Auditors' Risk Perception of Process Control Deficiencies:

a Discrete Choice Experiment

ABSTRACT

In risk-based auditing, data-driven analyses are often used to automatically detect process deficiencies. This introduces a challenge: the number of deficiencies is too large to inspect manually. Current approaches addressing this challenge neglect integrating the risk dimension or rely on auditors to manually integrate it. This study aims to increase the effectiveness of such data-driven analysis approaches by including the risk dimension when presenting process deficiencies for further inspection. We investigate how the deficiency type and the affected control activity are associated with perceived risk. We run a discrete choice experiment with 58 auditors interpreting deficiencies that occur in a procure-to-pay or an order-to-cash process and find that (a) deficiencies of type "missing" or deficiencies related to asset-decrementing activities are perceived as the riskiest, (b) the control activity contributes 75% of the risk perception, and (c) external and internal auditors share a similar risk perception.

I. INTRODUCTION

Risk assessment plays an important role in auditing. It encompasses identifying deficiencies from prescribed controls and investigating their impact on the effectiveness of internal controls (IFAC 2018b). To automatically detect process deficiencies, data-driven process analysis techniques prove invaluable as part of the risk assessment (Jans and Laghmouch 2023). These techniques enable the automatic comparison of process executions against predefined rules, resulting in the detection of deficiencies.

Often, the number of such deficiencies is so large that a manual investigation becomes impractical (Chiu and Jans 2019; Jans et al. 2014; Swinnen, Depaire, Jans, and Vanhoof 2011). Given the framework of risk-based auditing, prioritizing deficiencies based on perceived risks could be a viable approach to address this challenge (Perols and Murthy 2012). Unfortunately, the connection between perceived risks and process deficiencies remains unexplored to date. This study aims to establish an understanding of auditors' perception of risks associated with process deficiencies.

Various strategies have been proposed to address the challenge of large deficiency lists. Recent literature suggests approaches to group deficiencies to reduce auditors' cognitive effort in sifting through these potential alarms (Jans, Lybaert, and Vanhoof 2010; Perols and Murthy 2012; Swinnen et al. 2011; Yoon, Liu, Chiu, and Vasarhelyi 2021). Grouping deficiencies of similar types, such as similar invoices or similar process execution sequences, bears the potential to inspect a given group without considering individual case details. Although classification approaches do a good job of finding common properties between process deficiencies, they do not explicitly prioritize certain groups. Furthermore, in the light of risk-based auditing, prioritizing process deficiencies in terms of risk is recommended, but such classification does not consider the risk dimension of grouping cases.

Therefore, to enhance our understanding of how different types of process deficiencies are associated with risk perceptions among auditors, we investigate whether certain process deficiencies are perceived as riskier than others. We build upon a classification of three process deficiency types found to be relevant for financial statement audits: missing, reordered, and repeated process activities (Chiu and Jans 2019; Hosseinpour and Jans 2018), in connection with the various types of activities outlined in the Internal Control–Integrated Framework (2013). We propose that differentiating between deficiency and activity types is linked to varying levels of risk perception among auditors. For instance, the risk perception associated

with a missing activity may differ from that of a repeated activity. Furthermore, if a deficiency pertains, for example, to the activity of "create purchase order," it is likely distinct from the case of the activity of "receive payment." The Internal Control–Integrated Framework (2013) categorizes activities into relevant types in this context, distinguishing three key control activities: authorizing transactions, recording transactions, and handling assets (asset-increment, asset-decrement).

To explore how auditors perceive different process deficiencies in terms of risk, we conduct a discrete choice experiment (DCE)[1] (Hensher, Rose, and Greene 2005; Louviere 2000) with 58 auditors. We specifically investigate the impact of different deficiency and control activity types, as described in the previous paragraph, on risk perception. The participating auditors were presented with sets of process deficiencies and then asked to choose the process deficiency that they perceived as the most risky. The presented deficiencies varied in deficiency and activity types. For our study, we consider two business processes with which auditors are the most familiar: procure-to-pay (P2P) and order-to-cash (O2C). Our results show that the type of deficiency and affected control activity together relate to auditors' perceived risk. Specifically, they perceive a) missing activities as riskier than other types of deficiency and b) deficiencies related to asset-decrementing activities as the most risky, while c) impacted control activity accounts for 75 percent of auditors' risk perception, with process deficiency type determining the remaining. In other words, auditors' risk perception is more heavily influenced by the impacted control activity than by type of deficiency. Additionally, we investigate whether external auditors have a different risk perception than internal auditors and find that auditors generally have a similar perception of which types of deficiencies and control activities pose higher or lower risks.

[1] The institution at which the experiment took place approved the use of human participants.

Our study contributes to the literature by providing an initial review of how auditors associate risk with control deficiencies in a process context. Our findings facilitate understanding which process deficiencies are perceived as riskier than others. This understanding can be valuable in prioritizing process deficiencies when utilizing data-driven process analysis, which often generates an overwhelming number of alarms that cannot be investigated individually. Based on our results, we recommend grouping process deficiencies based on both deficiency type and the activity it affects. Auditors should prioritize auditing process activities that are missing. Furthermore, attention should be paid to the ultimate receipt or distribution of assets and their related recording, as these areas emerge as crucial focal points. However, the findings suggest that authorization, billing, and initial recording of activities may be of lesser concern. In this way, our study helps making data analytics techniques more feasible in auditing practice. Auditors can now intelligently select the most risky process deficiencies. Moreover, the incorporation of a discrete choice experiment in our study demonstrates the potential value of this research method in the field of accounting (Chung and Hensher 2015; Jones et al. 2012; Turner and Coote 2017).

The remaining paper is structured as follows. Section II provides the background of this study and develops research questions. Section III describes the conducted discrete choice experiments. Section IV presents and discusses the result. Section V concludes the paper.

