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Enterprise risk management and accruals estimation error

Joseph Johnston *, Jared Soileau

Department of Accountancy, Illinois State University, USA
Department of Accounting, E.J. Ourso College of Business, Louisiana State University, USA

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ABSTRACT

We examine the association between an enterprise risk management (ERM) program and accruals estimation error. ERM helps firms identify, assess, and manage risks at the enterprise level. We argue that through ERM managers gain a better understanding of firm processes and can more accurately estimate accruals. Using a sample of 11,538 firm-year observations from 2007 to 2011, we measured accruals estimation error and the choice to disclose an ERM program simultaneously using full information maximum likelihood. We find that having an ERM program is negatively related to accruals estimation error and that having an ERM program is positively associated with signed abnormal accruals, suggesting that our findings are not due to reduced earnings management. Our results are consistent with the theory that ERM improves managers' understanding of the firm and its potential risks. Our study is relevant to academics how study ERM and practitioners and managers who are considering implementing ERM.

1. Introduction

In this study, we investigate the relation between enterprise risk management (ERM) and accruals estimation error. Under traditional risk management techniques, managers focus only on controlling the downside risks within their department (silos). ERM stresses understanding risks at the enterprise level.[1] To that end, managers using ERM should consider how risks in one part of the enterprise (the risk of stock-outs from a particular vendor) relate to risks in another part of the enterprise (loss of sales from poor brand image). We posit that through the process of analyzing risk throughout the firm, managers have a better understanding of potential shocks to future cash flows and therefore can make better decisions, which in turn help improve accruals estimates.

The results of this study should be of interest to practitioners considering implementation of an ERM strategy. While there has been some evidence that an ERM program improves firm value and reduces earnings volatility, practitioners are still uncertain as to the benefits of ERM. A survey by AON Analytics found that 40% of respondents saw the "lack of tangible benefits" as a barrier to ERM implementation, topping the list of ERM implementation barriers (AON, 2010). That survey

* Corresponding author at: Campus Box 5520, Illinois State University, Normal, IL 61790-5520; 309-438-3830, USA.
E-mail addresses: jajohn6@ilstu.edu (J. Johnston), jareds@lsu.edu (J. Soileau).

[1] ERM had its genesis in the insurance and finance industries, where the risks being considered were generally financial in nature. Under traditional risk management in these industries, risk were classified into categories and managed within those categories, creating "risk silos" that were managed separately. The move toward an enterprise-wide view focused on reducing costs from risk-redundant risk management activities and made use of natural hedges within the organization. In this study, we focus on the impact of ERM on operational decision making and financial reporting activities in non-financial firms.

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highlighted several case studies of the uses of ERM. For example, Eli Lilly, Pirelli, and AZ Electronic Materials utilized ERM to improve risk management within their supply chains. Origin Energy and Clariant International found that ERM improved information flow within their operations. These improvements in planning result in fewer large adjustments to financial accounts and improve the estimation of accruals (Cohen et al., 2017; Bailey et al., 2018). Using a survey of corporate governance stakeholders (i.e., audit committees, CFOs, and external auditors), Cohen et al. (2017) investigated how ERM improves the financial reporting process. Among other things, they found that corporate governance stakeholders appreciate the role of ERM in aiding the development of accounting estimates. They highlighted that accounting estimates related to valuation of inventory and receivables, asset impairments, and loan loss reserves. These accounting estimates related directly to accrual estimation error. Based on the finding that corporate governance stakeholders value the improved accounting estimation that ERM produces, Cohen et al. (2017) called for more research on the link between ERM programs and accounting estimates. We answer this call.

We also add to the academic literature by identifying a potential tool for improving earnings quality. The current literature argues that one of the determinants of earnings quality is a manager's ability to estimate accruals (Dechow and Dichev, 2002; Francis et al., 2008; Demerjian et al., 2013). We argue that ERM provides managers and employees with a better understanding of potential future shocks to cash flows, thereby allowing this information to be incorporated into their accrual estimates. Finding that firms using ERM have lower accrual estimation errors has an impact on our knowledge about how managers can improve earnings quality.

Using a sample of 11,538 firm-year observations from the period 2007 to 2011, we examined the association between the selection of an ERM program and accruals estimation error. We identified firms that have an ERM program by using DirectEDGAR to search Securities and Exchange Commission (SEC) filings (10-K and proxy statements) for key terms associated with ERM processes. To proxy for accrual estimation error, we used the magnitude of abnormal accruals from the modified Jones model (Dechow et al., 1995). Because the choice of having an ERM program is likely endogenous and made on unobservable factors, we measured accruals estimation error and the probability of selecting an ERM program as a system of equations using a maximum likelihood approach (Tucker, 2010). We find that firms who disclose having an ERM program in place have significantly lower magnitudes of abnormal accruals in the current year and have significantly lower magnitudes of abnormal accruals for the following two years.

In robustness tests, we examined whether the reduction in abnormal accruals is simply due to a reduction of earnings management. It may be that firms with ERM programs simply have better internal controls and therefore less earnings management (Doyle et al., 2007; Ashbaugh-Skaife et al., 2009), resulting in a lower magnitude of abnormal accruals. Using the Dechow and Dichev (2002) measure of accruals estimation error as an alternative measure of abnormal accruals, we re-examined the effect of ERM on discretionary and innate accruals estimation errors and find that ERM is negatively related to both components of accruals estimation quality. Furthermore, if firms with ERM engaged in less earnings management, we would expect ERM also to be negatively related to signed abnormal accruals. However, we find that having an ERM program is positively related to signed abnormal accruals. Furthermore, we find that both negative and positive abnormal accruals increase with ERM. The weight of the evidence is inconsistent with the observed relation between ERM and the magnitude of abnormal accruals being due only to decreased earnings management.

The results of our study have several implications. First, our results suggest that managers in firms with ERM programs make better decisions, not only from a financial risk standpoint, but also from a financial reporting standpoint. Second, firms with ERM programs will likely have better reporting quality such that investors can more heavily rely on these firms' reported earnings in assessing the future cash flow to the firm. Finally, we note that the benefits to ERM programs go above and beyond those previously documented for financial and insurance firms, as these industries are intentionally excluded from our study.

The rest of the study is organized as follows. In the next section, we discuss the current literature on accruals estimation error and on ERM. Section 3 provides details of our research methodology. In Section 4 we present our empirical results and we conclude in Section 5.

2. Background development

Research on the determinants of accrual estimation error is relatively scarce. The extant literature closest to our study looks at the relation between manager ability and earnings quality. Prior literature also evaluates the effect of poor internal controls on earnings quality. With respect to ERM, studies have primarily concentrated on determinants of firm implementation of ERM and firm performance benefits within the finance and insurance industries.

2.1. Earnings quality

There is a growing literature investigating manager-level characteristics and earnings quality. Ge et al. (2011) and DeJong and Ling (2013) found that there are CFO fixed effects in determining accounting policies, including discretionary accruals. Francis et al. (2008) examined the relation between CEO reputation and earnings quality and concluded that firms with low quality earnings hire reputable CEOs who can manage the company effectively during volatile situations. Aier et al. (2005) found that CFOs with more financial expertise are less likely to restate their financial statements. Of particular relevance to

our study is the study by Demerjian et al. (2013) which directly measured managerial ability and found that managers with greater abilities have lower accruals estimation errors. Our study adds to the literature on the ability of managers to improve accrual quality by identifying a tool that managers use to improve their ability to estimate accruals. Specifically, we posit that ERM helps managers identify and respond to internal and external risk to reduce volatility of future cash flows, which results in lower accrual estimation error.

Research has also addressed the link between weaknesses in internal controls and accruals quality. Doyle et al. (2007) found that firms that disclose material internal control weaknesses have lower accruals quality and that weaknesses in company-level controls drive this relation. Ashbaugh-Skaife et al. (2009) presented similar results and showed that accruals quality increases after internal control weaknesses are remediated. Our study differs from these studies in that we look at whether ERM implementations reduce accrual estimation error. While ERM may reduce the probability of having a material internal control weakness, we suggest that the effect of risk management on accruals quality goes beyond the effect of internal controls. Specifically, a manager's initial focus on identifying an organization's financial, operational, strategic, and compliance risk and on considering controls to manage (mitigate, share, or accept) identified risk goes beyond the effect of focusing initially on internal controls.

