Developing a Quantitative Index for Evaluating the Effectiveness of Internal Control and Testing its Impact on Predicting Stock Crash Risk

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Abstract:

The main objective of the study is to develop a quantitative index for evaluating the effectiveness of internal control and to test its effect on predicting the risk of the stock price crash risk. To achieve this objective, the study was conducted through three steps, Firstly: Developing a quantitative index to evaluate the effectiveness of the internal control of the Egyptian companies, this index is based on the internal control index prepared by Chen et al. (2017a), taking into consideration the revised COSO standards for internal control in 2013, the special circumstances of the Egyptian business environment, the controls of the corporate governance guide updated in 2016, the relevant accounting and auditing standards, the Egyptian Companies Law, and the regulations and rules for listing and delisting in the Egyptian Stock Exchange, in addition to the findings of previous relevant research, Internal control was evaluated by the Analytical Hierarchy Methodology (AHP). The second step was the evaluation of the effectiveness of internal control in light of the proposed index for a sample of (49) companies out of the total listed companies on the Egyptian Stock Exchange within the EGX100 index during the period from 2018 to 2020, with a total of (147) observations. Finally, the proposed index was tested by measuring the effect of the level of effectiveness of internal control on the risk of stock price crash risk, which was measured by two measures DUVOL and NSCKEW. The study concluded that the average effectiveness of internal control for the research sample companies was (57%), ranging between (34%) and (84%). Which implies a great degree of ineffectiveness of internal control in the study sample, the internal control index has a negative impact on the risks of a stock price crash, that is, the more effective the internal control, the less is the possibility of stock price crash risk.

Keywords:

Internal Control Effectiveness, Internal Control Index, COSO, Stock Crash Risk

ملخص الدراسة:

يتمثل الهدف الرئيسي للدراسة في تطوير مؤشر كمي لتقييم فعالية الرقابة الداخلية واختبار تأثيره على التنبؤ بمخاطر انهيار أسعار الأسهم. ولتحقيق ذلك، قامت الدراسة بـ ؛ أولاً: تطوير مؤشر كمي لتقييم فعالية الرقابة الداخلية للشركات في البيئة المصرية، يستند في تكوينه على مؤشر الرقابة الداخلية الذي قام بإعداده Chen et al. (2017a)، في ضوء معايير COSO للرقابة الداخلية المعدلة عام ٢٠١٣، وبحيث يراعي الظروف الخاصة ببيئة االأعمال المصرية، حيث يأخذ النموذج في الإعتبار؛ ضوابط دليل حوكمة الشركات المحدث عام ٢٠١٦، معايير المحاسبة والمراجعة ذات الصلة، قانون الشركات المصري، ولوائح وقواعد القيد والشطب بالبورصة المصرية، إلى جانب ما توصلت له الأبحاث السابقة ذات الصلة، وعلى وجه التحديد، تم تقييم الرقابة الداخلية في ضوء منهجية التسلسل الهرمي التحليلي، ثانيًا: تقييم فعالية الرقابة الداخلية في ضوء النموذج المقترح لعينة من (49) شركة من إجمالي الشركات المقيدة في البورصة المصرية ضمن مؤشر EGX100 خلال الفترة من ٢٠١٨ إلى ٢٠٢٠، بإجمالي (١٤٧) مشاهدة، أخيراً: إختبار النموذج المقترح من خلال قياس تأثير مستوى فعالية الرقابة الداخلية على مخاطر انهيار سعر السهم التي تم قياسها بمقياسين NSCKEW. &DUVOL.، وتوصلت الدراسة إلى (١) بلغ متوسط فعالية الرقابة الداخلية لشركات عينة البحث (٥٧%) وبمدى يتراوح بين (٣٤%) و (٨٤%)، وتشير هذه النتيجة إلى تواضع فعالية الرقابة الداخلية في الشركات المصرية، كما أن هناك تباين كبير بين هذه الشركات فيما يتعلق بفعالية الرقابة الداخلية وهذا ما أظهرته قيم الحد الأدنى والأعلى، (٢) فعالية النموذج المقترح حيث توصلت الدراسة إلى أن مؤشر الرقابة الداخلية له تأثير سلبي على مخاطر انهيار أسعار الأسهم، أي أن الرقابة الداخلية الأكثر فعالية تقلل من احتمالية حدوث مخاطر انهيار الأسهم.

الكلمات الدالة

فعالية الرقابة الداخلية، مؤشر الرقابة الداخلية، مخاطر انهيار أسعار الأسهم

1. Introduction

In the new global economy, all types of organizations are increasingly in need for an effective internal control structure to achieve their objectives, among the objectives that every organization seek to achieve is the enhancement of financial reporting quality which can be achieved by an effective internal control system (Krishnan, 2005). Reliable financial reporting can benefit organizations in multiple ways; it would increase the public's confidence in the organization, thus increasing their investments in its shares, which will increase the price of its stock, give it the chance to expand its capital, improve its ability to operate efficiently, enable it to benefit from the available opportunities, deal with the surrounding threats, and avoid the non-compliance costs of violating applicable laws and regulations (Rice et.al., 2015).

According to the Committee of Sponsoring Organizations COSO, the internal control structure can be defined as a process that is affected by the entity's board of directors, management, and other personnel, designed to provide reasonable assurance regarding the achievement of objectives related to operations, reporting and compliance (COSO framework, 2013). The framework suggests that there are three predetermined goals for the internal control structure: reliability of financial reporting, compliance with applicable laws and regulations, and effectiveness and efficiency of operations. Multiple previous studies explored the association between the internal control structure and the above-mentioned objectives, as for the reliability of financial reporting, some researchers found that ineffective internal control is associated with lower earnings quality (for example, Doyle et al., 2007, Chan et al., 2008). As for compliance with applicable laws and regulations, Rice et al. (2015) points out that the absence of adequate regulatory monitoring suppresses the positive effects of internal controls. As for effectiveness and efficiency of operations, some researchers found that weak internal control structures negatively affect various measures of effectiveness and efficiency of operations such as lower inventory turnover and more inventory impairment (Feng et al., 2015) and lower internal capital transferring efficacy (D'Mello et al., 2017).

This topic was not given enough attention in Egypt which is characterized by inadequate enforcement mechanisms and poor accounting and auditing practices (Elbannan, 2011). Additionally, new governance reforms which appeared in 2005 and amended several times up to the final release of The Egyptian Corporate Governance Code in 2016 have established new supervisory mechanisms which are intended to improve the internal control effectiveness. In addition, some studies that were held in Egypt suggest that internal audit practices in Egyptian companies are still immature and that there is a great degree of variation in internal auditing practices among the Egyptian firms (Khlif & Samaha, 2016). These reasons justify the importance of studying topics related to internal control effectiveness and its association with different economic and accounting variables in the Egyptian context.

Turning to crash risk in the Egyptian context, Egypt recently faced major challenges on the political, military, economic, health, and many other levels (Abdou& Zaazou, 2013). The Egyptian political state has witnessed dramatic changes since 25th of January 2011; these changes have had tremendous effects on the investment environment and on the level of welfare of citizens, they affected investment negatively as they destroyed political stability which is the main determinant of any foreign or domestic investment decision. Generally, theses political changes increased the level of market risk (Helmy& Wagdi, 2016). Additionally, COVID-19 has hit important sectors hard, mainly tourism, remittances, and the oil sector. It has also affected the state's ability to provide a safety net for the working population. All of this happened after three years of severe abstention measures that were adopted as part of the economic program sponsored by the International Monetary Fund (Mabrouk et. al., 2020). The pandemic has negatively affected the investment environment all over the world including Egypt, Making the Egyptian economy vulnerable to higher degree of risk.

This has triggered conducting this study which aims to develop a quantitative index to assess the effectiveness of internal control in Egyptian companies, evaluate the effectiveness of internal control considering the proposed index for companies listed on the Egyptian Stock Exchange, and to test the proposed model by measuring the impact of the level of

effectiveness of internal control on the crash risk in the companies comprising the sample.

2. Literature review and hypothesis development

As a result of various recent crashes in global stock markets, stock price crashes have gained an increasing amount of attention by both finance experts and academics. The fact that management holds a greater level of private information about the firm and that management is mostly unwilling to report bad news about the firm, can be considered as main drivers to stock price crashes (Benmelech et al., 2010). Management tends to hoard bad news mainly because of the conflict between its interests and the interests of outside investors, managers may disclose or hide certain information about the firm to maximize their own benefits at the expense of the firm's shareholders, they can use multiple channels to mask bad economic news such as accrual manipulation, classification shifting, and opaque financial statements notes (Callen & Fang, 2017).In this situation of information asymmetry, investors may have more optimistic expectations about the performance of the firm, leading to an overestimation in the value of the firm, this situation will accumulate until the bad news is revealed, thus the stock price crash occurs (Hutton et al., 2009; Hao et. al., 2018).

