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ORIGINAL RESEARCH

Accounting information quality and systematic risk

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Abstract Whether and how accounting information quality affects the cost of capital has been a matter of much debate. We contribute to this debate by linking accounting information quality to systematic risk, inspired by recent theoretical discussions. Using the universe of firms jointly listed in the CRSP and Compustat databases from 1962 to 2012, we find that accounting information quality is significantly and negatively related to systematic risk. This relation is robust to alternative proxies for the two constructs, including a model-free measure of risk. Further analysis indicates that improving accounting information quality causes systematic risk to decrease. These findings have important implications for disclosure decisions, portfolio management, and asset pricing.

Keywords Accounting information quality · Systematic risk · Abnormal accruals · Endogeneity

JEL Classification G12 · G14 · M40

1 Introduction

Whether accounting information quality affects the cost of capital has been the central theme of a large and growing literature in accounting, economics, and finance. This literature provides considerable empirical evidence of a negative relation between the two constructs (Armstrong et al. 2013). However, the mechanism behind the relation has been a

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subject of intense debate (Beyer et al. 2010; Tang 2011). We contribute to the debate by investigating empirically whether and how accounting information quality is related to existing systematic risk factors (i.e., firm betas).

In neoclassical theory, a firm's cost of capital depends exclusively on exposure to systematic risk, i.e., systematic risk factors and risk premiums on these factors (Hughes et al. 2007; Armstrong et al. 2013). Thus, accounting information quality can affect the cost of capital in only three possible ways: First, accounting information quality constitutes an additional systematic risk factor that is distinct from other known such factors; second, accounting information quality itself is not a systematic risk factor but affects risk premiums on known such factors; and third, accounting information quality is somehow related to known systematic risk factors.

Previous studies have closely examined the first two possibilities, producing completely contradictory insights. For example, Easley and O'hara (2004), Francis et al. (2005), and Bandyopadhyay et al. (2017) suggest that accounting information quality is a priced systematic risk factor. However, Core et al. (2008) show that accounting information quality represents idiosyncratic risk that can be completely diversified away. Hughes et al. (2007) argue that high accounting information quality decreases risk premiums on known systematic factors, but Veronesi (2000) demonstrates the opposite. Despite these deadlock situations involving the first two possibilities, the third one has received relatively little attention in academic research.

A possible reason for the lack of attention is that accounting information quality is traditionally viewed as pertaining only to firm-specific information, which does not affect systematic risk. Recent theoretical work, however, shows that this view is incomplete. For example, Lambert et al. (2007) and Patton and Verardo (2012) demonstrate that an individual firm's accounting information quality affects investors' assessments of the covariance of the firm's cash flows with those of the market. Such theoretical support, along with the abovementioned deadlocks, makes it appropriate and necessary to subject the link between accounting information quality and systematic risk to an empirical analysis.

To conduct this analysis, we construct a dataset of 150,245 firm-year observations for the period 1962–2012. As our primary measures of accounting information quality, we use the extent to which accounting accruals map into operating cash flows (Dechow and Dichev 2002) and the absolute value of abnormal accruals (Jones 1991). Having been used widely for similar purposes (e.g., Rajgopal and Venkatachalam 2011),[1] these accruals-based variables allow us to examine a broad cross-section of firms over five decades. To gauge systematic risk, we take the traditional approach to decompose total risk into systematic and firm-specific risk through a market model regression, following a large number of studies (e.g., Jin 2002; Low 2009). As a robustness check, we also estimate systematic risk using the Fama–French (1993) three-factor model. After controlling for the usual determinants of systematic risk, we find that accounting information quality is significantly and negatively associated with systematic risk. The result is robust to alternative measures

[1] Rajgopal and Venkatachalam (2011) choose to use the squared value of abnormal accruals because it is believed to have more desirable distributional properties. However, we find that in our data, the absolute value is more normally distributed than the squared value. Because data transformations can alter the fundamental nature of the data, create curvilinear relationships, and complicate interpretations (Osborne 2002), we prefer to use the absolute value. Another reason that favors the absolute value is that conceptually, the absolute value of abnormal accruals is a more direct measure of earnings quality than the squared value of abnormal accruals. Empirically, the absolute value of abnormal accruals is more widely used than the squared value of abnormal accruals. We note that as in Rajgopal and Venkatachalam (2011), using either the absolute or the squared value produces similar results.

of accounting information quality such as earnings precision (Dichev and Tang 2009) and analyst forecast consensus (Zhang 2006).

A major challenge to statistical inference regarding the impact of accounting information quality is the endogeneity of this quality (Larcker and Rusticus 2010). In our setting, this problem could arise for a couple of reasons: First, the causality could run from systematic risk to accounting information quality; and second, both variables might be simultaneously determined. In light of this potential problem, we examine the causal relation between accounting information quality and systematic risk using the enactment of the Sarbanes–Oxley Act (SOX) in 2002 as a pseudo-natural experiment. Previous studies suggest that the enactment of SOX provides an arguably exogenous variation in accounting information quality (Kogan et al. 2009; Dyck et al. 2010). This variation allows us to adopt a differences-in-differences (DID) research design, which has become increasingly popular as an approach to identify causal effects (Armstrong et al. 2012). Our DID results show that in these experiments, improving accounting information quality causes systematic risk to decrease.