2.2. Enterprise risk management

The final stream of literature we contribute to is that on the benefits of ERM systems. Using a sample of firms from the insurance industry, Hoyt and Liebenberg (2011) found that firms that use ERM have a higher firm value relative to firms that do not. Using the appointment of a Chief Risk Officer (CRO) as a proxy for ERM adoptions, Beasley et al. (2008) and Pagach and Warr (2010) also found some evidence of a benefit to ERM adoption. Beasley et al. (2008) found that the magnitude of the market reaction to the announcement of a CRO is conditional on firm-specific characteristics. Pagach and Warr (2010) presented evidence that firms that appoint a CRO have lower earnings volatility, but only for firms that have a positive market reaction to the announcement of a CRO. By searching SEC filings for keywords related to risk management, Gordon et al. (2009) found that excess market returns are contingent on firm-specific characteristics. Using the Standard & Poor's (S&P) ERM Quality rating, Baxter et al. (2013) revealed a positive association with operating performance and firm value within the financial sector, while McShane et al. (2011) found a positive association between the S&P ERM Quality rating and firm value in the insurance industry.[2] Bailey et al. (2018) found a negative relation between the S&P ERM Quality rating and audit fees and audit delay. They argued that ERM allows managers to develop better accounting estimates, resulting in fewer year-end accounting adjustments.

Many of the extant studies used limited samples. Pagach and Warr (2010, 2011) and Beasley et al. (2008) used the appointment of a CRO as a proxy for ERM adoption and found little more than 100 adopters over roughly a ten-year period. Gordon et al. (2009), using a keyword search of SEC filings, found 112 firms using ERM in 2005 alone. Hoyt and Liebenberg (2011) focused on 117 firms in the insurance industry and identified fewer than 25 firms that adopted ERM. McShane et al.'s (2011) study contains 82 firm observations of which 31 were rated by S&P to have an ERM process greater than "adequate". Baxter et al.'s (2013) sample was limited to 165 firm-year observations over a three-year period (2006–2008).

We hope to add to this literature in two ways. First, we collected data covering all SEC 10-K and proxy filings over the period 2009–2011.[3] This should improve the power of the statistical test, which could explain the lack of findings in this area (see Pagach and Warr, 2010, 2011). Second, we link the use of ERM specifically to accruals quality to examine whether the increase in value and decrease in earnings volatility is due to better earnings quality or lower cash flow volatility. Finally, as noted by Baxter et al. (2013), the banking, finance, and insurance industries are heavily regulated, so results of prior studies focused on these industries may not be generalizable to other industries. To our knowledge, this is the most comprehensive study to consider the potential benefits of ERM for industries other than the heavily regulated banking, finance, and insurance industries.

We posit that having an ERM program in place improves management's ability to make good decisions about accrual-related choices and that this reduces accruals estimation error. One example of how this might occur can be found in the case of Eli Lilly (see AON, 2010). Eli Lilly implemented an ERM system in association with their Sarbanes-Oxley (SOX) compliance. They interviewed several managers throughout the firm and were able to identify risk that affected their supply chain. The managers indicated that, because of the risk identification, they were better able to predict fluctuations in supply and demand along their supply chain. As a result of fewer surprises in the supply chain, the balance in inventory more accurately represented the cash received for that inventory in the future, as opposed to having inventory written down due to obsolescence or expending additional cash due to the cost of expediting delivery or meeting production requirements. While the case of Eli Lilly is specific to accruals related to the supply chain, the process and planning involved in ERM implementation can be applied to alternative accruals choices.

[2] The S&P ERM Quality rating was only available for financial and insurance industries when we initiated our study.

[3] On December 16, 2009, the SEC approved and issued final rules, which included "New Disclosures about Board Leadership Structure and the Board's Role in Risk Oversight." The final rule, effective February 28, 2010, requires that companies disclose information related to the board of directors' oversight of risk. This requirement presents an opportunity for firms to disclose information related to their ERM process. As a result, the timing of our sample provides an opportunity to capture initial specific disclosure of risk management processes to proxy for ERM activities that was not available within samples from prior studies which used risk management disclosure as a proxy for ERM.

3. Research methodology

3.1. Sample selection

We collected data for accruals estimation error from Compustat and gathered data on ERM activities by searching the SEC 10-K and proxy statement filings using DirectEDGAR. Control variables were obtained from Compustat, CRSP, and Thompson Reuter's 13F databases. We excluded firms in the utility and financial industries (SIC codes 4000–4999 and 6000–6999 respectively) as these firms have significantly different accruals processes and regulatory requirements. We initially searched all firms in DirectEDGAR with filings from 1993 to 2011 to identify firms that have ERM programs. However, after we filtered the firms with available control variables, the proportion of firms that had ERM programs was extremely low (less than 50 per year) until 2007 and greatly increased in 2009 following the SEC disclosure requirement on risk oversight.[4] We therefore restricted our sample to the period from 2007 to 2011. We winsorized all continuous variables at the 1st and 99th percentiles within each year. Our final sample consisted of 3032 firms with 11,538 firm-year observations.[5] We identified 1532 firm-year observations representing 582 firms that had ERM programs. Table 1 contains the distribution of observations by fiscal year.

4. Identifying enterprise risk management programs

Prior literature has identified ERM firms using four different approaches. A couple of studies used survey data about ERM programs within the firm (Beasley et al., 2005; Soileau, 2010). Several other studies used the appointment announcement of a CRO as a proxy of firm adoption of an ERM program (Liebenberg and Hoyt, 2003; Beasley et al., 2008; Pagach and Warr, 2010, 2011). Other studies have performed keyword searches for terms related to risk management (Gordon et al., 2009; Hoyt and Liebenberg, 2011). Lastly, three studies relied on the S&P ERM Quality ratings for financial and insurance industry firms (McShane et al., 2011; Baxter et al., 2013; Bailey et al., 2018).

Survey data can lead to valuable insights into characteristics that are not publicly disclosed. However, there are two disadvantages to using survey data, both linked to the propensity to respond to the survey. The first is that the sample sizes tend to be small due to low response rates. For example, Beasley et al. (2005) received only 175 responses (a 10.3% response rate) and Soileau (2010) received a total of 496 responses (a 30.4% response rate). A related issue is that there is no information for the non-responders. To get a larger sample, we elected not to use survey data.

One alternative to survey data is to use public announcements of the appointment of a CRO (Liebenberg and Hoyt, 2003; Beasley et al., 2008; Pagach and Warr, 2010, 2011) as a proxy for ERM implementation. Even though there is a modest correlation between the appointment of a CRO and the use of ERM, Soileau (2010) noted that this appointment is a noisy measure of ERM implementation. Specifically, the role of the CRO may be fulfilled by an officer in a different position (e.g., the Chief Audit Executive) and a substantial portion of the ERM process is performed as part of the internal audit functions (Soileau, 2010). To reduce noise due to misclassification, we opted not to use disclosure of a CRO as a proxy for ERM implementation. Lastly, the S&P ERM Quality rating used by McShane et al. (2011) and Baxter et al. (2013) was only available for firms within the financial and insurance industries when we initiated this study. Due to a lack of available ratings and in order to expand upon prior literature on potential benefits of ERM by considering additional industries, we elected to use firm disclosures to identify firms with ERM systems.

We followed Hoyt and Liebenberg (2011) and Gordon et al. (2009) by electing to use a keyword search of 10-K and proxy statements filed with the SEC. As a result of the new disclosure requirement, we identified a large increase in the number of firms disclosing the use of risk management activities compared to prior studies. The main advantage of this method is that it provides a larger and more generalizable sample. However, this method has disadvantages. Firms are not required to specifically disclose if they have an established ERM program, even following the requirement for disclosure of board oversight of risk management. It is our opinion that, with the increased focus on risk management and the SEC disclosure requirement related to board oversight of risk management, managers would be more likely to discuss measures used to effectively assess, manage, and monitor risk.

