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Estimation risk and auditor conservatism

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Abstract Estimation risk occurs when individuals form beliefs about parameters that are unknown. We examine how auditors respond to the estimation risk that arises when they form beliefs about the likelihood of client bankruptcy. We argue that auditors are likely to become more conservative when facing higher estimation risk because they are risk-averse. We find that estimation risk is of first-order importance in explaining auditor behavior. In particular, auditors are more likely to issue going-concern opinions, are more likely to resign, and charge higher audit fees when the standard errors surrounding the point estimates of bankruptcy are larger. To our knowledge, this is the first study to quantify estimation risk using the variance-covariance matrix of coefficient estimates taken from a statistical prediction model.

Keywords Accounting estimates · Estimation risk · Bankruptcy · Going concern opinion · Auditor resignations · Audit fees

JEL classification M41 · M42 · G33

1 Introduction

Many accounting variables represent estimates of future outcomes. For example, the bad debt expense, pension liabilities, and depreciation expense all reflect managers' estimates of the future. In fact, many accounting variables are labeled as estimates, such as earnings forecasts and estimated contingent liabilities. Therefore decision-making under conditions of uncertainty is of fundamental importance in accounting. When individuals make predictions they must form beliefs about unknown parameters (Von Neumann and Morgenstern 1967). This entails estimation risk. Estimation risk matters

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because it alters the behavior of risk-averse individuals (Klein and Bawa 1976). This study shows that estimation risk has a large impact on the degree of conservatism exhibited by risk-averse auditors.

We focus on the estimation risk associated with predicting bankruptcy because auditors can incur substantial losses from litigation and reputation impairment when their clients file for bankruptcy (Palmrose 1987; Carcello and Palmrose 1994; Lys and Watts 1994; U.S. House of Representatives 1985, 1990; Firth 1990; Weil 2001; House of Lords 2011). These losses mean that it is important for auditors to form accurate expectations about the likelihood of bankruptcy. Estimation risk arises because the probability that a client will file for bankruptcy is not known. Instead, the probability must be estimated. The level of estimation risk captures the degree of imprecision in the point estimates of bankruptcy. We argue that estimation risk is likely to have a significant impact on auditor behavior because auditors are risk averse.

To clarify the distinction between bankruptcy risk and estimation risk, it is helpful to introduce some notation. Let B^* represent the risk that a company will file for bankruptcy in the future, where B^* is uncertain and therefore must be estimated. Let $\hat{B}^*$ represent the best point estimate of B^*. We measure estimation risk using the *standard errors* of the point estimates, ($SE\left(\hat{B}^*\right)$), because the standard errors reflect the precision of each point estimate. In particular, $\hat{B}^*$ is a less precise measure of the company's bankruptcy risk when $SE\left(\hat{B}^*\right)$ is larger, i.e., when there is more uncertainty surrounding the point estimate. When estimation risk ($SE\left(\hat{B}^*\right)$) is higher, it is more probable that the point estimate ($\hat{B}^*$) will turn out to be incorrect ex post, which imposes incremental risk upon risk-averse auditors.

To illustrate, consider two companies, Y and Z, that have the same point estimates of bankruptcy risk (i.e., $\hat{B}^{*y} = \hat{B}^{*z}$), but company Z has higher estimation risk, i.e., $SE\left(\hat{B}^{*z}\right) > SE\left(\hat{B}^{*y}\right)$. The higher estimation risk implies greater uncertainty in predicting Z's future bankruptcy status than predicting Y's future bankruptcy status, even though both companies have the same point estimates of bankruptcy. This uncertainty is expected to be important in explaining auditor behavior because auditors are risk averse.[1] Risk-averse auditors will respond differently to companies Y and Z because Z has greater estimation risk, even though they have the same point estimates of bankruptcy risk.

We expect that estimation risk causes risk-averse auditors to behave more conservatively. In particular, we predict that auditors respond to greater estimation risk by a) issuing more going-concern opinions, b) resigning more often from audit engagements, and c) charging higher audit fees. We test these predictions after controlling for the point estimates of bankruptcy ($\hat{B}^*$) to ensure that our estimation risk variable ($SE\left(\hat{B}^*\right)$) captures the incremental effect of estimation risk on auditor behavior.

[1] Our assumption that auditors are risk averse is consistent with risk-averse individuals self-selecting to enter the auditing profession (Davidson and Dalby 1993). It is also consistent with analytical models in which auditors are assumed to be risk averse (Baiman et al. 1987; Balachandran and Ramakrishnan 1987; Baiman et al. 1991).

A key premise of our study is that auditors are risk averse. However, this premise may not be true for several reasons. First, audit firms can insure against the losses that arise from litigation after clients file for bankruptcy. Second, they can mitigate idiosyncratic client-specific risks by spreading the risks across diversified portfolios of clients.[2] Even if auditors are risk averse, it is far from obvious that estimation risk will have an economically significant impact on their behavior. The ($SE\left(\hat{B}^*\right)$) variable is a second-moment risk because it measures the estimation uncertainty surrounding the point estimates of bankruptcy. In contrast, $\hat{B}^*$ is a first-moment risk because it measures the point estimates of bankruptcy. While prior research has shown that the first moment ($\hat{B}^*$) has an economically significant impact on auditor behavior, it is unclear whether the second moment ($SE\left(\hat{B}^*\right)$) also has an economically significant impact.

Our empirical analysis begins by estimating bankruptcy prediction models, which yield the point estimates of bankruptcy $\left(\hat{B}^*\right)$ and the standard errors surrounding the point estimates ($SE\left(\hat{B}^*\right)$) for each observation in the sample. The covariates in the bankruptcy models include measures of financial distress, such as profitability, leverage, liquidity, stock returns, return volatility, age, institutional ownership, and distance to default that are commonly used in bankruptcy prediction studies (e.g., Bharat and Shumway 2008; Beaver et al. 2012). Next, we confirm the evidence from prior research that the point estimates of bankruptcy risk, $\hat{B}^*$, affect auditors' going-concern decisions, resignation decisions, and audit fees. In particular, auditors are more likely to issue going-concern opinions, are more likely to resign, and charge higher audit fees when companies are more likely to go bankrupt.[3]

We then test our three hypotheses relating to the incremental effect of estimation risk. First, we test whether estimation risk ($SE\left(\hat{B}^*\right)$) explains auditors' going-concern reporting decisions. Consistent with our first hypothesis, we find highly significant positive coefficients on $SE\left(\hat{B}^*\right)$ in the going-concern reporting models. This is consistent with risk-averse auditors issuing more conservative audit reports when there is higher estimation risk. Second, we test whether estimation risk ($SE\left(\hat{B}^*\right)$) incrementally explains auditors' resignation decisions. We find that $SE\left(\hat{B}^*\right)$ is positively and significantly related to resignations. That is, auditors are more likely to resign when there is more uncertainty surrounding the point estimates of bankruptcy. Finally, consistent with our third hypothesis, we show that auditors charge significantly higher audit fees when estimation risk is higher.

[2] In Section 2, we explain that insurance and diversification are unlikely to render auditors completely risk neutral.

[3] There is evidence that audit firms use bankruptcy prediction models to assess companies' financial health (Eidleman 1995; Johnstone et al. 2016, p. 677). Even if an audit firm does not formally use a bankruptcy prediction model, we expect that the point estimates and standard errors are likely to correlate with auditors' rational beliefs about the expected likelihood of bankruptcy and the uncertainty that surrounds this likelihood.

Although the ($SE\left(\hat{B}^{*}\right)$) variable is a second-moment risk, we show that it has an economically significant impact on auditor behavior. For instance, we calculate the likelihood of an auditor issuing a going-concern opinion as $SE\left(\hat{B}^{*}\right)$ increases from the tenth percentile to the ninetieth percentile, holding all other variables (including the point estimates) constant. As $SE\left(\hat{B}^{*}\right)$ increases over this range, the likelihood of a going-concern opinion increases approximately *threefold*, from 2.6% to 7.5%. Similarly, the likelihood of an auditor resignation approximately *doubles* as $SE\left(\hat{B}^{*}\right)$ increases from the tenth percentile to the ninetieth percentile. Audit fees increase by 7.4% as $SE\left(\hat{B}^{*}\right)$ increases from its tenth percentile value to the ninetieth percentile. Thus estimation risk is of fundamental importance in understanding the behavior of auditors under conditions of uncertainty.

In a supplementary analysis, we argue that estimation risk matters more when companies are moderately distressed, rather than when they are financially healthy or severely distressed. This is becasuse an auditor is more likely to worry about the imprecision in the point estimates of bankruptcy when a company has a moderate level of distress. Consistent with this, we find that $SE\left(\hat{B}^{*}\right)$) significantly explains auditors' going-concern reporting decisions, their resignation decisions, and audit fees when companies are moderately distressed. In contrast, $SE\left(\hat{B}^{*}\right)$) is a weak or insignificant predictor of auditor behavior when companies are financially healthy or severely distressed. These findings reinforce our main result that auditors act conservatively in situations where estimation risk is likely to matter most.

This study makes two contributions to the literature. First, we contribute to the auditing literature by showing that auditors are more conservative when they are faced with higher estimation risk. Prior studies examine how auditor behavior is affected by the point estimates of bankruptcy.[4] We show that auditors also respond to the estimation risk that surrounds the point estimates. Thus it is not only the point estimates of bankruptcy ($\hat{B}^{*}$) that matter but also the uncertainty that surrounds the point estimates ($SE\left(\hat{B}^{*}\right)$). This is consistent with our theory that risk-averse auditors respond to elevated levels of estimation risk.

Second, our study is the first to quantify estimation risk using the variance-covariance matrix of coefficient estimates taken from a statistical prediction model. In prior research, estimation risk has been measured using the volatility in past realizations of the variable whose future value is to be predicted. For example, the volatility of *past* earnings has been used to measure the uncertainty that managers face when they forecast *future* earnings (e.g., Waymire 1985). In many settings, however, estimation risk cannot be inferred from past volatility. For

[4] Research shows that the point estimates of bankruptcy risk are highly significant in explaining the auditor's decision to issue a going-concern opinion (Mutchler 1985; Dopuch et al. 1987; Carcello and Neal 2000; DeFond et al. 2002; Carcello et al. 2009) or to resign from the engagement (Krishnan and Krishnan 1997; Ghosh and Tang 2015).

example, there is zero volatility in past bankruptcy outcomes for a company that has never previously gone bankrupt, but this does not mean there is zero estimation risk when estimating the company's *future* risk of bankruptcy. Even if a company has never gone bankrupt, there is significant uncertainty when predicting whether the company will go bankrupt. Therefore past realizations of the dependent variable are not always reliable for inferring estimation risk. We show that estimation risk can easily be calculated using the variance-covariance matrix of coefficient estimates together with company characteristics. We expect that our approach can be used in many other accounting settings where estimation risk is expected to affect the behavior of risk-averse agents.

The remainder of the paper is organized as follows. The next section develops the three hypotheses. The third section describes the research design, and the fourth section presents the sample and reports our main results. Section five reports the results from several supplementary analyses. Section six concludes.