II. BACKGROUND AND RESEARCH QUESTIONS

Risk Assessment and Information Overload in Auditing the Business Processes

Risk assessment is a crucial step during an audit. According to the International Standard on Auditing 400, risk assessment demands the identification of deficiencies from prescribed controls and the investigation of their impact on the effectiveness of internal controls (IFAC 2018b). Alongside, during the risk assessment phase, the auditor needs to understand the client's business environment by looking at the firm's history, risk profile, and business processes (IFAC 2019). Especially, the business processes reflect an important angle to look at because they reflect the daily operations of a company. If accompanied by proper decision aids and analytical techniques, focusing on business processes offers several advantages to the audit (Allen, Hermanson, Kozloski, and Ramsay 2006; Bierstaker, Hunton, and Thibodeau 2009; Werner et al., 2021; Werner and Gehrke 2019). The auditor obtains an objective overall understanding of the organization. Additionally, reporting based on process analysis techniques provides detailed insights into the extent to which a business has correctly followed its predefined procedures. These techniques leverage data-driven analysis to compare all recorded transactions within the system against a normative process model or a set business rules. By conducting this comparison, a comprehensive list of deviations between process executions and the norm, known as process deficiencies, can be automatically generated (Weidlich et al. 2011). An example of such a process deficiency could be the omission of “check solvency of customer” after the event “order receipt.” The solvency of the customer should be checked after any order is received.

One significant advantage of using data-driven process analysis techniques is that the complete set of transactions is screened and all potential process deficiencies are detected, overcoming the need for up-front sampling in auditing (Groomer and Murthy 1989). However, a challenge arises in the subsequent step: the application of data-driven process analysis in

auditing yields a large number of detected non-conforming transactions that cannot be manually processed. Examining all transactions individually is practically impossible, or at least economically infeasible, within an audit engagement's fee margins (Chan and Vasarhelyi 2011; Chiu and Jans 2019). Moreover, humans have a limited capacity to process large volumes of information, which applies to the accounting context too (Iselin 1988; Kleinmuntz 1990; Sweller 1988). Case studies show that auditors can be overwhelmed by the information overload caused by a large set of process deficiencies (Alles, Kogan, and Vasarhelyi 2008). The main challenge is to find a feasible way to process the set of identified deficiencies while preserving the advantage of a complete set of transactions included in the audit.

Classification approaches have been proposed to deal with the cognitive overload that is imposed on auditors when too many deficiencies need to be processed. The idea is to make abstraction of certain transaction features (e.g., the name of the customer), allowing the processing of transaction groups similar in terms of features of interest (e.g., transactions that miss an approval). By grouping cases, classification techniques compress information into a load that may be manageable to process (e.g., Jans et al. 2010; Perols and Murthy 2012; Swinnen et al. 2011). Whether the outcome is manageable depends on the size and number of groups. To illustrate, Chiu and Jans (2019) and Jans et al. (2014) identified 304 and 980 groups, respectively, referred to as "variants," in their studies. This indicates the possibility of the detection of numerous groups, rendering the manual processing of such a large number impractical. To alleviate this information overload, Chiu and Jans (2019) explore the concept of "grouping the groups," offering a method to condense the deficiencies into more manageable clusters.

Another approach to dealing with a large set of detected process deficiencies is prioritizing cases (Issa 2013; Li, Chan, and Kogan 2016). Although this approach supports auditors and managers in directing their investigations toward more suspicious process control

deficiencies, it does not give insight into why some deficiencies are more suspicious than others in a process context. Our study aims to gain insight into the prioritization of process deficiencies and provide an understanding of *why* auditors perceive some deficiencies as riskier than others. To do so, we postulate that a process deficiency is related to a type of deficiency and a type of control activity. Next, we provide some background to these two issues and a research question for each.

Type of Process Deficiencies

We tie process deficiencies to process deviations, where activities have been executed in a different way than stipulated by the normative process. Different types of process deficiencies are identified and discussed in business process management literature (e.g., Adriansyah, Van Dongen, and Zannone, 2013; Garcia-Banuelos, Dumas, La Rosa, De Weerdt, and Ekanayake 2014; Weber, Reichert, and Rinderle-Ma 2008). Adriansyah et al. (2013) propose three deficiency types: replacement, swapping, and repetition. Garcia-Banuelos et al. (2014) translate the detected deficiencies into natural language. Five of their proposed types relate directly to deficiencies in process procedures and are therefore relevant in a business-process context. The authors identify the following five process deficiencies: task skipping, unmatched repetition, task substitution, task relocation, and task absence or insertion. Weber et al. (2008) propose a similar set of deficiencies relevant in a process context: insert process fragment, delete process fragment, replace process fragment, swap process fragment, copy process fragment, and embed process fragment in a loop. In the literature, many of the identified process deficiencies are related to each other but are presented under different terminology. Based on a review of the literature and verbal protocol analysis of discussions with experienced auditors, Hosseinpour and Jans (2018) distinguish three types of process deficiencies relevant to a financial auditing context: activities that are missing, reordered, or

repeated. Our study explores the effect of these three deficiency types on how auditors perceive different process control deficiencies.

A clear understanding of how auditors perceive different types of process deficiency in terms of risk has not yet been established. However, an increased understanding of risk in this context is valuable when applying automated data analysis techniques, which enable the automated detection of process deficiencies but yield too many deficiencies to manually investigate. A risk understanding of process deficiency types can enable prioritizing a large set of detected process deficiencies. While classifying and prioritizing process deficiencies in auditing has been studied, a link between different process deficiency types and their risk has not been investigated yet. Therefore, we formulate the following research question.

RQ 1: In the context of the identified process deficiencies, how do auditors perceive the risk levels of different types of process deficiencies?