Another potential complication to any research like ours is the difficulty of appropriately measuring systematic risk. Some researchers (e.g., Lakonishok et al. 1994) argue that the traditional measure of systematic risk, beta, might not adequately capture the firm's exposure to the underlying risk factor. In addition, there is the possibility that conventional asset pricing models do not completely identify risk factors (Mitchell and Stafford 2000). To examine the potential influence on our results of what Fama (1998) calls the bad-model problem in measuring risk, we follow Lakonishok et al. (1994) and adopt a model-free approach in identifying fundamentally risky firms. The rationale of this approach is that systematically riskier firms should perform worse in extremely bad states of the world (Lakonishok et al. 1994). Accordingly, we classify the bottom (top) 25% of sample firms with the lowest (highest) annual returns in each of the stock market's ten worst years from 1962 to 2012 as risky (less risky) firms. In essence, this risk measure is based on the response of an individual firm's returns to market returns and thus captures largely the systematic component of firm risk. Using this alternative measure, we find qualitatively the same results regarding the relation between accounting information quality and systematic risk.

Our paper provides new insights into the mechanisms through which accounting information quality affects the cost of capital. In particular, we provide empirical evidence in support of the idea that it is plausible for accounting information quality to affect the cost of capital through a link with firm beta. This evidence not only sheds light on the empirical relation between accounting information quality and cost of capital but also provides guidance for future theoretical work that aims at a better understanding of the relation.

Our study also contributes to a large literature on the relation between financial reporting and firm risk, arguably one of the most fundamental issues in accounting and finance. This literature provides fairly clear evidence of a negative relation between financial reporting and idiosyncratic risk (Ashbaugh-Skaife et al. 2009; Rajgopal and Venkatachalam 2011; Chen et al. 2012; Isidro and Dias 2017). However, little is known about the relation between financial reporting and systematic risk. Among the first to investigate this relation are Francis et al. (2005), who report a negative association between accruals quality and firm beta. However, their analysis is univariate in nature and thus does not account for the potential influence of confounding factors. Cai et al. (2007) report that changes in accounting information quality around earnings announcements positively affect systematic risk. However, Savor and Wilson (2016) find that the change in systematic risk around earnings announcements is due to another possible component of systematic risk (which is what they call "announcement risk") instead of firms' market betas. In addition, Lang and Maffett (2011), Ng (2011), and Sadka (2011) show that higher accounting information quality is associated with lower liquidity risk, a component of systematic risk defined as the sensitivity of stock returns to unexpected changes in market liquidity. Different from these studies, we focus on the relation between accounting information quality and the primary component of systematic risk, that is, the sensitivity of an individual stock's returns to market returns.

Finally, our paper is related to a growing number of empirical studies that investigate the impact of firm-specific events on systematic risk. These papers have demonstrated that systematic risk varies with firm-specific events such as earnings announcements (Patton and Verardo 2012), share repurchases (Denis and Kadlec 1994), stock splits (Green and Hwang 2009), and uses of derivatives (Bartram et al. 2011). We add to this line of research by focusing on an important aspect of a major and regular firm-specific event, that is, the quality of the firm's financial reporting.

The paper proceeds as follows. Section 2 discusses the theoretical relation between accounting information quality and systematic risk. Section 3 describes the data. Section 4 presents the empirical results. Section 5 concludes.

2 Theoretical background

Classic asset pricing models (e.g., Sharpe 1964; Lintner 1965) maintain that the systematic risk of a firm represents the sensitivity of the firm's returns to market-wide information. Thus, if financial reporting conveys only firm-specific information, its quality should not affect systematic risk. However, recent theoretical discussions suggest that an individual firm's financial reports contain information about the entire economy in general.

For example, Patton and Verardo (2012) argue that financial reports of an individual firm provide valuable information not only about the prospects of the reporting firm but also about those of its peers and more generally the entire economy; therefore, investors can use the information of a given firm to revise their expectations about the profitability of non-reporting firms and of the entire economy in general. This process of learning across firms changes the covariance of the returns of an individual firm with those of the market, thereby altering the market beta of the firm (Patton and Verardo 2012). Because accounting information quality undoubtedly plays a critical role in investors' revision about market information, it should matter for systematic risk.

Lambert et al. (2007) also recognize that cash flows of individual firms are correlated. In their theoretical framework, accounting information quality affects investors' assessments of the covariance of an individual firm's cash flows with those of the market; therefore, systematic (covariance) risk varies with accounting information quality. Armstrong et al. (2013) extend the model of Lambert et al. (2007) by allowing investors to update not only about the aggregate risk factors in the economy but also about the firm-specific factor loadings. In this more general setup, they reach a similar conclusion regarding the impact of the quality of firm-specific information on systematic risk.[2]

[2] Although Lambert, Leuz, and Verrecchia (2007) and Armstrong, Banerjee, and Corona (2013) suggest that accounting information quality could affect systematic risk, the direction of this impact is ambiguous in their models. This ambiguity, however, is not inconsistent with the notion that accounting information quality is related to systematic risk.

Building on the work of Lambert et al. (2007), Core et al. (2015) posit that high disclosure quality of an individual firm can possibly lower its systematic risk. This effect occurs because disclosure quality reduces parameter uncertainty regarding the estimate of expected returns (Brown 1979). "Specifically, better disclosure improves investors' prediction of future cash flows. Since more of the realization of future cash flows is known, the covariance between the firm's cash flows and the cash flows of stocks in the market portfolio becomes lower, which in turn reduces firm beta and the cost of capital. This effect is not diversifiable because it is present for all covariance terms, and hence lowers systematic risk." (Core et al. 2015, p. 5)

Cheynel (2013) combines voluntary disclosure with asset pricing in the presence of systematic risk. In her model, investors use firm-specific information (i.e., voluntary disclosures) to update their estimate of firms' systematic risk per dollar of expected cash flows. She shows that better information (i.e., more disclosures) leads investors to expect more cash flows, which in turn dilute the firms' sensitivity to systematic risk.

