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Corporate Risk-Taking and Cash Holdings: The Moderating Effect of Investor Protection

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Abstract: **Research Question:** This paper investigates the association between corporate risk-taking and cash holdings and whether investor protection moderates this association. **Motivation:** The motives of cash holding have important implications for corporate decisions making and performance. Understanding the relationship between corporate risk-taking and cash holdings across firms in different institutional contexts enhances better comprehension of how companies manage their financial resources. **Idea:** The perspectives of the precautionary savings and agency theory are employed in setting the views on the link between corporate risk-taking, investor protection, and cash holdings. This study incorporates both sources of managerial incentive at the firm-level i.e. corporate risk-taking and country-level i.e. governance through investor protection in examining the determinants of corporate cash holdings. **Data:** The dataset comprises 104,687 firm-year observations from 58 countries from 2011-2020. Firm-level data were gathered from Thomson Reuters Fundamentals, while country-level data were extracted from the World Bank. **Method/Tools:** The regression model employs corporate cash holdings, measured by the proportion of cash and cash equivalents to total assets, as the dependent variable. The test variables are corporate risk-taking which is based on the standard deviation of the return on the asset over three years and investor protection which is based on the strength in control of corruption. **Findings:** The findings indicate that firms with higher risk incentives exhibit lower cash holdings while firms in countries with high levels of investor protection are shown to have lower cash holdings. However, the negative association between corporate risk-taking and cash holdings is attenuated for firms in stronger investor protection countries as compared to those in weaker investor protection countries. Our findings are robust to various specification tests, such as those that employ alternative variables. Overall, the findings reveal that the strength of country-level investor protection moderates the negative association between corporate risk-taking and cash holdings. **Contributions:** The findings provide

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insights into the way country-level governance, through the strength of investor protection, mitigates the agency costs in high-risk-taking firms concerning their cash management.

Keywords: Corporate risk-taking, corporate cash holdings, investor protection, corruption.
JEL Classification: G38, G18, M41, M43, M44

1. Introduction

In recent years, levels of corporate cash holdings (CCH) are witnessing a continuous increase all over the world (El-Halaby *et al*., 2021). Apparently, over the turn of the century, the common intuition was that firms with larger cash holdings should be safer due to the lower probability of financial distress (Chowdhury *et al*., 2021). The study on corporate cash management has become essential since failure to maintain liquidity position appropriately will risk firms facing bankruptcy even if they are profitable. The theoretical arguments for holding cash vary, supporting the fact that there are various motives for cash holdings, including transaction motive, precautionary motive, agency motive, and predation and speculative motives (Tran, 2020; Akhtar *et al*., 2018). While cash reserves are necessary to enable firms to capitalize on opportunities to invest in profitable projects to earn positive returns for shareholders, as well as a buffer against economic uncertainties, there are concerns that high cash reserves give rise to high agency costs because entrenched managers would be enticed to overinvest in unprofitable projects with the available liquid resources (Jensen, 1986; Opler *et al*., 1999). Our research is motivated by the dilemma associated with cash holdings, given the various managerial incentives across firms in different institutional settings. More specifically, we look at the link between corporate risk-taking and cash holdings using a large dataset of firms from various countries that allows us to also capitalize on the country-level institutional environment that influences managerial incentives.

CRT refers to the propensity to involve in activities that have equal potential benefits and harmful outcomes simultaneously, and hence it is fundamental to managerial decision-making. Prior studies suggest that CCH is determined by various aspects of corporate risks (e.g. Da Cruz *et al*., 2019; Weidemann, 2018), in which the mixed findings can be explained from two perspectives. The precautionary motive of cash asserts a positive association between CRT and CCH since the cash reserves can be efficiently employed by managers in potential investment opportunities including hedging against corporate downturns. However, the agency theory perspective asserts a negative association between CRT and CCH. High risk-taking behaviour would mean a greater probability of being too optimistic, which would result in the tendency to be involved in unprofitable investments, especially by entrenched managers.

Further, another source of managerial incentives is the country-level institutional contexts that influences managerial decisions and behaviours involving CRT and CCH. Studies that use samples of firms from various countries identify the strength of investor protection as the determinant of cash holding, albeit mixed findings on the direction of the associations (Dittmar *et al*., 2003; Iskandar-Datta and Jia, 2014; Tran, 2020). Investor protection serves as a source of governance that mitigates the agency problem (Kuan *et al*., 2012), but the effect could be complementary or substitutive on firm-level governance aspects surrounding firms. We attempt to further contribute to understanding on determinants of CCH by exploring whether, and how, CRT and investor protection affect CCH.

We examine the association between corporate risk-taking (CRT) and cash holdings (CCH) across firms in various institutional environments based on 104,687 firm-year observations from 58 countries from 2011-2020. CCH is proxied by the proportion of cash

and cash equivalents to the total assets while CRT is based on a standard deviation of the return on the asset over three years. Investor protection is measured by the indicator for Control of Corruption from the Worldwide Governance Indicators - World Bank. The results suggest a lower level of CCH for firms with higher levels of risk-taking, and a higher level of CCH for firms that are domiciled in high-level investor protection countries. We further find that the negative effect of CRT on CCH is attenuated for firms in countries with relatively stronger investor protection, suggesting that the strength of investor protection moderates the effect of CRT on CCH. The findings are shown to be consistent and robust across various tests.

Our study contributes to the prevalent literature in the following ways. First, to the best of our knowledge, this study is among the first to incorporate the perspective of CRT and investor protection on CCH. This approach adds to the empirical evidence on the direct impact of CRT and investor protection (Iskandar-Datta and Jia, 2014) on CCH. More specifically, the contribution is made to the literature on CCH, which currently suffers from inconsistent findings and theories. Second, is the use of a large sample of 104,687 firm-year observations from 58 countries from 2011-2020, an apparent addition to empirical evidence that uses a single-country setting and prior periods. Third, our study adds to the theory of cash holdings as we provide evidence on the agency theory of the holding of cash. We assert that managerial incentives that are sourced from CRT is mitigated by the governance from investor protection in assuring higher levels of cash holding. The findings that high-risk-taking firms in countries with strong investor protections exhibit high cash holdings provide practical implications for regulators in different countries regarding the need to set a strong institutional environment that protects investors.

The remainder of the paper is structured as follows. In Section 2, we review the related literature and develop our hypotheses. Section 3 describes the research design, while Section 4 presents the main results and results of robustness tests. We conclude in the final section.

2. Literature Review and Hypotheses Development

Theories acknowledge that the policy of CCH has both transaction and precautionary benefits (Keynes, 1936). The transaction benefits of cash refer to savings from the potential to incur the high cost of raising external capital, as cash is the least costly available capital for firms and hence, becomes a source of greater liquidity (Keynes, 1936). As for the precautionary benefits of cash, managers preserve cash for opportunities to invest in profitable projects and earn positive returns for shareholders when other sources of financing are unavailable or when cash flows are volatile (Opler *et al*., 1999). Nevertheless, there is evidence that cash holdings are associated with overinvestments in unprofitable projects and higher agency costs (Jensen, 1986; Opler *et al*., 1999) that may have an adverse impact on the potential returns to investors (Chen *et al*., 2015; Harford *et al*., 2014; Pinkowitz *et al.*, 2006). More recent literature shows that firms have various motives to reserve cash, including transaction motive, precautionary motive, agency motive, tax motive, and predation and speculative motives (Tran, 2020; Akhtar *et al.*, 2018). Firms of any size should maintain appropriate liquidity positions to avoid costly external financing for operational and investment needs but at the same time cater to the needs to minimize the agency conflicts associated with the holding of cash.

Managers play an important role as decision-makers in evaluating the costs and benefits of holding cash. A fundamental principle of finance is that managers should make investment and financing decisions that maximize the market value of equity to contribute positive net present values (Liu and Mauer, 2011). Yet, there is mixed evidence on whether managers employ value-increasing or value-decreasing cash holdings strategies. On one hand, managers generally prefer to hold large cash balances as part of precautionary motives, given that cash holdings are aimed at reducing overall firm risk and increasing managerial freedom to make

investment choices. It follows that managers presented with lucrative investment opportunities may choose to hold more cash (Opler *et al.,* 1999). On the other hand, the differential risk preference of managers and shareholders can entice non-accountable managers to hold more cash than those preferred by shareholders. Risk reduction is a typical agency problem as entrenched management is particularly prone to these risk differentials, choosing to hold cash rather than increase pay-outs to shareholders when faced with poor investment decisions (Bates *et al.,* 2009). In this paper, we look at the managerial incentives associated with CRT and investor protection as determinants of CCH. While CCH has garnered increased attention in the academic literature, limited works of literature address the linkage between corporate risk-taking and cash holdings especially by using a large sample of an international dataset in different institutional contexts.

2.1 Corporate Risk-Taking and Cash Holdings

Corporate risk-taking (CRT) is defined as conscious decision-making among alternative results under a probabilistic uncertainty situation (Dan-Jumbo, 2016). In this respect, CRT is a critical aspect of managerial decision-making since managers need to take risks that have important implications for corporate growth, performance, and survival (Kim and Buchanan, 2008). Formal economic assumptions of risk-taking suggest that if the expected values for two strategies are similar, but one is a greater gamble (uncertain), managers are more likely to choose the strategy with a more certain outcome. As long as managerial interests are aligned with those of the shareholders, CRT would yield positive future benefits. Yet, the misalignment of interests due to managerial self-serving behaviour and improperly designed incentives could cause CRT to adversely affect future performance.

The cash holdings are particularly appropriate to be adapted in exploring managerial incentives related to CRT because the decision to accumulate cash more than what is necessary is, to a large extent, at the discretion of managers with little scope for external scrutiny (Belghitar and Clark, 2014). It is a world phenomenon that firms hold cash due to some risk reasons, as shown by existing studies that applied various measurements of risk in understanding CCH. Some studies consider the perspective of risk associated with top management. This managerial risk preference is in line with the agency-based theoretic model that managerial risk-taking incorporates the idea of rationally risk-averse managers because a significant component of their wealth is tied to a particular organization. A study of US companies by Tong (2010) examines the implications of risk-related agency theory on CCH for a sample consisting of 1,768 observations during the period 1993-2000. The results suggest a negative relationship between CEO risk incentives and CCH. The easing pressure of higher risk-related agency problems alters the risk tolerance of the CEOs as it allows them to pursue riskier corporate policies. Hence, firms with higher CEO risk incentives hold less cash to assure lower managerial entrenchment, for which the CEOs would undertake managerial risk-increasing incentives in an efficient way to improve firm value.

Meanwhile, the links between risks and CCH have also been explored from the country-level perspective by, mostly, utilizing the economic risks and crisis. Hunjra *et al.* (2022) examine the impact of economic risk on CCH by using data from 552 listed firms in Pakistan, Sri Lanka, India, and Bangladesh from 2002 to 2018. The findings show that the variance of inflation has a negative effect while the variance of interest rate has a positive effect on CCH. Lozano and Yaman (2020) employ the precautionary motive perspective to analyse the relationship between the 2008 European financial crisis and CCH policies. By using a sample of 1,541 listed firms from 15 Western European countries, they found that the European financial crisis positively affects firms' cash holding policies in the short crisis period, where it was noted that volatility has a positive impact on cash holding. Yet, the European financial crisis negatively affects firms' cash holding policies during the long crisis period.

More relevant to our study are the empirical evidence that focuses on the link between firm-level risks and CCH. In general, a larger liquidity risk requires larger CCH, and higher solvency risk suggests lower CCH (Gryglewicz, 2011). Some studies identify the systematic risk implication on CCH. Systematic risk is also known as market risk, referring to the risk associated with changes that can be eliminated through diversification by investors (Azis *et al.*, 2021). There are two views on the relationship between systematic risk and CCH (Azis *et al.*, 2021). The first is that low systematic risk may reduce cash holdings as a low correlation with the shock of the aggregate risks tend to induce a shortage of cash flow in a situation where firms need it (Palazzo, 2012; Acharya *et al.*, 2013). The other view is that systematic risk can affect the way a company chooses to invest in cash. Additional cash functions as an alternative for declining leverage by corporations (Acharya *et al.*, 2011). Since banks are more inclined to grant a credit line to firms with low systematic risks, these high systematic risk firms consequently have more incentives to hold cash, and thus the systematic risk is positively associated with cash holding (Acharya *et al.*, 2013). However, in Azis *et al.* (2021), systematic risk is not shown to have an impact on CCH.

Further, the rising level of cash in the corporate's balance sheet could be due to lower investment (Acharya *et al.*, 2011). In Acharya *et al.* (2007), a firm that has high investment opportunities allocates its cash flow toward debt reductions to amplify its debt capacity, but firms prefer more cash to lower debt if their hedging needs are higher, that is, in a state of low future investment opportunities. Duchin (2010) shows that firms with cross-divisional diversification hold less cash to efficiently utilize their cash flows on better investment opportunities and to be less exposed to investment risks, while firms that are less diversified in their cash flows and investment opportunities face more investment risk and hold more cash for precautionary motives. Yet, Haushalter *et al.* (2007) show that firms with higher investment opportunities have higher predation risk, hold more cash, and use derivatives aiming to decrease the predation by cash-rich companies and gain market share on these rival groups, especially during economic downturns.

An aspect of risk that can explain our views is firm-level risks associated with financial constraints or distress. Almeida *et al.* (2004) indicate that a financially constrained may have to incorporate savings from incremental cash flows to protect its future and as a result would hold a considerable portion of cash as a hedging tool for downturns. Evidence indicates that the level of CCH increases when the probability of financial distress rises (Weidemann, 2018) and that financially constrained firms hold more cash as the volatility of cash flows increases (Han and Qiu, 2007) due to precautionary motives. Denis and Sibilkov (2010) posit that lower cash-constrained firms that are facing high costs of external financing tend to hold less cash than higher cash-constrained ones, particularly because the former produces lower cash flow than the latter. Similarly, Hugonnier *et al.* (2015) assert that the inability to raise external funds would cause firms with capital supply constraints to hold more cash to protect themselves against default risk. However, there are findings that financially constrained firms hold less cash than unconstrained firms (Arslan *et al.*, 2006).

Important empirical evidence, albeit limited, are those that employs international dataset with the view that the risks of having difficulty in accessing the capital market cause financial constraint that may exert influence on the precautionary motive of cash holding. Hoang *et al.* (2022) investigate the impact of COVID-19 exposure on CCH, using data across sixteen developing and developed economies. The results show that firms reserve more cash when their exposure to COVID-19 increases. They also find a cash burn effect during the COVID-19 pandemic, meaning that the cash holdings are drained when firm exposure to the pandemic exceeds a tipping point. Further analyses reveal that the cash burn effect is more pronounced in larger firms and firms with less cash reserve and tends to be stronger in countries with a

high level of individualism and weaker in countries with high levels of risk aversion, masculinity, and long-term orientation.

Considering all these factors and the mixed evidence addressed in the above-mentioned studies, it seems likely that the CCH is considerably sensitive to various aspects of corporate risks. The notable findings are the implicit support that mechanisms to manage the embodying risk related to agency cost of under-investment, financial constraints, and financial distress are likely to involve a significant adaptation in terms of CCH. We posit two differing perspectives on the way CRT determines CCH. On one hand, firms with high CRT can be predicted to have high CCH based on the precautionary motive of cash. In this regard, the holding of cash is aimed at fulfilling potential investment opportunities and serving as a buffer against the expected risk of liquidity, including the default risk from various potential investments. This is due to the risk preference behaviours of the managers that attempt to align their interests with those of the shareholders in generating more return. A given level of wealth related to cash holdings would help to lessen the effect of misalignment of risk preferences of shareholders which in turn fosters the growth and improve corporate performance. On the other hand, firms with high CRT may tend to hold less CCH due to the need to lower agency costs associated with potential managerial entrenchment from high risk-taking behaviours. In this sense, managers of high CRT firms are restricted from holding high cash to control the misappropriation of liquid assets. Further, it is expected that high CRT firms would ensure that cash is diverted into investments with better returns, including allocating debt reduction for opportunities and flexibilities in investment alternatives. Too much cash may contribute to the impairment of corporate performance because it insulates the firm from exogenous shocks and can engender managerial complacency or irrational optimism (O'Brien and Folta, 2009). Therefore, the impression of heightened risks and uncertainties will establish the importance of the less need for liquidity for firms. Given the mixed theoretical and empirical arguments, we propose the following hypothesis:

H_1: There is a relationship between corporate risk-taking and cash holdings

2.2 Investor Protection, Corporate Risk-Taking, and Cash Holdings

Literature on CCH introduces an aspect of governance that influences managerial incentives towards CCH, which is sourced from the country-level institutional contexts. Investor protection turns out to be crucial because, in many countries, the expropriation of minority shareholders and creditors by the controlling shareholders is extensive to the extent that the returns on their investments will never materialize due to the expropriation (La Porta *et al.*, 2000). Martins (2019) investigates whether investor protection is associated with how entrenched managers set corporate cash holdings. The results, which are based on an analysis involving 29 countries during the 2010 to 2013 period, find that the way shareholder protection shapes this association depends upon how managers become entrenched. Studies that employ investor protection as measures of country-level governance assert two opposing views on the way investor protection affects CCH.

From the view that investor protection serves as a control mechanism against managerial entrenchment, firms in strong investor protection regimes would be holding high cash reserves, and vice versa. Huang *et al.* (2013) show that a reduction in agency costs through strong investor protection plays a significant role in the corporate decisions of how much cash to hold. The agency costs are reduced in these countries because it is hard for managers to pursue their welfare over shareholders' interests, as there will be limited flexibility that possibly harms corporate assets (Bailey *et al.*, 2006; Hope *et al.*, 2007). Harford *et al*. (2008) find that US companies with better investor protection hold more cash, as they conclude that large amounts of cash are too visible to trigger shareholder action to pay more dividends.

Since better investor protection prevents overinvestment, firms are induced to keep high corporate cash holdings. Iskandar-Datta and Jia (2014) find a positive relationship between investor protection and corporate cash holdings, explained by the fact that firms in countries with low levels of investor protection tend to overinvest, which leads to lower CCH.

From the view that strong investor protection would mean a greater ability to exercise shareholders' rights, firms in a strong investor protection regime would be holding low cash reserves. Low monitoring of excessive cash holdings would result in personal benefits for managers (Jensen, 1986). Despite managers' preferences for higher levels of CCH, the extant literature shows that when investors are strongly protected, they can use their rights to pressure managers to use the excess cash to lower the cost of operations as well as to avoid the loss from under-investment due to the scarcity of funds (Akhtar *et al.*, 2018; Opler *et al.*, 1999). Dittmar *et al.* (2003) argue that investors would try to limit the cash at managers' discretion, and they must do so when managers have adequate power to raise easy funds and hold higher cash for empire-building motives and over-investment that harm the interests of shareholders. Seifert and Gonenc (2018) conclude that strong country-level and firm-level governance reduce cash holdings.

While extant literature highlights the role of investor protection in affecting CCH (Dittmar *et al.*, 2003; Harford *et al.*, 2008; Chen *et al.*, 2015; Iskandar-Datta and Jia, 2014), to the best of our knowledge, no studies to date have investigated how investor protection could moderate the effect of CRT on CCH. In line with the views above on the effect of CRT on CCH and investor protection on CCH, we posit that investor protection at the country level helps in establishing a governance framework to further minimize the level of agency conflicts, thus reducing the over- and under-investment of the free cash flow. When investor protection is high, investors can enforce strong monitoring mechanisms to control the managers' discretionary powers on CRT and CCH. In these environments, it is hard for managers to pursue their personal preferences over shareholders' interests. It means that, if firms possess effective governance to protect shareholder interests, or if investors are well protected, shareholders of high CRT firms would be willing to accept higher levels of cash holdings. On the other hand, in weak investor protection countries, there is lesser control over the managers that would allow the managers to invest in sub-optimal projects and hold cash for their benefits resulting in the need for high CRT firms to force lower levels of cash holding. We, therefore, expect the association of CRT and CCH to be mitigated by the impact of investor protection. We propose the following hypothesis:

H_2: Investor protection moderates the relationship between corporate risk-taking and cash holdings

3. Research Design

3.1 Sample Selection

Our sample includes non-financial firms from 58 countries covering the period of 2011 to 2020. We extract firm-level data from Thomson Reuters Fundamentals, while the country-level data are extracted from the World Bank. In deriving the sample, we follow the approaches of the prior studies (e.g., Ariff and Kamarudin, 2019; Wan Ismail *et al.*, 2015) to exclude highly regulated industries. They are the (i) financial institutions (SIC code between 6000 and 6999) and (ii) utility companies (SIC code between 4900 and 4999). Further, we winsorize the observations that fall in the top and bottom one percent of all continuous variables to mitigate the influence of outliers. Our final sample consists of 104,687 firm-year observations from 58 countries.

3.2 Regression Model

We regress Equation (1) to test the hypotheses set above on i) the relationship between corporate risk-taking and cash holding, and ii) the moderating effect of investor protection on the relationship between corporate risk-taking and cash holdings.

$$CCH_{it} = \beta_0 + \beta_1 CRT_{it} + \beta_2 D_{CCE\,it} + \beta_3 (CRT_{it} * D_{CCE\,it}) + \sum_k \beta_k FIRM_{it} + \sum_j \beta_j COUNTRY_{it} + \gamma_t + \varepsilon_{it} \quad (1)$$

where *i* and *t* denote firm *i* at the end of year *t*, *CCH* proxies for corporate cash holdings, *CRT* is a variable for corporate risk-taking, and D_{CCE} proxies for investor protection. We have included a range of control variables, which are commonly used in the literature (e.g., Bates *et al*., 2009; Phan *et al.,* 2019; Opler *et al*., 1999), to explain CCH. The firm-level control variables (*FIRM*) are *FSIZE* which is the natural logarithm of total assets; *LEV* which is the total liabilities over the total assets, *GROWTH* which refers to firm-specific growth based on changes in sales; *LOSS* which is an indicator for loss firms; *MKTBK* which is the ratio of the market-to-book value profit, *QUICK* which is the ratio of the current assets minus the inventory divided by the total current liabilities; *LIT* which is a dummy variable of high-litigation industries, classified as 1 if the SIC codes are between 2833–2836, 3570–3577, 3600–3674, 5200–5961, and 7370–7370, otherwise 0 (Ashbaugh *et al.,* 2003); *AGE* which is the natural log of the number of years since incorporation; and *RETEQ* which is the ratio of the retained earnings to total equity. We also employ cash flow patterns as a proxy for firm life cycle (*LIFECYCLE*) following Dickinson's (2011) vector for firm lifecycle namely, INTRODUCTION, GROWTH, MATURE, DECLINE, and SHAKE-OUT. This is in line with the findings of Faff *et al.* (2016) on the importance of the life cycle as a determinant of corporate policies including liquidity.

The country-level control variables (*COUNTRY*) are *GDP* which is the gross domestic product per capita to proxy for fluctuations in economic outcomes and inflation rate (*INF*) to proxy for monetary uncertainty that could affect CCH. The model includes fixed effects to control for unobserved time and industry-wide common factors.

3.3 Measurement for Dependent and Test Variables

The dependent variable in this study is corporate cash holdings, measured by the proportion of cash and cash equivalents to the total assets, as the measurement is extensively used in the literature (e.g., Acharya *et al.*, 2013; Palazzo, 2012). For the robustness analysis, we employ CCH2, which is measured by the total cash and cash equivalents divided by the total assets minus cash and equivalents, as used in Phan *et al.* (2019).

The test variables are corporate risk-taking (CRT) and investor protection (D_{CCE}). Following prior studies (e.g., Ahmad and Azhari, 2021; Bhuiyan *et al.,* 2021; Habib and Hasan, 2017; Li *et al.,* 2013), we measure corporate risk-taking based on the standard deviation of the return on the asset over three years. We employ CRT2, which is the standard deviation of the return on the asset over five years, for the robustness analysis. The standard deviation of the return on the asset is commonly used to proxy for the overall corporate risk-taking measures where higher values reflect greater risk-taking by the firms as compared to their counterparts.

In this paper, country-level investor protection is proxied by the strength concerning control of corruption. We employ an index for Control of Corruption (CCE) from the Worldwide Governance Indicators - World Bank. The focus on the perspective of the country-level strength in controlling corruption is made for the following reasons. First, corruption

has been shown to affect managerial incentives such as reflected in corporate investment efficiency (Nguyen and Tran, 2022). Second, corporate financial policies, such as cash holding, are potential channels through which firms can avoid rent seeking, as evidenced by studies on corruption and cash holdings (Thakur and Kannadhasan, 2019; Tran, 2020). Further, the strength in controlling corruption is the core feature in ensuring strong investor protection because corruption could undermine the ability of the established law enforcement and judicial systems. We create a dummy variable for a high-level investor protection country (D_{CCE}), in which we assign the value 1 if the score for control of corruption is higher than the median, and 0 otherwise. In an alternative analysis, we also employ alternative measures for investor protection using five (5) key dimensions of governance using the data from the Worldwide Governance Indicators - World Bank. They are Voice and Accountability (VAE), Political Stability and Lack of Violence (PVE), Government Effectiveness (GEE), Regulatory Quality (RQE), and Rule of Law (RLE).

4. Discussion of Results

4.1 Descriptive Statistics

Table 1 presents the descriptive statistics; Panel A depicts the statistics for the firm-level variables and Panel B provides the statistics for the country-level variables. In Panel A, the mean for CCH is 0.133 and CCH2 is 0.202. CRT and CRT2 are shown to have an average value of 0.044 and 0.053, respectively. For the control variables, the mean for FSIZE is 19.553, with a range between 15.014 and 24.735. The variables LEV, GROWTH, and MKTBK have mean values of 0.207, 0.079, and 2.531, respectively. QUICK has a mean value of 1.97 while RETEQ has a mean value of 0.027. The average value for the dummy variables of LOSS is 0.204 indicating that loss firms constitute 20.4 percent of the sample. Meanwhile, the mean for LIT is shown to be 0.03 showing that 3.0 percent of the sample are those from highly litigious industries. AGE has a mean value of 9.151. For the country-level variables in Panel B, the statistics show that Japan is the most heavily represented in the sample (n = 19,484), followed by China (n = 19,168). Meanwhile, the countries with the lowest observations are Cyprus (n = 6) and Malta (n = 2). For investor protection, Norway, Sweden, Singapore, and Switzerland are ranked among the countries with the highest scores for CCE while Nigeria, Ukraine, and Russian Federation are among the countries with the lowest score for CCE.

Table 1: Descriptive statistics

Panel A: Firm-level variables

Variable	Obs	Mean	Std. Dev.	Min	Max
CCH	104806	0.133	0.139	0	0.700
CCH2	104806	0.202	0.315	0	2.336
CRT	104806	0.044	0.086	0.001	0.997
CRT2	104806	0.053	0.080	0.002	0.663
FSIZE	104806	19.553	1.956	15.014	24.735
LEV	104806	0.207	0.176	0	0.684
GROWTH	104806	0.079	0.372	-0.731	3.402
LOSS	104806	0.204	0.403	0	1
MKTBK	104806	2.531	3.351	0.152	30.525
QUICK	104806	1.970	2.366	0.165	20.610
LIT	104806	0.030	0.171	0	1
AGE	104806	9.151	0.706	7.022	10.610
RETEQ	104806	0.027	2.080	-18.555	1.912

Table 2 presents the result of the pairwise correlation analysis among the dependent and independent variables. The results reveal that CCH is positively correlated with CRT, GROWTH, MKTBK, QUICK, LIT, and GDP. CCH is shown to be negatively associated with FSIZE, LEV, AGE, RETEQ, and INF. Although the results show several significant correlations between the independent variables, none of the correlations suggest any concern for multicollinearity.

4.2 Main Results

Table 3 presents the regression estimates that test for hypothesis 1 on the association between CRT and CCH and hypothesis 2 on the moderating effect of investor protection on the association between CRT and CCH. The results for the samples in low ($D_{CCE} = 0$) and high ($D_{CCE}=1$) levels of investor protection are reported in column (1) and column (2), respectively. The results show that CRT is positive and significant for both samples of firms. Column (3) reports the estimation for the pooled sample, where we include both test variables; CRT and D_{CCE}. Both CRT and D_{CCE} are shown to be positive and significant.

The results for the full regression analysis can be seen in Column (4). The results show that the coefficient for CRT is significantly negative, suggesting that firms with a higher level of CRT have a lower level of CCH. This finding is in support of hypothesis 1, where an association is expected to exist between CRT and CCH. Meanwhile, D_{CCE} is positive and significant, indicating that firms in high-level investor protection countries have higher cash holdings than firms in low-level investor protection countries.

The coefficient for CRT*D_{CCE}, which is positive and significant, is in line with the expectation set in hypothesis 2. The results suggest the moderating effect of investor protection on the association between CRT and CCH. More specifically, the results imply that the negative effect of CRT on CCH diminishes in firms in stronger institutional environment regimes, which is proxied by the countries' strength in controlling corruption. Hence, the strength of investor protection attenuates the agency costs arising from greater risk-taking on CCH.