2 Hypotheses

Prior research demonstrates that auditor behavior is affected by the *point estimates* of bankruptcy risk. For example, the audit reporting literature points out that auditors issue going-concern opinions when the point estimates of bankruptcy risk are higher (Mutchler 1985; Dopuch et al. 1987; Carcello and Neal 2000; DeFond et al. 2002; Carcello et al. 2009). Similarly, research on auditor resignations shows that bankruptcy risk is a key determinant of an auditor's decision to resign from an engagement (Krishnan and Krishnan 1997; Ghosh and Tang 2015).

An auditor faces the prospect of incurring losses (L) if its client enters bankruptcy. These losses occur because client bankruptcy increases the likelihood of an auditor being sued or incurring reputation losses (Palmrose 1987; Carcello and Palmrose 1994; Lys and Watts 1994; U.S. House of Representatives 1985, 1990; Firth 1990; Weil 2001; House of Lords 2011). Even if an auditor is certain about the amount of loss, L, there is some estimation risk because the auditor does not know for sure the client's probability of bankruptcy. Instead, the auditor must estimate the probability, which is the source of estimation risk.

For example, suppose the probability of bankruptcy is unknown but is believed to be either p_1 or p_2. If the true bankruptcy probability is p_1, the auditor's expected loss from bankruptcy is p_1 L; on the other hand, if the true bankruptcy probability is p_2, the auditor's expected loss from bankruptcy is p_2 L. Estimation risk occurs because the auditor does not know for sure whether the likelihood of bankruptcy is p_1 or p_2. Thus the auditor is unsure whether the expected loss from bankruptcy is p_1 L or p_2 L. In this simple example, a larger difference between p_1 and p_2 represents greater estimation risk. There is zero estimation risk when $p_1 = p_2$ because, in this situation, the auditor knows that the true probability of bankruptcy is $p_1 = p_2$.[5]

Without loss of generality, assume a 50:50 chance that p_1 is the true probability of bankruptcy and a 50:50 chance that p_2 is the true probability of bankruptcy. As p_1 and

[5] The case of zero estimation risk does not mean that the auditor knows whether the company will go bankrupt. It only means that the auditor knows the ex ante probability of bankruptcy. Therefore bankruptcy risk exists even in the absence of any estimation risk.

p_2 are equally likely, the best point estimate of the probability of bankruptcy is simply $(p_1 + p_2)/2$. Borrowing from the economics literature, we refer to $(p_1 + p_2)/2$ as the "certainty equivalent" bankruptcy probability. In turn, the auditor's certainty equivalent expected loss from bankruptcy is $(p_1 + p_2)$ L /2.

The utility function of a risk-averse auditor is illustrated in Fig. 1. The auditor's utility is a declining function of the expected loss from bankruptcy (i.e., the utility function has a negative slope, $U'(.) < 0$). Furthermore, the auditor's utility is declining at an increasing rate because the auditor is assumed to be risk averse (i.e., $U''(.) < 0$). As shown in Fig. 1, the assumption of risk aversion is equivalent to assuming that $U((p_1 + p_2)L/2) > 0.5\ U(p_1L) + 0.5\ U(p_2L)$. In other words, the auditor obtains higher utility when there is no estimation risk (i.e., when the auditor knows for sure that the expected loss is $(p_1 + p_2)L/2$), compared with when the auditor is unsure whether the expected loss is p_1L or p_2L).

The theoretical literature in economics shows that risk-averse individuals are willing to buy insurance to reduce the magnitude of the loss, *L*. Similarly, we expect that risk-averse auditors take steps to mitigate the losses associated with client bankruptcy (*L*). In particular, auditors can mitigate the losses (i.e., reduce the magnitude of *L*) in three ways: a) issuing going-concern opinions, b) resigning, and c) exerting greater effort.

We note that these conservative auditor responses are costly (just as purchasing insurance is costly). Issuing a going-concern opinion is costly because it increases the likelihood of client dismissal. Resigning is costly because the auditor ceases to earn fees from the client. Exerting more effort is also costly. While these strategies are costly, they are beneficial in terms of reducing the losses associated with client bankruptcy (i.e., they reduce the magnitude of *L*). Our main insight is that risk-averse auditors are more likely to adopt these risk-management strategies when estimation risk is higher.

Estimation risk makes it harder to predict whether a company will survive or go bankrupt. Therefore, when faced with greater estimation risk, a risk-averse auditor will

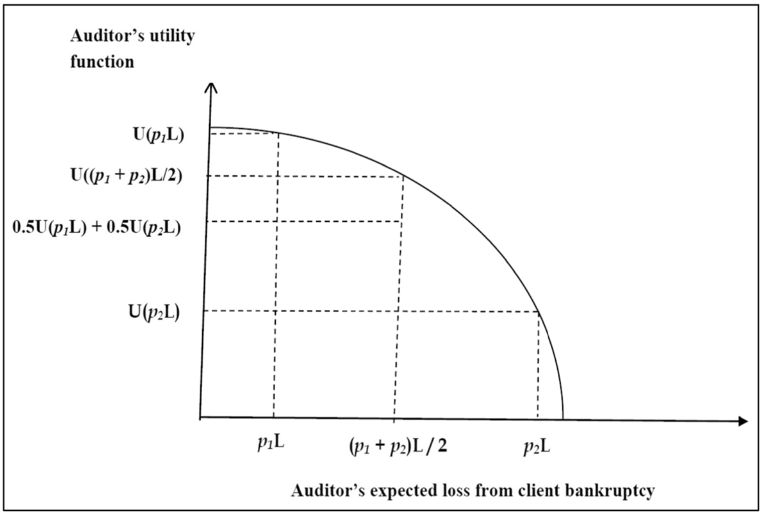

Fig. 1 The utility function of a risk-averse auditor. *L* = the losses incurred by an auditor when a client files for bankruptcy. The probability of bankruptcy is either p_1 or p_2. The above figure assumes a 50:50 chance that p_1 is the true probability of bankruptcy and a 50:50 chance that p_2 is the true probability of bankruptcy. The auditor does not know whether the true probability is p_1 or p_2 and so the auditor faces estimation risk

err on the side of caution by being more likely to issue a going-concern opinion. This leads to our first hypothesis.

HYPOTHESIS 1: *After controlling for the point estimate of bankruptcy, an auditor is more likely to issue a going-concern opinion when the standard error of the point estimate is higher.*

A similar logic applies to auditor resignations, which are another tool that auditors can use to manage risk. When faced with greater estimation risk, a risk-averse auditor will err on the side of caution by being more likely to resign.

HYPOTHESIS 2: *After controlling for the point estimate of bankruptcy, an auditor is more likely to resign when the standard error of the point estimate is higher.*

Finally, we expect that a risk-averse auditor will exert more effort and charge a higher risk premium when there is greater estimation risk. Therefore we predict a positive association between estimation risk and audit fees.

HYPOTHESIS 3: *After controlling for the point estimate of bankruptcy, audit fees are higher when the standard error of the point estimate is higher.*

All three hypotheses are predicated on a maintained assumption that auditors are risk averse. However, this assumption may not necessarily be true because audit firms can obtain professional indemnity insurance for litigation losses. Moreover, audit firms can mitigate idiosyncratic client risks by spreading them across diversified portfolios of clients. To the extent that auditors are not risk averse, we would not expect to find significant results for H1, H2, and H3.

We expect that audit firms are risk averse despite the availability of insurance and diversification. One reason is that audit firms are not *fully* insured against the risks of client bankruptcy. If audit firms were fully insured, they would have little incentive to supply high quality audits. Insurers avoid this moral hazard problem by providing audit firms with partial, rather than full, coverage. Moreover, while audit firms can insure against the losses from litigation, they cannot insure against the losses from damage to their *reputations*. Therefore reputational concerns will tend to make them more risk averse.

In addition, there are limitations to using portfolio diversification for risk management. First, audit firms' portfolios may not be fully diversified, as these firms specialize in certain types of clients to develop reputations for expertise. Second, the client portfolio of an individual partner is much less diversified than the client portfolio of the partner's audit firm. Therefore an individual partner is likely to be risk averse due to undiversified client-specific risks.[6]

[6] While an audit firm would want its partners to act in the best interests of the firm, in practice, many decisions are delegated to individual partners because audit firms cannot perfectly monitor the actions of individual partners. Consistent with firms delegating key decisions to partners, empirical research finds that audit outcomes are significantly affected by the characteristics of individual partners (Gul et al. 2013; Knechel et al. 2015). Moreover, partners are compensated based on the outcomes of their own audits as well as the audits of the entire firm (Knechel et al. 2013). Therefore audit outcomes are likely to be shaped by partners' own risk preferences as well as the risk preferences of their firms.

3 Research design

3.1 Measuring estimation risk ($SE(\hat{B}^*)$)

Let B^* represent the propensity that a company will file for bankruptcy in the future. A bankruptcy prediction model can be written as follows:

$$B^* = \alpha X + u \tag{1}$$

Eq. (1) has a vector of parameters (α), an error term (u), and a set of independent variables, X (including an intercept). The B^* variable is not observed but a bankruptcy dummy variable, B, is observed ex post. The mapping between B^* and B is defined as follows: $B^* \geq 0$ if B = one and $B^* < 0$ if B = zero.

Because B^* is unobservable, the variance of B^* is also unobservable. The binary variable, B, is observable, but past values of B cannot be used to measure estimation risk. This is because a company that has never gone bankrupt has only zero values for B, but this does not mean there is zero estimation risk when predicting the company's future bankruptcy status.

Although B^* is unobservable, estimating Eq. (1) yields point estimates of B^*; namely $\hat{B}^* = \hat{\alpha} X$. Each point estimate has some degree of estimation risk because the parameters of eq. (1) are unknown and therefore must be estimated. Each coefficient estimate ($\hat{\alpha}$) has a standard error that reflects the precision with which the coefficient is estimated. A higher standard error means the coefficient is estimated with less precision, implying greater estimation risk. The coefficient standard errors are simply the square roots of the leading diagonal entries of the estimated variance-covariance matrix of the coefficient estimates ($\hat{V}_{\hat{\alpha}}$). We use the variance-covariance matrix to compute the standard errors of the point estimates, i.e., $SE(\hat{B}^*)$. The value of $SE(\hat{B}^*)$ for the n'th observation in the sample is the square root of $X_n \hat{V}_{\hat{\alpha}} X_n'$, where X_n is a vector containing the values of the X variables for the n'th observation in the sample (Baum 2006).[7] Thus $SE(\hat{B}^*)$ captures the squared normalized distance of a data point from the centroid of the X variables (i.e., the first and third terms in $X_n \hat{V}_{\hat{\alpha}} X_n'$), where these distances are weighted by the variances of the coefficients on the X variables (i.e., the second term in $X_n \hat{V}_{\hat{\alpha}} X_n'$). In contrast, the point estimates ($\hat{B}^*$) capture the distance of a data point from the centroid of the X variables (the second term in $\hat{\alpha} X$), where these distances are weighted by the coefficients on the X variables (the first term in $\hat{\alpha} X$). Therefore bankruptcy risk ($\hat{B}^*$) and estimation risk ($SE(\hat{B}^*)$) are conceptually distinct (and in our sample they are negatively correlated with each other). For example, even if companies Y and Z have the same point estimates of bankruptcy, company Z would tend to have higher estimation risk

[7] X_n is a $1 \times k$ vector while $\hat{V}_{\hat{\alpha}}$ is a $k \times k$ matrix, where k corresponds to the number of X variables in the bankruptcy prediction model. In Stata, the values of SE($\hat{B}^*$) are obtained using the command: "predict [*varname*], stdp" after estimating the bankruptcy prediction model. For further details, see www.stata.com/statalist/archive/2004-04/msg00752.html.

than company *Y* if *Y*'s bankruptcy risk is driven by average values of the *X* variables, while *Z*'s bankruptcy risk is driven by abnormal values of the *X* variables that have offsetting effects (e.g., *Z* has large losses but also has low leverage). In this example, there is more uncertainty surrounding *Z*'s point estimate of bankruptcy because *Z*'s large losses suggest high bankruptcy risk, whereas *Z*'s low leverage suggests low bankruptcy risk.

