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Overnight cryptocurrency downside and opening versus intraday equity returns in Southeast Asia

Quan Pham

phamtruongquan@iuh.edu.vn

Industrial University of Ho Chi Minh City

Xuan Phan

Industrial University of Ho Chi Minh City

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Abstract

Cryptocurrency markets trade overnight while equity exchanges are closed. Whether the association between overnight cryptocurrency downside and equity returns appears at the opening or during trading may differ across markets. We examine this question in Vietnam, Singapore, Malaysia and Indonesia from August 2020 to July 2026. Automated end-to-end scripts collect and analyse publicly available market data and generate the tables and figures. In Vietnam, a one-standard-deviation increase in cryptocurrency downside is associated with a 2.3-basis-point lower VN-Index opening return and a 14.9-basis-point lower intraday return. The intraday coefficient accounts for 86% of the total estimated association. On common trading dates, the allocation differs between Vietnam and Singapore by 17.3 basis points and between Vietnam and Malaysia by 12.8 basis points. The results show that the association with overnight cryptocurrency downside is concentrated during trading in Vietnam, while its timing differs across the four markets.

Keywords: cryptocurrency; market closures; opening gap; intraday returns; price formation; Southeast Asia

1 Introduction

Equity exchanges close each day while cryptocurrencies continue to trade. Their overnight returns provide an observable signal before equity markets reopen. Cryptocurrency returns have distinctive risk exposures (Liu and Tsyvinski, 2021) and recurring intraday patterns (Brauneis et al., 2025). Different trading hours across exchanges allow us to examine when this overnight signal is associated with equity returns. The opening return measures the change from the previous close to the next open; the intraday return measures the subsequent change through the close.

Recent studies document the predictive content of overnight cryptocurrency returns. Mourey et al. (2025) find that weekend cryptocurrency losses predict weaker Monday equity returns in the United States (US), while Gu et al. (2026) report improvements in forecasts of the Cboe Volatility Index (VIX). For the US, Song (2026) separates opening from intraday returns for two exchange-traded funds, SPY (S&P 500) and QQQ (Nasdaq-100), and finds the stronger association with overnight Bitcoin losses at the opening. These findings raise a related question: how is the association divided between the opening and the rest of the session in other equity markets?

We examine Vietnam, Singapore, Malaysia and Indonesia between August 2020 and July 2026, using one benchmark index for each country. In Vietnam, we also examine VN30, VNMidcap and VNSmallcap to describe how the results vary by market capitalisation. For every trading session, we relate overnight cryptocurrency downside to the opening return, intraday return and their close-to-close sum. Estimating all three outcomes on the same observations with the same controls yields an exact decomposition of the coefficient. We use the VN-Index for comparisons with the three other countries. An end-to-end pipeline automatically retrieves the data, aligns them with each exchange's trading hours, estimates the models and regenerates every reported table and figure.

The Vietnamese estimates show a predominantly intraday association. In the VN-Index, a one-standard-deviation increase in the downside measure is associated with an opening return 2.3 basis points (bp) lower and an intraday return 14.9 bp lower. The estimated difference is 12.5 bp (95% interval 4.3–20.7; Holm-adjusted $p = 0.014$), with an intraday share of 0.86. The other Vietnamese indices display the same ordering. In cross-market comparisons on common trading dates, the allocation differences between the VN-Index and Singapore and Malaysia are 17.3 bp ($p = 0.003$) and 12.8 bp ($p = 0.006$), respectively, after Holm adjustment. Singapore has a larger opening than intraday point estimate, while the Indonesian contrast is less precisely estimated.

The contribution is to document where the association between overnight cryptocurrency downside and equity returns appears within the next session, and how that timing varies across Southeast Asian markets. Separating opening from intraday returns adds information that a close-to-close coefficient alone cannot provide. The estimates also allow the observed patterns to be related to existing accounts of opening incorporation, intraday reversal and continuation. Section 2 reviews these accounts, Section 3 presents the design, Section 4 reports the results, and Sections 5 and 6 discuss and conclude.