Most recently, Babenko et al. (2016) provide a dynamic asset pricing framework in which the conditional beta with respect to any priced source of risk depends on the history of firm-specific cash flow shocks. They illustrate the impact of firm-specific shocks on systematic risk using a firm with two divisions: The profit of the first division depends exclusively on idiosyncratic profitability shocks and the profit of the second division is driven only by systematic shocks. They view such a firm as a portfolio of a zero-beta asset and a risky asset. In this case, a negative idiosyncratic shock decreases the size of the zero-beta asset, making it a smaller fraction of the total portfolio value; as a result, the beta of the firm increases. Thus, the authors suggest that reducing the impact of a negative idiosyncratic shock can potentially decrease systematic risk. Because bad news tends to have a greater eventual impact when it is accumulated and withheld (Kothari et al. 2009), increases in accounting information quality (e.g., more timely and accurate reporting) are likely to decrease the impact of negative shocks and therefore reduce systematic risk.

In summary, several recently developed theories identify various mechanisms through which the accounting information quality of an individual firm can affect its systematic risk. Collectively, these mechanisms point to a negative relation between accounting information quality and systematic risk.[3]

3 Data

3.1 Sample construction

We start with all firm-year observations jointly listed in the CRSP and Compustat databases in the period 1962–2012. Based on this dataset, we construct two separate samples: the Dechow-Dichev (DD) sample and the abnormal accruals (|ABACC|) sample. To minimize the impact of outliers, we winsorize the main variables at the 1st and 99th percentiles. After omitting firms with missing data for firm risk or accounting information

[3] We acknowledge that a negative relation between accounting information quality and systematic risk is not the only view. For example, Johnstone (2016) argues that better information might actually leave investors less certain about future events and thus the relation between accounting information quality and systematic risk might be positive. The discrepancy in theoretical discussions seems to make our empirical analysis even more worthwhile.

quality, the DD sample consists of 128,201 observations. The |ABACC| sample is larger, with 150,245 observations.

3.2 Measures of systematic risk

As in Jin (2002), Low (2009), and others, we decompose total risk into systematic and idiosyncratic risk using the market model regression:

$$R_i = \alpha_i + \beta_i R_M + e_i, \tag{1}$$

where R_i is the return of individual stock i and R_M is the market return for the same period. Taking the variance of both sides of Eq. (1), we can express total risk in terms of its systematic and idiosyncratic components as follows:

$$VAR(R_i) = \beta_i^2 \times VAR(R_M) + VAR(e_i), \tag{2}$$

where *VAR(x)* refers to the variance of random variable x. In this traditional decomposition, the first term on the right-hand side of Eq. (2) is the systematic component of firm risk, while the second term is the idiosyncratic or firm-specific component. We therefore use the product of beta squared and the variance of market returns as a measure of systematic risk. This measure, in a cross-sectional setting, is equivalent to the absolute value of firm beta, β.

As a proxy for market returns, we use those for the CRSP value-weighted index. We estimate Eq. (1) using daily returns over every fiscal year for every firm in our sample. We define annual systematic risk as the square of the resulting beta multiplied by the variance of daily market returns computed over the same year.

Similarly, we decompose total risk into systematic and idiosyncratic risk using Fama and French's (1993) three-factor model. In this case, systematic risk is the sum of the three squared betas multiplied by the variance of market returns.

In addition to estimating beta using returns over a 1-year period, we also run the regression in Eq. (1) for every firm using daily returns over every month. We multiply the square of the beta from this monthly regression by the variance of market returns in the same month and define this product as monthly systematic risk. Based on these monthly measures, we compute their average value over the fiscal year as annual systematic risk. Because the results remain qualitatively the same whether we estimate beta over a year or a month, for brevity we report results involving betas based on daily returns over a 1-year period.

The raw risk measures are right-skewed, which is consistent with what Jin (2002) observes. To improve the distributional properties of these measures, we construct the rank of risk measures among all firms in our sample, following Jin (2002). Specifically, for every year in our sample period, we rank firms from 100 (the highest) to 1 (the lowest) based on their annual raw risk measures and create new rank variables that serve as alternative risk measures. In addition to ranking risk measures, we also take the natural logarithm of the risk measures. Using raw, rank, or logarithmic risk measures produces similar results. For brevity and also because transforming data has both pros and cons, we focus on the raw measures in reporting results.

3.3 Measures of accounting information quality

We compute two widely used measures of accounting information quality (e.g., Rajgopal and Venkatachalam 2011; Marquardt and Zur 2014). Our first measure, *DD*, is based on an idea originally proposed by Dechow and Dichev (2002), who models the relation between accruals and cash flows as follows:

$$TCA_{it} = \beta_0 + \beta_1 CFO_{i(t-1)} + \beta_2 CFO_{it} + \beta_3 CFO_{i(t+1)} + e_{it}, \quad (3)$$

where i indexes firm and t indexes time. *TCA* is total current accruals and *CFO* is cash flow from operations. Francis et al. (2005) improve this model by controlling for two additional determinants of accruals:

$$TCA_{it} = \beta_0 + \beta_1 CFO_{i(t-1)} + \beta_2 CFO_{it} + \beta_3 CFO_{i(t+1)} + \beta_4 \Delta REV_{it} + \beta_5 PPE_{it} + e_{it}, \quad (4)$$

where i indexes firm and t indexes time. *ΔREV* is the change in revenues and *PPE* is the gross value of property, plant, and equipment. We estimate Eq. (4) in each of Fama and French's (1997) 49 industry groups, in which there are at least 20 firms in a year. We use the standard deviation of a firm's residuals over 5 years (i.e., the current year and four previous years) as an indication of poor accounting information quality.

