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Accounting-based downside risk, cost of capital, and the macroeconomy

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Abstract We hypothesize that earnings downside risk, capturing the expectation for future downward operating performance, contains distinct information about firm risk and varies with cost of capital in the cross section of firms. Consistent with the validity of the earnings downside risk measure, we find that, relative to low earnings downside risk firms, high earnings downside risk firms experience more negative operating performance over the subsequent period, are more sensitive to downward macroeconomic states, and are more strongly linked to earnings attributes and other risk-related measures from prior research. In line with our prediction, we also find that earnings downside risk explains variation in firms' cost of capital, and that this link between earnings downside risk and cost of capital is incremental to several earnings attributes, accounting and risk factor betas, return downside risk, default risk, earnings volatility, and firm fundamentals. Overall, this study contributes to accounting research by demonstrating the key valuation and risk assessment roles of earnings downside risk derived from firms' financial statements, also shedding new light on the link between accounting and the macroeconomy.

Keywords Accounting performance · Earnings downside risk · Cost of capital · Financial statement analysis · Macroeconomy

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1 Introduction

This study examines the implications of earnings downside risk for firms' risk assessment and for valuation through the link to cost of capital. Over decades, the ability of financial statements to reflect underlying risk has been a topic of major interest to researchers and of importance for the accounting profession. It is widely accepted that earnings volatility (i.e., variance or standard deviation) plays a key role in risk assessment (e.g., Beaver et al. 1970; Beaver 1997). Risk, however, mainly manifests through downside rather than upside states (e.g., Bawa 1975), and so far little is known about the *downside* risk of earnings. A better understanding of such downside risk of earnings can enhance analysis and decision-making by investors and other users of financial statements. In particular, examining the implications of earnings downside risk for stock valuation through variation in cost of capital can improve the understanding of how firms' fundamentals relate to investment decisions. For example, Lipe (1998) shows that investors prefer accounting-based risk measures in their risk judgment, indicating the importance of accounting information in evaluating firms. Beaver et al. (1970) likewise suggest that it is likely that accounting measures "are, in fact, used by investors as surrogates for risk."

Earnings volatility and other existing accounting-based risk measures consist of both downside and upside variabilities with equal weights, and hence they reflect risk that is profoundly different from that manifested in the downside states. Given that risk is mainly driven by downside states, downside earnings volatility can also be valued differently from the upside. Furthermore, Dechow (1994) and Dechow et al. (1998) show that earnings are asymmetrically distributed, rendering it compelling to specifically examine the downside risk associated with earnings.[1] Relatedly, Kahneman and Tversky's (1979) prospect theory suggests that economic agents are more sensitive to downward outcomes (losses) than upward outcomes (gains), and Biddle et al. (2015) find that the downside nature of accounting conservatism plays a risk management role for cash flows. In an experimental setting, Koonce et al. (2005) confirm that investors emphasize negative more than positive expectations in their risk assessment using accounting information.[2]

We operationalize earnings downside risk (EDR, hereafter) by constructing a metric that focuses on the below-expectation variability in earnings. We employ the mathematical foundation associating risk with downward outcomes using the root lower partial moment framework following Stone (1973) and Fishburn (1977). To

[1] The asymmetry in the earnings distribution cannot be attributed to accounting conservatism. Conservatism may enhance the left skewness of earnings distribution but not that of cash flows distribution. The fact that cash flows are also asymmetrically distributed suggests that there are fundamental factors other than conservatism that affect the asymmetry in the earnings distribution.

[2] Roy (1952) and Gul (1991) also hold similar views. In particular, Roy (1952) suggests that individuals care more about downside than upside uncertainties, and Gul (1991) demonstrates that disappointment-averse agents place greater weights on unexpected negative outcomes in their utility functions.

calculate EDR, we estimate an earnings expectation model and use a probability-weighted function of below-expectation relative to above-expectation residuals (i.e., earnings surprises). We focus on unexpected downward earnings patterns to capture the notion that decision-makers associate risk with a failure to attain expected (or target) outcomes (Fishburn 1977). In essence, EDR captures the expectation for downward patterns in future operating performance. This metric differs from standard moment estimations such as earnings volatility which equally weights upside and downside states or semi-variance (i.e., below-mean variability) which uses the sample mean rather than expected earnings as a fixed reference level (for more information also see, e.g., Markowitz 1952, 1959; Tobin 1958; Fama 1965a; Samuelson 1967; Stone 1973; Fishburn 1977; Laughhunn et al. 1980; Nawrocki and Staples 1989; Unser 2000; Biddle et al. 2015).

We posit that EDR captures distinct risk information that varies with firms' cost of capital. Mathematically, the framework underlying EDR focuses on one side of the distribution of firms' fundamentals and employs the general mean-risk stochastic dominance model that captures risk (e.g., Fishburn 1977). Economically, because EDR indicates the expectation for future downward operating performance, we conjecture that high EDR firms are likely to be more sensitive to downward macroeconomic states. This stems from the fact that firms in aggregation comprise corporate profits, measured by the US Bureau of Economic Analysis (BEA) as an aggregate measure of firms' profitability. Because corporate profits are a component of gross domestic product (GDP) and are likely to be correlated with other GDP components (e.g., Fischer and Merton 1984; BEA 2004; Konchitchki and Patatoukas 2014a), a firm's expected earnings downward pattern captured by EDR is linked to an expected downward macroeconomic trend through its role in corporate profits, a driver of economic activity. Indeed, we find empirical supporting evidence that establishes a link between EDR and sensitivities to downward states of real GDP growth. Constructed from fundamental accounting data, a firm's downward patterns in earnings reflected by EDR can therefore relate to aggregate downside macroeconomic states. Such a connection introduces the notion of risk into the firm-specific EDR measure, which translates to cost of capital implications. Accordingly, we conjecture that EDR can explain cross-sectional variation in cost of capital, which will be higher for high EDR firms relative to low EDR firms.[3]

A natural question is how our accounting-based EDR measure relates to the stock-based measures of return downside risk from prior research (e.g., Chen et al. 2001; Kim et al. 2011). While both EDR and return downside risk examine downside scenarios, the two constructs differ in key ways. Indeed, EDR is not supposed to mimic return downside risk, and it can provide dimensions of fundamental risk not captured by the return-based measures. First, our EDR

[3] The link between EDR and cost of capital also relates to the notion of information acquisition. When high expectations exist about a value-relevant signal, such as an earnings downward pattern, investors are likely to engage in information acquisition to better understand it. This results in high investor marginal cost under the common assumption of increasing marginal cost to information acquisition. Accordingly, that cost can vary in the cross section such that it is positively associated with EDR, and investors who obtain the costly information need to be compensated by higher expected returns. This is the essence of Grossman and Stiglitz (1980).

measure focuses on more general downside patterns of firms' fundamental operations using accounting information and thus differs from return downside risk measures that often focus on extreme downward situations using stock price crashes or extreme left-tail returns.[4] Second, earnings (underlying EDR) and stock returns (underlying return downside risk) reflect different information in terms of persistence, predictability, and noise, driving differences between the EDR and return downside risk measures. Specifically, earnings are persistent (with an AR(1) coefficient of 0.84; see, for example, Sloan 1996), while stock returns are not (e.g., Fama 1965b). Building on the work of Bansal and Yaron (2004), who suggest long-run risk and equity premia for persistence in firm fundamentals' growth, we argue that our earnings-based measure can reflect a different dimension of risk compared with returns-based measures.[5] With regard to predictability, prior research compares information in earnings with that in returns: earnings can lag returns (e.g., Ball and Brown 1968); earnings can lead returns or can change for reasons not leading to returns (e.g., Beaver 1997; Beaver et al. 1997; Konchitchki 2011); and returns can move contemporaneously with earnings, with an increasing overlap when earnings are aggregated over time (e.g., Easton and Harris 1991; Easton et al. 1992).[6] Prior research also identifies stock-related effects that confound how firms' fundamentals such as earnings relate to returns, highlighting that earnings can provide information distinct from returns. For example, this research suggests that stock returns are affected by non-fundamental market disturbances, behavioral biases, investor opinion divergence and sentiment, stock market microstructure frictions, and short-sale constraints (e.g., Hong and Stein 2003; Pastor and Stambaugh 2003; Berkman et al. 2009). Consistent with the research across different areas, studies document a low explanatory power in the contemporaneous earnings-returns relation (e.g., Bernard 1989; Lev 1989; Easton et al. 1992; Hyan 1995), pointing to a marginal overlap between earnings and returns. However, the overlap in downside risk related to earnings and returns is an empirical matter, and thus in our empirical analyses we examine the information in EDR incremental to return downside risk measures.

We conduct two sets of analyses to examine the validity of the EDR measure and its link to cost of capital, using a large sample of US firms from 1976 to 2014. First,

[4] Examples of return downside risk studies are those by Chen et al. (2001) and Kim et al. (2011), who investigate conditional skewness in the distribution of stock returns (i.e., the negative coefficient of skewness) as well as stock price crash risk (i.e., the down-to-up volatility); Bali et al. (2009), who focus on extreme stock downside risks such as tail risk; and Jin and Myers (2006), Hutton et al. (2009), and Lang and Maffett (2011), who focus on stock price crashes.

[5] The basic idea is that news about earnings, which are persistent, alters perceptions regarding long-term expected growth rates and economic uncertainty (i.e., consumption volatility) and that this channel is important for explaining long-term risk and equity premia.

[6] Earnings information can lead returns because of, for example, the gradual information assimilation that stems from complexity, market segmentation, information costs, and investor attention constraints. For the theoretical front of this research, see, for example, Merton (1987), Hong and Stein (1999), Lee (2001), Hirshleifer and Teoh (2003). For the empirical front, see, for example, Cohen and Frazzini (2008), Menzly and Ozbas (2010). See also Miller (1977) and Mashruwala et al. (2012). Studies also show predictable returns for other reasons (e.g., Sloan 1996; Kang et al. 2010; Konchitchki 2011, 2013; DeFond et al. 2013; Konchitchki and Patatoukas 2014b) or suggest the macro role in the setting of equilibrium prices as the major function of accounting data (e.g., Beaver 2015).

to test the validity of EDR, we examine its implications for (a) subsequent earnings-based operating performance, (b) sensitivities to downward macroeconomic states, and (c) contemporaneous associations with earnings attributes and risk measures identified in prior research. Second, if EDR translates to cost of capital implications, we should observe a positive relation between our EDR measure and stock valuation. We examine whether this is the case using portfolio analysis and Fama and MacBeth (1973) cross-sectional regressions. We also test for incremental pricing information in EDR using measures related to risk and expected returns following prior research.

We document that high EDR firms experience more future negative outcomes as reflected in subsequent fundamental performance measures such as earnings losses and profit margins, and have higher sensitivities to downward macroeconomic states relative to low EDR firms. We also find that EDR is positively related to earnings attributes and risk measures from prior research, and that these other variables can collectively explain only one-quarter of the variation in contemporaneous EDR. These findings validate the EDR measure as capturing distinct risk information. In addition, we document that EDR is positively linked to firms' cost of capital as reflected in portfolio-level mean excess returns and firm-level subsequent excess returns, and that this link is incremental to several earnings attributes, accounting and risk factor betas, return downside risk, default risk, earnings volatility, and firm fundamentals. At the minimum, our evidence shows that EDR is correlated with information that is incrementally useful for explaining variation in cost of capital.

