}] > 0$. Thus, the expected loss is decreasing at a decreasing rate with respect to the mean asset value. This implies that in states of the economy where the mean asset value is large, the change in expected loss is less sensitive to changes in mean asset value. To see this result in intuitive terms, when the mean asset values are high enough, there is less likelihood of assets falling below the threshold value and as such, the expected loss will be less sensitive to mean asset values.

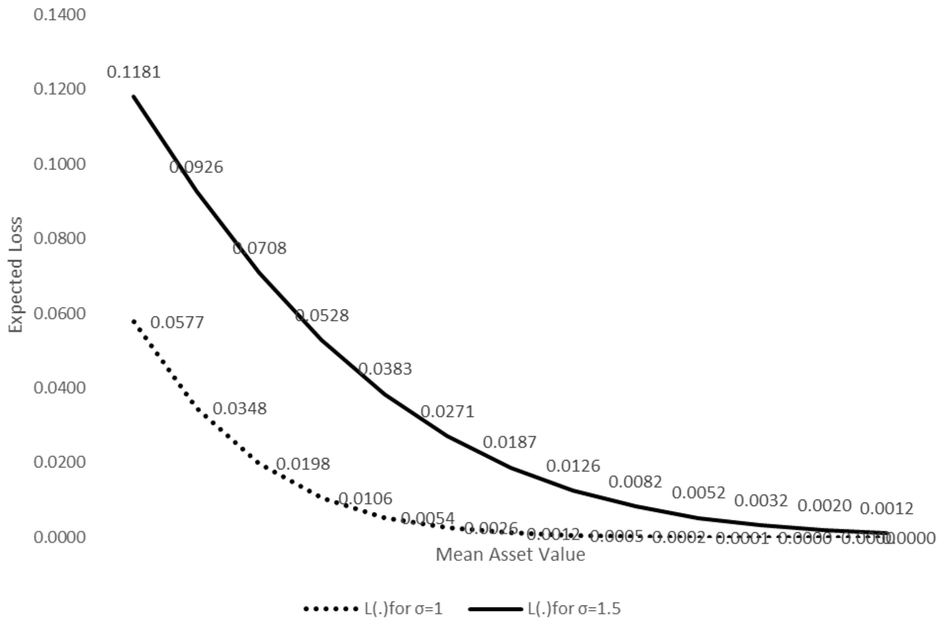
Figure 1 also suggests that $L(.)$ is higher for states of the economy with larger dispersion: the expected loss, $L(.)$ for $\sigma = 1$ is less than the expected loss for $\sigma = 1.5$. We make this observation precise by differentiating $L(.)$ with respect to σ, and using $\frac{\partial d_1}{\partial \sigma} = \sigma$ and $\frac{\partial d_2}{\partial \sigma} = -(\frac{\log(k)-\mu+\sigma^2}{\sigma^2})$ to get:

$$\begin{aligned} \frac{dL(.)}{d\sigma} &= exp\{d1\}\left[\frac{\partial d_1}{\partial \sigma}\right]N(d_2) + exp\{d_1\}n(d_2)\left[\frac{\partial d_2}{\partial \sigma}\right] \\ &= L(.)\sigma\left[1 - \left\{\frac{log(k)-\mu+\sigma^2}{\sigma^2}\right\}\left(\frac{n(d_2)}{\sigma N(d_2)}\right)\right] \end{aligned} \tag{3}$$

Thus, $\frac{dL(.)}{d\sigma} > 0$ if $log(k) - \mu + \sigma^2 < 0$ which occurs over the domain where the dispersion of asset values is sufficiently small. In effect, over the domain where the dispersion is sufficiently small, the expected loss increases with increases in dispersion. The intuition that expected loss should be increasing in dispersion occurs because the lenders are exposed to downside risk but do not benefit from the upside potential as illustrated by the example in the introduction. In addition, with $log(k) - \mu + \sigma^2 < 0$ and σ sufficiently small it can be shown that $[\frac{d^2L(.)}{d\sigma^2}] < 0$. Thus, the expected loss is less sensitive to dispersion when dispersion becomes much larger. The intuition here stems from the fact that when the dispersion is high, the lenders would have already written-off a substantial portion of the assets, and as such the incremental expected loss for the increased dispersion is small.

Figure 2 illustrates the effect of dispersion on the expected loss when $k = 1.5$, $\mu = 2$ and $\mu = 2.5$, and σ is varied from 1 to 4. It can be observed that the $L(.)$ for $\mu = 2$ and $\mu = 2.5$ increases up until $\sigma = 2.25$ and $\sigma = 3$, respectively and then decreases. More importantly, the higher mean asset value pushes the point up to which $L(.)$ increases further out. This

FIGURE 1
Expected Loss and Changes in Mean Asset Values



This figure shows the expected loss as a function of mean asset values and for two levels of dispersion of asset values, i.e., σ=1 and σ=1.5.

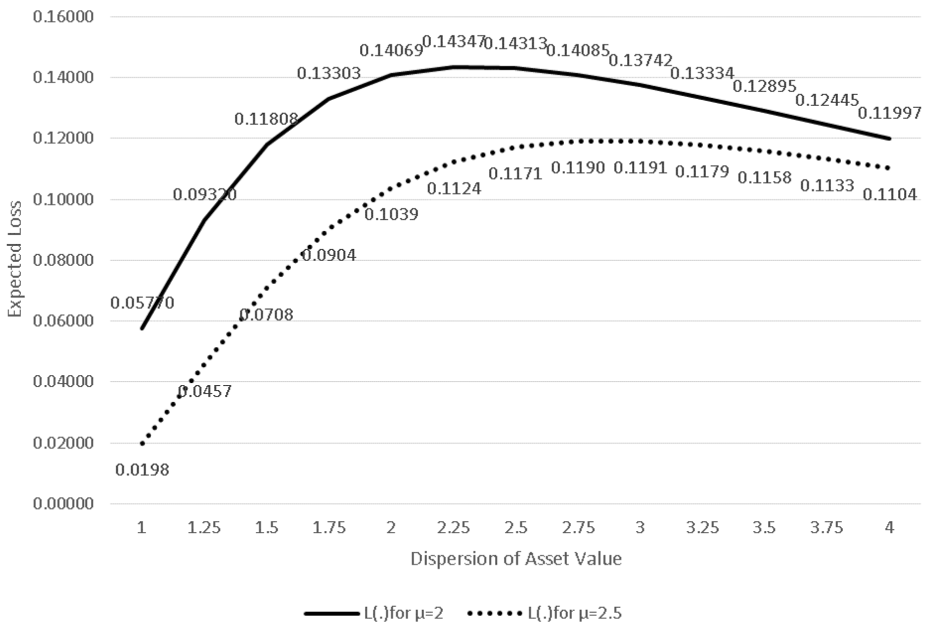
suggests that while the expected loss in economic states with higher mean asset values is less sensitive to dispersion (as observed in Figure 1 as well), the positive relation between dispersion and expected loss occurs over a larger domain of dispersion. Intuitively, in economies where the mean asset values are already high (i.e., more developed economies), an increase in the dispersion is the main effect that drives the expected loss. This finding suggests that the expected loss is more sensitive to changes in dispersion than changes in the mean asset values. Comparing the magnitudes of $\left|\frac{dL(.)}{d\mu}\right|$ and $\frac{dL(.)}{d\mu}$, it can be verified that $\left|\frac{dL(.)}{d\mu}\right| < \frac{dL(.)}{d\mu}$ for large μ and reasonably small σ. This result suggests that over the domain where μ is sufficiently large and σ is small, which is likely to be the characteristic of a developed economy such as the U.S., the loss is more sensitive to changes in dispersion of asset values than changes in the mean asset values.

These insights provide the following empirical predictions P1 to P3.

P1: The expected loss is positively related with the dispersion of asset values.

P2: The expected loss is negatively related with mean asset values.

FIGURE 2
Expected Loss and Changes in Dispersion of Asset Values



This figure shows the expected loss as a function of dispersion of asset values and for two levels of mean asset values, i.e., μ=2 and μ=2.5.

P3: The expected loss is more sensitive to the dispersion of asset values than the mean asset values.

For the empirical tests, we use the performance of the banks' loan portfolio and the performance of public debt as proxies for debt losses, we use aggregate earnings growth as proxy for mean asset values, and we use cross-sectional earnings dispersion as proxy for the dispersion of asset values. We use firm-specific earnings as a proxy for firm-specific asset values in our empirical analysis because earnings is the primary summary indicator of firms' performance, earnings figures are routinely used in debt contracts, and earnings data is widely available.

3. RESEARCH DESIGN

To examine the relation between loan portfolio performance, aggregate earnings growth, and cross-sectional earnings dispersion, we estimate the following model:

$$\Delta LLP_t / \Delta NCO_t / \Delta NPL_t = \alpha_1 + \beta_1 \cdot \Delta E_t + \gamma_1 \cdot Disp_t + \sum_{n=1}^{N} \delta_n \cdot Control_{n,t} + \varepsilon_t \qquad (4)$$

High aggregate loan loss provisions (ΔLLP), high aggregate net charge-offs (ΔNCO), and high aggregate non-performing loans (ΔNPL) represent poor bank/loan performance. ΔE stands for aggregate earnings growth and $Disp$ stands for cross-sectional earnings dispersion. Thus, we expect β_1 to be negative and γ_1 to be positive.

To examine the relation between bond portfolio performance, aggregate earnings growth, and cross-sectional earnings dispersion, we estimate the following model:

$$Ret\_HY_{t-1} = \alpha_2 + \beta_2 \cdot \Delta E_t + \gamma_2 \cdot Disp_t + \sum_{n=1}^{N} \delta_n \cdot Control_{n,t} + \varepsilon_{t-1} \qquad (5)$$

Low high-yield corporate bond market returns (Ret_HY) represent poor bond portfolio performance. Hence, we expect β_2 to be positive and γ_2 to be negative. We run a regression of lagged corporate bond market returns on aggregate earnings growth and cross-sectional earnings dispersion because we expect that returns will anticipate changes in dispersion.

