Market Efficiency and Price Integration in the Malaysian Bitcoin Market

Mohd. Rahimie Abd. Karim[1], Saizal Pinjaman[1,*], Izaan Jamil[1], Azmi Abd. Majid[1], Syamsul Hadi[2]

[1]Centre for Economic Development and Policy, Faculty of Business, Economics and Accountancy, Universiti Malaysia Sabah

[2]Faculty of Economics, Universitas Sarjanawiyata Tamansiswa

***Corresponding Author**

DOI: https://doi.org/10.47772/IJRISS.2026.1015EC0076

Received: 15 July 2026; Accepted: 20 July 2026; Published: 04 August 2026

ABSTRACT

This study examines the weak-form efficiency and international price integration of Malaysia's regulated Bitcoin market. Daily closing prices for Bitcoin traded in Malaysian ringgit (BTC/MYR), the international Bitcoin price in US dollars (BTC/USD), and the USD/MYR exchange rate are analysed over the 2021–2026 period using secondary market data. The international Bitcoin price is converted into ringgit to provide a currency-consistent benchmark for the local market. Random-walk behaviour is evaluated using the runs test, Ljung–Box test and variance-ratio test. Market integration is examined through unit-root tests, Engle–Granger cointegration analysis and an error-correction model. The daily results provide mixed evidence regarding weak-form efficiency. Although the runs test does not reject randomness in return signs, the Ljung–Box and variance-ratio results indicate dependence at selected horizons. This dependence becomes weaker in the weekly analysis, suggesting that the efficiency assessment is sensitive to data frequency. The local and international Bitcoin prices are cointegrated, with a long-run coefficient close to unity. The error-correction results further show that deviations from the long-run relationship are corrected over time and that international Bitcoin returns significantly influence short-run local price movements. Nevertheless, a small local price premium and residual volatility clustering remain. Overall, Malaysia's Bitcoin market is closely integrated with the international market but is not perfectly efficient at all horizons. The findings support policies promoting transparent benchmark pricing, market surveillance, adequate liquidity and volatility-risk controls among Malaysian digital asset exchanges.

Keywords: Bitcoin; market efficiency; random walk; price integration; digital asset exchange **JEL classifications**: C22; G14; G15; O33

INTRODUCTION

Bitcoin introduced a decentralised peer-to-peer payment system in which transactions can be validated without a conventional financial intermediary (Nakamoto, 2008). Since its introduction, Bitcoin has developed beyond its original payment function and has become a widely traded digital asset. Unlike securities traded on a single organised exchange, Bitcoin is traded continuously across numerous exchanges and against different fiat currencies. This decentralised structure expands access to the market, but it can also produce differences in liquidity, trading activity, transaction costs and information processing across trading venues.

Market efficiency provides a useful framework for evaluating this price behaviour. Under the weak form of the efficient market hypothesis, current asset prices incorporate information contained in past prices. Consequently, successive returns should not display a systematic pattern that can be predicted from their own history (Fama, 1970). The random-walk hypothesis is therefore commonly used to assess weak-form efficiency. If Bitcoin returns are serially independent, historical price movements should offer little explanatory power for future returns. If significant dependence is present, the market may not fully satisfy weak-form efficiency.

Empirical findings on Bitcoin efficiency remain mixed. Urquhart (2016) reports that Bitcoin returns were inefficient over the full sample, although some tests indicated greater efficiency in a later subperiod. Nadarajah and Chu (2017) subsequently show that the inference can change after an appropriate transformation of returns. Using a dynamic approach, Bariviera (2017) finds that the informational efficiency of daily Bitcoin returns improved over time, while Bitcoin volatility continued to exhibit long memory. Collectively, these studies indicate that Bitcoin efficiency should not be treated as a permanent or universal property. It may depend on the sample period, the statistical test and the market being examined.

Price integration is a related but distinct aspect of market quality. Because the same underlying Bitcoin can be traded on exchanges located in different countries, prices should move toward a common value after allowing for exchange rates and reasonable market frictions. Persistent deviations may indicate segmentation or slow information transmission. Makarov and Schoar (2020) document large and recurring Bitcoin price differences across exchanges and show that cross-country spreads are generally larger than spreads within the same country. Their findings demonstrate that the global nature of cryptocurrency trading does not automatically guarantee complete price integration.

Malaysia provides an appropriate setting in which to investigate these issues. The Capital Markets and Services (Prescription of Securities) (Digital Currency and Digital Token) Order 2019 came into force on 15 January 2019. The Securities Commission Malaysia subsequently introduced requirements for digital asset exchanges and registered Luno Malaysia as one of the initial recognised market operators in June 2019 (Securities Commission Malaysia, 2019). This framework created an identifiable regulated market in which Bitcoin is traded directly against the Malaysian ringgit. The local BTC/MYR price reflects global Bitcoin conditions, movements in USD/MYR and conditions specific to the Malaysian trading venue. Examining this price can therefore provide evidence about both the informational efficiency of the local market and its connection with the wider Bitcoin market.

The study also sits within a wider process of financial digitalisation. Zhou et al. (2023) find that financial-technology development had an overall positive association with the profitability of Chinese commercial banks, illustrating how digital innovation can affect established intermediaries. In a different segment of finance, Pinjaman (2025) explains how digital sukuk combine Islamic-finance structures with financial technology. These contributions do not establish the efficiency of cryptocurrency prices, but they show that digital finance encompasses both changes to conventional institutions and the development of digitally enabled instruments. This wider setting strengthens the need for market-specific evidence on a regulated Malaysian cryptocurrency venue.

Although the literature on cryptocurrency markets has grown substantially, much of the evidence on weak-form efficiency is based on aggregate Bitcoin prices or major international exchanges. Such evidence cannot automatically be applied to a particular national market because exchanges differ in liquidity, participant composition, operating arrangements and exposure to domestic currency movements. A result obtained from a global Bitcoin index may therefore conceal behaviour that is specific to the Malaysian BTC/MYR market.

Research involving Malaysia has also tended to address questions other than the efficiency and global integration of the locally traded Bitcoin price. Mohd Thas Thaker and Ah Mand (2021), for example, examine long-run and short-run relationships between a Bitcoin index and five Asian equity markets. Their analysis contributes to knowledge about Bitcoin and conventional financial assets, but it does not test the random-walk behaviour of BTC/MYR or compare a Malaysian exchange price with a currency-adjusted global Bitcoin benchmark.

BTC/MYR has appeared in broader cross-market research. Ye (2022) includes the Malaysian ringgit among 19 Bitcoin-fiat markets and studies international risk-return convergence using CryptoCompare data covering 2013 to 2020. That work is important because it establishes that the Malaysian currency pair has not been entirely absent from prior research. Nevertheless, its objective, dataset and period differ from the present study. It does not focus on the traded price from a Malaysian regulated exchange, and most of its sample precedes the more established post-registration operating period of Luno Malaysia.

A specific empirical question therefore remains. It is not yet clear whether the BTC/MYR price observed on a regulated Malaysian exchange follows a random walk, whether it shares a stable long-run relationship with the global Bitcoin price after conversion into ringgit, and whether deviations from that relationship are corrected in the short run. These issues concern different dimensions of market quality. A random-walk test evaluates dependence in the local price history, whereas cointegration evaluates whether the local and global price levels move together over time. An error correction model can then indicate whether the local price responds when the two prices move apart.

This study addresses the issue using daily Luno BTC/MYR prices, global BTC/USD prices and USD/MYR exchange rates for the period from February 2021 to July 2026. The global BTC/USD price is converted into Malaysian ringgit to construct a comparable benchmark. By using conventional time-series procedures, the study offers a focused and reproducible assessment of market efficiency and price integration during a recent period of Malaysia's regulated digital asset market.