Next, Fig. 2 shows how estimation risk ($SE(\hat{B}^*)$) affects the utilty function of a risk-averse auditor. Note that Fig. 2 shows the point estimates of bankruptcy ($\hat{B}^*$) and the standard errors of the point estimates ($SE(\hat{B}^*)$), rather than the predicted bankruptcy probabilities ($\hat{p}$) and the standard errors of the predicted probabilities ($SE(\hat{p})$).[8] This is because it is possible to calculate the standard errors of $\hat{B}^*$ using the variance-covariance matrix of the coefficient estimates as described above, whereas it is not possible to compute the standard errors of the predicted probabilities of bankruptcy ($SE(\hat{p})$).

To illustrate the difference between a point estimate and the standard error surrounding the point estimate, the top part of Fig. 2 shows two companies, *Z* and *Y*, that have the same point estimates of bankruptcy (i.e., they share the same value for $\hat{B}^*$) but their standard errors are different. In Fig. 2, company *Z*'s point estimate has a standard error of 1.50, whereas *Y*'s point estimate has a standard error of 1.00. This means the distribution has fatter tails for company *Z* than *Y*, so there is greater uncertainty surrounding the point estimate for *Z* (i.e., *Z* has higher estimation risk than *Y*). Theoretically, a risk-averse auditor would care about the *distribution* of estimated bankruptcy risks as well as the best point estimate, $\hat{B}^*$. In other words, a risk-averse auditor would care about $SE(\hat{B}^*)$ as well as $\hat{B}^*$.

For example, consider the upper and lower confidence limits for companies *Z* and *Y*. At the 95% confidence level (two-tailed), the upper confidence limit (UCL) equals the point estimate plus 1.96 multiplied by the standard error of the point estimate (i.e., $UCL = \hat{B}^* + 1.96 \times \mathrm{SE}(\hat{B}^*)$). Likewise, the lower confidence limit (LCL) equals the point estimate minus 1.96 multiplied by the standard error of the point estimate (i.e., $LCL = \hat{B}^* - 1.96 \times \mathrm{SE}(\hat{B}^*)$). As shown in Fig. 2, company *Z* has a higher *UCL* and a lower *LCL* compared with company *Y* because *Z* has a higher value of $\mathrm{SE}(\hat{B}^*)$; i.e., Z has higher estimation risk.

Importantly, the bottom part of Fig. 2 links estimation risk back to the utlity function of a risk-averse auditor. In particular, the utility function of a risk-averse auditor has the property that decreases in utility (ΔU) for a given increase in the expected loss (ΔE(Loss)) are increasing in the size of the expected loss (E(Loss)). Therefore the change in utility for an equal change in the expected loss (ΔE(Loss1) = ΔE(Loss2)) is greater for the upper confidence limit, compared with the lower confidence limit (i.e., ΔU2 > ΔU1 in Fig. 2). For a formal proof in the context of risk-averse investors, please see Hanoch and Levy (1969).

The key takeaway is that estimation risk provides risk-averse auditors with stronger incentives to mitigate the losses associated with client bankruptcy (i.e., *L*). We argue that auditors can mitigate these losses by being more likely to issue going-concern opinions (H1), more likely to resign (H2), and by charging higher audit fees (H3). In

[8] Traditionally, the point estimates of bankruptcy ($\hat{B}^*$) are called "z-scores" and are used to measure a company's financial distress (e.g., Altman 1968; Ohlson 1980; Zmijewski 1984).

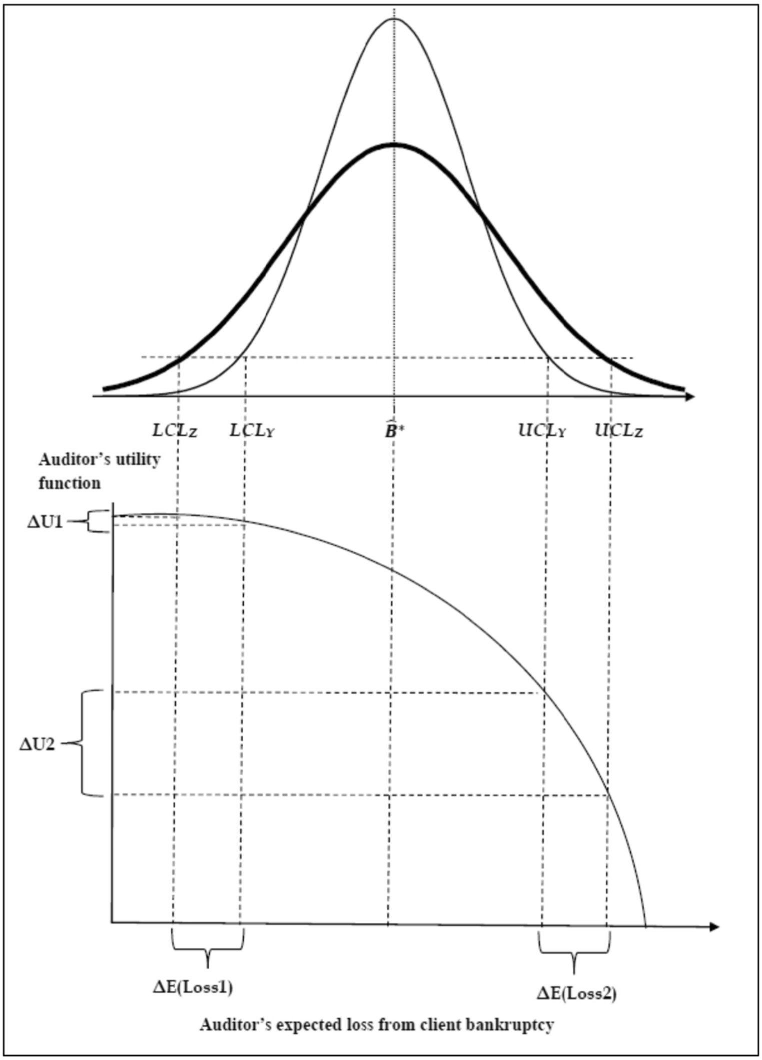

Fig. 2 The distribution of estimated bankruptcy risks for company Z and company Y and their impact on the utility of a risk-averse auditor. Company *Y* and company *Z* are assumed to have the same point estimates of bankruptcy risk ($\hat{B}^*$), but company *Z* has a higher standard error for its point estimate than company *Y*.
$\hat{B}^*$ = the point estimates of bankruptcy risk for company *Y* and company *Z*.
▬▬▬ = the density function of company *Z* (where *Z*'s point estimate is assumed to have a standard error of 1.50, i.e., SE$(\hat{B}^*)_Z = 1.50$).
——— = the density function of company *Y* (where *Y*'s point estimate is assumed to have a standard error of 1.00, i.e., SE$(\hat{B}^*)_Y = 1.00$).
LCL_Z = the lower confidence limit of bankruptcy risk for company *Z*, at the two-tailed 95% confidence level ($LCL_Z = \hat{B}^*$ - 1.96 × 1.50). UCL_Z = the upper confidence limit of bankruptcy risk for company *Z*, at the two-tailed 95% confidence level ($UCL_Z = \hat{B}^*$ + 1.96 × 1.50). LCL_Y = the lower confidence limit of bankruptcy risk for company *Y*, at the two-tailed 95% confidence level ($LCL_Y = \hat{B}^*$ - 1.96 × 1.00). UCL_Y = the upper confidence limit of bankruptcy risk for company *Y*, at the two-tailed 95% confidence level ($UCL_Y = \hat{B}^*$ + 1.96 × 1.00). ΔU1 is the change in auditor utility associated with a change in the expected loss, ΔE(Loss1). ΔU2 is the change in auditor utility associated with a change in the expected loss, ΔE(Loss2)

Fig. 2, this means that the auditor is more likely to issue a going-concern opinion (or resign or charge higher audit fees) to company *Z* rather than company *Y* because company *Z* has greater estimation risk than company *Y*.

3.2 Estimation risk and going-concern opinions

In studies of going-concern reporting, the following type of model is estimated:

$$GC^{*} = \beta_0 + \beta_1 \hat{B}^{*} + \theta Z_{GC} + \partial A_{GC} + v \tag{2}$$

where $GC^* \geq 0$ if GC = one and $GC^* < 0$ if GC = zero. The *GC* variable equals one if the company receives a going-concern modification in the auditor's report and zero otherwise. In Eq. (2), the $\hat{B}^{*}$ variable captures the point estimates of bankruptcy risk. The literature finds that the point estimates are highly significant in explaining auditors' decisions to issue going-concern opinions (Mutchler 1985; Dopuch et al. 1987; Carcello and Neal 2000; DeFond et al. 2002; Carcello et al. 2009). Therefore we expect a significant positive coefficient on $\hat{B}^{*}$ in eq. (2) (i.e., $\beta_1 > 0$). The Z_{GC} and A_{GC} variables capture company and auditor characteristics that explain going-concern reporting. (The Z_{GC} and A_{GC} variables are discussed in more detail below.) Eq. (2) is estimated with year and industry fixed effects.

To test H1, we augment Eq. (2) as follows:

$$GC^{*} = \beta_0 + \beta_1 \hat{B}^{*} + \beta_2 SE\left(\hat{B}^{*}\right) + \theta Z_{GC} + \partial A_{GC} + v \tag{3}$$

Under H1, an auditor is more likely to issue a going-concern opinion when there is greater estimation risk. We therefore predict a positive coefficient on $SE(\hat{B}^{*})$ in Eq. (3); i.e., $\beta_2 > 0$.

3.3 Estimation risk and auditor resignations

The research design for testing H2 is similar to that of H1. The main difference is that we replace GC^* with $RESIGN^*$, where $RESIGN^* \geq 0$ if *RESIGN* equals one and $RESIGN^* < 0$ if *RESIGN* equals zero. The *RESIGN* variable equals one if the auditor resigns and zero otherwise. The Z_R and A_R variables capture company and auditor characteristics that explain auditor resignations. (The Z_R and A_R variables are discussed in more detail below.) To test H2, we estimate the following model:

$$\mathrm{RESIGN}^{*} = \gamma_0 + \gamma_1 \hat{B}^{*} + \gamma_2 SE\left(\hat{B}^{*}\right) + \theta Z_R + \partial A_R + v \tag{4}$$

Under H2, an auditor is more likely to resign when there is greater estimation risk. We therefore predict a positive coefficient on $SE(\hat{B}^{*})$ in Eq. (4); i.e., $\gamma_2 > 0$. We also expect the coefficient on $\hat{B}^{*}$ to be positive (i.e., $\gamma_1 > 0$), as auditors are more likely to resign when the point estimates of bankruptcy are larger (Krishnan and Krishnan 1997; Ghosh and Tang 2015).