Type of Control Activity

Next to the type of deficiency, the type of control activity affected by a process deficiency may have an impact on how its risk is perceived. An activity impacted by a deficiency might be associated with a different risk level because different activity types may relate to different controls. Ineffective process controls increase the risk of material misstatement. Thus, we acknowledge the importance of control activities. Activities of a business process can be categorized using the classification laid down by the Committee of Sponsoring Organizations of the Treadway Commission (COSO). COSO defines internal control as a process effected by an entity's board of directors, management, and other personnel to ensure that operational effectiveness and efficiency objectives are achieved (Internal Control-Integrated Framework 2013; PCAOB 2007). COSO divides activities into three separate control-related duties: authorizing transactions, recording transactions, and handling assets. These control activities impact a company's financial reporting, either directly or

indirectly. If carried out correctly, they reduce the risk of fraud and error (Internal Control-Integrated Framework, 2013). The handling of assets control activity can take two directions, resulting in an increase or a decrease in assets. Although not included in the COSO framework, this feature is integrated into the Resource–Event–Agent (REA) ontology events (Gailly, Laurier, and Poels 2008).

REA specifications distinguish between decrementing and incrementing economic events (Gailly et al. 2008; Geerts and McCarthy 2002; McCarthy 1982). Consequently, asset-handling activities can be divided into "asset-decrement" and "asset-increment" activities, which results in four activity types: "authorizing transactions", recording transactions," "decrement asset," and "increment asset." We consider these as types of process control activities. Our study explores the effect of these types of process control activity on how auditors perceive different process control deficiencies. Different types of control activities and the knowledge that a deficiency is linked to these activities might be related to different levels of risk. How auditors perceive different control activities in terms of risk is not covered in the literature, and we formulate the second research question.

RQ 2: In the context of the identified process deficiencies, how do auditors perceive the risk levels of different types of process control activities?

Additionally, we are interested in the relative importance of the deficiency types and activity types on auditors' risk perception and formulate a third research question.

RQ 3: In the context of the identified process deficiencies, what is the relative importance of the type of deficiency and the type of process control activity in auditors' risk perception?

III. METHODOLOGY

We conducted two Discrete Choice Experiments (DCEs)[2] to investigate how auditors perceive the risks of process control deficiencies. More specifically, we focus on deficiencies in a procure-to-pay (P2P) process and an order-to-cash (O2C) process as assessed by auditors. A DCE is a stated preference method where a decision must be made between several hypothetical *choices* (Hensher, Rose, and Greene 2015).

A choice in a DCE is defined as an act of directly choosing between two or more alternatives described by attribute levels, which together form the so-called choice set. In a DCE, a respondent is typically presented with multiple choice sets and asked to choose the preferred option. DCEs have been widely used in applied economics, psychology, marketing, and transportation and logistics studies (Green and Rao 1971; Hensher et al. 2005; Louviere et al. 2000; McFadden 1974). Some applications in accounting studies exist (Chung and Hensher 2015; Jones et al. 2012). DCEs offer a solution to the limitation of asking decision-makers to rate alternatives by presenting them with a set of alternatives and asking them to choose one. This approach more accurately mirrors real-world decision-making in an accounting context, as decision-makers must weigh and compare all relevant alternatives to arrive at a decision. By adopting DCEs, decision-makers can effectively address the trade-offs involved in making decisions (Turner and Coote 2017). They are especially useful for investigating factors of these trade-offs and choice preferences, because they reveal relations between the participant's choice decision and related attributes (such as deficiency and activity type in our setting) (Hensher et al. 2015; Louviere, Hensher, and Swait 2000; Morikawa, Ben-Akiva, and McFadden 2002).

[2][3] The institution that conducted the experiment approved the use of human participants.

Experimental Design

In general, experiments allow us to estimate relations between the attributes' main effects and the auditor's choice. Here, the choice in our design relates to the deficiency the auditor perceived as the most risky. Additionally, a design must be efficient and extract the maximum amount of information. Given these two requirements, we base our study on a D-efficient experimental design (Huber and Zwerina 1996). This design takes only main effects into account because research shows that main effects account for at least 70–90% of the explained variance (Louviere et al. 2000). Moreover, the number of hypothetical choice situations is minimized to avoid burdening the participants (DeShazo and Fermo 2002).

Choice Tasks

In our choice task, a set of process deficiencies is shown to the auditors. From this set of deficiencies, auditors were asked which of these deficiencies they considered the most risky. For each task, this means they had to choose one option. Other experiments have often shown choice sets in a tabular form specifying the attributes and levels for each alternative. For our experiment, we use the Business Process Modeling and Notation standard (BPMN) to visualize the process control deficiencies. We included six choice sets with three choice alternatives in the experimental design.

Because auditors focus on one specific business process, we asked the participants of our experiment to assess process deficiencies of one process at a time. We selected a procure-to-pay (P2P) and an order-to-cash (O2C) process because these processes occur in almost every company, and auditors are familiar with these processes. Moreover, preferences are the most stable for more familiar goods (Hensher et al. 2005). The normative process models of the P2P and O2C processes are shown in Figures 1 and 2. A normative process model represents the flow of activities that should be followed through executing the process. All process behaviors that do not comply with the normative model is considered a process deficiency. To control for

the potential effects of starting point bias, fatigue, and learning, we randomized both the sequence of the two processes and the sequence of corresponding tasks (Kjaer 2005; Shaughnessy, Zechmeister, and Zechmeister 2000). Thus, some auditors had to assess the P2P process first, and others had to assess the O2C process first; both processes had to be assessed to complete the experiment.