Much of the current literature on stock price crashes pays particular attention to their causes in the light of the management hoarding bad news theory. A large and growing body of literature has investigated the firm-specific determinants of stock price crashes. For example, Hutton et. al. (2009) found that the lower the financial reporting quality, the higher the stock price crash risk. Francis et al. (2016) showed that the higher the real earnings management, the lower the stock price crash risk. Similarly, Kim & Zhang, (2016) demonstrated that the higher the degree of accounting conservatism in the financial statements, the lower the stock price crash risk. In addition to that, crash risk was found to be positively related to multiple variables: for instance, tax avoidance (Kim et al., 2011a), excess perks consumption (Xu et al., 2014), inside directors' ownership (Park & Song, 2018), and equity incentives (Kim et al., 2011b).

On the other hand, crash risk was found to be negatively related to other variables such as mandatory IFRS adoption (DeFond et al., 2015), corporate social responsibility (Kim et al., 2014), fair value disclosures (Hsu et al., 2018), and internal control effectiveness (Chen et al., 2017a; Kim et al., 2019).Other studies have considered the effect that external factors might have on price crash risk, Callen & Fang (2013) found that the presence of institutional investors mitigate the price crash risk, Robin & Zhang (2015) showed that auditor industry specialization may lead to lower degrees of price crash risks, price crash risk was also found to be negatively related to auditor tenure (Callen & Fang, 2017). Other external factors were found to increase the degree of price crash risk such as analyst coverage (Xu et al., 2013) and political incentives (Kim et al., 2011b).

In recent years, internal control has gained increasing attention by both academics and practitioners as a mechanism to reinforce corporate governance. Internal control is known to be a management activity designed to control different types of risks that a firm may face; it also can contribute to preventing immoral or opportunistic behavior by employees and management and support the process of rational decision making. Moreover, internal controls contribute to improving the efficiency of operations, safeguarding firm's assets, and increasing the reliability of financial reporting (Hao et al., 2018). There is a large volume of published studies describing the consequences of an effective internal control system. One of these consequences is the improvement of accounting information quality, many researchers demonstrated that effective internal controls decreased the level of earnings management practices in listed companies and increased the level of earnings persistence (Ashbaugh- Skaife et al., 2008; Altamuro & Beatty, 2010). Accordingly, companies with effective internal control systems are generally charged lower audit fees by audit firms. On the contrary, companies with less effective internal controls are charged higher audit fees (Raghunandan & Rama, 2006; Hoitash et al., 2008). In the same vein, previous studies found that effective internal control systems improve the efficiency of investments and the ability to manage the accompanied uncertainties (Cheng et al., 2013), they also found that companies with effective internal controls are advantaged by lower costs of equity capital and bank debts (Lin et al.,2014). Overall, there seems to be some evidence

to indicate that companies can obtain a considerable number of benefits and add value to their activities with the design and implementation of an effective internal control system. In the light of this discussion, this study is designed to test the following main hypothesis:

H_1: An effective internal control system has an impact on the Egyptian firms' crash risk

Among the expected benefits of an effective internal control system is the mitigation of information asymmetry and increasing the degree of transparency. According to the internal control framework (COSO, 2013) there are five components of the internal control system that may help to reduce the likelihood of management hiding bad news. The first component is the control environment which is the managers' overall attitude and actions regarding the internal control system and its importance. The control environment sets the tone of an organization and influences the employees' awareness towards control. The control environment is reflected in the ethical values, operating style, organizational structure, corporate culture, and the policies and procedures of human resources (Frazer, 2016). For control environment to be considered effective, managers should begin by being a positive example for the other employees. They also should clearly set the organization's objectives and precise job description to ensure the understanding of tasks and responsibilities by employees who should be rewarded for their high qualified work (IFAC, 2018). Control environment is considered the basis for the other four components of the internal control framework, as it equips the organization with required discipline and principles. Accordingly, a good control environment will help in preventing bad news hoarding thus, mitigating information asymmetry which may lead to e decreased level of potential crash risk. Based on this discussion, this study will test the following sub-hypothesis:

H_{1a}: An effective internal control environment has an impact on the Egyptian firms' crash risk

The second component in the internal control framework is the risk assessment which is related to the identification and analysis of the relevant risks, which are the basis for risk management policies undertaken by the

firm. Firms may face various kinds of risks that should be identified and managed, they should assess risks continuously to be able to adjust the mechanisms for identifying and dealing with risks related to internal or external changes that may arise in the macro-level, industry-level, or firm-specific level (Frazer, 2016; Gamage & Fernando, 2014).Regardless of the type of risks faced by firms, risk assessment helps in controlling them and avoiding extreme risk-taking behavior. Accordingly, risk assessment may help in decreasing crash risk. In the light of this discussion, this study will test the following sub-hypothesis:

H_{1b}: Effective risk assessment has an impact on the Egyptian firms' crash risk

The third component of the internal control framework is Control activities which are intended to help ensuring that corporate policies are carried out. Control activities should exist at all levels of the organization and reinforced in all its functions. They include a variety of activities such as verifications, approvals, authorizations, security of assets, reviews of performance, segregation of duties, and reconciliations. Well-designed and implemented control activities are expected to reduce the probability of sudden or drastic events, which in turn can help in reducing stock price crash risk. Accordingly, this study will test the following sub-hypothesis:

H_{1c}: Effective control activities has an impact on the Egyptian firms' crash risk

The foutrh component in the internal control framework is the Information and communication which is related to disclosing operational, financial, and compliance-related information; it is considered important for the purposes of managing and controlling the business. Information and communication are not only about the communication within the organization, but also, they are related to communication with outside parties such as customers, suppliers, regulators, and most importantly shareholders. Therefore, information and communication may prevent management from concealing bad news thus decreasing the degree of information asymmetry which may lead to a decreased level of potential crash risk. Accordingly, this study will test the following sub-hypothesis:

H_{1d}: Effective information and communication have an impact on the Egyptian firms' crash risk

The fifth component of the internal control framework is monitoring which is related to evaluating the performance of internal control systems through ongoing oversight activities or separate evaluations. Ongoing monitoring occurs during operations so that deficiencies in the internal control system are reported through monitoring. Serious issues relating to the four above-mentioned components are reported to top management or to the board of directors. Monitoring guarantees the soundness of the functions of the other four components of internal control. It also informs management of any internal control deficiencies, enabling them to take timely corrective actions, which may lead to improved ability to mitigate crash risk. In the light of this discussion, this study will test the following sub-hypothesis:

H_{1e}: Effective monitoring has an impact on the Egyptian firms' crash risk

3. Research methodology

3.1 Sample selection

The sample of this study consists of the Egyptian companies which are included in EGX100 over the period that spans from 2018 till 2020, 2018 is chosen as the first year for collecting study data because it became mandatory for Egyptian listed companies to publish their governance reports on 2018, before that date, most of the study data is not available. Four main criteria are employed for the inclusion in the sample:

- Banks and insurance companies are excluded from the sample because they are governed by special governance and internal control rules.
- Companies with financial year ending on 30th June are excluded.
- Companies with disclosure in foreign currencies are excluded.
- Companies with missing data are excluded.

According to these criteria, the final sample consists of 49 companies which belong to 9 sectors; the following table presents more details about the study sample.

Table 1
Sample distribution by sector

Sector	Number of companies	Percentage to total companies in the sample
Non-bank financial services	8	16.3%
Real estate	11	22.4%
Basic resources	6	12.2%
Health care & Pharmaceuticals	2	4.1%
Building materials	5	10.2%
Food, beverages, and Tobacco	7	14.3%
IT, Media, and Communication Services	3	6.1%
Travel & Leisure	4	8.2%
Industrial goods, services, and Automobiles	3	6.1%
Total	**49**	**100%**

3.2 Measurement of variables

3.2.1 Crash risk

Stock crash risk is defined as an event which occurs when a stock price falls dramatically in a short period of time (Chae et al., 2020), it is considered especially important to investors as they are more exposed to threats related to stock price falls and they would suffer more from vanishing of their wealth if the market crashed (Chen et. al., 2017b). The professional and academic attention that stock price risk has gained is because it is critical for the stability of the capital market which is an important determinant of investment decisions particularly for these investors who are risk averse.