3.4 Estimation risk and audit fees

We test H3 by estimating an audit fee model, where the dependent variable is the natural log of audit fees (*Ln(AF)*). The Z_F and A_F variables capture company and auditor charactertisitcs that explain audit fees. The audit fee model is:

$$Ln(AF) = \delta_0 + \delta_1 \hat{B}^* + \delta_2 SE\left(\hat{B}^*\right) + \theta Z_F + \partial A_F + v \tag{5}$$

Under H3, an auditor charges higher audit fees when there is greater estimation risk. We therefore predict a positive coefficient on $SE(\hat{B}^*)$ in Eq. (5).

3.5 The independent variables in the bankruptcy model (*X*)

We generate $\hat{B}^*$ and $SE\left(\hat{B}^*\right)$ by estimating the bankruptcy prediction model in Eq. (1). Our choice of *X* variables closely follows prior research on bankruptcy prediction. That said, there are many bankruptcy prediction studies, and the set of independent variables varies from study to study. We select the variables that are commonly found in the literature, while keeping the bankruptcy model reasonably parsimonious to avoid excessive sample attrition.

Prior studies find that accounting variables predict bankruptcy (Ohlson 1980; Zmijewski 1984; Beaver et al. 2012). Our accounting variables comprise a *LOSS* indicator (equal to one if a company reports losses and zero otherwise), a *LEVERAGE* ratio (total debt divided by total assets), a profitability measure (*ROA*, computed as net income divided by total assets), and a *LIQUIDITY* ratio (current assets divided by current liabilities) In addition, we control for company size using the natural log of market value (*LMV*).

Failing companies tend to have poor stock market returns and high return volatility before they file for bankruptcy (Aharony et al. 1980; Shumway 2001; Beaver et al. 2005; Campbell et al. 2008; Beaver et al. 2012). We therefore include a company's buy-and-hold return over the fiscal year (*RET*) and the standard deviation of returns over the fiscal year (*STDEV*). We also control for company age (*AGE*) and institutional ownership (*INSTOWN*). In addition, we include the distance to default (*DD*) measure of Bharat and Shumway (2008).[9] Finally, we include indicator variables for each year of the sample period (1995–2013) to control for temporal variation in bankruptcy.

[9] To compute *DD*, we follow the approach outlined in Bharat and Shumway (2008) (which is also consistent with Correia et al. 2012). In particular, we generate the *DD* measure by solving the following equation:

$$DD = \frac{\ln\left[\frac{\mathrm{E+D}}{\mathrm{D}}\right] + \left(r_{it-1} + 0.5\sigma_V^2\right)T}{\sigma_V\sqrt{T}},$$

where E = the market value of equity; D = the face value of debt (computed as the sum of short-term debt and half of the reported value of long-term debt); r_{it-1} is past year equity returns; σ_V = total volatility of the firm computed as $\frac{E}{E+D}\sigma_E + \frac{D}{E+D}\sigma_D$ where σ_E is the volatility of firm equity and σ_D is the volatility of firm's debt; σ_E is calculated using the standard deviation of stock returns in the past one year; and σ_D is calculated as $0.05 + 0.25*\sigma_E$.

3.6 Control variables in the going-concern reporting models (Z_{GC} and A_{GC})

We include company-specific variables in Eqs. (2) and (3) to control for known determinants of going-concern reporting (e.g., DeFond et al. 2002; Francis and Yu 2009). The *LTA* variable is the natural log of total assets. *Book-to-market* is the book value of equity divided by the market value of equity. *Leverage* equals total debt divided by total assets. *LLoss* is one if the company reports a loss in the previous year (zero otherwise). *ROA* is net income divided by total assets. *Cash flows* is operating cash flows divided by total assets. *Liquidity* is current assets divided by current liabilities. *Ret* is the buy-and-hold raw return over the fiscal year, while *Stdev* is the standard deviation of returns over the fiscal year. *New finance* is an indicator variable equal to one when there is an increase of 20% or more in long-term debt or common equity in the subsequent year (zero otherwise). *Investment* is short-term investment securities (including cash and cash equivalents) deflated by total assets, and *Reporting lag* is the number of days between the fiscal year-end and the earnings announcement date.

We also include auditor-specific controls commonly used in going-concern reporting research to capture the effects of auditor quality, expertise, and independence (e.g., Francis and Yu 2009; Huang and Scholz 2012). We control for auditor size (*Big),* where *Big* equals one if the company is audited by a Big Four firm (zero otherwise). We also control for the length of tenure between the company and audit firm (*Tenure*), whether a company is audited by an industry specialist (*Ind_spec),* the ratio of audit fees to total assets (*AF_ratio*), the ratio of non-audit fees to total fees (*NAF_ratio*), and whether a company received a going-concern opinion in the prior year (*LagGC*).

Finally, auditors may have proprietary information that is relevant to assessing the client's risk of bankruptcy, and this information could affect the auditor's decision to issue a going-concern opinion. However, Gerakos et al. (2016) find that auditors' going-concern opinions do not predict more bankruptices compared to a statsitical model based on public data. Nonetheless, we control for an auditor's private information about the risk of bankruptcy by including the ex post bankruptcy dummy (*B*) as an additional control variable.

3.7 Control variables in the auditor resignation models (Z_R *and* A_R)

The company-specific control variables in Eq. (4) are based on research on auditor resignations (Krishnan and Krishnan 1997; Huang and Scholz 2012). They include *LTA*, *Book-to-market*, *ROA*, *Cash flows*, and *Reporting lag*. In addition, we control for restatements announced during the most recent fiscal year. The *Restatement* variable equals one if the company announces a restatement during the year and zero otherwise. We control for *Special items*, calculated as the ratio of special items to total assets, and *Litigation risk*, which equals one if the company is in the biotech (SIC codes 2833–2836 and 8731–8734), computer (3570–3577 and 7370–7374), electronics (3600–3674), or retail (5200–5961) industries (zero otherwise). We also control for the auditor-specific variables that are included in the models of going-concern reporting (*Big, Tenure*, *Ind_spec, AF_ratio*, *NAF_ratio*, and *LagGC*). Finally, we include the ex post bankruptcy dummy (*B*) as a control for the auditor's proprietary information.

3.8 Control variables in the audit fee models (Z_F *and* A_F)

We control for company and auditor variables that have been shown to explain audit fees (Larcker and Richardson 2004; Venkataraman et al. 2008; Hribar et al. 2014). Our control variables capture size and complexity of the audit, audit risk, corporate events, and litigation risk. These control variables are *LTA*, *Book-to-market*, *Leverage*, *ROA*, *LLoss*, *Liquidity*, *and Litigation risk.* We further control for *Rec* (Receivables divided by total assets), *Inv* (Inventory divided by total assets), *Merger* (equals one if the company is engaged in a merger or acquisition and zero otherwise), *IPO* (equals one if the company is in the year of an initial public offering and zero otherwise), *SEO* (equals one if a company issues seasoned equity offering during the year and zero otherwise), and *Issue* (equals one if the company issues public debt during the year and zero otherwise). *Busseg* is the square root of the number of business segments of the company. *Foreign* is the percentage of foreign sales to total sales. *Employee* is the square root of employees (measured in thousands). *Yearend* equals one if a company's fiscal year-end is not in December. Our auditor-specific variables are *Big*, *Tenure*, and *GC* (*GC* = 1 if the auditor issues a going-concern opinion and zero otherwise). Finally, we include the ex post bankruptcy dummy (*B*) as a control for the auditor's proprietary information about the likelihood of bankruptcy.

4 Main results

4.1 Sample

The sample for the models of going-concern reporting, auditor resignations, and audit fees comprises SEC registrants over the period 2000 to 2013. Our starting point is 2000 because this is the first year data are available in the Audit Analytics database. The sample ends in 2013 to allow a subsequent two-year period in which to identify later bankruptcy events.

To generate the point estimates of bankruptcy ($\hat{B}^*$) and the standard errors of the point estimates (SE($\hat{B}^*$)), we estimate bankruptcy prediction models over rolling windows of the past five years. We use rolling windows because we use the point estimates and standard errors to explain auditors' *out-of-sample* behavior in the following year. For example, we estimate bankruptcy models for the five year period 1995–1999, and we use the resulting coefficients and standards errors to estimate $\hat{B}^*$ and SE($\hat{B}^*$) in the following year (2000). We then use these values of $\hat{B}^*$ and SE($\hat{B}^*$) to explain auditors' going-concern reports, resignations, and audit fees in year 2000. Similarly, we estimate bankruptcy models for the five year period 1996–2000 to generate the values of $\hat{B}^*$ and SE($\hat{B}^*$) that are used to explain auditors' going-concern reports, resignations, and audit fees in 2001. Thus the sample for the bankruptcy prediction models is from 1995 to 2012.

The bankruptcy indicator (*B*) is taken from Chava (2014)). (Also see Chava and Jarrow 2004 and Campbell et al. 2008.) It includes all bankruptcy filings (Chapters 7 or 11) recorded in *The Wall Street Journal* Index, the SDC database, SEC filings, and the CCH Capital Changes Reporter. We drop any audit reports or resignations that occur after the company files for bankruptcy. Returns data are from CRSP; institutional ownership data are from the Thomson Reuters 13-f filings database; corporate event data such as mergers and acquisitions, intitial public offerings, seasoned equity offerings, issuance of public debt are from SDC Platinum; data for other variables are from Compustat.

4.2 Descriptive statistics

Table 1 presents the annual incidence of bankruptcies, going-concern opinions, and auditor resignations. The mean value of *B* is 0.006, implying that the bankruptcy rate is 0.6% in our sample. The mean value of *GC* is 0.036, which means that 3.6% of audit opinions provide a warning about going-concern problems. The mean value of *RESIGN* indicates that auditors resign from 1.6% of their engagements. The mean value of audit fees is around $1.8 million.

Panel A, Table 2, reports descriptive statistics for the *X* variables that are used to predict bankruptcy. The mean log of market value (*LMV*) is 5.769, the mean leverage ratio is 0.212, and 35.4% of observations report losses (*LOSS*). The mean annual buy-and-hold return is 0.157 with an average standard deviation of 0.542.