2 Literature and predictions

2.1 Overnight information and the reopening

The relation between cryptocurrency and conventional asset returns varies across markets and market conditions (Corbet et al., 2018; Kostika and Laopodis, 2020). Daily return measures combine intervals in which equity prices are continuously updated with intervals in which the exchange is closed. Overnight measures isolate the latter interval. In the US setting, Mourey et al. (2025) associate weekend cryptocurrency losses with Monday equity declines, while Gu et al. (2026) document predictive content in cryptocurrency returns recorded outside US trading hours for

subsequent implied volatility. These findings motivate measuring overnight cryptocurrency returns relative to the receiving equity market.

The distinction between opening and intraday returns adds a question about when equity prices adjust. International studies show that the sequence of exchange hours matters for the observed transmission of market movements (Eun and Shim, 1989; Hamao et al., 1990). Research on trading mechanisms differentiates price discovery in opening auctions from price formation in continuous markets (Amihud and Mendelson, 1987; Madhavan and Panchapagesan, 2000). Song (2026) provides a directly related US comparison: Bitcoin returns observed from the preceding New York Stock Exchange (NYSE) close to 09:00 New York time are associated with opening gaps for SPY and QQQ, while the intraday association is relatively weak. These results motivate comparing the opening and intraday coefficients across countries.

2.2 Empirical patterns of opening and intraday returns

Let β^{ON} and β^{ID} be the coefficients of a pre-opening signal on the opening and intraday equity returns. On the same estimation sample with the same regressors, the close-to-close coefficient is $\beta^{TOT} = \beta^{ON} + \beta^{ID}$. The intraday proportion is $s = \beta^{ID}/\beta^{TOT}$ when the total coefficient is distinguishable from zero. Three patterns described in the overnight and intraday literature organise the interpretation of these coefficients (Table 1).

Opening incorporation places most of the association in the opening gap. An opening auction incorporates orders and information accumulated outside regular trading hours (Madhavan and Panchapagesan, 2000), producing an opening coefficient larger in magnitude than the intraday coefficient and an intraday proportion near zero. The US estimates of Song (2026) are consistent with this configuration.

Intraday reversal associates the pre-opening signal with an opening movement followed by a movement in the opposite direction. The separation of overnight and daytime investor demand provides one account of such reversals (Lou et al., 2019; Akbas et al., 2022). In coefficient terms, opening and intraday associations carry opposing signs, and the intraday share may be negative. The tendency toward reversal can vary with the direction of overnight returns.

Intraday continuation describes opening and intraday associations with the same sign. Evidence on delayed price adjustment, informed trading during the session and information diffusion offers related explanations (Barardehi et al., 2026; Gao et al., 2019; Tran and Tran, 2025). Common information arriving after the open can also contribute to same-sign associations. When the intraday coefficient is larger in magnitude, $s > 0.5$ and most of the close-to-close coefficient lies in the intraday component.

2.3 Market setting and empirical contrasts

Opening auctions, trading hours, investor participation and the pace of price adjustment differ across countries. Existing evidence on auctions (Madhavan and Panchapagesan, 2000) and intraday trading in China and Vietnam (Gao et al., 2019; Tran and Tran, 2025) motivates examining the opening and continuous-trading windows separately. We use the coefficient contrast $D_c = \widehat{\beta}_c^{ON} - \widehat{\beta}_c^{ID}$ to describe the allocation for market c. When both coefficients are negative, a positive D_c identifies the larger negative association in the intraday return. We estimate D_c within each market and compare the VN-Index with Singapore, Malaysia and Indonesia on common trading dates.

3 Data and research design

3.1 Closure windows and sample

We obtain five-minute spot prices for Bitcoin (BTC), Ether (ETH), XRP, Cardano (ADA), Solana (SOL), Dogecoin (DOGE), Litecoin (LTC) and TRON (TRX) from the Binance public historical archive. Prices are quoted in Tether (USDT), a stablecoin pegged to the US dollar (Binance, 2026). The eight-asset universe was determined before estimation. SOL observations begin on 11 August 2020, and 12 August 2020 is the first equity session with a complete closure-period history for all eight pairs. The sample ends on 31 July 2026, the last complete month available when the archive was frozen.