For its measurement, three main measures are usually employed in previous research: CRASH, NCSKEW, and DUVOL. The first measure CRASH is a dummy variable which equals 1 if the firm experiences crash risk and 0 otherwise. Specifically, if the firm-specific weekly return in year t is less than the negative value obtained by multiplying 3.09 by the standard deviation of the mean value of firm-specific weekly return distribution over the overall period, the firm is considered to have experienced a stock price crash (Khajavi & Zare, 2016; Chae et al., 2020). The second measure NCSKEW is a continuous variable which depicts the magnitude of crash risk. When the crash risk of a particular firm is high, the firm specific weekly return will be left-skewed. If the skewness of the firm-specific weekly return is severe, the crash risk is considered high (Yeung & Lento, 2018). The third measure DUVOL is the asymmetrical volatility between positive and negative stock returns. To measure DUVOL, the individual weekly returns of individual stock are divided into "down weeks" in which returns are lower than the annual average stock returns , and "up weeks" in which returns are higher than the annual average stock returns, then it is calculated by dividing the standard deviation of the sample group with the firm specific weekly return below the annual average stock return by the standard deviation of the sample group with the firm specific weekly return higher than the annual average stock return (Callen & Fang, 2017).

In this study, crash risk is measured by NCSKEW as it is the only measure that captures the magnitude of crash risk, and it is often used in previous studies dealing with crash risk. As a second stage of the study, and to test the robustness of the model, DUVOL measure is calculated for the study sample and the statistical tests are reperformed.

Both employed measures are based on the weekly stock return for each firm on the current week, two weeks forward and two weeks backward estimated as residuals from using the following market model (Jia, 2018):

$$R_{it} = \alpha_i + \beta_{1i} R_{m\,(t-2)} + \beta_{2i} R_{m\,(t-1)} + \beta_{3i} R_{mt} + \beta_{4i} R_{m\,(t+1)} + \beta_{5i} R_{m\,(t+2)} + \varepsilon_{it}$$

Where R_{it} is the stock return of firm (i) at week (t), Rm is the value-weighted market return at week (t), ε_{it} is the random error implies to the stock extremely return of firm (i) at week (t), and (W_{it}) is the extremely

negative weekly return for firm (i) at week (t), which is calculated as the natural logarithm of one plus the stock extremely return, i.e. ln $(1+\varepsilon_{it})$.

The first measure of crash risk is the negative conditional skewness of weekly returns during the current year NCSKEW, which is measured as the inverse of the third central moment of firm-specific weekly return scaled by the variance of firm-specific weekly return raised to 3/2. Accordingly, NCSKEW for the firm (i) at year (t) is measured by the following equation (Alp et al., 2022):

$$NCSKEW_{it} = - [n (n-1)^{3/2} \sum W^3_{it}] / [(n-1) (n-2)(\sum W^2_{it})^{3/2}]$$

Where W_{it} is the extremely negative weekly return and n is the number of weekly returns during the current year (t).

The second measure of crash risk is down-to-up volatility DUVOL, which is measured by the natural logarithm of the ratio of the standard deviation of weekly stock returns (W_{it}) during the "down" weeks (i.e., the weeks in which Wit is lower than its annual means) divided by the standard deviation of weekly stock returns (W_{it}) during the "up" weeks (i.e., weeks in which W_{it} is higher than its annual means). Particularly, DUVOL for the firm (i) at year (t) is computed as the following equation (Alp et al., 2022):

$$DUVOL_{it} = \log [(n_{up}-1)\sum_{Down} W^2_{it}]/ [(n_{Down}-1)\sum_{up} W^2_{it}]$$

Where n_{up} and n_{Down} are the number of up and down weeks at year (t) respectively.

Higher values of both NCSKEW and DUVOL indicate greater crash risk. The difference is that DUVOL does not involve the third moment and is less likely to be overly influenced by extreme weeks (Chen et al., 2001).

3.2.2 Internal control effectiveness

Numerous studies have tried to measure internal control quality relying on different measures. A group of studies held in the USA used the requirements of the Sarbanes Oxley (SOX) Act (Section 404) which requires that management must disclose the material weaknesses in their internal control systems. They relied on the information disclosed in annual reports after the imposition of the new Internal Control over Financial

Reporting (ICOFR) (Krishnan & Visvanathan, 2007; Barua et al., 2010). Other studies measured internal control quality depending on the available data concerning the investment in the internal audit function, by human resource investment in internal controls, or by the existence of audit committees (Choi et. al., 2013; Wan-Hussin & Bamahros, 2013; Länsiluoto et al., 2016; Hu et al., 2017). Other studies employed electronic evaluation and formulation of the opinion of internal controls over financial reporting by a computer program, as a knowledge-based system (KBS) (Wahdan & El- Sharawy, 2020). Another group of studies used the survey method to measure internal control quality especially in emerging economies where data on internal control quality is not always available (for example, Ebaid, 2011; Alzeban & Gwilliam, 2014; Khlif & Samaha, 2014 & 2016). Most of these studies used a dummy variable which indicates whether firms have internal control weaknesses or not. This measure is considered an unpretentious one which is not enough to clarify the degree of impact that internal control quality has on a specific issue.

For this reason, this study employs a different measure for internal control quality based on the internal control index developed by Chen et al. (2017a) which considers controls not only regarding the reliability of financial reporting and safeguarding of assets, but also related to the effectiveness and efficiency of operations and compliance with laws and regulations. This index relies on the five COSO components; control environment, risk assessment, control activities, information and communication, and monitoring which optimize the internal control system, integrate different perspectives regarding internal controls, and create a general platform to evaluate internal control quality. These five components are used as the first-level criteria in internal control, under each level; there is a sequence of sub-level criteria. The final index is composed of four levels of evaluation criteria consisting of 5 first-level criteria, 24 second-level criteria, 43 third-level criteria, and 144 fourth-level criteria. Furthermore, the scores of the first-level criteria are decreased according to a predetermined percentage if the firm receives regulatory penalties or public awareness for violating accounting rules or securities laws, the scores are also deducted if a firm encounters major accidents or safety, pollution, or product recalls.

The index developed by and employed in this study is based in its composition on the COSO standards for internal control revised in 2013, taking into account the specific circumstances of the Egyptian business environment, as it takes into account; The controls of the corporate governance guide updated in 2016, the relevant accounting and auditing standards, the Egyptian Companies Law, the regulations and rules for listing and delisting in the Egyptian Stock Exchange, in addition to the findings of previous research related to internal control effectiveness in Egyptian companies.

Specifically, internal control will be evaluated in light of the Analytic Hierarchy Process (AHP) which is a structured technique used to break down complex decisions into a hierarchy of easily understandable sub-problems, then qualitative and quantitative analyzes are performed for each problem Accordingly, the hierarchy of the internal control evaluation system will be built on four hierarchical levels in order from top to bottom (sub-objectives, standards, sub-criteria, and implementation of the plan) the exact steps for applying this index are as follows:

- The five components of internal control in the light of COSO framework (control environment, risk assessment, control activities, information and communication, and monitoring) are used as the first level standards.
- The first level is divided into a set of criteria in the second level (16 criteria), for example, the control environment criterion is divided into five criteria: corporate governance, internal auditing, human resources, social responsibility, and organizational values.
- The above-mentioned criteria are divided into sub-criteria at the third level (32 criteria), and at the fourth level, the sub-criteria are divided into implementation plans (172 indicators).
- Since each element in the rating system has a differential effect on the internal control of the company, each element should be weighted differently to improve the reliability of the overall internal control index, so once the internal control assessment hierarchy is built, comparisons are made for the elements of the same level to

determine its relative importance in the higher-level evaluation and therefore each item is assigned a score according to its relative importance.

Accordingly, each of the five components is evaluated as follows:

$$IC_i = \left(\sum_{j=1}^{n} \omega_{ij} IC_{ij}\right), \text{ i = 1, 2, 3, 4, 5; j = 1, 2, 3, …. N}$$

Where ICij is the value of the jth item at the 4th level associated with the ith item at the first level, ϕij is the impact factor of the jth item at the 4th level on the associated ith item at the first level.

The overall evaluation of the effectiveness of internal control is carried out as follows:

$$IC_{INDEX} = \omega_1 IC_1 + \omega_2 IC_2 + \omega_3 IC_3 + \omega_4 IC_4 + \omega_5 IC_5$$

Where IC_INDEX is the overall internal control index, IC_1 is the control environment index, IC_2 is the risk assessment index, IC_3 is the control activities index, IC_4 is the information and communication index, IC_5 is the monitoring index, and ω_i is the weight of the ith item at the 1st level.

The developed index which was employed to assess internal control effectiveness in the study sample is presented in the appendix.