For the control variables, the results in Table 3 report that GROWTH, MKTBK, QUICK, and GDP have positive relationships with CCH. Meanwhile, FSIZE, LEV, LOSS, LIT, AGE, RETEQ, and INF are negatively associated with CCH. Overall, the results for the control variables indicate a significant influence of these variables on CCHs, as shown by prior studies on CCH.

Taken together, the results in Table 3 support the hypothesis that i) there is an association between CRT and CCH, and ii) investor protection affects the relationship between CRT and CCH. The results indicate that while CRT has a negative effect on CCH, the effect is attenuated for firms in countries with high-level investor protection. In other words, in high-level investor protection countries, the negative impact of CRT on CCH becomes weaker, suggesting evidence of a moderating effect of investor protection on the agency cost arising from high CRT.

Table 1 ***(continued)***

Panel B: Country-level variables

Country	Obs	CCH	CCH2	CRT	CRT2	VAE	PVE	GEE	RQE	RLE	CCE	GDP	INF
Argentina	338	0.044	0.049	0.056	0.060	0.446	0.064	-0.079	-0.660	-0.531	-0.307	9.404	13.563
Australia	2023	0.173	0.331	0.152	0.165	1.365	0.952	1.593	1.860	1.752	1.829	10.949	1.794
Austria	208	0.102	0.139	0.025	0.030	1.395	1.100	1.550	1.456	1.856	1.519	10.798	1.860
Bangladesh	191	0.051	0.065	0.031	0.033	-0.636	-1.110	-0.746	-0.872	-0.678	-0.904	7.484	6.889
Belgium	169	0.070	0.113	0.042	0.050	1.343	0.653	1.456	1.269	1.432	1.520	10.720	1.583
Brazil	374	0.089	0.109	0.026	0.031	0.415	-0.321	-0.218	-0.099	-0.135	-0.268	9.212	6.416
Bulgaria	153	0.015	0.017	0.026	0.032	0.381	0.260	0.116	0.576	-0.094	-0.234	9.006	3.106
Canada	1681	0.129	0.220	0.105	0.120	1.451	1.116	1.756	1.736	1.781	1.854	10.757	1.387
Cayman Islands	22	0.267	0.489	0.036	0.049	0.502	1.192	1.199	0.942	0.797	0.830	11.279	1.279
Chile	830	0.043	0.053	0.035	0.041	1.029	0.337	1.101	1.362	1.227	1.261	9.589	3.903
China	19168	0.170	0.249	0.035	0.042	-1.598	-0.429	0.332	-0.224	-0.345	-0.303	9.002	2.368
China, Hong Kong	354	0.131	0.189	0.030	0.040	0.430	0.720	1.811	2.038	1.690	1.662	10.665	2.617
Colombia	140	0.026	0.028	0.022	0.027	0.073	-0.963	-0.012	0.389	-0.357	-0.310	8.793	3.621
Cyprus	6	0.106	0.120	0.081	0.098	1.016	0.506	0.954	1.006	0.791	0.712	10.193	0.120
Czechia	24	0.149	0.213	0.017	0.027	0.944	0.991	1.007	1.159	1.072	0.535	9.943	2.113
Germany	354	0.103	0.139	0.043	0.053	1.397	0.711	1.572	1.684	1.660	1.844	10.721	1.680
Greece	565	0.077	0.097	0.024	0.030	0.729	-0.062	0.306	0.430	0.289	-0.067	9.903	-0.390
Hungary	138	0.095	0.135	0.077	0.095	0.538	0.750	0.565	0.715	0.537	0.162	9.578	3.613
India	7768	0.035	0.044	0.035	0.041	0.362	-0.957	0.088	-0.300	-0.029	-0.317	7.480	4.162
Indonesia	1173	0.081	0.111	0.044	0.053	0.109	-0.544	-0.063	-0.176	-0.428	-0.479	8.209	4.131
Ireland	165	0.120	0.150	0.050	0.062	1.315	0.958	1.443	1.637	1.576	1.599	11.088	1.750
Israel	872	0.147	0.248	0.084	0.093	0.686	-0.960	1.284	1.253	1.035	0.862	10.561	1.325
Italy	63	0.052	0.061	0.024	0.031	0.975	0.420	0.481	0.719	0.368	0.203	10.430	1.147
Japan	19484	0.218	0.351	0.026	0.033	1.014	1.024	1.655	1.270	1.498	1.552	10.602	0.461
Jersey	119	0.148	0.214	0.077	0.095	1.279	1.354	1.285	0.902	1.730	1.132	.	.
Kuwait	605	0.068	0.095	0.042	0.052	-0.639	0.097	-0.090	-0.009	0.208	-0.193	10.468	0.291
Malaysia	1150	0.122	0.174	0.038	0.048	-0.279	0.152	0.976	0.709	0.548	0.220	9.272	1.327
Malta	2	0.059	0.064	0.028	0.028	1.106	1.118	1.003	1.278	0.985	0.476	10.317	1.847
Mauritius	141	0.060	0.092	0.034	0.042	0.814	0.905	0.931	1.035	0.838	0.314	9.200	1.580

Table 1 ***(continued)***

Country	Obs	CCH	CCH2	CRT	CRT2	VAE	PVE	GEE	RQE	RLE	CCE	GDP	INF
Mexico	331	0.058	0.067	0.034	0.041	0.010	-0.746	0.113	0.294	-0.558	-0.691	9.188	4.391
Morocco	302	0.056	0.073	0.021	0.026	-0.657	-0.385	-0.104	-0.169	-0.151	-0.281	8.024	0.906
Netherlands	163	0.092	0.127	0.051	0.063	1.536	0.978	1.842	1.857	1.847	1.958	10.829	1.344
New Zealand	332	0.089	0.150	0.067	0.087	1.570	1.480	1.760	1.944	1.917	2.240	10.638	2.233
Nigeria	208	0.089	0.124	0.053	0.056	-0.447	-1.973	-1.040	-0.857	-0.934	-1.095	7.730	8.395
Norway	424	0.121	0.195	0.065	0.076	1.691	1.221	1.888	1.692	1.987	2.187	11.320	1.435
Oman	115	0.053	0.065	0.031	0.037	-1.071	0.600	0.207	0.468	0.489	0.263	9.888	-1.619
Pakistan	111	0.089	0.134	0.042	0.051	-0.793	-2.406	-0.688	-0.662	-0.771	-0.891	7.342	8.676
Panama	13	0.007	0.007	0.019	0.018	0.543	0.319	0.129	0.362	-0.061	-0.483	9.571	1.594
Peru	326	0.043	0.051	0.034	0.042	0.203	-0.440	-0.187	0.496	-0.504	-0.466	8.789	2.503
Philippines	526	0.104	0.161	0.037	0.048	0.046	-1.061	0.062	-0.037	-0.437	-0.508	8.024	1.923
Poland	882	0.050	0.063	0.050	0.056	0.880	0.729	0.612	0.966	0.632	0.680	9.546	1.728
Portugal	113	0.060	0.068	0.018	0.022	1.142	0.936	1.132	0.854	1.106	0.886	9.981	1.383
Qatar	175	0.101	0.132	0.016	0.022	-1.150	0.886	0.838	0.665	0.833	0.891	11.108	-1.155
Republic of Korea	14059	0.095	0.123	0.050	0.058	0.727	0.368	1.192	1.061	1.101	0.573	10.305	1.232
Russian Federation	623	0.040	0.046	0.052	0.061	-1.047	-0.800	-0.178	-0.419	-0.770	-0.931	9.390	7.857
Saudi Arabia	565	0.048	0.058	0.032	0.039	-1.774	-0.533	0.159	0.041	0.160	0.134	10.026	0.542
Singapore	1466	0.183	0.297	0.074	0.085	-0.127	1.430	2.217	2.134	1.819	2.124	11.000	0.814
South Africa	854	0.091	0.117	0.043	0.050	0.639	-0.185	0.332	0.245	0.024	0.007	8.800	5.297
Spain	207	0.066	0.076	0.035	0.043	1.031	0.218	1.064	0.923	1.013	0.790	10.258	0.586
Sweden	144	0.095	0.153	0.032	0.037	1.592	1.059	1.765	1.834	1.917	2.172	10.927	1.703
Switzerland	849	0.116	0.160	0.038	0.046	1.568	1.327	1.977	1.731	1.884	2.064	11.368	-0.236
Thailand	3082	0.055	0.070	0.040	0.048	-0.804	-0.896	0.316	0.190	-0.041	-0.401	8.770	1.452
Turkey	1291	0.070	0.093	0.050	0.054	-0.537	-1.396	0.172	0.199	-0.149	-0.151	9.271	10.279
Ukraine	37	0.029	0.032	0.067	0.076	-0.148	-1.128	-0.583	-0.553	-0.788	-0.998	8.057	10.864
United Arab Emirates	231	0.069	0.081	0.044	0.052	-1.086	0.726	1.356	0.940	0.735	1.155	10.617	-1.424
United Kingdom	2661	0.132	0.210	0.058	0.070	1.308	0.399	1.537	1.712	1.686	1.783	10.672	2.095
USA	13023	0.144	0.224	0.061	0.075	1.038	0.421	1.491	1.393	1.557	1.312	10.965	1.676
Vietnam	3413	0.070	0.095	0.030	0.038	-1.398	0.111	-0.025	-0.434	-0.193	-0.473	7.944	3.325
Total	104806	0.133	0.202	0.044	0.053	0.208	0.179	0.958	0.716	0.753	0.627	9.801	2.007

Table 2: Correlation matrix

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
(1) CCH	1.000														
(2) CCH2	0.940*	1.000													
(3) CRT	0.162*	0.196*	1.000												
(4) CRT2	0.191*	0.224*	0.824*	1.000											
(5) FSIZE	-0.155*	-0.182*	-0.255*	-0.294*	1.000										
(6) LEV	-0.343*	-0.296*	-0.058*	-0.082*	0.238*	1.000									
(7) GROWTH	0.048*	0.041*	0.064*	0.091*	0.008*	-0.016*	1.000								
(8) LOSS	0.002	0.040*	0.337*	0.364*	-0.216*	0.122*	-0.095*	1.000							
(9) MKTBK	0.157*	0.155*	0.201*	0.220*	0.014*	0.036*	0.112*	0.062*	1.000						
(10) QUICK	0.438*	0.455*	0.127*	0.171*	-0.206*	-0.419*	0.010*	0.038*	0.016*	1.000					
(11) LIT	0.055*	0.042*	0.031*	0.048*	0.087*	-0.057*	0.005	0.040*	0.113*	0.030*	1.000				
(12) AGE	-0.070*	-0.089*	-0.148*	-0.195*	0.108*	-0.021*	-0.119*	-0.096*	-0.160*	-0.084*	-0.057*	1.000			
(13) RETEQ	-0.131*	-0.158*	-0.486*	-0.518*	0.258*	-0.058*	-0.033*	-0.359*	-0.372*	-0.038*	-0.075*	0.145*	1.000		
(14) GDP	0.214*	0.168*	0.093*	0.117*	0.216*	-0.092*	-0.009*	0.079*	0.028*	0.069*	0.176*	0.120*	-0.089*	1.000	
(15) INF	-0.123*	-0.089*	0.003	0.000	-0.066*	0.051*	0.048*	-0.011*	0.002	-0.035*	-0.023*	-0.091*	0.001	-0.393*	1.000

Notes: *** p<0.01, ** p<0.05, * p<0.1

4.3 Results using Alternative Measurements of Variables

We employ alternative measurements of the variables in our study to test whether our results could potentially be confounded by the choice of variables used in the main analysis in Table 3. The results are reported in Table 4; Panel A where D_{CCE} is replaced with five (5) dimensions of governance using the data from the Worldwide Governance Indicators - World Bank namely VAE, PVE, GEE, RQE, and RLE; Panel B where we replace CCH with CCH2, which is measured by the total cash and cash equivalents divided by the total assets minus cash and equivalents; and Panel C where CRT is replaced with CRT2, which is the standard deviation of the return on the asset over five years.

Overall, most of the results reported in Table 4 are consistent with those reported in Table 3. Mostly, CRT has significant and negative associations with CCH and significant associations are shown between proxies for investor protection and CCH. The results that employ these alternative measurements of variables also support hypothesis 2, on the moderating effect of investor protection on the association between CRT and CCH. Hence, our results are robust to alternative measurements of variables.

4.4 Robustness Tests

We also perform several analyses to ensure the robustness of our results, as presented in Table 5. In the first analysis that is reported in Column (1), we control for the impact of the COVID-19 crisis period due to the likelihood that COVID-19 would cause exogenous shock to CCH. This is because there is an increase in uncertainty and greater restrictions on firms' access to external financing because of crises (Tran, 2020) such as those that arise from the COVID-19 pandemic. Hence, we perform an analysis that excludes the COVID-19 sample. The results are similar to those reported as the main results in Table 3.

Second, we exclude firms from countries with less than 100 observations. We also exclude firms from the United States. We re-run equation (1) with the revised samples and the results are shown in Column (2) and Column (3) of Table 5. Again, we find results that are similar to our main results. The coefficients of CRT are significant and negative, while the coefficients of D_{CCE} are significant and positive. The coefficients for the interaction variable, $CRT*D_{CCE}$, are significant and positive, showing support for hypothesis 2. These results further validate our main findings.

Third, we employed weighted least squares (WLS) regression to address the concern that our results were biased by countries that were heavily represented since our number of observations varied substantially across countries. The approach, to using WLS, follows those of the prior studies (e.g., Jaggi and Low, 2011; Kamarudin *et al.*, 2020). In employing the WLS regression, we use the inverse of the number of observations in each country as a weight so that each country receives equal weight in the estimation. From the results shown in column (4), we further observe similar results that support hypothesis 1 and hypothesis 2.

Taken together, the robustness analyses that we employed validate our results on the relationship between corporate risk-taking and cash holding, and the moderating effect of investor protection on the relationship between corporate risk-taking and cash holdings. Firms with higher CRT are those with lower CCH, but the negative association between CRT and CCH is attenuated by the strength of investor protection.

Table 3: Main results

	(1) $D_{CCE}=0$	(2) $D_{CCE}=1$	(3) Full	(4) Full
Intercept	0.097***	0.008	0.108***	0.095***
	(9.502)	(0.403)	(13.259)	(11.706)
CRT	0.025***	0.089***	0.073***	-0.071***
	(3.458)	(13.633)	(14.592)	(-8.939)
D_{CCE}			0.020***	0.010***
			(16.215)	(7.660)
CRT*D_{CCE}				0.217***
				(23.451)
FSIZE	0.010***	-0.016***	-0.004***	-0.004***
	(35.824)	(-51.727)	(-17.371)	(-17.239)
LEV	-0.109***	-0.136***	-0.125***	-0.124***
	(-36.500)	(-38.042)	(-51.748)	(-51.470)
GROWTH	0.005***	-0.000	0.005***	0.004***
	(4.078)	(-0.307)	(5.445)	(4.479)
LOSS	-0.016***	-0.018***	-0.021***	-0.020***
	(-12.700)	(-11.875)	(-19.877)	(-19.320)
MKTBK	0.006***	0.006***	0.005***	0.005***
	(34.762)	(34.012)	(41.981)	(43.714)
QUICK	0.016***	0.022***	0.019***	0.019***
	(76.025)	(87.867)	(110.741)	(110.668)
LIT	0.021	-0.018***	-0.028***	-0.029***
	(1.347)	(-7.266)	(-12.545)	(-12.963)
AGE	-0.026***	0.009***	-0.005***	-0.004***
	(-31.412)	(12.827)	(-9.326)	(-7.443)
RETEQ	0.001	-0.001***	-0.003***	-0.002***
	(1.399)	(-4.687)	(-13.804)	(-10.871)
GDP	0.007***	0.030***	0.012***	0.013***
	(12.332)	(16.655)	(20.925)	(21.884)
INF	-0.001***	-0.008***	-0.003***	-0.002***
	(-9.366)	(-22.258)	(-16.788)	(-16.468)
2.LIFECYCLE	0.008***	0.013***	0.005***	0.006***
	(5.185)	(5.779)	(3.318)	(4.023)
3.LIFECYCLE	-0.001	0.010***	-0.004***	-0.003**
	(-0.380)	(4.720)	(-3.044)	(-1.990)
4.LIFECYCLE	-0.007***	0.010***	-0.011***	-0.009***
	(-3.455)	(3.350)	(-6.186)	(-4.928)
5.LIFECYCLE	0.025***	0.029***	0.019***	0.021***
	(14.014)	(12.066)	(12.806)	(13.932)
Industry Effects	Included	Included	Included	Included
Year Effect	Included	Included	Included	Included
Adj.R2	0.29	0.38	0.31	0.32
N	51439	53248	104687	104687
F-stat	631.569	957.880	1362.767	1347.139

Notes: t statistics in parentheses, * p<0.10, ** p<0.05, *** p<0.01

Table 4: Alternative measurements

Panel A: Regression estimates using five (5) other country governance replacing D_{CCE}

	(1)	(2)	(3)	(4)	(5)
MV	VAE	PVE	GEE	RQE	RLE
Intercept	0.053***	0.046***	0.100***	0.115***	0.128***
	(6.573)	(5.949)	(12.231)	(13.568)	(15.413)
CRT	-0.044***	-0.018**	-0.067***	-0.073***	-0.053***
	(-5.873)	(-2.338)	(-8.457)	(-9.337)	(-6.899)
D_{VAE}	-0.003**				
	(-2.107)				
CRT*D_{VAE}	0.190***				
	(2179)				
D_{PVE}		-0.003***			
		(-2.613)			
CRT*D_{PVE}		0.145***			
		(16.215)			
D_{GEE}			0.012***		
			(8.692)		
CRT*D_{GEE}			0.212***		
			(22.930)		
D_{RQE}				0.012***	
				(9.246)	
CRT*D_{RQE}				0.223***	
				(24.245)	
D_{RLE}					0.020***
					(14.597)
CRT*D_{RLE}					0.198***
					(2853)
FSIZE	-0.004***	-0.004***	-0.004***	-0.004***	-0.004***
	(-18.670)	(-18.427)	(-16.796)	(-17.136)	(-16.146)
LEV	-0.124***	-0.124***	-0.125***	-0.124***	-0.124***
	(-5391)	(-5577)	(-5767)	(-5494)	(-5701)
GROWTH	0.004***	0.005***	0.005***	0.005***	0.004***
	(4.351)	(4.608)	(4.534)	(4.523)	(4.484)
LOSS	-0.021***	-0.021***	-0.020***	-0.020***	-0.020***
	(-20.037)	(-20.013)	(-19.499)	(-19.171)	(-19.669)
MKTBK	0.005***	0.005***	0.005***	0.005***	0.005***
	(42.749)	(42.545)	(43.632)	(44.100)	(43.404)
QUICK	0.019***	0.019***	0.019***	0.019***	0.019***
	(110.409)	(110.597)	(110.657)	(110.423)	(110.478)
LIT	-0.026***	-0.025***	-0.029***	-0.029***	-0.028***
	(-1834)	(-1174)	(-12.915)	(-13.174)	(-12.641)
AGE	-0.003***	-0.003***	-0.005***	-0.005***	-0.005***
	(-6.215)	(-6.111)	(-8.213)	(-8.616)	(-9.088)
RETEQ	-0.003***	-0.003***	-0.002***	-0.002***	-0.003***
	(-1688)	(-12.700)	(-1069)	(-10.769)	(-1898)
GDP	0.018***	0.018***	0.012***	0.012***	0.009***
	(32.505)	(34.382)	(20.340)	(19.079)	(15.801)
INF	-0.003***	-0.003***	-0.002***	-0.003***	-0.003***
	(-16.968)	(-17.095)	(-15.703)	(-18.971)	(-17.114)
2.LIFECYCLE	0.006***	0.006***	0.006***	0.006***	0.006***
	(4.316)	(3.991)	(4.229)	(4.332)	(4.199)
3.LIFECYCLE	-0.002	-0.002	-0.002	-0.002	-0.002*
	(-244)	(-628)	(-643)	(-587)	(-764)
4.LIFECYCLE	-0.009***	-0.010***	-0.009***	-0.009***	-0.009***
	(-5.025)	(-5.476)	(-4.964)	(-4.714)	(-4.963)
5.LIFECYCLE	0.021***	0.021***	0.022***	0.022***	0.022***
	(14.133)	(13.602)	(14.194)	(14.330)	(14.253)
Adj.R2	0.31	0.31	0.32	0.32	0.32
N	104687	104687	104687	104687	104687
F-stat	1333.765	1325.366	1346.777	1350.694	1354.683

Notes: Industry and year effects are included. *t* statistics in parentheses, * p<0.10, ** p<0.05, *** p<0.01

Table 4 ***(continued)***

Panel B: Regression estimates replacing dependent variable CCH with CCH2

	(1)	(2)	(3)	(4)	(5)	(6)
MV	VAE	PVE	GEE	RQE	RLE	CCE
Intercept	0.187***	0.163***	0.285***	0.324***	0.318***	0.284***
	(10.166)	(9.229)	(15.121)	(16.687)	(16.762)	(15.260)
CRT	-0.056***	0.024	-0.126***	-0.138***	-0.081***	-0.131***
	(-3.281)	(1.395)	(-6.952)	(-7.691)	(-4.648)	(-7.205)
D_{VAE}	0.004					
	(1.313)					
$CRT*D_{VAE}$	0.501***					
	(24.370)					
D_{PVE}		0.003				
		(1.092)				
$CRT*D_{PVE}$		0.364***				
		(17.772)				
D_{GEE}			0.032***			
			(10.327)			
$CRT*D_{GEE}$			0.574***			
			(27.076)			
D_{RQE}				0.034***		
				(11.068)		
$CRT*D_{RQE}$				0.596***		
				(28.266)		
D_{RLE}					0.041***	
					(13.401)	
$CRT*D_{RLE}$					0.526***	
					(25.354)	
D_{CCE}						0.033***
						(10.707)
$CRT*D_{CCE}$						0.579***
						(27.260)
FSIZE	-0.011***	-0.011***	-0.011***	-0.011***	-0.010***	-0.011***
	(-22.722)	(-22.144)	(-20.958)	(-21.371)	(-20.762)	(-21.304)
LEV	-0.175***	-0.176***	-0.176***	-0.174***	-0.175***	-0.174***
	(-31.586)	(-31.826)	(-31.925)	(-31.589)	(-31.743)	(-31.595)
GROWTH	0.005**	0.006**	0.005**	0.005**	0.005**	0.005**
	(2.083)	(2.414)	(2.290)	(2.294)	(2.219)	(2.264)
LOSS	-0.033***	-0.033***	-0.031***	-0.030***	-0.032***	-0.031***
	(-13.752)	(-13.668)	(-13.122)	(-12.744)	(-13.374)	(-12.890)
MKTBK	0.011***	0.011***	0.011***	0.011***	0.011***	0.011***
	(38.514)	(38.553)	(39.615)	(40.144)	(39.204)	(39.721)
QUICK	0.048***	0.048***	0.048***	0.048***	0.048***	0.048***
	(122.639)	(122.897)	(122.972)	(122.708)	(122.732)	(123.016)
LIT	-0.055***	-0.049***	-0.060***	-0.061***	-0.057***	-0.061***
	(-10.758)	(-9.589)	(-11.796)	(-12.094)	(-11.222)	(-11.971)
AGE	-0.011***	-0.011***	-0.013***	-0.014***	-0.014***	-0.012***
	(-8.759)	(-8.471)	(-10.376)	(-10.874)	(-10.703)	(-9.717)
RETEQ	-0.007***	-0.007***	-0.006***	-0.006***	-0.007***	-0.006***
	(-13.390)	(-14.662)	(-12.512)	(-12.199)	(-13.428)	(-12.331)
GDP	0.027***	0.029***	0.015***	0.013***	0.012***	0.015***
	(21.256)	(23.151)	(10.848)	(9.508)	(8.674)	(11.160)
INF	-0.004***	-0.004***	-0.003***	-0.005***	-0.004***	-0.004***
	(-10.927)	(-11.031)	(-9.715)	(-13.579)	(-11.403)	(-10.516)
2.LIFECYCLE	0.002	0.001	0.002	0.003	0.002	0.001
	(0.761)	(0.368)	(0.737)	(0.844)	(0.713)	(0.455)
3.LIFECYCLE	-0.006**	-0.008***	-0.007**	-0.007**	-0.007**	-0.009***
	(-2.137)	(-2.617)	(-2.432)	(-2.383)	(-2.464)	(-2.946)
4.LIFECYCLE	-0.023***	-0.026***	-0.023***	-0.022***	-0.023***	-0.023***
	(-5.578)	(-6.157)	(-5.475)	(-5.199)	(-5.504)	(-5.460)
5.LIFECYCLE	0.032***	0.030***	0.032***	0.033***	0.032***	0.031***
	(9.236)	(8.532)	(9.312)	(9.452)	(9.328)	(8.963)
Adj.R2	0.30	0.30	0.30	0.30	0.30	0.30
N	104687	104687	104687	104687	104687	104687
F-stat	1233.587	1220.628	1249.959	1254.428	1251.451	1251.945

Notes: Industry and year effects are included. *t* statistics in parentheses, * p<0.10, ** p<0.05, *** p<0.01

Table 4 ***(continued)***

Panel C: Regression estimates replacing independent variable CRT with CRT2

	(1)	(2)	(3)	(4)	(5)	(6)
MV	VAE	PVE	GEE	RQE	RLE	CCE
Intercept	0.046***	0.041***	0.094***	0.109***	0.122***	0.088***
	(5.744)	(5.342)	(11.389)	(12.780)	(14.637)	(10.837)
CRT2	-0.059***	-0.016*	-0.083***	-0.086***	-0.069***	-0.090***
	(-6.951)	(-1.912)	(-9.419)	(-9.846)	(-8.073)	(-10.241)
D_{VAE}	-0.006***					
	(-4.520)					
CRT2*D_{VAE}	0.216***					
	(21.774)					
D_{PVE}		-0.005***				
		(-3.627)				
CRT2*D_{PVE}		0.147***				
		(14.975)				
D_{GEE}			0.008***			
			(5.940)			
CRT2*D_{GEE}			0.242***			
			(23.738)			
D_{RQE}				0.009***		
				(6.433)		
CRT2*D_{RQE}				0.249***		
				(24.724)		
D_{RLE}					0.016***	
					(11.671)	
CRT2*D_{RLE}					0.226***	
					(22.627)	
D_{CCE}						0.006***
						(4.534)
CRT2*D_{CCE}						0.253***
						(24.962)
FSIZE	-0.004***	-0.004***	-0.004***	-0.004***	-0.003***	-0.004***
	(-18.177)	(-17.937)	(-16.285)	(-16.675)	(-15.738)	(-16.744)
LEV	-0.124***	-0.124***	-0.124***	-0.124***	-0.124***	-0.124***
	(-51.313)	(-51.510)	(-51.698)	(-51.372)	(-51.658)	(-51.335)
GROWTH	0.004***	0.004***	0.004***	0.004***	0.004***	0.004***
	(4.123)	(4.453)	(4.388)	(4.393)	(4.334)	(4.310)
LOSS	-0.021***	-0.021***	-0.021***	-0.020***	-0.021***	-0.020***
	(-20.254)	(-20.229)	(-19.823)	(-19.499)	(-19.920)	(-19.701)
MKTBK	0.005***	0.005***	0.005***	0.005***	0.005***	0.005***
	(42.759)	(42.427)	(43.712)	(44.140)	(43.464)	(43.849)
QUICK	0.019***	0.019***	0.019***	0.019***	0.019***	0.019***
	(109.826)	(109.964)	(110.080)	(109.796)	(109.812)	(110.063)
LIT	-0.027***	-0.025***	-0.029***	-0.030***	-0.029***	-0.030***
	(-12.157)	(-11.395)	(-13.273)	(-13.536)	(-12.974)	(-13.357)
AGE	-0.003***	-0.003***	-0.004***	-0.004***	-0.004***	-0.003***
	(-5.159)	(-5.362)	(-7.090)	(-7.530)	(-8.004)	(-6.234)
RETEQ	-0.003***	-0.003***	-0.002***	-0.002***	-0.003***	-0.002***
	(-11.486)	(-12.736)	(-10.585)	(-10.111)	(-11.603)	(-10.212)
GDP	0.018***	0.018***	0.012***	0.012***	0.009***	0.013***
	(32.477)	(34.086)	(20.265)	(19.048)	(15.797)	(21.837)
INF	-0.003***	-0.003***	-0.002***	-0.003***	-0.003***	-0.002***
	(-17.034)	(-17.164)	(-15.753)	(-19.033)	(-17.222)	(-16.554)
2.LIFECYCLE	0.006***	0.006***	0.006***	0.006***	0.006***	0.006***
	(4.511)	(4.174)	(4.486)	(4.517)	(4.413)	(4.325)
3.LIFECYCLE	-0.001	-0.002	-0.002	-0.002	-0.002	-0.002
	(-0.835)	(-1.305)	(-1.170)	(-1.190)	(-1.346)	(-1.469)
4.LIFECYCLE	-0.008***	-0.009***	-0.008***	-0.008***	-0.008***	-0.008***
	(-4.635)	(-5.136)	(-4.531)	(-4.353)	(-4.543)	(-4.443)
5.LIFECYCLE	0.022***	0.021***	0.022***	0.022***	0.022***	0.022***
	(14.505)	(13.918)	(14.618)	(14.676)	(14.672)	(14.379)
Adj.R2	0.31	0.31	0.32	0.32	0.32	0.32
N	104687	104687	104687	104687	104687	104687
F-stat	1333.846	1322.915	1347.188	1350.568	1354.887	1349.026