For each session t in equity market c, the measurement interval starts at the market's previous close and ends at a cutoff before its next opening. Vietnam uses 14:45 on the preceding trading day to 08:45 local time; Singapore, Malaysia and Indonesia use their respective exchange closing and formal opening times. All timestamps are converted to Coordinated Universal Time before matching the cryptocurrency observations. The log return for cryptocurrency j over market c's closure is

$$r_{jct}^{C} = \log P_{jc,t}^{\text{cut}} - \log P_{jc,t-1}^{\text{close}}, \tag{1}$$

where the starting price is taken from the first available bar at or after the previous equity close and the ending price from the last bar at or before the cutoff. Intervals covering weekends or local public holidays account for 21.0–24.0% of the observed sessions (Table 2).

3.2 The cryptocurrency downside measure

We measure overnight downside using consensus-weighted market downside severity (CMDS), which combines how many cryptocurrencies declined and the median size of those declines. Negative breadth is $B_{ct}^{-} = N^{-1} \sum_{j=1}^{N} \mathbf{1}(r_{jct}^{C} < 0)$ for $N = 8$ cryptocurrencies. Downside severity is the absolute median of negative returns, $S_{ct}^{-} = |\operatorname{median}\{r_{jct}^{C} : r_{jct}^{C} < 0\}|$, with value zero when there are no negative returns. Their product defines

$$CMDS_{ct} = B_{ct}^{-} S_{ct}^{-}. \tag{2}$$

The measure is standardised within each equity market; reported coefficients therefore refer to a one-standard-deviation increase. An equal-weighted average of standardised Bitcoin and Ether closure returns (BTC–ETH) provides an alternative signed specification of the pre-opening signal in Section 4.4. Variable definitions appear in Supplementary Table S1.

3.3 Equity returns and data sources

The sample contains four Vietnamese indices (VN-Index, VN30, VNMidcap and VNSmallcap) and the Straits Times Index (STI), FTSE Bursa Malaysia KLCI (Kuala Lumpur Composite Index) and Jakarta Composite Index (JKSE). Let O_{ct} and C_{ct} be the reported opening and closing levels of index c in session t. We define the close-to-close, previous-close-to-open and open-to-close log returns as

$$R_{ct}^{TOT} = \log C_{ct} - \log C_{c,t-1}, \tag{3}$$

$$R_{ct}^{ON} = \log O_{ct} - \log C_{c,t-1}, \tag{4}$$

$$R_{ct}^{ID} = \log C_{ct} - \log O_{ct}, \tag{5}$$

which imply $R_{ct}^{TOT} = R_{ct}^{ON} + R_{ct}^{ID}$. The observed identity holds to floating-point precision (maximum absolute discrepancy 3.1×10^{-16}). The intraday measure covers the entire session, including any midday break. Estimation samples contain 1,432–1,502 sessions per index. The four Vietnamese series come from VNDIRECT, and the other indices from Yahoo Finance; VNDIRECT previous-close levels match the preceding recorded closes in all Vietnamese observations.

The two return components have different temporal interpretations. Closure-period CMDS is observed by the pre-opening cutoff, while the opening gap spans the period over which the predictor is formed. The opening coefficient therefore describes the association with repricing visible at the opening level. The intraday outcome begins after that level is set and captures the association with

subsequent price movements. This distinction motivates reporting both coefficients and their sum.

The accuracy of reported opening prices matters for the decomposition. We classify an opening as *stale* when it lies within 0.5 bp of the preceding close, giving a near-zero measured opening gap. The fraction of such observations ranges from 5.6% to 11.4% in the Vietnamese series, is 1.3% for the STI and 1.6% for the KLCI, and reaches 26.1% for the JKSE (Table 2). The baseline uses all reported opening prices. Additional estimates exclude stale observations, exclude months with clustered stale observations and use independent Vietnamese opening records (the iBoard platform of SSI Securities Corporation (SSI) for disputed stale openings and KB Securities Vietnam (KBSV) for the VN-Index). The alternative SSI iBoard series replaces a stale VNDIRECT opening only where the independent source reports a gap exceeding 5 bp; other stale sessions are omitted in that specification. These independent records allow us to check the results obtained from the original opening prices.