Viewed as a whole, this study contributes to accounting research by showing that earnings downside risk derived from financial statements contains distinct information about firm risk and incrementally explains cross-sectional variation in cost of capital. Our evidence on firms' downside fundamental risk sheds new light on the growing interdisciplinary research on the link between accounting and the macroeconomy, with implications for equity valuation (e.g., Chordia and Shivakumar 2005; Kothari et al. 2006; Hirshleifer et al. 2009; Konchitchki 2011, 2013; Ang et al. 2012; Konchitchki and Patatoukas 2014a, b; Li et al. 2014; Curtis et al. 2015; Shivakumar and Urcan 2015). In particular, we identify a source of firm-level risk that is linked to firms' sensitivities to downside macroeconomic patterns. Furthermore, our risk analysis focusing on accounting information and general downside scenarios contributes to stock-based downside risk research that often focuses on disastrous, extreme, or illiquid situations using proxies such as left-tail returns and stock price crashes (e.g., Chen et al. 2001; Jin and Myers 2006; Hutton et al. 2009; Kim et al. 2011; Ak et al. 2015). We believe that our risk analysis has the potential to stimulate risk research that focuses on accounting information, with implications for a wide range of decision-makers who are interested in assessing firms' risk and valuation. Notably, by demonstrating that earnings downside patterns are incrementally informative for assessing firms' risk and cost of capital, we inform accounting research on cost of capital, financial statement analysis, and accounting-based valuation—three major areas of high interest since the formation of accounting research.

For example, we explain why EDR can capture risk and drive cost of capital implications that are new to the accounting literature. We then find confirming evidence that EDR provides incremental ability to explain cost of capital variation, while it also shares commonalities with variables related to cost of capital from prior research. Our evidence thus informs accounting research on risk and cost of capital (e.g., Diamond and Verrecchia 1991; Botosan 1997; Francis et al. 2004; Core et al. 2008; Lara et al. 2011; Barth et al. 2008, 2013; Biddle et al. 2015). As another example, our study points to the incremental role of earnings downside volatility beyond the overall volatility used in prior research (e.g., Beaver et al. 1970; Jorgensen et al. 2012; Nekrasov 2012) and to an additional role of accounting in capturing firms' fundamental risk. In doing so, we extend the work of Beaver et al. (1970) and Koonce et al. (2005) regarding the usefulness of accounting information in risk assessment.

The remainder of the paper proceeds as follows. Section 2 develops an EDR measure. Section 3 discusses our research design and predictions. Section 4 describes the data and sample. Section 5 reports the evidence. Section 6 presents additional analyses. Section 7 concludes.

2 An earnings downside risk measure

We focus on the below-expectation volatility of earnings based on the tenet that earnings are asymmetrically distributed (e.g., Dechow 1994; Dechow et al. 1998) and that risk mainly manifests in downside states (e.g., Roy 1952; Bawa 1975; Kahneman and Tversky 1979; Gul 1991).

We note that a payoff's downside volatility, rather than its overall volatility, is key to valuation. This is because common utility functions are concave, capturing aversion to risk: investors prefer a consumption stream that is steady over time and across states of nature. Because marginal utility loss becomes larger as consumption declines, an asset's value decreases if its payoff covaries positively with downside consumption change, which dominates the valuation effect of covariation between the asset's payoff and upside consumption change due to diminishing marginal utility. EDR captures the exposure to the downside rather than the overall volatility of the earnings payoff. Extending the work of Stone (1973) and Fishburn (1977), we employ the theoretical risk framework of root lower partial moment as the mathematical foundation underlying EDR, as elaborated below.

Following prior research, we apply a modified relative root lower partial moment framework. Full details are described in Appendix 1. Our measure of earnings downside risk, *EDR*, is defined relative to expected earnings as the reference level, and given as follows:

$$EDR_{it} = \log\left[\frac{1+\text{Lower}_2(\tau_{it})}{1+\text{Upper}_2(\tau_{it})}\right] = \log\left\{\frac{1+\left[\left(\frac{1}{N}\right)\sum_{\gamma_{it}<\tau_{it}}(\tau_{it}-\gamma_{it})^2\right]^{1/2}}{1+\left[\left(\frac{1}{N}\right)\sum_{\gamma_{it}\geq\tau_{it}}(\gamma_{it}-\tau_{it})^2\right]^{1/2}}\right\}, \quad (1)$$

where we add one to both numerator and denominator to account for possible effects caused by small values and apply the natural logarithm for normalization; and Lower and Upper are respectively the root lower and upper partial moment described in Appendix 1. We estimate EDR_{it} for firm i using observations conditioned on fiscal year-end t. The variable γ_{it} refers to realized earnings (scaled, which we measure as earnings over assets, ROA) of firm i at fiscal year-end t, and τ_{it} refers to the corresponding earnings expectation that we estimate using the earnings expectation model below.

We adopt the following earnings expectation model to determine the expected level of earnings:

$$\begin{aligned} ROA_{it} = {} & \alpha_0 + \alpha_1 ROA_{it-1} + \alpha_2 SALE_{it-1} + \alpha_3 SIZE_{it-1} + \alpha_4 LEVERAGE_{it-1} \\ & + \alpha_5 STD\_ROA_{it-1} + \alpha_6 OC_{it-1} + \varepsilon_{it}, \end{aligned} \tag{2}$$

where ROA is annual earnings (income before extraordinary items) scaled by total assets (Compustat: IB/AT); $SALE$ is the ratio of total revenues to total assets (Compustat: SALE/AT); $SIZE$ is firm size, measured as the natural logarithm of market value of equity (Compustat: PRCC_F*CSHO); $LEVERAGE$ is the leverage ratio, calculated as long- plus short-term debts divided by total assets (Compustat: (DLTT + DLC)/AT); STD_ROA is the standard deviation of ROA estimated over the prior 3–5 fiscal years, as available; and OC is operating cycle, measured as the natural logarithm of 360 days multiplied by the following: accounts receivable scaled by total revenues (Compustat: RECT/SALE) plus inventory scaled by cost of goods sold (Compustat: INVT/COGS).

In our earnings expectation model, we include $SALE$ and OC as earnings determinants following Dechow et al. (1998). We include $SIZE$ following the intuition of Hall and Weiss (1967), Fiegenbaum and Karnani (1991), and Feng et al. (2015). We include ROA volatility (STD_ROA) and prior-period ROA to account for their possible effects on earnings predictability (e.g., Watts and Leftwich 1977; Dechow 1994; Minton et al. 2002; Dichev and Tang 2009). We include $LEVERAGE$ due to its dual possible effects on earnings, through the link to financial distress and the provision of external financing to support operations and investments.

The fitted value from Eq. (2) represents expected earnings, and the estimated residual, $\hat{\varepsilon}_{it}$, indicates the deviations below ($\hat{\varepsilon}_{it} < 0$) or above or equal to ($\hat{\varepsilon}_{it} \geq 0$) the expectation. Therefore, the EDR construction in Eq. (1) can be equivalently expressed as follows:

$$EDR_{it} = \log\left\{\frac{1 + \left[\left(\frac{1}{N}\right)\sum\left(\hat{\varepsilon}_{it} \times I\hat{\varepsilon}_{it<0}\right)^2\right]^{1/2}}{1 + \left[\left(\frac{1}{N}\right)\sum\left(\hat{\varepsilon}_{it} \times I\hat{\varepsilon}_{it\geq 0}\right)^2\right]^{1/2}}\right\}, \tag{3}$$

where $I\hat{\varepsilon}_{it<0}$ is an indicator variable that equals one if $\hat{\varepsilon}_{it} < 0$, that is, realized ROA is below its expected level and zero otherwise; $I\hat{\varepsilon}_{it\geq 0}$ is an indicator equal to one if $\hat{\varepsilon}_{it} \geq 0$ and zero otherwise; and N is the total number of residuals.

To estimate the residuals of the earnings expectation model in Eq. (2), we employ ordinary least squares (OLS) regressions for Fama and French (1997) industries over 3-year rolling windows, after winsorizing all input variables at the 1st and 99th percentiles of their sample distributions. Then, we use three to five (as available) residuals to compute EDR according to Eq. (3).[7] Appendix 2 provides summary statistics of the input variables and results from estimating the earnings expectation model we use to construct EDR.

3 Research design and predictions

3.1 Validity analyses

To validate the EDR measure, we conduct three tests that focus on the implications of EDR for (a) subsequent earnings-based operating performance, (b) sensitivities to downward macroeconomic states, and (c) contemporaneous earnings attributes and other risk-related measures from prior research.

3.1.1 Earnings downside risk and subsequent operating performance

We examine the link between EDR and firms' subsequent operating performance measured using various earnings-based variables. We first calculate the correlations of EDR with these measures over the subsequent year. We then investigate the link between EDR and subsequent performance by estimating the following multivariate regression model:

$$Performance_{it+1} = \beta_0 + \beta_1 EDR_{it} + \sum \beta_k CONTROLS1_{kit} + \varepsilon_{it+1}, \quad (4)$$

where $Performance_{it+1}$ refers to the 1-year-ahead earnings-based performance variable. We adopt the following performance measures: an indicator for negative income before extraordinary items (Compustat: IB), *DLOSS1*; an indicator for negative net income (Compustat: NI), *DLOSS2*; the ratio of income before extraordinary items to total revenues (Compustat: SALE), *IBM*; the ratio of net income to total revenues, *NIM*; the ratio of operating income after depreciation (Compustat: OIADP) to total revenues, *OPM*; and the gross profit margin, *GPM*, calculated as the difference between total revenues and cost of goods sold (Compustat: COGS) scaled by total revenues. Because margins are defined as profits out

[7] We note that (a) Equation (2) requires 3 years of input variables, (b) the independent variables are lagged by 1 year, of which the standard deviation of earnings requires at least 3 years of data, (c) and Eq. (3) requires a minimum of 3 years of residuals from Eq. (2). For example, estimating *EDR* for the fiscal year-end of 1975 requires residuals from the earnings expectation model from at least fiscal year 1973. The 3-year rolling-window requirement and 1-year lagged independent variables for estimating the residuals from Eq. (2) require regressor data as early as fiscal year 1970, and one of the inputs, *STD_ROA* of fiscal year 1970, requires *ROA* data from fiscal year 1968 (because we use *ROA* spanning three to 5 years to compute *STD_ROA*). Thus, a minimum of 8 fiscal years, from 1968 to 1975, are involved to obtain the *EDR* estimate for 1975. Similar to the restriction of Francis et al. (2005) that only firms with at least 7 years' accrual quality data could enter their sample, our estimation procedure requires at least 8 years of accounting data to obtain annual *EDR* estimates. Nevertheless, when we alternatively estimate our earnings expectation model using regressions by industry and for each fiscal year, which reduces the required minimum number of years to six, our main inferences are unchanged. Furthermore, we repeat our main tests after calculating *EDR* using 10 (rather than 3–5) earnings residuals following Eq. (3) and find similar inferences to those we report in the text.

of revenues, we set as missing those observations with negative or small revenues lower than \$10 million to avoid a negative or an extremely small denominator. We employ a probit estimation method when we use the subsequent loss indicator variables as the dependent variable or OLS when we use the margin measures of subsequent performance as the dependent variable. We follow Petersen (2009) and use clustering to estimate Eq. (4), as well as the EDR validation Eqs. (5) and (6) below, adjusting standard errors for possible cross-sectional and time-series residual correlations.

To specify our model and ensure that the estimated EDR-subsequent-performance links are not biased or inconsistent due to potential omission of firm fundamental characteristic or risk variables, we identify k control variables for Eq. (4), denoted as $CONTROLS1_{kit}$, following prior research on profit margins (e.g., Hall and Weiss 1967; Hurdle 1974; Connolly and Hirschey 1984; Feng et al. 2015) and implied sources for downside risk (e.g., Miller and Reuler 1996; Driouchi and Bennett 2010). Specifically, $CONTROLS1_{kit}$ includes the following variables measured at fiscal year-end t: book-to-market ratio, *BM*; market value of equity, *MVE*; *ROA*; *LEVERAGE*; cash holdings, *CASH*; changes in cash holdings, *ΔCASH*; research and development investment intensity, *Invest_RD*; capital investment intensity, *Invest_CAPX*; operating options, *OO*; return volatility, *SIGMA*; and year dummies. Appendix 3 provides detailed variable definitions.