3.2.3 Control variables

Following prior studies of stock price crash risk, five control variables concerning corporate characteristics are included in the model of this study. A large set of studies used firm size to control for other factors that affect stock crash risk and found that firm size has an impact on future stock price crash risk. However, these studies did not agree on how firm size would affect crash risk as several researchers have reported a positive association between firm size and crash risk (Yeung & Lento, 2018; Hao et al., 2018). The debate about this association has gained fresh prominence with many arguing that the association between firm size and crash risk is negative because different stakeholders consider larger firms due to their circumstances, which causes supervisory authorities to examine the quality of information disclosed by these firms. As a result, it is unlikely for large

firms to accumulate non-disclosure of bad news. Accordingly, reduces the risk of stock price falling (Khajavi & Zare, 2016; Dai et al., 2019). To measure size, natural logarithm of firm's total assets has been used. Firm age is also controlled in the model of this study because it is expected to capture the development of the firm over time, and it may affect investors' uncertainty about firms because as firms grow older, more firm-specific information is available to investors and accordingly, less uncertainty exists among them about firms' reporting quality (Ecker et al., 2006; Hamers et al., 2016).

Another group of studies used leverage to control for other factors that affect stock crash risk. This variable has been a controversial and much disputed subject as for its association with stock crash risk. Several studies were unable to find an association between leverage and crash risk (Lee, 2016; Dai et al., 2019). Moreover, other studies that have proven the association, disagreed about the nature of this association, several studies have argued that leverage is positively associated with crash risk because financially distressed firms are more subject to legal sues, the probability of financial distress increases when leverage increases, which suggests a higher litigation need for conservatism from more levered firms which can increase likelihood of stock price falling. Accordingly, firms with higher leverage ratios are subject to greater stock price crash risk (Khajavi & Zare, 2016; Yeung & Lento, 2018). On the other hand, numerous studies have argued a negative asssosiation between leverage and crash risk (Kim et al., 2014; Hao et al., 2018), this might be because firms' endogenous capital structure choice as less crash-prone firms may have stronger incentives to accumulate debt. Leverage is measured by the ratio of total liabilities to equity which is one of the most conventional measures used in prior capital structure studies.

Additionally, financial performance is controlled for in the study model because generally, previous literature has suggested a positive association between financial performance and crash risk (Liu, 2018). Controlling for financial performance is also because it intervenes in the association between effective internal control and crash risk, it is known that effective internal control can prevent the opportunistic motivation and the ability of management to disclose unrealistic performance of the firm and to

accumulate bad news. Accordingly, the financial performance of the firm may encourage management to selectively disclose financial news. As poor financial performance may lead management to hoard bad news, it can increase the crash risk, (Khajavi & Zare, 2016). Financial performance is proxied by return on assets ROA which is measured by income before extraordinary items divided by total assets.

Finally, numerous studies have investigated the impact of high-quality audits on crash risk, (Robin & Zhang, 2015) found that high-quality auditors can directly benefit investors by reducing tail risk and that industry-specialist auditors moderate the effects of opacity, accounting conservatism, and tax avoidance on crash risk. (Khajavi & Zare, 2016) found that there is a negative and significant relationship between audit quality and crash risk. In the same vein, (Chae et al., 2020) argued that whether a firm was audited by a large accounting firm is a factor to substitute for higher audit quality because large accounting firms are more likely to reduce managerial adjustments to earnings than other accounting firms. Various studies defined audit quality as high or low depending on the presence of an alliance with the Big 4 accounting firms (Deloitte, Ernst & Young EY, KPMG, and PricewaterhouseCoopers PwC) because they provide high-quality audits through internal training programs and peer reviews, and they are eager to maintain their professional brand name. Accordingly, audit quality is controlled in the model of this study using a BIG4 dummy variable.

4. Empirical Results

4.1 Descriptive statistics

To perform the initial analysis of data, descriptive statistics of quantitative variables are presented in Table 2. The table shows mean, maximum, minimum, and standard deviation of observations.

Table 2 presents the descriptive statistics for 147 firm-year observations during the period from 2018–2020. NCSKEW is the negative conditional skewness and DUVOL is the down-to-up volatility. IC_1 is the score assigned to the first internal control component, control environment. IC_2 is the score assigned to the second internal control component, risk assessment. IC_3 is the score assigned to the third internal control component, control activities.

IC_4 is the score assigned to the fourth internal control component, information and communication. IC_5 is the score assigned to the fifth internal control component, monitoring. IC is the ultimate score assigned to internal control according to the index developed and adopted in this study. ROA is the return on assets calculated by dividing income before extraordinary items by total assets. SIZE is the firm size measured by the natural logarithm of firm's total assets. LEV is Leverage which is measured by the ratio of total liabilities to equity. Age is the firm age measured by the natural logarithm of the years since its foundation till the year of the analysis. BIG_4 is a dummy variable that equals one when the firm is audited by a big4 audit firm and zero otherwise.

Table 2
Descriptive Statistics for the study variables

Variable	Obs	Mean	Std. Dev.	Min	Max
NCSKEW	147	-.127	1.261	-3.223	4.354
DUVOL	147	-.042	1.146	-2.804	3.302
IC_1	147	.591	.139	.271	.884
IC_2	147	.535	.144	.229	.836
IC_3	147	.511	.116	.279	.764
IC_4	147	.589	.128	.31	.861
IC_5	147	.584	.184	.2	.88
IC	147	.566	.124	.337	.842
ROA	147	-.002	.068	-.122	.114
SIZE	147	20.011	1.621	15.543	23.336
LEV	147	2.001	1.709	-5.797	4.788
AGE	147	3.326	.617	1.099	4.727
BIG_4	147	.408	.493	0	1

The table shows that the mean values of NCSKEW is -0.127 with minimum and maximum values of -3.223 and 4.354 respectively, this result is consistent with the results of Li et al. (2017), Cao et al. (2018), and Jebran et al. (2020) where the values of negative conditional skewness of weekly returns were (-0.205, -0.243, -0.243) respectively. As for the second

measure of crash risk DUVOL, it showed a mean value of -.042 with minimum and maximum values of -2.804 and 3.302 respectively. This result goes in the same vein as these of Andreou et al. (2017) and Dang et al. (2018) which showed mean values of down-to-top volatility of (-0.104, -0.055) respectively.

As table 2 shows, the mean value of our internal control index is 0.566, suggesting that our sample firms on average receive only 56.6% of the maximum possible points. More specifically, all the means of the partial components of the internal control measures are around 50% quality rate, this may be because of the relative ineffectiveness in the internal and external governance mechanisms in Egypt, weak investors' legal protection, absence of full transparency compared to well-established stock markets, and the relative newness of governance regulations. it may be more suitable to compare our results to those of studies conducted in Egypt as the Egyptian environment is characterized by certain attributes that may cause different results. Our results are consistent with those of (Khlif & Samaha, 2016) which showed a mean value of internal control quality of 1.139 on a scale that varies from 0 to 2.

Turning to control variables, the first control variable ROA has a mean value of -0.002; a negative value of ROA indicates a quite poor financial performance in Egyptian companies in the study period which was characterized by the spread of Corona pandemic and several economic and political reforms in Egypt. Comparing this result to previous studies, it agrees with Deng et al. (2018) and Harper et al. (2020) where ROA was (0.026, 0.037) respectively. The mean value of the firm size is 20.011 which goes in the same vein as Ben-Nasr & Ghouma (2018) and Chen et al. (2019) where the mean values of firm size were (20.877, 21.189) respectively. As for leverage, its minimum and maximum values are -5.797 and 4.788 respectively; a negative minimum value is because the liabilities of some of the firms in the study sample are more than their assets. its mean value is 2.001 which differs from some published studies (eg. Davydov, 2016; Habib & Hasan, 2017; Jia et al., 2018; Cao et al., 2018), this is due to that we employed a different measure for measuring leverage, which is the ratio of total liabilities to equity, while these studies used the ratio of total

liabilities to total assets to measure leverage, in addition to this, a high value of leverage in our sample is due to that most firms in the sample depend on liabilities rather than equity to finance their activities. Firm age has a mean value of 3.326 which is less than some previous studies such as (Chen et al., 2017b) with 9.6 years and more than others such as (Hamers et al., 2016) with 2.682 years. Finally, BIG_4 variable indicates that around 41% of the study sample is being audited by a big 4 firm.

4.2 Testing the study hypotheses

Before performing the regression analysis and to determine the quality and validity of the estimated models, the Variance Inflation Factor (VIF) test was conducted to ensure that the independent variables of the study did not suffer from the problem of multicollinearity as this problem may lead to various undesirable consequences such as; imprecise regression coefficients, failing to attain statistical significance, changing in the estimated signs of coefficients, or substantial changes in the estimated coefficients upon adding or deleting a few observations (Asteriou & Hall, 2015). The results in table 3 revealed that VIF values for all study variables are less than 10 which emphasizes that the multicollinearity problem did not exist, and that the study models are able to explain the effect of independent variables on crash risk.