Panel B, Table 2, presents descriptive statistics for the control variables in the models of going-concern reports, resignations, and audit fees. The mean log of total assets (*LTA)*

Table 1 Bankruptcies, going-concern opinions, auditor resignations, and audit fees

	Corporate bankruptcies (*B* = 1)		Going-concern audit opinions (*GC* = 1)		Auditors' resignations (*RESIGN* = 1)		Audit fees ($'000)	Total obs.
Year	N	%	N	%	N	%		
2000	54	2.04%	123	4.64%	22	0.83%	496	2653
2001	39	1.05%	165	4.46%	40	1.08%	526	3700
2002	29	0.73%	182	4.58%	57	1.43%	814	3973
2003	16	0.41%	121	3.08%	108	2.75%	1024	3923
2004	19	0.48%	111	2.79%	111	2.79%	1624	3979
2005	9	0.22%	115	2.82%	90	2.21%	1949	4073
2006	22	0.55%	120	3.00%	66	1.65%	2227	4005
2007	22	0.56%	143	3.64%	39	0.99%	2225	3924
2008	19	0.51%	217	5.80%	47	1.26%	2266	3739
2009	9	0.25%	148	4.08%	81	2.23%	2143	3626
2010	19	0.53%	112	3.09%	34	0.94%	2155	3619
2011	16	0.44%	103	2.85%	25	0.69%	2223	3617
2012	16	0.45%	116	3.29%	35	0.99%	2352	3530
2013	15	0.43%	102	2.90%	51	1.45%	2499	3521
Total	304	0.59%	1878	3.62%	806	1.55%		51,882

B = one if the company files for bankruptcy within 15 months of the company's fiscal year-end, zero otherwise. *GC* = one if the company receives a going-concern modification in the auditor's report, zero otherwise. *RESIGN* = one if the auditor resigns from the company, zero otherwise. The sample period is 2000–2013; *n* = 51,882

Table 2 Descriptive statistics

	Mean	1%	25%	50%	75%	99%
Panel A: determinants of bankruptcy (X)						
LMV	5.769	1.196	4.182	5.714	7.233	11.170
LEVERAGE	0.212	0.000	0.012	0.168	0.340	0.932
LOSS	0.354	0.000	0.000	0.000	1.000	1.000
ROA	–0.060	–1.605	–0.057	0.029	0.073	0.292
LIQUIDITY	2.991	0.299	1.279	2.010	3.351	20.875
RET	0.157	–0.877	–0.282	0.046	0.397	3.268
STDEV	0.542	0.112	0.303	0.454	0.677	1.899
AGE	2.267	0.000	1.609	2.303	2.996	4.344
INSTOWN	0.257	0.000	0.000	0.034	0.521	0.964
DD	0.110	0.000	0.000	0.000	0.011	0.998
Panel B: control variables						
LTA	6.038	1.759	4.498	5.928	7.466	11.218
Book-to-market	0.612	–0.725	0.258	0.470	0.779	3.632
Leverage	0.204	0.000	0.006	0.158	0.327	0.932
LLoss	0.348	0	0	0	1	1
ROA	–0.058	–1.599	–0.055	0.029	0.073	0.300
Cash flows	0.032	–0.946	0.008	0.075	0.130	0.347
Liquidity	3.029	0.322	1.297	2.032	3.406	20.875
Rec	0.138	0.000	0.051	0.115	0.193	0.535
Inv	0.099	0.000	0.001	0.051	0.154	0.560
Ret	0.166	–0.877	–0.253	0.067	0.408	3.268
Stdev	0.520	0.108	0.288	0.430	0.644	1.899
New finance	0.325	0	0	0	1	1
Investment	0.224	0.000	0.038	0.131	0.337	0.914
Reporting lag	48	15	32	44	60	120
Restatement	0.030	0	0	0	0	1
Special items	–0.020	–0.418	–0.013	0.000	0.000	0.084
Litigation risk	0.360	0	0	0	1	1
Merger	0.240	0	0	0	0	1
IPO	0.016	0	0	0	0	1
SEO	0.066	0	0	0	0	1
Issue	0.060	0	0	0	0	1
Busseg	1.368	1.000	1.000	1.000	1.732	2.646
Foreign	0.315	0.000	0.000	0.057	0.550	1.080
Employee	1.965	0.000	0.479	1.095	2.387	12.649
Yearend	0.292	0	0	0	1	1
Big	0.788	0	1	1	1	1
Tenure	6.613	1	3	5	9	20
Ind_Spec	0.378	0	0	0	1	1
AF_ratio	0.003	0	0.001	0.002	0.004	0.024
NAF_ratio	0.225	0	0.06	0.174	0.338	0.811

LMV = Log of market value. *LEVERAGE* = Total debt divided by total assets. *LOSS* = one if the company reports a loss in the current year, zero otherwise. *ROA* = Net income divided by total assets. *LIQUIDITY* = Current assets divided by current liabilities. *RET* = Buy-and-hold raw return over the fiscal year. *STDEV* = Standard deviation of returns over the fiscal year. *AGE* = Natural log of company age. *INSTOWN* = Institutional ownership. *DD* = Distance to default calculated using the approach outlined by Bharat and Shumway (2008). The financial ratio and returns variables are winsorized at the top and bottom 1% percentiles to address outlier issues. The sample period is 1995–2013; *n* = 79,393. *LTA* = Log of total assets. *Book-to-market* = Book value of equity divided by market value of equity. *Leverage* = Total debt divided by total assets. *LLoss* = One if the company reports a loss in the previous year, zero otherwise. *ROA* = Net income divided by total assets. *Cash flows* = operating cash flows divided by total assets. *Liquidity* = Current assets divided by current liabilities. *Rec* = Receivables divided by total assets. *Inv* = Inventory divided by total assets. *Ret* = Buy-and-hold raw return over the fiscal year. *Stdev* = Standard deviation of returns over the fiscal year. *New finance* = An indicator variable equal to 1 when there is an increase of 20% or more in company long-term debt or common equity in the subsequent year. *Investment* = Short-term investment securities (including cash and cash equivalents), deflated by total assets. *Reporting lag* = Number of days between fiscal year-end and earnings announcement date. *Restatement* = 1 if the company announces a restatement during the year, 0 otherwise. *Special items* = Special items divided by total assets. *Litigation risk* = 1 if the company is in the biotech (SIC codes 2833–2836 and 8731–8734), computer (3570–3577 and 7370–7374), electronics (3600–3674), or retail (5200–5961) industry, 0 otherwise. *Merger* = 1 if the company is engaged in a merger or acquisition, 0 otherwise. *IPO* = 1 if the company is in the year of initial public offering, 0 otherwise. *SEO* = 1 if the company issues seasoned equity offering during the year, 0 otherwise. *Issue* = 1 if the company issues public debt during the year, 0 otherwise. *Busseg* is the square root of the number of business segments of the company. *Foreign* is the percentage of foreign sales to total sales. *Employee* is the square root of employees (measured in thousands). *Yearend* = 1 if the company's fiscal year-end is not December. *Big* = 1 if the company is audited by a Big Four firm, 0 otherwise. *Tenure* = Length of tenure between the company and audit firm (measured in years). *Ind_spec* = 1 if the audit firm is a specialist in the company's industry, where the industry specialist is coded as being the audit firm with the largest industry market share, 0 otherwise. *AF_ratio* = Audit fee to total assets. *NAF_ratio* = Ratio of non-audit fees to the sum of audit plus non-audit fees. The variables are winsorized at the top and bottom 1% percentiles to address outlier issues. The sample period is 2000–2013; *n* = 51,882

is 6.038, and the mean *book-to-market* ratio is 0.612. Nearly 33% of company-years experience a 20% or more increase in debt or equity in the subsequent year (*New finance*). The mean number of days between the year-end and earnings announcement (*Reporting lag*) is 48. Only 3% of company-years contain a restatement announcement (*Restatement*). Thirty-six percent of company years belong to high litigation risk industries (*Litigation risk*), while 79% are audited by a Big Four firm. Mean auditor-client tenure is around seven years, and 38% of companies are audited by an industry specialist.

4.3 Results from the bankruptcy prediction models

To generate the point estimates ($\hat{B}^*$) and standard errors (SE($\hat{B}^*$)), we estimate bankruptcy prediction models over rolling windows of the past five years. Results are reported in Table 3.[10] In almost every window, we find that a company is more likely to go bankrupt if it has higher leverage (z-stats. range from 1.57 to 10.31),

[10] In some studies, bankruptcies are predicted using a hazard model (Shumway 2001; Beaver et al. 2005). The hazard model can be written as follows: $h(t|X) = h_0(t) \times \exp(\alpha X)$, where $h(t|X)$ is the hazard rate in year t, conditional on the values of X, $h_0(t)$ is the baseline hazard, while α are the model parameters. The hazard model is semi-parametric because the baseline hazard, $h_0(t)$, is left unestimated (Cleves et al. 2004). As $h_0(t)$ is not estimated, it is not possible to obtain point estimates or standard errors for the dependent variable, $h(t|X)$. Accordingly, the hazard model is not suitable for examining estimation risk. In contrast, the logit model is fully parametric, and it is straightforward to obtain point estimates and standard errors. Accordingly, we follow bankruptcy prediction studies that use logit (e.g., Campbell et al. 2008).

reports losses (z-stats. range from 1.62 to 7.75), or has lower liquidity (z-stats. range from −2.48 to -4.87). The coefficients on *RET* are significantly negative (z-stats. range from −1.88 to −4.53), indicating that a company is more likely to go bankrupt if it has low stock returns. The coefficients on *STDEV* are positive (z-stats. range from 1.29 to 4.13), which means that a company is more likely to go bankrupt if it has higher return volatility. These findings are generally consistent with research on bankruptcy prediction (Aharony et al. 1980; Shumway 2001; Beaver et al. 2005; Campbell et al. 2008; Beaver et al. 2012). We also find significant negative coefficients on *INSTOWN* (z-stats. Range from −2.67 to −6.71), indicating that companies with greater institutional ownership are less likely to go bankrupt. Finally, consistent with Bharat and Shumway (2008), the coefficents on the *DD* measure are positive, although their significance varies over time (z-stats. range from 0.60 to 4.73). The pseudo R^2s range from 22.50% to 35.18%, indicating reasonably high explanatory power.[11]

Next, we use the coefficient estimates from the bankruptcy prediction models to construct the point estimates of bankruptcy (i.e., $\hat{B}^* = \hat{\alpha}\, X$). Likewise, we use the variance-covariance matrix ($\hat{V}_{\hat{\alpha}}$) to compute the standard errors surrounding each point estimate. Descriptive statistics for the point estimates ($\hat{B}^*$) and their standard errors (SE($\hat{B}^*$)) are reported in Table 4.

Panel A shows that the point estimates range from −11.89 at the bottom percentile (least likely to go bankrupt) to −1.88 at the top percentile (most likely to go bankrupt). (The $\hat{B}^*$ values are all negative because the predicted bankruptcy probabilities are less than 50% for every observation in the sample.)

Panel B reports descriptive statistics for the standard errors of the point estimates, i.e., the values of SE($\hat{B}^*$). The standard errors range from 0.18 at the bottom percentile (lowest estimation risk) to 1.56 at the top percentile (highest estimation risk). Therefore there is considerable variation in estimation risk (SE($\hat{B}^*$)) within our sample.

Using the descriptive statistics in Panels A and B, we verify that estimation risk can have a large impact on the upper confidence limits of bankruptcy risk. For example, consider two companies, *Y* and *Z*, and assume for the sake of simplicity that their point estimates ($\hat{B}^*$) are both equal to −6.89 (i.e., the sample median). Now consider how differences in estimation risk, SE($\hat{B}^*$), affect their upper confidence limits of bankruptcy. Suppose that company *Y* has estimation risk of 0.18 (the lowest percentile according to Panel B). This would mean that, at the 95% confidence level (two-tailed), the upper confidence limit for *Y* is −6.54 (= −6.89 + 1.96 × 0.18). In contrast, suppose that company *Z* has estimation risk

[11] The Altman (1968) and Ohlson (1980) bankruptcy models report pseudo R^2s of 7% and 10% respectively. Likewise Campbell et al. (2008) obtain a pseudo R^2 of 11.4% in a model that predicts bankruptcy 12 months into the future (see their Table 4). Campbell et al. (2008) obtain higher pseudo R^2s, ranging from 26% to 31%, when the bankruptcy horizon is just one month (see their Table 3). In our study, the bankruptcy horizon is 15 months rather than one month because an auditor is required to consider the likelihood of failure for a period of up to one year and the audit report can be issued up to three months after the fiscal year-end.