The general purpose of this study is to examine market efficiency and price integration in the Malaysian Bitcoin market. Specifically, the study seeks to examine whether Bitcoin prices in the Malaysian market follow a random walk. This study also determines whether Malaysian Bitcoin prices have a long-run relationship with the currency-adjusted global Bitcoin price and examine the short-run adjustment of Malaysian Bitcoin prices toward the global Bitcoin price.

The study is significant for four main reasons. First, it provides updated evidence on whether Bitcoin prices in Malaysia follow a random walk by using the actual BTC/MYR price from a regulated Malaysian exchange. This helps show whether findings from global Bitcoin markets also apply locally. Second, the study examines whether Malaysian and international Bitcoin prices move together in the long run. By comparing Luno BTC/MYR with a BTC/USD benchmark converted into ringgit, the analysis separates changes in Bitcoin’s global price from changes in the USD/MYR exchange rate.

Third, the findings can assist regulators, especially the Securities Commission Malaysia, and researchers in assessing the development of Malaysia’s regulated digital asset market. Strong price integration may indicate a more connected market, while persistent price differences may point to liquidity or information-flow issues that deserve further study. Finally, the study shows that established methods—random-walk tests, unit-root tests, cointegration analysis and an error-correction model—can be applied clearly to Malaysia’s developing cryptocurrency market.

The remainder of the paper is organised as follows. Section 2 reviews the literature on weak-form Bitcoin market efficiency, international price differences and cryptocurrency price integration. Section 3 describes the Luno BTC/MYR, BTC/USD and USD/MYR data and explains the construction of the currency-adjusted global benchmark. It also presents the random-walk tests, cointegration procedure and error correction model. Section 4 reports and discusses the empirical results. Section 5 concludes the paper, identifies its limitations and suggests directions for future research.

LITERATURE REVIEW

This chapter reviews the theoretical and empirical literature relevant to market efficiency and price integration in the Malaysian Bitcoin market. The theoretical review draws on the weak-form efficient market hypothesis and the law of one price. The empirical review then synthesises evidence on Bitcoin return predictability, cross-exchange price discovery, international price differences and research connected with Malaysia. The final section identifies the specific gaps addressed by the present study.

Weak-Form Efficient Market Hypothesis

The weak-form efficient market hypothesis explains whether past price movements can predict future returns. According to Fama (1970), a market is efficient when prices reflect available information. Under weak-form efficiency, current prices already incorporate information from past prices and returns. Therefore, investors should not be able to consistently predict future returns by relying only on historical price movements. The random-walk hypothesis is commonly used to test this idea. If Bitcoin returns follow a random walk, past returns should not show a systematic relationship with future returns. Autocorrelation, runs and variance-ratio tests are useful for examining whether returns contain predictable patterns. A unit-root test can show whether Bitcoin prices are non-stationary, but this alone does not prove market efficiency. Evidence of weak-form efficiency is stronger when prices are non-stationary and returns do not show predictable dependence.

This theory is relevant to the Malaysian Bitcoin market because Bitcoin is traded continuously and information can move quickly across digital platforms. However, differences in liquidity, exchange access and investor behaviour may still create short-run price dependence. This study therefore applies the weak-form efficient market hypothesis to daily Luno BTC/MYR returns. If returns are random, the Malaysian market may be considered weak-form efficient. If returns show dependence, the market may not fully satisfy weak-form efficiency during the study period.

Law of One Price and Market Integration

The law of one price explains why the same asset should have similar prices across different markets after currency differences and trading costs are considered. Lamont and Thaler (2003) argue that identical assets should have the same price when expressed in a common currency. If price differences persist, traders may buy the asset in the cheaper market and sell it in the more expensive market, reducing the gap through arbitrage. Bitcoin is the same digital asset across exchanges, but its price may still differ temporarily because of transaction fees, bid–ask spreads, liquidity conditions, withdrawal delays and trading restrictions. Therefore, the key question is not whether prices are identical every day, but whether the Malaysian and global Bitcoin prices move together over time.

To make a valid comparison, the global BTC/USD price is converted into Malaysian ringgit using the USD/MYR exchange rate. Cointegration analysis is then used to examine whether Luno BTC/MYR and the converted global Bitcoin price share a common long-run relationship. Engle and Granger (1987) explain that cointegrated variables can be analysed using an error-correction model, which shows how short-run deviations from the long-run relationship are corrected.

In this study, cointegration is interpreted as evidence that Luno BTC/MYR and the converted global benchmark share a common long-run price path. The error correction coefficient then indicates whether the Malaysian price responds to an earlier deviation from that path. This framework is consistent with the law of one price, but cointegration should not be treated as complete proof of market efficiency. Two prices may share a long-run trend while short-run deviations remain economically meaningful. Accordingly, the random-walk analysis and price-integration analysis address related but distinct dimensions of the market.

Evidence on Bitcoin Market Efficiency

The empirical literature does not provide a single conclusion about Bitcoin's weak-form efficiency. Early evidence generally identifies return predictability, while later work increasingly reports improving or time-varying efficiency. The difference is not merely chronological. Findings also depend on the price series, sample frequency, transformation of returns and statistical test employed.

Urquhart (2016) provides an influential early assessment using several tests of Bitcoin returns. The full sample indicates inefficiency, but subsample results suggest that the market became more efficient in the later period. Nadarajah and Chu (2017) revisit the same general issue and show that a power transformation of Bitcoin returns can satisfy efficiency tests. Considered together, the two studies demonstrate that an efficiency conclusion can be sensitive to how the return distribution is handled. The second result does not simply overturn the first. It shows that non-normality and the statistical specification can influence whether randomness is rejected.

Research using long-memory and dynamic measures reinforces the importance of time variation. Bariviera (2017) finds persistent behaviour in daily returns during the earlier part of the sample but greater informational efficiency from around 2014, while volatility retains long memory. Tiwari et al. (2018), using several long-range dependence estimators, generally support Bitcoin price efficiency but identify episodes of inefficiency. These studies converge on the view that efficiency is not necessarily constant, although they differ in the estimators used to identify departures from random behaviour.

Evidence at higher frequencies introduces a further qualification. Sensoy (2019) reports that BTC/USD and BTC/EUR became more efficient at the intraday level after the beginning of 2016, but also finds lower efficiency at higher sampling frequencies and slightly greater efficiency for BTC/USD than BTC/EUR. The currency denomination and observation interval therefore matter. A market can appear relatively efficient at one frequency while still displaying short-lived dependence at another.

Broader cryptocurrency evidence points in a similar direction. Tran and Leirvik (2020) estimate a time-varying efficiency measure for five major cryptocurrencies. They find that the markets were mostly inefficient before 2017 and generally became more efficient during 2017 to 2019, with substantial variation across assets and time. The combined literature therefore does not justify a permanent classification of Bitcoin as efficient or inefficient. It supports re-examination when the market, currency pair, exchange or sample period changes.

This synthesis has a direct implication for Malaysia. Most established efficiency studies use BTC/USD, BTC/EUR, global indices or samples combining several cryptocurrencies. Their results establish suitable tests and show why sample-specific analysis is necessary, but they do not determine whether returns generated by an actual Malaysian BTC/MYR exchange price are random. A local-market test remains relevant even when the international Bitcoin market has become more mature.

Cross-Exchange Price Discovery and Price Integration

A second body of research examines how prices are formed across cryptocurrency exchanges. This literature generally agrees that Bitcoin markets are connected, but it also shows that the connection is uneven and that price differences can persist when market frictions restrict arbitrage.

Brandvold et al. (2015) analyse price discovery across major Bitcoin exchanges and find that information leadership is concentrated in a limited number of exchanges. Exchanges with greater trading volume and activity contribute more strongly to the common price. The study implies that a local exchange may follow information generated elsewhere rather than contribute equally to global price formation. This supports the use of a large international exchange price as a benchmark, while also allowing the local price to have its own short-run dynamics.