As an alternative measure of accounting information quality, we compute the absolute value of the firm's abnormal accruals (|ABACC|). In doing so, we apply the modified Jones' (1991) model and estimate the following regression for each of Fama and French's (1997) 49 industry groups with at least 20 firms in a year:

$$TA_{it} = \beta_0 + \beta_1 (\Delta REV_{it} - \Delta AR_{it}) + \beta_2 PPE_{it} + \beta_3 ROA_{it} + e_{it}, \quad (5)$$

where i indexes firm and t indexes time. *TA* is total accruals and *ΔAR* is the change in accounting receivable. The residuals from Eq. (5) serve as proxies for abnormal accruals (ABACC). A higher absolute value of abnormal accrual indicates lower accounting information quality.

3.4 Control variables

To isolate the effects of accounting information quality on systematic risk, we control for a set of variables that are related to firm risk. These variables represent major firm characteristics such as size, profitability, leverage, growth opportunities, capital expenditures, research and development (R&D) expenditures, and firm focus.[4] We define these variables in the same way as in Low (2009). In particular, *Firm size* is the natural logarithm of total assets at the beginning of the year. *Market-to-book* is the ratio of the market value of assets divided by the book value of assets at the beginning of the year. *ROA* is net income before extraordinary items divided by total assets at the beginning of the year. *R&D* is R&D expenditures scaled by total assets (missing values are set to be zero). *Net capital expenditures* is the difference between capital expenditures and sales of property, plant, and equipment divided by total assets (missing values are set to be zero. *Leverage* is total liabilities divided by total assets. *Business segments* is the number of business segments reported in the Compustat Segment Database. Finally, *Sales Herfindahl* is the sum of the squared ratios of segment sales to total sales.

[4] While there is a large empirical literature on systematic risk, there are few theoretical models on the determinants of firm betas (for a comprehensive discussion of this issue, see Hong and Sarkar (2007)). In examining systematic risk, previous studies typically control for major firm characteristics. Here we follow Low (2009) and control for this particular set of variables for two reasons. First, these firm-level variables cover the most important firm characteristics that are often used as controls for firm risk. Second, using the same control variables as in Low (2009) makes our results easily comparable. This comparability is desirable given that there is not a fixed set of control variables that is widely agreed upon by researchers.

3.5 Summary statistics

Table 1 provides summary statistics for the key variables in the sample. The average DD measure of accounting information quality is 5.62, with a standard deviation of 5.4. These statistics are slightly greater than those in Rajgopal and Venkatachalam (2011), who report that the same measure is 4.47 with a standard deviation of 4.15 in the early years (i.e., 1962–2001) of our sample period.[5] This difference is consistent with the notion that accounting information quality has decreased and the values of DD and |ABACC| have increased over time (Rajgopal and Venkatachalam, 2011). The correlation (not tabulated for brevity) between the two measures of accounting information quality, DD and |ABACC|, is 0.48 over the entire sample period. Again, this correlation is similar to that (0.44) in Rajgopal and Venkatachalam (2011).

4 Results

4.1 OLS regressions of systematic risk on accounting information quality

In Table 2, we estimate the relation between accounting information quality and systematic risk. The dependent variables are raw risk measures as we describe in Sect. 3.2. The proxy for accounting information quality is the DD or |ABACC| measure. As in Low (2009), the main explanatory variables (i.e., *Accounting information quality*, *Size*, *Market-to-book*, and *ROA*) are measured at the beginning of the year.

In addition to the extended model with the full set of control variables in Table 2, we also estimate a parsimonious model with what Low (2009) identifies as the three main control variables (i.e., *Size*, *Market-to-book*, and *ROA*). The parsimonious model reduces the risk that irrelevant control variables introduce spurious results, while the extended model mitigates concerns about omitted variables. In all our analyses, we estimate both the parsimonious and extended model. We only report results from the extended model because both models produce qualitatively the same results.

Panel A of Table 2 uses the DD measure as a proxy for accounting information quality. Panel B uses the |ABACC| measure. In both panels, the results show that there is a significant and positive relation between poor accounting information quality and systematic risk. The impact of accounting information quality on systematic risk is not only statistically significant but also economically meaningful. For example, the coefficient estimates in Panel A of Table 2 suggest that for a one-standard deviation decrease in the DD measure of accounting information asymmetry, market model-based systematic risk increases by about 14.7%.[6] In untabulated results, we also find that poor accounting information quality increases idiosyncratic risk (defined as the variance of the residuals from the market model regression) in the next period, consistent with Rajgopal and Venkatachalam (2011).

[5] For the same period (i.e., 1962–2001), our sample appears to be very comparable to that of Rajgopal and Venkatachalam (2011). For example, the DD measure is available for 95,270 firm-year observations in their sample and 95,461 in ours. Our average DD measure of information quality is 4.43, with a standard deviation of 4.46; theirs are 4.47 and 4.15 respectively. Our mean squared value of the ABACC measure is 0.75, with a standard deviation of 1.95; theirs are 0.91 and 2.39 respectively.

[6] This statistic is based on the mean value of the market-model systematic risk measure in Table 1.

Table 1 Summary statistics for the main variables

Variable	N	Mean	Median	Standard deviation	25th percentile	75th percentile
Systematic risk-MM (× 100)	150,245	0.011	0.004	0.020	0.001	0.012
Systematic risk-3F (× 100)	150,245	0.036	0.016	0.055	0.006	0.040
Accounting information quality-DD (× 100)	128,201	5.618	3.912	5.403	2.098	7.099
Accounting information quality-ABACC (× 100)	150,245	6.513	4.216	7.188	1.811	8.423
Size	136,362	11.697	11.583	2.136	10.100	13.220
Leverage	149,964	0.236	0.211	0.204	0.051	0.363
Market-to-book	150,245	1.882	1.339	1.625	1.021	2.038
ROA	150,245	− 0.035	0.036	0.249	− 0.028	0.074
R&D	150,245	0.044	0.000	0.096	0.000	0.043
Net capital expenditures	149,467	0.062	0.044	0.065	0.020	0.082
Business segments	134,850	0.425	0.000	0.576	0.000	1.099
Sales Herfindahl	133,179	0.833	1.000	0.242	0.622	1.000