Table 3 Results from estimating bankruptcy prediction models over rolling windows of five years

Estimation windows	SIZE	LEVERAGE	LOSS	ROA	LIQUIDITY	RET	STDEV	AGE	INSTOWN	DD	Obs.	Pseudo R^2
1995–1999	0.079	2.524	1.633	0.141	–0.189	–0.907	0.530	–0.147	–2.453	0.621	21,496	22.50%
z-stat	1.69*	7.62***	5.80***	0.85	–3.25***	–3.98***	2.64***	–1.60	–3.97***	2.70***		
1996–2000	0.068	2.268	1.659	–0.073	–0.228	–0.850	0.419	–0.097	–2.748	0.401	26,623	24.39%
z-stat	2.00**	9.21***	7.45***	–0.61	–4.87***	–4.17***	2.69***	–1.27	–5.99***	2.18**		
1997–2001	0.050	2.321	1.620	–0.063	–0.217	–0.772	0.498	–0.060	–3.001	0.272	26,004	23.86%
z-stat	1.69*	10.31***	7.75***	–0.58	–4.49***	–4.39***	3.52***	–0.85	–6.68***	1.62		
1998–2002	–0.006	2.270	1.383	–0.078	–0.210	–0.812	0.556	–0.016	–2.894	0.114	24,914	23.11%
z-stat	–0.20	10.12***	6.81***	–0.75	–4.28***	–4.45***	4.13***	–0.22	–6.67***	0.66		
1999–2003	–0.008	1.917	1.348	–0.114	–0.267	–0.914	0.538	–0.011	–2.750	0.123	23,679	23.89%
z-stat	–0.27	8.25***	6.26***	–1.06	–4.61***	–4.53***	3.87***	–0.14	–6.39***	0.70		
2000–2004	–0.048	1.906	1.315	–0.207	–0.252	–0.950	0.423	0.017	–2.788	0.118	22,672	25.90%
z-stat	–1.54	7.72***	5.81***	–1.85*	–3.85***	–3.78***	2.72***	0.21	–5.97***	0.60		
2001–2005	–0.135	1.703	0.852	–0.195	–0.245	–1.212	0.484	0.055	–2.057	0.260	21,768	25.85%
z-stat	–3.56***	5.31***	3.27***	–1.37	–2.48**	–4.08***	2.50**	0.56	–3.53***	0.97		
2002–2006	–0.223	1.372	0.442	–0.170	–0.283	–1.484	0.538	0.115	–1.784	0.449	21,207	24.85%
z-stat	–4.62***	3.58***	1.62	–0.94	–2.72***	–3.84***	2.15**	1.04	–2.89***	1.25		
2003–2007	–0.154	0.692	0.874	–0.548	–0.291	–0.885	0.206	0.204	–1.523	1.676	20,822	25.92%
z-stat	–2.83***	1.72*	2.75***	–2.74***	–2.79***	–2.48**	0.55	1.61	–2.49**	4.73***		
2004–2008	–0.151	0.687	0.744	–0.572	–0.220	–0.919	0.467	0.188	–2.154	1.466	20,593	24.28%
z-stat	–2.85***	1.61	2.49**	–3.10***	–2.79***	–2.20**	1.31	1.52	–3.25***	3.62		
2005–2009	–0.202	0.718	0.970	–0.330	–0.281	–0.780	0.657	0.097	–2.424	1.238	20,161	25.26%
z-stat	–3.50***	1.57	2.92***	–1.75*	–3.74***	–1.88*	1.85*	0.76	–3.17***	2.81***		
2006–2010	–0.134	1.122	1.505	–0.321	–0.337	–0.825	0.514	0.250	–3.601	1.173	19,644	28.60%

Table 3 (continued)

Estimation windows	SIZE	LEVERAGE	LOSS	ROA	LIQUIDITY	RET	STDEV	AGE	INSTOWN	DD	Obs.	Pseudo R^2
z-stat	–2.40**	2.50**	4.14***	–1.72*	–3.82***	–2.34**	1.44	1.88*	–3.96***	2.68***		
2007–2011	–0.139	1.595	2.390	–0.416	–0.348	–0.920	0.433	0.340	–3.373	1.128	19,190	34.32%
z-stat	–2.26**	3.48***	4.41***	–2.15**	–3.44***	–2.35**	1.29	2.25**	–4.07***	2.37**		
2008–2012	–0.098	2.011	2.276	–0.242	–0.352	–1.416	0.577	0.297	–3.169	0.943	18,751	35.18%
z-stat	–1.69*	3.96***	4.05***	–1.15	–3.02***	–2.28**	1.71*	1.83*	–3.65***	1.80*		
Average	–0.079	1.650	1.358	–0.228	–0.266	–0.975	0.489	0.088	–2.623	0.713	21,966	26.28%
z-stat	–1.45	5.50***	4.68***	–1.35	–3.58***	–3.38***	2.31**	0.54	–4.48***	2.05**		

We use rolling windows to ensure that our point estimates and their standard errors are used to explain auditors' out-of-sample behavior. For example, the bankruptcy model estimated over the period 2000–2004 is used to generate point estimates ($\hat{B}^*$) and standard errors (SE($\hat{B}^*$)) that are used to explain auditors' reporting and resignation decisions in 2005. Similarly, the bankruptcy model estimated over the period 2001–2005 is used to generate point estimates and standard errors that are used to explain auditors' reporting and resignation decisions in 2006. Z-stats are reported below the coefficient estimates. All models are estimated with year fixed effects, and the standard errors are corrected for clustering on each company and heteroskedasticity. See Tables 1 and 2 for the definitions of variables

Table 4 The point estimates of bankruptcy ($\hat{B}^*$) and the standard errors of the point estimates ($SE(\hat{B}^*)$)

Panel A: Point estimates of bankruptcy ($\hat{B}^*$)					
	Healthy			Distressed	
Percentiles	1%	20%	50%	80%	99%
$\hat{B}^*$	–11.89	–8.68	–6.93	–5.07	–1.88
Panel B: Standard errors of the point estimates ($SE(\hat{B}^*)$)					
	Low estimation risk			High estimation risk	
Percentiles	1%	20%	50%	80%	99%
$SE(\hat{B}^*)$	0.18	0.31	0.44	0.65	1.56

$B = 1$ if the company files for bankruptcy within 15 months of the company's fiscal year-end and 0 otherwise. $B^* \geq 0$ if $B = 1$, $B^* < 0$ if $B = 0$. $\hat{B}^*$ is the point estimate of B^*, which is estimated using the coefficients from the bankruptcy prediction models reported in Table 3. For example, the values of $\hat{B}^*$ in 2005 are predicted using the bankruptcy model estimated for the period 2000–2004 (Col. (1) of Table 3); the values of $\hat{B}^*$ in 2006 are predicted using the bankruptcy model estimated for the period 2001–2005 (Col. (2) of Table 3); etc. Estimation risk is measured using $SE(\hat{B}^*)$, which is the standard error of $\hat{B}^*$. The sample period is 2000–2013; $n = 51{,}882$

of 1.56 (the highest percentile according to Panel B). This would mean that, at the 95% confidence level (two-tailed), the upper confidence limit for Z is substantially higher at −3.83 (= −6.89 + 1.96 × 1.56). With an upper confidence limit of −6.56, Y remains outside of the top 45% of companies once we take account of estimation risk. In contrast, the upper confidence limit of −3.83 places company Z in the top 10%. Therefore the upper confidence limits of these two companies are vastly different, even though they have the same point estimates. For company Z the upper confidence limit lies within the top 10% because this company has high estimation risk (i.e., Z's density function in Fig. 1 has fat tails). For company Y, the upper confidence limit remains outside of the top 45% because Y has low estimation risk (i.e, Y's density function has thin tails). Accordingly, we expect that company Z's auditor is more likely to issue a going-concern opinion (H1), more likely to resign (H2), and charges higher audit fees (H3), compared with company Y's auditor, even though both companies have the same point estimates of bankruptcy.

4.4 Results from the models of going-concern reporting (H1)

Table 5 presents results for the going-concern reporting models. In column (1), we begin by regressing going-concern opinions on the point estimates ($\hat{B}^*$), the standard errors of the point estimates ($SE(\hat{B}^*)$), and control variables. Consistent with prior audit reporting studies, Table 5 finds a highly significant positive coefficient on the $\hat{B}^*$ variable (z-stat. = 16.90). That is, companies with higher point estimates of bankruptcy are more likely to receive going-concern opinions.

Next, we turn to our main variable of interest, $SE(\hat{B}^*)$. Under H1, auditors respond to higher estimation risk by being more likely to issue going-concern opinions. Thus we predict a significant positive coefficient on $SE(\hat{B}^*)$. As shown in Table 5, we do indeed

Table 5 The effect of estimation risk ($SE(\hat{B}^*)$) on auditors' going-concern reporting (H1)

	Full sample		Full sample	
		1		2
$\hat{B}^*$	0.743	16.90***	0.715	16.15***
$SE(\hat{B}^*)$	3.332	10.67***	3.213	10.23***
B			1.450	8.50***
LTA	–0.177	–4.74***	–0.192	–4.97***
Book-to-market	0.045	0.98	0.052	1.15
Leverage	–0.183	–0.86	–0.198	–0.92
LLoss	0.502	5.16***	0.488	5.01***
ROA	–0.208	–1.95*	–0.198	–1.84*
Cash flows	–2.080	–10.45***	–2.048	–10.22***
Liquidity	–0.050	–1.85*	–0.050	–1.81*
Ret	–0.341	–3.52***	–0.324	–3.35***
Stdev	–0.062	–0.59**	–0.056	–0.53
New finance	–0.236	–2.94***	–0.180	–2.23**
Investment	–1.614	–6.93***	–1.577	–6.78***
Reporting lag	0.015	9.60***	0.015	9.52***
Big	0.178	1.83*	0.176	1.79*
Tenure	–0.029	–3.00***	–0.024	–2.51**
Ind_spec	0.162	1.73*	0.148	1.55
AF_ratio	0.082	0.94	0.094	1.07
NAF_ratio	–0.285	–1.37	–0.313	–1.48
Laggc	2.957	23.36***	2.962	23.34***
Year dummies		YES		YES
Industry dummies		YES		YES
Pseudo R^2		51.82%		52.29%
Obs.		51,882		51,882

GC = 1 if the company receives a going-concern modification in the auditor's report and 0 otherwise. $GC^* \geq 0$ if GC = 1, $GC^* < 0$ if GC = 0. $\hat{B}^*$ = the company's point estimate of bankruptcy risk, where the point estimates are generated from the bankruptcy prediction models reported in Table 3. $SE(\hat{B}^*)$ = estimation risk, measured as the standard error of $\hat{B}^*$. See Tables 1 and 2 for the definitions of control variables

The sample period is 2000–2013. The standard errors are corrected for clustering on each company and heteroskedasticity. ***, **, * = statistically significant at the 1%, 5%, 10% levels, respectively (two-tailed)

find a highly significant positive coefficient on estimation risk (z-stat. = 10.67).[12] This is consistent with auditors increasing their propensity to issue going-concern opinions when estimation risk is higher.[13]

[12] Our results are similar if we estimate Eq. (3) without the Z_{GC} variables.