Aggregate earnings growth (ΔE) is the equal-weighted average of the annual change in firm-specific income before extraordinary items scaled by one-year lagged book value of equity. We use annual instead of quarterly data for our main analysis to avoid issues related to serial correlations of quarterly data and fourth-quarter effects, which are prominent in accounting-based variables. We use equal- instead of value-weighted variables in our regressions, and thus we do not require stock prices for our analysis, to capture the widest possible cross-section of borrowers' performance. An additional advantage of using equal- instead of value-weighted variables is that we include in our sample and place equal weight on smaller firms that are more likely to rely on loans for debt financing than larger firms. Our results are robust to using income before extraordinary items and interest expense instead of income before extraordinary items as a measure of firm-specific earnings in our analysis. Our results are also qualitatively similar but weaker when we scale firm-specific earnings by lagged total assets instead of lagged book value of equity.

Cross-sectional earnings dispersion (*Disp*) is the standard deviation of the annual change in firm-specific income before extraordinary items scaled by one-year lagged book value of equity. Our results are qualitatively similar when we use the inter-quartile range of firm-specific earnings changes, the 5th percentile of firm-specific earnings changes, or the semi-standard-deviation of firm-specific earnings changes instead of the standard deviation of firm-specific earnings changes as a measure of dispersion.

ΔLLP is the equal-weighted average of the annual change in bank-specific loan loss provisions scaled by one-year lagged total assets. Loan loss provisions is the amount charged against earnings to establish a reserve sufficient to absorb expected loan losses. ΔNCO is the equal-weighted average of the annual change in bank-specific net charge-offs scaled by one-year lagged total assets. Net charge-offs is the amount of asset write-downs minus recoveries of previous write-downs. ΔNPL is the equal-weighted average of the annual change in bank-specific non-performing loans scaled by one-year lagged total assets. Non-performing loans is the sum of (i) loans and leases carried on a non-accrual basis, (ii) loans which are 90 days past due both accruing and non-accruing, (iii) renegotiated loans, (iv) real estate acquired through foreclosure, and (v) repossessed movable property. Our results are robust to scaling the loan portfolio performance variables by lagged loans net of allowance for loan losses instead of lagged total assets.[1]

Ret_HY is the annual total return of the value-weighted high-yield Bank of America Merrill Lynch U.S. Corporate Bond index. The index tracks the performance of U.S. dollar denominated below-investment-grade corporate debt publicly issued in the U.S. domestic market. Securities included in the index must have below-investment-grade rating, at least 18

[1]The three proxies for loan portfolio performance (i.e., loan loss provisions, net charge-offs, and non-performing loans) differ in timeliness. Loan loss provisions capture expected losses while net charge-offs and non-performing loans primarily capture realized losses on the banks' loan portfolio. Our analysis does not show any differences in the timeliness of loan loss provisions, net charge-offs, and non-performing loans, likely due to the low frequency of our data.

months of original maturity, at least one year of remaining maturity, a fixed coupon schedule, and a minimum amount outstanding of \$100 million. Total return is the sum of the price return, the accrued interest return, and the coupon return. The annual return for year t is the cumulative return from April of year t through March of year $t+1$.

We use value- instead of equal-weighted market returns in our analysis because Bank of America Merrill Lynch only provides data on value-weighted indices. Nevertheless, our results are similar when we match the weighting scheme of the dependent and independent variables, that is, when we use value-weighted instead of equal-weighted aggregate earnings in the regression model 5. We use a high-yield instead of an investment-grade corporate bond index in our analysis because high-yield indices are more sensitive to changes in the probability of default and loss given default than investment-grade indices. Our results are similar albeit weaker when we use investment-grade instead of high-yield corporate bond market returns as the dependent variable in regression 5.

We control for $\Delta Term$, $\Delta Tbill$, $\Delta Default$, ΔVXO, and ΔGDP in the regressions (e.g., Fama and French 1989; Fama 1990; Fama and French 1993; Huang and Kong 2003; Tang and Yan 2010). $\Delta Term$ is the annual change in the term spread. Term spread is the yield spread between the ten-year constant-maturity Treasury bonds and the one-year constant-maturity Treasury bills. $\Delta Tbill$ is the annual change in the one-year constant-maturity Treasury-bill rate. $\Delta Default$ is the annual change in the default spread. Default spread is the yield spread between the Moody's BAA- and the AAA-rated corporate bonds. ΔVXO is the annual change in the one-month S&P100 implied volatility index.[2] ΔGDP is the annual growth in nominal Gross Domestic Product (GDP). Our results are robust to controlling for annual changes in the U.S. unemployment rate, aggregate leverage, and the equal-weighted NYSE/AMEX/NASDAQ stock market return in our regressions (Collin-Dufresne et al. 2001; Lilien 1982). Aggregate

[2] We use the one-month implied volatility index in our analysis instead of the three- or six-month implied volatility indices because data on the three- and six-month volatility indices only become available in January 2002 and January 2008, respectively.

leverage is the equal-weighted average of the firm-specific ratio of current and non-current debt divided by total assets in each year.

We use the residuals of an AR(1) model for all the variables in our regressions—with the exception of the corporate bond market returns—to remove the persistent component of the variables and mitigate potential spurious regression bias (e.g., Ferson et al. 2003). In the case of *Disp*, we also add a time trend in the AR model to account for trends in the time series (e.g., Jorgensen et al. 2012).[3] The choice of the lags in the AR model is based on the Akaike and BIC information criteria. Results are similar when we use an AR(2) or AR(3) model for the regression variables, with the exception of the relation between ΔNPL and *Disp* that becomes statistically non-significant. We also normalize the shocks in aggregate earnings growth (i.e., ΔE) and cross-sectional earnings dispersion (i.e., *Disp*) and add a constant to make both variables positive, which is useful for interpreting interaction terms.

We use annual data from 1961 to 2015 for our analysis. We retrieve data to estimate aggregate earnings growth and cross-sectional earnings dispersion from Compustat North America Fundamentals Annual. We retrieve data on loan portfolio performance from Compustat Bank Fundamentals Annual and data on bond portfolio performance from Bloomberg. We retrieve economic data from the website of the Federal Reserve Bank of St. Louis.

We only keep firms with December fiscal-year end to avoid mis-specifications due to different reporting periods.[4] We drop the top and bottom 2.5 percent of firms ranked by scaled firm-specific earnings, bank-specific loan loss provisions, bank-specific non-performing loans, and bank-specific net charge-offs to mitigate the influence of outliers. We drop firms with non-positive book value of equity from the earnings sample because book value of equity is

[3]The augmented Dickey-Fuller test rejects the null hypothesis of a unit root for all the regression variables at the 1 percent level, with the exception of ΔNPL in which case the test rejects the null hypothesis of a unit root at the 15 percent level.

[4]Results are qualitatively similar albeit weaker when we don't restrict our sample to December fiscal-year end firms—the coefficients on cross-sectional earnings dispersion are positive and statistically significant in the regressions with aggregate loan loss provisions and aggregate net charge-offs as the dependent variables, but they are positive (negative) and statistically non-significant in the regressions with aggregate non-performing loans (corporate bond market returns) as the dependent variable.

used as a scalar in the estimation of firm-specific earnings. We also remove banks (i.e., SIC codes 6000–6100) from the earnings sample to avoid a mechanical relation between aggregate earnings growth and cross-sectional earnings dispersion and the measures of loan portfolio performance.

Our data requirements and sample selection criteria yield a final earnings (loan performance) sample of 177,012 (17,572) firm-year observations representing 17,440 (1,669) unique non-financial (financial) firms. For the earnings (loan performance) sample, the annual number of observations ranges from a low of 138 (47) observations in 1961 (1963) to a high of 5,100 (659) observations in 1997 (2002) with an average of 3,218 (317) observations per year.

For the estimation of the models, we use ordinary least squares and the Newey-West heteroscedasticity- and autocorrelation-consistent standard errors. We set the bandwidth of the Bartlett kernel to the integer value of $4 \times (\frac{T}{100})^{\frac{2}{9}}$, where T is the number of observations used in the time-series regressions (Newey and West 1987, 1994).

Summary statistics for the main regression variables are reported in Table 1. Panel A presents univariate statistics and Panel B presents Pearson (Spearman) correlation coefficients below (above) the diagonal. As Panel B shows, the various measures of loan portfolio performance are positively and significantly correlated. Cross-sectional earnings dispersion is positively and significantly correlated with the various measures of loan portfolio performance, and it is unrelated with the high-yield corporate bond market returns. Aggregate earnings growth is unrelated to the loan portfolio performance measures, and it is positively and significantly related to the high-yield corporate bond market returns.

TABLE 1
Descriptive Statistics

Panel A: Univariate statistics

	Mean	Std. Dev.	5th Perc.	50th Perc.	95th Perc.	Skewness	Kurtosis	N
ΔLLP	0.000	0.155	−0.253	−0.003	0.281	0.144	7.213	54
ΔNCO	0.000	0.098	−0.165	−0.001	0.147	0.685	7.795	54
ΔNPL	0.000	0.323	−0.449	0.002	0.398	0.529	5.211	21
Ret_HY	0.072	0.109	−0.051	0.076	0.242	0.308	6.142	29
ΔE	2.183	1.000	0.570	2.155	3.952	1.036	6.581	54
Disp	3.375	1.000	2.020	3.316	5.392	0.514	7.186	54

Panel B: Correlation coefficients

	ΔLLP	ΔNCO	ΔNPL	*Ret_HY*	ΔE	*Disp*
ΔLLP	1	0.920***	0.888***	−0.288	−0.252	0.521**
ΔNCO	0.845***	1	0.925***	−0.130	−0.244	0.495**
ΔNPL	0.948***	0.912***	1	−0.238	−0.292	0.374*
Ret_HY	−0.163	0.025	−0.298	1	0.622***	−0.036
ΔE	−0.101	−0.061	−0.173	0.647***	1	0.201
Disp	0.544***	0.565***	0.469**	0.232	0.321**	1

This table presents summary statistics for the main variables of the regression models. Panel A presents univariate statistics and Panel B presents Pearson (Spearman) correlation coefficients below (above) the diagonal. See Appendix A for variables' definition. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively (two-tailed test).