Notes: Industry and year effects are included. *t* statistics in parentheses, * p<0.10, ** p<0.05, *** p<0.01

Table 5: Robustness analysis

	(1) ExclCOVID	(2) More100	(3) NonUSA	(4) REGWLS
Intercept	0.119***	0.095***	0.047***	0.112***
	(14.087)	(11.652)	(5.534)	(14.486)
CRT	-0.072***	-0.071***	-0.056***	-0.061***
	(-8.516)	(-8.932)	(-7.070)	(-7.613)
D_{CCE}	0.013***	0.010***	0.019***	0.010***
	(9.290)	(7.603)	(14.367)	(7.687)
CRT*D_{CCE}	0.215***	0.217***	0.187***	0.200***
	(21.780)	(23.454)	(19.168)	(21.368)
FSIZE	-0.003***	-0.004***	-0.002***	-0.005***
	(-14.970)	(-17.140)	(-8.707)	(-22.688)
LEV	-0.123***	-0.124***	-0.109***	-0.134***
	(-48.403)	(-51.349)	(-42.166)	(-55.165)
GROWTH	0.004***	0.004***	0.005***	0.006***
	(3.538)	(4.495)	(4.348)	(5.636)
LOSS	-0.020***	-0.020***	-0.022***	-0.020***
	(-18.400)	(-19.373)	(-19.588)	(-19.217)
MKTBK	0.006***	0.005***	0.007***	0.006***
	(42.012)	(43.680)	(47.963)	(46.590)
QUICK	0.019***	0.019***	0.019***	0.019***
	(105.404)	(110.577)	(106.074)	(112.015)
LIT	-0.028***	-0.029***	-0.030***	-0.009***
	(-11.968)	(-12.959)	(-4.794)	(-4.010)
AGE	-0.005***	-0.004***	-0.006***	-0.007***
	(-8.864)	(-7.387)	(-9.779)	(-11.961)
RETEQ	-0.003***	-0.002***	-0.000	-0.002***
	(-10.712)	(-10.916)	(-0.668)	(-9.304)
GDP	0.010***	0.013***	0.015***	0.016***
	(17.373)	(21.787)	(26.198)	(26.856)
INF	-0.003***	-0.002***	-0.002***	-0.002***
	(-16.056)	(-16.388)	(-12.402)	(-14.210)
2.LIFECYCLE	0.005***	0.006***	0.007***	0.006***
	(3.316)	(4.013)	(5.093)	(4.245)
3.LIFECYCLE	-0.002	-0.003**	0.001	-0.004***
	(-1.530)	(-2.030)	(0.609)	(-3.174)
4.LIFECYCLE	-0.009***	-0.009***	-0.008***	-0.010***
	(-4.798)	(-4.946)	(-4.288)	(-5.442)
5.LIFECYCLE	0.022***	0.021***	0.023***	0.020***
	(14.063)	(13.901)	(14.431)	(13.334)
Adj.R2	0.32	0.32	0.32	0.30
N	92984	104520	91664	104687
F-stat	1231.811	1344.429	1192.330	2487.428

Notes: Industry and year effects are included. *t* statistics in parentheses, * p<0.10, ** p<0.05, *** p<0.01

5. Conclusion

We attempt to investigate the corporate cash holdings decisions in the implication of ambiguity and uncertainty due to corporate risk-taking strategies. This paper employs data from 104,687 firm-year observations from 58 countries from 2011-2020 to examine the associations involving CRT, investor protection, and CCH. The hypothesis is set based on the mixed findings of the prior studies on the way CCH is determined by CRT and investor protection. The precautionary motives explain managerial incentives causing high CRT firms to hold high cash reserves, but the agency costs concern suggest that firms with high CRT would hold low cash reserves due to potential entrenchment of holding the liquid assets. We incorporate both sources of managerial incentive at the firm-level i.e. CRT and country-level i.e. governance through investor protection (that is measured by control of corruption) in examining whether, and how, CRT and investor protection determine CCH.

Our findings add to the empirical evidence on the link between corporate risk and CCH, as we show that high CRT is associated with low CCH. Higher risk-taking firms would tend to hold lesser cash reserve, as the agency costs associated with the holding of high cash reserve becomes a concern in firms with the tendency towards greater risk taking. Our findings contradict the notion that high CRT firms would employ precautionary motive strategies to be prepared for potential investments and safeguard against firms' future funding requirements. We further find that the strength of investor protection gives rise to the greater holding of cash, in line with Iskandar-Datta and Jia (2014) and Tran (2020). The most notable finding reported in this paper is the moderating effect of investor protection on the association between CRT and CCH. We provide evidence that the governance that is sourced from a country-level institutional environment serves to minimize the agency costs of holding high cash among high-risk-taking firms.

As with any empirical study, our findings are subject to several caveats. Most notably, the managerial risk incentives literature is still emerging, and researchers have not yet reached a consensus on the commonly accepted conceptual and/or operational definitions of risk-taking strategies. Although we focus on a notion of corporate risk-taking that relates to the dispersion of potential outcomes on cash holdings from managerial risk incentives, we note that this is a more holistic view of corporate risk-taking. As such, our conceptualization and operationalization of corporate risk-taking are homogeneous as we treat all types of risky behaviours equivalently. This may not capture other dimensions of multifaceted constructs of risks which might be influential to lead managerial incentives at the varying degree of efforts and risks, and that may appreciate or depreciate the firm values in the long run. Going forward, we encourage more research on CRT and CCH such as those that consider the concept of 'reasoned risk-taking' that focuses on the behavioural theories (Carpenter *et al.*, 2003) to explain managerial incentives related to CRT. It would also be beneficial to explore more on the life-cycle effect (Faff *et al.*, 2016) in understanding the link between CRT and CCH in various institutional contexts. Further, it is recommended for future research to focus on the regional economic level, such as ASEAN and MENA, to capture more of the institutional contexts that influences managerial incentives related to CRT including by incorporating other institutional variables, such as culture (Li *et al.*, 2013; Chen *et al.*, 2015), trust (Dudley and Zhang, 2016) and politics (Feng and Johansson, 2014).

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Impacts of COVID-19 and Related Government Policies on the Returns of the US Dollar Against the Malaysian Ringgit

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Abstract: Research Questions: What are the implications of COVID-19 and the related government policies on the returns of the United States dollar (USD) against the Malaysian Ringgit? **Motivation:** The implications of a global-scale pandemic on the exchange rate are not frequently examined, especially on the role of government policies. The exchange rate movement will affect Malaysia's economic performance as an open economy. Moreover, the suitability of government responses to the COVID-19 pandemic in exchange rate management should be investigated for future policymaking. **Ideas:** This paper estimates the exchange rate relationship with a few economic variables, including COVID-19 confirmed and death cases, by accounting for the high volatility in the exchange rate movement. **Data:** Daily data from March 3, 2020, to October 29, 2021, are analysed. The data are the confirmed and death cases of COVID-19, the COVID-19 response tracker (stringency index, containment and health index, economic support index, and government responses index), the return of the United States dollar against the Malaysian Ringgit, the weighted average of the 3-month interbank rate, FTSE Bursa Malaysia KLCI, West Texas Intermediate oil price and the United States 3-month treasury bill interest rate. The data is available from Bank Negara Malaysia, Our World in Data Databases, Blavatnik School of Government (University of Oxford), Yahoo Finance and Federal Reserve Bank of St. Louis. **Method: The** generalised autoregressive conditional heteroskedasticity estimation is deployed. **Findings:** An increase in the confirmed cases depreciates the value of the Malaysian Ringgit. Besides, the economic support initiatives bring the opposite effect. Other government policies lack robust evidence to show a significant impact on the exchange rate. Although COVID-19 and economic initiatives have an economically insignificant effect, comparing the coefficients show that the economic support initiatives could revert the implications of COVID-19 on the exchange rate. Furthermore, the stock market appreciates the examined exchange rate. **Contributions:** This paper provides empirical evidence of the impact of COVID-19 and the effectiveness of related responses in the Malaysian context. Besides, a few policy suggestions are given.

Keywords: COVID-19, exchange rate, GARCH, Malaysian Ringgit, government policy
JEL Classification: F31, H51, I18

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1. Introduction

One of the largest economic challenges in recent decades, the COVID-19 pandemic, has been linked to supply chain disruptions (Shahed *et al.*, 2021), a rising unemployment rate (Petrosky-Nadeau and Valletta, 2020; Su *et al.*, 2021), and influencing the equity market (Brueckner and Vespignani, 2021; Yiu and Tsang, 2021). These impacts, in turn, severely affect global economic growth (Vidya and Prabheesh, 2020) as consumption, investment, and global trade are lowered (Sawada and Sumulong, 2021).

In response to the pandemic, most governments imposed a series of movement and economic restrictions, nationwide or in specific states, to curb the spread of the disease for a specific duration. The Malaysian government is no exception. Nonetheless, economic activities were inevitably deterred by these policies. Therefore, the Malaysian government has launched fiscal stimulus packages to sustain the economy and jobs. According to the International Monetary Fund (n.d), the first fiscal stimulus package was launched at the end of February 2020, followed by several stimulus packages, including direct fiscal injections and indirect fiscal measures such as the withdrawal of pension funds. Besides, the Central Bank of Malaysia also provides grants for small-medium enterprises and targeted loan relief measures to the affected groups or individuals (Bank Negara Malaysia, n.d). Generally, all measures are expected to bring positive implications to the economy.

Though recent studies proposed the potential impact of the pandemic on the exchange rate, studies on whether government policies play any role in the relationship are limited. This paper aims to contribute to the existing literature by clarifying how the Malaysian government's responses affect the exchange rate market. This paper focuses on the time between March 3, 2020, to October 29, 2021, to achieve this objective. During that period, most of the population received two doses of vaccination, and the linkage between the pandemic and the exchange rate is expected to weaken following it. The Malaysian Ringgit (MYR) against the United States dollar (USD) is selected to represent the exchange rate market performance as it is the main international currency and is frequently used for international transactions.

Figure 1 illustrates the monthly average movement of USD against MYR during that period. The MYR appreciated from RM4.35 to USD1 to roughly RM4.05 to USD1 from March 2020 to January 2021. The possible factor behind the appreciation is the government's swift response, such as the fiscal injections. During this period, the average daily confirmed cases were below 700, and the average number of death cases was merely a single digit. Nonetheless, the average daily confirmed and death cases then rose to four and three digits, coinciding with the MYR depreciation. Due to fiscal constraints, the ability of the Malaysian government to launch economic stimulus packages at the previous magnitude has also been limited (Lim, 2020).

To better understand if the relationship between the pandemic and exchange rate performance is affected by government policies, this paper includes the government policies responding to the COVID-19 pandemic in the model by utilising the data from the COVID-19 government response tracker compiled by the University of Oxford. To date, this is the first paper that examines the influence of the COVID-19 pandemic on the value of the United States dollar against the Malaysian Ringgit (USD/MYR). It contributes to future policymaking as the output provides information on how a large-scale pandemic could affect the USD to MYR exchange rate. More importantly, knowledge about the effectiveness of the applied policies is essential for the government to react faster in responding to a similar challenge in the future. This paper is organised as below. Section 2 contains a review of the previous studies. Section 3 presents the methodology and data deployed to discover the impact of the pandemic on the USD to MYR exchange rate. The results are available in Section 4. Finally, Section 5 concludes the paper.

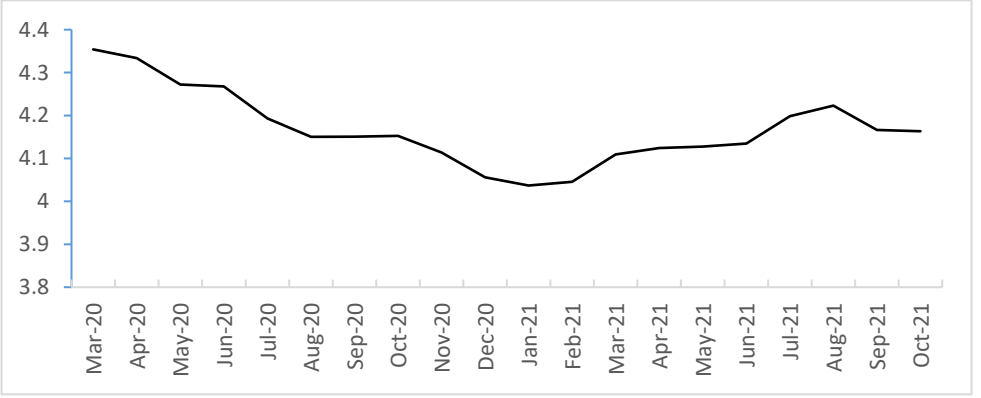

Figure 1: The average daily USD against MYR from March 3, 2021, to October 29, 2021

2. Literature Review

Previous studies examine the impact of COVID-19 on the exchange rate using the time series analysis except for Feng *et al.* (2021), who utilise the panel data. The previous paper is categorised into two parts. The first part focuses on the pandemic's repercussions on the exchange rate. The second part discusses the impact of the pandemic on other economic variables; the exchange rate is treated as a control variable.

According to Narayan (2020a), the time-varying Narayan and Popp unit root test suggests that the stationarity of the Japanese yen against the US dollar has changed following the COVID-19 outbreak. Particularly, the stationarity has changed from non-stationary to stationary. In other words, the COVID-19 pandemic is unlikely to have a persistent effect on the Yen-USD movement. Narayan (2020b) concludes that during the COVID-19 pandemic, the Japanese yen, Canadian dollar, and the Great British pound showed an explosive pattern because the null hypothesis of a unit root was rejected. Iyke (2020) covers several currencies from developed and developing countries to determine the ability of the COVID-19 pandemic to predict their exchange rate volatility and return against the USD in GARCH models. The results show that the forecasting ability of COVID-19 is stronger in the 5-day ahead forecast than in the 1-day ahead forecast. Besides, Narayan (2021) reports that the explanatory power of the exchange rate shocks on its movement has increased after the pandemic.

Furthermore, the interest rate differential has Granger caused the exchange rate in Brazil, Russia, India, Indonesia, China and South Africa during the COVID-19 pandemic, showing an indirect influence of the pandemic on the interest rate-exchange rate nexus (Garg and Prabheesh, 2021). Devpura (2021) discovered a statistically significant effect of the COVID-19 pandemic on the value of the Euro to USD only for short periods. Hoshikawa and Yoshimi (2021) observe the Korean stock market and exchange rate reactions to the COVID-19 pandemic. Besides, the impact of exchange rate interventions by the Korean authorities is also studied. Among the notable findings related to the exchange rate is that new COVID-19 cases led to currency appreciation seven days after the cases were registered. It could be due to repurchasing activity by the investors. Death cases have the opposite effect. Nonetheless, these effects are small and will be enlarged via their impact on the foreign holding of the Korean won. Finally, the interventions in the exchange rate have a marginal effect on the exchange rate.

Konstantakis *et al.* (2021) examine how the exchange rate between the Euro and the US dollar behaves before and after the COVID-19 pandemic. COVID-19 affects the exchange rate movement and increases its volatility. Benzid and Chebbi (2020) also find that the USD

volatility against the Sterling, Yuan and Euro increased after COVID-19 was confirmed and death cases rose. Finally, Feng *et al.* (2021), through the system GMM method on the panel data of 20 countries, shows that the COVID-19 confirmed cases and government economic support reduce the exchange rate volatility.

As for the second stream, Brueckener and Vespignani (2021) investigate COVID-19's impact on the stock market in Australia, with the exchange rate as one of the control variables. From their vector autoregressive model estimation, the COVID-19 new cases led to currency appreciation of the Australian dollar. The appreciation effect has also been found in the EUR/USD by Aloui (2021), who studied the quantitative easing transmission channel during the pandemic. The author further explains that currency appreciation weakens the effect of quantitative easing. Lastly, Rai and Garg (2021) estimate the relationship between the stock market and exchange rate in Brazil, Russia, India, Indonesia, China, and South Africa (BRIICS) countries. They summarise that the negative dynamics correlation between the stock market and the exchange rate market during the COVID-19 pandemic has shown that the capital outflow after the pandemic outbreak caused a decline in the stock market but a better exchange rate. This paper fills the knowledge gap by examining the impact of COVID-19 on the Malaysian Ringgit, an emerging country exposed to global trade. Besides, the effect of government responses to COVID-19 is also evaluated. Both areas have not been covered in the literature.

3. Conceptual Framework, Methods and Data

This section begins with the presentation of the conceptual framework. Theoretically, the impact of the pandemic will influence fluctuations in exchange rates for several reasons. Firstly, the pandemic is an unexpected event, and it is expected to exert a dominant explanatory power of exchange rate shocks over other factors based on the random walk hypothesis. The argument is even relevant if the pandemic persists for an extended period which causes the exchange rate to reflect the shocks of pandemics (Narayan, 2021). Iyke (2020) also suggests that a pandemic could be unexpected and informative in explaining exchange rate returns. It is because in the efficient market hypothesis, an asset return, which could include the exchange rate, reflect all information. However, the effect of COVID-19 on the exchange rate market, according to the efficient market hypothesis, could be temporary (Narayan, 2020a). Otherwise, a pandemic could facilitate the formation of a bubble in the currency market if the exchange rate market is inefficient (Narayan, 2020b).

Moreover, a pandemic creates capital outflows and negative market sentiment, exposing the currency to depreciation and greater exchange rate volatility (Iyke, 2020; Padhan and Prabheesh, 2021; Feng *et al.*, 2021). The depreciation effect caused by the pandemic coincidences with the smaller interest differential between domestic and global markets. The smaller differential weakens the demand for domestic currency following the monetary easing policy implemented globally (Garg and Prabhessh, 2021). Lastly, Feng *et al.* (2021) report that government interventions to curb the spread of COVID-19 could have ambiguous effects on asset markets. For instance, social distancing could negatively affect stock market volatility, while some intervention policies could improve stock market liquidity. In the context of this paper, the same effect could occur in the exchange rate market. In summary, the exchange rate could influence the exchange rate return according to the random walk and efficient market hypotheses. Moreover, the negative market sentiment also affects the currency markets through international capital movement. Besides, government intervention to curb the pandemic could have mixed impacts, depending on the intervention's effect on the economy.

Instead of examining the exchange rate behaviour in a random walk framework, this paper adopts the conceptual framework that the COVID-19 pandemic could affect the economic

fundamentals (Padhan and Prabheesh, 2021, Feng *et al.*, 2021; Garg and Prabhessh, 2021). Subsequently, it will influence the demand and supply of the Malaysian Ringgit. This paper applies the GARCH (1,1) models proposed by Bollerslev (1986) to investigate the relationship between the variables. The GARCH (1,1) model is applied because of the high volatility in the exchange rate movement. Moreover, the GARCH (1,1) model could capture the exchange rate volatility process and is a common method in the related literature (Cartwright and Raibko, 2015). As an implication of the conceptual framework, the mean equation of the GARCH model consists of a few selected determinants of the exchange rate. In particular, the mean equation and the variance equation for this GARCH (1,1) model can be illustrated by Equations (1) and (2), respectively.

$$ERR_t = \beta_0 + \beta_1 X + \varepsilon_t \quad (1)$$

$$\sigma_t^2 = \gamma_0 + \gamma_1 \mu_{t-1}^2 + \alpha_1 \sigma_{t-1}^2 \quad (2)$$

where ERR is the exchange rate growth rate, and X are all independent variables examined in this paper. These variables are the change of daily new confirmed cases of COVID-19 ($CONF$), the change of daily new death cases caused by COVID-19 ($DEATH$), government policies to handle the COVID-19, Malaysia interest rate ($MYIR\_3M$), international oil price ($LNOIL$), stock market index of Malaysia ($LNSTOCK$), and US interest rate ($USIR$). β_0, β_1, γ_0, γ_1 and α_1 are the parameters. Finally, ε_t is the zero-mean error term with the conditional variance shown by Equation (2). The error distribution is assumed to be normal.

In the GARCH model, conditional variance is an ARMA process which differs from the ARCH model, which assumes the conditional variance is an AR model. This paper tests the existence of the ARCH effect before conducting the GARCH model since the ARCH effect justifies the decision to estimate the model using the GARCH estimation. The ARCH test is conducted on the residual generated by regressing the exchange rate growth rate on its first autoregressive term. The null hypothesis of the ARCH test is that there is no ARCH effect. Furthermore, there are a few restrictions on the parameters in the variance equation to ensure strict positivity of conditional variances and stationarity. These restrictions are $\gamma_0>0$ $\gamma_1>0$, $\alpha_1>0$ and $\gamma_1 + \alpha_1 < 1$. Finally, the absence of the ARCH effect and serial correlation in the GARCH models is tested to examine the performance of the GARCH model. The correlogram of standardised residual squared is referred to determine serial correlation. EViews Statistical Software is deployed for this estimation.

All data is estimated in raw form except for the stock market index and oil price, in which both variables are transformed into the natural logarithm form. Since the oil price data recorded a negative value on April 20, 2020, a constant value is added to all oil price observations so that the negative value becomes one. After that, the created variable is transformed into a natural logarithm. It is worth highlighting that since the daily data is collected for estimation, the output and inflation effects are not considered in this paper. Nonetheless, the stock market variable in the GARCH estimation could capture the effect of economic growth and price level at a high frequency.

The data begins from March 3, 2020, to October 29, 2021. Table 1 presents the data sources for the variable applied in this paper. This paper measures the exchange rate's return by calculating the exchange rate's growth rate. The direct quote for the Malaysian Ringgit is used to obtain the exchange rate return. An increase (decline) in the exchange rate indicates that the MYR depreciates (appreciates) against the USD. The influence of COVID-19 is represented by its confirmed cases and death cases. Iyke (2020) and Feng *et al.* (2021) also applied both variables to measure the effect of the COVID-19 pandemic.

Table 1: Data source

Data	Sources
The value of the United States Dollar against the Malaysian Ringgit	Bank Negara Malaysia
Daily COVID-19 new confirmed cases	Our World in Data Databases
Daily COVID-19 new death cases	Our World in Data Databases
Stringency index	Blavatnik School of Government, University of Oxford
Containment and health index	Blavatnik School of Government, University of Oxford
Economic support index	Blavatnik School of Government, University of Oxford
Government responses index	Blavatnik School of Government, University of Oxford
The weighted average of the 3-month interbank rate	Bank Negara Malaysia
FTSE Bursa Malaysia KLCI	Yahoo Finance
West Texas Intermediate oil price	Federal Reserve Bank of St. Louis
US 3-month treasury bill interest rate	Federal Reserve Bank of St. Louis

Four government COVID-19 intervention policy indicators published by the Blavatnik School of Government, University of Oxford, are deployed to observe how these interventions or policies affect the exchange rate. These policies are expected to play a role in affecting the recovery and resilience of the economic sector. According to Hale *et al.* (2021), COVID-19-related policies are showcased via the stringency index (*STRINGENCY*), the containment and health index (*CONTAIN*), the economic support index (*ECONOMIC*) and the government response index (*RESPONSE*). Each of these indices reflects different policy aspects of government responses, and some aspects are included in more than one index. These policy aspects are containment and closure policies (8 policy indicators), economic policies (2 policy indicators) and health system policies (5 policy indicators). The stringency index indicates the degree of lockdown policies. It covers all eight containment and closure policies (involving restrictions on schools, workplaces, public places, gathering activities, transportation, home confinement, internal movement and international movement) and health system policies (i.e., public information campaign). Otherwise, the containment and health index observes the lockdown restrictions. It expands the coverage of the stringency index to another five indicators of health system policies which are testing policy, contact tracing, facial coverings policy, vaccination policy, and elderly people protection policies.

Otherwise, the economic support index measures the economic support to alleviate the impact of the pandemic in terms of income and debt relief. In contrast, the government response index measures the level of government responses to the pandemic, including all indicators included in the stringency index, containment and health index and economic support index. All indexes are ordinal. These four types of government policies are tested individually in this study.

This paper also includes a few control variables to account for other factors that could affect the exchange rate returns. These variables are also applied in previous papers and supported by economic theories. First, the weighted average of the Malaysian 3-month interbank rate is collected to gauge the implication of domestic interest rate changes on the exchange rate. Theoretically, a change in the domestic interest rate could affect the relative returns between domestic and foreign assets. Hence, the demand for domestic and the value of the domestic currency will change. At the same time, the impact could be the opposite if a rising interest rate increases the business operating costs, causing the expectation that economic activities will slow down in the future. It is worth mentioning that the previously

available data will be used to replace the missing daily data. Yiu and Tsang (2021) and Feng *et al.* (2021) also include an interest rate variable with a similar objective for their study.

The oil-exporting revenue has played a significant role in the fiscal performance of the Malaysian government. Hence, the oil price movement is proxied by the West Texas Intermediate oil price. Nonetheless, the increasing import following a rise in oil revenue could bring the opposite effect. Brueckner and Vespignani (2021) and Konstantatiks *et al.* (2021) also examine the same factor. Otherwise, the FTSE Bursa Malaysia KLCI measures the stock market performance in Malaysia. An active stock market will affect the demand and supply of the MYR, causing the return of MYR to change eventually. Lastly, the US 3-month treasury bill rate shows the US monetary policy, which could affect the value of USD/MYR externally. Typically, a rise in the US interest rate will cause the MYR to depreciate. Fang and Zhang (2021) also examined the influence of foreign interest rates when investigating the Chinese Renminbi during the COVID-19 pandemic.

This paper adopts three strategies to test the sensitivity of the results. First, instead of using the 3-month interest rate, the 1-month interest rate is deployed. Second, the normal error distribution in the GARCH estimation is replaced by the t-statistics error distribution. Third, ARDL and EGARCH models are estimated as alternative methods. Lastly, forecastability is used to determine the forecast performance of the estimated GARCH model. For this exercise, a shorter sample, covering data from March 3, 2020, to June 30, 2021, is estimated. After that, the root mean square error (RMSE) and mean absolute error (MAE) of the forecast from July 1, 2021, to October 29, 2021, is observed.

4. Result Discussions

When the ARCH effect is conducted on the return of USD/MYR, the ARCH is confirmed when the p-value of the chi-square is 0.000. These results justify that utilising a GARCH model is appropriate in this paper. The breakpoint unit root test is also conducted to determine the stationarity properties of the data, involving the innovative and addictive break types. The examined unit root equation is assumed to contain intercept only or intercept and trend components; the breakpoint for the former and latter is assumed to be found in the intercept and trend, respectively. The results are not presented here to save space and are available upon request. All variables are stationary at level, except for the new COVID-19 confirmed cases when the unit root equation is set to have intercept and trend components, and the break is addictive. In this case, the variables are treated as stationary at the level. Therefore, all variables are examined in their level form.

Next, Table 2 to Table 5 shows the impact of COVID-19 on the exchange rate in different categories of COVID-19 measures. The estimated GARCH model shows no ARCH effect and serial correlation at a 5% significance level. The correlogram diagrams are not reported here to conserve space and are available upon request. Hence, the performance of these models is considered satisfactory. Further, RMSE and MAE are roughly 0.23 and 0.17, respectively. To recap, RMSE and MAE measure the average distance between the predicted and actual exchange rate growth rates. Since the exchange rate growth rate ranges from 2.2 to –2.3 during the sample period, the forecasting ability of the GARCH model is considered reasonable. Furthermore, RMSE and MEA are similar in all models in Table 2 to Table 5, showing that the forecasting performance is not affected by different independent variables in a model.