Table 3
Results of variance inflation factor VIF tests

	1st model IC_1	2nd model IC_2	3rd model IC_3	4th model IC_4	5th model IC_5	6th model IC
IC_1	1.597					
IC_2		1.342				
IC_3			1.445			
IC_4				1.412		
IC_5					1.526	
IC						1.666
ROA	1.208	1.173	1.291	1.214	1.157	1.253
SIZE	1.399	1.197	1.15	1.148	1.337	1.343
LEV	1.187	1.212	1.205	1.19	1.201	1.198
AGE	1.125	1.117	1.115	1.13	1.116	1.166
BIG_4	1.16	1.14	1.15	1.185	1.16	1.172

Then the Wooldridge test was conducted to ensure that the residuals are not serially correlated as this problem may result in estimated variances of the regression coefficients to be biased and inconsistent, causing the hypothesis testing to be invalid, and R squared to be overestimated (Asteriou & Hall, 2015). The Wooldridge test was performed for the six models of the study and resulted in p-values higher than 0.1 which means that the null hypothesis is accepted (Drukker, 2003) i.e., there is no first-order autocorrelation among the study variables.

Table 4

Results of Wooldridge test for autocorrelation

	NCSKEW		DUVOL	
	Test statistic	p-value	Test statistic	p-value
1st model IC_1	0.350	0.5568	0.119	0.7311
2nd model IC_2	1.347	0.2515	0.379	.5411
3rd model IC_3	0.002	0.9848	0.138	.7115
4th model IC_4	1.156	0.2877	0.011	.9167
5th model IC_5	2.008	0.1629	0.006	0.9402
6th model IC	0.826	0.3680	0.001	0.9980

Because panel data was used to test the hypotheses of this study, Hausman tests were employed to examine which model was better (the fixed effects model or the random effects model). The test results of the first model are shown in table 5. The chi2 value in column 1 is 11.153 with a p-value of 0.084, which indicates that the random effect model is better suited for this model. As for the chi2 value in column 2, it reached 23.134 with a p-value of 0.001, so, we used the fixed effect model for regression for the second model. The regression results suggested that control environment (IC_1) was negatively associated with crash risk via NCSKEW and DUVOL. Column 1 indicates a significant negative impact of control environment on NCSKEW, the results on column 2 confirms this result as the impact of control environment is also negative and significant on the second measure of crash risk i.e., DUVOL. As for the control variables, only ROA was proven to have a negative significant impact on NCSKEW, while LEV had

a positive significant impact on NCSKEW, these results support that companies with higher degrees of financial performance are less prone to stock crash risk, and that those with more reliance on debt financing suffer more from potential cash risk. All other control variables were not proven to have a significant impact on NCSKEW. The results in column 2 support these results as LEV was proven to have a significant positive impact on the alternative measure of crash risk i.e., DUVOL. Therefore, the regression equations can be presented as follows:

NCSKEW = **2.397 - 6.089 (IC_1) - 3.811 (ROA)** + 0.035 (SIZE) **+ 0.105 (LEV)** + 0.069 (AGE) - 0.191 (BIG_4)

DUVOL = **4.267 - 6.876 (IC_1)** - 0.961 (ROA) - 0.165 (SIZE) **+ 4.423 (LEV)** + 0.927 (AGE) - 0.074 (BIG_4)

Table 5
Regression analysis of the effect of control environment (IC_1) on stock price crash risk

Dependent Variables		Independent Variables (1) NCSKEW	(2) DUVOL
IC_1	Coef.	-6.089	-6.876
	p-value	0.000	0.000
ROA	Coef.	-3.811	-0.961
	p-value	0.000	0.424
SIZE	Coef.	0.035	-0.165
	P-value	0.48	0.126
LEV	Coef.	0.105	4.423
	p-value	0.013	0.000
AGE	Coef.	0.069	0.927
	p-value	0.569	0.466
BIG_4	Coef.	-0.191	-0.074
	p-value	0.187	0.741
Constant		2.397	4.267
R^2		0.664	0.616
F-Value (Chi-sq.)	Coef.	(258.412)	(24.553)
	p-value	0.000	0.000
Hausman test	Chi-sq.	11.153	23.134
	P-value	0.084	0.000

Table 5 also confirms the overall significance of the used model as the p-value of both NCSKEW and DUVOL are 0.000 which means that the regression models for this hypothesis have a high fit. As for the explanatory power of the models, we find that the value of the coefficient of determination R^2 is equal to 0.664 and 0.616 for MCSKEW and DUVOL respectively, which means that the control environment explains about 66% and 61% of the changes in stock crash risk. Overall, the results in table 5 suggest that the more effective the control environment in the Egyptian listed companies, the lower the future stock price crash risk. The results support the assumption in H_{1a} that effective control environment reduces the risk of a stock price crash. This suggests that control environment enhances shareholder interests in the Egyptian stock market, as an effective control environment can mitigate information asymmetry and increase the degree of transparency by reducing the likelihood of managers hoarding bad news, thus reducing firm-specific stock price crash risk.

Before testing the second hypothesis, effective risk assessment has an impact on the Egyptian firms' crash risk, Hausman tests were used to examine which model to be used (the fixed effects model or the random effects model). The test results shown in table 6 suggested that the random effect model was better to be used for both models as chi2 was 9.423 and 12.096 with 0.151 and 0.06 p-values for both models respectively.

The regression results suggested that risk assessment (IC_2) was negatively associated with crash risk via NCSKEW and DUVOL. Column 1 indicates a significant negative impact of risk assessment on NCSKEW with a coefficient of -6.532, and the results on column 2 confirms this result as the impact risk assessment is also negative and significant on the second measure of crash risk i.e., DUVOL with a coefficient of -6.498. As for the control variables, three control variables were found to have a significant negative impact on NCSKEW (ROA, SIZE) which supports the results of the above two hypotheses and goes in line with the notion that being audited by a high-quality audit firm, can decrease the probability of stock crash risk. Turning to the second model, only SIZE was found to a have a negative significant impact on DUVOL. For both models, LEV was proven to have a positive significant impact on stock crash risk which supports the findings

for the above hypotheses. The regression equations for the two models can be presented as follows:

NCSKEW = **5.055 - 6.532 (IC_2) - 2.833 (ROA) - 0.088 (SIZE) + 0.662 (LEV)** - 0.04 (AGE) - 0.183 (BIG_4)

DUVOL = **5.107 - 6.498 (IC_2)** - 0.168 (ROA) **- 0.085 (SIZE) + 0.690 (LEV)** - 0.004 (AGE) - 0.183 (BIG_4)

Table 6
Regression analysis of the effect of risk assessment (IC_2) on stock price crash risk

Dependent Variables		Independent Variables (1) NCSKEW	(2) DUVOL
IC_2	Coef.	-6.532	-6.498
	p-value	0.000	0.000
ROA	Coef.	-2.833	-0.168
	p-value	0.009	0.876
SIZE	Coef.	-0.088	-0.085
	P-value	0.039	0.053
LEV	Coef.	0.662	0.690
	p-value	0.000	0.000
AGE	Coef.	-0.04	-0.004
	p-value	0.714	0.973
BIG_4	Coef.	-0.255	-0.183
	p-value	0.069	0.2
Constant		5.055	5.107
R^2		0.633	0.549
F-Value (Chi-sq.)	Coef.	(241.059)	(170.078)
	p-value	0.000	0.000
Hausman test	Chi-sq.	9.423	12.096
	P-value	0.151	0.06

Table 6 shows that the p-values of the used models are 0.000 for both models, which means that the regression models for this hypothesis have a high fit and have explanatory power of 0.633 and 0.549 for MCSKEW and DUVOL respectively, which means that the risk assessment explains about 63% and 55% of the changes in stock crash risk. Overall, the results in table 6 suggest that the more effective the risk assessment in the Egyptian listed companies, the lower the future stock price crash risk, this result support hypothesis H_{1b} that effective risk assessment reduces the risk of a stock

price crash. This can be because assessing risks continually enables management to adjust the mechanisms for identifying and dealing with risks related to internal or external changes that may arise. Accordingly, risk assessment may help in decreasing crash risk.

Now turning to the third hypothesis, effective control activities have an impact on the Egyptian firms' crash risk, to determine whether to use the fixed effects model or the random effects model, Hausman tests were performed for each model. The test results are shown in table 7, these results suggested that the random effect model was better to be used for the first model (NCSKEW) as the coefficient value was 6.401 with a p-value of 0.38, while the fixed effect model was better to be used with the second model (DUVOL) as the coefficient value was 24.221with a p-value of 0.