Each shown business process consisted of specific process activities (e.g., creating purchase requisition) presented in the normative model. Subsequently, three process deficiencies were shown to the auditor, each being a combination of a deficiency type and an activity. The deficiencies were tied to a process-specific activity and not to the COSO process control activity type that we attribute the activity to. For example, for the P2P process, "create purchase request" is a process-specific activity that belongs to the control activity type "recording." The experiment would show "create purchase request", and not "recording." The process-specific activities are translated into the COSO control activities at the analysis stage.

In the DCE, we test the impact of two attributes on the perceived risk of process deficiencies: the deficiency type and the relevant control activity. The levels associated with the deficiency types are "missing," "reordering," and "repetition" and the various control activity type levels are "authorizing," "recording," "asset-decrements," and "asset-increment." Notice that the activity types are at the level of controls, but the activities shown in the BPMN model were at the process-specific level. A translation between the process-specific activities and control activity types is presented in Table 1.

The participants were given a brief narrative of the first normative business process, followed by an example of a choice task to familiarize respondents with the expected task (Kjaer, 2005). After that, the choice tasks that were part of the experiment were presented one by one. A choice task consisted of the normative process model, visualized in BPMN, followed by three process deficiencies that hypothetically occurred during process execution. The

deficiencies were presented textually and visually. All visual representations were based on the BPMN standard and were chosen to be as intuitive as possible. When working with colors to highlight the process deficiencies, a single neutral color was chosen for the three deficiency types to minimize unintentional biases toward specific deficiency types. The participants were asked to choose the deficiency that they perceive as the riskiest. For example, an auditor had to choose between a purchase order that was signed before it was created (reordering sign), a purchase request that is missing (missing purchase request), or a double payment (repetition pay). An example of this choice task is visualized in Figure 3.

Participants and Procedures

Our DCE addressed 58 auditors with an average work experience of 13 years. The participating auditors executed, for each of the business processes, six choice tasks presenting three process deficiencies, resulting in 348 observation points per examined business process. As shown in Table 2, 41 men (70.7 percent) and 16 women (29.3 percent) participated; their average age was 38.4 years (SD = 10.6). Most of them were professionally active in Belgium (75.9 percent) and in the Netherlands (20.7 percent) with a Big Four auditing firm (58.6 percent). The rest worked at either a second-tier (13.7 percent) auditing firm or other firms (25.9%). Of our participants, 67.2 percent were employed as external financial auditors (as opposed to internal auditors), and 27.6 percent had a specific industry specialization. We asked whether they were familiar with the BPMN modeling language; 44.9 percent confirmed they were. All were fluent in English, but it was the native language of only a few.

The data collection was survey-based. We integrated the DCE for the P2P and O2C business processes into a web-based questionnaire (see Supplementary Material) together with an introduction and some socio-demographic questions. All auditors assessed both the P2P and O2C processes and thus participated in both experiments. This controls for demographics across the experiments and facilitates comparing the experiments' findings.

Data Analysis

To analyze the choices of the study participants, we postulate that auditors prioritize process deficiencies by investigating the process deficiency that they would most regret not having chosen if it hypothetically turned out the riskiest. A financial auditor is generally responsible for obtaining reasonable assurance that financial statements are free from material misstatement. An auditor does not want to risk issuing a clean opinion on financial statements while overlooking an error or a potential fraud (IFAC 2018a). At every audit stage, auditors want to avoid wrongly commenting on the company's financial statements. We thus approach choice behavior from the perspective of random regret (RR) theory. Random regret minimization (RRM) assumes that decision makers choose the alternative they would most regret not having chosen if it turned out to be the best choice (Chorus 2012; Hensher, Greene, and Chorus 2013). RRM models align best with choices regarded as difficult to make, or important, or which one needs to justify to others (Lizin et al. 2022). The latter aligns well with a context in which auditors make important choices they need to justify in an audit report.

The RRM model assumes that decision-makers (in our study, auditors) minimize regret in a decision-making situation. The total regret of a given choice alternative is expressed as:

$$RR_i = R_i + \epsilon_i = \sum_{j \neq i} \sum_{m} ln\,(1 + exp\,[\beta_m * (x_{jm} - x_{im})]) \; + \epsilon_i \qquad \textit{Eq. 1}$$

The total random regret RR_i associated with a choice alternative i that might be experienced is unknown because it consists of the "observed" regret R_i and the "unobserved" regret ε_i component. The observable component of regret R_i is measured using a DCE and takes x attributes (characteristics of the presented alternative) and m individual levels into account. $x_{im}\ and\ x_{jm}$ denote the values associated with attribute x_m for the considered alternative i and another alternative j , respectively (Chorus, van Cranenburgh, and Dekker 2014).

The participant's choice is the dependent variable, and the participant wants to minimize the regret associated with its choice. This choice is stored as a dummy variable equal to zero when the choice alternative is not chosen. A conditional logistic regression is used to estimate the β-parameters belonging to the attribute levels of the deficiency type and process-activity attributes in the RR model. The deficiency-type "reordering" and the process-activity "approve purchase requisition" were chosen to be the reference against which other attribute levels were measured. As a result, the estimated coefficients can be interpreted as the *maximum* change in regret due to a change from the reference level to the considered level. Therefore, the actual regret experienced by an auditor depends on the performance of the considered process deficiency to other process deficiencies in the choice task.

IV. RESULTS

The results of the experiments must be interpreted against the backdrop of the used analysis approach (random regret theory) to describe the auditor's choice behavior. When confronted with a set of process deficiencies, an auditor wants to minimize the anticipated regret of not identifying the deficiency with the highest potential risk. The results provide insights into the factors that prompt auditors to perceive some process control deficiencies as riskier than others.

Risk Perception Regarding Types of Process Deficiency

Tables 3 and 4 show the conditional logistic results of the RR model for the P2P and O2C experiments. Both produce an R^2 value, representing a good model fit for discrete choice modeling (in contrast to its linear model equivalent) (Hensher et al. 2015). The complementary Wald Chi-square results are presented in Table 5.