Table 2: GARCH output (Stringency index)

Model 1 Mean equation	Coefficient	p-value	Model 2 Mean equation	Coefficient	p-value
CONF	1.86E-05	0.0701	CONF	1.89E-05	0.0624
DEATH	-4.21E-05	0.9328	DEATH	-4.23E-05	0.9319
STRINGENCY	0.0021	0.0703	STRINGENCY	0.0022	0.0602
MYIR_3M	0.1395	0.0006	MYIR_3M	0.1834	0.0003
Constant	-0.4232	0.0004	LNOIL	0.0631	0.1893
			Constant	-0.8034	0.0084
Variance equation	Coefficient	p-value	Variance equation	Coefficient	p-value
Constant	0.0097	0.0000	Constant	0.0099	0.0000
Residual term	0.3425	0.0000	Residual term	0.3532	0.0000
GARCH term	0.5809	0.0000	GARCH term	0.5698	0.0000
Diagnostic tests			Diagnostic tests		
ARCH effect test	0.0259 (0.8723)		ARCH effect test	0.0042 (0.9484)	
Correlogram	No correlation		Correlogram	No correlation	
RMSE	0.227		RMSE	0.227	
MAE	0.174		MAE	0.174	
Model 3 Mean equation	Coefficient	p-value	Model 4 Mean equation	Coefficient	p-value
CONF	1.84E-05	0.092	CONF	1.87E-05	0.0845
DEATH	-9.69E-05	0.8332	DEATH	-9.89E-05	0.8297
STRINGENCY	0.0022	0.077	STRINGENCY	1.65E-03	0.2310
MYIR_3M	0.1893	0.0001	MYIR_3M	2.33E-01	0.0000
LNOIL	0.0569	0.2286	LNOIL	4.39E-02	0.3509
LNSTOCK	-3.5543	0.0085	LNSTOCK	-3.5172	0.0102
Constant	-0.7812	0.0089	USIR	-0.3234	0.1665
			Constant	-7.53E-01	0.0122
Variance equation	Coefficient	p-value	Variance equation	Coefficient	p-value
Constant	0.0107	0.0000	Constant	1.08E-02	0.0000
Residual term	0.3336	0.0000	Residual term	0.3383	0.0000
GARCH term	0.5722	0.0000	GARCH term	0.5657	0.0000
Diagnostic tests			Diagnostic tests		
ARCH effect test	0.0243 (0.8761)		ARCH effect test	0.0135 (0.9076)	
Correlogram	No correlation		Correlogram	No correlation	
RMSE	0.231		RMSE	0.230	
MAE	0.178		MAE	0.177	

Notes: The value in the parentheses indicates the p-value of the ARCH effect test.

The findings offer a few conclusions. First, a rise in confirmed COVID-19 cases would lead to a depreciation of the MYR value against the USD at a 10% significance level. Otherwise, the death cases show a negative coefficient sign but are statistically insignificant. Hence, this study supports Garg and Prabheesh (2021) and Feng *et al.* (2021) that the unexpected pandemic outbreak could cause capital outflows and negative market sentiment in Malaysia. However, the impact could be economically insignificant, as shown by the relatively small coefficient size of both COVID-19 indicators. For example, the coefficient size of confirmed cases is 1.87E-05, as shown by Model 4 in Table 2. Iyke (2020) also found that the variable's coefficient is small.

Table 3: GARCH output (Containment and health index)

Model 1 Mean equation	Coefficient	p-value	Model 2 Mean equation	Coefficient	p-value
CONF	1.86E-05	0.0978	CONF	1.87E-05	0.0964
DEATH	-3.92E-05	0.9305	DEATH	-3.97E-05	0.9291
CONTAIN	0.0015	0.3966	CONTAIN	0.0015	0.3795
MYIR_3M	-0.0423	0.4572	MYIR_3M	0.0211	0.7611
Constant	-0.0306	0.8742	LNOIL	0.0289	0.7093
			Constant	-0.2084	0.6502
Variance equation	Coefficient	p-value	Variance equation	Coefficient	p-value
Constant	0.0035	0.0021	Constant	0.0003	0.002
Residual term	0.1288	0.0000	Residual term	0.1263	0.0000
GARCH term	0.8267	0.0000	GARCH term	0.8304	0.0000
Diagnostic tests			Diagnostic tests		
ARCH effect test	2.2371 (0.1347)		ARCH effect test	2.3217 (0.1276)	
Correlogram	No correlation		Correlogram	No correlation	
RMSE	0.226		RMSE	0.226	
MAE	0.174		MAE	0.174	
Model 3 Mean equation	Coefficient	p-value	Model 4 Mean equation	Coefficient	p-value
CONF	1.94E-05	0.0977	CONF	1.95E-05	0.0965
DEATH	-4.59E-05	0.9137	DEATH	-4.52E-05	0.9151
CONTAIN	0.0015	0.3927	CONTAIN	1.18E-03	0.5714
MYIR_3M	-0.0232	0.7155	MYIR_3M	-5.49E-03	0.9348
LNOIL	0.0207	0.7922	LNOIL	2.84E-03	0.9738
LNSTOCK	-4.0631	0.0057	LNSTOCK	-4.0359	0.0067
Constant	-0.1614	0.7238	USIR	-0.201	0.5445
			Constant	-8.30E-02	0.8718
Variance equation	Coefficient	p-value	Variance equation	Coefficient	p-value
Constant	0.0033	0.0022	Constant	3.28E-03	0.0221
Residual term	0.1197	0.0000	Residual term	0.1168	0.0000
GARCH term	0.8371	0.0000	GARCH term	0.8397	0.0000
Diagnostic tests			Diagnostic tests		
ARCH effect test	3.5179 (0.0607)		ARCH effect test	3.6709 (0.0554)	
Correlogram	No correlation		Correlogram	No correlation	
RMSE	0.230		RMSE	0.230	
MAE	0.177		MAE	0.177	

Notes: The value in the parentheses indicates the p-value of the ARCH effect test.

Furthermore, statistical evidence substantiates that Malaysian government policies influence the performance of the Malaysian Ringgit. In particular, a higher stringency index (economic support index) leads to the MYR depreciation (appreciation) in almost all estimated models. These summaries are anticipated because the ease of economic activities positively impacts economic performance. If the economic activities are restricted, the negative economic prospects will lower the demand for the Malaysian Ringgit. Moreover, the financial support provided by the Malaysian government managed to prevent the economy from further recession, improving the Malaysian Ringgit's performance.

Table 4: GARCH output (Economic support index)

Model 1 Mean equation	Coefficient	p-value	Model 2 Mean equation	Coefficient	p-value
CONF	2.07E-05	0.0458	CONF	1.97E-05	0.0742
DEATH	-1.85E-05	0.9717	DEATH	-2.05E-05	0.9649
ECONOMIC	-0.0054	0.0000	ECONOMIC	-0.0047	0.0000
MYIR_3M	0.0777	0.0683	MYIR_3M	-0.0969	0.0810
Constant	0.2392	0.0754	LNOIL	0.0033	0.9660
			Constant	0.5164	0.2409
Variance equation	Coefficient	p-value	Variance equation	Coefficient	p-value
Constant	0.0113	0.0000	Constant	0.0046	0.0013
Residual term	0.3308	0.0000	Residual term	0.1505	0.0000
GARCH term	0.5641	0.0000	GARCH term	0.7937	0.0000
Diagnostic tests			Diagnostic tests		
ARCH effect test	0.0305 (0.8613)		ARCH effect test	1.1560 (0.2823)	
Correlogram	No correlation		Correlogram	No correlation	
RMSE	0.224		RMSE	0.225	
MAE	0.173		MAE	0.173	
Model 3 Mean equation	Coefficient	p-value	Model 4 Mean equation	Coefficient	p-value
CONF	2.01E-05	0.0804	CONF	1.99E-05	0.0826
DEATH	-3.47E-05	0.9375	DEATH	-8.50E-05	0.8600
ECONOMIC	-0.0039	0.0003	ECONOMIC	-4.66E-03	0.0000
MYIR_3M	-0.0947	0.0707	MYIR_3M	1.91E-01	0.0015
LNOIL	-0.0073	0.9253	LNOIL	-5.42E-03	0.9165
LNSTOCK	-3.9883	0.0076	LNSTOCK	-3.7362	0.0018
Constant	0.4969	0.2562	USIR	-0.781	0.0001
			Constant	4.43E-02	0.8982
Variance equation	Coefficient	p-value	Variance equation	Coefficient	p-value
Constant	0.0048	0.0012	Constant	0.0132	0.0000
Residual term	0.1497	0.0000	Residual term	0.3191	0.0000
GARCH term	0.791	0.0000	GARCH term	0.5459	0.0000
Diagnostic tests			Diagnostic tests		
ARCH effect test	1.6941 (0.1931)		ARCH effect test	0.1614 (0.6879)	
Correlogram	No correlation		Correlogram	No correlation	
RMSE	0.231		RMSE	0.230	
MAE	0.178		MAE	0.178	

Notes: The value in the parentheses indicates the p-value of the ARCH effect test.

Additionally, the coefficient size of the stringency index and economic support index is smaller than other explanatory variables, except for COVID-19 indicators. For example, the stringency index and economic support index's coefficient size in Model 4 in Table 2 and Table 4 are 1.65E-03 and –4.66E-03, respectively. Two points can be summarised by interpreting these coefficient sizes. First, both policies have a more impactful effect on the exchange rate than the pandemic. Second, the appreciation effect of government economic support steps surpasses the depreciation effect caused by the rising confirmed COVID-19 cases. Otherwise, the containment and health steps and the level of government response to COVID-19 are statistically insignificant determinants of USD/MYR return.

Table 5: GARCH output (government response index)

Model 1 Mean equation	Coefficient	p-value	Model 2 Mean equation	Coefficient	p-value
CONF	1.89E-05	0.0931	CONF	1.89E-05	0.0919
DEATH	-3.66E-05	0.9351	DEATH	-3.72E-05	0.9337
RESPONSE	0.0014	0.4492	RESPONSE	0.0015	0.4279
MYIR_3M	-0.0482	0.3972	MYIR_3M	-0.0275	0.6918
Constant	-0.0139	0.9447	LNOIL	0.0284	0.7140
			Constant	-0.1894	0.6824
Variance equation	Coefficient	p-value	Variance equation	Coefficient	p-value
Constant	0.0035	0.0022	Constant	0.0034	0.0021
Residual term	0.1281	0.0000	Residual term	0.1254	0.0000
GARCH term	0.8274	0.0000	GARCH term	0.8312	0.0000
Diagnostic tests			Diagnostic tests		
ARCH effect test	2.2776 (0.1313)		ARCH effect test	2.3706 (0.1236)	
Correlogram	No correlation		Correlogram	No correlation	
RMSE	0.227		RMSE	0.227	
MAE	0.174		MAE	0.174	
Model 3 Mean equation	Coefficient	p-value	Model 4 Mean equation	Coefficient	p-value
CONF	1.96E-05	0.0932	CONF	1.97E-05	0.092
DEATH	-4.34E-05	0.9183	DEATH	-4.27E-05	0.9198
RESPONSE	0.0014	0.4383	RESPONSE	0.0011	0.6310
MYIR_3M	-0.028	0.6617	MYIR_3M	0.009	0.8935
LNOIL	0.0204	0.7945	LNOIL	0.0004	0.9961
LNSTOCK	-4.0617	0.0060	LNSTOCK	-4.031	0.0072
Constant	-0.1464	0.7500	USIR	-0.2217	0.5052
			Constant	-0.0554	0.9157
Variance equation	Coefficient	p-value	Variance equation	Coefficient	p-value
Constant	0.0033	0.0022	Constant	0.0033	0.0021
Residual term	0.1193	0.0000	Residual term	0.1159	0.0000
GARCH term	0.8374	0.0000	GARCH term	0.8404	0.0000
Diagnostic tests			Diagnostic tests		
ARCH effect test	3.5644 (0.0590)		ARCH effect test	3.7411 (0.0533)	
Correlogram	No correlation		Correlogram	No correlation	
RMSE	0.231		RMSE	0.231	
MAE	0.178		MAE	0.178	

Notes: The value in the parentheses indicates the p-value of the ARCH effect test.

The following discussion covers the control variables. First, the effect of the domestic 3-month interbank rate is ambiguous from Table 2 to Table 5. Although the variable is statistically significant in Table 2, the same conclusion is found in Table 4 only. Next, the oil price has a statistically insignificant depreciation effect on the value of the MYR. Third, a better stock market increases the demand for MYR since it could prompt future investments from foreign investors. The coefficient sign from Table 2 to Table 5 suggests that a one per cent increase in the stock index could cause the Malaysian Ringgit to appreciate by 0.03 to 0.04 per cent. Please note that the coefficient value is divided by 100 since a level-log model is estimated here. Lastly, a higher 3-month treasury bill interest rate in the US has a statistically insignificant appreciation effect on the MYR. Observing the variance equation shows that residual and GARCH terms are statistically significant. It suggests that the past news will affect the variance of the residual and the existence of heteroscedasticity, respectively. Besides, the conditional variance stationarity is achieved since both coefficients are more than zero and the total of both coefficients are less than one.

Table 6: GARCH output (Stringency index, Malaysian 1-month interbank rate)

Model 1 Mean equation	Coefficient	p-value	Model 2 Mean equation	Coefficient	p-value
CONF	1.89E-05	0.0701	CONF	1.91E-05	0.644
DEATH	-2.85E-05	0.9328	DEATH	-2.51E-05	0.9606
STRINGENCY	0.0017	0.0703	STRINGENCY	0.0017	0.1726
MYIR_1M	0.1921	0.0006	MYIR_1M	0.2427	0.0014
Constant	-0.4772	0.0004	LNOIL	0.0445	0.3912
			Constant	-0.7713	0.0285
Variance equation	Coefficient	p-value	Variance equation	Coefficient	p-value
Constant	0.0100	0.0000	Constant	0.0104	0.0000
Residual term	0.3289	0.0000	Residual term	0.3394	0.0000
GARCH term	0.5871	0.0000	GARCH term	0.5743	0.0000
Diagnostic tests			Diagnostic tests		
ARCH effect test	0.0212 (0.8841)		ARCH effect test	0.0078 (0.9299)	
Correlogram	No correlation		Correlogram	No correlation	
RMSE	0.225		RMSE	0.224	
MAE	0.173		MAE	0.172	
Model 3 Mean equation	Coefficient	p-value	Model 4 Mean equation	Coefficient	p-value
CONF	1.99E-05	0.0865	CONF	2.02E-05	0.0805
DEATH	-4.66E-05	0.9135	DEATH	-4.51E-05	0.9177
STRINGENCY	8.50E-04	0.5111	STRINGENCY	3.26E-04	0.8315
MYIR_1M	0.0789	0.3674	MYIR_1M	0.1492	0.0899
LNOIL	0.0539	0.4368	LNOIL	0.0213	0.7824
LNSTOCK	-4.0927	0.0540	LNSTOCK	-4.0803	0.0054
Constant	-0.4609	0.2845	USIR	-0.3601	0.1927
			Constant	-0.3822	0.4173
Variance equation	Coefficient	p-value	Variance equation	Coefficient	p-value
Constant	0.0037	0.0009	Constant	0.0042	0.0010
Residual term	0.1279	0.0000	Residual term	0.1373	0.0000
GARCH term	0.8266	0.0000	GARCH term	0.8115	0.0000
Diagnostic tests			Diagnostic tests		
ARCH effect test	2.9860 (0.0844)		ARCH effect test	2.3528 (0.1251)	
Correlogram	No correlation		Correlogram	No correlation	
RMSE	0.229		RMSE	0.229	
MAE	0.178		MAE	0.177	

Notes: The value in the parentheses indicates the p-value of the ARCH effect test.

The impact of COVID-19 and government policy is first examined by replacing the domestic interest rate with a 1-month interest rate; see Table 6 to Table 9 for the results. The model performance measured by the ARCH effect, autocorrelation and forecastability according to RMSE and MAE is similar to those in Table 2 to Table 5. Based on the findings, the impact of the confirmed and death cases is largely supported. As for the COVID-19-related measures, only the economic support index has a statistically significant and robust effect in all estimated models, and its appreciation effect on the MYR remains unchanged. Hence, this paper shows the positive impact of the policies that aim to offer economic support in sustaining MYR against USD. While the coefficient size of the economic support policy is larger compared to other government policies, which is similar to those of Table 4, the coefficient size becomes larger in Model 4 of Table 8 compared to that of Table 4, in which the coefficient increases from –4.66-E03 to -0.0046.

Table 7: GARCH output (Containment and health index, Malaysian 1-month interbank rate)

Model 1 Mean equation	Coefficient	p-value	Model 2 Mean equation	Coefficient	p-value
CONF	1.79E-05	0.0832	CONF	1.86E-05	0.0948
DEATH	-3.56E-05	0.9438	DEATH	-4.50E-05	0.9210
CONTAIN	-0.0030	0.0575	CONTAIN	0.0019	0.2654
MYIR_1M	0.2311	0.0001	MYIR_1M	0.1023	0.2952
Constant	0.6419	0.0002	LNOIL	0.0547	0.4349
			Constant	-0.5827	0.1987
Variance equation	Coefficient	p-value	Variance equation	Coefficient	p-value
Constant	0.0102	0.0000	Constant	0.0039	0.0008
Residual term	0.3441	0.0000	Residual term	0.1414	0.0000
GARCH term	0.5735	0.0000	GARCH term	0.8122	0.0000
Diagnostic tests			Diagnostic tests		
ARCH effect test	0.0170 (0.8962)		ARCH effect test	1.7090 (0.1911)	
Correlogram	No correlation		Correlogram	No correlation	
RMSE	0.224		RMSE	0.223	
MAE	0.172		MAE	0.172	
Model 3 Mean equation	Coefficient	p-value	Model 4 Mean equation	Coefficient	p-value
CONF	1.92E-05	0.0989	CONF	1.96E-05	0.0909
DEATH	-5.20E-05	0.9027	DEATH	-4.96E-05	0.9087
CONTAIN	0.0018	0.2913	CONTAIN	0.0011	0.5992
MYIR_1M	0.0947	0.3027	MYIR_1M	0.1477	0.1061
LNOIL	0.0519	0.4604	LNOIL	0.0246	0.7511
LNSTOCK	-4.0673	0.0058	LNSTOCK	-4.0604	0.0058
Constant	-0.5493	0.2242	USIR	-0.3002	0.3006
			Constant	-0.4537	0.3668
Variance equation	Coefficient	p-value	Variance equation	Coefficient	p-value
Constant	0.0035	0.0008	Constant	0.0039	0.0009
Residual term	0.1265	0.0000	Residual term	0.1340	0.0000
GARCH term	0.8291	0.0000	GARCH term	0.8172	0.0000
Diagnostic tests			Diagnostic tests		
ARCH effect test	3.0686 (0.0798)		ARCH effect test	2.5601 (0.1096)	
Correlogram	No correlation		Correlogram	No correlation	
RMSE	0.226		RMSE	0.229	
MAE	0.175		MAE	0.176	

Notes: The value in the parentheses indicates the p-value of the ARCH effect test.

On the other hand, the stringency index, containment and health index and government response have a statistically significant impact on the exchange rate only in the basic model in Table 6, Table 7 and Table 9, respectively. Similarly, these policy measurements' coefficient size is considered economically insignificant yet larger than those of COVID-19 indicators. Due to its statistical insignificance, this paper does not explain its coefficient for brevity. As for the control variables, the results largely align with those reported in Table 2 to Table 5. The conclusions from the variance equation in Table 2 to Table 5 remain intact in this sensitivity test.

Table 8: GARCH output (Economic support index, Malaysian 1-month interbank rate)

Model 1 Mean equation	Coefficient	p-value	Model 2 Mean equation	Coefficient	p-value
CONF	2.08E-05	0.0518	CONF	2.10E-05	0.0466
DEATH	-1.58E-05	0.9757	DEATH	-1.24E-05	0.9809
ECONOMIC	-0.0051	0.0000	ECONOMIC	-0.0047	0.0001
MYIR_1M	0.0833	0.1906	MYIR_1M	0.1443	0.1183
Constant	0.2176	0.2283	LNOIL	0.0393	0.5038
			Constant	-0.1028	0.8220
Variance equation	Coefficient	p-value	Variance equation	Coefficient	p-value
Constant	0.0109	0.0000	Constant	0.0112	0.0000
Residual term	0.3011	0.0000	Residual term	0.3139	0.0000
GARCH term	0.5911	0.0000	GARCH term	0.5783	0.0000
Diagnostic tests			Diagnostic tests		
ARCH effect tests	0.0293 (0.8642)		ARCH effect tests	0.0183 (0.8925)	
Correlogram	No correlation		Correlogram	No correlation	
RMSE	0.225		RMSE	0.224	
MAE	0.173		MAE	0.172	
Model 3 Mean equation	Coefficient	p-value	Model 4 Mean equation	Coefficient	p-value
CONF	2.06E-05	0.0752	CONF	1.96E-05	0.0989
DEATH	-4.24E-05	0.9242	DEATH	-6.30E-05	0.8964
ECONOMIC	-0.0031	0.0417	ECONOMIC	-0.0046	0.0006
MYIR_1M	0.0019	0.9875	MYIR_1M	0.1220	0.2580
LNOIL	0.0404	0.5638	LNOIL	-0.0427	0.6015
LNSTOCK	-3.9971	0.0088	LNSTOCK	-3.8806	0.0022
Constant	0.0318	0.9533	USIR	-0.6562	0.0015
			Constant	0.3476	0.5614
Variance equation	Coefficient	p-value	Variance equation	Coefficient	p-value
Constant	0.0048	0.0010	Constant	0.0110	0.0000
Residual term	0.1449	0.0000	Residual term	0.2386	0.0000
GARCH term	0.7958	0.0000	GARCH term	0.6348	0.0000
Diagnostic test			Diagnostic test		
ARCH effect test	1.9287 (0.1649)		ARCH effect test	0.2619 (0.6088)	
Correlogram	No correlation		Correlogram	No correlation	
RMSE	0.228		RMSE	0.230	
MAE	0.176		MAE	0.178	

Notes: The value in the parentheses indicates the p-value of the ARCH effect test.

Table 9: GARCH output (government response index, Malaysian 1-month interbank rate)

Model 1 Mean equation	Coefficient	p-value	Model 2 Mean equation	Coefficient	p-value
CONF	1.81E-05	0.0783	CONF	1.88E-05	0.0910
DEATH	-3.37E-05	0.9470	DEATH	-4.33E-05	0.9237
RESPONSE	0.0032	0.0504	RESPONSE	0.0019	0.2946
MYIR_1M	0.2365	0.0001	MYIR_1M	0.1007	0.3228
Constant	-0.6696	0.0003	LNOIL	0.0576	0.4084
			Constant	-0.5967	0.2031
Variance equation	Coefficient	p-value	Variance equation	Coefficient	p-value
Constant	0.0102	0.0000	Constant	0.0037	0.0007
Residual term	0.3471	0.0000	Residual term	0.1382	0.0000
GARCH term	0.5710	0.0000	GARCH term	0.8163	0.0000
Diagnostic tests			Diagnostic tests		
ARCH effect test	0.0170 (0.8963)		ARCH effect test	1.8425 (0.1747)	
Correlogram	No correlation		Correlogram	No correlation	
RMSE	0.224		RMSE	0.223	
MAE	0.173		MAE	0.172	
Model 3 Mean equation	Coefficient	p-value	Model 4 Mean equation	Coefficient	p-value
CONF	1.95E-05	0.0946	CONF	1.99E-05	0.0861
DEATH	-5.01E-05	0.9063	DEATH	-4.71E-05	0.9132
RESPONSE	0.0018	0.3231	RESPONSE	9.44E-04	0.6759
MYIR_1M	0.0944	0.3306	MYIR_1M	0.1477	0.1230
LNOIL	0.0541	0.4394	LNOIL	0.0244	0.7547
LNSTOCK	-4.0679	0.0600	LNSTOCK	-4.0609	0.0060
Constant	-0.5618	0.2320	USIR	-0.3201	0.2695
			Constant	-0.4411	0.4069
Variance equation	Coefficient	p-value	Variance equation	Coefficient	p-value
Constant	0.0035	0.0008	Constant	0.0039	0.0009
Residual term	0.1251	0.0000	Residual term	0.1332	0.0000
GARCH term	0.8309	0.0000	GARCH term	0.8181	0.0000
Diagnostic tests			Diagnostic tests		
ARCH effect test	3.1804 (0.0745)		ARCH effect test	2.6013 (0.1068)	
Correlogram	No correlation		Correlogram	No correlation	
RMSE	0.227		RMSE	0.230	
MAE	0.176		MAE	0.177	

Notes: The value in the parentheses indicates the p-value of the ARCH effect test.

The second sensitivity analysis assumes that the error terms are distributed according to the t-statistic. The results are reported in Table 10 to Table 13. The model performance is mostly satisfactory, except for the basic model in Table 12, where the correlogram detects correlation. Again, COVID-19 affects the exchange rate via the number of confirmed cases. Its coefficient size is similar to those reported in Table 2 to Table 5, ranging from 1.81E-05 to 2.12E-05. The insignificance of the degree of stringency is proven again in this robustness analysis. Although the effect could be small in magnitude, the economic support policy will appreciate the value of USD/MYR among the government policies; its coefficient size is also larger than the coefficients of COVID-19 confirmed and death cases. Similar to the previous robustness analysis, the coefficient size of economic support policy in Model 4 of Table 12 is taken to interpret the coefficient. The value –0.0054 and is similar to the previous robustness. Most other control variables are statistically insignificant, and their coefficient sign supports the previous results. There is consistent proof that a better stock market performance inflates the value of MYR against USD, albeit with a slightly larger coefficient (roughly 4.8 across

Table 10 to Table 13). The conditional variance stationarity is also found in this sensitivity analysis. The residual term and the GARCH term in the variance equation are similar to the baseline estimation displayed in Table 2 to Table 5.

Table 10: GARCH output (Stringency index, error distribution: student's t)

Model 1 Mean equation	Coefficient	p-value	Model 2 Mean equation	Coefficient	p-value
CONF	2.00E-05	0.0329	CONF	2.00E-05	0.0323
DEATH	2.72E-05	0.9528	DEATH	2.73E-05	0.9524
STRINGENCY	0.0011	0.3040	STRINGENCY	0.0011	0.3079
MYIR_3M	0.0511	0.3076	MYIR_3M	0.0752	0.2224
Constant	-0.1838	0.1945	LNOIL	0.0413	0.4286
			Constant	-0.4189	0.2218
Variance equation			Variance equation		
Constant	0.009	0.0048	Constant	0.0088	0.0054
Residual term	0.2544	0.0009	Residual term	0.2515	0.0009
GARCH term	0.6602	0.0000	GARCH term	0.6546	0.0000
Diagnostic tests			Diagnostic tests		
ARCH effect test	0.1743 (0.6763)		ARCH effect test	0.1971 (0.6571)	
Correlogram	No correlation		Correlogram	No correlation	
RMSE	0.224		RMSE	0.224	
MAE	0.172		MAE	0.172	
Model 3 Mean equation	Coefficient	p-value	Model 4 Mean equation	Coefficient	p-value
CONF	1.86E-05	0.0495	CONF	1.89E-05	0.0462
DEATH	-1.06E-05	0.9806	DEATH	-1.22E-05	0.9777
STRINGENCY	0.001	0.3312	STRINGENCY	7.37E-04	0.5321
MYIR_3M	0.0989	0.0930	MYIR_3M	0.1276	0.0489
LNSTOCK	-4.7504	0.0001	LNSTOCK	-4.7738	0.0001
LNOIL	0.0448	0.3687	LNOIL	0.0161	0.7523
Constant	-0.4771	0.1457	USIR	-0.2844	0.1612
			Constant	-0.3652	0.2759
Variance equation			Variance equation		
Constant	0.0098	0.0054	Constant	0.0104	0.0041
Residual term	0.2427	0.0018	Residual term	0.2578	0.0015
GARCH term	0.6509	0.0000	GARCH term	0.6313	0.0000
Diagnostic tests			Diagnostic tests		
ARCH effect test	0.2498 (0.6172)		ARCH effect test	0.1700 (0.6801)	
Correlogram	No correlation		Correlogram	No correlation	
RMSE	0.231		RMSE	0.232	
MAE	0.178		MAE	0.179	

Notes: The value in the parentheses indicates the p-value of the ARCH effect test.