We used a keyword search for firms' 10-K and proxy statement filings with the SEC available through DirectEDGAR. We queried all 10-K and proxy filings (DEF-14) available from 1993 to 2011 with the terms used either by Hoyt and Liebenberg (2011) or by Gordon et al. (2009), as well as with additional related terms.[6] We read through the results, filtered out obvious

[4] The effective date of the SEC's final rule related to disclosure of the board's role in risk oversight (see fn. 3) coincided with the 2009 fiscal year for SEC filers with fiscal year ends from December 31, 2009 to May 31, 2010. Therefore, we found a large increase in the number of disclosures beginning with the 2009 fiscal year.

[5] When we used future accruals estimation error, our sample size was reduced to 2,506 firms with 9,796 firm-year observations, and the ERM subsample comprised 520 firms for 1,363 firm-year observations. Using the Dechow and Dichev measures of estimator error, our sample was reduced to 1,717 firms with 4,534 firm-year observations, and the ERM subsample was 220 firms with 347 firm-year observations.

[6] The specific terms we used were: "enterprise risk management", "chief risk officer", "risk committee", "strategic risk management", "consolidated risk management", "holistic risk management", "integrated risk management", "corporate risk management", "operations risk management", "operational risk management", "enterprise risk officer", "strategic risk officer", and "ERM". We required that the search terms be within the same paragraph.

Table 1
Distribution of observations by year and ERM.

	Non-ERM		ERM		Total	
	Obs.	Percent	Obs.	Percent	Obs.	Percent
2007	2388	20.70	76	0.66	2464	21.36
2008	2265	19.63	92	0.80	2357	20.43
2009	2006	17.39	299	2.59	2305	19.98
2010	1740	15.08	530	4.59	2270	19.67
2011	1616	14.01	526	4.56	2142	18.56
Total	10,015	17.74	1523	3.76	11,538	100

This table presents the distribution of observations by year and ERM group. The *Obs.* columns are the number of observations per year and group (ERM vs. Non-ERM). The *Percent* column is the percent of observations in that year and group relative to the full sample. Firms are considered to have an ERM program if they mention enterprise risk management in some form in their 10-K or proxy statement filing with the SEC.

incorrect matches, and verified that each hit discussed enterprise-wide risk management activities along some dimension.[7] We included a firm in the ERM group if they had disclosed enterprise-wide risk management activities.[8] Following Hoyt and Liebenberg (2011), we assumed that once a firm has implemented an ERM program, they keep that program in place. Therefore, once a firm was included in our ERM group, they were included in every year after that.

5. Measuring accruals estimation error

Next, we needed an appropriate measure of accruals estimation error. As our primary measure, we adopted two related measures based on the modified Jones model of abnormal accruals. The first is the magnitude of the absolute value of abnormal accruals in the present year (*Abs(ABACC)*). The second measure is the sum of the magnitudes of abnormal accruals for the present and two subsequent years ($OPAQUE_{t+2}$). Our second measure is effectively the measure used in Hutton et al. (2009), which they refer to as earnings opacity.

We estimated the magnitude of abnormal accruals (*Abs(ABACC)*) following Hutton et al. (2009). We first estimated total accruals using ordinary least square of Eq. (1) by fiscal year and two-digit SIC industry for all firms in the Compustat database (excluding utility, financial, and insurance industry codes).

$$\frac{TACC_{i,t}}{Assets_{i,t-1}} = \alpha_0 \frac{1}{Assets_{i,t-1}} + \alpha_1 \frac{\Delta REV_{i,t}}{Assets_{i,t-1}} + \alpha_2 \frac{PPE_{i,t}}{Assets_{i,t-1}} + \varepsilon_{i,t} \tag{1}$$

where

$TACC_{i,t}$ = Firm *i*'s total accruals, which are equal to income before extraordinary items as shown on the cash flow statement less cash flow from operating activities before extraordinary items. (In terms of Compustat mnemonics: $TACC_{i,t}$ = IBC – (OANCF – XIDOC))
$\Delta REV_{i,t}$ = Firm *i*'s change in sales (SALE) in year *t*
$PPE_{i,t}$ = Firm *i*'s gross property, plant and equipment (PPEGT) in year *t*
$Assets_{i,t-1}$ = Firm *i*'s total assets (AT) in year $t-1$

We then estimated normal accruals using the parameters from the above estimation but subtracting the change in receivables (ΔREC) from the change in sales (ΔREV). Abnormal accruals (*ABACC*) are then defined as the difference between actual accruals (*TACC*) and normal accruals ($\widehat{TACC}$) as follows:

$$\frac{\widehat{TACC}_{i,t}}{Assets_{i,t-1}} = \hat{\alpha}_0 \frac{1}{Assets_{i,t-1}} + \hat{\alpha}_1 \frac{\Delta REV_{i,t} - \Delta REC_{i,t}}{Assets_{i,t-1}} + \hat{\alpha}_2 \frac{PPE_{i,t}}{Assets_{i,t-1}} \tag{2}$$

$$ABACC_{i,t} = \frac{TACC_{i,t}}{Assets_{i,t-1}} - \frac{\widehat{TACC}_{i,t}}{Assets_{i,t-1}} \tag{3}$$

Modified Jones model abnormal accruals have been used primarily to proxy for earnings management in the accounting literature. However, we are interested in the accrual estimation error and not in earnings management per se. We relied on the analysis of Hribar and Nichols (2007) that the magnitude of abnormal accruals is related to the error variance in the accrual estimation model (Eq. (1)). This provides us with a firm-specific measure of the accrual estimation error. Even though this is a crude measure of managers' ability to estimate accruals, we maintain that it is a suitable one.

[7] The SEC requires firms to disclose in the 10-K or a proxy statement who is responsible for risk oversight. For our purpose, this disclosure was not sufficient and we required firms to explicitly discuss enterprise-wide risk management activities.

[8] To evaluate the validity of our measure, we correlated our disclosure-based measure with the survey-based measure of Soileau (2010). Of the 271 firms identified in Soileau (2010) which are also in our sample, we identified 220 as having ERM programs.

Our second measure ($OPAQUE_{t+2}$) of accrual estimation error includes not only the current magnitude of abnormal accruals but also the magnitude of abnormal accruals for the following two years. Specifically, we summed the magnitudes of abnormal accruals for the years t, $t+1$, and $t+2$. This measure is similar to the earnings opacity measure used by Hutton et al. (2009).

As a robustness test, we also implemented the Dechow and Dichev (2002) measure of accruals estimation error as modified by McNichols (2002). The use of this measure led to large sample attrition because it requires a minimum of seven years of data and the restriction of additional variables needed to measure innate and discretionary accruals estimation error, resulting in a sample size of only 4534. We began by estimating the regression of total accruals on current, lag, and lead operating cash flows as well as revenue and property, plant and equipment. Specifically, we estimated the following regression by year and industry:

$$\frac{TACC_{i,t}}{Assets_{i,t-1}} = \alpha_0 + \alpha_1 \frac{\text{CFO}_{i,t-1}}{Assets_{i,t-2}} + \alpha_2 \frac{\text{CFO}_{i,t}}{Assets_{i,t-1}} + \alpha_3 \frac{\text{CFO}_{i,t+1}}{Assets_{i,t}} + \alpha_4 \frac{\Delta REV_{i,t}}{Assets_{i,t-1}} + \alpha_5 \frac{PPE_{i,t}}{Assets_{i,t-1}} + \varepsilon_{i,t} \tag{4}$$

where CFO is cash flow from operations, and all the other variables are as defined above.

To capture future estimation error ($AQ_{i,t+5}$), we used the standard deviation of the residuals for years t through $t+5$. We then split the estimation error into innate and discretionary components following Francis et al. (2005), with some adjustments such that the measures cover years t through $t+5$. Specifically, we ran the following regression:

$$AQ_{i,t+5} = \alpha_0 + \alpha_1 SIZE_{i,t+5} + \alpha_2 \sigma(CFO)_{i,t+5} + \alpha_3 \sigma(Sales)_{i,t+5} + \alpha_4 Log(OC_{i,t+5}) + \alpha_5 NEG_{i,t+5} + \mu_{i,t} \tag{5}$$

where:

$AQ_{i,t+5}$ = Standard deviation of the residuals from Eq. (4) for years t through $t+5$
$SIZE_{i,t+5}$ = Log of total assets in year $t+5$
$\sigma(CFO)_{i,t+5}$ = Standard deviation of quarterly cash flow from operations scaled by total assets for years t through $t+5$
$\sigma(Sales)_{i,t+5}$ = Standard deviation of quarterly sales scaled by total assets for years t through $t+5$
$OC_{i,t+5}$ = The firm's operating cycle in year $t+5$
$NEG_{i,t+5}$ = The proportion of negative quarterly earnings over years t through $t+5$

We defined the innate component of accruals estimation error ($InnateAQ_{i,t+5}$) as the predicted value from Eq. (4) and the discretionary component of accruals estimation error ($DisAQ_{i,t+5}$) as the residual of Eq. (4). This allowed us to look at both the operational effects of ERM and the internal control-related effects of ERM.