Pieters and Vivanco (2017) move beyond exchange leadership by connecting price inconsistencies to market characteristics. They document systematic price differences across 11 Bitcoin markets and find that markets without customer-identification requirements are more likely to deviate from representative prices. Their results show that regulatory and institutional arrangements can affect price alignment. Regulation may improve transparency and market access for some participants, but compliance requirements and differences in funding channels may also distinguish a regulated local venue from an offshore global exchange.

Makarov and Schoar (2020) provide broader evidence using tick data from 34 exchanges across 19 countries. They identify large and recurring arbitrage spreads, especially across countries, and show that deviations can persist for days or longer. Cross-country spreads are larger than within-country spreads, which the authors relate to market segmentation and limits on the movement of arbitrage capital. Their findings qualify the frictionless law of one price. Bitcoin is transferable across borders, but fiat funding, regulation and capital mobility remain locally constrained.

These studies are complementary rather than contradictory. Brandvold et al. (2015) explain where price information is produced, while Pieters and Vivanco (2017) and Makarov and Schoar (2020) explain why prices need not align immediately across venues and countries. Together, they suggest that price integration should be examined at two horizons. Long-run cointegration assesses whether local and global prices ultimately share a common trend, whereas an error correction model evaluates how the local price reacts to temporary separation from that trend.

Much of the cross-exchange literature uses high-frequency data and large international exchange panels. Those designs are valuable for identifying rapid price discovery and arbitrage spreads, but they do not answer the narrower question faced by this paper. The present study focuses on whether the daily closing price on Luno Malaysia is tied to a global price after explicitly controlling for USD/MYR. The daily approach cannot describe intraday arbitrage, but it can provide conventional and transparent evidence on longer-run integration and daily adjustment.

Evidence Related to Malaysia and Bitcoin-Fiat Markets

Empirical research directly centred on the Malaysian BTC/MYR market is limited. Related Malaysian and regional studies usually examine Bitcoin alongside conventional financial assets or include the ringgit pair within a broad international sample. These studies are informative, but their dependent variables and research questions differ from the local-market efficiency and integration questions considered here.

Recent research on the ringgit provides a closely related efficiency benchmark. Kok et al. (2025) apply runs, variance-ratio and Ljung–Box tests to RM/USD and report significant predictability in the pre-COVID-19 period but stronger support for weak-form efficiency after the pandemic. Using monthly bilateral rates, Pinjaman et al. (2025) find that the ringgit against selected ASEAN currencies generally exhibits I(1) behaviour consistent with a random walk, while crisis-period disruptions and later recovery indicate that efficiency is not constant. Pinjaman et al. (2026) reach a similar regional conclusion: ASEAN exchange-rate efficiency weakened during the pandemic, particularly for Malaysia and Singapore, before those markets regained efficiency afterward. Synthesised together, these studies show that Malaysian currency efficiency is sensitive to the sample period, shock environment and test design.

This ringgit literature is methodologically relevant because the present benchmark contains USD/MYR, but it does not determine whether Luno BTC/MYR is efficient. The cited exchange-rate studies use different data frequencies, market structures and research settings from the present study, which examines daily returns in the Malaysian Bitcoin market. The present study therefore extends the Malaysian efficiency discussion to a regulated digital asset while retaining the currency conversion needed for a valid local–global comparison.

Mohd Thas Thaker and Ah Mand (2021) examine the long-run and short-run relationships between a Bitcoin index and five Asian equity markets using VECM, Granger causality and complementary methods. Their analysis demonstrates that conventional cointegration and error correction procedures can be applied to Bitcoin relationships. However, the study concerns Bitcoin and stock-market indices in Japan, Korea, Singapore, the Philippines and Hong Kong. It does not examine a Malaysian BTC/MYR exchange price or compare that price with a currency-adjusted global Bitcoin benchmark.

Ye (2022) is more directly relevant because the study includes BTC/MYR among 19 Bitcoin-fiat markets. Using CryptoCompare prices from 2013 to 2020, the thesis investigates cross-market risk-return convergence and later considers sentiment and long-memory relationships. This evidence confirms that BTC/MYR has appeared in international Bitcoin research. It also prevents the present paper from claiming that the Malaysian currency pair has never been examined.

The exchange-rate component may also carry an information process of its own. Taasim et al. (2025) identify a cointegrating relationship between ringgit volatility against the US dollar and a Google Trends uncertainty measure, implying that currency volatility and online information uncertainty move together over the long run. Their dependent variable is ringgit volatility rather than Bitcoin, so the result is not evidence of cryptocurrency integration. It nevertheless reinforces the need to model USD/MYR explicitly instead of attributing every movement in BTC/MYR to Bitcoin-market conditions.

Nevertheless, Ye's multicountry design and market-wide risk-return distance measures are not equivalent to testing the weak-form efficiency of a specific Malaysian exchange or estimating a conventional local-global cointegrating relationship. The sample also largely precedes the period covered by the current Luno dataset. Malaysia's regulatory framework for digital asset exchanges took effect in 2019, and Luno Malaysia was registered as one of the initial recognised market operators in June of that year (Securities Commission Malaysia, 2019). Evidence based on Luno data from 2021 onward therefore represents a later regulated-market setting.

The Malaysian evidence can consequently be located between two established literatures. International efficiency studies provide the tests for return randomness, and cross-exchange studies provide the rationale for analysing common prices and deviations. Malaysia-related work establishes the relevance of Bitcoin to regional finance but leaves room for a focused examination of an actual regulated BTC/MYR trading venue.

Gaps in the Literature

Most studies on Bitcoin market efficiency focus on global Bitcoin indices or major markets such as BTC/USD and BTC/EUR. Their findings may not fully represent the Malaysian market because BTC/MYR can be influenced by local liquidity, investor participation and movements in the ringgit. Although Ye (2022) includes BTC/MYR in a wider 19-market sample, the study uses CryptoCompare data ending in 2020 and does not focus specifically on Luno BTC/MYR. Therefore, limited evidence exists on the actual BTC/MYR closing price from a regulated Malaysian exchange during 2021–2026, a period in which Malaysia’s digital asset market became more established.

Previous studies also often examine market efficiency and cross-market price integration separately. This study combines random-walk tests with cointegration and an error-correction model to examine both issues together. It tests whether Luno BTC/MYR returns follow a random walk, whether the local price moves with BTC/USD after conversion through USD/MYR, and whether short-run price differences are corrected over time. The study therefore contributes recent Malaysian evidence by applying conventional time-series methods to a regulated local Bitcoin market.

DATA AND METHODOLOGY

This chapter describes the data and the conventional time-series procedures used to answer the three research objectives. The analysis first constructs a currency-adjusted global Bitcoin benchmark and examines the Malaysian return series for random-walk behaviour. It then tests whether the Malaysian and global-equivalent price levels share a long-run relationship and, if they do, estimates the short-run adjustment of the Malaysian price through an error-correction model.

Data Sources and Sample

The study uses secondary daily closing-price data obtained from the public historical-data pages of Twelve Data. The local market series is Bitcoin quoted in Malaysian ringgit on Luno (BTC/MYR); the international benchmark is Bitcoin quoted in U.S. dollars on Coinbase Pro (BTC/USD) and Twelve Data; and the currency conversion series is the U.S. dollar–Malaysian ringgit exchange rate (USD/MYR). The source pages identify the relevant exchange or market and report daily open, high, low and close observations (Twelve Data, 2026a, 2026b, 2026c). Closing prices are used because they provide one consistent observation per date for all three series. This study focuses on Bitcoin because BTC/MYR provides the most continuous and comparable daily price series for the Malaysian market during the study period. Bitcoin also has the strongest international benchmark and the highest relevance for examining local–global price integration. The analysis is therefore designed as a focused case study of the Malaysian Bitcoin market rather than a general test of all digital assets.