4. RESULTS

This section presents the results of our empirical analysis. Section 4.1. examines the relation between loan portfolio performance and cross-sectional earnings dispersion, Section 4.2. examines the relation between bond portfolio performance and cross-sectional earnings dispersion, Section 4.3. examines the conditional relation between the performance of the loan and bond portfolios and cross-sectional earnings dispersion, and Section 4.4. examines the ability of cross-sectional earnings dispersion to predict the performance of loan portfolios.

4.1. Loan Portfolio Performance and Cross-Sectional Earnings Dispersion

We begin our empirical analysis by examining the relation between loan portfolio performance, aggregate earnings growth, and cross-sectional earnings dispersion. We focus on three loan portfolio performance measures: aggregate loan loss provisions, aggregate net charge-offs, and aggregate non-performing loans. Table 2 Panel A presents the results of the regressions with aggregate loan loss provisions (ΔLLP) as the dependent variable, Panel B with aggregate net charge-offs (ΔNCO) as the dependent variable, and Panel C with aggregate non-performing loans (ΔNPL) as the dependent variable. Column 1 of Table 2 shows the results of the regressions with aggregate earnings growth (ΔE) as the independent variable, Column 2 with cross-sectional earnings dispersion ($Disp$) as the independent variable, Column 3 with both aggregate earnings growth and cross-sectional earnings dispersion as independent variables, and Column 4 with aggregate earnings growth, cross-sectional earnings dispersion, and the control variables included in the regressions.

The results of Table 2 are consistent with our predictions. First, in line with predictions 1 and 2, loan portfolio performance is worse during periods of high cross-sectional earnings dispersion and low aggregate earnings growth. The coefficient on our dispersion measure is positive and statistically significant in all regressions, suggesting that ΔLLPs, ΔNCOs, and ΔNPLs are higher when cross-sectional earnings dispersion is high. The coefficient on aggregate earnings growth is negative and statistically significant in Column 3 of Panels A and B and is statistically non-significant in all other regressions, suggesting that ΔLLPs and ΔNCOs are higher when aggregate earnings growth is low.[5]

Second, in line with prediction 3, our results suggest that ΔLLPs, ΔNCOs, and ΔNPLs are more sensitive to cross-sectional earnings dispersion than aggregate earnings growth. The explanatory power of our model rises when dispersion is included in the regressions. For example, in Table 2 Panel A the adjusted R^2 is equal to -1 percent when aggregate earnings growth is the only explanatory variable (Column 1), and it increases to 36 percent when the cross-sectional earnings dispersion is included as explanatory variable together with aggregate earnings growth in the regression (Column 3).[6]

The positive and statistically significant relation between the loan portfolio performance measures and the cross-sectional earnings dispersion persists even after controlling for $\Delta Term$, $\Delta Tbill$, $\Delta Default$, ΔVXO, and ΔGDP in the regressions (see, Table 2 Panels A, B, and C Column 4). The relation between dispersion and the loan portfolio performance measures is not only statistically but also economically significant—a one-standard deviation positive shock in dispersion corresponds to a 6.3 percent, 4.4 percent, and 7.8 percent increase in annual aggregate loan loss provisions, aggregate net charge-offs, and aggregate non-performing loans, respectively (see, Table 2 Panels A, B, and C Column 4). From the five control variables included in the regressions, ΔGDP has the highest explanatory power for loan portfolio

[5]Prior to 1987, loan loss provisions were tax deductible. The 1986 Tax Reform Act prohibited the tax deductibility of loan loss provisions and mandated that only loan charge-offs should be tax deductible. This change in tax rules eliminated managers' incentives to use loan loss provisions for tax management purposes, and thus increased the ability of loan loss provisions to capture changes in credit risk (e.g., Liu and Ryan 1995). We examine whether the relation between aggregate loan loss provisions, aggregate earnings growth, and cross-sectional earnings dispersion is different when we exclude the pre-1987 period from our analysis, and our results are similar.

[6]Figure 1 predicts a negative and convex relation between loan portfolio losses and aggregate earnings growth, and Figure 2 predicts a positive and concave relation between loan portfolio losses and cross-sectional earnings dispersion. To test the predictions of non-linear relations between loan portfolio losses, aggregate earnings growth, and cross-sectional earnings dispersion, we add squared terms for aggregate earnings growth and cross-sectional earnings dispersion in the regression model 4. The results of our untabulated analysis provide support to the prediction of a negative and convex (positive and concave) relation between loan portfolio losses and aggregate earnings growth (cross-sectional earnings dispersion).

performance, with higher ΔGDP being associated with better loan portfolio performance.

Note that the maximum number of observations in Table 2 decreases from 54 when ΔLLP and ΔNCO are the dependent variables to 21 when ΔNPL is the dependent variable due to data limitations—data on non-performing loans in Compustat Bank Fundamentals Annual is available only from 1993 onwards. Also, the maximum number of observations decreases to 28 when we control for ΔVXO in the regressions because data on VXO is only available from 1986 onwards. Our results are similar when we exclude ΔVXO from the regressions.

Our paper argues that cross-sectional earnings dispersion is associated with loan portfolio performance because it captures variation in expected and actual defaults and losses given default. Prior literature, however, suggests that there could be indirect links between dispersion and loan portfolio performance. For example, Bloom (2009) suggests that higher dispersion implies higher firm-level uncertainty, which reduces investments and lowers economic activity and could in turn be associated with lower loan portfolio performance. To test whether our documented relation between cross-sectional earnings dispersion and loan portfolio performance is attributable to dispersion's ability to capture expected and actual defaults and losses given default, we repeat our analysis for a sample of firms with zero or close to zero leverage. We expect that the relation between earnings dispersion and loan portfolio performance will be non-significant for the sample of firms with zero or close to zero leverage.

We measure firm-specific leverage as the ratio of current and non-current debt divided by total assets. We classify firms with leverage equal to or below 5% as firms with zero or close to zero leverage. Approximately 25% of the firms in our sample have leverage equal to or below 5%. The results of our untabulated analysis are in line with our expectations—the cross-sectional earnings dispersion of firms with zero or close to zero leverage is unrelated to loan portfolio performance. These results are in line with the idea that cross-sectional earnings dispersion is negatively related to loan portfolio performance because is it is directly related to actual and expected defaults and losses given default. Untabulated results are similar when we measure cross-sectional earnings dispersion over a sample of firms with zero leverage. Approximately 13% of the firms in our sample have zero leverage.

TABLE 2
Contemporaneous Loan Portfolio Performance

Panel A: Loan loss provisions				
	ΔLLP_t	ΔLLP_t	ΔLLP_t	ΔLLP_t
	(1)	(2)	(3)	(4)
ΔE_t	−0.016		−0.048**	0.018
	(0.022)		(0.022)	(0.020)
$Disp_t$		0.084**	0.100**	0.063***
		(0.033)	(0.040)	(0.022)
$\Delta Term_t$				0.033
				(0.027)
$\Delta Tbill_t$				0.018
				(0.024)
$\Delta Default_t$				0.000
				(0.074)
ΔVXO_t				0.004
				(0.004)
ΔGDP_t				−0.069***
				(0.014)
Constant	0.034	−0.285**	−0.232**	−0.315***
	(0.053)	(0.109)	(0.105)	(0.092)
N	54	54	54	28
R^2	1%	30%	38%	68%
Adj. R^2	−1%	28%	36%	56%

(*Continued*)

TABLE 2—*Continued*

Panel B: Net charge-offs				
	ΔNCO_t	ΔNCO_t	ΔNCO_t	ΔNCO_t
	(1)	(2)	(3)	(4)
ΔE_t	−0.006		−0.027*	0.014
	(0.019)		(0.013)	(0.016)
$Disp_t$		0.055**	0.064**	0.044***
		(0.025)	(0.027)	(0.015)
$\Delta Term_t$				0.026
				(0.022)
$\Delta Tbill_t$				0.028**
				(0.013)
$\Delta Default_t$				0.037
				(0.062)
ΔVXO_t				−0.001
				(0.004)
ΔGDP_t				−0.049***
				(0.011)
Constant	0.013	−0.187**	−0.158*	−0.216***
	(0.043)	(0.080)	(0.085)	(0.069)
N	54	54	54	28
R^2	0%	32%	39%	69%
Adj. R^2	−2%	31%	36%	57%

(*Continued*)

TABLE 2—*Continued*

Panel C: Non-performing loans	ΔNPL_t	ΔNPL_t	ΔNPL_t	ΔNPL_t
	(1)	(2)	(3)	(4)
ΔE_t	−0.038		−0.093	0.035
	(0.038)		(0.054)	(0.043)
$Disp_t$		0.098*	0.132*	0.078*
		(0.052)	(0.069)	(0.043)
$\Delta Term_t$				0.053
				(0.058)
$\Delta Tbill_t$				0.036
				(0.045)
$\Delta Default_t$				0.080
				(0.191)
ΔVXO_t				0.007
				(0.011)
ΔGDP_t				−0.086***
				(0.024)
Constant	0.082	−0.334	−0.252	−0.418*
	(0.150)	(0.200)	(0.184)	(0.206)
N	21	21	21	21
R^2	3%	22%	37%	70%
Adj. R^2	−2%	18%	30%	53%

This table presents the results of regressions of contemporaneous aggregate loan loss provisions, net charge-offs, and non-performing loans on aggregate earnings growth, cross-sectional earnings dispersion, and a set of control variables using annual frequency data. See Appendix A for variables' definition. We use ordinary least squares for the calculation of the regression coefficients and the Newey-West heteroscedasticity- and autocorrelation-consistent standard errors with three lags. Standard errors are in parentheses below the coefficient estimates. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively (two-tailed test).