The coefficients of the attribute levels in Tables 3 and 4 are interpreted as follows. $\beta > 0$ (< 0) suggests that regret increases (decreases) if the level of the attribute in a non-chosen

alternative increases in comparison to the level of the same attribute in the chosen alternative. Because all attribute levels are dummy-coded, we can state that changes from the reference level to another attribute level lead to changes in regret.

For the P2P experiment, the deficiency-type "missing" differs significantly from the reference level "reordering" at the 1 percent significance level. Furthermore, a Wald chi-square test indicates that "missing" also significantly differs from "repetition" (Wald chi-square = 19.45, $p < 0.01$). Likewise, for the O2C experiment, "missing" significantly differs from the reference level "reordering" at a significance level of 1 percent. Furthermore, there exists a significant difference between "missing" and "repetition" (Wald chi-square = 22.85, $p < 0.01$). Thus, process control deficiency type "missing" is perceived as the riskiest deficiency type for both business processes.

We conclude that process control deficiencies that link to missing out on activities are assessed as riskier than other types in the case of both procure-to-pay and order-to-cash business processes. This suggests that auditors tend to see any missing activity as a red flag, independent of which activity is missing or which business process is considered. This finding is not surprising, especially not where auditors rely on the effectiveness of internal controls over financial reporting. If auditors identify that one or more controls are malfunctioning, the estimated control risk is assessed as higher than in a well-governed control environment. This finding aligns with the safeguarding nature of controls in reducing the risk of financial statement misstatement (Auditing Standard No. 2).

Risk Perception regarding the Types of Process Control Activity

The conditional logistic regression results for the process control activities are included in Tables 3 and 4. The complementary Wald Chi-square results are shown in Table 6. For the P2P experiment, the process-activities "create purchase requisition," "receive goods or services," "receive invoice," and "pay" differ significantly from the reference level "approve

purchase requisition" ($p < 0.01$). Moreover, a relatively small significant difference ($p < 0.10$) exists between the activity "sign" and the reference level "approve PR." A deficiency that impacts the activity "receive goods or services" is perceived as a higher risk deficiency than a similar deficiency affecting the activity "approve purchase requisition." More specifically, a shift from the reference level "approve purchase requisition" to "receive goods or services" results in an increase of 0.64 in regret. Similar conclusions are drawn for the other process-specific activities with significant coefficient values. For the O2C experiment, all attribute levels prove important and are perceived riskier than the reference level "create sales quotation" at a significance level of 5%. For example, a shift from the reference level "create sales quotation" to "receive payment" results in an increase of 0.55 in regret.

For operational reasons, the auditors in the experiment were shown deficiencies affecting process-specific activities (i.e., the activities shown in the process models) instead of the COSO process control activity types. In Figure 4, a ranking of the process-specific activities is presented graphically with related control activity types in parentheses. For the P2P experiment, a clear order of control activity types is visible. Each process-specific activity belongs to a control activity type. To test whether the process-specific activities significantly differ from each other in terms of risk perception, the Wald Chi-squares are calculated and displayed in Table 6. A deficiency affecting an authorizing-activity is perceived as relatively the least risky, followed by a deficiency affecting a recording-activity. A deficiency affecting an activity that handles assets (e.g., increment assets, decrement assets) is perceived to have the highest potential risk. For the O2C experiment, a more nuanced line is visible. Auditors seem to be the most concerned with the ultimate receipt or distribution of assets and the related recording, and less concerned with authorization, billing, and initial recording.

We conclude that auditors perceive deficiencies related to asset-decrement activities as the most significant risks in both procure-to-pay (P2P) and order-to-cash (O2C). Asset-

decrement activities involve the outflow of goods, services, or money. When these activities exhibit deficiencies, they may be associated with asset misappropriation, a common form of fraud. However, further investigation is needed to establish whether asset misappropriation is indeed a cause of higher risk perception in this context. Furthermore, auditors need to consider evaluating assets from a going-concern principle, which, as described in the International Standard on Auditing 570 (Revised), mandates auditors to assess whether a company possesses sufficient financial stability to continue its operations. Throughout the audit process, auditors must remain vigilant for any indication of events that could potentially jeopardize the entity's ability to operate as a going concern (IFAC 2016). Hence, the going-concern aspect becomes particularly relevant when examining deficiencies related to asset-related activities. From a risk assessment standpoint, conducting thorough investigations into deficiencies in activities involving the handling of assets is crucial. This may explain why auditors consider asset-decrement activities as the most risky, though further research is required to validate this assumption.

Importance of Deficiency Type versus Activity Type

To better understand which attribute predominates auditors' risk perception when confronted with a set of process control deficiencies, we calculate attribute importance for the deficiency-type and process-activity attributes. Three steps were followed to obtain attribute importance: (1) calculate the difference between the highest and lowest coefficients (regret range) for each attribute (i.e. deficiency type and activity types), (2) sum up the regret ranges, and (3) divide the regret range of one attribute from Step 1 by the sum of the regret ranges from Step 2 (Lizin et al. 2022). The results of this calculation are presented in Table 7. For the P2P experiment, the activity type contributes a 74.44 percent share in risk perception (versus a 25.56 percent share of deficiency type). Similarly, for the O2C experiment, an attribute importance of 75.98 percent was found for activity type (versus a 24.02 percent importance of deficiency

type). These values suggest that the process activity that is affected by the deficiency seems to have a more significant impact on the auditor's risk perception than the deficiency type. This result is slightly more pronounced for the P2P experiment than for the O2C experiment. Hence, perceived risks are mainly influenced by the affected activity, independent of what type of deficiency is related to that activity. This is an important insight because it allows the calibration of the effectiveness of data-driven analysis techniques and their outputs. Tools that support the automatic discovery of process deficiencies in business processes can best organize the output in terms of impacted control activities, and present deficiency type as a secondary level.