In additional analysis, we made use of the signed abnormal accruals from Eq. (2). We used the abnormal accruals in the current year ($ABACC$) and the sum of signed abnormal accruals from year t through year $t+2$ ($SUMABACC$) to assess whether the observed relation between the magnitude of abnormal accruals and ERM was due to earnings management. Using the signed amounts allowed us to infer whether ERM firms on average tend to have income-increasing or income-decreasing abnormal accruals.

6. Estimating the effect of ERM on accruals estimation error

Because implementation of ERM is chosen by firms based on unobservable factors, it was necessary to control for potential bias due to endogeneity by using an appropriate technique (Tucker, 2010). Like Hoyt and Liebenberg (2011), we estimated the relation between accruals quality and ERM as a system of simultaneous equations using a maximum likelihood method. This approach mitigates selection bias due to both observed and unobserved factors and requires less stringent assumptions relative to alternative two-step procedures such as the standard Heckman's model (Tucker, 2010). We modeled the magnitude of abnormal accruals ($Abs(ABACC_{i,t})$) as a function of ERM and a number of control variables:

$$\begin{aligned} Abs(ABACC_{i,t}) = {} & \beta_0 + \beta_1 ERM_{i,t} + \beta_2 SIZE_{i,t} + \beta_3 \sigma(CFO)_{i,t} + \beta_4 \sigma(Sales)_{i,t} + \beta_5 Log(OC_{i,t}) + \beta_6 NEG_{i,t} + \beta_7 MTB_{i,t} \\ & + \beta_8 GROWTH_{i,t} + \beta_9 OPAGUE_{i,t-1} + \beta_{10} ROA_{i,t} + \vartheta_{i,t} \end{aligned} \tag{6}$$

where

$Abs(ABACC_{i,t})$ = The magnitude of abnormal accruals for firm i in year t
$ERM_{i,t}$ = An indicator variable equal to 1 if the firm is identified as having an enterprise risk management system, 0 otherwise
$SIZE_{i,t}$ = The log of total assets in year t
$\sigma(OCF_{i,t})$ = The standard deviation of cash flow from operations scaled by total assets over the previous eight quarters[9]
$NEG_{i,t}$ = The proportion of quarters with losses over the past eight quarters

[9] Quarterly operating cash flow is only available from Compustat on a year-to-date basis. For quarters 2 through 4, we adjusted the year-to-date cash flow by subtracting the prior year-to-date cash flow.

$MTB_{i,t}$ = The log of the firm's market-to-book ratio at the end of the fiscal year
$GROWTH_{i,t}$ = The average sales growth over the past three years$OPAQUE_{i,t-1}$
Earnings opacity from year *t-1*, which is equal to the sum of the magnitude of abnormal accruals for the period *t-3* to *t-1*
$\sigma(SALES_{i,t})$ = The standard deviation of sales scaled by total assets over the prior eight quarters
$ROA_{i,t}$ = The firms return on assets in year *t*, measured as earnings before extraordinary items divided by average total assets
$Log(OC_{i,t})$ = The log of the firm's operating cycle in year *t*

Following the literature on accruals quality (Dechow and Dichev, 2002; Francis et al., 2005), we included variables to control for the innate factors that make estimating accruals difficult. We included firm size (*SIZE*) as larger firms are generally more stable and more well diversified, which reduces the accrual estimation error. The standard deviations of sales ($\sigma(SALE)$) and cash flows ($\sigma(OCF)$) were included to capture volatility in operations. Firms with higher operating volatility are typically going to have more assumptions in estimating accruals. We included the proportion of losses (*NEG*) because loss firms generally have large shocks that are difficult to estimate. Estimations made for longer periods are innately more difficult to make. We therefore included the log of the firm's operating cycle ($Log(OC)$). In addition to factors commonly used in the accruals quality literature, we also controlled for growth and firm performance, which are related to misspecification in the modified Jones model (Kothari et al., 2005; Collins et al., 2017). Specifically, we included average sales growth over the previous three years (*GROWTH*) and the log of the firm's market-to-book ratio (*MTB*) to capture past growth and future potential growth. To control for firm performance, we included the firm's return on assets (*ROA*). Finally, we included the sum of the magnitude of the past three years' abnormal accrual ($OPAQUE_{t-1}$) to control for other factors related to the firm's reporting quality.

We specified the choice of having an ERM program using the following probit model:

$$R(ERM_{i,t} = 1|X_{i,t}) = \Phi(X'_{i,t}\beta)$$
$$\Phi\Big(\beta_0 + \beta_1 SIZE_{i,t} + \beta_2 \sigma(OCF)_{i,t} + \beta_3 NEG_{i,t} + \beta_4 MTB_{i,t} + \beta_5 GROWTH_{i,t} + \beta_6 OPAQUE_{i,t-1} + \beta_7 LEV_{i,t} + \beta_8 INTANG_{i,t} + \beta_9 DIVERS_{i,t} + \beta_{10} INSTOWN_{i,t} + \beta_{11} SLACK_{i,t} + \beta_{12}\sigma(RET)_{i,t} + \beta_{13} RET_{i,t} + \upsilon_{i,t}\Big) \quad (7)$$

where

$ERM_{i,t}$ = An indicator variable equal to 1 if the firm discloses evidence of an enterprise risk management system, 0 otherwise
$SIZE_{i,t}$ = The natural log of total assets
$\sigma(OCF_{i,t})$ = The standard deviation of cash flow from operations scaled by total assets over the previous eight quarters
$NEG_{i,t}$ = The proportion of quarters with losses over the past eight quarters
$MTB_{i,t}$ = The log of the firm's market-to-book ratio at the end of the fiscal year
$GROWTH_{i,t}$ = The average sales growth over the past three years
$OPAQUE_{i,t-1}$ = Earnings opacity from year *t-1*, which is equal to the sum of the magnitude of abnormal accruals for the period *t-3* to *t-1*
$LEV_{i,t}$ = Leverage measured as the ratio of total liabilities to total assets
$INTANG_{,\ i,t}$ = Intangible intensity measured as intangible assets divided by total assets
$DIVERS_{i,t}$ = Firm diversification, measured as the Herfindahl concentration index based on business segment sales
$INSTOWN_{i,t}$ = The percent of shares outstanding held by institutions as of the most recent calendar quarter end
$SLACK_{i,t}$ = Financial slack, measured as the ratio of cash to total assets
$\sigma(RET_{i,t})$ = The standard deviation of the firm's monthly returns over the fiscal year
$RET_{i,t}$ = Cumulative returns over the fiscal year