Each regression includes the same six US controls: the S&P 500 return, Nasdaq Composite return, change in the VIX, Intercontinental Exchange (ICE) US Dollar Index return, change in the 10-year US Treasury yield and front-month West Texas Intermediate crude-oil futures return. The controls use the most recent daily values treated as available by 16:15 New York time before the relevant market opening; the timing convention uses values at the US market close rather than separately verified publication times. The regressions additionally contain the lagged equity-index return and weekday and month-year fixed effects.

3.4 Reproducible, end-to-end analysis

A single suite of executable scripts reproduces the analysis from data retrieval to the final tables and figures. The workflow automatically downloads five-minute cryptocurrency prices from Binance Public Data, Vietnamese index histories through the VNDIRECT DChart historical-data interface, and international equity-index and US control series from Yahoo Finance. We check Vietnamese opening prices against independent records from SSI iBoard and KBSV. For each download, the scripts record the source, query parameters, retrieval date and file checksum.

The scripts convert timestamps to a common standard, apply each exchange calendar and pre-opening cutoff, calculate overnight cryptocurrency returns and CMDS, and construct the three equity returns. The remaining scripts select the samples, check opening prices, estimate the models and uncertainty measures, run the additional analyses, and generate the tables and figures directly from the results. The end-to-end pipeline has been executed successfully to reproduce the reported analyses and presentation materials. Versioned configurations, manifests, automated checks and file hashes trace the results back to the downloaded data. Supplementary Table S5 summarises the

workflow and its reproducibility records.

Use of generative artificial intelligence. ChatGPT Sol 6.1 and Claude Opus 5.5 were used to assist with coding and drafting the manuscript in English.

3.5 Estimation and inference

For index c and outcome $k \in \{TOT, ON, ID\}$, the model is

$$R^k_{ct} = \alpha^k_c + \beta^k_c CMDS_{ct} + \gamma^{k\prime}_c X_{ct} + \rho^k_c R^{TOT}_{c,t-1} + \delta^k_{dow} + \delta^k_{ym} + \varepsilon^k_{ct}, \tag{6}$$

where X_{ct} contains the six US controls. All three regressions for a market use identical observations and regressors. The fitted coefficients therefore satisfy the same additive identity as the returns: $\widehat{\beta}^{TOT}_c = \widehat{\beta}^{ON}_c + \widehat{\beta}^{ID}_c$. Standard errors use Newey–West heteroskedasticity- and autocorrelation-consistent (HAC) covariance estimates with five lags (Newey and West, 1987).

The within-market allocation is summarised by $D_c = \widehat{\beta}^{ON}_c - \widehat{\beta}^{ID}_c$, using the joint HAC covariance of the opening and intraday regressions for inference. The intraday share, $\widehat{s}_c = \widehat{\beta}^{ID}_c / \widehat{\beta}^{TOT}_c$, is reported with a delta-method interval and checked using a circular moving-block bootstrap with five-session blocks and 4,999 draws (Politis and Romano, 1992). As a ratio of coefficients, this share measures the composition of an estimated association rather than explained variance. Its interval may extend outside zero and one, and the ratio is reported only where the total coefficient is distinguishable from zero.

Cross-market inference compares the VN-Index D_c with the corresponding D_c for the STI, KLCI and JKSE using their common trading dates. The joint HAC covariance includes cross-market dependence and is compared with a common-date circular moving-block bootstrap with five-session blocks and 2,999 draws. Holm adjustment (Holm, 1979) is applied to the three primary VN-Index comparisons and separately to the seven tests of opening versus intraday coefficients. VN30, VNMidcap and VNSmallcap are overlapping segments of the Vietnamese market; nine additional comparisons with the other countries are presented as supplementary segment analyses with Holm adjustment within that family (Supplementary Table S3).