As shown in Table 1, the raw Luno series contains 1,992 daily observations from 31 January 2021 to 15 July 2026. All 1,992 Luno observations are retained for the local random-walk analysis, yielding 1,991 daily log returns. For the price-integration analysis, the three series are merged by calendar date and only dates observed in all three sources are retained. This produces a balanced matched sample of 1,492 observations from 1 February

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS | Volume X Issue XV August 2026 | Special Issue on Economics

2021 to 15 July 2026 for the cointegration and error-correction models. Because the USD/MYR market mainly follows business days whereas Bitcoin trades continuously, the matched sample is composed primarily of weekdays. Consequently, a return following a non-trading day measures the change between consecutive matched observations rather than necessarily a one-calendar-day change.

Variables and Measurement

Table 1. Variables, Measurement and Data Sources

Variable and symbol	Measurement	Role in the analysis	Source
Local Bitcoin price, $P_{L,t}$	Daily Luno BTC/MYR closing price; MYR per BTC.	Observed Malaysian market price and principal study variable.	Twelve Data (2026a): Luno BTC/MYR
Global Bitcoin price, $P_{USD,t}$	Daily Coinbase Pro BTC/USD closing price; USD per BTC.	International Bitcoin-price component of the benchmark.	Twelve Data (2026b): Coinbase Pro BTC/USD
Exchange rate, X_t	Daily USD/MYR closing rate; MYR per USD.	Converts the global dollar price into ringgit.	Twelve Data (2026c): USD/MYR
Implied global price, $P_{G,t}$	$P_{USD,t}$ multiplied by X_t; MYR per BTC.	Currency-adjusted global benchmark comparable with the local price.	Derived from BTC/USD and USD/MYR
Log local price, $p_{L,t}$	Natural logarithm of $P_{L,t}$.	Price-level series for unit-root, cointegration and ECM analysis.	Derived
Log global price, $p_{G,t}$	Natural logarithm of P_t.	Benchmark price-level series for unit-root, cointegration and ECM analysis.	Derived
Log returns, $r_{L,t}$ and $r_{G,t}$	First differences of the respective log prices.	Tests short-horizon randomness and measures price changes.	Derived
Local premium, $Premium_t$	$P_{L,t}\ /\ P_{G,t} - 1$.	Descriptive measure of the percentage local-price deviation from the benchmark.	Derived

The conversion to a common currency is essential. A direct comparison of BTC/MYR with BTC/USD would combine Bitcoin-price movements with differences in currency units. Multiplying the dollar Bitcoin price by the MYR value of one U.S. dollar produces a benchmark expressed in the same MYR-per-Bitcoin unit as the Luno price. Natural logarithms are then used because differences in logs can be interpreted approximately as proportional price changes and because the cointegration analysis concerns the co-movement of price levels.

Method of Analysis and Variable Construction

The empirical work proceeds in five stages. First, the variables are constructed and described using summary statistics and time plots. Second, the full calendar-day local price is tested for a unit root and its return series is examined for serial dependence and random-walk behaviour. Third, the integration order of both log-price series is established over the matched sample. Fourth, the Engle–Granger procedure tests for a long-run relationship. Fifth, conditional on cointegration, an error-correction model estimates short-run adjustment. All statistical tests use a 5% significance level, while 1% and 10% results may be reported to show the strength of the evidence.

The currency-adjusted global Bitcoin price is calculated as:

$$P_{G,t} = P_{USD,t} \times X_t \qquad (1)$$

Where $P_{G,t}$ is the implied global price in MYR, $P_{USD,t}$ is the Coinbase Pro BTC/USD close and X_t is the USD/MYR close expressed as MYR per USD. The log price series are:

$$p_{L,t} = ln(P_{L,t}) \quad and \quad p_{G,t} = ln(P_{G,t}) \tag{2}$$

The continuously compounded return for series i, where i is L $(local)$ or G $(global\ benchmark)$, is:

$$r_{i,t} = \Delta p_{i,t} = p_{i,t} - p_{i,t-1} \tag{3}$$

For the first objective, $r_{L,t}$ is calculated from every consecutive calendar-day Luno observation. For models involving the benchmark, changes are calculated between consecutive observations in the matched sample.

For descriptive purposes, the local premium relative to the currency-adjusted global benchmark is:

$$Premium_t = (P_{L,t} / P_{G,t}) - 1 \tag{4}$$

The descriptive analysis reports the number of observations, mean, median, standard deviation, minimum, maximum, skewness and kurtosis for prices, returns and the premium. Plots of the two log prices, local returns and the premium are used to identify broad co-movement, volatility clustering and unusually large observations before formal estimation.

Unit-Root and Random-Walk Tests

The first objective is evaluated with several complementary tests because a unit root in the price level is consistent with, but does not by itself prove, weak-form efficiency. The Augmented Dickey–Fuller (ADF) test is first applied to the full daily $P_{L,t}$ series at levels and first differences. It is then applied to both $P_{L,t}$ and $P_{G,t}$ over the matched sample as the prerequisite for cointegration.

The null hypothesis is $H_0\colon \gamma = 0$, indicating a unit root, against the alternative $H_1\colon \gamma < 0$. An intercept is included in the main price-level specification, and an intercept-plus-trend form is used as a sensitivity check. For first differences, an intercept is sufficient. The lag length k is chosen by the Akaike information criterion from a maximum of 20 lags and is checked to ensure that the residuals are not serially correlated. Cointegration analysis proceeds only if both log prices are classified as integrated of order one, I(1).

Serial dependence in local returns is assessed using the Ljung–Box portmanteau statistic (Ljung & Box, 1978). For m return lags, the statistic is:

$$Q(m) = n(n + 2)\, \Sigma_{(j=1)^\wedge m} [\hat{\rho}_{j^2}\, (n - j)] \tag{5}$$

Where n is the number of returns and $\hat{\rho}_j$ is the sample autocorrelation at lag j. The null hypothesis is that the first m autocorrelations are jointly zero. For the full daily Luno return series, results are reported for m = 7, 14 and 30, representing approximately one week, two weeks and one month. Rejection indicates linear dependence inconsistent with a simple random walk.

The non-parametric Wald–Wolfowitz runs test provides a second view of randomness that does not require normally distributed returns (Wald & Wolfowitz, 1940). Returns above and below the sample median are coded as two signs, observations equal to the median are excluded, and a run is an uninterrupted sequence of identical signs. If n_+ and n_- denote the two sign counts and $n = n_+ + n_-$, the large-sample standardisation is:

$$Z_R = \frac{[R - E(R)]}{Var(R)^{1/2}}, \quad where\ E(R) = 1 + \frac{2n_+n_-}{n} \text{ and } Var\ (R) = \frac{2n_+n_-(2n_+n_- - n)}{n^2(n-1)} \tag{6}$$

A statistically unusual number of runs rejects the null that the sign sequence is random. Because it uses signs rather than return magnitudes, this test complements the autocorrelation-based procedure.

Finally, the Lo–MacKinlay variance-ratio test compares the variance of a q-period price change with q times the variance of a one-period change (Lo & MacKinlay, 1988):

$$VR(q) = Var(p_{L,t} - p_{L,t-q}) / [q\, Var(p_{L,t} - p_{L,t-1})] \qquad (7)$$

Under the random-walk null hypothesis, $VR(q) = 1$. Values below one suggest negative serial dependence, while values above one suggest positive dependence. Heteroskedasticity-robust test statistics are reported for q = 2, 7, 14 and 30 because cryptocurrency returns commonly exhibit changing variance. The local market is regarded as broadly consistent with weak-form efficiency only when the combined evidence does not reveal systematic return predictability; conclusions are not based on one test in isolation.