Our results are robust to using the Commercial Bank data from the Federal Reserve Bank of Chicago instead of the Compustat Bank Fundamentals Annual data to measure the performance of the loan portfolio. The Commercial Bank dataset contains accounting data for all commercial banks that file the Report of Condition and Income (Call Report) and are regulated by the Federal Reserve System, Federal Deposit Insurance Corporation, and the Comptroller of the Currency. The advantage of the Compustat data is that it covers a longer time series compared to the Call Report data—Compustat provides sufficient data for our analysis from 1961 onwards while Call Report data is available from 1984 onwards. In addition, Compustat covers both commercial banks and savings institutions, while the Call Report data only covers commercial banks. The advantage of the Call Report over the Compustat data, however, is that the Call Report data covers all commercial banks that file a Call Report, while Compustat only covers the leading commercial banks and savings institutions. Table 3 presents the results of our analysis using the Call Report data and our conclusions remain unchanged—cross-sectional earnings dispersion is an important determinant of loan portfolio performance.

TABLE 3
Contemporaneous Loan Portfolio Performance—Call Report Data

Panel A: Loan loss provisions				
	ΔLLP_t	ΔLLP_t	ΔLLP_t	ΔLLP_t
	(1)	(2)	(3)	(4)
ΔE_t	−0.002		−0.024	0.013
	(0.017)		(0.014)	(0.017)
$Disp_t$		0.044**	0.053**	0.039***
		(0.019)	(0.022)	(0.013)
$\Delta Term_t$				0.007
				(0.025)
$\Delta Tbill_t$				0.007
				(0.016)
$\Delta Default_t$				0.022
				(0.046)
ΔVXO_t				0.000
				(0.003)
ΔGDP_t				−0.033**
				(0.012)
Constant	0.005	−0.155**	−0.133*	−0.180**
	(0.042)	(0.065)	(0.066)	(0.067)
N	30	30	30	28
R^2	0%	24%	29%	51%
Adj. R^2	−4%	21%	24%	34%

(*Continued*)

TABLE 3—*Continued*

Panel B: Net charge-offs				
	ΔNCO_t	ΔNCO_t	ΔNCO_t	ΔNCO_t
	(1)	(2)	(3)	(4)
ΔE_t	0.002		−0.011	0.009
	(0.015)		(0.010)	(0.012)
$Disp_t$		0.034**	0.038**	0.027***
		(0.015)	(0.016)	(0.009)
$\Delta Term_t$				0.016
				(0.013)
$\Delta Tbill_t$				0.010
				(0.009)
$\Delta Default_t$				0.010
				(0.035)
ΔVXO_t				−0.000
				(0.002)
ΔGDP_t				−0.025***
				(0.008)
Constant	−0.005	−0.123**	−0.110*	−0.125**
	(0.036)	(0.050)	(0.057)	(0.050)
N	28	28	28	26
R^2	0%	31%	33%	68%
Adj. R^2	−4%	28%	28%	56%

(*Continued*)

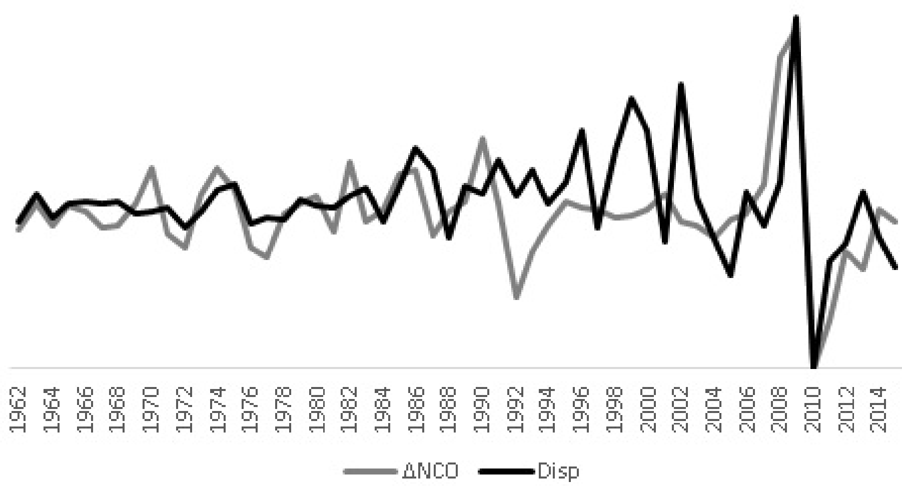
TABLE 3—*Continued*

Panel C: Non-performing loans				
	ΔNPL_t	ΔNPL_t	ΔNPL_t	ΔNPL_t
	(1)	(2)	(3)	(4)
ΔE_t	−0.034*		−0.055**	0.001
	(0.019)		(0.022)	(0.019)
$Disp_t$		0.033	0.053*	0.042**
		(0.024)	(0.030)	(0.019)
$\Delta Term_t$				0.008
				(0.024)
$\Delta Tbill_t$				0.013
				(0.014)
$\Delta Default_t$				0.116
				(0.081)
ΔVXO_t				−0.002
				(0.005)
ΔGDP_t				−0.041***
				(0.012)
Constant	0.074	−0.116	−0.063	−0.164*
	(0.062)	(0.091)	(0.086)	(0.086)
N	30	30	30	28
R^2	9%	10%	30%	66%
Adj. R^2	6%	6%	25%	54%

This table presents the results of regressions of contemporaneous aggregate loan loss provisions, net charge-offs, and non-performing loans on aggregate earnings growth, cross-sectional earnings dispersion, and a set of control variables using the Call Report annual frequency data. See Appendix A for variables' definition. We use ordinary least squares for the calculation of the regression coefficients and the Newey-West heteroscedasticity- and autocorrelation-consistent standard errors with three lags. Standard errors are in parentheses below the coefficient estimates. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively (two-tailed test).

Figure 3 plots ΔNCO and $Disp$ over time. We standardize ΔNCO and add a constant to make the two time series comparable. As Figure 3 shows, the two time series closely track each other. Figure 3 further highlights the importance of cross-sectional earnings dispersion for the performance of loan portfolios.

FIGURE 3
Dispersion and Aggregate Net Charge-Offs over Time



This figure shows *Disp* and Δ*NCO* over time. We standardize Δ*NCO* and add a constant to make the two time series comparable. See Appendix A for variables' definition.

4.2. Bond Portfolio Performance and Cross-Sectional Earnings Dispersion

While banks provide for most debt in the market, some firms borrow by publicly issuing bonds. The bond holders face similar payoff functions as banks. Thus, we examine whether corporate bond portfolios have similar sensitivities to cross-sectional earnings dispersion and aggregate earnings growth as loan portfolios. More specifically, we examine the relation between lagged high-yield corporate bond market returns and cross-sectional earnings dispersion and aggregate earnings growth. Since we employ lagged corporate bond market returns in our regressions, we examine whether *expected* cross-sectional earnings dispersion is associated with corporate bond market prices.

The results of the estimation of regression model 5 are reported in Table 4. Our findings using corporate bond market returns as dependent variable are consistent with our findings using loan portfolio performance measures. First, corporate bond market returns are negatively and significantly related to expected dispersion and positively, albeit non-significantly, related to aggregate earnings growth. Second, the two variables—aggregate earnings growth and cross-sectional earnings dispersion—explain up to 35 percent of the variation in annual corporate bond market returns. Third, the main explanatory power of the model comes from the cross-sectional earnings dispersion rather than the aggregate earnings growth—the explanatory power of aggregate earnings growth for corporate bond market returns is -3 percent (Table 4 Column 1) while the explanatory power of cross-sectional earnings dispersion for corporate bond market returns is 35 percent (Table 4 Column 2).

The relation between lagged corporate bond market returns and cross-sectional earnings dispersion persists even after including the various control variables in our regression (Table 4 Column 4). The relation between dispersion and corporate bond market returns is not only statistically but also economically significant—a one-standard deviation positive shock in dispersion corresponds to a 4.4 percent decrease in annual corporate bond market returns. The results of Table 4 further highlight the importance of cross-sectional earnings dispersion for debt cycles.[7]

[7]Figure 1 predicts a negative and convex relation between bond portfolio losses and aggregate earnings growth, and Figure 2 predicts a positive and concave relation between bond portfolio losses and cross-sectional earnings dispersion. To test the predictions of non-linear relations between bond portfolio losses, aggregate earnings growth, and cross-sectional earnings dispersion, we add squared terms for aggregate earnings growth and cross-sectional earnings dispersion in the regression model 5. The results of our untabulated analysis provide support to the prediction of a negative and convex (positive and concave) relation between bond portfolio losses and aggregate earnings growth (cross-sectional earnings dispersion).

TABLE 4
Lagged Bond Portfolio Performance

	Ret_HY_{t-1} (1)	Ret_HY_{t-1} (2)	Ret_HY_{t-1} (3)	Ret_HY_{t-1} (4)
ΔE_t	−0.007		0.015	0.001
	(0.017)		(0.009)	(0.012)
$Disp_t$		−0.049**	−0.054**	−0.044***
		(0.022)	(0.023)	(0.011)
$\Delta Term_t$				−0.016
				(0.015)
$\Delta Tbill_t$				−0.038***
				(0.010)
$\Delta Default_t$				−0.020
				(0.060)
ΔVXO_t				0.003
				(0.002)
ΔGDP_t				0.049***
				(0.014)
Constant	0.092**	0.245***	0.232***	0.255***
	(0.037)	(0.075)	(0.076)	(0.035)
N	28	28	28	28
R^2	1%	38%	40%	73%
Adj. R^2	−3%	35%	35%	63%

This table presents the results of regressions of lagged high-yield corporate bond market returns on aggregate earnings growth, cross-sectional earnings dispersion, and a set of control variables using annual frequency data. See Appendix A for variables' definition. We use ordinary least squares for the calculation of the regression coefficients and the Newey-West heteroscedasticity- and autocorrelation-consistent standard errors with three lags. Standard errors are in parentheses below the coefficient estimates. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively (two-tailed test).

Next, we examine the relation between corporate bond market returns, aggregate earnings growth, and cross-sectional earnings dispersion for bonds of various maturities and various credit ratings. Our predictions imply that the sensitivity of corporate bond market returns to earnings dispersion will increase with bond maturities and decrease with bond credit ratings. To examine our hypothesis, we sort bonds into portfolios of various maturities and various credit ratings, and estimate the regression model 5 for each bond portfolio.