If EDR is linked to future downward operating performance, we expect significantly positive coefficients on the loss dummies and negative coefficients on the earnings-based margin variables. Such findings would validate the EDR measure as capturing risk regarding future downward patterns in firms' fundamentals.

3.1.2 Earnings downside risk and sensitivities to downward macroeconomic states

We examine the link between EDR and the macroeconomy by estimating three firm-level sensitivities (betas) to future negative macroeconomic shocks, which relate to our focus on downward states. First, we obtain $beta\_negshock\_g_{t+1} - g_t$, the sensitivity of a firm's earnings to future negative GDP shocks. We estimate it by regressing earnings—income before extraordinary items or net income (both scaled by total assets)—on subsequent-year GDP growth during negative macro-shock periods, defined as year-over-year drops in the growth rate of real GDP by 1 % or more. Our inferences are not sensitive to alternative cutoffs for percentage drops including one standard deviation of the macro shocks as well as drops up to 4 %.

Second, we estimate $beta\_negshock\_g_{t+1} - E_t^{SPF}(g_{t+1})$, the sensitivity of a firm's earnings to future negative macroeconomic shocks, using the Survey of Professional Forecasters (SPF) of the Federal Reserve Bank of Philadelphia as the expectation of future real GDP growth. We use the SPF quarterly consensus forecasts over the subsequent year to obtain a 1-year-ahead SPF median consensus forecast, denoted as $E_t^{SPF}(g_{t+1})$. Consistent with the symmetric distribution of individual SPF panelists' GDP growth forecasts, our inferences below are identical when we use the mean consensus expectations. We then obtain from the Fed's SPF the corresponding year's realization of real GDP growth, denoted as g_{t+1}, and construct a GDP growth forecast error as $g_{t+1} - E_t^{SPF}(g_{t+1})$. We estimate $beta\_negshock\_g_{t+1} - E_t^{SPF}(g_{t+1})$ by regressing the two scaled earnings measures above on the subsequent-year GDP growth forecast errors during negative macro-shock periods when the realizations of GDP growth drop below the expectations. Using percent drops up to 4 % or one standard deviation of the macro shocks below the expectation does not qualitatively change our results.

To obtain the third sensitivity estimate to negative macro conditions, we focus on the sensitivity of a firm's earnings to macroeconomic recessions, the epicenter of downward patterns in firms' operating performance and general economic outcomes. We estimate this beta, denoted as *beta_recession*, by regressing the two scaled earnings measures above on real GDP growth rates during economic recession periods. We identify recessions using the reference dates for downside macroeconomic business cycles available from the National Bureau of Economic Research (NBER).[8]

Then we perform three tests: (a) a correlation analysis of EDR with the set of macro sensitivities, (b) a portfolio analysis of the macro sensitivities based on EDR decile portfolios, and (c) an out-of-sample portfolio analysis of subsequent operating performance during the downside macroeconomic states of recessions for EDR decile portfolios strictly formed in pre-recession periods. High EDR firms having a stronger EDR-macro link in the correlation and portfolio analyses, as well as a worse subsequent operating performance during downward macro states in the out-of-sample analysis, would be consistent with these firms, in terms of operating activities, tending to be more sensitive to aggregate downward macroeconomic conditions than low EDR firms, which constitutes a risk captured by our EDR measure.

3.1.3 Earnings downside risk, earnings attributes, and other risk-related measures from prior research

We next examine the contemporaneous associations of EDR with earnings attributes and other earnings- and stock-based risk measures. With respect to earnings attributes, prior research suggests the following attributes for earnings: accrual quality, earnings persistence, earnings predictability, value relevance, earnings smoothing, timeliness, and conservatism (e.g., Francis et al. 2004; Barth et al. 2013). These attributes relate to the information revealed by earnings, and, as a result, EDR may simply incorporate a combination of earnings attributes resulting in its link to earnings downward patterns. Therefore we investigate how EDR relates to these earnings attributes and whether it provides incremental information.

We first construct the following earnings attribute measures from prior research: accrual quality, *Acc_Q*; earnings persistence, *Persist*; earnings predictability, *Predict*; value relevance, *Relevance*; earnings smoothing, *Smooth*; timeliness,

[8] See http://www.nber.org/cycles/cyclesmain.html.

Timely; and conservatism, *Conserv*.[9] Appendix 3 provides detailed information about the construction of these variables. To ease the interpretation of results from our empirical analyses, we conform the variables to the same ordering, when needed, such that larger (smaller) values correspond to lower (higher) quality in terms of the attribute. We then examine the correlations of EDR with these attributes.

To further examine the link between EDR and earnings attributes and, more importantly, to test whether information in EDR can be subsumed by these attributes, we estimate the following OLS regression model:

$$EDR_{it} = \beta_0 + \sum \beta_n Attributes_{nit} + \sum \beta_j CONTROLS2_{jit} + \varepsilon_{it}, \quad (5)$$

where $Attributes_{nit}$ refers to the *n*th earnings attribute (*Acc_Q*, *Persist*, *Predict*, *Relevance*, *Smooth*, *Timely*, and *Conserv*) of firm *i* at fiscal year-end *t*. We also add the following variables as controls, denoted as $CONTROLS2_{jit}$, each measured for firm *i* at fiscal year-end *t*, with *j* denoting the *j*th control variable: *BM*; *MVE*; *ROA*; *LEVERAGE*; *CASH*; *ΔCASH*; *Invest_RD*; *OO*; *SIGMA*; organizational slack, *SLACK*; human resource slack, *SLACK_emp*; and year dummies. These variables, with definitions detailed in Appendix 3, capture possible sources of earnings-based risk implied in prior literature (e.g., Miller and Reuler 1996; Zhang 2009; Driouchi and Bennett 2010).

If EDR shares commonalities with an earnings attribute, we expect to find a significantly positive estimated coefficient on that attribute variable. Importantly, the explanatory power of the independent variables in the regression model (i.e., the adjusted R^2) provides a formal test of the extent to which earnings attributes can collectively explain the variation in EDR, indicating the information in EDR is incremental to the earnings attributes.

To further assess the property of EDR as an incremental indicator for downside risk, we test for the link of EDR with other stock- and earnings-based risk measures including return downside risk, default risk, earnings volatility, and earnings beta. Downside risk measures are often constructed using stock returns, which can provide information substantially different from that in earnings, as suggested in prior research. EDR also differs from default risk, that is, the probability that firms will not be able to repay their debts, because EDR focuses on more general downside risk of firm fundamentals not limited to the extreme case of default. In addition, because of the asymmetry in the earnings distribution, EDR differs from earnings volatility, which consists of both downside and upside variabilities in a symmetric way relative to the sample mean. EDR also differs from earnings beta, a traditional covariance-based accounting risk estimate. Whereas earnings beta captures the relation between firms' fundamentals and aggregate earnings using both downside and upside states of nature, EDR emphasizes downside states.

We adopt two extensively used return downside risk measures, the down-to-up volatility, *DUVOL*, and the negative coefficient of skewness, *NCSKEW* (e.g., Chen

[9] These earnings attributes are also widely used in other studies (e.g., Minton and Schrand 1999; Aboody et al. 2005; Core et al. 2008; Kim and Qi 2010; Kim and Sohn 2011; Lara et al. 2011; Badertscher et al. 2012; Barth et al. 2013).

et al. 2001; Kim et al. 2011; Kim and Zhang 2014, 2015). We measure default risk by Merton's (1974) and Vassalou and Xing's (2004) expected default frequency (*EDF*). We calculate earnings volatility, *VOL_ROA*, as the standard deviation of earnings, and earnings beta, *BETA_ROA*, as the estimated slope from a time-series regression of a firm's ROA on the value-weighted average of earnings across all firms (e.g., Beaver et al. 1970). Appendix 3 provides more details about these variables.

We conduct two sets of tests: examining the correlations of *EDR* with *DUVOL*, *NCSKEW*, *EDF*, *VOL_ROA*, and *BETA_ROA*, and estimating the following OLS regression model:

$$EDR_{it} = \beta_0 + \beta_1 RDR_{it} + \beta_2 EDF_{it} + \beta_3 VOL\_ROA_{it} + \beta_4 BETA\_ROA_{it} + \sum \beta_n Attributes_{nit} + \sum \beta_j CONTROLS2_{jit} + \varepsilon_{it}, \quad (6)$$

where *RDR* refers to return downside risk, that is, *DUVOL* or *NCSKEW*. The control variable set $CONTROLS2_{jit}$ is the same as in Eq. (5), and we estimate the model with and without controlling for earnings attributes. If EDR captures risk, we expect a generally positive link of EDR with other risk-related measures in the correlation and regression analyses. More importantly, the adjusted R^2 from the regression analysis indicates the extent to which other measures can collectively subsume information in EDR.

3.2 Earnings downside risk and cost of capital

Next, we examine the link between EDR and cost of equity capital, that is, the discount rate or the rate of return that a firm's equity capital is expected to earn in an alternative investment with risk equivalent to the firm's risk profile. The cost of equity capital can provide equity investors information and assurance of the expected return for providing capital. We use two common asset pricing approaches employing subsequent monthly excess stock returns (e.g., Barth et al. 2013). The first analysis focuses on monthly excess returns to portfolios constructed on the basis of EDR. The second analysis employs firm-level Fama and MacBeth (1973) cross-sectional regressions that focus on the incremental ability of EDR to explain variation in equity returns.

For accounting information to be assimilated in stock prices, we align EDR_{it} and other accounting-based measures for fiscal year t with returns beginning 6 months after the fiscal year-end, that is, returns over months $t + 7$ trough $t + 18$ after fiscal year ending month t (e.g., Fama and French 1993). To perform the portfolio analysis, each month we sort stocks into decile portfolios based on the most recent EDR estimates and then calculate average monthly excess return for each portfolio. A significant and positive mean return difference between the top and bottom EDR portfolios indicates an equity premium for EDR. To perform the Fama–MacBeth analysis, we regress subsequent monthly excess stock returns on current EDR, with or without controlling for other measures. Specifically, each month we estimate the following cross-sectional regression model and then obtain time-series averages of the estimated coefficients on each regressor:

$$RET_{it+1} - RF_{t+1} = \beta_0 + \beta_1 EDR_{it} + \sum \beta_z CONTROLS3_{zit} + \sum \beta_n Attributes_{nit} + \varepsilon_{it+1}, \quad (7)$$

where $RET_{it+1} - RF_{t+1}$ refers to the monthly excess returns over the 12 months of $t + 1$ after fiscal year-end t, with RF indicating the risk-free return, while, as above, allowing 6 months for assimilation of accounting information. We include two sets of control variables to assess the incremental information in EDR for the cost of capital. The first set, denoted as $CONTROLS3_{zit}$ for the zth control variable for firm i at fiscal year-end t, includes variables related to cross-sectional variation in returns that are common controls in asset pricing tests, as follows: *MVE*; *BM*; momentum, *MOM*; and sensitivities to stock market returns and to the size, book-to-market, and momentum factors, denoted as *MKTbeta*, *SMBbeta*, *HMLbeta*, and *UMDbeta*, respectively. $CONTROLS3_{zit}$ also includes the following measures for firm fundamentals possibly related to equity premia: total accruals over total assets, *TCA* (e.g., Sloan 1996; Khan 2008; Hirshleifer et al. 2009); *ROA* (e.g., Cooper et al. 2008); earnings surprises, *SUE* (e.g., Mikhail et al. 2004; Kothari et al. 2005, 2006); and *BETA_ROA* (e.g., Beaver et al. 1970). We also add to this first set of controls the following risk measures: *RDR* (*DUVOL* or *NCSKEW*); *EDF*; and *VOL_ROA*. The second set of control variables denoted as $Attributes_{nit}$ (where $n = 1$ to 7) includes the earnings attributes as in Eq. (5). Appendix 3 provides detailed information about all these variables. We base our statistical inferences on Newey and West (1987) heteroskedasticity- and autocorrelation-consistent standard errors.