The sample consists of 150,245 firm-year observations jointly listed in the CRSP and Compustat databases in the period 1962–2012, for which both systematic risk and accounting information quality (ABACC-based) are available. *Systematic risk-MM* is the measure of systematic risk based on the market model regression. We estimate the market model using daily returns over every year for every firm in the sample. In this case, systematic risk is the squared value of the beta coefficient of the market model regression multiplied by the variance of market returns. *Systematic risk-3F* is the measure of systematic risk based on the Fama–French (1993) three-factor model regression. We estimate the three-factor model using daily returns over every year for every firm in the sample. In this case, systematic risk is the sum of the squared values of the beta coefficients of the three-factor model regression multiplied by the variance of market returns. *Accounting information quality-DD* is calculated from the modified version of the Dechow and Dichev (2002) model. *Accounting information quality-ABACC* is the absolute value of abnormal accruals based on the Jones (1991) model. *Size* is the natural logarithm of total assets. *Leverage* is the ratio of total liabilities to total assets. *Market-to-book* is the ratio of the market value of assets divided by the book value of assets. *ROA* is net income before extraordinary items divided by total assets. *R&D* is R&D expenditures scaled by total assets. *Net capital expenditures* is the difference between capital expenditures and sales of property, plant, and equipment divided by total assets. *Business segments* is the number of business segments reported in the Compustat Segment Database. *Sales Herfindahl* is the sum of the squared ratios of segment sales to total sales. Measures of systematic risk and accounting information quality have been multiplied by 100 for expositional convenience

Table 2 OLS regression of systematic risk on accounting information quality

	Dependent variable: systematic risk-MM	Dependent variable: systematic risk-3F
Panel A: Using DD as a proxy for accounting information quality		
Accounting information quality-DD	0.0002***	0.0009***
	(0.0000)	(0.0000)
Size	0.0025***	0.0019***
	(0.0000)	(0.0000)
Market-to-book	0.0008***	0.0019***
	(0.0000)	(0.0002)
ROA	− 0.0053***	− 0.0362***
	(0.0005)	(0.0014)
Leverage	0.0023***	0.0116***
	(0.0003)	(0.0010)
R&D	0.0111***	0.0339***
	(0.0009)	(0.0030)
Net capital expenditures	0.0026**	0.0038
	(0.0011)	(0.0030)
Business segments	− 0.0008***	− 0.0046***
	(0.0001)	(0.0030)
Sales Herfindahl	0.0091***	0.0087***
	(0.0002)	(0.0006)
Constant	− 0.0231***	− 0.0005
	(0.0004)	(0.0010)
Observations	114,023	114,023
R-squared	0.134	0.072
Panel B: Using |ABACC| as a proxy for accounting information quality		
Accounting information quality-ABACC	0.0001***	0.0004***
	(0.0000)	(0.0000)
Size	0.0024***	0.0017***
	(0.0000)	(0.0000)
Market-to-book	0.0008***	0.0021***
	(0.0000)	(0.0002)
ROA	− 0.0057***	− 0.0374***
	(0.0004)	(0.0013)
Leverage	0.0020***	0.0101***
	(0.0003)	(0.0009)
R&D	0.0116***	0.0370***
	(0.0009)	(0.0028)
Net capital expenditure	0.0010	− 0.0027
	(0.0010)	(0.0028)
Business segments	− 0.0009***	− 0.0049***
	(0.0001)	(0.0003)
Sales Herfindahl	0.0099***	0.0112***
	(0.0002)	(0.0006)

Table 2 continued

	Dependent variable: systematic risk-MM	Dependent variable: systematic risk-3F
Constant	− 0.0216***	0.0050***
	(0.0003)	(0.0010)
Observations	122,803	122,803
R-squared	0.132	0.066

This table estimates the impact of accounting information quality on systematic risk. Consistent with Low (2009), the main explanatory variables (i.e., *Accounting information quality*, *Size*, *Market-to-book*, and *ROA*) are measured at the beginning of the year. Variable definitions are in Table 1. All regressions include firm- and year-fixed effects. Robust standard errors for coefficient estimates are under the corresponding coefficients and in parentheses. *** indicates statistical significance at the 1% level

In both panels of Table 2, the signs and significance of the control variables are generally consistent with those in Low (2009). For example, as in Low (2009), we find that systematic risk is significantly and negatively associated with ROA and firm focus, but positively related to firm size, market-to-book ratio, and firm leverage. A notable difference between our results and those of Low (2009) involves the impact of R&D expenditures on systematic risk. We find that the relation is significant and positive, but Low (2009) reports the opposite in Table 5 of hers. A positive relation is consistent with the widely accepted notion that R&D expenditures represent risky investments.

Taken together, the results in Tables 2 clearly indicate that poor accounting information quality is associated with high systematic risk. This relation is robust to risk measures based on alternative asset pricing models and to alternative proxies for accounting information quality.

4.2 Fama–MacBeth regressions of systematic risk on accounting information quality

In the previous section we examine the relation between accounting information quality and systematic risk using pooled times-series cross-sectional data. This approach maximizes the power of our tests, but also gives rise to the concern that time-series correlations or common time trends in accounting information quality and systematic risk might account for the observed patterns in the pooled data. Although the fact that we find qualitatively the same results using rank measures of systematic risk should alleviate this concern,[7] we further address this issue by estimating Fama–MacBeth regressions. Specifically, we first estimate cross-sectional regressions in Table 2 for every year in our sample period. We then use the time series of these cross-sectional estimates to obtain final estimates for the parameters and standard errors. Table 3 summarizes the Fama–MacBeth regression results regarding the relation of interest. Clearly, these results are consistent with those based on OLS and pooled data, confirming a positive relation between poor accounting information quality and high systematic risk.