Table 11: GARCH output (Containment and health index, error distribution: student's t)

Model 1 Mean equation	Coefficient	p-value	Model 2 Mean equation	Coefficient	p-value
CONF	1.94E-05	0.0382	CONF	1.94E-05	0.0373
DEATH	1.88E-05	0.9672	DEATH	1.87E-05	0.9672
CONTAIN	0.0020	0.155	CONTAIN	0.00198	0.1568
MYIR_3M	0.0616	0.2412	MYIR_3M	0.0865	0.1772
Constant	-0.26984	0.1163	LNOIL	0.0425	0.4131
			Constant	-0.5119	0.1548
Variance equation			Variance equation		
Constant	0.0089	0.0047	Constant	0.0088	0.0053
Residual term	0.2565	0.0008	Residual term	0.2541	0.0008
GARCH term	0.6491	0.0000	GARCH term	0.6532	0.0000
Diagnostic tests			Diagnostic tests		
ARCH effect test	0.2015 (0.6535)		ARCH effect tests	0.2251 (0.6352)	
Correlogram	No correlation		Correlogram	No correlation	
RMSE	0.223		RMSE	0.223	
MAE	0.171		MAE	0.171	
Model 3 Mean equation	Coefficient	p-value	Model 4 Mean equation	Coefficient	p-value
CONF	1.81E-05	0.0552	CONF	1.84E-05	0.0510
DEATH	-1.72E-05	0.9683	DEATH	-1.70E-05	0.9688
CONTAIN	0.0018	0.1865	CONTAIN	0.0014	0.3997
MYIR_3M	0.1077	0.0801	MYIR_3M	0.1302	0.0478
LNSTOCK	-4.7163	0.0001	LNSTOCK	-4.7429	0.0001
LNOIL	0.0454	0.3616	LNOIL	0.0204	0.6885
Constant	-0.5546	0.1087	USIR	-0.2467	0.2496
			Constant	-0.4386	0.2180
Variance equation			Variance equation		
Constant	0.0097	0.0052	Constant	0.0102	0.0042
Residual term	0.2456	0.0017	Residual term	0.2575	0.0015
GARCH term	0.6497	0.0000	GARCH term	0.6337	0.0000
Diagnostic tests			Diagnostic tests		
ARCH effect test	0.2561 (0.6128)		ARCH effect test	0.1881 (0.6645)	
Correlogram	No correlation		Correlogram	No correlation	
RMSE	0.230		RMSE	0.231	
MAE	0.178		MAE	0.178	

Notes: The value in the parentheses indicates the p-value of the ARCH effect test.

All estimated models are also examined using the augmented autoregressive distributed lag (ARDL) estimation since some papers with similar objectives deployed that method. A few noticeable results can be summarised. First, the ARDL estimations do not prove that the confirmed COVID-19 cases have any statistical significance impact. Second, the statistical insignificance of the death cases is still supported, although the coefficient signs change from negative to positive. Third, the stock market's appreciation effect on the exchange rate is also supported. We argue that the GARCH estimator provides a more reliable output in this research because of the ARCH effect on the exchange rate data. Moreover, the estimated ARDL models encounter non-normality and heteroskedasticity. The results are available upon request.[1]

[1] Following the suggestion of reviewers, EGARCH model is estimated as well to examine the results. In general, the EGARCH (1,1) model supports the depreciation effect of new cases of COVID. Besides, stock market and economic support policy also influence the exchange rate growth. However, this paper prefers the GARCH model because (i)

Table 12: GARCH output (Economic support index, error distribution: student's t)

Model 1 Mean equation	Coefficient	p-value	Model 2 Mean equation	Coefficient	p-value
CONF	2.04E-05	0.7566	CONF	2.12E-05	0.0246
DEATH	-2.45E-05	0.9919	DEATH	4.39E-05	0.9247
ECONOMIC	-0.0022	0.3835	ECONOMIC	-0.0047	0.0001
MYIR_3M	-0.026	0.8777	MYIR_3M	0.0274	0.6577
Constant	0.2037	0.6769	LNOIL	0.0311	0.5511
			Constant	0.1482	0.6757
Variance equation			Variance equation		
Constant	0.1119	0.3757	Constant	0.0109	0.0031
Residual term	0.1500	0.2903	Residual term	0.2556	0.0010
GARCH term	0.6000	0.1603	GARCH term	0.6219	0.0000
Diagnostic tests			Diagnostic tests		
ARCH effect test	23.9814 (0.0000)		ARCH effect test	0.0479 (0.8268)	
Correlogram	correlation		Correlogram	No correlation	
RMSE	0.224		RMSE	0.224	
MAE	0.172		MAE	0.172	
Model 3 Mean equation	Coefficient	p-value	Model 4 Mean equation	Coefficient	p-value
CONF	1.97E-05	0.039	CONF	1.95E-05	0.0434
DEATH	-1.05E-07	0.9998	DEATH	-9.85E-06	0.9822
ECONOMIC	-0.0039	0.0004	ECONOMIC	-0.0054	0.0000
MYIR_3M	0.0479	0.4220	MYIR_3M	0.1170	0.0774
LNSTOCK	-4.7398	0.0001	LNSTOCK	-4.9228	0.0000
LNOIL	0.0330	0.5047	LNOIL	-0.0412	0.4708
Constant	0.0429	0.8990	USIR	-0.7071	0.0001
			Constant	0.3997	0.2907
Variance equation			Variance equation		
Constant	0.0127	0.0031	Constant	0.0162	0.0034
Residual term	0.2525	0.0021	Residual term	0.2823	0.0020
GARCH term	0.6027	0.0000	GARCH term	0.5378	0.0000
Diagnostic tests			Diagnostic tests		
ARCH effect test	0.0725 (0.7977)		ARCH effect test	0.2490 (0.6178)	
Correlation	No correlation		Correlation	No correlation	
RMSE	0.232		RMSE	0.232	
MAE	0.179		MAE	0.179	

Notes: The value in the parentheses indicates the p-value of the ARCH effect test.

RMSE and MEA of EGARCH are higher or the same as those of the GARCH model, (ii) the asymmetric effect is found only when economic support policy is estimated and (iii) ARCH effect and serial correlation are still found in all models except for the cases of economic support policy. Also, as highlighed by a reviewer, the Brent Crude oil price could be an leading indicator compared to other oil prices. Estimating the model using the Brent Crude oil price does not change the impact of COVID-19 found in this paper. All results are available upon request.

Table 13: GARCH output (Government response index, error distribution: student's t)

Model 1 Mean equation	Coefficient	p-value	Model 2 Mean equation	Coefficient	p-value
CONF	1.97E-05	0.0351	CONF	1.97E-05	0.0343
DEATH	2.24E-05	0.9611	DEATH	2.22E-05	0.9611
RESPONSE	0.0019	0.1892	RESPONSE	0.0019	0.1903
MYIR_3M	0.0574	0.2802	MYIR_3M	0.0825	0.2041
Constant	-0.2579	0.1485	LNOIL	0.0427	0.4122
			Constant	-0.5033	0.1708
Variance equation			Variance equation		
Constant	0.0089	0.0048	Constant	0.0088	0.0054
Residual term	0.2558	0.0008	Residual term	0.2533	0.0009
GARCH term	0.6500	0.0000	GARCH term	0.6542	0.0000
Diagnostic tests			Diagnostic tests		
ARCH effect test	0.1967 (0.6574)		ARCH effect test	0.2206 (0.6386)	
Correlogram	No correlation		Correlogram	No correlation	
RMSE	0.224		RMSE	0.224	
MAE	0.172		MAE	0.171	
Model 3 Mean equation	Coefficient	p-value	Model 4 Mean equation	Coefficient	p-value
CONF	1.85E-05	0.0505	CONF	1.89E-05	0.0460
DEATH	-1.31E-05	0.9759	DEATH	-1.23E-05	0.9774
RESPONSE	0.0017	0.2494	RESPONSE	0.0011	0.5364
MYIR_3M	0.1031	0.1002	MYIR_3M	0.1269	0.0551
LNSTOCK	-4.7046	0.0001	LNSTOCK	-4.7398	0.0001
LNOIL	0.0458	0.3587	LNOIL	0.0184	0.7191
Constant	-0.5385	0.1283	USIR	-0.2684	0.2214
			Constant	-0.4025	0.2750
Variance equation			Variance equation		
Constant	0.0096	0.0054	Constant	0.0102	0.0043
Residual term	0.2442	0.0018	Residual term	0.2563	0.0016
GARCH term	0.6514	0	GARCH term	0.6344	0
Diagnostic tests			Diagnostic tests		
ARCH effect test	0.2507 (0.6166)		ARCH effect test	0.1764 (0.6745)	
Correlogram	No correlation		Correlogram	No correlation	
RMSE	0.231		RMSE	0.233	
MAE	0.178		MAE	0.179	

Notes: The value in the parentheses indicates the p-value of the ARCH effect test.

5. Conclusion

This paper investigates the impact of the COVID-19 pandemic and COVID-19-related policies on USD/MYR using the GARCH estimation. A few noticeable findings can be summarised. First, the results suggest that the confirmed cases have a depreciation effect on USD/MYR. However, the impact of the confirmed cases is economically insignificant. Second, the economic support policies appreciate the value of MYR against USD, substantiating the arguments that the government's effort to stimulate the economy will affect the economy positively. Although the effect could be economically insignificant, the coefficient size of economic support initiatives is larger than that of COVID-19, implying that these initiatives could revert the depreciation effect caused by COVID-19. Third, evidence shows that the stricter policy limiting the economy and human movement, the more depreciation pressure on the USD/MYR. However, the statistical significance is not robustly supported by the robustness analysis. Fourth, the stock market performance has a robust positive effect on the value of MYR.

The insignificant economic impact of the confirmed cases of COVID-19 implies that the pandemic is not the direct factor that depreciated MYR. However, lower demand for domestic products and the uncertainties caused by the pandemic could influence USD/MYR via its influence on the stock market. Hence, the authorities should not underestimate the effect of the pandemic. Additionally, the Malaysian authorities should be more proactive in using fiscal resources to support the exchange rate should a similar event happen again, following the robust conclusion that these policies appreciated MYR against USD.

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Determinants of Dividend Policies in Shariah Compliant and Non-Shariah Compliant Firms: A Panel Quantile Approach

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Abstract: Research Questions: Do Shariah-compliant firms have a different dividend policy from non-Shariah-compliant firms? Does this policy reflect similarity at different quantile levels of dividend? Motivation: The purpose of this paper is to investigate whether Shariah-compliant firms have different determinants than non-Shariah-compliant firms, using the linear and panel quantile methods. **Idea:** The different selection criteria between Shariah-compliant and non-Shariah-compliant firms may contribute to a different dividend policy. **Data:** Data collected via DataStream and the Securities and Exchange Commission within the top 200 based on market capitalisation in 2019 for the period from 2010 to 2019. **Method/ Tools:** To test the hypothesis, the study used pooled OLS, random and fixed effects. To determine the most appropriate model, we use the Breusch-Pagan-Lagrange multiplier test (LM) and the Hausman test. To further investigate the difference between the dividend policy of Shariah-compliant and non-Shariah-compliant firms, the study also uses the quantile approach to examine the determinants of dividend at different quantile levels. **Findings:** The study not only reveals differences in the dividend policies of Shariah-compliant and non-Shariah-compliant firms in the linear approach, but also in the quantile approach. In a linear regression approach, firm size, growth opportunities, profitability, and free cash flow were found to be significant determinants of dividends for Shariah-compliant firms. On the other hand, firm size, growth opportunities, profitability, and risk were found to be significant determinants of dividends of non-Shariah-compliant firms. In the panel quantile approach, all tested variables (except at 0.50 quantile for non-Shariah compliant companies) were found to be significant determinants of dividend for both Shariah and non-Shariah compliant firms. The finding implies that the result of the linear approach may overgeneralize to different quantiles, so a comparison using a different approach may provide more insight into these determinants. **Contributions:** The study contributes to the existing knowledge on the determinants of dividend policy of Shariah-compliant and non-Shariah-compliant firms, especially by comparing it with the linear and quantile approaches, which has been neglected in previous studies.

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JEL Classification: G0, G1, G3

1. Introduction

Answering the question of whether Shariah-compliant firms have a different dividend policy than non-Shariah-compliant firms is crucial, especially for religiously motivated investors who otherwise diversify their investments into other forms of investment other than the equity markets (e.g. gold, real estate). In order to attract Muslim investors to invest in the stock market, the business owner must follow the standard business procedures prescribed by Shariah (Farooq and Tbeur, 2013). Shariah can be referred to as Islamic law derived from divine revelation (Al-Quran) and the practises of Prophet Muhammad P.b.u.h (Al-Hadith) (Adam and Bakar, 2014). The difference between Shariah-compliant and non-Shariah-compliant dividends should be understood carefully, because the non-Shariah-compliant firm includes activities that prohibit Muslims from investing. The non-Sharia-compliant firm includes three elements, gharar (insecurity), maisir (gambling) and riba (usury), which are considered haram (Aziah Abu Kasim, 2012). The Shariah-compliant dividend was introduced to meet the needs of Muslim investors who invest in the stock markets and receive profits in the form of dividends or homemade dividend. Due to the growing number of Muslim populations worldwide, the demand for Shariah-compliant investments such as dividends needs to be met.

Dividends were introduced specifically to distribute corporate profits to shareholders. However, the motivation for paying dividends to shareholders is associated with many theories, and one of the most popular is the agency cost theory to regulate the financial distribution of the firm. Dividends can serve as a governance mechanism, especially in emerging markets (Farooq and Tbeur, 2013). Early theories of governance mechanisms suggest that dividends can mitigate agency costs by reducing the cash available to managers to invest in unprofitable projects (Jensen, 1986). Much earlier research also suggests that high dividends can mitigate conflict by reducing the cash available to managers (Grossman and Hart, 1980). The results were later formalised in the form of a model known as the substitution model, in which dividends can be used as a substitute for the stakeholder monitoring function. This model assumes that the dividend payout signals to the market that there are fewer opportunities to tunnel incentives because the dividend payout makes less cash available.

The development of dividend theories enriches dividend research, especially in uncovering the factors that determine dividend policy. Previous research focused only on determining the dividend payout ratio, and less attention was paid to the influence of religious elements such as Shariah compliance on dividend policy. Studies on Shariah compliance in dividend policy have been conducted for several decades. For example, the study comparing dividend policies of Shariah and non-Shariah compliant firms in the MENA region was published by Farooq and Tbeur in 2013. Similarly, the study examining dividend policies in the stock exchanges of Gulf Cooperation Council (GCC) countries found that Shariah-compliant firms are likely to pay more dividends than their non-Shariah-compliant counterparts (Guizani, 2017). However, the Employee Provident Fund (EPF) chief executive officer posited that the lower dividend payout in the Malaysian EPF is due to the fact that Shariah-compliant assets are not exposed to global international conventional banking systems such as global banks and global insurance firms (Luqman Hariz, 2018). Moreover, most global banks do not have a Shariah compliance module, so the income from this module cannot be included in the Shariah-compliant dividend (Luqman Hariz, 2018). On contrary, the study on dividend payout in Indonesian firms shows a negative relationship between Shariah-compliant firms and dividends, suggesting that Shariah-compliant firms are less

likely to pay dividends than non-Shariah-compliant firms (Tyas and Bandi, 2021). The mix of international evidence and announcements by Malaysian EPFs on their dividend payments motivates the study to find out the different determinant of dividend policies between the Shariah and non-Shariah firms in Malaysia.

In addition to the mixed results, the study is also motivated by the different characteristics of Shariah-compliant and non-Shariah-compliant firms that contribute to the difference in dividend payouts. One of the most prominent examples is the leverage ratio of Shariah and non-Shariah firms. Shariah-compliant firms are subject to certain restrictions on the amount of debt they can take on and the amount of cash they can hold (Cheong, 2020). In addition, bank loans often contain covenants that prevent a firm from paying a dividend (Allen and Gottesman, 2006), and this is very important to protect the firm's ability to repay the loan. In fact, non-Shariah-compliant (conventional) firms have a higher debt-to-asset ratio than Shariah-compliant firms, which is due to the mandatory auditing process that Shariah-compliant firms in Malaysia are subjected to (Rashid and Wei, 2019). Limiting debt and leverage in Shariah-compliant firms should play an important role in determining dividend policy. On the other hand, the non-Shariah-compliant firms that are not affected by this rule should have a different dividend policy than their counterparts of Shariah-compliant firms.

To fill the gap of mixed results and gain a better understanding of the different determinants of dividend in Shariah and non-Shariah compliant firms, we compare the results of the analysis using linear and quantile approaches, which have been neglected in the previous studies. By using quantiles, we can not only specifically understand how different quantiles of the dividend respond to their factors, but we can also understand that different quantiles of the dividend amount may not respond to the factors in the same or similar way as the linear approach. Moreover, we must not overgeneralise our results under the linear approach as different quantiles may respond differently, and this can be used as a reference for future research in dividend determinants.

The rest of this paper is organised as follows. Section two discusses the literature review and section three discusses the methodology used in this study. Section four discusses the results and the robustness tests used in this study. Section five concludes with a discussion of the conclusions.

2. Literature Review

According to Brigham and Daves (2016), dividends are the distribution of a firm's profits to its shareholders. Dividend policy is "the practise followed by management in deciding whether to pay dividends or, in other words, the size and pattern of cash distributions to shareholders over time" (Lease *et al*., 2000). It is well known that there are contentious issues related to dividend policy, such as the optimal proportion of profits to be distributed as dividends, the competing priority of using profits to pay shareholders or to invest in expected profitable projects, and the appropriate form of dividend payment. This complexity of dividend policy is referred to by Black (1976) as the "dividend puzzle" The dividend puzzle has been increased by the distinction between Shariah-compliant and non-Shariah-compliant firms, as debt and receivables policies differ, which greatly affects dividend policy. Therefore, it is important to understand the factors that influence dividend policy, especially for Shariah-compliant firms, in order to solve the dividend puzzle for Shariah-compliant investments.

Islamic finance has piqued the interest of many stockbrokers. According to recent findings, the market for Shariah-compliant financial products has grown by about thirty per cent in recent years (Robinson, 2007). Considering the importance of Shariah-compliant products or assets, this paper aims to document the dividend policy of Malaysian Shariah-compliant firms. According to La Porta *et al*. (2000), dividend policy can serve as a proxy for corporate governance mechanisms in emerging markets. They consider dividend policy as an

important mechanism for firms to build their reputation. Gomes (2000), in a similar study, concludes that firms can reduce agency costs and improve their reputation by distributing large amounts of cash in the form of dividends. One way dividend payouts mitigate agency conflicts is by reducing the free cash flow available to managers (Grossman and Hart, 1980). According to Jensen (1986), high dividend payouts can reduce agency costs by reducing the free cash flow that could be spent on unprofitable projects. According to the previous literature, the payment of high dividends reflects the good faith of management and signals low agency problems and good corporate governance mechanisms.

One of many reasons why Shariah-compliant firms have different dividend determinants than the non-Shariah compliant is because Shariah-compliant firms must have low leverage, low accounts receivable, and low holdings of cash and interest-bearing securities (Farooq and Tbeur 2013). Previous research has shown that all three characteristics lead to lower payout ratios. For example, Higgins (1972) documents that debt is an important determinant of corporate dividend policy. They demonstrate that firms with high leverage have historically paid lower dividends than other firms. They argue that firms pay lower dividends to avoid the higher costs of borrowing. Moreover, bank loans often contain clauses that restrict dividend payments (Allen and Gottesman, 2006). Rozeff (1982) found that a firm with a higher leverage ratio will choose a lower dividend payout. Moreover, a higher leverage ratio leads to a lower dividend payout (Aivazian *et al*., 2003; Omran and Pointon, 2004). Based on the above theoretical arguments, it can be argued that financial constraints are extremely important for corporate dividend policy. In addition to low leverage, one of the most important characteristics of Shariah-compliant firms is a low level of accounts receivable. Empirical evidence from the past suggests that a high level of accounts receivable not only reduces available liquidity but also increases tunnelling incentives for the firm (Marquardt and Wiedman, 2004; Caylor, 2009).

The difference between Shariah and non-Shariah determinants of dividends may also be due to the clientele effect. According to Farooq and Tbeur (2013), Shariah-conscious investors constitute a significant portion of the clientele of Shariah-compliant firms. These Shariah-conscious investors use mutual funds and other types of institutional investors to invest their capital in Shariah-compliant assets (Farooq and Tbeur, 2013). Since institutional investors are better controlled (Brickley *et al*., 1988), Shariah-compliant firms indirectly have better governance than non-Shariah-compliant firms. Consequently, a firm with better governance (Shariah-compliant firm) may have a higher payout than a firm with weaker governance (non-Shariah-compliant firm) and this difference should lead to different dividend determinants of payout policy.

In addition to the theoretical arguments, previous empirical studies also show that Shariah-compliant firms pay more dividends than non-Shariah-compliant firms. Previous empirical studies show that Shariah-compliant firms pay 10.33 percentage points more dividends than non-Shariah-compliant firms (Guizani, 2017). Moreover, they find that the probability of paying dividends is 2.2056 times higher than non-Sharia-compliant firms (Guizani, 2017). One possible reason for the higher dividend payments by Shariah-compliant firms compared to non-Shariah-compliant firms could be insider ownership and high third-party ownership (Imamah *et al*., 2019). In addition, Anwer *et al*. (2021) have documented that Shariah-compliant firms in the United States are more likely to make a total distribution, cash dividend and buyback compared to non-Shariah-compliant firms. Although important previous studies demonstrate the significant difference between Shariah-compliant and non-Shariah-compliant firms, some other studies find the opposite. For example, Alnori and Bugshan (2022) and Alnori *et al*. (2022) find that there is no significant difference between Shariah and non-Shariah compliant firms when it comes to the relationship between dividend and cash holding. In other words, it shows that Shariah-compliant and non-Shariah-compliant firms do

not have a significant difference in the relationship between cash holding and dividend decision.

In conclusion, despite the contradictory results in the literature, we strongly believe that the noticeable differences in the characteristics of Shariah-compliant firms compared to non-Shariah-compliant firms should influence their dividend policy differently. Since Shariah-compliant firms have specific financial characteristics such as low leverage and low accounts receivable, Shariah-compliant firms should have different dividend policies or determinants than non-Shariah-compliant firms. To further fill the gap in the literature in comparing Shariah-compliant and non-Shariah-compliant dividend determinants, we extend the regression using the quantile approach, which has often been neglected in previous studies. Based on the above argument, we hypothesise that:

H1: The Shariah-compliant firms have a different dividend policy than the non-Shariah-compliant firms when using a linear regression approach.

H2: The Shariah-compliant firms have a different dividend policy than the non-Shariah-compliant firms when using the quantile regression approach.

3. Methodology

This section explains the methodology used and the data collection. The data collection period of the study is from 2010 to 2019. The study chooses this period because the Securities and Exchange Commission report that distinguishes between Shariah and non-Shariah compliant firms started in 2010. The data in this study consists of the 200 largest firms based on their market capitalisation in 2019. The reason for selecting the 200 largest firms is that the sample in the study has a significant market capitalisation so that investors can earn a return on their investments. However, due to some incomplete financial data, we could only include 195 firms in the sample during the selected period. The study selects Malaysia as the sample because Malaysia can be considered well developed in terms of the application of Shariah law in various industries. For example, Malaysia has a track record of more than 30 years in building and nurturing the Islamic finance industry (which is subject to Shariah law) (Bank Negara Malaysia, n.d.).

The data used for the study comes from DataStream and the Securities and Exchange Commission website. The dependent variable used in this study is dividend per share (DPS), which has also been used in other previous studies on dividends (Bakri *et al*., 2021; Bakri, 2021). In order to examine the main determinants of dividend policy, the study uses the main dividend determinants proposed by Fama and French (2001) such as firm size, investment opportunities and profitability. In addition, the study used additional factors used in previous dividend studies such as leverage, free cash flow and risk following Bakri *et al*. (2021) and Bakri (2021). The original quantile method was developed by Koenker and Bassett (1978), however, in this study we used the modified version of panel quantile developed by Powell (2016) to run the quantile regression. To examine the hypothesis in the study, we use the model as follows:

Model for Hypothesis 1

$$DPS_{i,t} = \beta_0 + \beta_1 Log(Size)_{I,t} + \beta_2 Tobins'Q_{I,t} + \beta_3 ROA_{I,t} + \beta_4 Leverage_{I,t} + \beta_5 FCF_{I,t} + \beta_6 Risk_{i,t} + \delta_{i,t} + \mu_{i,t} + \varepsilon_{i,t} \quad (1)$$

Model for Hypothesis 2

$$DPS_{i,t} = \beta_{0.10,0} + \beta_{0.10,1}\text{Log(Size)}_{I,t} + \beta_{0.10,2}\,\text{Tobins}'\text{Q}_{I,t} + \beta_{0.10,3}\text{ROA}_{I,t} + \beta_{0.10,4}\text{Leverage}_{i,t} + \beta_{0.10,5}\text{FCF}_{i,t} + \beta_{0.10,6}\text{Risk}_{i,t} + \varepsilon_{i,t} \quad (2)$$

$$DPS_{i,t} = \beta_{0.25,0} + \beta_{0.25,1}\text{Log(Size)}_{I,t} + \beta_{0.25,2}\,\text{Tobins}'\text{Q}_{I,t} + \beta_{0.25,3}\text{ROA}_{I,t} + \beta_{0.25,4}\text{Leverage}_{i,t} + \beta_{0.25,5}\text{FCF}_{i,t} + \beta_{0.25,6}\text{Risk}_{i,t} + \varepsilon_{i,t} \quad (3)$$

$$DPS_{i,t} = \beta_{0.50,0} + \beta_{0.50,1}\text{Log(Size)}_{I,t} + \beta_{0.50,2}\,\text{Tobins}'\text{Q}_{I,t} + \beta_{0.50,3}\text{ROA}_{I,t} + \beta_{0.50,4}\text{Leverage}_{i,t} + \beta_{0.50,5}\text{FCF}_{i,t} + \beta_{0.50,6}\text{Risk}_{i,t} + \varepsilon_{i,t} \quad (4)$$

$$DPS_{i,t} = \beta_{0.75,0} + \beta_{0.75,1}\text{Log(Size)}_{I,t} + \beta_{0.75,2}\,\text{Tobins}'\text{Q}_{I,t} + \beta_{0.75,3}\text{ROA}_{I,t} + \beta_{0.75,4}\text{Leverage}_{i,t} + \beta_{0.75,5}\text{FCF}_{i,t} + \beta_{0.75,6}\text{Risk}_{i,t} + \varepsilon_{i,t} \quad (5)$$

$$DPS_{i,t} = \beta_{0.90,0} + \beta_{0.90,1}\text{Log(Size)}_{I,t} + \beta_{0.90,2}\,\text{Tobins}'\text{Q}_{I,t} + \beta_{0.90,3}\text{ROA}_{I,t} + \beta_{0.90,4}\text{Leverage}_{i,t} + \beta_{0.90,5}\text{FCF}_{i,t} + \beta_{0.90,6}\text{Risk}_{i,t} + \varepsilon_{i,t} \quad (6)$$

where $DPS_{i,t}$= Dividend Per Share, $Log(Size)_{i,t}$ = Natural Logarithm of total asset, $Tobin's\ Q_{i,t}$ = Market value of assets / replacement value of assets, $ROA_{i,t}$ = Return on Asset, $Leverage_{i,t}$ = Total liabilities / total asset, $FCF_{i,t}$= Free Cash Flow per share, $Risk_{i,t}$= Historic Beta, $\delta_{i,t}$= Dummy variable equals 1 for different industry, $\mu_{i,t}$= Dummy variable equals 1 for different year, $\varepsilon_{i,t}$= Error term, and $\beta_0, \beta_1, \beta_2, \beta_3, \beta_4, \beta_5$ are the coefficient of the regression model.

Table 1: Variables definition

Variables	Symbol	Proxy
Dividend per share	DPS	Dividend per share
Firm size	Log (Size)	Natural logarithm of total asset
Investment opportunities	Tobin's Q	Market value divide replacement value of assets
Profitability	ROA	Return on asset
Leverage	Leverage	Total liabilities / total asset
Free cash flow	FCF	Free cash flow per share
Risk	Beta	Historic beta
Industry fixed effect	Industry	Dummy equal to 1 for different industry
Year fixed effect	Year	Dummy equal to 1 for different year

To test the hypothesis developed in this study, we used a total of six models. Model to test hypothesis one and model two to six to test hypothesis two. The first model was examined using pooled OLS analysis, random effect and fixed effect. Before examining the model, the data were winsorised at the 1st and 99th percentiles to alleviate concerns about outliers. The study also performs a correlation analysis to determine the presence of multicollinearity in the study data. In addition, the study uses various diagnostic tests such as the White test and the Breusch-Pagan Lagrange Multiplier test (LM) to identify problems with heteroskedasticity and serial correlation in the data. To mitigate this problem, we used robust standard error calculations in each model (hypothesis one). In models two to six, we used the panel quantile approach. The regression in the panel quantile approach is a 0.10, 0.25, 0.50, 0.75 and 0.90 level regression.

The descriptive statistics in Table 2 show the mean, standard deviation, minimum and maximum values for each variable tested in this study. As shown in Table 2, the mean values for dividend per share, log(size) and Tobin's Q are 0.09, 14.25 and 1.73 respectively, while the mean values for ROA, leverage, FCF and risk are 7.74, 0.39, 0.04 and 1.05 respectively. The standard deviation of all the variables tested range from the lowest value of 0.166 to the

highest value of 7.948. The minimum and maximum for each variable tested are also shown in Table 2 in column five and six respectively. Table 3 shows the correlation analysis to determine the relationship between the variables. A higher value of the correlation analysis indicates an early sign of multicollinearity. Any correlation above 0.60 may indicate multicollinearity problems. The decision to exclude investment opportunities and profitability as shown in Table 3 (above 0.60) may lead to a loss of important information, as these factors are considered important determinants of dividend policy, as suggested by Fama and French (2001). However, the decision to omit variables due to multicollinearity problems should ultimately be made using variance inflation factor (VIF) analysis. As can be seen in Table 2 in the VIF column, none of the values is higher than 10. The rule of thumb for multicollinearity problems occurs when the VIF value exceeds the value of 10. So, based on table 2, the data presented in the study should have a minimal risk of multicollinearity if this criterion is met.