If EDR identifies a source of risk, we expect it to be incrementally informative about the cost of capital relative to the other measures.

4 Data and sample

We construct our original sample using US listed firms from 1968 to 2014. We obtain accounting variables from the Compustat North America Fundamentals Annual File (WRDS: FUNDA) available from Wharton Research Data Services (WRDS). We extract monthly raw stock returns (Monthly Stock File; WRDS: MSF) and daily raw stock returns (Daily Stock File; WRDS: DSF) from the Center for Research in Security Prices (CRSP) database in WRDS. We obtain the risk-free rate (i.e., US 1-month T-bill rate) and the Fama–French and momentum factors from the Fama–French Portfolios and Factors File (WRDS: FF). We obtain time-series macroeconomic data of mean and median consensus expectations for future real GDP growth from the SPF available from the Federal Reserve Bank of Philadelphia, Real-Time Data Research Center. The SPF has been widely used in prior research to proxy for macroeconomic expectations (e.g., Zarnowitz and Braun 1993; Sims 2002; Ang et al. 2007; Ulrich 2013; Konchitchki 2013; Konchitchki and Patatoukas 2014a, b). We also use the SPF to obtain realization data of GDP growth. The Federal Reserve Bank of Philadelphia collects, organizes, and aligns the realizations and expectations of GDP growth data using the most recent reports of the National Income and Product Accounts released by the BEA.

We use Compustat data to construct EDR and CRSP stock return data to estimate the return downside risk and default risk measures. We use both Compustat's annual accounting data and CRSP's daily or monthly stock return data to estimate other control variables. Our final sample includes 100,095 firm-year observations with EDR estimates for fiscal year-ends from 1975 to 2013, which match the corresponding stock return data from January 1976 to December 2014.[10]

Table 1 reports descriptive statistics of variables used in the analyses. The mean and median of *EDR* are −0.001 and −0.002, respectively, suggesting that the root lower partial moment of unexpected earnings is slightly smaller than the corresponding root higher partial moment. (Note that the natural logarithm is used in the *EDR* construction.) The standard deviation of *EDR* is 0.079, indicating high variation in downside risk about firm fundamentals. In addition, the signs and magnitudes of the remaining variables are generally consistent with prior research. For example, despite differences in the sample selections and estimation periods, the earnings attributes estimates are largely consistent with the results of Francis et al. (2004). As other examples, the means of earnings volatility (*VOL_ROA*) and earnings beta (*BETA_ROA*) equal 0.055 and 1.226, respectively, and both are largely comparable to those reported by Beaver et al. (1970). Furthermore, the mean default risk measure (*EDF*) equals 0.061, relatively close to the value of 0.042 reported by Vassalou and Xing (2004), despite the different estimation periods. Also, the mean value of stock market beta is close to one (i.e., 0.978), consistent with the fact that our comprehensive sample represents the stock market portfolio. Appendix 2 provides additional summary statistics of the input variables and estimation results of the earnings expectation model underlying *EDR*.

5 The evidence

5.1 Validity analyses

5.1.1 Earnings downside risk and subsequent operating performance

Table 2 reports results from examining the link of EDR with subsequent earnings-based operating performance. Panel A reports correlations of *EDR* with the subsequent year's loss indicators (*DLOSS1* and *DLOSS2*) and the earnings-based margin variables (*IBM*, *NIM*, *OPM*, and *GPM*). The results show that *EDR* is significantly positively correlated with the loss indicators and significantly negatively correlated with the margin variables. These findings indicate that higher EDR firms tend to have worse operating performance over the subsequent year, as expected if our EDR measure is valid. Panel B provides multivariate regression results from estimating Eq. (4) using a probit (OLS) model when the dependent variable is the subsequent loss indicators (margin variables), and it shows that the

[10] Because we allow a 6-month lag after the fiscal year-end for assimilation of accounting information when we examine subsequent stock returns, according to Compustat's fiscal year definition, the earliest month with a valid match between EDR and returns is January 1976, with correspondence to the fiscal year of 1975 with a June fiscal year-end.

Table 1 Descriptive statistics

Variables	Mean	SD	Median	Q1	Q3
EDR	−0.001	0.079	−0.002	−0.022	0.014
DLOSS1	0.180	0.384	0.000	0.000	0.000
DLOSS2	0.185	0.389	0.000	0.000	0.000
IBM	0.039	0.306	0.050	0.017	0.097
NIM	0.041	0.343	0.051	0.017	0.099
OPM	0.106	0.296	0.096	0.045	0.179
GPM	0.361	0.273	0.337	0.224	0.491
Acc_Q	0.035	0.037	0.025	0.014	0.043
Persist	−0.369	0.433	−0.384	−0.614	−0.123
Predict	0.056	0.403	0.027	0.013	0.055
Relevance	−0.421	0.253	−0.405	−0.619	−0.208
Smooth	0.671	0.569	0.550	0.273	0.942
Timely	−0.463	0.252	−0.457	−0.665	−0.257
Conserv	1.476	416.717	−1.187	−1.888	−0.582
DUVOL	−0.011	0.291	−0.013	−0.203	0.177
NCSKEW	−0.048	0.591	−0.054	−0.381	0.271
EDF	0.061	0.190	0.000	0.000	0.002
VOL_ROA	0.055	0.135	0.025	0.012	0.055
BETA_ROA	1.226	7.124	0.668	−0.196	1.760
SIZE	5.648	2.151	5.573	4.072	7.112
BM	0.848	7.917	0.612	0.364	0.975
MOM	0.063	0.370	0.028	−0.131	0.195
MKTbeta	0.978	0.670	0.939	0.587	1.322
SMBbeta	0.753	0.994	0.616	0.116	1.247
HMLbeta	0.223	1.039	0.276	−0.282	0.763
UMDbeta	−0.112	0.660	−0.090	−0.422	0.224
TCA	0.008	0.785	0.005	−0.021	0.035
ROA	0.035	0.243	0.040	0.009	0.076
SUE	0.331	2.432	0.260	−0.716	1.231

This table presents descriptive statistics for variables used in the analyses. Appendix 3 provides detailed variable definitions. Our final sample with EDR estimates includes 100,095 firm-year observations for fiscal year-ends from 1975 to 2013, which match the corresponding stock return data from January 1976 to December 2014

link between EDR and subsequent underperformance is unaffected by adding the control variables. Specifically, the estimated coefficients on *EDR* are highly significant (t statistics >4.40 in absolute values), with positive signs on the loss indicator variables and negative signs on the earnings-based margin variables. Taken together, the signs and significance of the estimated correlations in Panel A and coefficients on EDR in Panel B are consistent with our prediction that EDR captures the expectation for future operating underperformance. Therefore, evidence in Table 2 supports the validity of the EDR measure as reflecting downside risk in firms' fundamentals.

Table 2 Earnings downside risk and subsequent operating performance

Panel A: Correlations of *EDR$_t$* with subsequent loss indicators and profit margin variables						
	$DLOSS1_{t+1}$	$DLOSS2_{t+1}$	IBM_{t+1}	NIM_{t+1}	OPM_{t+1}	GPM_{t+1}
Pearson	0.153	0.151	-0.063	-0.060	-0.059	-0.054
p-value	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
Spearman	0.177	0.176	-0.259	-0.249	-0.218	-0.176
p-value	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001

Panel B: Probit or OLS regressions of subsequent loss indicators or profit margin variables on *EDR$_t$* and controls						
	$DLOSS1_{t+1}$	$DLOSS2_{t+1}$	IBM_{t+1}	NIM_{t+1}	OPM_{t+1}	GPM_{t+1}
EDR_t	0.409***	0.360***	-0.345***	-0.325***	-0.346***	-0.271***
	(5.05)	(4.40)	(-16.38)	(-15.80)	(-16.56)	(-16.10)
BM_t	10.099***	10.008***	3.142***	3.021***	3.047***	1.702***
	(2.79)	(2.73)	(4.87)	(4.69)	(5.23)	(3.00)
MVE_t	-9.742***	-9.494***	1.779***	1.750***	1.732***	0.890***
	(-4.24)	(-4.46)	(21.21)	(21.03)	(20.49)	(12.48)
ROA_t	-3.032***	-3.005***	0.167***	0.165***	0.161***	0.112***
	(-27.64)	(-27.34)	(7.96)	(7.98)	(8.32)	(8.98)
$LEVERAGE_t$	0.734***	0.658***	-0.146***	-0.121***	0.148***	-0.008
	(22.56)	(20.53)	(-23.68)	(-19.48)	(24.78)	(-1.32)
$CASH_t$	0.865***	0.806***	0.053***	0.058***	-0.037***	0.097***
	(20.93)	(19.61)	(6.51)	(7.17)	(-4.78)	(11.08)
$\Delta CASH_t$	-0.568***	-0.527***	0.194***	0.185***	0.181***	0.073***
	(-5.64)	(-5.45)	(11.69)	(11.23)	(11.75)	(4.42)
$Invest\_RD_t$	1.349***	1.246***	-0.318***	-0.320***	-0.402***	0.863***
	(9.08)	(7.36)	(-11.97)	(-12.12)	(-15.74)	(22.69)
$Invest\_CAPX_t$	0.287***	0.235**	0.239***	0.225***	0.195***	0.570***
	(2.70)	(2.25)	(11.78)	(11.03)	(9.69)	(27.57)
OO_t	0.057***	0.072***	-0.045***	-0.048***	-0.093***	-0.122***
	(3.77)	(4.88)	(-15.89)	(-16.88)	(-32.67)	(-38.13)
$SIGMA_t$	0.199***	0.193***	-0.059***	-0.057***	-0.062***	-0.013***
	(38.40)	(37.51)	(-51.27)	(-50.49)	(-54.74)	(-17.15)
Intercept	-2.879***	-2.791***	0.582***	0.578***	0.556***	0.463***
	(-15.10)	(-14.49)	(16.62)	(16.55)	(17.39)	(15.26)
Obs.	100,095	100,095	96,235	96,235	96,235	96,235
Pseudo R^2	22.27%	21.15%				
Adjusted R^2			16.72%	15.69%	18.75%	8.40%

Panel A reports Pearson and Spearman correlations of EDR with subsequent loss indicators and profit margins. Panel B reports results from probit (OLS) regressions of subsequent loss indicators (profit margins) on EDR and control variables, following Eq. (4). Appendix 3 provides detailed variable definitions

***, **, * statistical significance at 1, 5, and 10 % levels, respectively, and *t* statistics are in parentheses

5.1.2 Earnings downside risk and sensitivities to downward macroeconomic states

Table 3, Panel A, shows that EDR exhibits significantly positive correlations with the three firm-specific estimates of sensitivities to downward macroeconomic states, that is, $beta\_negshock\_g_{t+1} - g_t$, $beta\_negshock\_g_{t+1} - E_t^{SPF}(g_{t+1})$, and *beta_recession*. Panel B reports portfolio means and differences in means of the macro sensitivities for the top and bottom EDR decile portfolios. The results show that the high EDR portfolio has significantly higher sensitivities to future negative macroeconomic

Table 3 Earnings downside risk and sensitivities to downward macroeconomic states