Engle–Granger Cointegration Test

The second objective concerns long-run price integration. If $p_{L,t}$ and $p_{G,t}$ are both I(1), the Engle–Granger two-step method is appropriate for testing whether a stationary equilibrium combination exists between the two prices (Engle & Granger, 1987). The first step estimates the long-run equation by ordinary least squares:

$$p_{L,t} = a + b\, p_{G,t} + u_t \qquad (8)$$

Where b measures the long-run association between the currency-adjusted global price and the local price, and u_t is the estimated price deviation. A positive b close to one would be economically consistent with proportional co-movement, although b is estimated rather than imposed. In the second step, an ADF regression without an intercept or trend is applied to the estimated residual:

$$\Delta \hat{u}_t = \phi \hat{u}_{t-1} + \Sigma_{(j=1)^k}\, \psi_j\, \Delta \hat{u}_{t-j} + v_t \qquad (9)$$

The null hypothesis is that $\hat{u}_t$ has a unit root and the two prices are not cointegrated. Rejection using Engle–Granger residual-based critical values indicates that deviations from the estimated long-run relation are stationary and that the prices are cointegrated. Standard ADF critical values are not used for this residual test because $\hat{u}_t$ is generated by the first-stage regression.

Error-Correction Model

The third objective is examined only if cointegration is established. The error-correction model (ECM) combines short-run changes with the lagged long-run disequilibrium term:

$$\Delta p_{L,t} = c + \lambda \hat{u}_{t-1} + \sum_{i=1}^{p} \varphi_i \Delta p_{L,t-i} + \sum_{j=0}^{q} \theta_j \Delta p_{G,t-j} + e_t \qquad (10)$$

The coefficient λ is the error-correction coefficient. A statistically significant negative value supports adjustment of the Malaysian price toward the long-run relationship after a deviation. For example, λ = −0.20 would indicate that approximately 20% of the previous matched-period disequilibrium is corrected in the current period, holding the included short-run changes constant. The θ coefficients measure the short-run response of the local price to current and lagged changes in the global benchmark. Lag orders p and q are selected by the Akaike information criterion from models containing up to 10 matched-day lags, subject to satisfactory residual serial-correlation diagnostics.

Diagnostic Tests and Robustness

Several diagnostics are used to determine whether the ECM is adequately specified. First, the Ljung–Box test is applied to the estimated residuals at 5, 10 and 20 lags; failure to reject supports residual serial independence. Second, Engle (1982) ARCH Lagrange-multiplier test is applied to squared residuals to detect remaining conditional heteroskedasticity. Third, the Jarque–Bera test assesses residual normality from skewness and kurtosis (Jarque & Bera, 1980). Normality is treated as a supporting diagnostic rather than a condition for accepting the economic relationship, given the heavy tails commonly observed in cryptocurrency returns.

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS | Volume X Issue XV August 2026 | Special Issue on Economics

If heteroskedasticity or low-order residual dependence remains, coefficient estimates are retained but statistical inference is reported with Newey–West heteroskedasticity-and-autocorrelation-consistent standard errors (Newey & West, 1987). The model is also re-estimated after reasonable lag adjustments if the serial-correlation test rejects. As a data-frequency robustness check, the principal random-walk, cointegration and ECM results are repeated using the final common observation of each week. Weekly sampling reduces the influence of different daily market-closing conventions and helps determine whether the conclusions depend on same-date timing differences.

Together, the ADF, Ljung–Box, runs and variance-ratio tests address the first objective; the Engle–Granger test addresses the second; and the ECM addresses the third. Residual diagnostics and the weekly check assess sensitivity to model specification and daily timing differences.

RESULTS AND ANALYSIS

Descriptive Statistics

Table 2 describes the full 1,992-observation Luno price series and the 1,492-observation common-date sample used for price-integration analysis. Returns and the premium are expressed in percentage terms. Because the implied benchmark return is calculated between common foreign-exchange dates, its observation interval is not identical to the uninterrupted calendar-day Luno return interval.

Table 2. Key statistics

Variable	N	Mean	Median	Std. dev.	Minimum	Maximum	Skewness	Excess kurtosis
Luno BTC/MYR close (MYR)	1,992	245,455.63	230,005.00	121,736.58	72,670.00	518,500.00	0.504	-0.844
Luno BTC/MYR close, matched (MYR)	1,492	254,927.60	248,170.00	122,041.60	72,670.00	518,500.00	0.398	-0.925
Coinbase Pro BTC/USD close (USD)	1,492	59,012.63	57,880.00	28,996.83	15,790.00	124,750.00	0.397	-0.905
USD/MYR close	1,492	4.3438	4.3105	0.2436	3.8873	4.7950	0.169	-1.045
Implied global BTC/MYR (MYR)	1,492	253,883.57	246,655.24	121,997.92	72,318.20	525,571.75	0.413	-0.915
Local premium (%)	1,492	0.459	0.321	1.488	-6.214	16.316	3.299	23.252
Luno daily log return (%)	1,991	0.033	0.008	2.596	-17.093	11.772	-0.239	4.467
Implied matched log return (%)	1,491	0.045	0.016	3.437	-25.312	19.049	-0.281	5.380

Within the matched sample, the mean Luno price was MYR254,927.60 compared with an implied global mean of MYR253,883.57. The mean local premium was therefore positive but small at 0.459%, and the median premium was 0.321%. Its 1.488% standard deviation and range from −6.214% to 16.316% show that short-lived deviations could nevertheless be materially larger than the typical premium. The premium's strong positive skewness and excess kurtosis indicate that the largest deviations were concentrated in the upper tail rather than distributed symmetrically.

The full daily Luno return averaged 0.033% with a standard deviation of 2.596%. Its minimum was −17.093% and its maximum was 11.772%. Excess kurtosis of 4.467 confirms a heavy-tailed return distribution, supporting the use of heteroskedasticity-robust variance-ratio statistics and robust ECM standard errors. These descriptive features establish volatility and non-normality, but they do not by themselves determine whether returns are predictable or whether the two price levels are integrated.

Preliminary Unit-Root Results

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS | Volume X Issue XV August 2026 | Special Issue on Economics

The ADF tests establish the time-series properties required for the subsequent analyses. Table 3 reports the ADF statistic, the Akaike-selected lag and the applicable 5% critical value. Failure to reject at the price level followed by rejection in first differences indicates an I(1) series.

Table 3. Augmented Dickey–Fuller unit-root results

Series	Deterministic terms	Lag	ADF statistic	5% critical	Decision
Full Luno log price	Intercept	2	-1.257	-2.86	Do not reject unit root
Full Luno log price	Intercept and trend	2	-1.417	-3.41	Do not reject unit root
Full Luno log return	Intercept	1	-29.493	-2.86	Reject unit root
Matched Luno log price	Intercept	0	-1.295	-2.86	Do not reject unit root
Matched global log price	Intercept	1	-1.345	-2.86	Do not reject unit root
Matched Δ log Luno price	Intercept	1	-25.863	-2.86	Reject unit root
Matched Δ log global price	Intercept	0	-39.980	-2.86	Reject unit root

For the full local series, the ADF statistics of −1.257 with an intercept and −1.417 with an intercept and trend are less negative than their 5% critical values. The unit-root null is therefore not rejected for the log price. In contrast, the return statistic is −29.493, so the unit-root null is decisively rejected for the first difference. The matched local and global log prices show the same pattern: both are non-stationary in levels and stationary in first differences. The I(1) requirement for the Engle–Granger analysis is consequently satisfied.

Objective 1: Random-Walk Behaviour of the Malaysian Bitcoin Price

Table 4. Random-walk tests for full-sample daily Luno returns

Test	Horizon	Statistic	p-value	5% inference
Ljung–Box Q	m = 7	15.537	0.0297	Serial dependence
Ljung–Box Q	m = 14	27.699	0.0156	Serial dependence
Ljung–Box Q	m = 30	60.584	<0.001	Serial dependence
Runs test	Median signs	Z = -0.314	0.754	Random signs
Variance ratio	q = 2	VR = 1.006; Z = 0.196	0.845	Do not reject
Variance ratio	q = 7	VR = 1.181; Z = 2.292	0.0219	Reject random walk
Variance ratio	q = 14	VR = 1.243; Z = 2.120	0.0340	Reject random walk
Variance ratio	q = 30	VR = 1.320; Z = 1.932	0.0533	Do not reject

Objective 1 asks whether the Malaysian Bitcoin price follows a random walk. The ADF evidence is consistent with a stochastic price trend, but weak-form efficiency also requires an absence of systematic dependence in returns. Table 4 therefore combines the Ljung–Box, runs and heteroskedasticity-robust variance-ratio results for the 1,991 full-sample daily Luno returns.