Table 2: Descriptive statistics

Variable	Obs	Mean	Std. Dev.	Min	Max	VIF
DPS	1,808	0.0978	0.1662	0.0000	1.0000	N/A
Log(size)	1,808	14.2505	1.6215	9.8861	19.0014	1.22
Tobin's Q	1,808	1.7314	1.4178	0.5360	8.3339	1.92
ROA	1,798	7.7441	7.9483	-16.8400	33.8500	1.95
Leverage	1,808	0.3910	0.1872	0.0511	0.8289	1.27
FCF	1,808	0.0353	0.2129	-0.7230	0.8190	1.05
Risk	1,808	1.0526	0.6780	-0.2950	3.1360	1.06

Table 3: Pearson correlation matrix

	DPS	Log(size)	Tobin's Q	ROA	Leverage	FCF	Risk
DPS	1						
Log(size)	0.1936***	1					
Tobin's Q	0.4819***	-0.1553***	1				
ROA	0.3909***	-0.1944***	0.6586***	1			
Leverage	0.0316	0.3801***	0.0420*	-0.1645***	1		
FCF	0.0827***	0.0271	-0.036	0.1147***	-0.1007***	1	
Risk	-0.2528***	0.1292***	-0.1800***	-0.1778***	0.1392***	-0.0186	1

Notes: *Denotes significance at the 10% level. ** Denote significance at the 5% level. *** Denote significance at the 1% level.

4. Results

The results of the regression analysis consisting of panel analyses, random effects analyses and fixed effects analyses are presented in Table 4. The result shows that there are significant differences between Shariah and non-Shariah compliant firms in the determinants of dividend. From Table 4, Model I, log(size), Tobin's Q and ROA significantly affect dividend policy in all samples (Shariah and non-Shariah compliant firms) with t-values of 2.29, 3.24 and 3.91 respectively. However, in model II (Shariah compliant firms), log(size), Tobin's Q, ROA and FCF were found to be significant determinants of dividend payout with t-values of 2.53, 2.36, 4.11 and -2.22 respectively. In contrast, in model III (non-Shariah compliant firms), we found that log(size), Tobin's Q, ROA and risk as significant determinants of dividend policy with t-values of 2.62, 2.47, 2.41 and 2.28, respectively. All the models presented in Table 4 are the best fitting model after performing Breusch-Pagan test LM and Hausman test as shown in the bottom section of Table 4.

Overall, we found that three factors as suggested by Fama and French (2001), namely log(size), investment opportunities and profitability, consistently affect dividend policy in all models tested using linear approaches. However, leverage, free cash flow and risk were found to affect the dividend policy of Shariah-compliant and non-Shariah-compliant firms in

different ways. For example, free cash flow was found to be a significant determinant of dividend policy for Shariah-compliant firms but not for non-Shariah-compliant firms. This is mainly because Shariah-compliant firms largely rely on the availability of cash to pay dividends, as they do not allow large amount of debt and must have low leverage as part of screening criteria. For these reasons, this may contribute to the significant determinants of dividend payout compared to the non-Shariah compliant firms.

Table 4: Fixed and random effect analysis (Main Analysis – Hypothesis 1)

	Model I: Full sample (Fixed Effect with RSE)		Model II: Shariah-compliant firms (Fixed Effect with RSE)		Model III: Non-Shariah compliant firms (Random Effect with RSE)	
Regressors	Regression coefficient	t-statistics	Regression coefficient	t-statistics	Regression coefficient	z-statistics
Constant	-0.1086	-1.80	-0.1076	-1.94	-0.2894	2.59*
$Log(size)_{i,t}$	0.0108	2.29*	0.0116	2.53*	0.0206	2.62**
$Tobin's\ Q_{i,t}$	0.0254	3.24**	0.0199	2.36*	0.0416	2.47*
$ROA_{i,t}$	0.0014	3.91***	0.0013	4.11***	0.0036	2.41*
$Leverage_{i,t}$	0.0190	0.46	0.0061	0.13	0.0466	0.75
$FCF_{i,t}$	-0.0300	-1.72	-0.0418	-2.22*	0.0126	0.33
$Risk_{i,t}$	-0.0077	-1.74	-0.0072	-1.52	-0.0254	2.28*
BP-LM Test	4638.58 (0.0000***)		3701.19 (0.0000***)		433.33 (0.0000***)	
Hausman Test	62.78 (0.0000***)		59.70 (0.000***)		11.37 (0.0775)	
Industries	No		No		No	
Year	No		No		No	
R-Squared	0.3127		0.2909		0.4173	

Notes: *Denotes significance at the 10% level. ** Denote significance at the 5% level. *** Denote significance at the 1% level. Industries and Year effect only use in pooled OLS, however, since it's not best fit model (as per Breusch Pagan LM (BP-LM) test and Hausman test) both effects are not included.

On the contrary, we have demonstrated that risk is another important determinant of dividend policy for non-Shariah-compliant firms in addition to the three main factors proposed by Fama and French (2001). One of the main factors for the significant influence of risk as a determinant of dividend policy is the fact that non-Shariah compliant firms are involved in riskier business activities. According to Durand *et al*. (2013), Shariah-compliant firms are not involved in risky business activities such as gambling, alcohol, military, firearms and nuclear power, which are found in non-Shariah-compliant firms. In addition, Hong and Kacperczyk (2009) have documented that non-Shariah-compliant firms are involved in gambling, alcohol, tobacco and gaming, which are risky and neglected by investors who adhere to norms. For these reasons, risk becomes an important factor for the non-Shariah-compliant firms in deciding their dividend policy.

Although Allen and Gottesman (2006) found that bank loans contain a clause that restricts dividend payments, debt or leverage was consistently found to be an insignificant determinant of dividend policy in linear approaches. Moreover, restricted debt financing in Shariah-compliant firms may affect dividend payout dynamics, which are affected by political risks, leading to a failure to pay dividends (Karimov *et al*., 2021). Based on this argument, we strongly believe that dividend can become an important determinant of dividend when we analyse the data from different perspectives. To further explore the data, we use the quantile method as it can capture different quantiles of the dividend and shows how the determinants of the dividend respond at different quantile levels. Moreover, the quantile method provides a clear view of the determinants of the dividend as it groups a given sample into different quantiles that may or may not show similar responses to the determinants of the dividend in linear approaches. The results of the quantile method are presented in Table 5.

Table 5 shows the results of the panel quantile method. The table is divided into three panels: the analysis of the whole sample, the second section is the Shariah-compliant firm and the last section is the non-Shariah-compliant firm. As can be seen in Panel 1, all the factors tested in this study are significant at the 0.01 per cent level. The result is different when compared with the whole sample in the linear approach in Table 4, Model I. For example, only log(size), Tobin's Q and ROA are significant in the linear approach. However, using the quantile approach, we can find a significant difference where three more variables are found to be significant, namely leverage, FCF and risk. The result is consistent at all percentile levels which ranges from 0.10 to 0.90 as shown in Table 5, Section 1.

Table 5: Panel quantile analysis (Main Analysis – Hypothesis 2)

Regressors	Model I: 0.10 quantile	Model II: 0.25 quantile	Model III: 0.50 quantile	Model IV: 0.75 quantile	Model V: 0.90 quantile
Panel 1: Full sample					
$Log(size)_{i,t}$	0.0044***	0.0081***	0.0188***	0.0302***	0.0422***
$Tobin's\ Q_{i,t}$	0.0009***	0.0027***	0.0188***	0.0854***	0.1315***
$ROA_{i,t}$	0.0005***	0.0010***	0.0011***	0.0017***	0.0004***
$Leverage_{i,t}$	-0.0092***	-0.0289***	-0.0653***	-0.0884***	-0.2046***
$FCF_{i,t}$	0.0164***	0.0395***	0.0602***	0.0761***	0.0504***
$Risk_{i,t}$	-0.0047***	-0.0119***	-0.0208***	-0.0304***	-0.0544***
Panel 2: Shariah compliant firms					
$Log(size)_{i,t}$	0.0057***	0.0106***	0.0214***	0.0344***	0.0474***
$Tobin's\ Q_{i,t}$	0.0011***	0.0010***	0.0111***	0.0632***	0.1435***
$ROA_{i,t}$	0.0004***	0.0007***	0.0010***	0.0004***	-0.0020***
$Leverage_{i,t}$	-0.0212***	-0.0415***	-0.0605***	-0.0564***	-0.1711***
$FCF_{i,t}$	0.0146***	0.0434***	0.0594***	0.0359***	0.1431***
$Risk_{i,t}$	-0.0039***	-0.0111***	-0.0220***	-0.0391***	-0.0605***
Panel 3: Non-Shariah compliant firms					
$Log(size)_{i,t}$	0.0032***	0.0105***	0.0155***	0.0228***	0.0289***
$Tobin's\ Q_{i,t}$	0.0035***	0.0179***	0.0627***	0.0975***	0.1083***
$ROA_{i,t}$	0.0009***	0.0038***	0.0050***	0.0034***	0.0035***
$Leverage_{i,t}$	-0.0131***	-0.0337***	-0.0180	-0.1643***	-0.1992***
$FCF_{i,t}$	0.0049***	0.0187***	0.0729***	0.0480***	0.0427***
$Risk_{i,t}$	-0.0026***	-0.0047***	-0.0203***	-0.0247***	-0.0574***

Notes: *Denotes significance at the 10% level. ** Denote significance at the 5% level. *** Denote significance at the 1% level.

In Panel 2, the study discovers another significant difference between using the linear and quantile approaches. The determinants of dividend policy in Shariah compliant firms show that all the variables tested are significant at the 0.01 level. Compared to the results in Table 4, model II, only log(size), Tobin's Q, ROA and free cash flow turn out to be significant determinants of dividend policy using linear approaches. However, when quantile approaches were used, two other variables, leverage and risk, were also found to be significant. Another striking difference discovered in this section is the change in sign from positive and significant to negatively significant. For instance, the quantile ROA from 0.10 to 0.75 was found to be positively significant in determining dividend policy. However, at the 0.90 quantile level, ROA changes to negative significance in determining dividend policy at the 0.01 level.

In Panel 3, the striking difference between linear and quantile approaches continues. In Table 4, model III, only log(size), Tobin's Q, ROA and risk were found to significantly affect dividend policy. In the quantile approaches, on the other hand, all tested variables have a significant impact on dividend policy at the 0.01 level, except ROA. At the 0.50 quantile level, leverage is not a significant determinant of dividend policy for non-Shariah compliant

firms. The signs of the tested variables are consistent at the different quantile levels between 0.10 and 0.90.

As shown in Table 5, the use of the study's quantile regression provides a clear view of the determinants of dividends. Specifically, how different quantiles of dividend levels may affect the determinants of dividends in Shariah-compliant versus non-Shariah-compliant firms. The model presented by hypothesis two allows us to better understand the behaviour of dividend determinants when compared with linear approaches. For example, a variable that has been shown to be insignificant in linear approaches (leverage, FCF and risk) may become significant at different dividend quantile levels. Another example is a variable that has been shown to be positively significant may turn out to be negative at different quantile levels (ROA). It can be concluded that there are significant differences between Shariah-compliant and non-Shariah-compliant firms when compared using quantile approaches. This research proves that the use of quantile method should be carried out to better understand the determinants of dividend as it shows that we cannot treat all quantiles of dividend level at different levels equally.

5. Conclusion

The study examines the different determinants of dividend policy between Shariah and non-Shariah compliant firms. Using data from 2010 to 2019, a panel analysis was conducted, namely random, fixed and quantile analysis. The results indicate that there are significant differences between Shariah and non-Shariah compliant firms in linear approaches and quantile approaches. In linear approaches, firm size, investment opportunities, profitability and free cash flow were found to be significant determinants of dividend policy for Shariah compliant firms. In contrast, firm size, investment opportunities, profitability and risk were found to be significant determinants of dividend policy in non-Shariah-compliant firms. Using the quantiles method, the study found no significant differences between Shariah-compliant and non-Shariah-compliant firms in the determinants of dividends. However, this result is not consistent at every quantile level. For example, profitability was found to negatively affect dividend policy in Shariah-compliant firms at the 0.90 quantile level.

Based on the findings, the study contributes in two ways. First, the study extends the literature on the comparison of Shariah-compliant and non-Shariah-compliant dividends. Previous research on the comparison of dividends focuses on the MENA region and the GCC countries, while less research has been conducted in Malaysia on the comparison of Shariah-compliant and non-Shariah-compliant dividends. This study confirms that the comparison between Shariah-compliant and non-Shariah-compliant dividends in Malaysia is unique as some of the dividend determinants are different from those in the MENA region, GCC countries and neighbouring countries such as Indonesia. Thus, this study confirms that the mixed results of previous empirical studies may be due to the different context of a country, hence the Malaysian context provides unique empirical insights. Secondly, the paper also contributes to the literature by using quantiles approaches, which are neglected especially when examining the determinants of dividends and comparing Shariah-compliant and non-Shariah-compliant firms.

However, this study is not without limitations. First, the data is limited to the Malaysian context, so the results cannot be extrapolated to countries with different environments than Malaysia. Second, the results are limited to a proxy for Shariah compliance obtained from data from the Securities and Exchange Commission. Therefore, the results are not necessarily transferable to other indicators of Shariah compliance. Future studies could therefore consider other indicators of Shariah compliance that might yield similar or different results. Despite this limitation, the study provides new insights into the differences between Shariah and non-Shariah compliance, especially in the Malaysian context using the quantile method.

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Weak Form of Call Auction Prices: Simulation Using Monte Carlo Variants

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Abstract: Research Question: This paper explores the pre-market auction price behaviour. The pre-market auction is a short duration auction, where the orders are executed with too little time for revision by the makers. The literature paid attention to application of random walk hypothesis (RWH) and its variants in efficient market (EMH) tests. **Motivation:** The pre-opening auction is an extremely short duration auction where traders are interested in a limited number of large cap stocks and the orders are not transparent. The interest lies on efficiency tests of discrete prices during the pre-market auction for the benefit of investors. **Idea**: The mechanism of price discovery in call auctions is important since they could impact normal markets. We aim to test major relevant hypotheses for pre-opening equilibrium prices. The rejection of the randomness would mean that it is possible to use historical stock prices alone. **Data**: The sample comprises all 50 NSE 50 Index constituent stocks sampled during the year 2019. The NSE constituent stocks maintain the highest market capitalization and have a long history of trading. **Method/Tools**: It summarizes the source literature on objectively driven synthesis on simulation-based decision making since the early period of 1973. Multivariate lognormal distribution is a challenging method than ordinary univariate Monte Carlo. By generating a 50 X 50 covariance matrix of prices and solving for Cholesky roots, the results were compared against lognormal multivariate Monte Carlo simulation to explore the estimates of volatility. **Findings**: The results demonstrate a good case for the tests of RWH and objectively arriving at the pre-opening equilibrium prices. The co-efficient of variation (COV) remained at 3.33%. We found that the stock prices were correlated among themselves, which infers the weak form of efficiency. Previous results had mentioned that MC generated higher sample variances and unsuitable, however, we found lower variances in using multi-variate Monte Carlo. **Contributions**: The contribution lies in the attempts using multi-variate log normal distribution to deduce prices with lower estimated variance. The results have implications to making trade decisions and portfolio construction during the Covid period, where high degree of persisting decline happened to indices.

Keywords: Pre-opening, efficient, multivariate log-normal, Monte Carlo.
JEL Classification: G11, C14, C15, C19

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1. Introduction

An efficient stock market attracts genuine investors to the capital market. The weak form of efficient market hypothesis (EMH) states that a stock's current price would be reflected in the stock's historical prices (Fama, 1991). In a pre-market auction, the individual trade orders are collated and the equilibrium opening prices are derived for each stock and publicly displayed each day. During the short period auction, the makers cannot see the order position of each other, until the final allocation are displayed at the end of the auction. In an efficient market such equilibrium prices may follow Random Walk (RWH). However, due to the very nature of the pre-market, one would expect the equilibrium prices to have some degree of influence with the stock closing prices of the previous trading day (historical). Shiller (1981) identified that stock prices were volatile than their expected discounted cash flows would have made Camerer (1990) observed that prices were volatile and random. Further works on efficient market hypothesis on normal markets had provided mixed inferences. The pre-opening auction prices would follow random walk and could be consistent with the weak form of the EMH (see Malkiel, 2003; Fama, 1991). There exist alternative methods to test for the weak form of market efficiency (e.g., runs test, unit root test, etc.) on normal trading data. However, the technique of Monte Carlo simulation (MC) were not used abundantly in field applications. The MC method is more relevant today because of the uncertainty during the Covid period, where high degree of te persisting decline happened to indices. Technical analysis could not be relied on because of its strong demand on historical prices alone.

There are few questions examined here; how to use MC simulations to stock prices, how accurate is MC method, how to improve the accuracy and reliability for the simulation of the stock prices, respectively? Although, there are many ways of using MC simulation, this study will concentrate on basic approaches with historical data as input parameters; how effectively and efficiently the prediction may result in knowledge to benefit the investors? The results could demonstrate a good case for the tests of RWH and objectively arriving at the pre-opening equilibrium prices. We would find that the stock prices were correlated among themselves, which infers the weak form of efficiency. The contribution would lie in the attempts using multi-variate log normal distribution to deduce prices with lower estimated variance. The results have implications for making trade decisions and portfolio construction during the Covid period.

The rest of the paper is divided into sections; Section 2 highlights the literature review; Section 3 discusses the Hypotheses; Section 4 explains the methodology; Section 5 describes the data; Section 6 describes the results of simulation. Lastly, Section 7 gives concluding remarks.

2. Literature Review

Early discussions of the RWH quote Tversky and Kahneman (1974) who had suggested ‘the rule of thumb’ in “decision making”. The thumb rule occurs when the current price levels were used as “anchors” to arrive at future prices. Later, a growing body of literature paid attention to application of RWH and its variants in testing forms of the EMH. Camerer (1990) had examined price bubbles to distinguish rational response from irrational herd behaviour in the market. Ariely *et al*. (2006) argued that the judgment approach led to biased response. Few studies had devoted to comparing the results between ARIMA (time series) and MC methods in models of stock price, real estate price, interest rate yield, derivative and option prices, etc.

Table 1 summarizes a chronological account of relevant findings in the literature since early period of 1973. It presents relevant source literature in the domain of objectively driven synthesis on simulation based decision making since early period of 1973. As shown in Table 1, many authors have inferred RWH whereas, only a few have negated RWH. Few authors,

Chang and Ting (2000), negated RWH by variance ratio tests of the Taiwan Stock Exchange index. Lo and MacKinlay (1998) tested RWH using variance ratio and did not confirm it for indices of for USA. The use of MC for auction prices were few. Specifically, the works of Boyle (1977), Hoesli *et al.* (2005), Whiteside (2008), had been discussed in the literature. Hoesli *et al.* (2005) applied MC simulation to derive and compare the Swiss real estate market prices. Hoesli *et al.* (2005) detected the sensitivity of input parameters of MC. Whiteside (2008) had confirmed that MC could be used to simulate conditional distribution in input functions. The useful properties of MC were highlighted in applications of EMH, and RWH. Cheung and Coutts (2001) demonstrated the weak form of Hang Seng index. Abraham *et al.* (2002) tested RWH for Kuwait, Saudi Arabia and Bahrain markets. Buguk and Brorsen (2003) found some evidence of weak form of the Istanbul exchange. Asiri (2008) confirmed RWH for Bahrain stock prices. Erdos and Ormos (2010) inferred weak-form of the US market. Okpara (2010) inferred random walk in the Nigerian market. Alexeev and Tapon (2011) demonstrated the weak-form efficiency for the Toronto Stock Exchange (TSX).

Table 1: Summary of simulations applications to stock prices

Source	Year	Global	Purpose	Inferences & limitations
Malkiel	1973	TSX	Weak form efficiency for stocks.	Weak form efficiency for stocks.
Tversky and Kahneman	1974	Theory	Psychological bias and heuristic judgments in numeric “decision making”.	Heuristic Judgments could lead to strong bias and systemic errors.
Boyle	1977	USA	MC simulation for option pricing.	MC can be used for numerical forecasting of European stock call options that pay dividends.
Camerer	1990	USA	Asset price bubbles.	Rational response is distinguished from irrational bias observed in the market.
Lo and MacKinlay	1998	USA	RWH random walk using variance ratio.	Do not follow random walks, simple specification test.
Chang and Ting	2000	Taiwan	RWH on variance ratio tests of the stock index.	Negated RWH on variance ratio tests of the stock index.
Cheung and Coutts	2001	Cross Country	Weak-form efficiency.	Confirmed weak form
Abeysekera	2001	India	RWH for the Calcutta Stock Exchange (CSE).	Negated RWH
Abraham *et al.*	2002	Cross Country	Variance ratio test to explore the weak-form.	Confirmed weak form
Buguka and Brorsen	2003	Turkey	RWH for stock prices.	Confirmed RWH for stock prices
Jabbour and Liu	2005	Hang Seng	MC simulation by the number of simulations.	MC simulation is increased by a larger number of attempts in simulations.
Hoesli *et al.*	2005	Theory	Monte Carlo simulation finds its application in much wider areas	MC simulation can be adopted for stocks
Ariely *et al.*	2006	USA	The judgment leads to bias and errors carried over previous prices.	Judgments are unreliable

Table 1 ***(continued)***

Source	Year	Global	Purpose	Inferences & limitations
Asiri	2008	Bahrain	Unit root test for RWH for BSE	Prices follow a random walk, confirmed RWH for stock prices
Whiteside	2008	Theoretical	conditional distribution in input functions.	MC could be used to simulate conditional distribution in input functions.
Charles and Darne	2009	Shanghai & Shenzhen	RWH.	RWH was rejected.
Farid *et al.*	2010	Tehran	Generated (VaR) with MC for automobile stocks.	Suggested generating VaR (value at risk) forecast with MC
Erdos and Ormos	2010	USA	Tested weak-form of the US market.	Confirmed weak form
Okpara	2010	Nigerian	RWH	Confirmed random walk
Gupta and Siddiqui	2010	Teheran	RWH and used the Kolmogorov–Smirnov test (K–S) test.	did not exhibit a weak form of market efficiency.
Alexeev and Tapon	2011	Toronto	Demonstrated the weak-form efficiency.	Confirmed weak-form efficiency for the TSE
Landauskas and Valakevičius	2011		Compared standard MC simulation with Markov chain MC simulation (MCMC).	After 300 executed trajectories, the average stock price after 50 trades was exactly the same.
Khan *et al.*	2011	India	Used the unit root test and the GARCH model to test RWH for BSE and NSE	Negated the presence of RWH.
Khan and Vieito	2012	Portuguese	Efficient market hypothesis.	Did not Infer RWH, market was inefficient.
Pant and Bishnoi	2012	India	Used unit root test, autocorrelation and variance ratio to NSE.	RWH was rejected.
Abidin and Jaffar	2014	Malaysian	Implemented MC to Malaysian stocks to find its acceptance.	MC is applicable to stocks
Kyng and Otto	2014	Europe	Multivariate normal Log- normal distribution to European stock options	Suggested multi-asset, multi-period simulation to arrive at the option price.
Mishra *et al.*	2015	India	RWH	Rejected the presence of RWH.
Sonono and Mashele	2015	South Africa	Compared MC with the VG (parametric) model in stock price behaviour in terms of the hit ratios applied to the JSE top 40 index.	GBM worked better than the VG (parametric) model in terms of the hit ratios.
Reddy and Clinton	2016	Australia	Deployed MC for multi-period price samples of large stocks.	Inferred MC as a promising technique for simulation of prices.
Zhang	2020	Asia	Adopted MC for Asian option prices	Derived higher accuracy in a forecast of Asian option prices using Monte Carlo

Notes: Authors' compilation from literature.

However, the tests of RWH by using MC methods specific to call auction price were few. In separate studies, Timothy and Otto (2014), had implemented multivariate distribution model to European stock options to confirm their usability. Abidin and Jaffar (2014) had implemented MC to Malaysian stocks to find its acceptance. Reddy and Clinton (2016) deployed MC to Australian stocks to compare its accuracy over other methods. Boyle (1977) presented the application of the MC to option pricing, who modelled underlying stock returns as continuous and sudden processes. Jabbour and Liu (2005) found that MC simulation accuracy improved with larger number of simulations. Landauskas and Valakevičius (2011) compared standard MC simulation with Markov chain MC simulation (MCMC) on similar trades. After 300 executed trajectories, Landauskas and Valakevičius (2011) found that the average stock price of a sample of 50 trades were identical in both methods. Landauskas and Valakevičius (2011) stated that more number of intervals used in sampling led to higher forecast accuracy. Similarly, the specific tests of accepting RWH were also conducted by few other authors, namely, Charles and Darne (2009) rejected RWH for the Shanghai and Shenzhen markets. Khan and Vieito (2012) inferred that the Portuguese market was inefficient. Sonono and Mashele (2015) showed that the GBM worked better than the VG (parametric) model in stock price behaviour in terms of the hit ratios applied to JSE (South Africa). Zhang (2020) adopted MC for Asian option prices, and, derived higher accuracy in forecast of option prices using MC. Farid *et al*. (2010) suggested generating VaR (value at risk) forecast with MC simulation for automobile stocks in Tehran. Khan *et al*. (2011) used the unit root test and the GARCH model to test RWH for BSE and NSE in India. Gupta and Siddiqui (2010) examined the RWH for the NSE indices in India and used the Kolmogorov–Smirnov test (K–S) test. The results did not exhibit a weak form of market efficiency. Pant and Bishnoi (2012) used unit root test, autocorrelation and variance ratio tests to reject the RWH for NSE. Mishra *et al*. (2015) conduct unit root tests on NSE indices and failed to support RWH. Siddiqui and Patil (2017) also demonstrated that the MC were suited for many Indian stock prices.

3. Hypotheses

As mentioned above, previous findings on RWH tests using methods other than MC based were mixed in nature. Mishra et al (2015) tested RWH on NSE indices and failed to support it. Gupta and Siddiqui (2010) examined the RWH for the NSE indices in India and could not confirm the weak form of market efficiency. We therefore, proceed to test the following hypotheses to characterize the behaviour of pre-opening equilibrium prices.

If the random walk hypothesis is rejected for pre-opening prices, it would imply that historical prices are related to current prices.

H_1: Call auction equilibrium prices follow random walk.

Alternatively, if prices exhibit pure randomness, one cannot foresee prices to his/her benefit.

H_2: The correlation between equilibrium prices today and the previous day are insignificant.

Alternatively, if prices exhibit pure randomness, there is no possibility of correlations among stocks either.

H_3: The correlation between the auction prices of different stocks is insignificant.

If the MC method is an appropriate candidate for simulation, an appropriate distribution exists to achieve accurate forecast prices.

H_4: Multivariate lognormal distribution could provide higher accuracy than simple univariate MC.

4. Methodology

The MC (Geometric Brownian Motion) with normal distribution is a case of dimension independence. It differs from numerical analysis whose accuracy could fall with more number of dimensions. The basic notion is that the future prices are conditionally independent of past prices. The common geometric Brownian motion GBM is a Markov process is given as:

$$\Delta P_{i,t} / P_{i,t} = \mu\Delta t + \sigma\varepsilon\sqrt{\Delta t}) \quad (1)$$

where "P" is the stock price, "μ" is the expected return, "σ" (Greek sigma) is the standard deviation of returns, "t" is Time Step, and "ε " (Greek epsilon) is the random variable.

$$\text{or } \Delta P_{i,t} = P_{i,t} (\mu\Delta t + \sigma\varepsilon\sqrt{\Delta t}) \quad (2)$$

where, $\mu\Delta t$ is the drift, and $\sigma\varepsilon\sqrt{\Delta t}$ is the shock. Price drifts up by the expected return for each period. But the drift will be shocked (added or subtracted) by a random term. The stock price follows increments where each increment is a drift plus/minus a random shock of the standard deviation (σ). The residual between the log of Prices (ΔP_t) in two consecutive periods are given as:

$$\varepsilon_t = \text{Log}(P_t) - \text{Log}\ (P_{t-1}) \quad (3)$$

The residuals "ε_t" represent the prediction error observed to analyze the weak form hypothesis. Subsequently, the Multivariate Monte Carlo Simulation (MVMC) is described by relaxing independence assumption, which takes into consideration the correlation between prices. Suppose that $X = (X_1,..., X_n)$ is a random vector (natural log of equilibrium prices of N stocks), then Σ, the covariance matrix of X, is the (n×n) matrix that has $(i, j)^{th}$ element given by:

$$\Sigma_{i,j}\ (C) = \text{Cov}(X_i, X_j) \quad (4)$$

The Cholesky Decomposition of Covariance Matrix could reduce the Covariance Matrix to a lower triangular matrix. The Cholesky Matrix is written as:

$$\Sigma = LDL^T \quad (5)$$

where, L is a lower triangular matrix and D is a diagonal matrix with positive diagonal elements. Since the variance-covariance (VACOV) matrix (Σ) is symmetric positive-definite, we can therefore write:

$$\Sigma = LDL^T = (L\sqrt{D})(\sqrt{D}L^T) = (\sqrt{D}L^T)^T(\sqrt{D}L) \quad (6)$$

where, the matrix $C = \sqrt{D}L^T$ satisfies:

$$C^TC = \Sigma \quad (7)$$

where C is the Cholesky Decomposition of Σ. We generate random prices by using a multivariate lognormal random vector with mean μ and variance-covariance (VACOV) matrix $\Sigma^{'}$, which are passed as input:

$$X = (e^{Y1},...,e^{Yn}) \quad (8)$$

where $Y := (Y_1,...,Y_n) \sim MN(\mu,\Sigma)$. Since, X = exp(Y), the natural log of prices, Ys are generated. We proceed to implement the above methods to our test sample dataset.