Data on high-yield bond indices of various credit ratings are only available from 1996:Q4 onwards. Hence, we use quarterly instead of annual frequency data for this analysis to increase the power of our tests. We also use overlapping four-quarter returns for this analysis to account for the fact that returns could anticipate changes in dispersion more than one quarter in advance. Hence, the return for quarter t is the cumulative return from one month after the end of quarter $t-4$ to one month after the end of quarter t. ΔE is the equal-weighted average of the seasonally differenced income before extraordinary items scaled by four-quarters lagged book value of equity. *Disp* is the standard deviation of the seasonally differenced income before extraordinary items scaled by four-quarters lagged book value of equity. We use the residuals of an AR(2) model (instead of an AR(1) model) for all regression variables.

The coefficients on cross-sectional earnings dispersion in the regressions with the bond portfolios of various maturities are tabulated in Table 5. Consistent with Table 4, we find that the coefficients on cross-sectional earnings dispersion are negative and statistically significant in four out of the five regressions—the coefficient on dispersion is statistically non-significant in the regression with the shortest-maturity portfolio (Column 1). Aggregate earnings growth is also positively and significantly related to lagged corporate bond market returns in four out of the five regressions. As predicted, the sensitivity of corporate bond market returns to expected dispersion increases in absolute magnitude (i.e., the relation becomes more negative) as bond maturity increases. More specifically, the coefficient on dispersion is -0.022 for bond portfolios with maturities between 1 and 3 years and it declines to -0.097 for bond portfolios with maturities of 15+ years (see, Table 5 Columns 1 and 5). In terms of absolute values, the coefficient on cross-sectional earnings dispersion for the bond portfolio with the shortest maturity is 23 percent of the coefficient on dispersion for the bond portfolio with the longest maturity. Also note that the increase in the absolute value of the dispersion coefficients is monotonic.

TABLE 5
Lagged Bond Portfolio Performance—Various Maturities

	$Ret\_1\_3_{t-1}$	$Ret\_3\_5_{t-1}$	$Ret\_5\_10_{t-1}$	$Ret\_10\_15_{t-1}$	Ret_15+_{t-1}
	(1)	(2)	(3)	(4)	(5)
ΔE_t	0.023	0.043***	0.078***	0.078**	0.098***
	(0.015)	(0.016)	(0.026)	(0.032)	(0.036)
$Disp_t$	−0.022	−0.041***	−0.074***	−0.075**	−0.097***
	(0.014)	(0.016)	(0.025)	(0.030)	(0.034)
$\Delta Term_t$	0.007	0.004	−0.010	−0.012	−0.031
	(0.010)	(0.012)	(0.018)	(0.020)	(0.024)
$\Delta Tbill_t$	−0.028***	−0.038***	−0.054***	−0.063***	−0.064***
	(0.007)	(0.008)	(0.011)	(0.013)	(0.014)
$\Delta Default_t$	0.002	0.004	0.012	0.004	0.017
	(0.018)	(0.021)	(0.033)	(0.031)	(0.040)
ΔVXO_t	−0.000	−0.000	−0.001	−0.001	−0.002
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
ΔGDP_t	0.005***	0.006**	0.008**	0.007**	0.009**
	(0.002)	(0.002)	(0.003)	(0.004)	(0.004)
Constant	0.029	0.008	−0.032	−0.023	−0.050
	(0.023)	(0.025)	(0.039)	(0.046)	(0.054)
N	118	118	118	118	118
R^2	29%	35%	34%	30%	30%
Adj. R^2	24%	31%	30%	26%	25%

This table presents the results of regressions of lagged corporate bond market returns for indices of various maturities on aggregate earnings growth, cross-sectional earnings dispersion, and a set of control variables using quarterly frequency data. See Appendix A for variables' definition. We use ordinary least squares for the calculation of the regression coefficients and the Newey-West heteroscedasticity- and autocorrelation-consistent standard errors with four lags. Standard errors are in parentheses below the coefficient estimates. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively (two-tailed test).

Similar to the analysis for bond portfolios with different maturities, our predictions imply that the sensitivity of corporate bond market returns to cross-sectional earnings dispersion will increase as credit ratings decrease. The coefficients on cross-sectional earnings dispersion in the regressions with the bond portfolios of various credit ratings are tabulated in Table 6.

As predicted, the sensitivity of corporate bond market returns to expected cross-sectional earnings dispersion increases in absolute magnitude (i.e., the relation becomes more negative) as credit ratings decrease. More specifically, the coefficient on dispersion is −0.042 and is statistically significant at the 1 percent level for the bond portfolio that includes bonds with credit ratings between AAA and AA and it declines to −0.318 and is statistically significant at the 1 percent level for the bond portfolio that includes bonds with credit ratings of CCC− (see, Table 6 Columns 1 and 5). In terms of absolute values, the coefficient on dispersion for the bond portfolio with the highest credit ratings is 13 percent of the coefficient on dispersion for the bond portfolio with the lowest ratings. Also note that the increase in the absolute magnitude of the dispersion coefficients is monotonic, similar to the case for bond indices with different maturities. The number of observations in Table 6 varies from 73 to 118 depending on data availability for the various indices. In sum, our findings suggest that prices of lower-rated and longer-maturity bond portfolios are more sensitive to shocks in dispersion compared to prices of higher-rated and shorter-maturity bond portfolios, respectively.

TABLE 6
Lagged Bond Portfolio Performance—Various Credit Ratings

	$Ret\_AAA\_AA_{t-1}$	$Ret\_A\_BBB_{t-1}$	Ret_BB_{t-1}	Ret_B_{t-1}	Ret_CCC-_{t-1}
	(1)	(2)	(3)	(4)	(5)
ΔE_t	0.045***	0.083***	0.121***	0.146***	0.322***
	(0.015)	(0.028)	(0.045)	(0.034)	(0.077)
$Disp_t$	−0.042***	−0.080***	−0.118***	−0.145***	−0.318***
	(0.014)	(0.027)	(0.043)	(0.032)	(0.073)
$\Delta Term_t$	−0.010	−0.010	0.020	−0.006	0.000
	(0.017)	(0.019)	(0.034)	(0.031)	(0.063)
$\Delta Tbill_t$	−0.057***	−0.054***	0.008	0.026	0.052
	(0.009)	(0.011)	(0.038)	(0.035)	(0.071)
$\Delta Default_t$	0.013	0.012	0.020	0.036	0.078
	(0.031)	(0.034)	(0.038)	(0.045)	(0.066)
ΔVXO_t	−0.001	−0.001	0.001	0.002	0.003
	(0.001)	(0.001)	(0.001)	(0.001)	(0.003)
ΔGDP_t	0.007**	0.008**	0.004	0.005	0.005
	(0.003)	(0.004)	(0.004)	(0.005)	(0.006)
Constant	0.011	−0.040	−0.103	−0.151***	−0.391***
	(0.026)	(0.042)	(0.063)	(0.048)	(0.100)
N	118	118	73	73	73
R^2	28%	35%	43%	48%	48%
Adj. R^2	24%	30%	37%	43%	42%

This table presents the results of regressions of lagged corporate bond market returns for indices of various credit ratings on aggregate earnings growth, cross-sectional earnings dispersion, and a set of control variables using quarterly frequency data. See Appendix A for variables' definition. We use ordinary least squares for the calculation of the regression coefficients and the Newey-West heteroscedasticity- and autocorrelation-consistent standard errors with four lags. Standard errors are in parentheses below the coefficient estimates. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively (two-tailed test).

Figure 4 summarizes the results of Tables 5 and 6. The figure plots the coefficients on dispersion for bond portfolios of various maturities (Panel A) and various credit ratings (Panel B). The figure shows that the coefficients on dispersion decline (i.e., increase in absolute value) as the corporate bond maturities increase and the corporate bond credit ratings decrease.

The results of Tables 4, 5, and 6 are in line with theoretical literature that links uncertainty —measured as the cross-sectional dispersion in economic variables—to corporate bond credit spreads through the presence of market frictions (e.g., Gilchrist et al. 2014; Arellano et al. 2016; Christiano et al. 2014). A number of empirical papers also link uncertainty and dispersion to credit spreads. More specifically, Bekaert and Hoerova (2016) show that credit spreads contain information about uncertainty at the aggregate level. Campbell and Taksler (2003) find that corporate bond credit spreads are positively associated with idiosyncratic volatility at the firm level, and Guntay and Hackbarth (2010) show that corporate bond credit spreads are positively associated with earnings forecast dispersion at the firm level. Assuming that earnings dispersion captures changes in economic conditions (Bloom 2009), our results are also in line with literature that shows that credit spreads have predictive power for the economy (e.g., Gertler and Lown 1999; Gilchrist et al. 2009; Gilchrist and Zakrajsek 2012; Faust et al. 2013).[8]

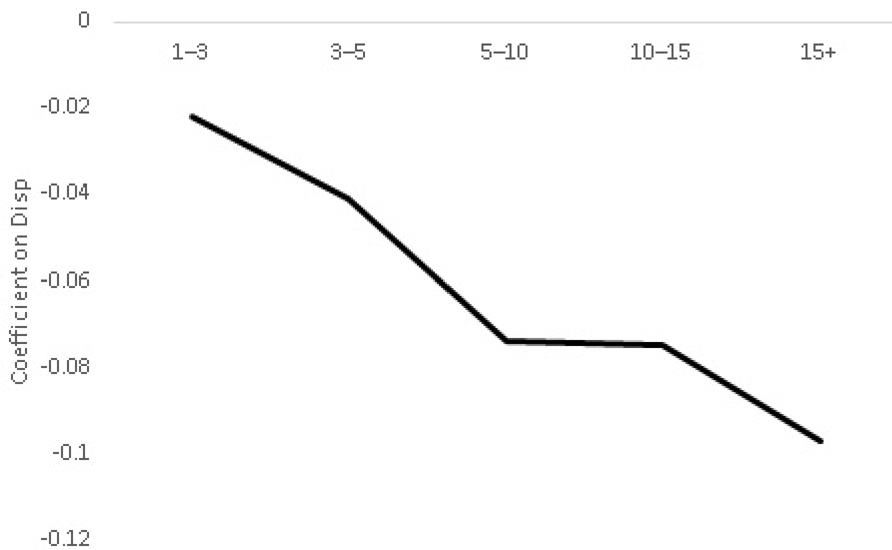
4.3. Conditional Relation between Loan and Bond Portfolio Performance and Cross-Sectional Earnings Dispersion