3.6 Specification selection and multiplicity

The within-session decomposition and the three primary VN-Index contrasts were specified in an earlier analysis version. A subsequent correction to opening prices reported by the provider changed

the VN-Index allocation contrast from 18.7 to 12.5 bp and the three cross-market contrasts from 23.4, 19.1 and 21.4 bp to 17.3, 12.8 and 13.3 bp. The article's focus on within-session timing followed consideration of five analyses of the same dataset: conditional-mean associations, extreme losses, lower-quantile forecasts, closure-length interactions and within-session timing. Holm adjustment is applied within each specified group of comparisons. Section 5.3 quantifies sensitivity to the wider selection of the timing result.

4 Results

4.1 Close-to-close associations

Overnight cryptocurrency downside has a negative estimated association with next-session close-to-close returns in all seven indices (Table 3). A one-standard-deviation increase in CMDS corresponds to coefficients of −17.2 bp for the VN-Index, −18.3 bp for VN30, −26.3 bp for VNMidcap and −23.3 bp for VNSmallcap. The coefficients are −8.9 bp for the STI, −3.9 bp for the KLCI and −16.6 bp for the JKSE. Six of the seven estimates have Holm-adjusted $p \leq 0.005$; the KLCI estimate has $p = 0.160$. Relative to each index's daily return standard deviation, the coefficients range from 5.7% for the KLCI to 17.3% for VNMidcap.

The association is larger in absolute value when the six US controls are omitted. For the VN-Index, the close-to-close coefficient changes from −17.2 bp with controls to −23.7 bp without them, and the same ordering appears in the other six indices. We decompose these conditional coefficients into opening and intraday components.

4.2 Predominantly intraday allocation in Vietnam

The decomposition places most of the negative VN-Index association in the intraday component (Table 4; Fig. 1). The opening coefficient is −2.3 bp (standard error 1.9 bp, $p = 0.230$), compared with −14.9 bp for the intraday coefficient (standard error 4.4 bp, $p < 0.001$). Their difference, D, is 12.5 bp, with a 95% confidence interval of 4.3–20.7 bp and Holm-adjusted $p = 0.014$. VN30, VNMidcap and VNSmallcap display the same ordering, with intraday coefficients between −15.5 and −21.8 bp and allocation differences of 12.7, 17.4 and 16.8 bp, respectively (adjusted $p = 0.012$–0.017).

The intraday coefficient accounts for 0.86 of the VN-Index total (95% delta-method interval 0.68–1.05; moving-block bootstrap interval 0.68–1.14). Across all four Vietnamese indices the corresponding shares are 0.83–0.86, with confidence-interval lower bounds of at least 0.68 (Fig. 2, panel A). Thus, the opening coefficient represents about 0.14 of the estimated VN-Index total. In all four indices,

the lower bounds exceed 0.5, indicating that most of the estimated association lies in the intraday return.