The tests do not give a uniform answer. The runs statistic is −0.314 with a p-value of 0.754, so the sequence of positive and negative returns does not depart significantly from randomness. The two-day variance ratio is also close to unity and insignificant. However, the Ljung–Box statistics reject joint zero autocorrelation at 7, 14 and 30 lags. The variance-ratio test rejects at q = 7 and q = 14, where the ratios of 1.181 and 1.243 indicate positive intermediate-horizon dependence; the q = 30 result is marginal at p = 0.0533.

Accordingly, the first objective is answered with evidence against a strict daily random walk, although the departure is not present in every property of the returns. The finding is better described as limited daily predictability than as complete inefficiency: return signs appear random, while magnitude-based tests identify dependence over selected horizons. This test-sensitive result is consistent with the mixed and evolving Bitcoin evidence reported by Urquhart (2016), Bariviera (2017) and Tiwari et al. (2018). It also parallels Malaysian exchange-rate evidence that efficiency changes across periods and shock conditions (Kok et al., 2025; Pinjaman et al., 2025, 2026). The comparison concerns the evolution of efficiency rather than equivalence between fiat-currency and cryptocurrency markets.

Objective 2: Long-Run Price Integration

Because the matched local and global log prices are both I(1), the second objective is evaluated using the Engle–Granger procedure. The long-run equation uses 1,492 common-date observations as swhon in Table 5.

Table 5. Engle–Granger long-run and residual-based results

Measure	Estimate/statistic	Std. error/lag	Test benchmark	p-value	Interpretation
Intercept, a	0.0124	0.0088	t = 1.407	0.160	Long-run constant
Global log-price coefficient, b	0.999356	0.000715	t = 1397.6	<0.001	Near-proportional association
R^2	0.999238	—	—	—	Long-run fit
Residual ADF	-5.418	Lag 17	5% critical = −3.34	<0.01	Cointegrated

The estimated global-price coefficient is 0.999356, extremely close to one, and the regression explains 99.924% of the variation in the matched local log price. High R^2 alone cannot establish cointegration, but the residual ADF statistic of −5.418 is more negative than the 5% Engle–Granger critical value of −3.34 and also exceeds the approximate 1% threshold of −3.90 in absolute magnitude. The no-cointegration null is therefore rejected. Objective 2 is achieved: the Malaysian and currency-adjusted global Bitcoin prices share a stable long-run relationship over the sample.

The near-unit slope is economically compatible with the law of one price, while the descriptive premium and stationary equilibrium error show that exact equality is not required on every date. The result complements cross-exchange evidence that Bitcoin venues can share a common price process even when temporary spreads arise from market frictions (Brandvold et al., 2015; Makarov & Schoar, 2020). Because Taasim et al. (2025) show that ringgit volatility and information uncertainty can themselves share a long-run relationship, explicitly incorporating USD/MYR is important: otherwise, persistent currency-related movements could be mistaken for a local Bitcoin premium.

Objective 3: Short-Run Adjustment

Cointegration permits estimation of the ECM for the third objective. The Akaike criterion selected nine lags of the local return and four lags of the global-benchmark return. After lag construction, the model contains 1,482 observations and has an R^2 of 0.932. Table 6 reports Newey–West HAC inference with 5 lags.

The error-correction coefficient is -0.1552 with a HAC p-value below 0.001. Its negative and statistically significant sign confirms convergence toward the long-run relation. Approximately 15.5% of the preceding matched-period deviation is corrected in the current period, holding the included short-run changes constant. Objective 3 is therefore achieved: the Malaysian Bitcoin price responds systematically when it has moved away from the equilibrium relationship.

Table 6. Error-correction model estimates

Parameter	Coefficient	HAC std. error	z-statistic	p-value
Constant	-0.000024	0.000197	-0.121	0.903
ECT(-1)	-0.155219	0.046073	-3.369	<0.001
ΔpL(-1)	-0.334478	0.071102	-4.704	<0.001

ΔpL(-2)	-0.211752	0.057168	-3.704	<0.001
ΔpL(-3)	-0.033492	0.042326	-0.791	0.429
ΔpL(-4)	-0.094026	0.041025	-2.292	0.0219
ΔpL(-5)	0.029863	0.009437	3.164	0.0016
ΔpL(-6)	0.012524	0.007853	1.595	0.111
ΔpL(-7)	0.022882	0.006333	3.613	<0.001
ΔpL(-8)	0.009259	0.007457	1.242	0.214
ΔpL(-9)	-0.004979	0.008922	-0.558	0.577
ΔpG	0.849890	0.014440	58.858	<0.001
ΔpG(-1)	0.331042	0.067990	4.869	<0.001
ΔpG(-2)	0.212215	0.050120	4.234	<0.001
ΔpG(-3)	0.056114	0.039868	1.408	0.159
ΔpG(-4)	0.097519	0.038593	2.527	0.0115

The contemporaneous global-return coefficient is 0.8499 and highly significant, implying that a 1% change in the currency-adjusted global benchmark is associated with an approximately 0.85% same-period change in the Malaysian price, conditional on the other terms. The first, second and fourth global lags are also positive and significant, whereas several negative early local-return lags indicate short-run correction of prior local movements. These coefficients describe the adjustment path within the sample; they are not a claim that every temporary price difference offers a tradable gain after costs and timing differences.

Diagnostic Tests and Robustness

Table 7. Daily ECM diagnostic results

Diagnostic	Horizon	Statistic	p-value	Inference
Ljung–Box residual test	m = 5	Q = 1.108	0.953	No rejection
Ljung–Box residual test	m = 10	Q = 8.202	0.609	No rejection
Ljung–Box residual test	m = 20	Q = 31.374	0.0504	No rejection
ARCH LM	5 lags	LM = 185.666	<0.001	Conditional heteroskedasticity
Jarque–Bera	Residual distribution	JB = 20803.859	<0.001	Non-normal residuals
Durbin–Watson	First-order pattern	DW = 2.013	—	Close to 2

The daily ECM is satisfactory with respect to residual serial correlation as shown in Table 7. Ljung–Box p-values are 0.953 at five lags, 0.609 at ten lags and 0.0504 at twenty lags, while the Durbin–Watson statistic is 2.013. Thus, the null of no residual autocorrelation is not rejected at 5%, although the twenty-lag result is close to the threshold. The ARCH LM and Jarque–Bera tests reject homoskedasticity and normality. This is consistent with the heavy tails observed descriptively and justifies the HAC standard errors used for coefficient inference; it does not overturn the estimated long-run relation or adjustment coefficient.

Table 8. Weekly robustness results

Weekly result	Estimate/statistic	Benchmark/p-value	Inference
ADF: weekly local log price	-1.204	5% critical −2.86	Do not reject unit root
ADF: weekly local return	-15.774	5% critical −2.86	Stationary return
Ljung–Box: weekly return	Q(4) = 8.666	p = 0.0700	No rejection at 5%
Runs: weekly return	Z = -0.238	p = 0.812	Random signs
Variance ratio: q = 8	VR = 1.297	p = 0.0959	No rejection at 5%
Long-run slope	b = 1.000342	R^2 = 0.999024	Near-unit association
Residual ADF	-7.690	5% EG critical −3.34	Weekly cointegration

Weekly ECT(−1)	-0.4218	p <0.001	42.2% weekly correction
Weekly contemporaneous global return	0.9068	p <0.001	Positive short-run response

The weekly results qualify rather than contradict the daily efficiency finding as shown in Table 8. Weekly Ljung–Box, runs and variance-ratio tests do not reject randomness at 5%, suggesting that the daily dependence weakens after temporal aggregation. In contrast, the integration results strengthen: the weekly slope is 1.000342, the residual ADF statistic is −7.690, and the weekly error-correction coefficient is −0.4218 with $p < 0.001$. The same-day weekly global coefficient is 0.9068 and highly significant. Long-run integration and corrective adjustment are therefore robust to the alternative frequency, even though residual ARCH and non-normality remain and robust inference is still required. The daily–weekly contrast is also consistent with Kok et al. (2025) and Pinjaman et al. (2025, 2026), whose ringgit results show that efficiency classifications depend on the observation period and prevailing market conditions.