Figures 1 and 2 suggest that when the good and bad states of the economy are characterized by a combination of the mean asset values and dispersion in asset values, the combined effect

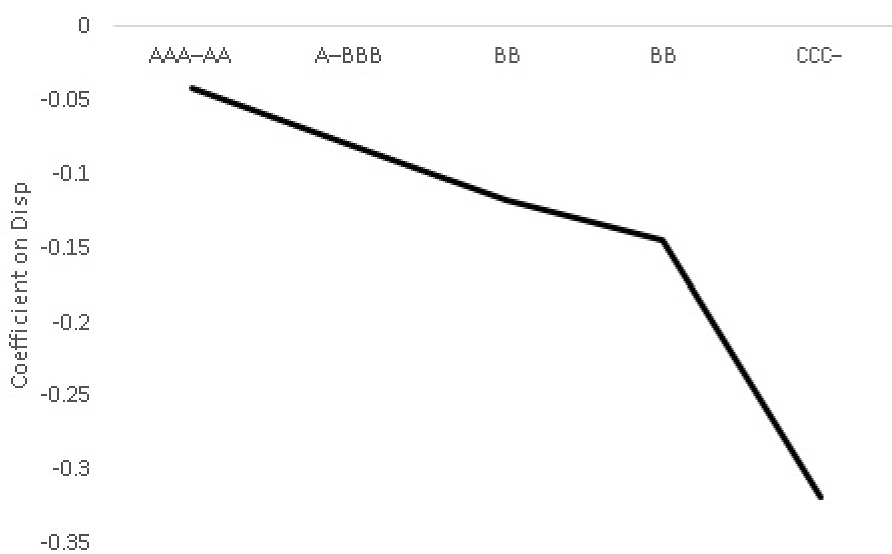
[8] Our paper and the papers cited in this paragraph are related to but distinct from Merton (1974). Merton (1974) expresses corporate debt prices as a function of volatility of firm value. We use cross-sectional dispersion in firm values to explain debt cycles.

FIGURE 4
Dispersion and Corporate Bond Indices of Various Maturities and Credit Ratings

Panel A: Corporate bond indices of various maturities



Panel B: Corporate bond indices of various credit ratings



This figure shows the coefficients on *Disp* for regressions with corporate bond indices of various maturities (Panel A) and various credit ratings (Panel B) as dependent variables. The regression coefficients on *Disp* are taken from Tables 5 and 6. See Appendix A for variables' definition.

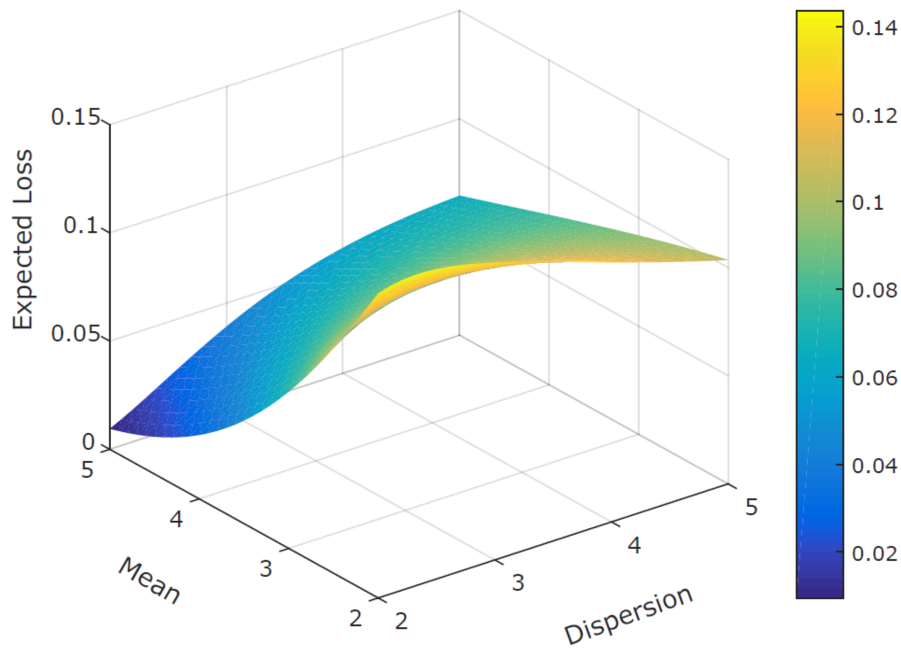
of the two should lead to a non-linear relation between the state of the economy and loan and bond portfolio performance. Figure 5 provides the expected loss when μ is varied over the range $\mu = 5$ to $\mu = 2$ with the higher mean asset values characterizing a good economy; and σ is varied over the range $\sigma = 2$ to $\sigma = 5$ with the lower dispersion characterizing a good economy. In effect, the good state of the economy is near the origin, and the bad state of the economy is farthest away from the origin. Figure 6 provides a two-dimensional rendition of the hyperplane, where we let μ and σ vary over the same range such that when μ changes by an amount δ, σ increases by the same amount δ. We plot these values to show the combined effect of mean asset values and dispersion in asset values in a simpler fashion.

Figures 5 and 6 show that the mean and the dispersion effects combine to make the expected loss highly sensitive moving from the good state to the mediocre state of the economy. However, the expected loss is less sensitive when moving from the mediocre state to the bad state of the economy. In effect, when the economy moves from a good to a mediocre state the effects of lower mean asset value and higher dispersion combine to substantially increase the expected loss. Intuitively, conditional on starting from a good economy characterized by high mean asset values and low dispersion, when the economy moves to a medium mean asset value and medium dispersion, more assets are likely to fall below the threshold value primarily because of the dispersion effect, but also because of both effects (see, Figures 1 and 2).

However, starting from a mediocre state characterized by medium mean asset values and medium dispersion, when we move to a bad state characterized by low mean asset values and high dispersion, the dispersion effect is muted and it is the mean effect that is dominant. Intuitively, starting from mediocre dispersion, the additional assets that are likely to fall below the threshold value are fewer when dispersion increases—in effect most bad assets have already been written-off. As such, it is the mean effect that plays a dominant role. The expected loss is less sensitive to the mean asset value than it is to the dispersion (see, P3); and as such the combined effect is muted when moving from a mediocre state to a bad state of the economy.

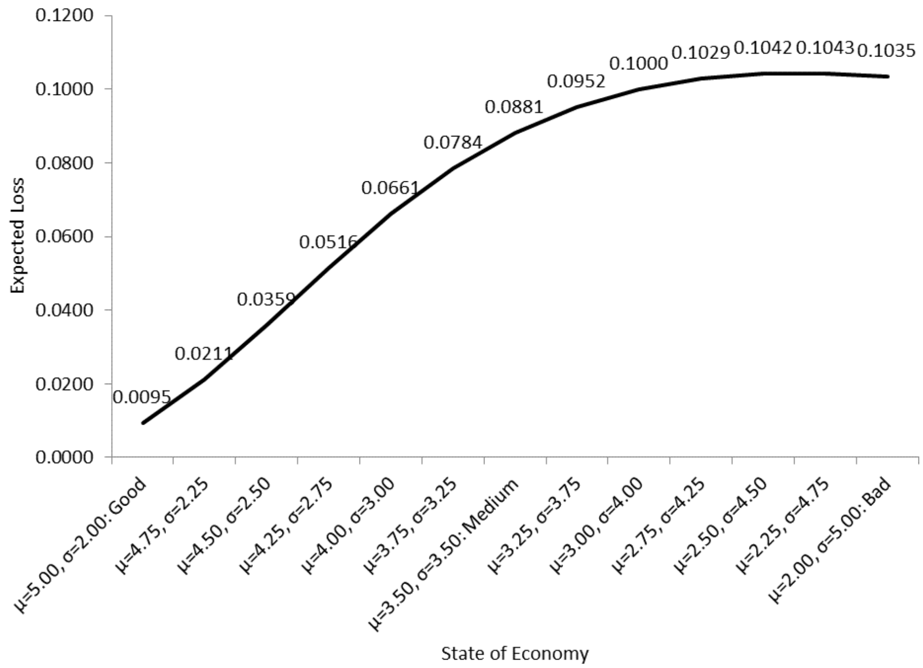
Overall, these effects combined suggest that the expected loss increases substantially when comparing the economic peaks and troughs, but within the troughs the changes in the expected loss are not likely to be very sensitive to changes in mean asset values and dispersion.

FIGURE 5
Expected Loss and State of the Economy—Three Dimensional Graph



This figure shows the expected loss for various states of the economy in a three-dimensional graph. Higher (lower) mean asset values and lower (higher) dispersion of asset values represent good (bad) states of the economy.

FIGURE 6
Expected Loss and State of the Economy—Two Dimensional Graph



This figure shows the expected loss for various states of the economy in a two-dimensional graph. Higher (lower) mean asset values and lower (higher) dispersion of asset values represent good (bad) states of the economy.