We included control variables that prior literature suggests are related to having an ERM program (Hoyt and Liebenberg, 2011; Pagach and Warr, 2011). We included firm size (*SIZE*) because larger firms are more complex and have more resources, thereby allowing an ERM program in a cost-effective manner. Therefore, larger firms are more likely to have ERM programs in place. We included the standard deviation of cash flow ($\sigma(OCF)_{i,t}$) and the standard deviation of stock returns ($\sigma(RET)_{i,t}$) to capture operational and market volatility respectively. Firms with higher operating and market volatility benefit more from ERM. We included the proportion of negative earnings (*NEG*) because loss firms are more likely to have large shocks, and an ERM program is likely to mitigate these large shocks. Pagach and Warr (2011) argued that growth option may be a concern to firms considering an ERM program because firms with lots of growth opportunity have large unrealized profits which they may lose out on if they enter bankruptcy. We controlled for growth option using the firm's market-to-book ratio (*MTB*) and average past sales (*GROWTH*). We included the previous year's earnings opacity ($OPAQUE_{t-1}$) to control for factors related to the previous accruals estimation error. We also included the firm's leverage (*LEV*) to control for financial distress. Firms with high leverage may have to adhere to debt covenants, and they may have ERM programs to help them manage this adherence. We also controlled for intangible intensity (*INTANG*). Hoyt and Liebenberg (2011) and Pagach and Warr (2011) argued that firms may have difficulty liquidating intangible assets if bankruptcy occurs, so firms with higher intangibles are more likely to have an ERM program. Hoyt and Liebenberg (2011) argued that firms that operate in many different industries are more

complex and therefore would see greater benefits from ERM programs. We captured diversification inversely by including the normalized Herfendahl concentration index based on business segment sales (*DIVERS*). If a firm only has one business segment, their concentration would be at the maximum of 1. The more diversified a firm is, the closer *DIVERS* gets to 0. We included the percentage of shares held by institutions (*INSTOWN*) to control for pressure by large shareholders who may demand effective mitigation of risks through ERM programs. Financial slack may have an impact on ERM programs. As Pagach and Warr (2011) noted, firms with low financial slack may use ERM to better manage their cash flows. We included the ratio of cash to total assets (*SLACK*) to proxy for financial slack. We included the firm's annual stock return (*RET*) to control for common shareholders' demand for an ERM program through price pressure.

In Table 2, we present the sample means, medians, and standard deviations for the variables we used in our sample. The average of ERM is 0.132, indicating that ERM observations make up 13.2% of the sample. The average (median) magnitude of abnormal accruals is 0.072 (0.046), which is comparable to prior literature (e.g., Hribar and Nichols (2007) reported 0.101 and 0.052 for these values). The average (median) value of $OPAQUE_{t+2}$ is 0.209 (0.162), which is in line with Hutton et al. (2009) who reported a mean (median) value of 0.243 (0.174). Other variables in Table 2 have values similar to prior literature (e.g., Francis et al., 2005; Hoyt and Liebenberg, 2011; and Pagach and Warr, 2011).

In Table 3, we divide the sample by ERM group and test the difference in means for our variables across the two subsamples. Consistent with our conjecture, firms that have ERM programs have significantly lower accrual estimation error. Firms that have ERM programs have an average *Abs(ABACC)* of 0.054 compared to the 0.075 average for non-ERM firms. The difference of −0.020 is significant at the 1% level. When we consider the longer-term three-year accrual estimation error, $OPAQUE_{t+2}$, we find it has an average of 0.160 for the ERM subsample and 0.217 for the non-ERM subsample. The difference in $OPAQUE_{t+2}$ between the two subsamples is −0.057 and is significant at the 1% level. Interestingly, the average signed abnormal accrual *ABACC* is −0.011 for the ERM subsample, compared to −0.021 for the non-ERM subsample. This suggests that, on average, firms with ERM programs have more income-increasing (fewer income-decreasing) abnormal accruals with a significant (at the 1% level) difference of 0.01. The three-year sum of signed abnormal accruals ($SUMABACC_{t+2}$) is less negative for the ERM subsample (-0.027 compared to −0.047), which similarly indicates that ERM firms tend to have more income-increasing (fewer income-decreasing) abnormal accruals. These univariate tests are consistent with our conjectures that ERM reduces accruals estimation error.

Relative to non-ERM firms, ERM firms tend to be large, have lower variability in operating cash flows, fewer reported losses, higher growth potential, but lower prior growth in sales. As with future opacity ($OPAQUE_{t+2}$), prior years' opacity ($OPAQUE_{t-1}$) tends to be lower for the ERM subsample.[10] ERM firms tend to have higher leverage and intangibles, greater diversity (less concentrated in one business segment), more institutional shareholders, less financial slack, lower returns volatility, higher annual returns, lower sales volatility, better financial performance, and shorter operating cycles.

In Table 4, we present the correlations for our sample. For brevity, we only present the correlations for the variables in our accruals estimation equation and we exclude the forward-looking accruals estimation error ($OPAQUE_{t+2}$). The correlation between *ERM* and *Abs(ABACC)* is negative (-0.084), as expected. Furthermore, the correlation between *ERM* and *ABACC* is positive (0.033). These correlations are consistent with our tests of means, which suggests that ERM reduces accruals estimation error. In the next section, we present the results of the multivariate tests of our hypothesis that ERM reduces accruals estimation error.

7. Empirical results

7.1. Test of the treatment effect of ERM on accruals estimation error

We tested our hypothesis that ERM reduces accrual estimation error by running Eqs. (6) and (7) simultaneously using a full information maximum likelihood estimation.[11] We expected β_1 in Eq. (6) to be negative, consistent with the argument that ERM helps managers better estimate shocks in future cash flows, which would thereby be associated with lower accruals estimation errors. We present the results of our main analysis in Table 5. The first two columns are the parameters from Eq. (6) and Eq. (7), respectively, calculated using *Abs(ABACC)* as the dependent variable in Eq. (6). The last two columns are the same except that $OPAQUE_{t+2}$ is used as the dependent variable in Eq. (6). When we use *Abs(ABACC)*, we find the treatment effect of having an ERM program reduces accrual estimation error by −0.067, which is significant at the 1% level. When we take into account future accruals estimation error using $OPAQUE_{t+2}$, we find that having an ERM program reduces the accruals estimation error over the three-year period by −0.127, which is also significantly different from zero at the 1% level. These results support our main hypothesis that having an ERM program reduces accruals estimation error.

Our control variables are similar for the two models, with some notable exceptions. Within the model that uses model using *Abs (ABACC)* as the accruals equation, all the variables, except for size and operating cycles, are significantly different from zero at the 5% level or less. Consistent with our expectations, firms with higher cash flow and sales volatility have higher accruals estimation error (coefficients = 0.228 and 0.175, respectively). Firms with a greater proportion of negative

[10] Note that the ERM subsample shows a decrease in *OPAQUE* over time (0.174 for $OPAQUE_{i,t-1}$ vs. 0.160 for $OPAQUE_{i,t+2}$), whereas the non-ERM subsample has a slight increase in *OPAQUE* over time (0.213 for $OPAQUE_{i,t-1}$ vs. 0.217 for $OPAQUE_{i,t+2}$). We did not formally test this, but rather we just make the observation of the temporal trend in opacity.

[11] We included year and one-digit SIC industry fixed effect, and we clustered the standard errors by firm (Petersen, 2009).

Table 2
Summary statistics full sample.

	Obs.	Mean	Median	Std. Dev.
$ERM_{i,t}$	11,538	0.132	0.000	0.339
$Abs(ABACC_{i,t})$	11,538	0.072	0.046	0.083
$OPAQUE_{i,t+2}$	9796	0.209	0.162	0.166
$ABACC_{i,t}$	11,538	−0.019	−0.010	0.105
$SUMABACC_{i,t+2}$	9796	−0.045	−0.028	0.197
$SIZE_{i,t}$	11,538	6.082	6.039	1.969
$\sigma(OCF)_{i,t}$	11,538	0.034	0.024	0.030
$NEG_{i,t}$	11,538	0.308	0.143	0.345
$Log(MTB_{i,t})$	11,538	1.124	1.040	0.532
$GROWTH_{i,t}$	11,538	0.150	0.073	0.403
$OPAQUE_{i,t-1}$	11,538	0.208	0.154	0.179
$LEV_{i,t}$	11,538	0.447	0.442	0.211
$INTANG_{i,t}$	11,538	0.176	0.106	0.193
$DIVERS_{i,t}$	11,538	0.250	0.250	0.136
$Log(INSTOWN_{i,t})$	11,538	0.447	0.522	0.214
$SLACK_{i,t}$	11,538	0.212	0.140	0.212
$Log(\sigma(RET)_{i,t})$	11,538	−3.387	−3.406	0.465
$RET_{i,t}$	11,538	0.080	−0.012	0.661
$\sigma(SALES)_{i,t}$	11,538	0.044	0.031	0.041
$ROA_{i,t}$	11,538	−0.012	0.037	0.187
$Log(OC_{i,t})$	11,538	4.639	4.713	0.769
$AQDD_{i,t}$	4534	0.039	0.031	0.028
$INNATEAQDD_{i,t}$	4534	0.039	0.035	0.019
$DISAQDD_{i,t}$	4534	0.000	−0.002	0.020