Panel A: Correlations of EDR_t with firm-specific sensitivities to future negative macro states

	Earnings proxied by scaled income before extraordinary items			Earnings proxied by scaled net income		
	*beta_negshock_* $g_{t+1} - g_t$	*beta_negshock_* $g_{t+1} - E_t^{SPF}(g_{t+1})$	*beta_recession*	*beta_negshock_* $g_{t+1} - g_t$	*beta_negshock_* $g_{t+1} - E_t^{SPF}(g_{t+1})$	*beta_recession*
Pearson	0.079	0.052	0.106	0.065	0.049	0.110
p-value	<0.0001	<0.0001	<0.001	<0.0001	<0.001	<0.001
Spearman	0.116	0.057	0.081	0.106	0.057	0.081
p-value	<0.0001	<0.0001	<0.001	<0.0001	<0.001	<0.001

Panel B: EDR_t-based portfolio analysis of sensitivities to future negative macro states

	Earnings proxied by scaled income before extraordinary items			Earnings proxied by scaled net income		
EDR_t	*beta_negshock_* $g_{t+1} - g_t$	*beta_negshock_* $g_{t+1} - E_t^{SPF}(g_{t+1})$	*beta_recession*	*beta_negshock_* $g_{t+1} - g_t$	*beta_negshock_* $g_{t+1} - E_t^{SPF}(g_{t+1})$	*beta_recession*
1 (L)	-0.247	-0.553	-0.479	-0.175	-0.552	-0.433
10 (H)	1.245	0.625	0.318	1.350	0.673	0.369
H – L	1.492	1.178	0.797	1.525	1.225	0.802
t-statistic	(5.35)***	(6.86)***	(6.33)***	(5.27)***	(6.94)***	(6.23)***

Panel C: Out-of-sample EDR portfolio analysis: operating performance during recessions based on pre-recession classifications of EDR

EDR_t (constructed during pre-recession periods)	The following are measured during recession periods:					
	$DLOSS1_{t+1}$	$DLOSS2_{t+1}$	IBM_{t+1}	NIM_{t+1}	OPM_{t+1}	GPM_{t+1}
1 (L)	0.232	0.232	-0.373	-0.375	-0.346	0.045
10 (H)	0.393	0.391	-2.186	-2.177	-1.927	-1.311
H – L	0.161	0.159	-1.813	-1.802	-1.581	-1.356
t-statistic	(10.19)***	(10.09)***	(-2.33)**	(-2.32)**	(-2.18)**	(-2.06)**

Panel A reports Pearson and Spearman correlations of EDR with firm-specific sensitivities to downward macroeconomic states based on real GDP growth. Panel B reports portfolio means and differences in means of the firm-specific sensitivities for firms in top and bottom EDR decile portfolios. Panel C reports out-of-sample results for portfolio means and differences in means of loss indicators and profit margins during NBER recessions for firms in the top and bottom EDR decile portfolios constructed ex ante during pre-recession periods. To estimate earnings sensitivities to the macroeconomy, we proxy for earnings using either income before extraordinary items or net income, both scaled by total assets. Appendix 3 provides detailed variable definitions

***, **, and * indicate statistical significance at 1, 5, and 10 % levels, respectively, and *t* statistics are in parentheses

shocks relative to the low EDR portfolio, in both economic and statistical terms and across the three sensitivity estimates. In all cases, the sensitivity estimates change from negative in low EDR portfolios to positive in high EDR portfolios, with *t* statistics >5.27. Evidence from both panels suggests that EDR relates to future negative macroeconomic shocks proxied by drops in GDP growth, falling below SPF expectations, and NBER recessions. The findings corroborate EDR's nature of capturing downside risk of firm fundamentals, which are linked to downward macroeconomic states. Panel C reports out-of-sample results for portfolio means and differences in means of the future operating performance measures during recessions for the top and bottom EDR decile portfolios constructed ex ante in pre-recession periods. This panel shows that, for high EDR firms sorted prior to recessions, the loss indicators and operating margins during recessions have demonstrated a significantly deteriorated pattern, relative to the pre-recession low EDR firms, with *t* statistics for the high-minus-low differences between 2.06 and 10.19 (in absolute values). Thus, an out-of-sample difference in EDR before recessions identifies a significant spread in underperformance during recessions. This result also corroborates the findings in Panels A and B regarding the downward macro sensitivities and further confirms EDR's ability in reflecting risk of downward states.

Overall, Table 3 provides evidence that EDR captures cross-sectional variation in firms' sensitivities to future negative macroeconomic shocks including recessions. The findings are consistent with our conjecture that EDR is linked to downward macroeconomic patterns, and they add to the validity of the EDR measure as capturing risk.

5.1.3 Earnings downside risk, earnings attributes, and other risk-related measures from prior research

Table 4 provides results from examining the links of our EDR measure to earnings attributes and other risk-related measures from prior research. Panels A and B report contemporaneous correlations of EDR with earnings attributes and other risk measures, respectively. In Panel A, *EDR* is positively correlated with all earnings attributes except for *Conserv* and significantly so (except for one insignificance in the Pearson case for *Persist*), suggesting that EDR generally shares commonalities with earnings attributes. In Panel B, *EDR* is consistently positively correlated with all risk measures including the return downside risk measures (*DUVOL* and *NCSKEW*), default risk measure (*EDF*), earnings volatility (*VOL_ROA*), and earnings beta (*BETA_ROA*). All these correlations are significant at least at the 10 % level except for one correlation significant at 11.2 % level, suggesting that EDR shares some overlapping risk information with other risk measures. However, the results also show that, in both Panels A and B, all the correlation magnitudes are relatively small (lower than 0.10 in all but one of the Pearson cases and 0.12 in all Spearman cases), implying that the information in EDR is not subsumed by any of these other measures when analyzed on a standalone basis.

Table 4, Panel C, reports contemporaneous regression results of EDR with earnings attributes and other risk variables. Model 1 shows that the adjusted R^2 from estimating Eq. (5) is 16.60 %, indicating that earnings attributes together with other controls can explain only a small portion (less than fifth) of the variation in EDR. In other words, EDR is not a combination of other variables; rather, it has its own merit of reflecting information beyond that embedded in earnings attributes and the other controls. Similarly, Models 2–5 report results from contemporaneous regressions of EDR on risk measures following Eq. (6) and show that the adjusted R^2 varies between 21.11 and 25.30 %, suggesting that return downside risk, default risk, earnings volatility, and earnings beta, as well as earnings attributes and the other controls, can collectively explain only up to one quarter of the cross-sectional variation in EDR, indicating that EDR reflects distinct information not subsumed by variables from prior research.

Table 4 Earnings downside risk, earnings attributes, and other risk-related measures from prior research

Panel A: Correlations of EDR_t with earnings attributes

	Acc_Q_t	$Persist_t$	$Predict_t$	$Relevance_t$	$Smooth_t$	$Timely_t$	$Conserv_t$
Pearson	0.088	-0.002	0.098	0.046	0.098	0.029	-0.025
p-value	<.0001	0.6047	<.0001	<.0001	<.0001	<.0001	<.0001
Spearman	0.036	0.015	0.002	0.073	0.086	0.047	-0.034
p-value	<.0001	<.0001	0.5376	<.0001	<.0001	<.0001	<.0001

Panel B: Correlations of EDR_t with other risk-related measures

	$DUVOL_t$	$NCSKEW_t$	EDF_t	VOL_ROA_t	$BETA\_ROA_t$
Pearson	0.006	0.006	0.061	0.242	0.068
p-value	0.073	0.112	<.0001	<.0001	<.0001
Spearman	0.014	0.012	0.111	0.065	0.109
p-value	<.0001	0.0005	<.0001	<.0001	<.0001

Panel C: Contemporaneous regressions of EDR_t on earnings attributes, risk-related measures, and controls

	Model 1	Model 2	Model 3	Model 4	Model 5
Acc_Q_t	0.114***			0.018	0.018
	(4.75)			(0.85)	(0.85)
$Persist_t$	-0.004***			-0.004***	-0.004***
	(-5.26)			(-5.93)	(-5.94)
$Predict_t$	0.129***			0.020	0.020
	(6.32)			(1.23)	(1.23)
$Relevance_t$	0.010***			0.010***	0.010***
	(5.38)			(6.06)	(6.06)
$Smooth_t$	0.007***			0.003***	0.003***
	(7.65)			(3.74)	(3.75)
$Timely_t$	0.000			0.001	0.002
	(-0.06)			(0.97)	(0.98)
$Conserv_t$	0.000			0.000	0.000
	(-0.99)			(-0.69)	(-0.69)
$DUVOL_t$		0.005***		0.004***	
		(6.30)		(4.40)	
$NCSKEW_t$			0.002***		0.002***
			(5.37)		(4.09)
EDF_t		0.019***	0.019***	0.021***	0.021***
		(10.35)	(10.36)	(8.39)	(8.38)
VOL_ROA_t		0.216***	0.216***	0.221***	0.221***
		(11.74)	(11.74)	(7.44)	(7.44)
$BETA\_ROA_t$		0.013***	0.013***	0.014***	0.014***
		(12.63)	(12.65)	(12.25)	(12.28)
BM_t	-2.337***	-2.460***	-2.459***	-2.035***	-2.034***
	(-6.11)	(-8.67)	(-8.67)	(-5.45)	(-5.45)
MVE_t	0.268***	0.258***	0.258***	0.274***	0.274***
	(12.68)	(15.81)	(15.83)	(12.95)	(12.95)
ROA_t	-0.084***	-0.106***	-0.105***	-0.095***	-0.095***
	(-11.40)	(-13.97)	(-13.97)	(-13.18)	(-13.18)
$LEVERAGE_t$	-0.003	-0.010	-0.010	-0.013***	-0.013***
	(-1.28)	(-5.02)***	(-5.04)***	(-4.86)	(-4.87)
$CASH_t$	-0.072***	-0.074	-0.074***	-0.077***	-0.077***
	(-17.71)	(-24.12)***	(-24.14)	(-24.83)	(-24.84)
$\Delta CASH_t$	0.005	0.004	0.004	0.008	0.008
	(0.78)	(0.76)	(0.77)	(1.23)	(1.24)
$Invest\_RD_t$	0.024*	0.004	0.005	0.003	0.003
	(1.92)	(0.36)	(0.38)	(0.28)	(0.30)
OO_t	0.002**	0.000	0.000	-0.001	-0.001
	(2.08)	(-0.02)	(0.02)	(-1.30)	(-1.28)
$SIGMA_t$	0.001*	0.000	0.000	-0.001*	-0.001*
	(1.82)	(-0.15)	(-0.17)	(-1.67)	(-1.66)
$SLACK_t$	0.000*	0.000	0.000***	0.000	0.000
	(-1.93)	(2.69)***	(2.69)	(1.62)	(1.62)

Table 4 continued

Panel C: Contemporaneous regressions of EDR_t on earnings attributes, risk-related measures, and controls					
	Model 1	Model 2	Model 3	Model 4	Model 5
$SLACK\_emp_t$	0.013	0.026	0.026***	0.023***	0.023***
	(1.38)	(2.80)***	(2.81)	(2.58)	(2.58)
Intercept	0.116***	0.124	0.124***	0.105***	0.105***
	(5.89)	(8.62)***	(8.62)	(5.38)	(5.38)
Obs.	55,368	82,480	82,480	52,266	52,266
Adjusted R^2	16.60%	21.12%	21.11%	25.20%	25.30%

Panel A (B) reports Pearson and Spearman correlations of EDR with earnings attributes (several risk-related measures). Panel C reports results from contemporaneous regressions of EDR on attributes and several risk-related measures following Eqs. (5) and (6). Appendix 3 provides detailed variable definitions

***, **, * indicate statistical significance at 1, 5, and 10 % levels, respectively, and *t* statistics are in parentheses

In sum, results from Table 4 show that EDR is positively related to contemporaneous earnings attributes and risk measures identified in prior research. However, EDR does not move in lockstep with these other measures and reflects incremental risk information. Indeed, the earnings attributes and risk measures from prior research can collectively explain only a small portion of the variation in contemporaneous EDR, indicating that even the combination of all other measures cannot subsume the information embedded in EDR. Overall, these findings distinguish EDR from earnings attributes and other measures and point to its validity in capturing distinct information.