5. Data

The sample comprises NSE 50 Index constituent stocks, which have a long history of trading. The reason for picking NIFTY stocks is the availability of adequate historical data, greater volume of transactions, and consistency as the elements of a popular index. Due to their larger volumes, NIFTY stocks also attract greater institutional interest during the pre-market period. The period of sampling days pertained to the year 2019. The equilibrium prices were collected for consecutive 30 trading days. Each day, the data were collected only after NSE displayed the equilibrium prices after 9.15AM, which is the closing time of pre-opening call.

The descriptive statistics of 50 NSE stocks are given in Table 2, which includes the average equilibrium prices, Std. dev. of prices, average volume of trading, average value of trading, and market capitalization, respectively. The standard deviation of prices varies from 0.82% to 3.53% in the sample. The volume of auctions during pre-market is related to the market capitalization of stocks. There is no observed relationship between standard deviation of prices and market capitalization.

6. Results

The test results against each hypothesis are described here. We proceed with the first 500 simple MC simulation trials. Later, we conduct 500 independent trials for multi-variate log normal distribution. We calculate the t-values and compare the probability of significance for 99.99% confidence limits (95% confidence limit, $t_{TABULATED} = 1.6$, and, 99.99% confidence limit $t_{TABULATED} = 3.46$).

For the correlation tests, we follow Ratner (2009) who suggests that the Pearson coefficient higher than (≥) 0.3 is numerically significant. For the first hypothesis, for example, for the ticker ACC as in Table 2, Average (ε_t) = -0.001; Standard Error (ε_t) = 0.00; $t_{CALCULATED}$=| -0.001/0.003| = 0.21. Since, $t_{CALCULATED} < t_{TABULATED}$, the null hypothesis cannot be rejected. Therefore, auction prices follow a random distribution. We continue to compute the Standard Error (εt) to infer insignificant $t_{CALCULATED}$ for similar other tickers named in Table 1. The results are similar to those reported by Asiri (2008) and Okpara (2010).

We compute the correlation between each stock's residual errors (εt,εt-1) in the second hypothesis separately. As in Table 2, for the first ticker ACC, $\rho_t = -0.31$. Since $\rho_t > 0.3$, it is significant. Therefore, the null hypothesis cannot be rejected. We continue to compute the correlation tests to infer significant $t_{CALCULATED}$ for similar other tickers named in Table 1. The reported tests are similar to the findings of Reddy and Clinton (2016), who have also reported a negative correlation (ρ) during short periods of simulation.

Towards the third hypotheses of correlations between any two stocks, we compute the correlations ($\rho_{i,j}$) between the residual errors in the sample. As in Table 2, for example, between the tickers ACC and Ambuja Cements, we find the correlation ($\rho_{i,j}$) equals 0.67. Since $\rho_{i,j} > 0.3$, it is significant. Therefore, the null hypothesis cannot be rejected.

We continue to compute the correlation tests to infer significant $t_{CALCULATED}$ for similar other tickers named in Table 1. These results are in line with the findings of Schwartz and Whitcomb (1977) and Pant and Bishnoi (2012).

Table 2: Descriptive statistics

No.	Ticker	Average price (INR)	Std. dev. of price (INR)	Average volume (No)	Average value (INR 0.1 mil.)	Average market capitalization (INR 10 mil.)
1	ACC CEMENT LTD	1,462.79	20.43	235.13	3.43	13,677
2	AMBUJA CEMENT LTD	221.18	3.10	2,020.50	4.46	16,906
3	ASIAN PAINTS LTD	572.21	13.51	864.63	4.91	25,796
4	AXIS BANK	1,887.73	37.78	1,019.13	19.14	62,290
5	BAJAJ AUTO LTD	2,217.08	57.53	306.00	6.93	29,615
6	BANK OF BARODA	855.07	16.57	1,575.13	13.43	15,980
7	BHARTI AIRTEL	338.84	2.77	3,413.13	11.57	40,110
8	BHEL ELECTRICAL LTD	245.49	5.58	9,118.63	22.28	22,089
9	BPCL PETROLEUM LTD	572.02	15.81	3,434.75	19.64	14,805
10	CAIRN ENERGY	371.29	4.12	2,078.25	7.73	21,771
11	CIPLA LTD	425.60	4.51	2,075.88	8.85	21,531
12	COAL INDIA LTD	391.07	6.51	5,108.88	19.90	25,518
13	DLF ESTATES	212.71	6.53	10,258.50	21.73	9,410
14	DR.REDDY'S PHARMA	2,455.15	32.36	254.63	6.20	31,135
15	GAIL LTD	448.32	11.11	2,279.13	10.36	20,837
16	GRASIM LTD	3,508.21	53.58	70.50	2.48	22,281
17	HCLTECH	1,426.69	18.19	672.63	9.61	38,473
18	HDFC LTD	979.43	13.94	1,566.13	15.52	153,225
19	HDFC BANK	827.91	8.73	2,206.50	18.19	153,052
20	HEROMOTO CORP	2,606.00	70.36	6,516.38	176.97	31,026
21	HINDALCO	166.69	1.85	5,565.88	9.30	21,305
22	HINDUSTAN UNILEVER	622.26	5.50	717.25	4.48	44,130
23	ICICI BANK LTD	1,425.09	19.47	2,299.75	32.75	163,445
24	IDFC LTD	129.02	1.41	10,658.88	13.70	16,112
25	INDUSIND BANK	563.00	11.42	537.63	3.04	24,407
26	INFOSYS LTD	3,243.67	45.83	1,604.00	52.07	156,655
27	ITC LTD	326.16	10.40	20,984.13	67.04	180,026
28	JINDAL STEEL LTD	326.20	7.16	1,643.25	5.36	11,703
29	KOTAK BANK	911.73	30.28	1,059.75	9.60	34,695
30	L & T LTD	1,675.26	21.81	2,385.13	40.20	135,366
31	LUPIN PHARMA	1,011.56	13.26	326.63	3.30	24,070
32	M &M LTD	1,177.71	25.65	1,661.38	19.60	54,110
33	MARUTI LTD	2,431.41	48.38	776.63	19.01	32,047
34	MCDOWELLS BEVERAGES	2,650.45	93.69	626.88	16.19	20,607
35	NMDC MINERALS LTD	178.96	4.36	2,552.25	4.52	14,091
36	NTPC POWER LTD	154.34	3.33	6,742.13	10.42	31,598
37	ONGC GAS LTD	428.65	12.16	24,910.38	106.29	76,760
38	PNB BANK	967.57	10.85	518.75	5.02	14,352
39	POWERGRID CORP OF INDIA	133.28	1.78	5,026.38	6.69	29,209
40	RELIANCE INDUSTRIES	1,049.36	28.28	10,936.63	113.33	171,092
41	SBI BANK OF INDIA	2,645.71	45.73	1,502.38	39.73	81,454
42	SS SESA STERLITE LIMITED	295.37	2.93	6,065.00	17.93	36,431
43	SUNPHARMA LTD	634.98	7.83	3,859.50	24.94	47,671
44	TATAMOTORS LTD	440.10	4.94	6,225.00	420.28	78,855
45	TATAPOWER LTD	104.21	1.98	5,527.25	5.74	18,782
46	TATASTEEL LTD	529.34	9.19	4,938.38	26.15	35,010
47	TCS SOFTWARE LTD	2,279.74	31.85	655.00	14.94	117,556
48	TECH MAHNIDRA LTD	2,012.53	18.45	1,524.50	30.69	30,042
49	ULTRA CEMENT CO	2,738.54	36.64	95.88	2.64	27,990
50	WIPRO	533.87	4.38	917.00	4.90	34,884

Notes: National Stock Exchange of India (2019)

In continuation, using simple MC, Table 3 produces the summary statistics of simple univariate MC simulation on the sample of 50 stocks.

Table 3: Univariate log-normal MC simulation of 100 trials

No.	Stock Name	Mean	Median	Std dev	Co-efficient of variation	Min	Max
1	ACC CEMENT LTD	1469.75	1467.32	6.75	0.46%	1459.53	1482.76
2	AMBUJA CEMENT LTD	226.91	227.08	0.63	0.28%	225.58	227.84
3	ASIAN PAINTS LTD	551.61	551.32	1.40	0.25%	549.40	555.35
4	AXIS BANK	1879.19	1882.85	13.94	0.74%	1853.48	1898.72
5	BAJAJ AUTO LTD	2133.31	2141.20	17.65	0.83%	1758.70	2608.91
6	BANK OF BARODA	869.60	869.35	3.99	0.46%	861.92	877.28
7	BHARTI AIRTEL	340.83	340.94	1.23	0.36%	337.94	342.92
8	BHEL ELECTRICAL LTD	245.98	246.44	1.39	0.57%	242.51	247.99
9	BPCL PETROLEUM LTD	596.68	595.38	3.65	0.61%	591.25	606.02
10	CAIRN ENERGY	377.08	376.78	1.07	0.28%	375.48	379.29
11	CIPLA LTD	418.36	418.37	1.15	0.27%	414.99	420.24
12	COAL INDIA LTD	394.31	393.60	2.33	0.59%	390.28	398.69
13	DLF ESTATES	229.33	229.33	1.64	0.72%	225.26	233.13
14	DR. REDDY'S PHARMA	2431.52	2432.36	3.59	0.15%	2422.99	2436.96
15	GAIL LTD	438.20	439.35	6.24	1.42%	426.62	447.57
16	GRASIM LTD	3600.88	3604.80	7.66	0.21%	3580.02	3611.85
17	HCLTECH	1401.14	1401.39	3.46	0.25%	1393.34	1408.12
18	HDFC LTD	979.38	978.82	3.36	0.34%	973.17	986.80
19	HDFC BANK	842.44	842.49	0.82	0.10%	840.82	844.79
20	HEROMOTO CORP	2728.85	2726.42	22.19	0.81%	2680.64	2766.53
21	HINDALCO	167.40	167.12	0.96	0.57%	165.80	169.57
22	HINDUSTAN UNILEVER	629.61	629.54	1.52	0.24%	626.79	632.80
23	ICICI BANK LTD	1456.50	1457.12	5.96	0.41%	1445.34	1466.71
24	IDFC LTD	131.77	131.76	0.25	0.19%	131.25	132.37
25	INDUSIND BANK	553.34	553.75	1.84	0.33%	549.20	556.79
26	INFOSYS LTD	3193.93	3193.28	9.51	0.30%	3174.75	3216.85
27	ITC LTD	337.70	337.54	0.92	0.27%	335.66	340.15
28	JINDAL STEEL LTD	342.07	342.95	3.12	0.91%	335.59	348.04
29	KOTAK BANK	929.35	929.24	4.96	0.53%	918.91	938.95
30	L & T LTD	1722.42	1722.49	8.11	0.47%	1700.97	1737.62
31	LUPIN PHARMA	987.87	987.90	2.26	0.23%	983.38	992.32
32	M &M LTD	1230.49	1230.30	3.11	0.25%	1223.93	1238.17
33	MARUTI LTD	2515.63	2511.06	17.68	0.70%	2482.82	2546.98
34	MCDOWELLS BEVERAGES	2779.87	2780.90	29.57	1.06%	2721.64	2844.93
35	NMDC MINERALS LTD	188.46	188.42	1.61	0.85%	185.59	191.60
36	NTPC POWER LTD	161.42	161.32	0.43	0.27%	160.61	162.45
37	ONGC GAS LTD	439.97	441.58	4.60	1.05%	428.53	445.70
38	PNB BANK	979.77	979.87	1.42	0.14%	976.65	982.04
39	POWERGRID CORP OF INDIA	137.93	138.03	0.49	0.36%	137.00	138.85
40	RELIANCE INDUSTRIES	1091.82	1091.48	6.42	0.59%	1081.65	1102.26
41	SBI BANK OF INDIA	2696.16	2697.89	11.29	0.42%	2674.44	2713.64
42	SS SESA STERLITE LIMITED	295.88	295.48	1.55	0.52%	293.25	299.22
43	SUNPHARMA LTD	630.34	630.18	1.35	0.21%	627.65	633.27
44	TATAMOTORS LTD	448.33	448.28	1.14	0.25%	445.83	450.65
45	TATAPOWER LTD	107.21	107.04	0.55	0.51%	106.45	108.35
46	TATASTEEL LTD	543.11	543.21	5.41	1.00%	532.36	550.62
47	TCS SOFTWARE LTD	2246.14	2244.44	6.14	0.27%	2235.29	2260.83
48	TECH MAHNIDRA LTD	1985.22	1985.87	5.14	0.26%	1974.18	1992.67
49	ULTRA CEMENT CO LTD	2775.71	2776.64	7.28	0.26%	2755.85	2787.22
50	WIPRO LTD	530.79	530.96	1.41	0.27%	527.64	533.33

Notes: National Stock Exchange of India (2019)

Table 3 shows the higher deviation between historical volatility and estimates, displaying the nature of a karyolitic curve. As shown in Table 2, the standard deviation of prices varied from 0.82% to 3.53%. However, in simulated output, the standard deviation estimates vary

from 0.1% to 1.42%, which have fallen, by about 3/4th of the actual variance. This implies univariate MC simulation cannot be accepted for field use and prediction. Therefore, simple MC generates prices which are not close to the actual.

In continuation, towards the fourth hypothesis Table 4 shows the summary statistics of multivariate MC simulation on the sample of 50 stocks.

The standard deviation varies between 0.68% to 3.33%, which is closer to the historical variation between 0.82% to 3.53%, in descriptive statistics in Table 2. Therefore, we cannot reject the null hypothesis which is the fourth hypothesis. This is in consonance with the findings of Milevsky and Posner (1998). In contrast Clewlow and Strickland (1998), and Hull and White (2012) had mentioned that MC generated higher sample variances and unsuitable, we found multi-variate that reduces the variance.

Overall, the findings are consistent with the weak form of the EMH. The implications of these findings are important to portfolio managers and investors. Since the simulated prices vary within reasonable limit, they can be used as forecast prices. The prediction may result in knowledge to benefit the investors. The novelty of this research stems from the lack of an exact current method that either use semi-parametric or time series techniques to price behaviour. The MC method can potentially become an effective tool to predict and model stock prices. MC simulation has advantages over time series based ARIMA models (Abidin and Jaffar, 2012). Although it is often highlighted that when the number of variables are many in the dataset, PDE (Partial Differential Equations), numerical techniques (or finite difference methods) are less practical. Hence, the Monte-Carlo method provides an effective approach for complex situations such as multi-dimensionality.

7. Conclusions

This paper investigated the mechanism of price discovery in pre-opening call auctions. The pre-opening auction is an extremely short duration auction where traders are interested in a limited number of large-cap stocks. This study examined weak-form efficiency for companies listed in NSE50. By generating a 50 X 50 covariance matrix of prices and solving for Cholesky roots, the results were compared with lognormal multivariate MC simulation to explore the estimates of volatility. We found that the stock prices were correlated among themselves, which infers the weak form of efficiency for pre-market auction prices.

The difference in the results of this study lies in the unique approach of choosing multi-variate log normal distribution to produce a lower estimated variance. The weak-form efficiency is observed using MC evaluation. Monte Carlo method (MC) was not used abundantly in field applications. The prediction may result in knowledge to benefit the investors. This method is more relevant today because of the uncertainty during the Covid period.

There are few limitations in the use of Multivariate lognormal distribution. MC model rely on the assumption of normality of returns. The other limitation is it does not provide comparative analysis against other predictive methods like Martingale. Since the long-run estimates of variances may not remain stable, MC is only suitable for short-run price forecasts. Further works must conduct add more relevant economic factors to improve the performance of MC simulations. Further research may explore innovative variants of Monte Carlo methods to be applied to stock prices, or indices. Lastly, portfolio-level tests of pre-market auction prices, and long-run historical simulation would be beneficial to develop robust trade strategies.

Table 4: Multivariate log-normal MC simulation

No.	Stock Name	Mean	Median	Std. Dev.	Coefficient of variation	Min	Max
1	ACC CEMENT LTD	1468.76	1470.41	20.84	1.42%	1426.00	1515.35
2	AMBUJA CEMENT LTD	224.63	224.61	3.37	1.50%	216.22	231.92
3	ASIAN PAINTS LTD	553.97	553.16	13.64	2.46%	522.06	584.17
4	AXIS BANK	1903.28	1900.67	34.19	1.80%	1827.28	1984.57
5	BAJAJ AUTO LTD	2208.90	2206.94	51.96	2.35%	2059.39	2337.87
6	BANK OFBARODA	871.74	871.61	17.71	2.03%	832.16	914.83
7	BHARTI AIRTEL	342.23	341.90	3.03	0.89%	336.82	350.96
8	BHEL ELECTRICAL LTD	245.85	245.69	4.88	1.98%	235.72	257.47
9	BPCL PETROLEUM LTD	595.58	593.84	15.89	2.67%	562.97	630.90
10	CAIRN ENERGY	374.43	374.94	4.31	1.15%	364.30	383.93
11	CIPLA LTD	415.75	415.98	4.49	1.08%	401.73	423.01
12	COAL INDIA LTD	397.21	396.98	7.02	1.77%	381.21	414.95
13	DLF ESTATES	222.22	222.30	6.61	2.97%	205.61	238.33
14	DR.REDDY'S PHARMA	2441.69	2440.68	35.85	1.47%	2359.94	2520.39
15	GAIL LTD	435.56	436.33	10.34	2.37%	415.55	461.23
16	GRASIM LTD	3558.14	3554.09	53.48	1.50%	3430.47	3685.17
17	HCLTECH	1412.63	1415.42	16.68	1.18%	1368.06	1443.11
18	HDFC LTD	979.86	980.37	14.86	1.52%	928.37	1023.40
19	HDFC BANK	839.46	838.86	9.00	1.07%	819.48	861.26
20	HEROMOTO CORP	2707.60	2704.30	68.66	2.54%	2563.34	2874.28
21	HINDALCO	168.54	168.73	1.93	1.15%	163.61	173.08
22	HINDUSTAN UNILEVER	628.82	628.59	6.03	0.96%	614.78	644.07
23	ICICI BANK LTD	1452.15	1455.39	19.40	1.34%	1402.28	1498.70
24	IDFC LTD	130.81	130.82	1.40	1.07%	127.55	133.99
25	INDUSIND BANK	558.32	557.64	11.51	2.06%	534.11	593.52
26	INFOSYS LTD	3193.89	3196.99	41.74	1.31%	3097.05	3281.43
27	ITC LTD	334.08	334.43	10.67	3.19%	305.80	364.26
28	JINDAL STEEL LTD	334.95	334.91	6.87	2.05%	321.03	350.38
29	KOTAK BANK	926.97	930.32	30.90	3.33%	846.97	1019.43
30	L & T LTD	1719.53	1720.30	19.79	1.15%	1676.22	1766.13
31	LUPIN PHARMA	995.99	994.61	10.78	1.08%	973.10	1022.31
32	M &M LTD	1225.90	1224.77	27.78	2.27%	1149.53	1307.68
33	MARUTI LTD	2480.85	2483.25	46.07	1.86%	2379.03	2575.97
34	MCDOWELLS BEVERAGES	2732.75	2728.40	87.37	3.20%	2509.99	2953.02
35	NMDC MINERALS LTD	185.46	185.56	4.19	2.26%	174.86	195.43
36	NTPC POWER LTD	159.61	160.18	3.20	2.00%	151.78	166.50
37	ONGC GAS LTD	430.00	430.22	9.69	2.25%	408.06	455.38
38	PNB BANK	978.53	978.61	12.05	1.23%	950.15	1010.41
39	POWERGRID CORP OF INDIA	136.48	136.43	1.61	1.18%	132.66	140.03
40	RELIANCE INDUSTRIES	1088.85	1086.04	28.34	2.60%	1027.22	1178.81
41	SBI BANK OF INDIA	2699.76	2698.52	45.65	1.69%	2571.39	2843.33
42	SESA STERLITE LIMITED	293.04	292.82	2.53	0.86%	287.69	301.28
43	SUNPHARMA LTD	634.31	634.05	6.77	1.07%	612.28	648.44
44	TATAMOTORS LTD	447.83	448.35	4.64	1.04%	435.08	456.17
45	TATAPOWER LTD	107.53	107.59	2.14	1.99%	101.48	112.53
46	TATASTEEL LTD	545.38	545.88	8.95	1.64%	522.73	565.68
47	TCS SOFTWARE LTD	2246.90	2248.49	28.59	1.27%	2167.87	2316.08
48	TECH MAHNIDRA LTD	1999.87	1999.21	14.58	0.73%	1969.43	2046.53
49	ULTRA CEMENT CO LTD	2752.81	2756.75	36.35	1.32%	2654.09	2855.53
50	WIPRO LTD	532.82	532.85	3.63	0.68%	524.64	544.58

Notes: National Stock Exchange of India (2019)

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The Effects of Lockdown, Economic Stimulus Packages and National Recovery Plan Announcements on the Malaysian Stock Market

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Research Question: This research aims to investigate the effects of lockdown, economic stimulus packages and national recovery plan announcements during the COVID-19 pandemic on the Malaysian stock market. **Motivation:** This study will provide insight on how the efforts made by the Malaysian government to battle the pandemic through different types of announcements will affect the Malaysian stock market across different industries. **Idea:** This study posits that all events i.e., lockdown, economic stimulus packages and recovery plan announcements will significantly influence the behaviour of the Malaysian stock market. **Data:** A sample of 13 sectorial indexes are selected. The sample period taken for the study is from January 2, 2019 to October 29, 2021. **Method/Tools:** The study employs an event study methodology. Cumulative abnormal return (CAR) is used to calculate the total of all abnormal returns surrounding the announcements. The event window employed in this study is 10 days i.e. five days before (-5 to -1) and five days after (+1 to +5) the announcements. When there is an overlapping event, a shorter event window such as one/two days before and one/two days after the announcement will be examined for robustness testing. **Findings:** The results of the study show that the impact of all announcements varies across different time periods. For example, the first three Movement Control Order (MCO) 1.0, 2.0 and 3.0 announcements have significantly affected the indexes negatively, while the Total Lockdown (TL) announcement at a later period lead to a positive impact. **Contributions:** Findings of this study have important implications for policymakers and investors. Handling and managing the stock market during the pandemic requires a sensible strategy, in which officials should quickly notify the public of their intended plan without causing panic or any feeling of insecurity. For investors, these results are useful for them to manage their investment portfolio and risk.

Keywords: COVID-19, lockdown, stock market, stimulus package, recovery plan, Malaysia.
JEL Classification: E61, G10, G18

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1. Introduction

On 25th January 2020, the first three cases of COVID-19 were detected in Malaysia after the infection was confirmed among three travellers from Wuhan, China. On 16th March 2020, the Prime Minister of Malaysia held a live countrywide telecast to declare the decision of the central government in enforcing the first Movement Control Order (MCO 1.0), a countrywide lockdown order from 18th March 2020 to 31st March 2020. The Malaysian government announced another two MCOs and a Total Lockdown event afterwards. Malaysia's economy stems from both external and internal factors. In terms of external factors, as China and Singapore are the largest trading partners of Malaysia, these countries were also facing disruption to their industrial efficiency and economy brought by the COVID-19 pandemic. Any damage that affects the industrial efficiency of China could cause a severe influence on local Malaysian producers or manufacturers which greatly rely upon raw materials from China. Aside from trade, most tourists who visit Malaysia also come from China. When Malaysia's borders were closed, the airline and hotel industries had to swallow the hardest hit from the implementation of the lockdown.

On the other hand, in regards to internal factors and in view of macroeconomics, MCO 1.0 had restrained business operations and interstate travel had caused massive negative influences on the scales of consumption and business investment in the local economy. Most domestic businesses such as sole proprietors and small and medium enterprises (SMEs) which were impacted by the lockdown had to deal with the liquidity crisis related to shrinking in their earnings and cash flow problems. As a result, many businesses and individual entrepreneurs were forced to shut down and file for bankruptcy. It has been proven that the COVID-19 pandemic has influential impacts to the economy of a country (El Keshky *et al.*, 2020). Some pundits, such as Tejvan (2018), stated that when the economy is anticipated to enter a recession, the stock markets will typically show a downturn. On the other hand, Brown (2019) mentioned that when the economy is weak, it does not necessarily indicate that the stock market is weak as well. Therefore, in this research, the question is, do the events caused by the COVID-19 pandemic affect the Malaysian stock market, including all the other industrial indexes?

When this worldwide, life-threatening and infectious disease is mentioned, many pessimistic thoughts and fears cross into investors' minds. Undoubtedly, it was shown that the COVID-19 pandemic also greatly affected the stock market in Malaysia. Among the publicly traded companies, a majority of the primary shareholders disposed their stocks during the early few trading days of MCO 1.0 as a consequence of the uncertainty brought by the COVID-19 pandemic (The Star, 2020). In general, the Kuala Lumpur Composite Index (KLCI) had encountered a decreasing trend since early January 2020, and on 19th March 2020, the second day of MCO, the KLCI had reported its lowest number of 1,219.71 in the last 10 years. Airline stocks were the most downtrodden stocks in 2020, and several blue chip stocks such as consumer products and banking could not avoid the downturn. However, some stocks involved in the healthcare industry performed extremely well, especially glove manufacturers (Bloomberg, 2020). Several empirical research showed evidence that the Malaysian stock market are influenced by investor sentiments. Some researchers found that in the short run, the Malaysian stock market had positive impacts and overreact to intense internal and external events such as economic crisis, domestic political events, and the SARS outbreak which happened in 2002 (Ali, *et al.*, 2010; Ali *et al.*, 2020). On the contrary, Chia *et al.* (2020) argued that in the short run, the Malaysian stock market was impacted negatively but insignificantly by daily new confirmed COVID-19 cases and deaths. These researchers also stated that the lockdown had favourable and significant impacts on the Malaysian stock market, most likely due to the economic stimulus packages.

Since there were no further details on the effects of these events on the Malaysian stock market, this research mainly focuses on the effects of the lockdown, the economic stimulus package and the national recovery plan due to the COVID-19 pandemic on the Malaysian stock market. For now, the major gap in other published studies related to COVID-19 is the insufficiency of thorough insight on the effects of COVID-19 facing all industries in a specific market. It is noteworthy that the COVID-19 pandemic lasted for more than a year and it impacted all industries. Therefore, this research tackles the gap in knowledge by involving all the industrial indexes in Malaysia as the sample of research. These industrial indexes include (1) Consumer, (2) Construction, (3) Energy, (4) Finance, (5) Healthcare, (6) Industrial Product, (7) Plantation, (8) Property, (9) REIT, (10) Technology, (11) Telecommunication, (12) Transportation and (13) Utilities.

2. Literature Review

2.1 Infectious Virus Outbreak and Stock Market

It is undeniable that an infectious disease event could affect a wide range of economic and social consequences, which is also shown in stock market performances. Previous research on the effects of H7N9 on the stock market by Jiang *et al.* (2017), using a distributed lag non-linear model, claimed that in China, the stock market's movement, driven by investors' concern and negativity about future profits due to the epidemic, resulted in major economic damage to markets. Despite that, studies on the performances of stock markets during outbreaks of infectious diseases are still few (Ali *et al.*, 2010; Donadelli *et al.*, 2017; Jiang *et al.*, 2017). Although Hong Kong was severely affected by the SARS outbreak, there was no significant impact towards the Hang Seng Index (Siu & Wong, 2004). During the 2014 Ebola outbreak, associated with extensive media exposure, the event had affected US stock prices. Ichev and Marinč (2018) used event-study and regression-based approach and revealed that the effect on stock prices typically shows adverse effects, and domestic news coverage, on the other hand, has a substantial influence on local stock exchange, and the impact is particularly more noticeable in small-cap, more volatile equities, and less stable industries. Similarly, Nippani and Washer (2004) showed that the SARS outbreak only caused adverse impacts to the stock markets of China and Vietnam.