The regression results suggested that control activities (IC_3) was negatively associated with both crash risk measures NCSKEW and DUVOL. In the first model control activities was proven to have a significant negative impact on NCSKEW with a coefficient of -5.303, in the second model control activities was found to have a negative and significant impact on DUVOL with a coefficient of -6.555. As for the control variables, two control variables were found to have a significant negative impact on NCSKEW (ROA and SIZE) which goes in the same vein with the results of the above findings. As for the second model, only SIZE was found to a have a negative significant impact on DUVOL. For both models, LEV was found to have a positive significant impact on stock crash risk which supports the findings for the above hypotheses that the higher degree of companies' reliance in debt financing, the more subject they are to stock crash risk. The regression equations for the two models can be presented as follows:

NCSKEW = **5.404 - 5.303 (IC_3) - 4.093 (ROA) - 0.102 (SIZE) + 0.1(LEV)** - 0.152 (AGE) - 0.181 (BIG4)

DUVOL = **5.871 - 6.555 (IC_3)** - 0.557 (ROA) **- 0.301 (SIZE) + 0.607 (LEV)** + 1.212 (AGE) - 0.191 (BIG4)

Table 7
Regression analysis of the effect control activities (IC_3) on stock price crash risk

Dependent Variables		Independent Variables (1) NCSKEW	(2) DUVOL
IC_3	Coef.	-5.303	-6.555
	p-value	0.000	0.000
ROA	Coef.	-4.093	-0.557
	p-value	0.000	0.668
SIZE	Coef.	-0.102	-0.301
	P-value	0.033	0.008
LEV	Coef.	0.1	0.607
	p-value	0.011	0.008
AGE	Coef.	-0.152	1.212
	p-value	0.227	0.37
BIG_4	Coef.	-0.181	-0.191
	p-value	0.247	0.419
Constant		5.404	5.871
R^2		0.580	0.567
F-Value (Chi-sq.)	Coef.	(193.184)	(20.085)
	p-value	0.000	0.000
Hausman test	Chi-sq.	6.401	24.221
	P-value	0.38	0.000

The results, as shown in table 7 indicates that the regression models for this hypothesis have a high fit with p-values of .000 for both models. It also shows the models have explanatory power of 0.580 and 0.567 for MCSKEW and DUVOL respectively, which means that the control activities explain about 58% and 57% of the changes in stock crash risk. Taken together, the results in table 7 indicate that the more effective the control activities in the Egyptian listed companies, the lower they are prone to future stock price crash risk, this result support hypothesis H_{1c} that effective control activities reduce the risk of a stock price crash. This can be because control activities are intended to help ensuring that corporate policies are carried out, and if they are well-designed and implemented, they are expected to reduce the probability of sudden or drastic events, which in turn can help in reducing stock price crash risk

Turning to the fourth hypothesis, effective information and communication have an impact on the Egyptian firms' crash risk, Hausman tests were performed to examine which model was better (the fixed effects model or the random effects model) and the test results of both models indicated that the fixed effect model for regression was more suitable to be employed as chi2 values were 14.857 and 37.735 with p-values of 0.021 and 0 respectively. The regression results suggested that information and communication (IC_4) have a negative impact on both of crash risk measures NCSKEW and DUVOL as the regression coefficient was -6.178 and -6.266 respectively, this result supports the fourth hypothesis that effective communication of information with internal and external parties such as customers, suppliers, regulators, and shareholders may prevent management from concealing bad news thus decreasing the degree of information asymmetry which may lead to a decreased level of potential crash risk.

As for the control variables, for the first model, only ROA was proven to have a negative significant impact on NCSKEW. And for the second model, only SIZE had a negative significant impact on DUVOL, while LEV had a positive significant impact in both models. These results prove that companies which perform better financially, or with greater levels of size in terms of total assets are more stable and less subject to crash risk, while those companies with higher degrees of reliance on debts for financing their activities are more subject to stock crash risk. All other control variables were not proven to have a significant impact on NCSKEW or DUVOL. The regression equations for the two models can be presented as follows:

NCSKEW = **3.988 - 6.178 (IC_4) - 4.392 (ROA)** - 0.157 (SIZE) **+ 1.934 (LEV)** + 0.658 (AGE) - 0.254 (BIG_4)

DUVOL = **6.105 - 6.266 (IC_4)** - 1.101 (ROA) **- 0.225 (SIZE) + 2.061 (LEV)** + 0.504 (AGE) - 0.18 (BIG_4)

As table 8 shows, the regression models for this hypothesis have a high fit because the overall significance of the used models have p-values of 0.000. Moreover, the value of the coefficient of determination R^2 is equal to 0.633 and 0.593 for MCSKEW and DUVOL respectively, which means that the information and communication explains about 63% and 59% of the changes in stock crash risk. Taken together, the results in table 8 show that

the more effective the information and communication in the Egyptian listed companies, the lower the future stock price crash risk. The results support the assumption that effective information and communication reduces the risk of a stock price crash. The results also go in line with the argument that effective communication of companions' information with parties inside and outside the company will act as a deterrent for management to hoard bad news which will reduce the degree of information asymmetry and decrease the probability of crash risk.

Table 8
Regression analysis of the effect of information and communication (IC_4) on stock price crash risk

		Independent Variables	
Dependent Variables		(1) NCSKEW	(2) DUVOL
IC_4	Coef.	-6.178	-6.266
	p-value	0	0
ROA	Coef.	-4.392	-1.101
	p-value	0.001	0.373
SIZE	Coef.	-0.157	-0.225
	P-value	0.168	0.041
LEV	Coef.	1.934	2.061
	p-value	0.001	0.009
AGE	Coef.	0.658	0.504
	p-value	0.627	0.7
BIG_4	Coef.	-0.254	-0.18
	p-value	0.287	0.432
Constant		3.988	6.105
R^2		0.633	0.593
F-Value (Chi-sq.)	Coef.	26.402	22.367
	p-value	0.000	0.000
Hausman test	Chi-sq.	14.857	37.735
	P-value	0.021	0

As for the fifth sub-hypothesis, Hausman tests were also performed to examine whether to use the fixed effects or the random effects model. The test results shown in table 9 indicates that the fixed effect model is better suited for both models, as the chi2 values are 17.364 And 45.204, with p-values of 0.008 and 0 respectively.

Table 9
Regression analysis of the effect of monitoring (IC_5) on stock price crash risk

Dependent Variables		Independent Variables (1) NCSKEW	(2) DUVOL
IC_5	Coef.	-5.54	-5.479
	p-value	0.000	0.000
ROA	Coef.	-4.065	-0.838
	p-value	0.001	0.468
SIZE	Coef.	-0.105	-0.18
	P-value	0.316	0.083
LEV	Coef.	0.193	0.221
	p-value	0.000	0.038
AGE	Coef.	1.288	1.13
	p-value	0.303	0.356
BIG_4	Coef.	-0.115	-0.045
	p-value	0.602	0.834
Constant		0.73	2.887
R^2		0.689	0.645
F-Value (Chi-sq.)	Coef.	34.030	27.809
	p-value	0.000	0.000
Hausman test	Chi-sq.	17.364	45.204
	P-value	0.008	0.000

The regression results suggested that monitoring (IC_5) was negatively associated with crash risk via NCSKEW and DUVOL. Column 1 indicates a significant negative impact of monitoring on NCSKEW with a coefficient of -5.54, the results on column 2 confirms this result as the impact of control environment is also negative and significant on the second measure of crash risk i.e., DUVOL with a coefficient of -5.479. As for the control variables, only ROA was proven to have a negative significant impact on NCSKEW, while LEV had a positive significant impact on NCSKEW, these results support that companies with higher degrees of financial performance are less prone to stock crash risk, and that those with more reliance on debt financing suffer more from potential cash risk. All other control variables were not proven to have a significant impact on NCSKEW. The results in column 2 support these results as LEV was proven to have a significant positive impact on the alternative measure of crash risk i.e., DUVOL, the regression equations can be presented as follows:

NCSKEW = **0.73 - 5.54 (IC_5) - 4.065 (ROA)** - 0.105 (SIZE) **+ 0.193 (LEV)** + 1.288 (AGE) - 0.115 (BIG_4)

DUVOL = **2.887 - 5.479 (IC_5)** - 0.838 (ROA) - 0.18 (SIZE) **+ 0.221 (LEV)** + 1.13 (AGE) - 0.045 (BIG_4)

As table 9 shows, the regression models for this hypothesis have a high fit because the overall significance of the used models have p-values of.000. In addition to that, the value of the coefficient of determination R^2 is equal to 0.689 and 0.645 for MCSKEW and DUVOL respectively, which means that monitoring, explains about 69% and 65% of the changes in stock crash risk. Collectively, the results in table 9 show that the more effective the monitoring in the Egyptian listed companies, the lower the future stock price crash risk. The results support the assumption in H_{1e} that effective monitoring reduces the risk of stock price crash. The results also go in line with the argument that monitoring guarantees the soundness of the functions of the other four components of internal control (control environment, information and communication, risk assessment, and control activities) as it informs management of any internal control deficiencies, enabling them to take timely corrective actions, which may lead to improved ability to mitigate crash risk.