5.2 Earnings downside risk and cost of capital

Table 5, Panel A, reports results from the portfolio analysis of stock returns to EDR-based portfolios and indicates that firms in the high EDR decile portfolio have significantly higher subsequent excess returns relative to firms in the low EDR decile portfolio. The monthly return spread is 0.005 and statistically significant (t statistic = 3.99). With regard to economic significance, high EDR firms have an equity premium of 50 basis points per month in excess of the risk-free rate (6.17 % per year, monthly compounded) relative to low EDR firms. Therefore, Panel A shows higher expected returns for stocks issued by high EDR firms relative to stocks issued by low EDR firms, in terms of statistical and economic significance.

Table 5, Panel B, reports results from Fama and MacBeth (1973) cross-sectional regression analysis following Eq. (7). This analysis focuses on the incremental ability of EDR to explain variation in subsequent stock returns. (In this panel, we use returns stated in percentages to ease exposition in terms of the number of decimal digits.) The major coefficients of interest are those on EDR across the six model specifications that we estimate. The results show that the estimated coefficients on *EDR* are all significantly positive. In particular, in Model 1, for example, the estimated *EDR* coefficient is statistically significant and equal to 4.088 (t statistic = 3.20). This significance is also in economic terms. Specifically, a one standard deviation increase in *EDR* (i.e., 0.079) is associated with an increased monthly excess return of 32.30 basis points (i.e., 0.079*4.088*100) or 3.95 % per year when compounded monthly. The results are unchanged in Models 2–6, which include different sets of control variables; with common

Table 5 Earnings downside risk and cost of capital

Panel A: Portfolio analysis of subsequent monthly excess returns (*RET_{t+1}* - *RF_{t+1}*) for *EDR_t* portfolios

	1 (L)	10 (H)	H - L	t-statistic
	0.013	0.018	0.005***	(3.99)

Panel B: Fama-MacBeth regressions of subsequent monthly excess percentage returns (*(RET_{t+1} - RF_{t+1})*100*) on *EDR_t* and controls

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
EDR_t	4.088***	2.218**	4.099***	2.832***	2.639**	2.701**
	(3.20)	(2.43)	(3.06)	(2.65)	(2.40)	(2.43)
MVE_t		-0.229***		-0.193***	-0.205***	-0.205***
		(-7.47)		(-6.47)	(-7.07)	(-7.04)
BM_t		0.189***		0.207***	0.202***	0.200***
		(2.72)		(2.66)	(2.65)	(2.62)
MOM_t		-0.008		0.001	0.043	0.037
		(-0.06)		(0.00)	(0.30)	(0.26)
$MKTbeta_t$		0.182**		0.193**	0.182*	0.184**
		(2.13)		(1.99)	(1.96)	(1.97)
$SMBbeta_t$		-0.047		-0.018	-0.010	-0.011
		(-0.91)		(-0.33)	(-0.17)	(-0.19)
$HMLbeta_t$		0.046		0.062	0.065	0.064
		(0.87)		(1.09)	(1.16)	(1.15)
$UMDbeta_t$		-0.206***		-0.173**	-0.158**	-0.155**
		(-3.13)		(-2.54)	(-2.41)	(-2.38)
TCA_t		-1.439***		-1.252***	-1.206***	-1.233***
		(-4.82)		(-3.48)	(-3.26)	(-3.37)
ROA_t		-0.709		-1.445*	-1.522**	-1.532**
		(-1.34)		(-1.93)	(-2.12)	(-2.13)
SUE_t		0.015		0.043***	0.048***	0.048***
		(1.48)		(3.04)	(3.00)	(3.02)
$BETA\_ROA_t$		0.008		0.018*	0.017	0.017
		(0.91)		(1.73)	(1.49)	(1.45)
Acc_Q_t			4.087***	-0.889	-0.918	-0.891
			(2.60)	(-0.59)	(-0.63)	(-0.63)
$Persist_t$			0.044	-0.042	-0.047	-0.038
			(0.87)	(-0.73)	(-0.82)	(-0.68)
$Predict_t$			0.757	-0.165	-0.445	-0.351
			(0.77)	(-0.22)	(-0.46)	(-0.38)
$Relevance_t$			-0.184**	-0.202**	-0.211**	-0.215**
			(-1.99)	(-2.07)	(-2.11)	(-2.13)
$Smooth_t$			0.087	-0.039	-0.038	-0.043
			(1.50)	(-0.77)	(-0.66)	(-0.75)
$Timely_t$			-0.047	0.163*	0.174*	0.181**
			(-0.54)	(1.74)	(1.92)	(1.98)
$Conserv_t$			0.002	0.001	0.001	0.001
			(1.30)	(0.79)	(0.92)	(0.83)
$DUVOL_t$					0.371***	
					(4.19)	
$NCSKEW_t$						0.156***
						(3.33)
EDF_t					0.014	0.014
					(0.13)	(0.13)
VOL_ROA_t					0.302	0.239
					(0.28)	(0.24)
Intercept	1.661***	2.284***	1.006**	2.003***	2.118***	2.122***
	(3.24)	(4.36)	(2.34)	(4.53)	(4.86)	(4.81)
Obs.	822,794	817,384	555,369	551,770	551,381	551,381
Adjusted R^2	5.68%	9.42%	6.30%	10.27%	10.47%	10.47%

Panel A reports the difference in average subsequent monthly excess returns between top and bottom EDR decile portfolios. Monthly excess returns are measured as raw monthly returns over the US 1-month T-bill rate. Panel B reports estimation results from Fama and MacBeth (1973) regressions of future monthly excess percentage returns on EDR and control variables, following Eq. (7). Appendix 3 provides detailed variable definitions

***, **, and * Statistical significance at 1, 5, and 10 % levels, respectively, and *t* statistics are in parentheses and calculated using the Newey and West (1987) correction controls in asset pricing tests and firm fundamentals in Model 2; earnings attributes in Model 3; the combination of the two sets of controls in Model 4; and additional controls for return downside risk and other relevant risk measures in Models 5 and 6. Across Models 2–6, the estimated coefficients on *EDR* vary between 2.218 and 4.099, with their *t* statistics between 2.40 and 3.06. These results are also economically significant: a one standard deviation increase in *EDR* is associated with an increased monthly excess return of 17.50–32.40 basis points across the different model specifications (or 2.12–3.96 % per year). Thus, Panel B indicates that EDR is positively associated with cost of capital, incremental to the pricing effects of a battery of control variables. The results also suggest that the positive premium to EDR documented in Panel A is robust to adding control variables based on stock or accounting information or both.

Consistent with our prediction, Table 5 reveals a positive link between EDR and cost of capital, in terms of statistical and economic significance, and this link is incremental to various accounting- and stock-based measures following prior research.

6 Additional analyses

6.1 Cost of capital implications for alternative measurement schemes

We test the sensitivity of our cost of capital analyses to six alternative measurement schemes underlying EDR. First, we replace the ROA expectation from Eq. (2) with either previous-year industry mean of ROA or zero ROA, both of which are possible benchmarks used by managers and investors in performance comparison. We denote the relative root lower partial moment estimates based on these alternative benchmarks as *EDR_ind* and *EDR_neg*, respectively. Second, the earnings expectation model relies on realized ROA data to generate ex post unexpected earnings for EDR measurement. We also consider a set of ex ante EDR measures. We follow Miller and Reuler (1996) and employ analysts' consensus forecasts of earnings per share (EPS) to obtain ROA expectations that capture information about future fundamentals. More specifically, we calculate forward-looking ROAs by multiplying the analysts' consensus forecasts of EPS (retrieved from IBES) by the number of shares outstanding and dividing this product by total assets. We then adopt prior firm-specific ROA, prior industry average ROA, and zero ROA as alternative ROA benchmarks for the analyst-based consensus forecasts and construct ex ante EDR measures denoted as *EDR_ibes1*, *EDR_ibes2*, and *EDR_ibes3*, respectively. Third, we examine whether the EDR-return relation is sensitive to constructing EDR without scaling by its corresponding upside potentials by using *EDR_undeflat*, which denotes the root lower partial moment earnings estimate undeflated by its upper counterpart.

Table 6 reports Fama–MacBeth baseline regression results using these alternative EDR measures. The results show that the alternative EDR measures—ex post (*EDR_ind* and *EDR_neg*), ex ante (*EDR_ibes1*, *EDR_ibes2*, and *EDR_ibes3*), and undeflated (*EDR_undeflat*)—are all significantly positively linked with cost of capital. These findings are consistent with our baseline results. Collectively,

Table 6 Additional analyses

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
EDR_ind$_t$	1.415**					
	(2.17)					
EDR_neg$_t$		1.624**				
		(2.23)				
EDR_ibes1$_t$			2.896***			
			(5.29)			
EDR_ibes2$_t$				2.150***		
				(5.11)		
EDR_ibes3$_t$					2.992***	
					(5.29)	
EDR_undeflat$_t$						2.340**
						(2.05)
MVE$_t$	-0.221***	-0.221***	-0.157***	-0.158***	-0.157***	-0.219***
	(-7.36)	(-7.34)	(-4.43)	(-4.46)	(-4.42)	(-7.32)
BM$_t$	0.187***	0.185***	0.090	0.103	0.092	0.205***
	(2.70)	(2.68)	(0.82)	(0.94)	(0.84)	(2.97)
MOM$_t$	-0.014	-0.013	-0.054	-0.017	-0.054	-0.014
	(-0.10)	(-0.09)	(-0.30)	(-0.09)	(-0.30)	(-0.10)
MKTbeta$_t$	0.181**	0.182**	0.136	0.159	0.137	0.174**
	(2.13)	(2.15)	(1.28)	(1.50)	(1.30)	(2.03)
SMBbeta$_t$	-0.054	-0.055	0.067	0.084	0.068	-0.052
	(-1.08)	(-1.10)	(0.86)	(1.09)	(0.87)	(-1.05)
HMLbeta$_t$	0.048	0.047	0.075	0.080	0.074	0.047
	(0.90)	(0.89)	(1.04)	(1.13)	(1.03)	(0.89)
UMDbeta$_t$	-0.202***	-0.199***	-0.153*	-0.157**	-0.152*	-0.195***
	(-3.09)	(-3.04)	(-1.92)	(-2.00)	(-1.92)	(-2.96)
TCA$_t$	-1.588***	-1.592***	-1.533***	-1.447***	-1.536***	-1.439***
	(-4.97)	(-4.98)	(-4.79)	(-4.55)	(-4.79)	(-4.79)
ROA$_t$	-0.302	-0.214	0.220	-1.280**	0.200	-0.828*
	(-0.54)	(-0.38)	(0.42)	(-2.53)	(0.38)	(-1.73)
SUE$_t$	0.007	0.006	0.008	0.015	0.008	0.012
	(0.69)	(0.63)	(0.71)	(1.23)	(0.71)	(1.16)
BETA_ROA$_t$	0.006	0.006	0.027	0.029*	0.027	0.009
	(0.64)	(0.62)	(1.64)	(1.83)	(1.64)	(0.97)
Intercept	1.980***	2.287***	1.799***	1.828***	1.925***	2.160***
	(3.56)	(4.35)	(3.83)	(3.91)	(4.12)	(4.18)
Obs.	817,384	817,384	459,625	459,625	459,625	817,384
Adjusted R^2	9.47%	9.47%	13.62%	13.61%	13.63%	9.47%

The table presents robustness tests from Fama–MacBeth regressions, following Eq. (7), of future monthly excess percentage returns on six alternative EDR measures: *EDR_ind*$_t$ and *EDR_neg*$_t$ that replace the ROA expectation estimated from Eq. (2) with previous-year industry mean of ROA and zero ROA, respectively; *EDR_ibes1*$_t$, *EDR_ibes2*$_t$, and *EDR_ibes3*$_t$ based on expected ROA using analysts' consensus forecasts; and *EDR_undeflat*$_t$ that we calculate without scaling by Upper in Eq. (8). Appendix 3 provides detailed variable definitions

***, **, and * indicate statistical significance at 1, 5, and 10 % levels, respectively, and *t* statistics are in parentheses and calculated using the Newey and West (1987) correction

evidence in Table 6 suggests that the positive relation between EDR and cost of capital is robust to alternative EDR measurement schemes.[11]

[11] The effects of *EDR_ibes1*, *EDR_ibes2*, and *EDR_ibes3* on the cost of capital appear stronger than those of *EDR_ind* and *EDR_neg*. However, analysts' forecast data are only available for about half of our sample, and hence we do not adopt these measures in our main tests.