Several researchers used event-study approach with GARCH process to examine that in relation to the Taiwan stock market, the SARS outbreak had negative impacts only for certain industries such as hospitality, tourism, wholesalers, and retail industries. In contrast, the biotechnology industry exhibited a significant positive connection with stock returns in Taiwan during the SARS outbreak (Chen *et al.*, 2007; Chen *et al.*, 2009). The investigation by Jiang *et al.* (2017) concluded that there is a significant connection between the daily registered number of Influenza A virus H7N9 cases and the overall stock price of the Shanghai Composite Index along with the stock price related to traditional Chinese medicine and biological and biomedicine manufacturing industries in China.

2.2 COVID-19 and Stock Market

Most of the preliminary research showed the negative impacts of the COVID-19 pandemic on global stock market performance (Al-Awadhi *et al.*, 2020; Ashraf, 2020; Alfaro *et al.*, 2020; Zhang *et al.*, 2020; Liu *et al.*, 2020; He *et al.*, 2020; Hassan and Gavilanes, 2021; Kodres, 2020; Zeren and Hizarci, 2020). Due to COVID-19, the biggest negatively impacted sectors on the stock market include oil & gas, apparels, automotive, transportation, manufacturing, and hotel businesses (Schoenfeld, 2020). Several researchers suggest to invest in some defensive stocks like education, food, banking, consumer and healthcare sectors (Tashanova *et al.*, 2020; Li *et al.*, 2020; Nia, 2020). Goodell (2020) suggested not to invest

in financial industries because this industry experienced a high number of non-performing loans due to debtors' foregone earnings and a significant number of depositor withdrawals.

Several studies also reported that the lockdown and stimulus package announcements significantly affected the stock market. For example, using an event study approach, Alam *et al.* (2020) found that the lockdown announcements made by the Indian government had a positive impact on the stock market performance. A similar finding was reported by Sun *et al.* (2021) for China, Hong Kong, Korea, Japan, and U.S stock markets. On the other hand, Bouri *et al.* (2022) and Shafiullah *et al.* (2022) reported that the stock market in New Zealand and several other countries show a declining trend after stimulus package announcements were made by their governments.

As for the Malaysian stock market, researchers discovered various results on the effects of the COVID-19 pandemic. Lee *et al.* (2020) found that larger numbers of COVID-19 cases in Malaysia had negative effects on the KLCI index and all sectorial indexes performance, excluding the Real Estate Investment Trusts (REIT) index. Ramdhan *et al.* (2020) discovered that the number of COVID-19 daily cases exhibited a uniform significant positive effect on financial, consumer goods and medical services index during the lengthen lockdown period. Chia *et al.* (2020) revealed that the daily new confirmed COVID-19 cases and deaths had adverse but negligible effects on the performance of the Malaysian stock market. However, the Malaysian stock market exhibited significant and positive effects throughout the lockdown period. A more recent study by Song *et al.* (2022) reported that Malaysian stock market react negatively to the MCO annoucements especially at the beginning period.

Based on the discussion above, this study hypothesises that all announcements made by the Malaysian government during the COVID-19 pandemic i.e., lockdown, economic stimulus packages and recovery plan, have significant effects on the Bursa Malaysia and other sectorial indexes of the Malaysian stock market.

3. Data and Methodology

3.1 Data

Table 1 describes the list of indexes that were selected to assess the effects of several announcements owning to the COVID-19 pandemic on the Malaysian stock market. KLCI is used as the benchmark index to compute the abnormal returns for 13 other sectorial indexes within Malaysia. Daily closing prices of these indexes from 2nd January 2019 to 29th October 2021 were collected.

Table 1: List of indexes

Definition	Abbreviation	No. of Constituents
Kuala Lumpur Composite Index (KLCI)	KLCI	30
Kuala Lumpur Consumer Product	KLCM	168
Kuala Lumpur Construction	KLCT	52
Kuala Lumpur Energy	KLEN	31
Kuala Lumpur Finance	KLFI	31
Kuala Lumpur Healthcare	KLHC	13
Kuala Lumpur Industrial Product	KLIP	221
Kuala Lumpur Plantation	KLPL	42
Kuala Lumpur Property	KLPR	98
Kuala Lumpur REIT	KLRE	17
Kuala Lumpur Technology	KLTE	41
Kuala Lumpur Telecommunications and Media	KLTC	16
Kuala Lumpur Transportation and Logistics	KLTP	32
Kuala Lumpur Utilities	KLUT	12

The source of data used for this research are collected from the website Investing.com, an open-access website with real-time quotes, portfolio, streaming charts, livestock market data, global index prices, and so on. He *et al.* (2020) and Liu *et al.* (2020) used this website as their source of data for their studies.

Recently, numerous past research have sought to assess the impacts of the COVID-19 pandemic on stock market returns in the short run (Liu *et al.*, 2020; Zhang *et al.*, 2020). Similarly, the event of interest of this research are important announcements due to COVID-19 such as lockdown, economic stimulus packages and exit strategy news on Malaysian media. These announcements and information are likely to grab the front pages of print and electronic media throughout the globe and attract the attention of investors. Therefore, several important event dates in this study are chosen and tabulated in Table 2, Table 3 and Table 4.

Table 2: List of COVID-19 lockdown and their announcement dates

Date	Description - Lockdown	Abbreviation
16th Mar 2020	First Movement Control Order	MCO 1.0
11th Jan 2021	Second Movement Control Order	MCO 2.0
10th May 2021	Third Movement Control Order	MCO 3.0
28th May 2021	Total Lockdown	TL

Table 3: List of COVID-19 Economic Stimulus Packages (ESP) and their announcement dates

Date	ESP	Description - Economic Stimulus Package	Abbreviation
27th Feb 2020	ESP1	Bolstering Confidence, Stimulating Growth and Protecting Jobs	-
27th Mar 2020	ESP2	Prihatin Rakyat Economic Stimulus Package	PRIHATIN
06th Apr 2020	ESP3	Additional Prihatin Economic Stimulus Package	PRIHATIN PLUS
05th Jun 2020	ESP4	National Economic Recovery Plan	PENJANA
23rd Sep 2020	ESP5	Prihatin Supplementary Initiative Package	KITA PRIHATIN
18th Jan 2021	ESP6	Protection of the Economy and People of Malaysia	PERMAI
17th Mar 2021	ESP7	Strategic Programme to Empower the People and the Economy	PEMERKASA
31st May 2021	ESP8	Additional Strategic Programme to Empower the People and the Economy	PEMERKASA PLUS
28th Jun 2021	ESP9	National People's Well-Being and Economic Recovery Package	PEMULIH

Table 4: List of COVID-19 National Recovery Plan (NRP) and their announcement dates

Date	Description – National Recovery Plan	Abbreviation
15th Jun 2021	Announcement of National Recovery Plan	NRP
08th Sep 2021	Announcement of National Recovery Plan Phase 2	NRP2
29th Sep 2021	Announcement of National Recovery Plan Phase 3	NRP3
15th Oct 2021	Announcement of National Recovery Plan Phase 4	NRP4

3.2 Methodology

The empirical work in this study is on the basis of event study methodology. This study attempts to exhibit how Malaysian financial markets, especially the KLCI and its sectorial indexes, react after the announcement of lockdown, economic stimulus packages and national recovery plans due to the COVID-19 pandemic. According to Holler (2014), the suggested event window generally spans from one to eleven days and is proportionally revolved around the event day. The event window employed in this research to determine the impact of important announcement on stock indexes is 10 days, five days before (-5 to -1) and five days after (+1 to +5) the announcement of information about the important events. This event

window length was also used by Sun *et al.* (2021) in their research. Actual returns within the event window and anticipated expected returns are determined to calculate abnormal returns for all days within the event window. Investors can employ abnormal returns to inspect the comparison between a single asset portfolio performance and a benchmark index, which is often generated using the CAPM equation, whereas in this paper, Market Model is used. By employing the market return as a baseline, abnormal returns enable investors to evaluate the real magnitude of earnings and losses. When there is an overlapping event, a shorter event window such as one/two days before and one/two days after the announcement will be examined for robustness testing.[2]

The information required to determine the expected returns is provided by the estimation window. Previous research examining the sensitivity of results (e.g., the expected return on the event date) proposed that as long as the estimation window lengths surpass 100 days, outcomes are not sensitive to altering estimation window lengths (Armitage, 1995; Park, 2004). Besides, according to Liu *et al.* (2020), owning to the great degree of uncertainty in the securities market, an estimation window duration that is too long may not be correct. Therefore, the estimation window for this research is from day -105 to day -6, the day before the MCO 1.0, which is from 15th October 2019 to 06th March 2020. As the announcement of ESP1 was before MCO 1.0, the estimation window for the announcement of ESP1 is from 30th September 2019 to 19th Feb 2020. Figure 1 below illustrates an example of the timeframe for the event study in days for MCO 1.0.

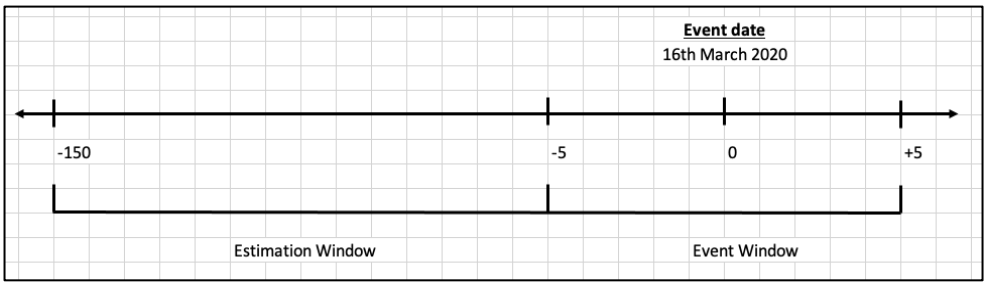

Figure 1: Event study timeframe

The daily actual return, and market return are calculated by using Equation (1):

$$R_{i,t} = \frac{P_{i,t} - P_{i,t-1}}{P_{i,t-1}} \quad (1)$$

where $R_{i,t}$ is the actual return for index i on day t, $P_{i,t}$ denotes the closing price for an index i on day t, and $P_{i,t-1}$ is the closing price of index i in the previous trading day. Expected returns are calculated by utilising market model, shown in Equation 2:

$$E(R_{i,t}) = \alpha_i + \beta_i (R_{m,t}) + \varepsilon_{i,t} \quad (2)$$

where $E(R_{i,t})$ is the expected return of index i and $R_{m,t}$ is the market return on day t (as the event day is day 0) within the estimated window, with $\varepsilon_{i,t}$ as the statistic disturbance. $\alpha_i + \beta_i$ are the regression estimation from an OLS using estimation window for both index and market return. To obtain α_i, insert "intercept (daily closing price of actual return from day -6 to day -

[2] The results of this robustness test are consistent with the reported findings. Details of the results can be provided by the corresponding author upon request.

105; daily closing price of market return from day -6 to day -105)" in Microsoft Excel spreadsheet; to obtain β_i, insert "slope (daily closing price of actual return from day -6 to day -105; daily closing price of market return from day -6 to day -105)" in Microsoft Excel spreadsheet. After getting the estimated coefficients, $\alpha_i + \beta_i$, the formulas below are used to compute the expected return and abnormal return (AR) using Equation 3:

$$AR_{i,t} = R_{i,t} - E(R_{i,t}) \quad (3)$$

Cumulative abnormal return (CAR) of index i over a window from t_0 to t_1 is computed using Equation (4):

$$CAR_i(t_0, t_1) = \sum_{t=t_0}^{t_1} AR_{i,t} \quad (4)$$

The significance of the coefficient of CAR on event day t_0 for a specific event window ($t_{-5} - t_5$), t-statistic or t-Test are calculated as per Equation 5:

$$\text{t-Test}_{CAR} = CAR / SE \quad (5)$$

where SE is standard error and can be obtained by inserting "steyx (daily closing price of actual return from day -6 to day -105; daily closing price of market return from day -6 to day -105)" in Microsoft Excel spreadsheet.

4. Results and Discussion

Table 5 and 6 report the CAR for both (-5,-1) and (+1,+5) event windows where Panel A is for Lockdown announcements, Panel B for ESP announcements and Panel C for NRP announcements. Based on both tables, this study concludes that lockdown announcements, especially MCO1.0, 2.0 and 3.0, have a significant negative effect on sectorial indexes of the Malaysian stock market, because investors have a negative outlook on the Malaysian stock market due to the lockdown announcements. However, TL announcement showed that most sectorial indexes have a significant positive effect, because investors thought TL would not be as strict as MCO 1.0, and the Malaysian government would not risk the country's economy again.

This study also concludes that ESP announcements have a significant positive effect on most of the industrial indexes of the Malaysian stock market. Investors have an optimistic outlook on the early stage of ESPs as they have confidence that the Malaysian government is attempting to handle the COVID-19 issue and the country's economy. However, ESP1, ESP4, ESP5, ESP6, ESP7 and ESP 9 announcements showed that most of the sectorial indexes have significant negative effects. This is because in the later stage of ESPs, investors had lost confidence in the Malaysian government in addressing the pandemic and perform profit-taking activities. In terms of ESP1, it showed a negative impact, most likely because of the spill-over effect from China when they imposed lockdown in early January and February.

Table 5: Summary of CAR (-5, -1) of all Bursa Malaysia sectorial indexes

Events	KLCM	KLCT	KLEN	KLFI	KLHC	KLIP	KLPL	KLPR	KLRE	KLTE	KLTC	KLTP	KLUT
Panel A: Announcement of Lockdown													
MCO1.0	-0.0413***	-0.0532***	-0.2080***	-0.0204***	-0.0472***	-0.0892***	-0.0484***	-0.0666***	-0.0589***	-0.0634***	-0.0104*	-0.0303***	-0.0304***
MCO2.0	-0.0199***	-0.0817***	-0.0596***	-0.0238***	0.0102	-0.0213***	0.0081	-0.0667***	-0.0268***	-0.0507***	-0.0338***	-0.0746***	-0.0476***
MCO3.0	-0.0008	-0.0052	0.0160	0.0038	-0.0498***	0.0176***	0.0332***	-0.0031	-0.0115***	-0.0468***	0.0124**	0.0187***	-0.0053
TL	0.0133***	-0.0193*	-0.0225*	0.0096***	-0.0363***	0.0068	-0.0038	-0.0012	-0.0036	0.0473***	0.0396***	0.0169**	-0.0018
Panel B: Announcement of Economic Stimulus Packages													
ESP1	-0.0208***	-0.0585***	-0.0252**	0.0058	0.1554*	-0.0303***	-0.0092	-0.0143**	-0.0024	0.0038	-0.0174***	-0.0252***	-0.0066
ESP2	0.0003	0.0129	0.0901***	0.0300***	0.0519***	0.0190***	0.0054	0.0262***	0.0901***	0.0590***	0.0231***	0.0260***	0.0269***
ESP3	0.0283***	0.0477***	0.1473***	-0.0121***	0.0014	0.0222***	0.0067	0.0001	-0.0125***	0.0593***	-0.0023	0.0389***	0.0351***
ESP4	-0.0179***	-0.0512***	0.0049	-0.0246***	-0.0483***	0.0361***	-0.0679***	0.0411***	0.0138***	-0.0658***	-0.0802***	-0.0227***	-0.0165***
ESP5	0.0128***	0.0025	0.0189	0.0035	-0.0223**	-0.0023	0.0120*	0.0004	-0.0055	-0.0262**	0.0156***	-0.0039	0.0020
ESP6	0.0209***	0.0158	0.0257**	0.0059	-0.0097	0.0305***	-0.0073	0.0205***	0.0031	0.1256***	0.0366***	0.0420***	0.0110**
ESP7	0.0184***	0.0229**	0.0243*	-0.0082**	-0.0028	0.0282***	0.0054	0.0431***	0.0030	0.0258**	0.0268***	0.0062	0.0155***
ESP8	0.0106***	0.0071	0.0027	0.0084**	-0.0251**	0.0178***	-0.0168***	0.0056	0.0026	0.0309**	0.0349***	0.0263***	0.0008
ESP9	-0.0004	-0.0047	-0.0195	0.0151***	-0.0424***	0.0006	-0.0099	-0.0116	-0.0046	-0.0232*	0.0046	0.0033	-0.0126**
Panel C: Announcement of National Recovery Plan													
NRP	0.0066*	0.0295***	0.0287**	0.0087**	-0.0140	-0.0009	-0.0197***	0.0242***	0.0132***	-0.0062	-0.0068	0.0340***	-0.0003
NRP2	0.0248***	0.0545***	0.0331**	0.0028	-0.0114	0.0288***	-0.0123*	0.0396***	0.0044	0.0343***	0.0277***	0.0173***	0.0135**
NRP3	0.0023	-0.0002	0.0516***	-0.0112***	-0.0074	0.0296***	-0.0059	-0.0025	0.0009	-0.0026	-0.0154***	-0.0036	-0.0206***
NRP4	-0.0044	0.0354***	0.0760***	0.0114***	-0.0058	0.0034	-0.0174***	0.0294***	0.0162***	-0.0244**	0.0093	0.0159**	-0.0059

Notes: *Significant at the 10% level. ** Significant at the 5% level. *** Significant at the 1% level.

Table 6: Summary of CAR (+1, +5) of all Bursa Malaysia sectorial indexes

Events	KLCM	KLCT	KLEN	KLFI	KLHC	KLIP	KLPL	KLPR	KLRE	KLTE	KLTC	KLTP	KLUT
Panel A: Announcement of Lockdown													
MCO1.0	-0.0323***	-0.0476***	-0.1099***	-0.0279***	-0.0293***	-0.0633***	-0.0057	-0.1250***	-0.0683***	-0.0859***	-0.0586***	-0.0948***	-0.0634***
MCO2.0	0.0165***	0.0357***	0.0082	0.0034	-0.0030	0.0431***	-0.0241***	0.0316***	-0.0076**	0.1463***	0.0453***	0.0440***	0.0149***
MCO3.0	-0.0216***	-0.0475***	-0.0367***	0.0078**	0.0217**	-0.0315***	-0.0357***	-0.0101	-0.0199***	-0.0374***	-0.0249***	-0.0373***	-0.0024
TL	0.0133***	0.0139	-0.0061	0.0080**	-0.0238**	0.0144**	-0.0143**	0.0031	0.0214***	0.0303**	0.0055	0.0743***	0.0129**
Panel B: Announcement of Economic Stimulus Packages													
ESP1	-0.0229***	-0.0299***	-0.0702***	0.0076**	0.0862	-0.0027	-0.0304***	-0.0275***	0.0053	-0.0139	-0.0138**	-0.0403***	0.0045
ESP2	0.0283***	0.0477***	0.1473***	-0.0121***	0.0014	0.0222***	0.0067	0.0001	-0.0125***	0.0593***	-0.0023	0.0389***	0.0351***
ESP3	0.0016	0.0251**	-0.0586***	-0.0110***	0.0337***	0.0191***	-0.0013	0.0014	-0.0148***	-0.0040	0.0095	0.0156**	0.0026
ESP4	0.0050	0.0207**	-0.0540***	0.0403***	0.0039	-0.0046	0.0165**	-0.0197***	0.0046	0.0437***	-0.0089	-0.0159**	-0.0109**
ESP5	-0.0008	0.0173*	-0.0287**	-0.0025	0.0413***	0.0215***	-0.014**	-0.0129*	-0.0048	0.0229*	-0.0241***	-0.0064	-0.0078
ESP6	-0.0114***	-0.0240**	-0.0225*	0.0032	-0.0033	-0.0181***	0.0001	-0.0084	-0.0015	0.0294**	0.0173***	0.0044	-0.0116**
ESP7	-0.0001	0.0032	-0.0281**	-0.0021	-0.0192*	0.0132**	0.0043	-0.0085	-0.0039	0.0221*	-0.0242***	-0.0276***	-0.0159***
ESP8	0.0154***	0.0346***	0.0134	0.0208***	-0.0634***	0.0142**	-0.0159**	0.0186***	0.0309***	0.0066	0.0065	0.0771***	0.0094*
ESP9	0.0025	-0.0154	0.0227*	0.0048	-0.0410***	0.0164**	-0.0036	0.0008	-0.0052	0.0358***	0.0198***	0.0190***	0.0071
Panel C: Announcement of National Recovery Plan													
NRP	-0.0059	-0.0030	-0.0137	0.0024	-0.0116	-0.0160**	-0.0087	-0.0153**	-0.0038	-0.0077	0.0277***	-0.0020	-0.0080
NRP2	0.0129***	0.0012	0.0056	0.0079**	-0.0434***	0.0158**	-0.0094	0.0152**	-0.0115***	0.0231*	0.0071	0.0153**	0.0038
NRP3	-0.0029	-0.0087	0.0372***	-0.0107***	-0.0180*	0.0096	0.0776***	0.0097	0.0013	-0.0011	-0.0044	0.0116*	-0.0024
NRP4	0.0021	-0.0050	-0.0152	0.00862**	-0.0146	-0.0021	-0.0021	-0.0015	-0.0028	0.0107	-0.0013	0.0056	-0.0020

Notes: *Significant at the 10% level. ** Significant at the 5% level. *** Significant at the 1% level.

Finally, this study reports that most other industrial indexes in the Malaysian stock market respond positively to the NRP2, NRP3 and NRP4 announcements, but negatively to the first NRP announcement. This is because during the first NRP announcement, the Malaysian government only proposed the recovery plan and did not take action, and the confirmed cases are still high. However, after the announcement of NRP2, investors realised that the Malaysian government kept their word and acted on implementing the recovery plan. Hence, this action had regained investors' confidence and they started investing in the Malaysian stock market.

The findings reported in this study have important implications for policymakers and investors. For example, government and central banks could utilise the findings of this research to effectively implement the fiscal and monetary policy during any pandemic. Besides, handling the COVID-19 situation requires a sensible strategy, in which officials should quickly notify the market on their plans without causing insecurity to it. For market players or investors, the findings are useful for them to plan for their investment portfolio and manage their risks.

5. Conclusion

The purpose of this study is to look at the immediate impacts of lockdown, economic stimulus package and national recovery plan (exit strategy) announcements due to COVID-19 on the Malaysian stock markets. This study adds to the literature by examining the different announcements made by the Malaysian government to battle the unanticipated financial market impacts of COVID-19. The results of this research, from the perspective of an investor, highlight the relevance of not just the organisation's business characteristic, but also the investment risks posed by an unexpected occurrence. In short, the results of the study exhibit that the lockdown, ESP and NRP announcements, significantly impacted the performances of all sectors in the Malaysian stock market.

The government could utilise the findings of this research to effectively implement the fiscal and monetary policies. Besides, by effectively managing existing debts, central bank authorities would enable banks to be more lenient towards businesses in economically distressed industries including construction, manufacturing, leisure, travel and tourism industries. Handling the COVID-19 situation requires a sensible strategy, in which officials should quickly notify residents of their health care system plans without causing insecurity. For investors, these results are useful for them to manage their investment portfolio and risk.

There are several limitations in this study, one of which is that the research only looked at the instant and short-term impacts of the announcement of events on Malaysian stock markets owning to the short-term event windows. This research did not explore the association between the stock market and the number of confirmed cases. Future researchers can enhance the findings by utilising a broader sample period and considering looking into additional important event announcements due to COVID-19 in Malaysia. Future studies may also consider employing Wilcoxon Signed Rank Test or other research techniques such as multiple regression model to study the impact of different announcements on individual firms as well as indexes' mean returns.

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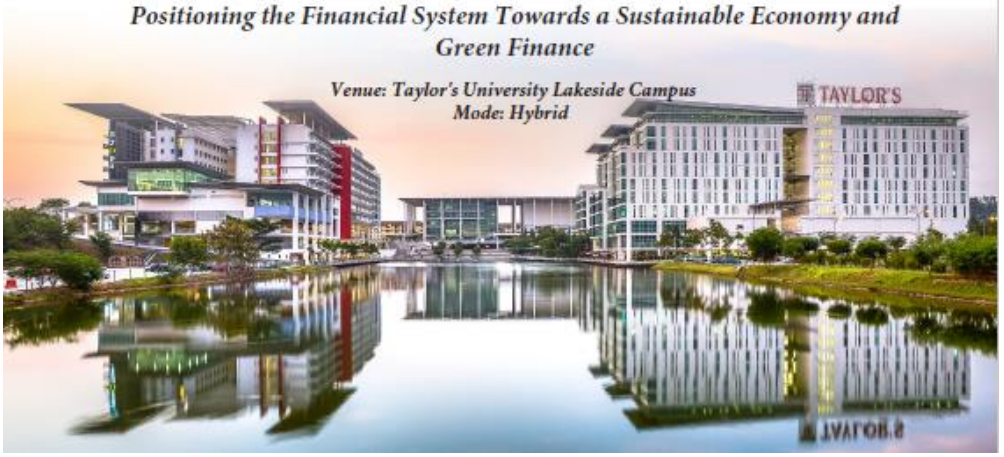
18-20 OCTOBER 2023



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The MFA is proud to be the pioneer in organizing a national-level conference that specializes in finance. Since its inaugural workshop in 1999, the meeting of finance academicians and practitioners has developed to become an annual symposium and today, owing to the overwhelming response, the meeting is now known as an annual conference. The conference is hosted by local institutions of higher learning, both public and private, on rotational basis.

The conference is a great platform for academicians and practitioners to discuss and exchange ideas pertaining to issues related to finance. It also provides an avenue for researchers to share their findings on financial issues relevant to Malaysia. Selected papers from the conference are published in the Capital Market Review which is an official publication of Bursa Malaysia and Research Institute of Investment Analysts Malaysia (RIIAM).

Previous MFA Annual Conference:

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Theme: The Malaysian Financial Crisis and its Recovery
Host: Universiti Malaya (UM)

2001: THE MALAYSIAN FINANCE ASSOCIATION 3RD ANNUAL SYMPOSIUM
Theme: Malaysian Capital Markets: Challenges for the New Millennium
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2002: THE 4TH ANNUAL MALAYSIAN FINANCE ASSOCIATION SYMPOSIUM
Theme: Globalization and Malaysian Financial Market: Strategies for Sustainable Growth
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2003: MALAYSIAN FINANCE ASSOCIATION'S (MFA'S) 5TH ANNUAL SYMPOSIUM
Theme: Competitiveness and Stability Financial Strategies in Malaysia
Host: Multimedia University (MMU)

2004: THE MALAYSIAN FINANCE ASSOCIATION 6TH ANNUAL SYMPOSIUM
Theme: Revitalising the Financial Market: The Tasks Ahead
Host: Universiti Utara Malaysia (UUM)

2005: THE MALAYSIAN FINANCE ASSOCIATION 7TH ANNUAL CONFERENCE
Theme: Consolidation and Prudent Financial Management: Roads to Malaysian Economic Prosperity
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2006: THE MALAYSIAN FINANCE ASSOCIATION 8TH ANNUAL CONFERENCE
Theme: Managing Finance for Global Business Growth
Host: Universiti Malaysia Sabah (UMS)

2007: THE MALAYSIAN FINANCE ASSOCIATION 9TH ANNUAL CONFERENCE
Theme: Positioning Malaysia as A Premier Financial Market
Host: Universiti Teknologi MARA (UiTM)

2008: THE MALAYSIAN FINANCE ASSOCIATION 10TH ANNUAL CONFERENCE
Theme: Strengthening Malaysia's Position as a Vibrant, Innovative and Competitive Financial Hub
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2009: THE MALAYSIAN FINANCE ASSOCIATION 11TH ANNUAL CONFERENCE
Theme: Financial Markets, Governance and Growth: Issues & Challenges
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Theme: Re-Engineering the Financial System towards a Global Innovation Economy
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Theme: Financial Inclusion as A Means to Minimize Fragility
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Theme: Towards a Vibrant Social Finance for A Sustainable Banking and Financial System
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MFA

Malaysian Finance Association

OBJECTIVES

The objectives of MFA are to stimulate public interest in finance related studies, to encourage the research and discussion of finance related issues with special reference to Malaysia, to issue Malaysian finance Journals and other publications with the prior approval of the relevant authorities, to promote and organize conferences, forums, dialogues and activities between private and public sectors on current finance issues of national and international concerns; and to undertake such management, economic, and other activities as the Association deems appropriate for the furtherance, promotion and execution of its aforesaid objectives.

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Membership is open to academicians, professionals and students in the area of Finance, Banking, Economics, Insurance, Real Estate, Accounting and other finance related area.

There are three types of membership: Ordinary Membership, Associate Membership and Life Membership.

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The Ordinary Membership is open to all academicians and working person in the field of Accounting, Banking, Business Administration, Economics, Finance, Financial Engineering, Actuarial Science, Data Science, Insurance and other finance related area. Ordinary member is eligible to attend and vote at all general meetings of the Association.

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The Life Membership is open to Malaysian academicians, an extension of ordinary membership and entitles to all the rights and privileges of ordinary members.

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