Now turning to the aggregate measure of internal control effectiveness which was calculated depending on the five components of internal control framework as was explained in the measurement of variables section. Firstly, Hausman tests were used to examine which model to be used (the fixed effects model or the random effects model). The test results shown in table 10 suggested that the random effect model was better to be used for NCSKEW with a p-value of 0.232, while the fixed effect model was better used for DUVOL with a p-value of .004.

The regression results suggested that internal control effectiveness (IC) was negatively associated with both crash risk measures NCSKEW and DUVOL. In the first model internal control effectiveness was proven to have a significant negative impact on NCSKEW with a coefficient of -7.703, in the second model internal control effectiveness was found to have a negative and significant impact on DUVOL with a coefficient of -8.211. It

can be noted that the aggregate measure of internal control effectiveness produced higher negative coefficients than those of individual components of internal control framework. As for the control variables, the results are in the same vein with those of individual models, as ROA was found to have a significant negative impact on NCSKEW. And for both models, LEV found to have a positive significant impact on stock crash risk which supports the findings for the above hypotheses. The regression equations for the two models can be presented as follows:

NCSKEW = **3.287 - 7.703 (IC) - 2.644 (ROA)** + 0.043 (SIZE) **+ 0.074 (LEV)** - 0.004 (AGE) - 0.133 (BIG4)

DUVOL = **6.069 - 8.211 (IC)** - 0.214 (ROA) - 0.162 (SIZE) **+ 0.204 (LEV)** + 0.567 (AGE) - 0.084 (BIG4)

Table 10
Regression analysis of the effect of internal control effectiveness (IC) on stock price crash risk

Dependent Variables		Independent Variables (1) NCSKEW	(2) DUVOL
IC	Coef.	-7.703	-8.211
	p-value	0.000	0.000
ROA	Coef.	-2.644	-0.214
	p-value	0.004	0.846
SIZE	Coef.	0.043	-0.162
	P-value	0.291	0.097
LEV	Coef.	0.074	0.204
	p-value	0.043	0.000
AGE	Coef.	-0.004	0.567
	p-value	0.97	0.622
BIG_4	Coef.	-0.133	-0.084
	p-value	0.285	0.679
Constant		3.287	6.069
R^2		0.725	0.683
F-Value (Chi-sq.)	Coef.	(368.007)	(33.112)
	p-value	0.000	0.000
Hausman test	Chi-sq.	8.083	18.928
	P-value	0.232	0.004

Table 10 also confirms the overall significance of the used model as the p-value of both NCSKEW and DUVOL are 0.000 which means that the regression models for this hypothesis have a high fit. As for the explanatory power of the models, we find that the value of the coefficient of determination R^2 is equal to 0.725 and 0.683 for MCSKEW and DUVOL respectively, which means that the effectiveness of internal control explains about 72% and 68% of the changes in stock crash risk. Overall, the results in Table 10 suggest that the more effective the internal control in the Egyptian listed companies, the lower the future stock price crash risk. The results support the assumption in H_1 that effective internal control reduces the risk of a stock price crash as companies can obtain a considerable number of benefits and add value to their activities with the design and implementation of an effective internal control system.

5. Discussion and Conclusion

The present study was designed to achieve two main objectives: constructing an internal control index for Egyptian companies based on the internal control index developed by Chen et al. (2017a) and considering the specific circumstances of the Egyptian business environment such as the controls of the corporate governance guide updated in 2016, the relevant accounting and auditing standards, the Egyptian Companies Law, the regulations, and rules for listing and delisting in the Egyptian Stock Exchange, in addition to the findings of previous research related to internal control effectiveness in Egyptian companies. The second objective was to validate our index by confirming the relation between internal control quality and stock crash risk. Further, we theorize that our internal control index has a negative impact on crash risk, and find that better internal control reduces the probability of crash risk occurrence.

The results of this study indicate that internal control effectiveness has a negative and significant impact on stock crash risk, this result seems to be consistent with other studies which found that internal control effectiveness is negatively associated with stock price crash risk (Chen et al., 2017b; Ng'etich, 2017; Kim et al., 2019). A possible explanation for this result may be that internal control measures are intended to contribute to preventing

immoral or opportunistic behavior by employees and management, supporting the process of rational decision making, improving the efficiency of operations, safeguarding firm's assets, and increasing the reliability of financial reporting which ultimately will reduce the degree of risks that a company may face, including stock crash risk. This result corroborates the findings of a great deal of the previous work in this field, for instance, internal control effectiveness was found to improve the accounting information quality by decreasing the level of earnings management practices and increasing the level of earnings persistence (Ashbaugh- Skaife et. al.,2008; Altamuro & Beatty, 2010). Internal control effectiveness was also found to decrease the audit fees charged by audit firms (Raghunandan& Rama, 2006; Hoitash et. al., 2008). It also can improve the efficiency of investments and the ability to manage the accompanied uncertainties (Cheng et. al., 2013).

This study did not only test the impact of internal control effectiveness on crash risk, but it also tested the impact of each component of the internal control framework, control environment, risk assessment, control activities, information and communication and monitoring on crash risk. As for control environment, it was found to have a negative impact on crash risk which goes in line with previous studies (Chen et al., 2017b; Zhang et al., 2017) this is because control environment is considered the basis for the other four components of the internal control framework and a good control environment will help in preventing bad news hoarding thus, mitigating information asymmetry which may decrease the probability of crash risk. The second component, risk assessment was proven to have a negative impact on crash risk; this is because it helps in controlling different types of risks faced by the company and avoiding extreme risk-taking behavior. However, this result differs from the results of (Chen et al., 2017b) which were unable to find an association between risk assessment and crash risk, but it agrees with (Gong et al., 2021). The third component, control activities, was also found to have a negative impact on crash risk because well-designed and implemented control activities are expected to reduce the probability of sudden or drastic events, which in turn can help in mitigating stock crash risk, this result contradicts the result of (Chen et al., 2017b) but goes in the same vein with (Lobo et al., 2020; Gong et al., 2021). The fourth

component of internal control framework, information and communication was also found to have a negative impact on crash risk which is consistent with previous studies (Chen et al., 2017b; Fu et al., 2021) and is because communicating the company's information acts as a deterrent for management from concealing bad news thus decreasing the degree of information asymmetry which will lead to decreasing potential crash risk. finally, the fifth component, monitoring was found to a have a negative impact on crash risk which corroborates previous work (Chen et al., 2017b; Hao et al., 2018) this result can be because monitoring guarantees the reliability of the functions of the other four components of internal control and it informs management of any internal control deficiencies, enabling them to take timely corrective actions, which may lead to improved ability to mitigate crash risk.

However, with a relatively small sample size due the unavailability of data required to apply the proposed internal control index in the Egyptian market, caution must be applied, as the findings would have been different if tests were performed on larger sample size. Two measures were used to measure stock price crash risk NCSKEW and DUVOL, caution also must be applied as employing other measures of stock price crash risk would cause a difference in results. It is important to bear in mind that the results of this study may have differ if applied on financial institutions as they are governed by special internal control regulations. Finally and most importantly, employing the internal control index developed by this study in countries other than Egypt must be done with a great deal of caution as this index has taken into account the specific circumstances of the Egyptian business environment such as the controls of the corporate governance guide updated in 2016, the relevant accounting and auditing standards, the Egyptian Companies Law, the regulations, and rules for listing and delisting in the Egyptian Stock Exchange, in addition to the findings of previous research related to internal control effectiveness in Egyptian companies. In future investigations, it might be possible to use a sample size that is composed of a larger number of companies, employing other measures of stock price crash risk, measuring the internal control effectiveness in financial institutions, and investigating its impact on crash risk, and

developing the internal control effectiveness index to be applicable in other countries.

This study contributes to the growing literature on the implications of internal control for managers and investors. It highlights the important role of internal control in lowering crash risk. It also explores the consequences that internal control effectiveness may have on capital markets. As for accounting literature, it extends the existing previous studies on crash risk as it identifies a new factor that has a significant impact on crash risk. Therefore, it presents useful implications for various parties; The Egyptian Stock Exchange can use the proposed index for the periodic evaluation of the effectiveness of internal control in listed companies with the possibility of developing a new index that ranks these companies according to the level of effectiveness as applied in China Stock Exchange. As for financial brokerage companies, they can use the proposed index to evaluate investment alternatives in companies because the level of internal control effectiveness affects stock prices, so they can guide investors to take rational investment decisions. Creditors also can use the proposed index to make decisions regarding granting loans. Additionally, this study has various implications for the audit profession, external auditors can use the index to assess the effectiveness of the internal control when performing the audit process, thus facilitating their roles in making the decision to accept or reject the client, planning the audit process, and determining the volume of audit evidence to be accumulated. While internal auditors can use the index to assess the effectiveness of the company's internal control, thus facilitating their roles in identifying deficiencies in the internal control system and suggesting the necessary corrections on a sound basis.