[7] Note that the rank risk measures are ranks (from 100 to 1) of firms based on their raw risk measures in a single year. Thus, the rank measures do not vary with market volatility. In essence, the rank measures compare the absolute value of firm betas in a single year.

Table 3 Fama–MacBeth regressions of systematic risk on accounting information quality

	Dependent variable: systematic risk-MM	Dependent variable: systematic risk-3F	Dependent variable: systematic risk-MM	Dependent variable: systematic risk-3F
Accounting information quality-DD	0.0003***	0.0009***		
	(0.0000)	(0.0001)		
Accounting information quality-ABACC			0.0001***	0.0003***
			(0.0000)	(0.0000)

This table summarizes the Fama-MacBeth regression results regarding the impact of accounting information quality on systematic risk. Model specifications here are exactly the same as those in Table 2. The difference is that instead of using pooled time-series cross-sectional data, here we estimate cross-sectional regressions year by year and for every year in our sample period. Reported are the mean values and standard errors (in parentheses) of the year-by-year estimates for the parameters of the variables of primary interest. Variable definitions are in Table 1. *** indicates statistical significance at the 1% level

4.3 DID regressions of systematic risk on accounting information quality

In Sects. 4.1 and 4.2, we establish that there is a positive association between poor accounting information quality and systematic risk. But is the relation causal? If so, what is the direction of causality? Although using lagged explanatory variables mitigates concerns about reverse causality and simultaneity, this approach alone might be inadequate for assessing causality because firm characteristics tend to exhibit substantial serial correlations.

The conventional remedy for endogeneity is to estimate instrumental variable (IV) models using two-stage least squares (2SLS). This approach relies heavily on the availability of valid and strong instruments for the endogenous variables. Because it is difficult to find variables that are highly correlated with accounting information quality but uncorrelated with systematic risk, we examine the causal relation between the two constructs using the enactment of SOX as a pseudo-natural experiment.

On July 30, 2002, U.S. Congress enacted SOX to protect investors from fraudulent accounting activities by corporations. This federal law mandates strict reforms to improve financial disclosures from corporations. For example, SOX requires that firm managers must individually certify the accuracy of financial information. SOX also increases the independence of outside auditors who review the accuracy of corporate financial statements. A number of papers (Kogan et al. 2009; Dyck et al. 2010) find that accounting information quality has improved since the enactment of SOX. Thus, if poor accounting information quality increases systematic risk, we expect firms with poorer accounting information quality in the pre-SOX period to exhibit a greater reduction in this risk in the post-SOX period.

To examine whether this is the case, we adopt a differences-in-differences (DID) research design that is similar to what Low (2009) uses. Specifically, we estimate the following cross-sectional and time-series model using data for a period around the enactment of SOX (i.e., 3 years before and after the event)[8]:

$$Y_{it} = \alpha_t + \beta_i + \gamma Post_t \times High_i + \delta Post_t + \varphi Control\ Variables_{it} + \varepsilon_{it}, \quad (6)$$

where i indexes firm and t indexes time. Y is the dependent variable of interest (i.e., systematic risk). α and β are year and firm fixed effects, respectively. *Post* is a dummy variable that equals one for observations in the post-SOX period and zero otherwise. *High* is a dummy variable that equals one for firms with accounting information quality measures greater than the median values of the measures averaged over three pre-SOX years. As in Low (2009), we omit *High* because the specification includes year (for the pre-SOX years only) and firm fixed effects. The coefficient on the interaction term, γ, indicates whether the post-SOX reduction in systematic risk is greater for firms with high pre-SOX accounting information quality measures (i.e., poor accounting information quality).

It is worth noting that our DID framework essentially compares the change in systematic risk for a firm with low accounting information quality before and after the enactment of SOX and compares this change to that for a firm with high accounting information quality over the same period. The use of firm fixed effects in this framework takes into account any unobserved cross-sectional heterogeneity across firms. The inclusion of year fixed effects accounts for any market-wide fluctuations in systematic risk.

In Panel A of Table 4, we estimate the DID regression around the enactment of SOX in 2002. Here, *Post* is a dummy variable that equals one for observations in 2002, 2003, and 2004, and zero for observations in 1999, 2000, and 2001. *High* is a dummy variable that equals one for firms with the DD measure greater than its median value of this measure averaged over three pre-SOX years. The results show that the coefficient estimates for both *Post* $\times$ *High* and *Post* are significant and negative in both models. Such results suggest that firms with a high DD measure (i.e., low accounting information quality) tend to experience a greater reduction in systematic risk, following the enactment of SOX in 2002. In addition, the results also suggest that in the post-SOX period, systematic risk generally decreases. Overall, the findings are consistent with the notion that higher accounting information quality causes systematic risk to decrease.

Panel B of Table 4 is the same as Panel A except that in Panel B, *High* is a dummy variable that equals one for firms with the |ABACC| measure greater than its median value of this measure averaged over three pre-SOX years. Clearly, the coefficient estimates for both *Post* $\times$ *High* and *Post* remain significant and negative in both models, suggesting that firms with a high |ABACC| measure (i.e., low accounting information quality) tend to experience a greater reduction in systematic risk, following the enactment of SOX in 2002.