6.2 Other analyses

We conduct five additional analyses, untabulated for brevity. First, we control for cash-flow news by subtracting it from realized returns to measure cost of capital (e.g., Botosan et al. 2011; Ogneva 2012). Second, we repeat the cost of capital analyses by (a) using the return downside beta following Ang et al. (2006) to replace the market beta, (b) adding special items as an additional control variable following Dechow and Ge (2006), and (c) measuring EDR using an indicator variable that equals one if ROA falls below its expected level estimated from Eq. (2) and zero otherwise.[12] Third, we estimate pooled OLS regressions as an alternative to the monthly Fama–MacBeth regressions of excess stock returns. Our inferences from these three additional analyses are unchanged relative to those we report above. Fourth, earnings are comprised of two components: accruals and operating cash flows, which can contribute differently to the downside risk of earnings due to the fundamental role of accrual accounting. Specifically, accruals and cash flows from operations reflect different features of the accounting process, suggesting that realizations and expectations of accruals may provide more accurate forecasts of future performance than those of cash flows (e.g., Barth et al. 2001; Callen and Segal 2004). Also, losses from downward patterns often manifest in a timely manner through accruals (e.g., Dechow 1994; Dechow et al. 1998). In particular, relative to cash flows from operations, accruals can incorporate future downward performance into earnings more timely when expectations exist about downward patterns in firms' operating performance. Thus, the nature of accrual accounting dictates that accruals-based downside risk can more accurately and timely reflect downside volatility in firms' fundamentals relative to downside risk from cash flows from operations. As a result, we propose that the link between EDR and cost of capital is more related to accrual downside risk. Accordingly, we construct downside risk measures based on accruals and cash flows from operations using the estimation similar to that we use to construct *EDR*, where we estimate deviations as residuals from expectation models of accruals and cash flows from operations and estimate cost of capital regressions for Fama and French (1997) industries over 3-year rolling windows. In untabulated results we find that the cost of capital implications for EDR are mainly attributable to accrual downside risk, pointing to the role of accrual accounting in capturing firms' fundamental risk. Our last additional analysis examines the debt pricing implications of EDR. Although we focus on risk from the perspective of equity holders and thus on the cost of equity capital, EDR can be priced in debt markets where debt holders are asymmetrically sensitive to negative shocks relative to positive ones because their upside payoff is generally limited. We follow Francis et al. (2005) and use interest expense as a percentage of interest-bearing debt as a proxy for cost of debt capital. We then estimate a cost of debt capital regression model similar to that in Table 6 and find a significantly positive relation between EDR and cost of debt.

[12] We also consider earnings skewness as an additional variable when relevant in our correlation and regression analyses (specifically in Table 4, Panels B and C, and in Tables 5, 6). We measure earnings skewness using the skewness coefficient of earnings for every firm-year in our sample, calculated over 10-year rolling windows. We find significantly positive contemporaneous correlation between EDR and earnings skewness and unchanged inferences about EDR when earnings skewness is added in the regressions. Because earnings skewness is not commonly used as a risk measure in the literature, while we focus on the incremental information in EDR relative to common risk measures from prior research, we do not tabulate these findings.

7 Conclusion

The ability of financial statements to reflect underlying risk has long been a notable topic of high interest to researchers and practitioners (e.g., Beaver et al. 1970; Beaver 1997). As Beaver and Manegold (1975) explain: "The issue of what information affects assessments of risk is an important topic, because it is one aspect of value of information at both the private and social level. Given that real resources are expended in the generation of information, such as financial statement data, evidence on the relationship between such information and risk assessments bears directly upon the information decisions made by firms' managements and by regulatory bodies." In this study, we hypothesize that earnings downside risk (EDR), which measures the expectation for future downward operating performance using firms' financial statements, contains distinct information about firms' downside fundamental risk and varies with firms' cost of capital.

Consistent with the validity of the EDR measure in capturing risk, we document that, relative to low EDR firms, high EDR firms experience more negative subsequent operating performance, have higher sensitivities to downward macroeconomic states, and are more strongly linked to contemporaneous earnings attributes and other risk-related measures identified in prior research. In line with our predictions, we also document that EDR explains cross-sectional variation in cost of capital and incrementally so relative to several earnings attributes, accounting and risk factor betas, return downside risk, default risk, earnings volatility, and firm fundamentals. Overall, this study contributes to accounting research by demonstrating the key valuation and risk assessment roles of earnings downside risk derived from firms' financial statements, also shedding new light on the link between accounting and the macroeconomy.

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Appendix 1: Root lower partial moments

A long line of research spanning decades has studied cases where there is a possibility for realizing an outcome that is worse than some specified level. For example, Markowitz (1952, 1959) suggests semi-variance as a risk measure. Another example is Tobin (1958) who investigates conditions under which variance is a valid risk measure. Other authors (e.g., Fama 1965a; Samuelson 1967) object to variance in the area of portfolio selection if security prices are distributed according to a non-normal stable Paretian distribution for which variance is undefined (also see, e.g., Stone 1973; Laughhunn et al. 1980).

Relatedly, according to Stone's (1973) generalized risk measure, the lower partial moment for a variable with value γ can be expressed as $\int_{-\infty}^{\tau} |\tau - \gamma|^{\alpha} f(\gamma) d\gamma$, where $\alpha \geq 0$, τ is the reference (target) level, and $f(\gamma)$ is the probability density function for γ. The moment indicator α reflects the relative importance of the magnitude of the deviation from below the reference level.[13] For $\alpha = 2$, this moment corresponds to the lower partial second moment, with its discrete case equals to $\left(\frac{1}{N}\right) \sum_{\gamma < \tau} (\tau - \gamma)^2$ where N is the number of sample observations.

The lower partial moment allows flexible target levels and is applicable to any arbitrary distribution, which differs from semi-variance where the reference level is fixed at the sample mean (e.g., Markowitz 1959). Prior research across different areas has employed the lower partial moment framework. For example, in an experimental study on individual investors' risk perception in a financial decision-making context under two different modes of information presentation (or framing), Unser (2000) finds that symmetrical risk measures like variance can be dismissed in favor of shortfall measures like lower partial moments.

Several other empirical and simulation studies also show the superiority of portfolio selection criteria based on mean lower partial moments relative to those based on the traditional approach based on mean–variance, under the assumption of shortfall-risk oriented investors (e.g., Nawrocki and Staples 1989; see also Unser 2000). Even for symmetric distributions, the lower partial moment can differ from semi-variance and variance if the reference level is not equal to the sample mean. Also see Biddle et al. (2015).

In addition, Stone (1973) introduces root lower partial moment that is homogeneous of degree one and thus more suitable for economic analysis. Unlike traditional moment estimations, the root lower partial moment calculates moments by including observations only in the downside fraction below a reference level rather than over the entire distribution, with the following expression for the discrete case with $\alpha = 2$: $\text{Lower}_2(\tau) = \left[\left(\frac{1}{N}\right) \sum_{\gamma < \tau} (\tau - \gamma)^2\right]^{1/2}$, where the subscript 2 refers to the second-moment case in the general lower partial moment formula. Thus, this expression represents the square root of the lower partial second moment, that is, the square root of $\left(\frac{1}{N}\right) \sum_{\gamma < \tau} (\tau - \gamma)^2$, indicating volatility below the reference level τ. Similarly, the root upper partial moment, which measures the moment when a variable value deviates above the reference level is (for the square root in the discrete case): $\text{Upper}_2(\tau) = \left[\left(\frac{1}{N}\right) \sum_{\gamma \geq \tau} (\gamma - \tau)^2\right]^{1/2}$. To construct our EDR measure, we use the relative root lower partial moment metric (LowerUpper), which deflates the root lower partial moment by its upper counterpart, as follows:

[13] This lower partial moment is a special case of Stone's (1973) three-parameter risk measure $L(\tau, \alpha, \eta) = \int_{-\infty}^{\eta} |\tau - \gamma|^{\alpha} f(\gamma) d\gamma$ (where $\alpha \geq 0$), by setting the range parameter η equal to the reference level τ (also see Fishburn 1977).

$$\text{LowerUpper}_2(\tau) = \frac{\left[\left(\frac{1}{N}\right)\sum_{\gamma<\tau}(\tau-\gamma)^2\right]^{1/2}}{\left[\left(\frac{1}{N}\right)\sum_{\gamma\geq\tau}(\gamma-\tau)^2\right]^{1/2}}. \tag{8}$$

The rationale of the relative root lower partial moment metric follows from the fact that, although risk-averse agents dislike downside states and favor upside states, higher root upper partial moment usually accompanies higher root lower partial moment. Using Upper to scale Lower controls for firm-level differences in the upside states and thus refines the comparison of downside risk across firms. Also, the relative root lower partial moment incorporates cases where investors have asymmetric reactions to downside versus upside states (for more information also see, e.g., Markowitz 1952, 1959; Tobin 1958; Fama 1965a; Samuelson 1967; Stone 1973; Fishburn 1977; Laughhunn et al. 1980; Nawrocki and Staples 1989; Unser 2000).

Appendix 2: Results from estimating earnings expectation model

Table 7 presents results from estimating unexpected (i.e., residual) earnings from the earnings expectation model in Eq. (2), using the sample data described in Sect. 4. The estimated residuals are used in the EDR construction according to

Table 7 Results from estimating earnings expectation model

Panel A: Distribution of input variables for the ROA prediction model

	Mean	SD	Median	Q1	Q3
ROA_t	0.02	0.43	0.04	0.08	0.08
ROA_{t-1}	0.02	0.43	0.04	0.08	0.08
$SALE_{t-1}$	1.04	0.93	0.90	0.38	1.44
$SIZE_{t-1}$	5.48	2.19	5.40	3.88	6.96
$LEVERAGE_{t-1}$	0.23	0.21	0.20	0.06	0.35
OC_{t-1}	4.98	1.23	4.83	4.33	5.33
STD_ROA_{t-1}	0.06	0.33	0.02	0.01	0.06

Panel B: Coefficient and R^2 estimates from the ROA prediction model

	Average coefficient	*t* statistic
ROA_{t-1}	0.48	(57.57)***
$SALE_{t-1}$	0.03	(8.85)***
$SIZE_{t-1}$	0.01	(9.49)***
$LEVERAGE_{t-1}$	−0.04	(−2.94)***
OC_{t-1}	−0.00	(−0.18)
STD_ROA_{t-1}	−0.00	(−0.01)
Intercept	−0.05	(−4.09)***
Average obs.	205	
Average adj. R^2	41.8 %	

Table 7 continued

Panel C: Distribution of predicted and unexpected earnings from the ROA prediction model

	Mean	SD	Median	Q1	Q3
Predicted earnings	0.02	0.35	0.03	0.00	0.07
Unexpected earnings	0.00	0.25	0.00	−0.02	0.03

This table reports in Panel A the descriptive statistics of input variables for the earnings expectation model according to Eq. (2) and in Panel B the average coefficients and adjusted R^2 estimated from the model using OLS regressions by industry and 3-year rolling windows. Panel C reports descriptive statistics of predicted earnings and unexpected earnings estimated from the model

Eq. (3) and following Sect. 2. Panel A reports summary statistics for the input (dependent and independent) variables in the model. Panel B reports average estimated coefficients as well as average adjusted R^2 for the regressions estimated by industry and using 3-year rolling windows.