This table presents the summary statistics for the entire sample. The sample period is from 2007 to 2011. Variables are defined as follows: $ERM_{i,t}$ is an indicator variable equal to one for firm-year observations in or after the firm has been determined to have an enterprise risk management program. $Abs(ABACC_{i,t})$ is the absolute value of abnormal accruals from the modified Jones model. $OPAQUE_{i,t+2}$ is the sum of the absolute value of abnormal accruals from year *t* to year *t + 2* inclusive. $ABACC_{i,t}$ is the signed abnormal accruals from the modified Jones model. $SUMABACC_{i,t+2}$ is the sum of signed abnormal accruals from year *t* to year *t + 2* inclusive. $SIZE_{i,t}$ is the natural log of total assets. $\sigma(OCF)_{i,t}$ is the standard deviation of quarterly operating cash flow over the previous eight quarters. $NEG_{i,t}$ is the proportion of quarters the firm reported a loss. $Log(MTB_{i,t})$ is the log of one plus the firm's market-to-book ratio. $GROWTH_{i,t}$ is the average annual sales growth over the previous three years. $OPAQUE_{i,t-1}$ is the sum of the absolute value of abnormal accruals from year *t-1* to year *t-3* inclusive. $\sigma(SALES)_{i,t}$ is the standard deviation of quarterly sales revenue over the previous eight quarters. $ROA_{i,t}$ is the firm's return on assets. $Log(OC_{i,t})$ is the log of one plus the firm's operating cycle. $LEV_{i,t}$ is the firm's leverage ratio defined as total liabilities over total assets. $INTANG_{i,t}$ is asset intensity, defined as intangibles divided by total assets. $DIVERS_{i,t}$ is the firm's concentration index based on the firm's segment sales. $Log(INSTOWN_{i,t})$ is the log of one plus the percent of share held by institutional owners. $SLACK_{i,t}$ is the firm's financial slack, measured as the ratio of cash to total assets. $Log(\sigma(RET)_{i,t})$ is the log of the standard deviation of monthly returns over fiscal year *t*. $RET_{i,t}$ is the cumulative monthly return for the firm over the fiscal year. $AQDD_{i,t}$ is the $InnateAQ_{t+5}$.

earnings have lower accruals estimation error (coefficient = −0.028). Firms with higher market-to-book ratios and sales growth have higher accruals estimation error (coefficients = 0.006 and 0.009, respectively). Firms with higher prior earnings opacity have higher accruals estimation error (coefficient = 0.054). Finally, firms with high operating performance (ROA) tend to have lower accruals estimation error (coefficient = −0.189).

With respect to the ERM prediction model, we find the following. Larger firms are more likely to have an ERM program (coefficient = 0.209). Firms with higher sales growth are less likely to have ERM (coefficient = −0.416). Highly leveraged firms and firms with more institutional owners are more likely to have ERM (coefficients = 0.423 and 0.579, respectively). Firms with more financial slack and higher stock return volatility are less likely to have ERM (coefficients = −0.597 and −0.272, respectively).

When we use $OPAQUE_{t+2}$ as our measure of accruals estimation error, we find similar coefficients for the control variables with the following exceptions. The association between size and accruals estimation error is negative at the 1% level (coefficient = −0.005). Secondly, the proportion of quarters with negative earnings is positively related to accruals estimation error (coefficient = 0.021). The signs and significance of all other control variables are similar to the estimates from the model using *Abs(ABACC)*.

8. Additional analysis

In our main analysis, we argue that firms that have an ERM program can reduce accruals estimation error through better decision making. It is possible that ERM reduces accruals estimation error by mitigating earnings management. In this section, we offer evidence that the improvement in accruals estimation error is not solely due to a reduction in earnings management. First, we used the Dechow and Dichev (2002) model to measure accruals estimation error and break the error into the discretionary component and the innate component following Francis et al. (2005). If ERM only reduces earnings management, then we should not expect any significant relation between ERM and the innate component of accruals estimation

Table 3
Difference in means across ERM groups.

	ERM	Non-ERM	Diff.
$Abs(ABACC_{i,t})$	0.054	0.075	−0.020***
$OPAQUE_{i,t+2}$	0.160	0.217	−0.057***
$ABACC_{i,t}$	−0.011	−0.021	0.010***
$SUMABACC_{i,t+2}$	−0.027	−0.047	0.020***
$SIZE_{i,t}$	7.574	5.855	1.719***
$\sigma(OCF)_{i,t}$	0.026	0.035	−0.009***
$NEG_{i,t}$	0.192	0.326	−0.134***
$Log(MTB_{i,t})$	1.189	1.114	0.075***
$GROWTH_{i,t}$	0.078	0.161	−0.083***
$OPAQUE_{i,t-1}$	0.173	0.213	−0.040***
$LEV_{i,t}$	0.519	0.436	0.083***
$INTANG_{i,t}$	0.214	0.171	0.043***
$DIVERS_{i,t}$	0.218	0.255	−0.037***
$Log(INSTOWN_{i,t})$	0.540	0.433	0.107***
$SLACK_{i,t}$	0.155	0.221	−0.065***
$Log(\sigma(RET)_{i,t})$	−3.615	−3.352	−0.263***
$RET_{i,t}$	0.181	0.064	0.117***
$\sigma(SALES)_{i,t}$	0.037	0.045	−0.007***
$ROA_{i,t}$	0.040	−0.020	0.060***
$Log(OC_{i,t})$	4.596	4.646	−0.050**
$AQ_{i,t+5}$	0.030	0.040	−0.010***
$InnateAQ_{i,t+5}$	0.029	0.040	−0.011***
$DisAQ_{i,t+5}$	0.001	0.000	0.001

This table presents the sample means by ERM group and the difference between the means. The first column presents the means for the ERM group, the second column presents the means for the non-ERM group, and the third column presents the difference. Variables are defined in Table 2. *, **, *** indicate significance differences at the 10, 5, and 1 percent levels.

Table 4
Correlation coefficients for the accruals model.

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
(1)	$Abs(ABACC_{i,t})$	1.000										
(2)	$ABACC_{i,t}$	−0.438	1.000									
(3)	$ERM_{i,t}$	−0.084	0.033	1.000								
(4)	$SIZE_{i,t}$	−0.268	0.063	0.295	1.000							
(5)	$\sigma(OCF)_{i,t}$	0.254	−0.044	−0.105	−0.394	1.000						
(6)	$NEG_{i,t}$	0.287	−0.255	−0.131	−0.446	0.285	1.000					
(7)	$Log(MTB_{i,t})$	0.038	−0.066	0.047	0.064	0.093	−0.043	1.000				
(8)	$GROWTH_{i,t}$	0.147	−0.044	−0.070	−0.069	0.165	0.109	0.173	1.000			
(9)	$OPAQUE_{i,t-1}$	0.245	−0.077	−0.075	−0.333	0.273	0.275	0.054	0.147	1.000		
(10)	$\sigma(SALES)_{i,t}$	0.147	−0.014	−0.062	−0.209	0.502	0.147	−0.043	0.058	0.117	1.000	
(11)	$ROA_{i,t}$	−0.425	0.484	0.109	0.385	−0.251	−0.698	0.005	−0.132	−0.225	−0.058	1.000
(12)	$Log(OC_{i,t})$	0.017	0.020	−0.022	−0.079	0.042	0.067	−0.066	−0.081	0.039	−0.111	−0.074

This table presents the correlation coefficients for our test variables and the other control variables in the accruals model. Variables are defined in Table 2. All bold correlations are significant at least at the 10% level.

error. Second, we examined the relationship between ERM and signed abnormal accruals. If ERM only reduces earnings management, then we should observe a negative relation between ERM and signed abnormal accruals.

In Table 6, we present our results for the relation between ERM and accruals estimation error from the Dechow and Dichev model. Consistent with our main finding, there is a negative and significant relationship between ERM and accruals estimation error (coefficient = −0.020). Furthermore, when we break the accruals estimation error into its discretionary and innate components, we find that there is a significant and negative relation between ERM and both the discretionary component (coefficient = −0.021) and the innate component (coefficient = −0.011). This suggests that ERM reduces earnings management and helps managers make better decisions about the future.