Risk Perception of External Auditors versus Internal Auditors

To test the effect of the covariate EA on the attribute levels' coefficients, we included it as an interaction with all the coefficients in the model. The EA covariate is a dummy variable, taking a value of 1 if the study participant is an external auditor. The results of the RR model, which includes the EA dummy, are presented in Tables 8 and 9. Neither the P2P nor the O2C model shows any significant results for the interaction variables. This suggests that both internal and external audit functions perceive different deficiency types and process activities similarly in terms of perceived risk, and there is no significant difference in risk perception between the two groups of auditors. The findings are consistent with that of Ashton (1974), which suggests that external auditors tend to agree with internal auditors in an internal control testing setting.

V. CONCLUSION

To increase the effectiveness of data-driven analysis techniques in auditing, it is essential to understand how auditors perceive the risk of identified process deficiencies. Understanding the risks associated with different process deficiencies can help auditors decide

which deficiencies to prioritize. We posit that both deficiency and activity type might have an impact on the risk perception of auditors. The deficiency and activity type are important to take into account when prioritizing deficiencies. In this study, we investigate whether auditors assess control deficiencies as more risky or less, depending on the type of deficiency or type of involved activity. To this end, we conduct a discrete choice experiment with 58 experienced auditors considering two ordinary business processes: Procure-to-Pay and Order-to-Cash.

We obtained three main findings. First, process activities that are missing are perceived as the riskiest compared to the other deficiency types (repetition/reordering). Second, comparing both business processes, auditors seem the most concerned with the ultimate receipt or distribution of assets and the related recording and less concerned with authorization, billing, and initial recording activities. Third, auditors' risk perception depends more on the affected control activity than on deficiency type. Additionally, external and internal auditors share a similar risk perception concerning deficiency and activity types.

This work has implications for control testing and the effectiveness of data-driven analysis techniques. First, the insights of this study provide an increased understanding of which deficiencies are assessed as riskier than other deficiencies and why (e.g., because of a specific deficiency type or control activity that is affected.) This allows us to prioritize process deficiencies in an auditing setting. The insights from this study can be used in analytical techniques as domain knowledge to guide the auditor toward more suspicious cases. For instance, control testing through data-driven techniques can now be optimized by including a prioritization layer that presents the most relevant information first (i.e. the deficiencies perceived as riskiest) to the auditor. This would go beyond the classification and prioritization approaches proposed in prior research and would include explaining why certain deficiencies are assessed as riskier. Consequently, this improves information quality (Ballou and Pazer 1995) and decision-making quality (Chengalur-Smith, Ballou, and Pazer 1999) in control

testing because the auditor can make an informed decision on whether to thoroughly investigate a deficiency or not.

Second, our research makes a methodological contribution. Discrete choice experiments are rare in accounting research and only a few studies using discrete choice have been published in accounting journals (Chung and Hensher 2015; Jones et al. 2012; Turner and Coote 2017). Our research exemplifies that discrete choice experiments have the potential to reveal not only user preferences but also perceptions related to control tasks that might be based on the implicit knowledge of auditors. Such knowledge is not only theoretically relevant but also holds the promise to leverage the potential of automating control tasks in an auditing context.

As one of the first studies to examine the risk perception of auditors regarding process control deficiencies, our study is exploratory and descriptive. Some limitations and restrictions are present. First, caution should be used to generalize our findings since mainly auditors employed in Belgium and The Netherlands participated in the experiment. Although all the participating auditors must comply with the International Standards on Auditing, cultural differences may influence their risk perception (Douglas and Wildavsky 1982). Second, we postulate that the type of process deficiency and the affected control activity influence the risk assessment of process control deficiencies. Our results confirm that deficiency type and control activity affect risk perception. While our results demonstrate a solid explanatory power, they are confined to the attributes (deficiency type and control activity type) that were included in the experiment. Other aspects of a deficiency, such as the monetary value of the deficiency, might also influence auditors' risk perception but were out of the scope of this study.

We recommend future research on the potential effect of additional determinants of perceived risks of control deficiencies. Last, we only considered two business processes to keep the tasks of the participating auditors feasible. Although our results indicate that some

deficiency types and control activities are perceived as riskier than others, they also indicate that the risk perception associated with control activities might be process-specific. Future research on such impact of process-specific control activities must be analyzed further.

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FIGURE CAPTIONS

FIGURE 1

Procure-to-Pay Business Process

FIGURE 2

Order-to-Cash Business Process

FIGURE 3

An Example of a Choice Task as Presented to the Participants

FIGURE 4

Relative Risk Perception Associated with the Process-Specific Activities

TABLES (9)

TABLE 1

Attributes and Attribute Levels for the Procure-to-Pay and Order-to-Cash Experiment

Experiment	Attribute	Process-specific activity	Control activity type
P2P/O2C	Deficiency type	Missing	-
		Reordering	-
		Repetition	-
P2P	Process Activity	Create Purchase Request	Recording transactions
		Approve Purchase Request	Authorizing transactions
		Sign	Authorizing transactions
		Receive goods or services	Handling assets (increment)
		Receive invoice	Recording transactions
		Pay	Handling assets (decrement)
O2C	Process activity	Create Sales Quotation	Recording transactions
		Create Sales Order	Recording transactions
		Approve Invoice	Authorizing transactions
		Ship goods or provide services	Handling assets (decrement)
		Invoice customer	Recording transactions
		Receive payment	Handling assets (increment)

Two Discrete Choice experiments were conducted in this study: one for a Procure-to-Pay (P2P) and one for an Order-to-Cash (O2C) business process. The attributes that were investigated in these experiments are the deficiency type and the affected process activity. The deficiency type has three potential values (missing, reordering, and repetition), referred to as attribute levels. The process activity has six attribute levels that depend on the business process in the experiment. Since the process activities are process-specific and differ among the two conducted experiments, we also categorized them according to the COSO control activities to compare the results of both experiments with regard to control activity types.