[13] In an untabulated test, we estimate an alternate version of model 1 by including all of the bankruptcy predictor variables (*X*) in the going-concern reporting model. In this specification, we are forced to drop the point estimate ($\hat{B}^*$), as it is a linear function of the *X* variables, i.e., there is perfect multicollinearity between $\hat{B}^*$ and the *X* variables. The coefficients on estimation risk ($SE(\hat{B}^*)$) remain positive and highly significant. Therefore our results are robust to replacing $\hat{B}^*$ with the *X* variables.

Not only are the results statistically significant, they are also significant in terms of their economic magnitude. To measure the economic importance of estimation risk, we calculate how the probability of issuing a going-concern opinion changes as $SE\left(\hat{B}^*\right)$ increases from the tenth percentile value to the ninetieth percentile, when all other variables including the point estimates of bankruptcy risk are held constant. As estimation risk increases over this range, the predicted probability of issuing a going-concern opinion increases approximately threefold, from 2.6% to 7.5%. Therefore estimation risk has a large impact on going-concern reporting. For the sake of comparison, we also calculate the going-concern probabilities as $\hat{B}^*$ increases from its tenth percentile value to the ninetieth percentile, with all other variables held constant. The likelihood of a going-concern opinion increases more than tenfold, from 0.4% to 7.2%, as $\hat{B}^*$ increases from its tenth percentile value to the ninetieth percentile. Therefore the point estimates of bankruptcy have a larger impact on going-concern reporting than do the standard errors of the point estimates. The signs and significance of the control variables in Table 5 are consistent with prior research on the determinants of going-concern reporting (e.g., DeFond et al. 2002).

In model 2, we additionally control for the ex post bankruptcy dummy (*B*) to check whether our inferences are affected by an auditor's properietary information about the likelihood of bankruptcy. After adding this control, we continue to find that estimation risk is a highly significant determinant of going-concern opinions (z-stat. = 10.23).

Overall we provide strong evidence that estimation risk positively affects auditors' going-concern reporting decisions.

4.5 Results from the models of auditor resignations (H2)

Table 6 reports the results for auditor resignations. In model 1, we regress auditor resignations on the point estimates of bankruptcy risk $\left(\hat{B}^*\right)$, their standard errors $\left(SE\left(\hat{B}^*\right)\right)$, and the control variables. Consistent with prior literature, Table 6 finds a significant positive coefficient on the point estimates of bankruptcy ($\hat{B}^*$) (z-stat. = 4.63). That is, auditors are more likely to resign when a company has a higher likelihood of bankruptcy.

Next, we turn to our main variable of interest, $SE\left(\hat{B}^*\right)$. Under H2, auditors respond to higher estimation risk by being more likely to resign. Thus we predict a significant positive coefficient on $SE\left(\hat{B}^*\right)$. Consistent with H2, model 1 shows a highly significant positive coefficient on estimation risk (z-stat. = 3.27).[14] The effect of $SE\left(\hat{B}^*\right)$ in model 1 is also significant in terms of its economic magnitude. Holding all other variables constant at their mean values, the probability of auditor resignation nearly doubles from 1.2% to 2.0%, as $SE\left(\hat{B}^*\right)$ increases from its tenth percentile value to the ninetieth percentile. Therefore estimation risk has a large impact on auditors' resignation decisions. In comparison, the likelihood of

[14] We obtain very similar results if we estimate Eq. (4) without the Z_R variables.

Table 6 The effect of estimation risk ($SE(\hat{B}^*)$) on auditors' resignation decisions (H2)

	1		2	
	Coefft.	z-stat.	Coefft.	z-stat.
$\hat{B}^*$	0.149	4.63***	0.134	4.09***
$SE(\hat{B}^*)$	0.719	3.27***	0.667	3.00***
B			1.115	4.53***
LTA	–0.165	–4.73***	–0.169	–4.80***
Book-to-market	0.117	2.08**	0.122	2.21**
ROA	0.336	2.64***	0.362	2.84***
Reporting lag	0.014	8.01***	0.014	7.98***
Restatement	0.887	5.85***	0.897	5.90***
Special items	–1.885	–4.54***	–1.826	–4.35***
Litigation risk	0.005	0.05	0.010	0.11
Big	–0.539	–5.37***	–0.541	–5.36***
Tenure	–0.071	–6.24***	–0.069	–6.11***
Ind_spec	0.027	0.27	0.026	0.25
AF_ratio	0.226	2.26**	0.237	2.36**
NAF_ratio	–0.105	–0.45	–0.110	–0.47
Laggc	–0.036	–0.23	–0.044	–0.28
Year dummies		YES		YES
Industry dummies		YES		YES
Pseudo R^2		11.69%		11.90%
Obs.		51,882		51,882

RESIGN = 1 if the auditor resigns from the company and 0 otherwise. $RESIGN^* \geq 0$ if *RESIGN* = 1, $RESIGN^* < 0$ if *RESIGN* = 0. $\hat{B}^*$ = the company's point estimate of bankruptcy risk, where the point estimates are generated from the bankruptcy prediction models reported in Table 3. $SE(\hat{B}^*)$ = estimation risk, measured as the standard error of $\hat{B}^*$. See Tables 1 and 2 for the definitions of control variables

The sample period is 2000–2013. The standard errors are corrected for clustering on each company and heteroskedasticity. ***, **, * = statistically significant at the 1%, 5%, 10% levels, respectively (two-tailed)

auditor resignation more than doubles, from 1.0% to 2.2%, as $\hat{B}^*$ increases from its tenth percentile value to the ninetieth percentile.

In model 2, we additionally control for an auditor's proprietary information about the risk of bankruptcy by including the ex post bankruptcy dummy variable (*B*). We continue to find that auditor resignations are positively associated with estimation risk (z-stat. = 3.00).

4.6 Results from the models of audit fees (H3)

Table 7 reports the results for the audit fee models. In model 1, we regress the natural logarithm of audit fees on the point estimates of bankruptcy risk $(\hat{B}^*)$, their standard errors $(SE(\hat{B}^*))$, and the control variables. As expected, Table 7 finds a significant positive coefficient on the point estimates of bankruptcy ($\hat{B}^*$) (t-stat. = 5.15). That is, auditors charge higher fees when companies have higher point estimates of bankruptcy risk.

Table 7 The effect of estimation risk ($SE\left(\hat{B}^*\right)$) on audit fees (H3)

	1		2	
	Coefft.	t-stat.	Coefft.	t-stat.
$\hat{B}^*$	0.023	5.15***	0.023	5.09***
$SE\left(\hat{B}^*\right)$	0.136	4.43***	0.135	4.41***
B			0.048	1.30
Client size	0.484	65.78***	0.484	65.68***
Book-to-market	–0.098	–11.33***	–0.098	–11.33***
Leverage	–0.211	–6.00***	–0.212	–6.01***
ROA	–0.330	–19.40***	–0.329	–19.37***
LLoss	0.145	15.70***	0.145	15.70***
Rec	0.983	15.50***	0.983	15.49***
Inv	0.308	5.18***	0.307	5.17***
Liquidity	–0.028	–12.88***	–0.028	–12.89***
Litigation risk	0.033	2.03**	0.033	2.03**
Merger	0.094	9.53***	0.094	9.53***
IPO	0.233	9.59***	0.233	9.58***
SEO	0.039	3.08***	0.039	3.08***
Issue	0.078	3.95***	0.079	3.95***
Busseg	0.122	8.88***	0.122	8.88***
Foreign	0.003	1.13	0.003	1.13
Employees	0.036	5.27***	0.036	5.27***
Yearend	–0.064	–4.30***	–0.064	–4.31***
Big	0.355	22.07***	0.355	22.07***
Tenure	0.000	–0.44	0.000	–0.42
GC	0.072	3.39***	0.070	3.24***
Year dummies		YES		YES
Industry dummies		YES		YES
R^2		81.99%		81.99%
Obs.		51,882		51,882

LnAF = natural logarithm of audit fees. $\hat{B}^*$ = the company's point estimate of bankruptcy risk, where the point estimates are generated from the bankruptcy prediction models reported in Table 3. $SE\left(\hat{B}^*\right)$ = estimation risk, measured as the standard error of $\hat{B}^*$. See Tables 1 and 2 for the definitions of control variables

The sample period is 2000–2013. The standard errors are corrected for clustering on each company and heteroskedasticity. ***, **, * = statistically significant at the 1%, 5%, 10% levels, respectively (two-tailed)

Next, we turn to our main variable of interest, $SE\left(\hat{B}^*\right)$. Under H3, auditors respond to higher estimation risk by charging higher audit fees. Thus we predict a significant positive coefficient on $SE\left(\hat{B}^*\right)$. Consistent with H3, model 1 shows a highly significant positive coefficient on estimation risk (t-stat. = 4.43). The effect of $SE\left(\hat{B}^*\right)$ in model 1 is also significant in terms of its economic magnitude. Ceteris paribus, we find that audit fees increase by 7.4% ($46,613), as $SE\left(\hat{B}^*\right)$ increases from its tenth percentile value to the ninetieth percentile. Therefore estimation risk has a significant impact on audit fees. In comparison, audit fees increase by 13.8% ($85,347), as $\hat{B}^*$ increases from its tenth percentile value to the ninetieth percentile. The signs and significance of the control variables are consistent with prior audit fee research (e.g., Hribar et al. 2014).

In model 2, we additionally control for the ex post bankrupcy dummy (B) and find that this does not affect our infereneces. We continue to observe that audit fees are positively associated with estimation risk (t-stat. = 4.41).

5 Supplementary analyses

In this section, we conduct several supplementary analyses. First, we address the concern that $SE\left(\hat{B}^*\right)$ might be capturing bankruptcy risk rather than estimation risk. Second, we show that estimation risk ($SE\left(\hat{B}^*\right)$) has a bigger effect on auditor behavior when companies are moderately distressed, rather than healthy or severely distressed. Third, we demonstrate that our results for ($SE\left(\hat{B}^*\right)$) are driven by the squared normalized values of the X variables rather than time-varying estimates of the variance-covariance matrices. Fourth, we show that our findings for ($SE\left(\hat{B}^*\right)$) are not attributable to the X variables having nonlinear effects on bankruptcy. Finally, we demonstrate that the results hold for both Big Four and non-Big Four auditors.

5.1 Is $\mathrm{SE}\left(\hat{\mathrm{B}}^*\right)$ capturing bankruptcy risk?

A concern is that our estimation risk variable ($SE\left(\hat{B}^*\right)$) might be inadvertently capturing misspecification of the bankruptcy prediction model. In particular, we want to be sure that $SE\left(\hat{B}^*\right)$ is not capturing the effects of bankruptcy risk. To examine this, we include $SE\left(\hat{B}^*\right)$ in the bankruptcy prediction model. If $\mathrm{SE}\left(\hat{\mathrm{B}}^*\right)$ is inadvertently capturing bankruptcy risk rather than estimation risk, we would expect to find significant positive coefficients on $\mathrm{SE}\left(\hat{\mathrm{B}}^*\right)$ in the bankruptcy prediction model.