Table 7 presents our results of the treatment effect of ERM on signed abnormal accruals. We find that firms that have an ERM program have significantly higher abnormal accruals (*ABACC*). Thus, the use of ERM is significantly related to more income-increasing abnormal accruals (coefficient = 0.131) on average. This evidence is inconsistent with the alternative hypothesis that ERM reduces accruals estimation error through decreased earnings management. Similarly, we find the sum of abnormal accruals over the following three years is significantly positively related to ERM with a coefficient of

Table 5
Maximum Likelihood estimation for the treatment effect of ERM on the Magnitude of abnormal accruals.

	$Abs(ABACC_{i,t})$		$OPAQUE_{i,t+2}$	
	Accruals	ERM	Accruals	ERM
$ERM_{i,t}$	***−0.067*** ***		***−0.127*** ***	
$SIZE_{i,t}$	0.001	0.209***	−0.005***	0.197***
$\sigma(OCF)_{i,t}$	0.228***	1.082	0.841***	2.027
$NEG_{i,t}$	−0.028***	−0.203*	0.021**	−0.301**
$Log(MTB_{i,t})$	0.006**	−0.017	0.018***	−0.049
$GROWTH_{i,t}$	0.009**	−0.416**	0.050***	−0.395**
$OPAQUE_{i,t-1}$	0.054***	0.154	0.166***	0.180
$\sigma(SALES)_{i,t}$	0.175***		0.310***	
$ROA_{i,t}$	−0.189***		−0.234***	
$Log(OC_{i,t})$	0.000		0.003	
$LEV_{i,t}$		0.423**		0.579**
$INTANG_{i,t}$		−0.122		−0.238
$DIVERS_{i,t}$		−0.178		−0.262
$Log(INSTOWN_{i,t})$		0.579***		0.550**
$SLACK_{i,t}$		−0.597**		−0.529**
$Log(\sigma(RET)_{i,t})$		−0.272***		−0.300***
$RET_{i,t}$		0.007		0.016
Observation				9796
Log pseudo likelihood				2725.969
Wald test of independent equations				195.364***

This table presents the maximum likelihood estimation of the treatment effect of ERM on accruals estimation error. The first two columns use $Abs(ABACC_{i,t})$ as the proxy for the accruals estimation error. The last two columns use $OPAQUE_{i,t+2}$ as the proxy for the accruals estimation error. The *Accruals* columns use the respective accruals estimation error variables as the dependent variable. The *ERM* column uses the ERM indicator as the dependent variable and is estimated using a probit model. The *Accruals* and *ERM* equations are estimated simultaneously. The sample period runs from 2007 to 2011. Fixed effects for year and one-digit SIC industries are included in all equations. Standard errors are clustered by firm. Variables are defined in Table 2. *, **, *** indicate significance at the 10, 5, and 1 percent levels.

Table 6
Maximum Likelihood Estimation for the Treatment Effect of ERM on Accruals Estimation Error.

	$AQ_{i,t+5}$		$DisAQ_{i,t+5}$		$InnateAQ_{i,t+5}$	
	Accruals	ERM	Accruals	ERM	Accruals	ERM
$ERM_{i,t}$	***−0.020*** ***		***−0.021*** ***		***−0.011*** ***	
$SIZE_{i,t}$	−0.003***	0.158***	0.001***	0.169***	−0.004***	0.132***
$\sigma(OCF)_{i,t}$	0.156***	0.778	0.096***	−0.033	0.058***	0.677
$NEG_{i,t}$	0.016***	−0.183	0.002	−0.295	0.013***	0.054
$Log(MTB_{i,t})$	0.001	−0.130	0.001	−0.147	0.001	−0.060
$GROWTH_{i,t}$	0.001	−0.715**	−0.003*	−0.732**	0.003***	−0.602**
$OPAQUE_{i,t-1}$	0.014***	0.317	−0.008**	0.170	0.024***	0.355
$\sigma(SALES)_{i,t}$	0.072***		0.013		0.061***	
$ROA_{i,t}$	−0.029***		−0.007		−0.023***	
$Log(OC_{i,t})$	0.002**		−0.000		0.002***	
$LEV_{i,t}$		0.684**		0.617**		0.792**
$INTANG_{i,t}$		−0.004		0.125		−0.325
$DIVERS_{i,t}$		−0.179		−0.134		−0.237
$Log(INSTOWN_{i,t})$		0.755**		0.703**		0.854**
$SLACK_{i,t}$		−0.741**		−0.454		−1.264***
$Log(\sigma(RET)_{i,t})$		−0.280**		−0.189*		−0.420***
$RET_{i,t}$		0.076*		0.086**		0.011
Observation		4,534		4,534		4,534
Log pseudo Likelihood		9,823.847		10,320.011		13,661.086
Wald test of independent equations		74.025***		74.436***		105.260***

This table presents the maximum likelihood estimation of the treatment effect of ERM on accruals estimation error. The first two columns use $AQ_{i,t+5}$ as the proxy for the accruals estimation error. The next two columns use the discretionary component of $AQ_{i,t+5}$ ($DisAQ_{i,t+5}$) and the last two columns use the innate component of $AQ_{i,t+5}$ ($InnateAQ_{i,t+5}$) as the proxy for the accruals estimation error. The *Accruals* column uses the respective accruals estimation error variables as the dependent variable. The *ERM* column uses the ERM indicator as the dependent variable and is estimated using a probit model. The *Accruals* and *ERM* equations are estimated simultaneously. The sample period runs from 2007 to 2011. Fixed effects for year and one-digit SIC industries are included in all equations. Standard errors are clustered by firm. Variables are defined in Table 2. *, **, *** indicate significance differences at the 10, 5, and 1 percent levels.

Table 7
Maximum likelihood estimation for the treatment effect of ERM on Signed abnormal accruals.

	$ABACC_{i,t}$		$SUMABACC_{i,t+2}$	
	Accruals	ERM	Accruals	ERM
$ERM_{i,t}$	***0.131******		***0.257******	
$SIZE_{i,t}$	−0.014***	0.245***	−0.026***	0.237***
$\sigma(OCF)_{i,t}$	0.160**	−2.083*	0.139	−0.314
$NEG_{i,t}$	0.046***	−0.273**	0.034**	−0.290**
$Log(MTB_{i,t})$	−0.015***	−0.033	−0.025***	−0.114*
$GROWTH_{i,t}$	0.008**	−0.359**	−0.025**	−0.192
$OPAQUE_{i,t-1}$	−0.014	0.046	−0.064**	0.138
$\sigma(SALES)_{i,t}$	−0.135***		−0.078	
$ROA_{i,t}$	0.383***		0.545***	
$Log(OC_{i,t})$	0.003*		0.006	
$LEV_{i,t}$		0.203		0.668***
$INTANG_{i,t}$		−0.828***		−1.306***
$DIVERS_{i,t}$		−0.047		−0.329*
$Log(INSTOWN_{i,t})$		0.223		0.145
$SLACK_{i,t}$		−1.179***		−0.885***
$Log(\sigma(RET)_{i,t})$		−0.175**		−0.239**
$RET_{i,t}$		0.006		0.115***
Observation		11,538		9796
Log pseudo Likelihood		8351.024		285.070
Wald test of independent equations		647.350***		494.727***

This table presents the maximum likelihood estimation of the treatment effect of ERM on signed discretionary accruals. The first two columns use $ABACC_{i,t}$ as the proxy for the discretionary accruals. The last two columns use $SUMABACC_{i,t+2}$ as the proxy for the discretionary accruals. The *Accruals* column uses the respective accruals estimation error variables as the dependent variable. The *ERM* column uses the ERM indicator as the dependent variable and is estimated using a probit model. The *Accruals* and *ERM* equations are estimated simultaneously. The sample period runs from 2007 to 2011. Fixed effects for year and one-digit SIC industries are included in all equations. Standard errors are clustered by firm. Variables are defined in Table 2. *, **, *** indicate significance differences at the 10, 5, and 1 percent levels.

0.257. We conclude that our observed results on the relation between ERM and the magnitude of abnormal accruals is not due to earnings management but rather to better decision making by managers.