TABLE 2

Demographics[a]

	Number of participants	Percentage
Men	41	70.7
Age (mean; standard deviation)	38.4	10.6
Aged 24-30 years	14	
Aged 31-40 years	26	
Aged 41-50 years	8	
Aged 51-60 years	8	
Aged 61 years or older	2	
Years of experience		
mean; standard deviation	13.2 (mean)	11.1 (s.d.)
median; standard deviation	10 (mean)	11.1 (s.d.)
Country		
Belgium	44	75.9
The Netherlands	12	20.7
Other countries	2	3.4
Company		
Big Four	34	58.6
Second Tier	8	13.7
Other	15	25.9
Missing data	1	1.7
External financial auditor (yes)	39	67.2
Industry specialization[b] (yes)	16	27.6
Knowledge of BPMN[c] (yes)	26	44.8
English as native language (yes)	2	3.4

[a]The demographics for the 58 auditors participating in the discrete choice experiment

[b]Auditors indicated whether they were specialized in a specific industry (e.g. banking) or whether they audited multiple industries

[c]Business Process Modeling and Notation

The number of participants in the experiments equals 58. This panel presents the demographics of this sample.

TABLE 3

Conditional Logistic Results of the Procure-to-Pay Experiment (LL = -310.57, R^2 = 0.14)

						95% Confidence Interval	
Regret function	**Coefficient**	**Sign. level**	**S.E.**	**z**	**Prob.**	**Lower limit**	**Upper limit**
ASC	-0.4376	1%	0.0930	-4.71	0.0000	-0.6198	-0.2553
Deficiency type							
Reordering	reference						
Repetition	0.0083	n.s.	0.1233	0.07	0.9464	-0.2334	0.2499
Missing	0.4757	1%	0.1152	4.13	0.0000	0.2499	0.7015
Process activity							
Approve PR[a]	reference						
Create PR[b]	0.7247	1%	0.2454	2.95	0.0031	0.2438	1.2056
Sign	0.3073	10%	0.1753	1.75	0.0795	-0.0362	0.6508
Receive G/S[c]	1.3854	1%	0.2491	5.56	0.0000	0.8972	1.8736
Receive invoice	0.6427	1%	0.2033	3.16	0.0016	0.2442	1.0411
Pay	1.3385	1%	0.2209	6.06	0.0000	0.9055	1.7715

[a] Approve Purchase Requisition

[b] Create Purchase Requisition

[c] Receive Goods or Services

This panel shows the conditional logistic results of the Procure-to-Pay experiment. 58 auditors participated in this experiment by answering six choice tasks, resulting in a total of 348 observations.

TABLE 4

Conditional Logistic Results of the Order-to-Cash Experiment (LL = -285.49, R^2 = 0.23)

						95% Confidence Interval	
Regret function	**Coefficient**	**Sign. level**	**S.E.**	**z**	**Prob**	**Lower limit**	**Upper limit**
ASC	-0.3784	1%	0.0979	-3.86	0.0001	-0.5702	-0.1865
Deficiency type							
Reordering	reference						
Repetition	0.1239	n.s.	0.1213	1.02	0.3072	-0.1139	0.3617
Missing	0.6352	1%	0.1239	5.13	0.0000	0.3923	0.8781
Process activity							
Create SQ[a]	reference						
Approve invoice	0.5984	5%	0.2401	2.49	0.0127	0.1277	1.0691
Ship G/S[b]	2.0087	1%	0.2637	7.62	0.0000	1.4919	2.5255
Create SO[c]	1.0631	1%	0.2643	4.02	0.0001	0.5451	1.5811
Receive payment	0.5456	1%	0.2054	2.66	0.0079	0.1430	0.9482
Invoice customer	0.8410	1%	0.2130	3.95	0.0001	0.4236	1.2585

[a] Create Sales Quotation

[b] Ship Goods or Services

[c] Create Sales Order

This panel shows the conditional logistic results of the Order-to-Cash experiment. 58 auditors participated in this experiment by answering six choice tasks, resulting in a total of 348 observations.

TABLE 5

Wald Chi-square Results - Deficiency Types

Process	Variable 1	Variable 2	p-value
Procure-to-Pay	Repetition	Missing	0.0001
Order-to-Cash	Repetition	Missing	< 0.0001

This panel shows the Wald Chi-square results of the deficiency type attribute levels for the two conducted discrete choice experiments. 58 auditors participated in the experiments by answering six choice tasks, resulting in a total of 348 observations for each experiment.

TABLE 6

Wald Chi-square Results - Activity Types

(given that process activity 1 is perceived as riskier than process activity 2)

Panel A: Procure-to-Pay experiment

	Create PR (recording)	Sign (authorizing)	Receive G/S (increment asset)	Receive invoice (recording)	Pay (decrement asset)
Create PR (recording)		0.0682	0.0015	n.s.	0.0002
Sign (authorizing)			< 0.0001	0.0668	< 0.0001
Receive G/S (increment asset)				0.0001	n.s.
Receive invoice (recording)					0.0014
Pay (decrement					

Panel B: Order-to-Cash experiment

	Create SQ (recording)	Ship G/S (decrement asset)	Invoice customer (recording)	Approve invoice (authorizing)	Receive payment (increment asset)
Create SQ (recording)		< 0.0001	n.s.	0.0160	0.0144
Ship G/S (decrement asset)			< 0.0001	< 0.0001	< 0.0001
Invoice customer (recording)				n.s.	0.0820
Approve invoice (authorizing)					n.s.
Receive payment (increment asset)					

These panels show the Wald Chi-square results of the process activity attribute levels for the two conducted discrete choice experiments. 58 auditors participated in the experiments by answering six choice tasks, resulting in a total of 348 observations for each experiment.