Malaysia in the Context of Regulated Asian Digital Asset Markets

The Malaysian market should also be interpreted within the wider development of regulated digital asset markets in Asia. Compared with larger and more internationally connected markets such as Singapore and Hong Kong, Malaysia may have a smaller local trading base and lower liquidity, which can allow temporary price differences to persist. Nevertheless, the cointegration and error-correction findings indicate that the Malaysian Bitcoin market remains closely connected to international price movements in the long run. This comparison is contextual rather than empirical, as the present study does not estimate equivalent models for other Asian markets.

CONCLUSION AND POLICY RECOMMENDATIONS

This study examined whether the Malaysian Bitcoin price follows a random walk, whether it shares a stable long-run relationship with a currency-adjusted global benchmark, and how it adjusts when the two prices diverge. Using Luno BTC/MYR, Coinbase Pro BTC/USD and USD/MYR observations, the analysis combined conventional unit-root and random-walk tests with Engle–Granger cointegration and an error-correction model. The findings answer all three objectives, but they also show why market efficiency, market integration and market risk should not be treated as interchangeable concepts.

The first finding provides qualified support for the weak-form efficient-market hypothesis. The Malaysian Bitcoin log price contains a unit root and the signs of daily returns appear random, which are features compatible with an unpredictable price path. Nevertheless, the Ljung–Box tests identify return dependence and the variance-ratio tests reject the random walk at the seven- and fourteen-day horizons. The evidence therefore rejects a strict daily random walk without implying that returns are easily or consistently forecastable. When the data are aggregated weekly, the Ljung–Box, runs and variance-ratio tests no longer reject randomness at the 5% level. Efficiency is consequently frequency-dependent in this sample: short-lived dependence exists in daily movements, but it weakens as information and trading adjustments accumulate over a longer interval.

This mixed result is consistent with the empirical literature rather than being an anomaly. Urquhart (2016) and Nadarajah and Chu (2017) report departures from Bitcoin efficiency, while Bariviera (2017), Tiwari et al. (2018), Sensoy (2019) and Tran and Leirvik (2020) show that efficiency varies across periods, frequencies, currencies and methods. The conclusion also agrees with Malaysian and ASEAN exchange-rate studies that find pre- and post-shock differences in weak-form efficiency (Kok et al., 2025; Pinjaman et al., 2025, 2026). The present evidence adds a regulated cryptocurrency-market perspective: weak-form efficiency is not a fixed label attached permanently to Bitcoin or to the ringgit, but depends on the horizon and market conditions under which information adjustment is measured.

The second and third findings support long-run price integration consistent with the law of one price as a long-run tendency. The Malaysian and currency-adjusted global log prices are both I(1), but their estimated equilibrium error is stationary. The long-run slope of 0.999356 is almost exactly one, while the average local premium is only 0.459%. These results indicate that the two price series are tied to a common underlying Bitcoin value after the US-dollar price is translated into ringgit. They do not require equality on every date: the premium can vary temporarily, but it cannot drift without bound over the sample. This distinction between long-run convergence and short-run dispersion is consistent with the law-of-one-price framework discussed by Lamont and Thaler (2003) and with cryptocurrency evidence that common prices coexist with temporary cross-market spreads (Pieters & Vivanco, 2017; Makarov & Schoar, 2020).

The error-correction results connect the long-run theory to the short-run data. The adjustment coefficient of −0.1552 indicates that approximately 15.5% of the preceding matched-period disequilibrium is corrected in the current period. The contemporaneous global-return coefficient of 0.8499 is also highly significant, and the weekly counterpart rises to 0.9068. Thus, international price movements are transmitted rapidly to Malaysia, while the remaining discrepancy is removed progressively. The result is compatible with Brandvold et al. (2015), who show that price discovery is concentrated in leading Bitcoin exchanges, and with Makarov and Schoar (2020), who show that market segmentation can delay complete cross-market equalisation.

The near-unit long-run relation arises first from the asset itself. A Bitcoin traded in Malaysia represents the same transferable digital unit as a Bitcoin traded internationally. Once the global BTC/USD price is multiplied by USD/MYR, the principal currency-of-quotation difference is removed. Common global information about adoption, regulation, macroeconomic conditions and cryptocurrency risk is therefore incorporated into both series, creating a shared stochastic trend. The strong contemporaneous association suggests that international price movements are closely reflected in the Malaysian market. At the same time, the long-run link between ringgit volatility and information uncertainty reported by Taasim et al. (2025) indicates why the currency conversion is economically substantive rather than a mechanical scaling exercise.

Temporary premiums and lagged adjustment can nevertheless arise because the law of one price operates through a market process rather than instantaneously. Trading fees, bid–ask spreads, the depth of the local order book, differences in investor demand, fiat deposit and withdrawal arrangements, compliance requirements, exchange-specific operating conditions and the timing of foreign-exchange observations can all slow equalisation. Cross-border arbitrage is also not frictionless: traders must move funds or digital assets across venues, manage settlement and counterparty risks, and satisfy the rules of the relevant platforms. These frictions help explain why the local premium has a positive mean and occasional large observations even though the equilibrium error is stationary. This interpretation is consistent with Pieters and Vivanco (2017) and Makarov and Schoar (2020), who associate cross-market price differences with regulation, segmentation and limits to arbitrage.

The daily return dependence may reflect the same adjustment process. Global information can reach the local order book quickly but not always completely within one observation interval, leaving continuation over selected horizons; negative local-return lags in the ECM also indicate correction after earlier local movements. By the weekly frequency, these short-run effects have largely been absorbed, which explains why weekly random-walk tests are less likely to reject. Finally, the ARCH effect, heavy tails and non-normal residuals indicate that volatility arrives in clusters. Cryptocurrency news, global risk episodes and liquidity changes can generate bursts of unusually large movements, so a market may be well integrated in price levels while remaining highly volatile. These mechanisms are economically plausible interpretations of the estimates, not separate causal effects identified by the observational design.

The findings support stronger implementation of Malaysia’s existing digital asset market regulations. DAX operators should provide transparent and timely trading information, including market prices, spreads, fees and deviations from international reference prices. This would help regulators and investors identify whether price differences reflect normal market conditions, exchange-rate movements or liquidity problems. Platforms should also strengthen market surveillance, especially during periods of unusual trading activity or high volatility. Clear reporting on trading volume, order-book conditions, system outages and market-making arrangements would improve regulatory oversight.

To support orderly trading, DAX operators should maintain adequate liquidity and disclose any market-making incentives or conflicts of interest. They should also regularly test their trading, wallet and settlement systems against major price and volume shocks. Finally, investor communication should clearly explain that close links with international Bitcoin prices do not remove local price differences or Bitcoin's high volatility. Information provided to investors should distinguish between price alignment, market efficiency and investment risk.

The study is limited to Bitcoin and one Malaysian exchange because a continuous and comparable daily dataset was required for the random-walk, cointegration and error-correction analyses. The findings should therefore not be generalised automatically to other cryptocurrencies or all Malaysian trading venues. Future research may extend the analysis to Ethereum and other sufficiently liquid digital assets, compare matched prices across Malaysian exchanges, and examine whether investor sentiment, policy announcements, global volatility and trading activity affect short-run price deviations. Comparative evidence from other regulated Asian cryptocurrency markets would also strengthen understanding of the role of market size, liquidity and regulation.