Panels A and B in Table 8 present the results for positive abnormal accruals and negative abnormal accruals, respectively. When we examine positive abnormal accruals, we find that ERM firms tend to have higher positive abnormal accruals in the current year (coefficient = 0.082) as well as over the next three years (coefficient = 0.198). This suggests that ERM firms actually have more income-increasing abnormal accruals, which is contrary to the hypothesis that ERM merely mitigates earnings management. In Panel B, we also find that firms with ERM tend to have smaller negative accruals in the current year (coefficient = 0.095) and over the next three years (coefficient = 0.220), suggesting that ERM firms also have fewer instances of income-decreasing abnormal accruals.

9. Robustness checks

In our main analysis, we used full information maximum likelihood to estimate the treatment effect of ERM on accruals estimation error. The reason why we did this is that the use of ERM is an endogenous choice and the choice variables are not observable (see Tucker (2010) for a review of this issue). The full information maximum likelihood method requires fewer assumptions about the distribution of the error terms relative to the standard two-step procedures, but at the cost of being more computationally intensive. Nevertheless, we re-estimated the treatment effect of ERM on the accruals estimation error using the standard Heckman two-stage model. Our results are similar regardless of the estimation technique used.

Also in our main analysis, we incorporated the effect of ERM on future accruals estimation error by using the sum of the magnitudes of abnormal accruals from year *t*, year *t + 1*, and year *t + 2*. Since this sum includes the current year, it may be that the observed relation between ERM and $OPAQUE_{t+2}$ is only due to the decrease in accruals estimation error in the current year. We estimated the treatment effects of ERM on accruals estimation error for each of the years *t*, *t + 1*, and *t + 2* individually. In unreported results, we find that firms that have ERM have significantly lower magnitudes of the absolute value of abnormal accruals (*Abs(ABACC)*) in each of these years.

In selecting our sample, we found that firms who have ERM made up a small proportion of the sample each year until 2007. As a result, our sample begins in 2007. If it began in 1994 (the first year for which data is available from DirectEDGAR), we still find that firms that have an ERM program have a significantly lower magnitude of abnormal accruals. Finally, because our results may be affected by the financial crisis in 2007–2008, we reran our analysis excluding these years and continued to find similar results.. Thus, our results are robust to the choice of time period.

Table 8
Maximum likelihood estimation for the treatment effect of ERM on positive and negative signed abnormal accruals.

Panel A. Positive Abnormal Accruals

	$ABACC_{i,t}$		$SUMABACC_{i,t+2}$	
	Accruals	ERM	Accruals	ERM
$ERM_{i,t}$	***0.082******		***0.198******	
$SIZE_{i,t}$	−0.010***	0.244***	−0.022***	0.262***
$\sigma(OCF)_{i,t}$	0.303***	−2.022	−0.031	−0.220
$NEG_{i,t}$	0.030***	−0.319**	0.020	−0.374**
$Log(MTB_{i,t})$	−0.004*	0.011	0.003	−0.048
$GROWTH_{i,t}$	0.016***	−0.291**	−0.007	−0.081
$OPAQUE_{i,t-1}$	0.048***	0.100	0.075**	0.433*
$\sigma(SALES)_{i,t}$	0.070**		−0.042	
$ROA_{i,t}$	0.133***		0.271***	
$Log(OC_{i,t})$	0.001		−0.001	
$LEV_{i,t}$		0.069		0.479**
$INTANG_{i,t}$		−0.526***		−1.381***
$DIVERS_{i,t}$		−0.046		−0.530**
$Log(INSTOWN_{i,t})$		0.256*		0.505**
$SLACK_{i,t}$		−0.558**		−0.602**
$Log(\sigma(RET)_{i,t})$		0.138*		−0.066
$RET_{i,t}$		0.003		0.113**
Observation		4954		4319
Log pseudo likelihood		6199.373		828.425
Wald test of independent equations		239.873***		173.624

Panel B. Negative Abnormal Accruals

	$ABACC_{i,t}$		$SUMABACC_{i,t+2}$	
	Accruals	ERM	Accruals	ERM
$ERM_{i,t}$	***0.095******		***0.220******	
$SIZE_{i,t}$	−0.006***	0.210***	−0.015***	0.198***
$\sigma(OCF)_{i,t}$	−0.235**	−0.586	−0.062	−0.509
$NEG_{i,t}$	0.052***	−0.299**	0.048***	−0.339**
$Log(MTB_{i,t})$	−0.007**	−0.034	−0.015**	−0.159**
$GROWTH_{i,t}$	−0.000	−0.689***	−0.040***	−0.499**
$OPAQUE_{i,t-1}$	−0.037***	−0.216	−0.119***	−0.061
$\sigma(SALES)_{i,t}$	−0.220***		−0.014	
$ROA_{i,t}$	0.312***		0.439***	
$Log(OC_{i,t})$	0.004**		0.007*	
$LEV_{i,t}$		0.248		0.877***
$INTANG_{i,t}$		−0.406**		−0.861***
$DIVERS_{i,t}$		0.051		−0.176
$Log(INSTOWN_{i,t})$		0.330*		0.042
$SLACK_{i,t}$		−0.978***		−0.622**
$Log(\sigma(RET)_{i,t})$		−0.314***		−0.362***
$RET_{i,t}$		0.045		0.166***
Observation				6584
Log pseudo likelihood				6172.925
Wald test of independent equations				401.970

This table presents the maximum likelihood estimation of the treatment effect of ERM on positive and negative signed discretionary accruals. Panel A reports the sample firms that have positive current abnormal accruals and Panel B reports the sample firms that have negative current abnormal accruals. The first two columns use $ABACC_{i,t}$ as the proxy for the discretionary accruals. The last two columns use $SUMABACC_{i,t+2}$ as the proxy for the discretionary accruals. The *Accruals* column uses the respective accruals estimation error variables as the dependent variable. The *ERM* column uses the ERM indicator as the dependent variable and is estimated using a probit model. The *Accruals* and *ERM* equations are estimated simultaneously. The sample period runs from 2007 to 2011. Fixed effects for year and one-digit SIC industries are included in all equations. Standard errors are clustered by firm. Variables are defined in Table 2. *, **, *** indicate significance differences at the 10, 5, and 1 percent levels.

10. Conclusion

In this study, we examined whether having an ERM program reduces accruals estimation error. We identified firms with ERM programs by searching 10-K and proxy statement filings with the SEC. We measured accruals estimation error using the magnitude of modified Jones model accruals. Using a sample from 2007 to 2011, we estimated a maximum likelihood treatment effects model that controls for endogeneity in the selection of an ERM program and found a significant negative relation between the magnitude of abnormal accruals. In additional tests, we found that firms with ERM tend to have lower innate accruals estimation error and more income-increasing abnormal accruals, suggesting that the observed relation between the magnitude of abnormal accruals and ERM is not due to ERM restricting earnings management within the firm. The results are more consistent with our proposition that ERM reduces accruals estimation error because managers have a

better understanding of the firm and its associated risks and can therefore better predict future shocks to cash flows and more accurately estimate the accruals of the firm.

The results of our study are important to managers considering adopting an ERM program. There has been increasing interest in risk management in general and in enterprise-wide risk management more specifically in recent years. Our own observation is that disclosure of an ERM program dramatically increased in 2009 and has continued to increase since then. As more managers are considering implementing an ERM program, we contend that an additional benefit of an ERM program is improved decision making and more accurate estimation of accruals.

Like any study, our results are not without limitations. First, we relied on disclosure in 10-K and proxy statements for our measure of ERM. However, nothing requires firms to disclose an ERM program. To the extent that these firms also benefit from ERM, this misclassification would bias against us finding any result. Also, just because a firm discloses that they have some sort of ERM program does not mean that they have fully implemented the program. Firms could be at different stages of implementation or may have ERM in name only and without any real mature and systematic process. This too would bias against us finding results. That said, it would be interesting for future studies to assess how different stages and forms of implementation are associated with accruals estimation errors.

Our results are also relevant to academics looking to better understand earnings quality. More specifically, our study adds to the literature by suggesting that ERM programs may improve earnings quality through lower accruals estimation error. While we argue that ERM improves managerial decision making over accruals estimation, future research may consider this link more directly. Future research may also consider how managerial ability mitigates the link between ERM and accruals estimation error.

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