Figures 5 and 6 above imply that the relation between the loan or bond portfolio performance and the cross-sectional earnings dispersion is non-linear and it depends on the state of the economy. To examine the non-linear or conditional relation between loan and bond portfolio performance and cross-sectional earnings dispersion, we run the following regressions:[9]

$$\Delta LLP_t / \Delta NCO_t / \Delta NPL_t = \alpha_3 + \beta_3 \cdot \Delta E_t + \gamma_3 \cdot Disp_t + \delta_3 \cdot \Delta E_t \cdot Disp_t + \varepsilon_t \qquad (6)$$

$$Ret\_HY_{t-1} = \alpha_4 + \beta_4 \cdot \Delta E_t + \gamma_4 \cdot Disp_t + \delta_4 \cdot \Delta E_t \cdot Disp_t + \varepsilon_{t-1} \qquad (7)$$

We then plot the predicted values for ΔLLP, ΔNCO, ΔNPL, and *Ret_HY* using the coefficient estimates from the regression models 6 and 7, respectively, for various hypothetical

[9]Untabulated results are similar to the tabulated findings when we include the control variables of models 4 and 5 in the regression models 6 and 7. The only exception is the results of the regressions for aggregate non-performing loans that are non-significant, presumably due to the low number of available observations.

states of the economy. Good (bad) states of the economy are states with high (low) ΔE and low (high) $Disp$. The various states of the economy are constructed using hypothetical combinations of +/−3 standard deviations around the mean for ΔE and $Disp$.

Figure 7 plots the predicted values for ΔLLP_t (Panel A), ΔNCO_t (Panel B), ΔNPL_t (Panel C), and Ret_HY_{t-1} (Panel D) for hypothetical states of the economy. The y-axis is the predicted values and the x-axis is the state of the economy. The predicted values plotted in Figure 7, Panels A–D show a non-linear relation between loan and bond portfolio performance and the state of the economy, consistent with Figures 5 and 6. During periods of high (low) aggregate earnings growth and low (high) cross-sectional earnings dispersion, the performance of loan and bond portfolios is high (low). But the loan and bond portfolio performance is decreasing at a decreasing rate as we move from the good to the bad states of the economy. The intuition for this non-linear relation is that as we move from the mediocre to the bad states of the economy, most assets have already been written off, and the impact of the incremental deterioration in economic conditions is lower than when moving from the good to the mediocre states of the economy.

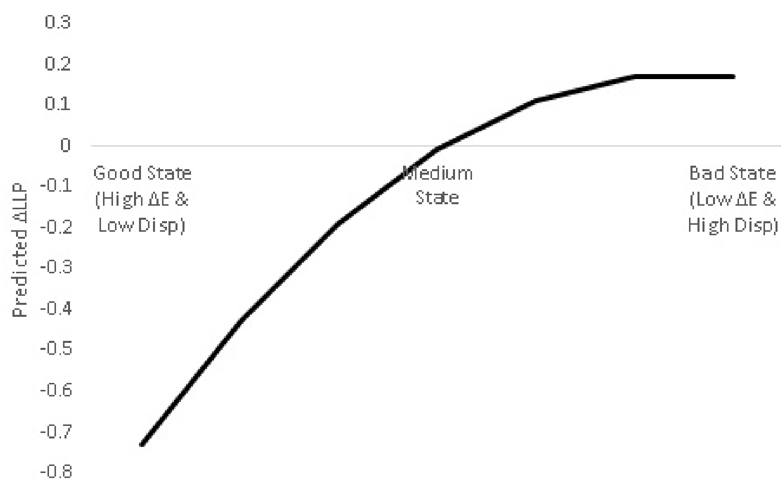
4.4. Forward Loan Portfolio Performance and Cross-Sectional Earnings Dispersion

We also examine whether cross-sectional earnings dispersion can predict the future loan portfolio performance. Cross-sectional earnings dispersion can have predictive power for loan portfolio performance because there can be a delay between the time a borrower becomes unable to pay her debt obligations and the time the loss on the loan portfolio is recognized. To examine whether cross-sectional earnings dispersion has predictive power for loan portfolio performance, we use quarterly instead of annual frequency data because the lower frequency data can mask the predictive power of dispersion for loan portfolio performance.

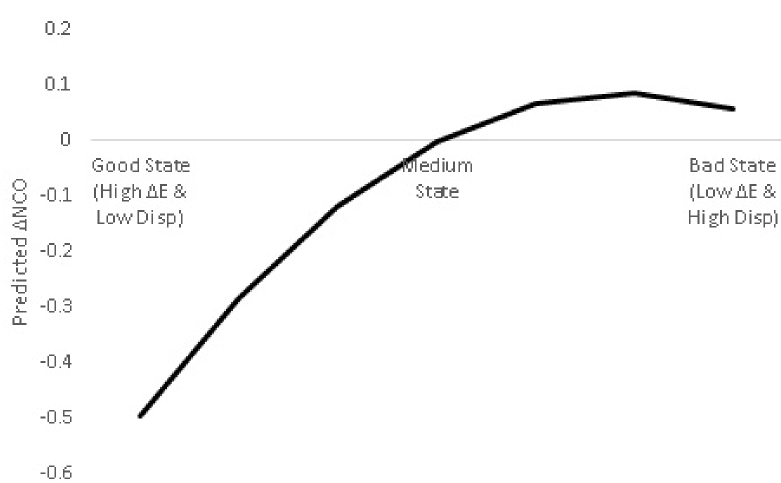
In the quarterly regressions, ΔLLP, ΔNCO, and ΔNPL is the equal weighted average of the seasonally differenced loan loss provisions, net charge-offs, and non-performing loans,

FIGURE 7
Predicted Loan and Bond Portfolio Performance and State of the Economy

Panel A: Predicted contemporaneous aggregate loan loss provisions



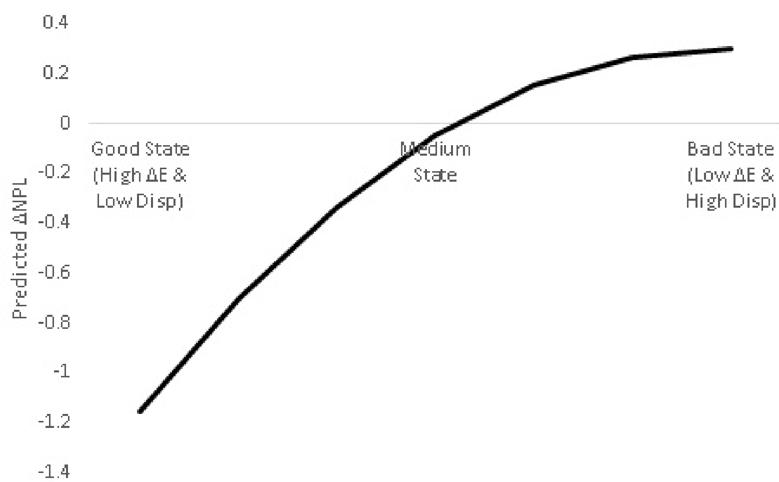
Panel B:Predicted contemporaneous aggregate net charge-offs



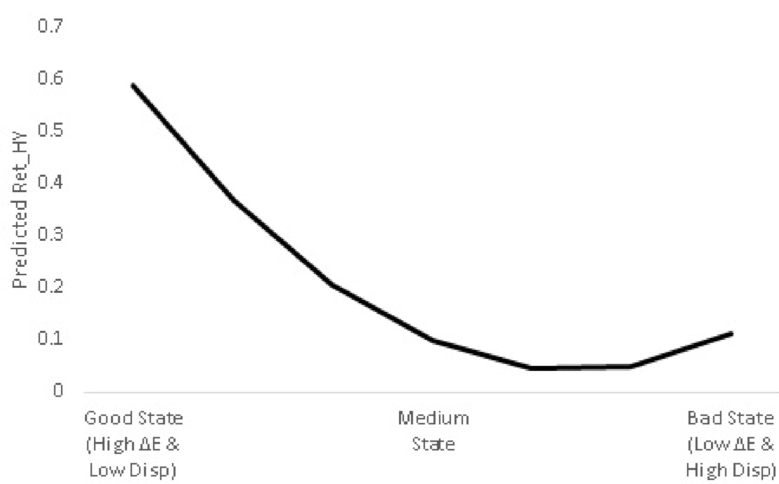
(*Continued*)

FIGURE 7—*Continued*

Panel C: Predicted contemporaneous aggregate non-performing loans



Panel D: Predicted lagged corporate bond market returns



This figure shows the predicted values for ΔNPL_t (Panel A), ΔNCO_t (Panel B), ΔNPL_t (Panel C), and Ret_HY_{t-1} (Panel D) for various states of the economy using the coefficient estimates from models 6 and 7. The states of the economy are constructed using hypothetical combinations of +/$-$3 standard deviations around the mean for ΔE and $Disp$ during the sample period. Good (bad) states of the economy are states with high (low) ΔE and low (high) $Disp$. We use annual frequency data for the regressions. See Appendix A for variables' definition.

respectively, scaled by four-quarters lagged total assets. We use the residuals of an AR(2) model for all the regression variables. Hence, we run the regression model 4 using one-, two-, three-, and four-quarters ahead ΔLLP, ΔNCO, and ΔNPL as the dependent variables. Table 7 shows that, in line with our expectations, cross-sectional earnings dispersion has predictive power for the performance of loan portfolios for one and two quarters ahead. The results of Table 7 highlight the importance of cross-sectional dispersion for loan portfolio performance.