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Appendix
Internal control evaluation index

IC1: control environment (first level: sub-objective level)

IC11: corporate governance (second level: standard level)		
Third level: sub-standard level	Fourth level: plan execution level	Score
IC111: Institutional arrangement	IC11101: Any manual or guideline on internal control in the company ؟	1 for yes, 0 for no
	IC11102: Any outside organization to help the company improve its internal control quality؟	
IC112: Shareholder's composition	IC11201: Chairman of the board also the controlling shareholder?	
	IC11202: Ownership percentage of institutional shareholders	To be standardized
	IC11203: Number of institutional shareholders in the top 10 shareholder list	To be standardized
	IC11204: Average percentage of shareholders taking part in the shareholder meeting	To be standardized
IC113: board of directors	IC11301: Board size	1 for 5 or more, 0 otherwise
	IC11302: Number of board committees	To be standardized
	IC11303: Any committee in charge of internal control (audit committee or risk management committee at the board level)?	1 for yes, 0 for no
	IC11304: Number of audit committee members	To be standardized
	IC11305: Percentage of independent directors on the board	To be standardized
	IC11306: Average attendance ratio of board meetings for independent directors	To be standardized
	IC11307: Number of dissenting proposals by independent directors	To be standardized
IC114: Management	IC11401: Is the board chairman and the CEO one person?	1 for no, 0 for yes
	IC11402: Percentage of executives on the board	To be standardized
	IC11403: Percentage of shares owned by	To be standardized

	the management	
	IC11404: Are the shares owned by the management available for circulation?	1 for yes, 0 for no
IC12: internal audit		
IC121: internal audit implementation	IC12101: Any internal audit department in the company (at the execution level)?	1 for yes, 0 for no
	IC12102: Does the internal audit department report to the board?	
IC13: human resource		
IC131: recruiting and training	IC13101: Any human resource policy?	1 for yes, 0 for no
	IC13102: Does the human resource policy contain provisions on recruiting?	
	IC13103: Does the human resource policy contain provisions on training?	
	IC13104: Does the human resource policy contain provisions on job transferring?	
IC132: incentives	IC13201: Does the human resource policy contain provisions on salaries?	1 for yes, 0 for no
	IC13202: Does the human resource policy contain provisions on evaluations?	
	IC13203: Does the human resource policy contain provisions on promotion?	
	IC13204: Does the human resource policy have previsions on rewards or punishments?	
	IC13205: Is the salary linked to performance?	
	IC13206: Percentage of shares owned by employees	To be standardized
IC133: severance	IC13301: Does the human resource policy contain provisions on discharging?	1 for yes, 0 for no
	IC13302: Does the human resource policy contain provisions on resigning?	
	IC13303: Any audit upon the departure of the chairman, CEO, and other executives?	
IC14: social responsibility		
IC14101: Any social responsibility report released?		1 for yes, 0 for no
IC15102: Any charitable donation?		
IC14103: Does the company pay attention to environment, safety, and product quality?		
IC14104: Does the company have a social responsibility		

committee?		
IC14105: Does the company have a social responsibility policy?		
IC15: organizational culture		
IC151: morality	IC15101: Is there a charter of ethics and professional conduct?	1 for yes, 0 for no
	IC15102: Does the company receive customer suggestions and complaints?	
IC152: legal awareness	IC15201: Any legal department?	1 for yes, 0 for no
	IC15202: Any counselor?	
	IC15203: Is there an independent compliance department?	

IC2: risk assessment (first level: sub-objective level)

IC21: objective setting (second level: standard level)		
Third level: sub-standard level	Fourth level: plan execution level	Score
IC21: Any objective for risk management?		1 for yes, 0 for no
IC22: risk recognition		
IC221: risk evaluation	IC22101: Any committee or department for risk management?	1 for yes, 0 for no
	IC22102: Any risk evaluation disclosed in the annual report?	
IC222: internal risk	IC22201: Any internal risk disclosed in the annual report?	1 for yes, 0 for no
	IC22202: Any financial risk disclosed?	
	IC22203: Any safety and environment risk disclosed?	
	IC22204: Any other internal risk disclosed?	
	IC22205: Any significant loss over the past 2 years?	1 for no, 0 for yes
IC223: external risk	IC22301: Any external risk disclosed in the annual report?	1 for yes, 0 for no
	IC22302: Any economic risk disclosed?	
	IC22303: Any legal risk disclosed?	
	IC22304: Any social risk disclosed?	
	IC22305: Any technology risk disclosed?	
	IC22306: Any environment risk disclosed?	
	IC22307: Any other external risk disclosed?	
IC23: risk analysis		

IC231: risk evaluation method	IC23101: Any quantitative risk analysis in the annual report?	1 for yes, 0 for no
	IC23102: Are risks sorted by importance or are main risks specified?	
IC24: risk response		
C241: response strategies	IC24101: Any risk response strategy disclosed?	1 for yes, 0 for no
	IC24102: Any analysis of risk tolerance?	
C242: risk management measure	IC24201: Any risk management measure taken to control risk?	1 for yes, 0 for no
	IC24202: Any change in risk evaluation and response from the annual report for last year to that for this year?	

IC3: control activities (first level: sub-objective level)

IC31: separation of duties (second level: standard level)		
Third level: sub-standard level	Fourth level: plan execution level	Score
IC311: separation of duties	IC31101: Any control for in compatible separation of duties?	1 for yes, 0 for no
	IC31102: Any employees' rotation?	
IC312: authorizing and approving?	IC31201: Any control for authorizing and approving?	
	IC31202: Is the approving of material matters in accordance with existing procedures?	
IC321: property control	IC32101: Any loss of inventories?	1 for no, 0 for yes
	IC32102: More asset impairment this year than last year?	
IC322: budget control	IC32201: Is annual budget discussed in the shareholder meeting or other similar setting?	1 for yes, 0 for no
C323: operating control	IC32301: Any operational analysis?	1 for yes, 0 for no
IC324: performance control	IC32401: Any report resulting from the performance analysis?	1 for yes, 0 for no
	IC32402: Does current performance compare to past performance and competitor performance?	
	IC32403: Any disclosure of future plans?	

IC4: information and communication (first level: sub-objective level)

IC41: information communication		
Third level: sub-standard level	Fourth level: plan execution level	Score
IC411: internal communication	IC41101: Number of board meetings	
	IC41102: Number of Audit Committee meetings	
	IC41103: Number of risk management committee meetings	
	IC41104: Number of Governance Committee meetings	
IC412: external communication	IC42201: Any mechanism for information disclosure?	
	IC42202: Any mechanism for managing relations with investors?	
	IC42203: Any link for investor relations on the corporate website?	
	IC42204: Any investor visits or seminars been organized?	
IC42: information		
IC421: information transparency	IC42101: Are all resolutions from shareholder meetings disclosed?	
	IC42102: Are all resolutions from board meetings disclosed?	
	IC42103: Is there a policy related to disclosure and transparency?	
	IC42104: Is there a policy for reporting violations?	
	IC42105: Is there a policy governing related party transactions?	
IC422: information accuracy	IC42201: Audit opinion	
	IC42202: Any change in accounting policies and estimates?	
	IC42203: Any auditor switching?	
	IC42204: Any dissenting statements from the formal auditor because of switching?	
C423: information timeliness	IC42301: Are the periodic reports released on the scheduled date?	
	IC42302: Are the periodic reports released on time as required	

IC5: monitoring (first level: sub-objective level)

IC51: internal monitoring function (second level: standard level)		
Third level: sub-standard level	Fourth level: plan execution level	Score
IC511: Monitoring from Internal Control Department	C51101: Any inspection of internal control from the internal audit department?	
IC512: Monitoring from the Board of Directors	IC51201: Did the audit committee discuss the internal control inspection in its responsibility report?	
	IC51202: Did the independent directors discuss the internal control inspection in their responsibility report?	
IC52: internal control deficiencies		
IC521: internal control disclosure	IC52101: Any internal control evaluation report?	
	IC52102: Any significant risks in executing the internal control?	
	IC52103: Any plan to improve internal control?	
	IC52104: Any opinion from the auditor on internal control?	