The results are reported in Table 8. We find that estimation risk $SE\left(\hat{B}^*\right)$ is an insignificant predictor of bankruptcy (z-stats. = 0.41, 0.60). In contrast, the point estimates of bankruptcy are highly significant predictors (z-stats. = 9.24, 9.13). These findings confirm that the point estimates are capturing bankruptcy risk, while the standard errors are capturing estimation risk rather than bankruptcy risk.

5.2 Does estimation risk ($SE\left(\hat{B}^*\right)$) matter more when companies are moderately distressed?

We expect that $SE\left(\hat{B}^*\right)$ matters more when companies are moderately distressed, compared to when they are financially healthy or severely distressed. Estimation risk is less

Table 8 The insignificant relation between estimation risk ($SE\left(\hat{B}^*\right)$) and the likelihood of bankruptcy

	1		2	
	Coefft.	z-stat.	Coefft.	z-stat.
$\hat{B}^*$	0.879	9.24***	0.796	9.13***
$SE\left(\hat{B}^*\right)$	0.356	0.41	0.494	0.60
LTA	0.151	4.94***	0.168	4.01***
Book-to-market	0.124	1.78*	0.071	1.05
Leverage	0.114	0.34	–0.155	–0.45
LLoss	0.202	0.86	0.385	2.29**
ROA	–0.458	–3.67***	–0.372	–2.76***
Ret	–0.355	–1.48	–0.263	–1.18
Stdev	0.191	1.05	–0.036	–0.18
Big			0.039	0.22
Tenure			–0.111	–5.68***
Ind_spec			0.199	1.31
AF_ratio			–0.455	–2.83***
NAF_ratio			0.039	0.12
GC			1.393	8.59***
Year dummies		YES		YES
Industry dummies		YES		YES
Pseudo R^2		27.10%		30.59%
Obs.		51,882		51,882

$B = 1$ if the company files for bankruptcy within 15 months of the company's fiscal year-end and 0 otherwise. $B^* \geq 0$ if $B = 1$, $B^* < 0$ if $B = 0$. $\hat{B}^*$ = the company's point estimate of bankruptcy risk, where the point estimates are generated from the bankruptcy prediction models reported in Table 3. $SE\left(\hat{B}^*\right)$ = the standard error of $\hat{B}^*$. See Tables 1 and 2 for the definitions of control variables

The sample period is 2000–2013. The standard errors are corrected for clustering on each company and heteroskedasticity. ***, **, * = statistically significant at the 1%, 5%, 10% levels, respectively (two-tailed)

important when a company is severely distressed (i.e., when $\hat{B}^*$ is very large) because, in this situation, the auditor would likely issue a going-concern opinion, resign, or exert more audit effort, even if the point estimates of bankruptcy are measured with a high degree of imprecision. Similarly, estimation risk is unlikely to matter much when a company is financially healthy because, in this situation, the auditor would be unlikely to issue a going-concern opinion, resign, or exert greater audit effort, regardless of the imprecision in the point estimates of bankruptcy. Instead, we expect that $SE\left(\hat{B}^*\right)$ matters more when the point estimates ($\hat{B}^*$) indicate a moderate level of financial distress because, in this situation, an auditor is likely to worry more about the degree of imprecision in the estimates.

To examine this, we re-estimate our going-concern, resignation, and audit fee models for the following three subsamples:

i. financially healthy observations (i.e., $\hat{B}^*$ is less than the 50th percentile value),
ii. moderately distressed observations (i.e., $\hat{B}^*$ exceeds the 50th percentile value but is less than the 80th percentile value), and
iii. highly distressed observations (i.e., $\hat{B}^*$ exceeds the 80th percentile value).

The results for these subsamples are shown in Table 9. Consistent with expectations, we find that $SE\left(\hat{B}^*\right)$ is a highly significant determinant of auditors' GC reports, resignations, and audit fees in the subsample of moderately distressed observations. In contrast, $SE\left(\hat{B}^*\right)$ is generally insignificant in the other two subsamples. These findings reinforce our main result that auditors act conservatively in situations where $SE\left(\hat{B}^*\right)$ is likely to matter most.

5.3 The source of variation in $SE\left(\hat{B}^*\right)$

The estimation risk variable is equal to the square root of $X_n \hat{V}_{\hat{\alpha}} X_n{'}$, where the n subcript denotes the n'th observation in the sample, X_n is a vector containing the

Table 9 Results after partitioning the sample into financially healthy observations, moderately distressed observations, and severely distressed observations. An observation is classified as financially healthy if its predicted bankruptcy probability is less than the median. An observation is classified as moderately distressed if its predicted bankruptcy probability is greater than the median but less than the 80th precentile. An observation is classified as severely distressed if its predicted bankruptcy probability is greater than the 80th percentile

	Financially healthy		Moderately distressed		Severely distressed	
	Coefft.	z-stat.	Coefft.	z-stat.	Coefft.	z-stat.
Panel A: Results for the audit reporting models (H1)						
$\hat{B}^*$	0.452	2.47**	0.612	3.48***	0.375	5.28**
$SE\left(\hat{B}^*\right)$	1.154	1.68*	2.112	2.61***	–0.116	–0.17
CONTROLS		YES		YES		YES
Year dummies		YES		YES		YES
Industry dummies		YES		YES		YES
Pseudo R^2		52.25%		47.27%		39.36%
Obs.		25,941		15,565		10,376
Panel B: Results for the auditor resignation models (H2)						
$\hat{B}^*$	0.088	1.14	0.150	1.11	0.246	3.31***
$SE\left(\hat{B}^*\right)$	0.593	1.87*	1.464	2.19**	–0.774	–0.81
CONTROLS		YES		YES		YES
Year dummies		YES		YES		YES
Industry dummies		YES		YES		YES
Pseudo R^2		11.90%		11.40%		11.25%
Obs.		25,941		15,565		10,376
Panel C: Results for the audit fee models (H3)						
$\hat{B}^*$	–0.011	–1.50	0.054	4.72***	0.041	4.34***
$SE\left(\hat{B}^*\right)$	–0.013	–0.34	0.316	4.50***	0.111	1.17
CONTROLS		YES		YES		YES
Year dummies		YES		YES		YES
Industry dummies		YES		YES		YES
R^2		82.59%		81.25%		77.82%
Obs.		25,941		15,565		10,376

values of the X variables, and $\hat{V}_{\hat{\alpha}}$ is the estimated variance-covariance matrix of the coefficient estimates. In our main tabulated tests, there are two sources of variation in $SE\left(\hat{B}^*\right)$. First, the value of $SE\left(\hat{B}^*\right)$ for observation n depends on the squared distances between the values of the X variables for observation n and the mean values of the X variables. Second, there is also some time variation in the estimates of $\hat{V}_{\hat{\alpha}}$ and $\hat{\alpha}$ because the bankruptcy prediction models are estimated using rolling windows.

We expect that our results for $SE\left(\hat{B}^*\right)$ are driven by the variation in X, rather than the time variation in the estimated variance-covariance matrices. For example, if two companies have the same point estimates of bankruptcy ($\hat{B}^*$), but one point estimate is driven by average X values and the other is driven by more extreme X values that offset each other (e.g., abnormally large losses but abnormally low leverage), the latter point estimate would have greater estimation risk than the former point estimate. Auditors would thus be more conservative for the latter observation.

To determine that it is the variation in X variables that drives our results (rather than the time-varying variance-covariance matrices), we re-estimate a single bankruptcy model using one pooled sample to ensure that the estimated variance-covariance matrix is held constant over the sample period. We then re-compute the values of $\hat{B}^*$ and $SE\left(\hat{B}^*\right)$ and plug them back into our equations for auditors' going-concern reports, resignations, and audit fees. We continue to find that the standard errors of the point estimates of bankruptcy are positive and significantly associated with going-concern opinions (z-stat. = 10.27), resignations (z-stat. = 2.98), and audit fees (t-stat. = 3.03). Moreover, the point estimates of bankruptcy also retain highly significant positive coefficients in each of the three models (z-stats =18.29, 4.07; t-stat. = 5.41).

5.4 Estimating a nonlinear bankruptcy model

Given that the estimation risk variable reflects abnormal or unusual values of the X variables, it is important to verify that our results are not driven by omitted nonlinear effects of the X variables. To some extent this concern is alleviated by the additional analysis of Section 5.1, which shows that $SE\left(\hat{B}^*\right)$ is not simply capturing bankruptcy risk. As an additional robustness test, we re-estimate the bankruptcy models after adding the squared values of all the continuous X variables as extra covariates. We then re-estimate $\hat{B}^*$ and $SE\left(\hat{B}^*\right)$ and plug these variables into our models for going-concern opinions, resignations, and audit fees. We continue to find that the standard errors of the point estimates of bankruptcy ($SE\left(\hat{B}^*\right)$) are significantly and positively associated with going-concern opinions (z-stat. = 9.88), resignations (z-stat. = 3.08), and audit fees (t-stat. = 5.71). Moreover, the point estimates of bankruptcy, which are now a nonlinear function of the X variables, also remain highly significant in each of the three models (z-stats. = 16.13 and 3.54; t-stat. = 4.56).

5.5 The big four and non-big four audit firms

Next, we examine whether the Big Four and non-Big Four audit firms respond differently to estimation risk. A differential response would be expected if Big Four and non-Big Four auditors have different attitudes toward risk. The more risk averse the auditor, the greater the effect of estimation risk on auditor conservatism. A priori, it is unclear whether the Big Four or non-Big Four auditors are more averse to risk. On one hand, the Big Four auditors may be more risk averse because they have more reputational capital at stake and deeper pockets (DeAngelo 1981; Weber et al. 2008). If so, they would be more sensitive to estimation risk than the non-Big Four. On the other hand, the Big Four may be less risk averse because their portfolios of clients are more highly diversified (Francis and Krishnan 2003). Thus it is an open empirical question whether the Big Four and non-Big Four auditors are equally sensitive to estimation risk.

To examine this, we estimate the going-concern, resignation, and audit fee models separately for both groups. Consistent with the pooled results, we find significant positive coefficients on $SE(\hat{B}^{*})$ in both subsamples (results untabulated). Moreover, we find no significant difference in the coefficients on $SE(\hat{B}^{*})$ between Big Four and non-Big Four auditors for the going-concern and resignation models. However, we find that Big Four auditors place a significantly higher weight on $SE(\hat{B}^{*})$ in our audit fee regressions.

6 Conclusions

Estimation risk imposes incremental uncertainty on risk-averse individuals and therefore affects their behavior. We examine how estimation risk affects auditors' going-concern reports, their resignation decisions, and audit fees. We demonstrate that auditors are more likely to issue going-concern opinions when the point estimates of bankruptcy are estimated with greater imprecision. Additionally, auditors have a greater propensity to resign when the point estimates of bankruptcy have bigger standard errors. Finally, we show that auditors charge higher fees when faced with higher estimation risk surrouding the point estimates of bankruptcy. These findings are consistent with estimation risk helping explain auditor behavior. In particular, our findings suggest that auditors are more conservative when they face greater estimation risk.

These findings matter because decision-making under uncertainty is a key theme of accounting research. We have demonstrated that it is simple to compute estimation risk using the variance-covariance matrix of coefficient estimates and to then examine how this risk affects the behavior of risk-averse individuals. This study's methodology for measuring estimation risk can be used in other accounting settings, where the decisions of risk-averse individuals are likely to be affected by estimation risk.

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