TABLE 7
Forward Loan Portfolio Performance—Quarterly Data

Panel A: Loan loss provisions

	ΔLLP_{t+1} (1)	ΔLLP_{t+2} (2)	ΔLLP_{t+3} (3)	ΔLLP_{t+4} (4)
ΔE_t	−0.028**	−0.031***	−0.011	−0.008
	(0.012)	(0.008)	(0.009)	(0.008)
$Disp_t$	0.028**	0.027***	0.011	0.007
	(0.012)	(0.008)	(0.009)	(0.008)
$\Delta Term_t$	0.005	−0.016	−0.012	−0.004
	(0.014)	(0.013)	(0.017)	(0.013)
$\Delta Tbill_t$	0.001	−0.002	−0.013	0.007
	(0.013)	(0.007)	(0.018)	(0.011)
$\Delta Default_t$	−0.025	0.033	0.038***	0.008
	(0.019)	(0.021)	(0.012)	(0.019)
ΔVXO_t	0.001	−0.002	0.001*	0.001*
	(0.001)	(0.002)	(0.001)	(0.000)
ΔGDP_t	0.001	−0.004	0.003	−0.000
	(0.002)	(0.003)	(0.002)	(0.002)
Constant	0.039**	0.043***	0.013	0.010
	(0.017)	(0.014)	(0.014)	(0.015)
N	120	119	118	117
R^2	7%	16%	14%	4%
Adj. R^2	1%	11%	9%	−2%

(*Continued*)

TABLE 7—*Continued*

Panel B: Net charge-offs	ΔNCO_{t+1} (1)	ΔNCO_{t+2} (2)	ΔNCO_{t+3} (3)	ΔNCO_{t+4} (4)
ΔE_t	−0.024***	−0.019***	−0.005	−0.012**
	(0.008)	(0.005)	(0.005)	(0.006)
$Disp_t$	0.024***	0.018***	0.006	0.010*
	(0.007)	(0.005)	(0.005)	(0.005)
$\Delta Term_t$	0.007	0.006	0.005	0.003
	(0.007)	(0.007)	(0.005)	(0.006)
$\Delta Tbill_t$	0.002	0.002	0.005	0.013***
	(0.005)	(0.006)	(0.005)	(0.004)
$\Delta Default_t$	−0.021	0.001	0.020*	0.027**
	(0.013)	(0.008)	(0.011)	(0.012)
ΔVXO_t	0.000	0.000	0.001**	0.000
	(0.000)	(0.000)	(0.000)	(0.000)
ΔGDP_t	−0.000	−0.001	−0.000	−0.002
	(0.001)	(0.001)	(0.001)	(0.001)
Constant	0.033***	0.027***	0.007	0.017*
	(0.011)	(0.008)	(0.007)	(0.009)
N	120	119	118	117
R^2	19%	17%	18%	23%
Adj. R^2	14%	12%	13%	18%

(*Continued*)

TABLE 7—*Continued*

Panel C: Non-performing loans

	ΔNPL_{t+1} (1)	ΔNPL_{t+2} (2)	ΔNPL_{t+3} (3)	ΔNPL_{t+4} (4)
ΔE_t	−0.087***	−0.080**	−0.034	−0.027
	(0.025)	(0.035)	(0.028)	(0.033)
$Disp_t$	0.085***	0.076**	0.033	0.029
	(0.025)	(0.033)	(0.026)	(0.030)
$\Delta Term_t$	0.069**	0.036	0.026	0.017
	(0.033)	(0.031)	(0.033)	(0.036)
$\Delta Tbill_t$	0.031	0.020	0.021	0.025
	(0.025)	(0.024)	(0.023)	(0.026)
$\Delta Default_t$	0.046*	0.067**	0.096*	0.027
	(0.026)	(0.028)	(0.056)	(0.056)
ΔVXO_t	0.003**	0.003*	0.002	0.003
	(0.001)	(0.002)	(0.002)	(0.002)
ΔGDP_t	0.000	0.001	0.003	0.008
	(0.003)	(0.003)	(0.005)	(0.006)
Constant	0.130***	0.121**	0.053	0.043
	(0.037)	(0.049)	(0.042)	(0.049)
N	91	91	91	91
R^2	34%	35%	16%	9%
Adj. R^2	28%	29%	9%	1%

This table presents the results of regressions of forward aggregate loan loss provisions, net charge-offs, and non-performing loans on aggregate earnings growth, cross-sectional earnings dispersion, and a set of control variables using quarterly frequency data. See Appendix A for variables' definition. We use ordinary least squares for the calculation of the regression coefficients and the Newey-West heteroscedasticity- and autocorrelation-consistent standard errors with four lags. Standard errors are in parentheses below the coefficient estimates. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively (two-tailed test).

5. ADDITIONAL UNTABULATED ROBUSTNESS TESTS

Our conclusions are robust to the following additional untabulated robustness tests. First, our results are similar when we use the natural logarithm of firm-specific earnings changes instead of the raw numbers in the estimation of aggregate earnings growth and cross-sectional earnings dispersion. Second, our results remain unchanged when we control for recessionary periods in our regressions. Recessionary periods are measured using the NBER recession indicator from the Federal Reserve Bank of St. Louis. Third, our results are robust to using lagged changes in credit default swap (CDS) spreads instead of lagged corporate bond market returns as a dependent variable in the regressions. CDS spreads are the spreads of the Markit North America Investment Grade 5-year CDS index downloaded from Bloomberg. We use quarterly-frequency data for this analysis because the CDS data is only available from 2004:Q3 onwards.

6. CONCLUSION

This study predicts that losses on a portfolio of loans or bonds depend not only on the mean performance of borrowers but also on the cross-sectional dispersion in borrowers' performance. Dispersion is particularly important for debt markets because of the asymmetric payoff function of debt investors—debt investors are more sensitive to negative shocks than positive shocks. Thus, the portion of the firms that are poorly performing impacts debt investors more than the portion of the firms that are well performing. Since the portion of the firms that are poorly performing increases with dispersion, debt markets are highly sensitive to dispersion. Empirical analysis shows that dispersion explains a significant portion of the variation in aggregate loan and bond portfolios, and is even more important than aggregate performance in understanding variations in debt portfolios. Overall, our empirical findings confirm our predictions that debt market cycles should be defined as a function of both the mean borrowers' performance and the cross-sectional dispersion in borrowers' performance.

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APPENDIX A
Variables' Definition

Variable	Definition
ΔLLP	In the annual regressions, ΔLLP is the equal-weighted average of the annual change in bank-specific loan loss provisions scaled by one-year lagged total assets. In the quarterly regressions, ΔLLP is the equal-weighted average of the seasonally-differenced bank-specific loan loss provisions scaled by four-quarters lagged total assets. We use the residuals of an AR(1) (AR(2)) model in the annual (quarterly) regressions.
ΔNCO	In the annual regressions, ΔNCO is the equal-weighted average of the annual change in bank-specific net charge-offs scaled by one-year lagged total assets. In the quarterly regressions, ΔNCO is the equal-weighted average of the seasonally-differenced bank-specific net charge-offs scaled by four-quarters lagged total assets. We use the residuals of an AR(1) (AR(2)) model in the annual (quarterly) regressions.
ΔNPL	In the annual regressions, ΔNPL is the equal-weighted average of the annual change in bank-specific non-performing loans scaled by one-year lagged total assets. In the quarterly regressions, ΔNPL is the equal-weighted average of the seasonally-differenced bank-specific non-performing loans scaled by four-quarters lagged total assets. We use the residuals of an AR(1) (AR(2)) model in the annual (quarterly) regressions.
Ret_HY	Ret_HY is the annual total return of the value-weighted high-yield Bank of America Merrill Lynch U.S. Corporate Bond index. The annual return for year t is the cumulative return from April of year t through March of year $t+1$. Total return is the sum of the price return, the accrued interest return, and the coupon return.
ΔE	In the annual regressions, ΔE is the equal-weighted average of the annual change in firm-specific income before extraordinary items scaled by one-year lagged book value of equity. In the quarterly regressions, ΔE is the equal-weighted average of the seasonally-differenced firm-specific income before extraordinary items scaled by four-quarters lagged book value of equity. We use the residuals of an AR(1) (AR(2)) model in the annual (quarterly) regressions. ΔE is normalized and we add a constant to make the variable positive.

(*Continued*)

APPENDIX A —*Continued*

Disp	In the annual regressions, *Disp* is the standard deviation of the annual change in firm-specific income before extraordinary items scaled by one-year lagged book value of equity. In the quarterly regressions, *Disp* is the standard deviation of the seasonally-differenced firm-specific income before extraordinary items scaled by four-quarters lagged book value of equity. We use the residuals of an AR(1) (AR(2)) model with a time trend in the annual (quarterly) regressions. *Disp* is normalized and we add a constant to make the variable positive.
Δ*Term*	In the annual (quarterly) regressions, $\Delta Term$ is the annual (quarterly) change in the term spread. Term spread is the yield spread between the ten-year constant-maturity Treasury bonds and the one-year constant-maturity Treasury bills. We use the residuals of an AR(1) (AR(2)) model for the annual (quarterly) regressions.
Δ*Tbill*	In the annual (quarterly) regressions, $\Delta Tbill$ is the annual (quarterly) change in the one-year constant-maturity Treasury-bill rate. We use the residuals of an AR(1) (AR(2)) model for the annual (quarterly) regressions.
Δ*Default*	In the annual (quarterly) regressions, $\Delta Default$ is the annual (quarterly) change in the default spread. Default spread is the yield spread between the Moody's BAA- and the AAA-rated corporate bonds. We use the residuals of an AR(1) (AR(2)) model for the annual (quarterly) regressions.
Δ*VXO*	In the annual (quarterly) regressions, ΔVXO is the annual (quarterly) change in the one-month S&P100 implied volatility index. We use the residuals of an AR(1) (AR(2)) model for the annual (quarterly) regressions.
Δ*GDP*	In the annual (quarterly) regressions, ΔGDP is the annual (quarterly) growth in nominal Gross Domestic Product (GDP). We use the residuals of an AR(1) (AR(2)) model for the annual (quarterly) regressions.
Ret_1_3 / 3_5 / 5_10 / 10_15 / 15+	*Ret*_1_3/3_5/5_10/10_15/15+ is the overlapping four-quarter total return of the value-weighted Bank of America Merrill Lynch U.S. Corporate Bond index that includes corporate bonds with remaining maturities 1–3, 3–5, 5–10, 10–15, and 15+ years, respectively. The overlapping four-quarter return for quarter t is the cumulative return from one month after the end of quarter $t-4$ to one month after the end of quarter t. Total return is the sum of the price return, the accrued interest return, and the coupon return.

(*Continued*)

APPENDIX A —*Continued*

Ret_AAA_AA/ A_BBB / BB / B / CCC−	*Ret_AAA_AA/A_BBB/BB/B/CCC−* is the overlapping four-quarter total return of the value-weighted Bank of America Merrill Lynch U.S. Corporate Bond index that includes corporate bonds with ratings AAA–AA, A–BBB, BB, B, and CCC and lower, respectively. The overlapping four-quarter return for quarter t is the cumulative return from one month after the end of quarter $t-4$ to one month after the end of quarter t. Total return is the sum of the price return, the accrued interest return, and the coupon return.

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