TABLE 7

Attribute Importance

Process	Attribute	Attribute importance
Procure-to-Pay	Deficiency type	25.56%
	Process activity	74.44%
Order-to-Cash	Deficiency type	24.02%
	Process activity	75.98%

This panel shows how much the attributes in the Discrete Choice Experiments contribute to the risk perception of the participating auditors. 58 auditors participated in each experiment by answering six choice tasks, resulting in a total of 348 observations for each experiment.

TABLE 8

Conditional Logistic Results of the P2P Experiment with External Auditor (EA) dummy (LL = -326.05, R^2 = 0.15)

						95% Confidence Interval	
Regret function	**Coefficient**	**Sign. level**	**S.E.**	**z**	**Prob.**	**Lower limit**	**Upper limit**
ASC	-0.3862	1%	0.0970	-3.98	0.0001	-0.5764	-0.1960
Deficiency type							
Reordering	Reference						
Repetition	-0.3035	n.s.	0.2058	-1.47	0.1403	-0.7069	0.0999
Missing	0.1372	n.s.	0.1906	0.72	0.4716	-0.2364	0.5109
Repetition *** EA**	0.4876	10%	0.2897	1.68	0.0924	-0.0802	1.0553
Missing *** EA**	0.4380	10%	0.2497	1.75	0.0795	-0.0515	0.9274
Process activity							
Approve PR[a]	Reference						
Create PR[b]	1.0066	5%	0.4651	2.16	0.0304	0.0951	1.9182
Sign	0.6418	10%	0.3623	1.77	0.0765	-0.0683	1.3519
Receive G/S[c]	1.4865	1%	0.4789	3.10	0.0019	0.5478	2.4251
Receive invoice	0.5206	n.s.	0.4076	1.28	0.2015	-0.2783	1.3194
Pay	1.5942	1%	0.4484	3.56	0.0004	0.7154	2.4730
Create PR[b] *** EA**	-0.4938	n.s.	0.4363	-1.13	0.2577	-1.3490	0.3614
Sign *** EA**	-0.4686	n.s.	0.3553	-1.32	0.1872	-1.1650	0.2278
Receive G/S[c] *** EA**	-0.2524	n.s.	0.4240	-0.60	0.5517	-1.0833	0.5786
Receive invoice *** EA**	0.0216	n.s.	0.4323	0.05	0.9601	-0.8257	0.8689
Pay *** EA**	-0.4002	n.s.	0.3820	-1.05	0.2948	-1.1490	0.3485

[a] Approve Purchase Requisition

[b] Create Purchase Requisition

[c] Receive Goods or Services

This panel shows the conditional logistic results of the Procure-to-Pay experiment. The dummy variable External Auditor (EA) is added as an interaction with other variables in this model. EA has value 1 if the auditor answering the choice task is an external auditor. The value of EA is 0 if the auditor has an internal audit function. 58 auditors participated in this experiment by answering six choice tasks, resulting in a total of 348 observations.

TABLE 9

Conditional Logistic Results of the O2C Experiment with External Auditor (EA) dummy (LL = -329.24, R^2 = 0.23)

						95% Confidence Interval	
Regret function	**Coefficient**	**Sign. level**	**S.E.**	**z**	**Prob.**	**Lower limit**	**Upper limit**
ASC	-0.3552	1%	0.1050	-3.38	0.0007	-0.5609	-0.1494
Deficiency type							
Reordering	Reference						
Repetition	-0.0639	n.s.	0.2118	-0.30	0.7629	-0.4790	0.3512
Missing	0.5891	1%	0.2120	2.78	0.0054	0.1737	1.0045
Repetition *** EA**	0.4330	n.s.	0.2888	1.50	0.1338	-0.1331	0.9990
Missing *** EA**	0.1673	n.s.	0.2544	0.66	0.5108	-0.3313	0.6658
Process activity							
Create SQ[a]	Reference						
Approve invoice	0.3633	n.s.	0.4367	0.83	0.4054	-0.4926	1.2192
Ship G/S[b]	1.6015	1%	0.4475	3.58	0.0003	0.7245	2.4785
Create SO[c]	0.7199	n.s.	0.4441	1.62	0.1050	-0.1506	1.5903
Receive payment	0.7771	5%	0.3723	2.09	0.0368	0.0475	1.5067
Invoice customer	0.6994	10%	0.4050	1.73	0.0841	-0.0943	1.4932
Approve invoice *** EA**	0.3132	n.s.	0.5204	0.60	0.5472	-0.7067	1.3332
Ship G/S[b] *** EA**	0.3867	n.s.	0.4545	0.85	0.3949	-0.5041	1.2775
Create SO[c] *** EA**	0.4395	n.s.	0.5168	0.85	0.3951	-0.5734	1.4524
Receive payment *** EA**	-0.4600	n.s.	0.3800	-1.21	0.2261	-1.2048	0.2848
Invoice customer *** EA**	0.0988	n.s.	0.4317	0.23	0.8189	-0.7474	0.9450

[a] Approve Purchase Requisition

[b] Create Purchase Requisition

[c] Receive Goods or Services

This panel shows the conditional logistic results of the Order-to-Cash experiment. The dummy variable External Auditor (EA) is added as an interaction with other variables in this model. EA has value 1 if the auditor answering the choice task is an external auditor. The value of EA is 0 if the auditor has an internal audit function. 58 auditors participated in this experiment by answering six choice tasks, resulting in a total of 348 observations.