REFERENCES

1. Bariviera, A. F. (2017). The inefficiency of Bitcoin revisited: A dynamic approach. Economics Letters, 161, 1–4. https://doi.org/10.1016/j.econlet.2017.09.013
2. Brandvold, M., Molnár, P., Vagstad, K., & Valstad, O. C. A. (2015). Price discovery on Bitcoin exchanges. Journal of International Financial Markets, Institutions and Money, 36, 18–35. https://doi.org/10.1016/j.intfin.2015.02.010
3. Dickey, D. A., & Fuller, W. A. (1979). Distribution of the estimators for autoregressive time series with a unit root. Journal of the American Statistical Association, 74(366), 427–431. https://doi.org/10.1080/01621459.1979.10482531
4. Engle, R. F. (1982). Autoregressive conditional heteroscedasticity with estimates of the variance of United Kingdom inflation. Econometrica, 50(4), 987–1007. https://doi.org/10.2307/1912773
5. Engle, R. F., & Granger, C. W. J. (1987). Co-integration and error correction: Representation, estimation, and testing. Econometrica, 55(2), 251–276. https://doi.org/10.2307/1913236
6. Fama, E. F. (1970). Efficient capital markets: A review of theory and empirical work. The Journal of Finance, 25(2), 383–417. https://doi.org/10.2307/2325486
7. Jarque, C. M., & Bera, A. K. (1980). Efficient tests for normality, homoscedasticity and serial independence of regression residuals. Economics Letters, 6(3), 255–259. https://doi.org/10.1016/0165-1765(80)90024-5
8. Kok, S. C., Pinjaman, S., & Geetha, C. (2025). The predictability of the Ringgit Malaysia against the United States dollar exchange rate. International Journal of Research and Innovation in Social Science, 9(15), 1018–1026. https://doi.org/10.47772/IJRISS.2025.915EC00727
9. Lamont, O. A., & Thaler, R. H. (2003). Anomalies: The law of one price in financial markets. Journal of Economic Perspectives, 17(4), 191–202. https://doi.org/10.1257/089533003772034952
10. Ljung, G. M., & Box, G. E. P. (1978). On a measure of lack of fit in time series models. Biometrika, 65(2), 297–303. https://doi.org/10.1093/biomet/65.2.297
11. Lo, A. W., & MacKinlay, A. C. (1988). Stock market prices do not follow random walks: Evidence from a simple specification test. The Review of Financial Studies, 1(1), 41–66. https://doi.org/10.1093/rfs/1.1.41
12. Makarov, I., & Schoar, A. (2020). Trading and arbitrage in cryptocurrency markets. Journal of Financial Economics, 135(2), 293–319. https://doi.org/10.1016/j.jfineco.2019.07.001
13. Mohd Thas Thaker, H., & Ah Mand, A. (2021). Bitcoin and stock markets: A revisit of relationship. Journal of Derivatives and Quantitative Studies, 29(3), 234–256. https://doi.org/10.1108/JDQS-07-2020-0016
14. Nadarajah, S., & Chu, J. (2017). On the inefficiency of Bitcoin. Economics Letters, 150, 6–9. https://doi.org/10.1016/j.econlet.2016.10.033
15. Nakamoto, S. (2008). Bitcoin: A peer-to-peer electronic cash system. https://bitcoin.org/bitcoin.pdf

16. Newey, W. K., & West, K. D. (1987). A simple, positive semi-definite, heteroskedasticity and autocorrelation consistent covariance matrix. Econometrica, 55(3), 703–708. https://doi.org/10.2307/1913610
17. Pieters, G., & Vivanco, S. (2017). Financial regulations and price inconsistencies across Bitcoin markets. Information Economics and Policy, 39, 1–14. https://doi.org/10.1016/j.infoecopol.2017.02.002
18. Pinjaman, S. (2025). Digital sukuk: The evolution and potential of digital Islamic bonds. In T. Endress & Y. F. Badir (Eds.), Business and management in Asia: Finance and investments in the digital age (pp. 139–155). Springer. https://doi.org/10.1007/978-981-96-3452-1_9
19. Pinjaman, S., Kok, S. C., & Janin, Y. (2025). Market efficiency of the Malaysian ringgit against selected ASEAN currencies exchange rates for pre-, during, and post-COVID-19 pandemic. International Journal of Research and Innovation in Social Science, 9(15), 1451–1460. https://doi.org/10.47772/IJRISS.2025.915EC00761
20. Pinjaman, S., Kok, S. C., Aralas, S., Basuki, A. T., Hadi, S., Nugraha, P., & Darsono, S. N. A. C. (2026). Pandemic shocks and time-varying weak-form efficiency in ASEAN foreign exchange markets: An empirical investigation. Optimum: Jurnal Ekonomi dan Pembangunan, 16(1), 138–147. https://doi.org/10.12928/optimum.v16i1.15560
21. Securities Commission Malaysia. (2019, June 4). SC registers three digital asset exchanges. https://www.sc.com.my/resources/media/media-release/sc-registers-three-digital-asset-exchanges
22. Securities Commission Malaysia. (2026, May 20). Guidelines on recognized markets. https://www.sc.com.my/regulation/guidelines/recognizedmarkets
23. Sensoy, A. (2019). The inefficiency of Bitcoin revisited: A high-frequency analysis with alternative currencies. Finance Research Letters, 28, 68–73. https://doi.org/10.1016/j.frl.2018.04.002
24. Taasim, S. I., Teruki, N. A., Sabu, Z., Pinjaman, S., & Mojolou, R. A. (2025). Ringgit Malaysia uncertainty spillover from Google Trends uncertainty. International Journal of Research and Innovation in Social Science, 9(15), 367–372. https://doi.org/10.47772/IJRISS.2025.915EC0022
25. Tiwari, A. K., Jana, R. K., Das, D., & Roubaud, D. (2018). Informational efficiency of Bitcoin: An extension. Economics Letters, 163, 106–109. https://doi.org/10.1016/j.econlet.2017.12.006
26. Tran, V. L., & Leirvik, T. (2020). Efficiency in the markets of crypto-currencies. Finance Research Letters, 35, Article 101382. https://doi.org/10.1016/j.frl.2019.101382
27. Twelve Data. (2026a). Bitcoin to Malaysian ringgit (BTC/MYR): Historical data. Retrieved July 15, 2026, from https://twelvedata.com/markets/615816/crypto/luno/btc-myr/historical-data
28. Twelve Data. (2026b). Bitcoin to US dollar (BTC/USD): Historical data. Retrieved July 15, 2026, from https://twelvedata.com/markets/499377/crypto/coinbase-pro/btc-usd/historical-data
29. Twelve Data. (2026c). US dollar/Malaysian ringgit (USD/MYR): Historical data. Retrieved July 15, 2026, from https://twelvedata.com/markets/104355/forex/usd-myr/historical-data
30. Urquhart, A. (2016). The inefficiency of Bitcoin. Economics Letters, 148, 80–82. https://doi.org/10.1016/j.econlet.2016.09.019
31. Wald, A., & Wolfowitz, J. (1940). On a test whether two samples are from the same population. The Annals of Mathematical Statistics, 11(2), 147–162. https://doi.org/10.1214/aoms/1177731909
32. Ye, J. (2022). Bitcoin cross-market price dynamics: Three essays looking into consensus, fear and memory [Doctoral dissertation, University of Southampton]. University of Southampton Institutional Repository. https://eprints.soton.ac.uk/472089/
33. Zhou, T. X., Osman, Z., & Pinjaman, S. (2023). The impact of financial technology on commercial banks: A case study of China. Malaysian Journal of Social Sciences and Humanities, 8(7), Article e002443. https://doi.org/10.47405/mjssh.v8i7.2443