4.4 Results based on a model-free measure of firm risk

Up to this point, we have relied on risk measures that stem from parameterized factor models. Although these models provide the conventional approach to measure firm risk, a frequently voiced concern regarding these models is that they might be incomplete in identifying risk factors (Lakonishok et al. 1994; Fama 1998; Mitchell and Stafford 2000). In light of this potential bad-model problem in measuring risk (Fama 1998), we follow

[8] We believe that a 3-year window is long enough for the effects of an event to materialize but also short enough to mitigate the effects of confounding factors. Using a 1-year or 2-year window yields similar results.

Table 4 Differences-in-differences regression of systematic risk on accounting information quality

	Dependent variable: systematic risk-MM	Dependent variable: systematic risk-3F
Panel A: Using DD as a proxy for accounting information quality		
Post × high	− 0.0066***	− 0.0168***
	(0.0007)	(0.0021)
Post	− 0.0046***	− 0.0140***
	(0.0005)	(0.0014)
Size	0.0055***	0.0075***
	(0.0004)	(0.0015)
Market-to-book	0.0043***	0.0082***
	(0.0003)	(0.0007)
ROA	0.0012	− 0.0195***
	(0.0014)	(0.0050)
Leverage	0.0018	0.0046
	(0.0019)	(0.0072)
R&D	− 0.0119**	− 0.0198
	(0.0048)	(0.0180)
Net capital expenditures	0.0065	− 0.0214
	(0.0046)	(0.0155)
Business segments	0.0004	− 0.0013
	(0.0007)	(0.0024)
Sales Herfindahl	− 0.0121***	− 0.0393***
	(0.0005)	(0.0014)
Constant	− 0.0511***	− 0.0341**
	(0.0045)	(0.0172)
Observations	24,553	24,553
R-squared	0.244	0.123
Panel B: Using |ABACC| as a proxy for accounting information quality		
Post × high	− 0.0074***	− 0.0152***
	(0.0007)	(0.0029)
Post	− 0.0046***	− 0.0145***
	(0.0004)	(0.0015)
Size	0.0055***	0.0061***
	(0.0004)	(0.0019)
Market-to-book	0.0043***	0.0084***
	(0.0003)	(0.0008)
ROA	0.0013	− 0.0207***
	(0.0014)	(0.0052)
Leverage	0.0018	0.0025
	(0.0018)	(0.0072)
R&D	− 0.0121**	− 0.0208
	(0.0048)	(0.0180)
Net capital expenditures	0.0075	− 0.0222
	(0.0046)	(0.0166)

Table 4 continued

	Dependent variable: systematic risk-MM	Dependent variable: systematic risk-3F
Business segments	0.0004	− 0.0007
	(0.0007)	(0.0025)
Sales Herfindahl	− 0.0121***	− 0.0405***
	(0.0005)	(0.0019)
Constant	− 0.0508***	− 0.0167
	(0.0044)	(0.0216)
Observations	25,785	25,785
R-squared	0.243	0.086

The exogenous event is the enactment of the Sarbanes–Oxley Act (SOX) in 2002. *Post* is a dummy variable that equals one for observations in 2002, 2003, and 2004, and zero for observations in 1999, 2000, and 2001. *High* is a dummy variable that equals one for firms with the DD (in Panel A) or |ABACC| (in Panel B) measure greater than the median value of the measure averaged over three pre-event years. Consistent with Low (2009), the main explanatory variables (i.e., *Accounting information quality*, *Size*, *Market-to-book*, and *ROA*) are measured at the beginning of the year. Variable definitions are in Table 1. Robust standard errors for coefficient estimates are under the corresponding coefficients and in parentheses. *** and ** indicate statistical significance at the 1% and 5% levels, respectively

Lakonishok et al. (1994) and adopt an alternative, nonparametric approach in identifying fundamentally risky firms.

Lakonishok et al. (1994) argue that for firms to be fundamentally risky for any reason, they must underperform other firms in the states of the world when the marginal utility of wealth and the price of risk are high. They further suggest that performance in extreme bad states indicates how risky a firm is, "even when conventional measures of risk such as beta and standard deviation do not show it" (Lakonishok et al. 1994, p. 1569). Following this idea, we classify the bottom (top) 25% of sample firms (hereafter bottom and top firms respectively) with the lowest (highest) annual returns in each of the stock market's ten worst years from 1962 to 2012 as high-risk (low-risk) firms. The ten worst years for the stock market in the U.S. are 1962, 1966, 1969, 1973, 1974, 1977, 2000, 2001, 2002, and 2008, based on value-weighted annual returns to the S&P 500 portfolio.[9]

It is important to note that the nonparametric risk measure captures largely the systematic component of firm risk because it is based on the response of an individual firm's returns to market returns.[10] Thus, if poor accounting information quality increases systematic risk, we expect the accounting information quality measures (i.e., DD and |ABACC|) to be higher for bottom firms than for top firms.

[9] Over 50 years from 1962 to 2012, S&P 500 has negative returns in only 12 years. The returns in the ten worst years range from − 6.98% (in 1977) to − 36.55% (in 2008). The other two negative returns are − 4.7% (in 1981) and − 3.06% (in 1990). We note that using the ten worst years for the CRSP equally-weighted portfolio in the sample period produces virtually the same results.

[10] It is possible that the worst-time performance of stocks (especially individual ones) might reflect both systematic and idiosyncratic risk factors. One way to alleviate this concern is to identify the states of the world that are truly reflective of the states of the market instead of those of the individual firms in a sample. In addition, one can use a large sample so that the idiosyncratic components of firm performance would matter less when firm performance is averaged out. We have taken both steps in the study.