The average estimated coefficients on lagged *ROA* and *SALE* are significantly positive, consistent with Dechow et al. (1998). *SIZE* is also significantly positively associated with earnings, consistent with prior research and the notion that big firms have competitive advantages (e.g., Hall and Weiss 1967; Fiegenbaum and Karnani 1991; Feng et al. 2015). In addition, the average adjusted R^2 is 41.8 %, demonstrating that there is a significant portion of earnings that is unexplained, which indicates a source of risk in firms' fundamentals. Our EDR measure is designed to capture this risk in the downward fraction of firms' unexpected earnings.

Panel C shows that unexpected earnings have a standard deviation of 0.25 and a mean of zero. The zero mean is consistent with the regression validity, in that the residual mean is expected to be zero under the OLS estimation. The lower quartile of unexpected earnings is about 0.08 standard deviation below its mean, whereas those of expected earnings (in Panel C) and total earnings (in Panel A) are about 0.06 and 0.03 standard deviation below their means, respectively. These findings indicate that the downside volatility of residual earnings is relatively large.

Appendix 3: Variable definitions

Earnings downside risk measure

EDR_{it}: Proxy for earnings downside risk. We calculate it for firm *i* at the fiscal year-end *t* as the natural logarithm of the ratio of one plus the root lower partial moment of earnings (Compustat: IB) over total assets (Compustat: AT), which is denoted as Lower, to one plus the root upper partial moment of earnings over total assets, which is denoted as Upper, according to Eqs. (2) and (3) in the text.

Operating performance measures

$DLOSS1_{it}$: An indicator variable that is equal to one if annual income before extraordinary items (Compustat: IB) is negative for firm *i* in fiscal year *t* and zero otherwise.

$DLOSS2_{it}$: An indicator variable that is equal to one if annual net income (Compustat: NI) is negative for firm *i* in fiscal year *t* and zero otherwise.
IBM_{it}: The ratio of annual income before extraordinary items (Compustat: IB) to total revenues (Compustat: SALE) for firm *i* in fiscal year *t*.
NIM_{it}: The ratio of annual net income (Compustat: NI) to total revenues (Compustat: SALE) for firm *i* in fiscal year *t*.
OPM_{it}: The ratio of annual operating income after depreciation (Compustat: OIADP) to total revenues (Compustat: SALE) for firm *i* in fiscal year *t*.
GPM_{it}: Annual gross profit margin ratio, calculated as the difference between total revenues (Compustat: SALE) and cost of goods sold (Compustat: COGS) divided by total revenues (Compustat: SALE) for firm *i* in fiscal year *t*.

Sensitivities to downward macroeconomic states
$beta\_negshock\_g_{t+1} - g_t$: The sensitivity of a firm's earnings scaled by total assets (Compustat: IB/AT or NI/AT) to future negative GDP changes defined as year-over-year drops in the growth of real GDP by 1 % or more, estimated by regressing scaled earnings on subsequent-year real GDP growth during periods of negative macro changes using a 5-year rolling window.
$beta\_negshock\_g_{t+1} - E_t^{SPF}(g_{t+1})$: The sensitivity of a firm's earnings scaled by total assets (Compustat: IB/AT or NI/AT) to future unexpected negative GDP shocks defined as the realizations of GDP growth falling by 3 % below expectations using SPF consensus forecasts, estimated by regressing scaled earnings on subsequent-year real GDP growth forecast errors during periods of negative macro shocks using a 5-year rolling window.
beta_recession: The sensitivity of a firm's earnings scaled by total assets (Compustat: IB/AT or NI/AT) to real GDP growth during recession periods as defined by the NBER at http://www.nber.org/cycles.html.

Measures for return downside risk, default risk, and earnings volatility
$DUVOL_{it}$: Proxy for return downside risk for firm *i* in year *t* and calculated as the natural logarithm of the ratio of standard deviation of residual returns below the mean to standard deviation of residual returns above the mean. The residual return is the natural logarithm of one plus the residual estimated from an expanded market model using monthly stock returns over a 5-year rolling window (e.g., Kim et al. 2011).
$NCSKEW_{it}$: Proxy for return downside risk for firm *i* in year *t* and calculated as negative one times the third moment of residual returns divided by the standard deviation of residual returns raised to the third power. The residual returns and estimation windows are the same as in the *DUVOL* estimation.
EDF_{it}: Proxy for default risk for firm *i* in year *t* and estimated as the expected default frequency following the procedures in Vassalou and Xing (2004).
VOL_ROA_{it}: Proxy for earnings volatility for firm *i* at fiscal year-end *t* and calculated as the standard deviation of the residuals estimated from our earnings expectation model using three to 5 years' (as available) data.

Earnings attribute measures

Acc_Q_{it}: Proxy for accrual quality for firm i at fiscal year-end t (following Dechow and Dichev 2002), calculated as the percentile ranking of standard deviation of residuals estimated from the accrual expectation model over a 10-year rolling window.

$Persist_{it}$: Proxy for earnings persistence for firm i at fiscal year-end t and calculated as the percentile ranking of negative one times the slope coefficient from an AR(1) model for the ratio of earnings to total assets (Compustat: NI/AT) over a 10-year rolling window.

$Predict_{it}$: Proxy for predictability for firm i at fiscal year-end t and calculated as the percentile ranking of the square root of the error variance estimated from an AR(1) model for the ratio of earnings to total assets (Compustat: NI/AT) over a 10-year rolling window.

$Relevance_{it}$: Proxy for value relevance for firm i at fiscal year-end t and calculated as the percentile ranking of negative one times the R^2 from the OLS regression of 12-month returns on the level and change in earnings scaled by market value of equity [Compustat: NI/(PRCC_F*CSHO)], estimated over a 10-year rolling window.

$Smooth_{it}$: Proxy for earnings smoothing for firm i at fiscal year-end t and calculated as the percentile ranking of the ratio of standard deviation of net income divided by total assets (Compustat: NI/AT) to that of OCF divided by total assets. Standard deviations are calculated over a 10-year rolling window.

$Timely_{it}$: Proxy for timeliness for firm i at fiscal year-end t and calculated as the percentile ranking of negative one times the R^2 from the reverse earnings-returns model in Basu (1997), estimated over a 10-year rolling window.

$Conserv_{it}$: Proxy for conservatism for firm i at fiscal year-end t and calculated as the percentile ranking of the ratio of the coefficient of negative returns to that of positive returns from the reverse earnings-returns coefficient model in Basu (1997), estimated over a 10-year rolling window.

Control variables for validity tests

BM_{it}: Book-to-market ratio [Compustat: SEQ/(PRCC_F*CSHO)] for stock i measured at fiscal year-end t.

MVE_{it}: Market value of equity (Compustat: PRCC_F*CSHO) for stock i at fiscal year-end t.

$CASH_{it}$: The ratio of cash holdings and cash equivalents to total assets (Compustat: CHE/AT) for firm i at fiscal year-end t.

$\Delta CASH_{it}$: The ratio of changes in cash holdings and cash equivalents to total assets (Compustat: CHCHE/AT) for firm i at fiscal year-end t.

$Invest\_CAPX_{it}$: The ratio of capital expenditures to total assets (Compustat: CAPX/AT) for firm i at fiscal year-end t.

$Invest\_RD_{it}$: The ratio of R&D expenditures to total assets (Compustat: XRD/AT) for firm i at fiscal year-end t.

$LEVERAGE_{it}$: The ratio of the sum of interest-bearing long-term and short-term debts to total assets (Compustat: (DLTT + DLC)/AT) of firm i at fiscal year-end t.

OO_{it}: The ratio of property, plant, and equipment to total assets (Compustat: PPEGT/AT) for firm i at fiscal year-end t.
ROA_{it}: The ratio of income before extraordinary items to total assets (Compustat: IB/AT) of firm i at fiscal year-end t.
$SIGMA_{it}$: Standard deviation of daily stock returns for firm i in fiscal year t.
$SLACK_{it}$: The mean of industry-adjusted ratio of inventory to total revenues (Compustat: INVT/SALE), industry-adjusted ratio of accounts receivable to total revenues (Compustat: RECT/SALE), and industry-adjusted ratio of selling, general, and administrative expenses to total revenues (Compustat: XSGA/SALE) for firm i at fiscal year-end t.
$SLACK\_emp_{it}$: Industry-adjusted ratio of the number of employees to total revenues (Compustat: EMP/SALE) for firm i at fiscal year-end t.

Cost of capital and control variables used in asset pricing tests

$RET_{it+1} - RF_{t+1}$: Proxy for the cost of equity capital of firm i in month $t+1$ and measured as the firm's raw return RET_{it+1} minus risk-free rate RF_{t+1} approximated by the US 1-month T-bill rate.
MOM_{it}: Previous buy-and-hold return of stock i and calculated as the return over the 11-month period ending 1-month prior to month t, following Carhart (1997).
$MKTbeta_{it}$: Sensitivity of stock i's return to CRSP value-weighted market return that we estimate based on monthly data over the past 60 months ending in month t.
$SMBbeta_{it}$: Sensitivity of stock i's return to the size factor of Fama and French (1993) that we estimate based on monthly data over the past 60 months ending in month t.
$HMLbeta_{it}$: Sensitivity of stock i's return to the book-to-market factor of Fama and French (1993) that we estimate based on monthly data over the past 60 months ending in month t.
$UMDbeta_{it}$: Sensitivity of stock i's return to the momentum factor of Carhart (1997) that we estimate based on monthly data over the past 60 months ending in month t.
TCA_{it}: Total accruals scaled by total assets (Compustat: TA) for firm i at fiscal year-end t. Total accruals are estimated as $(\Delta CA_{it} - \Delta CL_{it} - \Delta Cash_{it} + \Delta STDEBT_{it} + \Delta TP_{it} - DP_{it})$, where ΔCA_{it}, ΔCL_{it}, $\Delta Cash_{it}$, $\Delta STDEBT_{it}$, and ΔTP_{it} are 1-year changes in current assets (Compustat: ACT), current liabilities (Compustat: LCT), cash and short-term investments (Compustat: CHE), short-term debt (Compustat: DLC), and income tax payable (Compustat: TXP), respectively, for firm i in fiscal year t. DP_{it} is depreciation expense (Compustat: DP) for firm i in fiscal year t.
SUE_{it}: Proxy for earnings surprises, estimated as unexpected earnings [*ROA* of fiscal year t minus expected *ROA* from Eq. (2)] scaled by the standard deviation of the unexpected earnings.
$BETA\_ROA_{it}$: The sensitivity of earnings scaled by market value of equity [Compustat: IB/(PRCC_F*CSHO)] to the value-weighted aggregate earnings scaled by market value of equity, calculated over a 10-year rolling window, following prior research (e.g., Beaver et al. 1970).

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