Table 5 Differences in accounting information quality between bottom and top performing firms in the worst years for the stock market

	Bottom firms (1)	Top firms (2)	Difference (1)–(2)	*T*(*z*)-statistic
Accounting information quality-DD	8.211	5.639	2.572***	16.38
	(5.450)	(3.882)	(1.568***)	(14.651)
Accounting information quality-ABACC	9.916	6.845	3.071***	13.66
	(5.757)	(4.511)	(1.246***)	(9.679)

This table tests for mean and median (in parentheses) differences in accounting information quality between the worst and best performing firms in the ten worst years for the stock market from 1962 to 2012. The ten worst years in the U.S. are 1962, 1966, 1969, 1973, 1974, 1977, 2000, 2001, 2002, and 2008, based on annual returns to the S&P 500 portfolio. In each of the 10 years, we classify the bottom (top) 25% of sample firms with the lowest (highest) annual returns as bottom (top) firms. Thus, bottom firms are systematically risker than top firms (Lakonishok et al. 1994). Variable definitions are in Table 1. The significance of the mean (median) difference is based on a two-tailed *t* test (Wilcoxon rank sum test). *** indicates statistical significance at the 1% level

Table 5 examines the mean and median differences in DD and |ABACC| between bottom and top firms in the ten worst years for the stock market. The results clearly indicate that the bottom firms have significantly higher DD and |ABACC| (i.e., poorer accounting information quality) than top firms, which is consistent with the notion that lower accounting information quality is associated with higher systematic risk.

In Table 6, we regress the nonparametric risk measure on accounting information quality. Here we use data in the ten worst years for the stock market. The dependent variable is a dummy variable (*Bottom*) that equals one for bottom firms and zero for others. Given the dichotomous nature of the dependent variable, we estimate the regressions through probit and logit. We only report the probit results because both methods produce virtually the same results. Using both measures of accounting information quality, we find a significant and positive relation between poor accounting information quality and the *Bottom* dummy. The results regarding the control variables in both models are generally consistent with those in Table 2. Again, these findings confirm that poor accounting information quality is related to high systematic risk.

Collectively, the results in Tables 5 and 6 indicate that the positive relation between poor accounting information quality and systematic risk is robust to a model-free risk measure. Thus, the relation we document is unlikely to be driven by the bad-model problem in measuring risk.

4.5 Additional robustness checks

To further check the robustness of the relation between accounting information quality and systematic risk, we conduct two additional tests.

First, we examine the robustness of our main results to alternative measures of accounting information quality. Following Dichev and Tang (2009) and Ng (2011), we measure earnings precision as the standard deviation of earnings over the most recent 5 years, with earnings defined as earnings before extraordinary items deflated by average total assets. Following Zhang (2006), we measure analyst forecast consensus using the inter-analyst standard deviation of EPS forecasts deflated by the stock price at the time

Table 6 Probit regression of stock performance on accounting information quality in the worst years for the stock market

	Dependent variable: bottom dummy	Dependent variable: bottom dummy
Accounting information quality-DD	0.019***	
	(0.002)	
Accounting information quality-ABACC		0.008***
		(0.002)
Size	− 0.055***	− 0.058***
	(0.006)	(0.006)
Market-to-book	0.067***	0.072***
	(0.006)	(0.006)
ROA	− 0.458***	− 0.520***
	(0.053)	(0.051)
Leverage	0.678***	0.655***
	(0.052)	(0.050)
R&D	1.224***	1.293***
	(0.115)	(0.112)
Net capital expenditures	0.522***	0.456**
	(0.185)	(0.179)
Business segments	− 0.142***	− 0.126***
	(0.039)	(0.038)
Sales Herfindahl	− 0.292***	− 0.233**
	(0.097)	(0.094)
Constant	− 0.233**	− 0.175
	(0.119)	(0.115)
Observations	16,417	17,164
Pseudo-R^2	0.073	0.069

This table examines the link between accounting information quality and the probability of being one of the worst performing firms in the worst years for the stock market. Based on annual returns to the S&P 500 portfolio, the ten worst years in the U.S. are 1962, 1966, 1969, 1973, 1974, 1977, 2000, 2001, 2002, and 2008 over the period 1962–2012. In each of the 10 years, we classify the bottom 25% of sample firms with the lowest annual returns as bottom firms. Thus, bottom firms are systematically risker than other firms (Lakonishok et al. 1994). The dummy dependent variable, *Bottom*, equals one for bottom firms and zero for others. Other variable definitions are in Table 1. Robust standard errors for the coefficient estimates are under the coefficient estimates and in parentheses. We follow Low (2009) and measure the main explanatory variables (i.e., *Accounting information quality*, *Size*, *Market-to-book*, and *ROA*) at the beginning of the year. ***, **, and * indicate statistical significance at the 1, 5, and 10% levels, respectively

when the standard deviation is computed. Using earnings precision and analyst consensus as alternative measures of accounting information quality, we find that the results (not tabulated for brevity) are highly consistent with those based on accruals quality.

Second, we repeat the DID analysis in Table 4 by excluding the event year (e.g., 2002 for the SOX analysis) and comparing three pre-event years (e.g., 1999–2001 for the SOX analysis) against three post-event years (e.g., 2003–2005 for the SOX analysis). We find that excluding the event year does not alter the results in any meaningful way. If anything, the coefficient estimates for the interaction term slightly increase after excluding the event year. This is consistent with the fact that including the event year in the post-event period only makes us underestimate the effect of the event.

5 Concluding remarks

We investigate whether and how accounting information quality affects systematic risk in the universe of firms jointly listed in the CRSP and Compustat databases from 1962 to 2012. Using various measures of accounting information quality and systematic risk, we find that the two constructs are significantly and negatively correlated. We examine the causal nature of this relation by adopting three pseudo-natural experiments and a differences-in-differences approach. The results suggest that increases in accounting information quality cause systematic risk to decrease. Overall, our results provide empirical support to several recently developed theories that suggest a negative effect of accounting information quality on systematic risk. Such an effect has important implications for disclosure decisions, hedging strategies, portfolio management, and asset pricing.

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