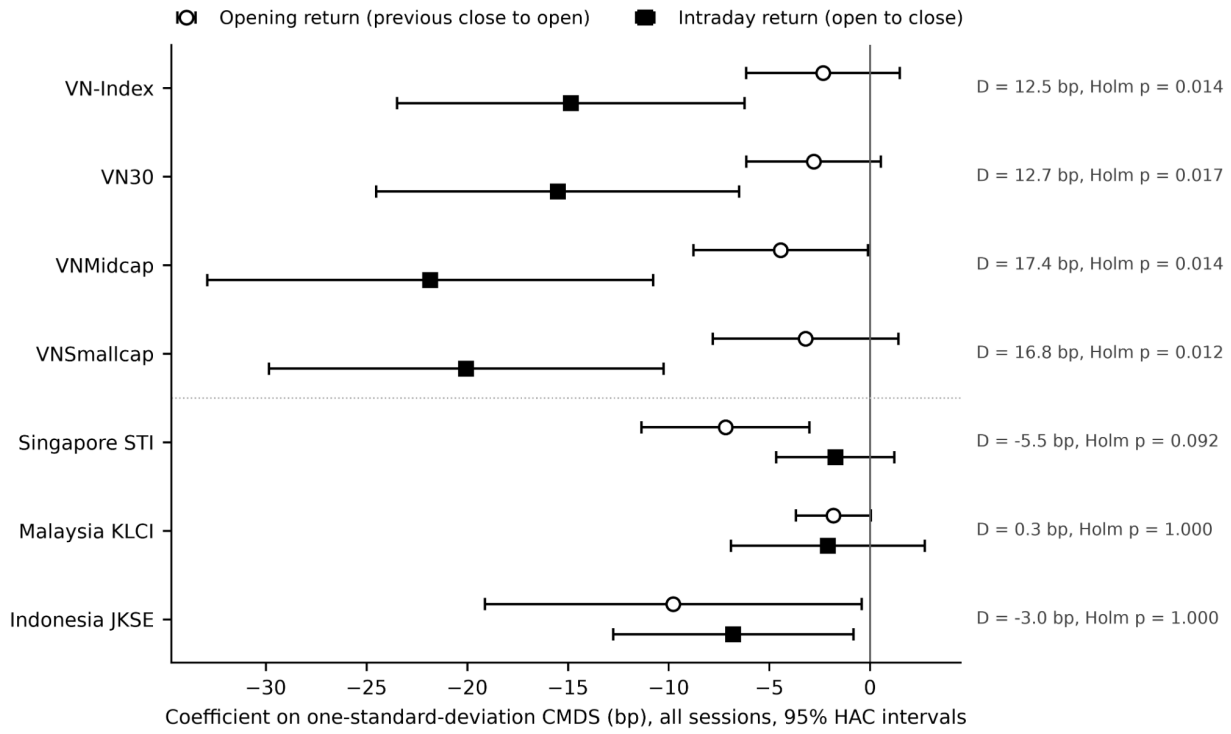

Figure 1: Opening and intraday associations with overnight cryptocurrency downside.

The same allocation appears with alternative opening observations (Table 6). After excluding stale sessions, the four Vietnamese differences range from 11.9 to 17.2 bp (Holm-adjusted $p \leq 0.026$). Excluding months with clustered stale openings yields differences of 12.0–20.0 bp ($p \leq 0.029$). Using independent opening levels where they contradict the principal provider yields 12.2–17.2 bp ($p \leq 0.011$ in the corresponding four-index family). For the VN-Index, independent KBSV openings produce a difference of 12.4 bp in the full 1,489-session sample ($p = 0.002$, unadjusted) and 12.6 bp among 1,406 sessions with non-stale KBS openings ($p = 0.003$).

4.3 Cross-market differences

The opening and intraday coefficients differ across the three other countries (Table 4; Fig. 1). In Singapore, the STI opening coefficient is −7.2 bp and the intraday coefficient is −1.7 bp. Their difference is −5.5 bp (95% interval −10.4 to −0.5; raw $p = 0.031$, Holm-adjusted $p = 0.092$), with an intraday share of 0.19 (95% interval −0.08–0.47). The KLCI has opening and intraday coefficients of −1.8 and −2.1 bp; its close-to-close coefficient is imprecisely estimated, so an intraday share is not reported. For Indonesia, the JKSE coefficients are −9.8 and −6.8 bp, yielding $D = -3.0$ bp

(adjusted $p = 1.000$) and an intraday share of 0.41 (95% interval 0.09–0.73). Its comparatively high stale-opening frequency is relevant to the precision of that decomposition.

On common trading dates, the VN-Index allocation difference exceeds that of Singapore by 17.3 bp (95% interval 7.0–27.6; joint-HAC and bootstrap standard errors both 5.2 bp; Holm-adjusted $p = 0.003$). The corresponding Vietnam–Malaysia difference is 12.8 bp (95% interval 4.4–21.2; joint-HAC standard error 4.3 bp, bootstrap standard error 4.5 bp; adjusted $p = 0.006$). The Vietnam–Indonesia estimate is 13.3 bp (95% interval −0.5–27.1; adjusted $p = 0.059$). The VN-Index differs from Singapore and Malaysia in these direct comparisons (Table 5; Fig. 2, panel B).

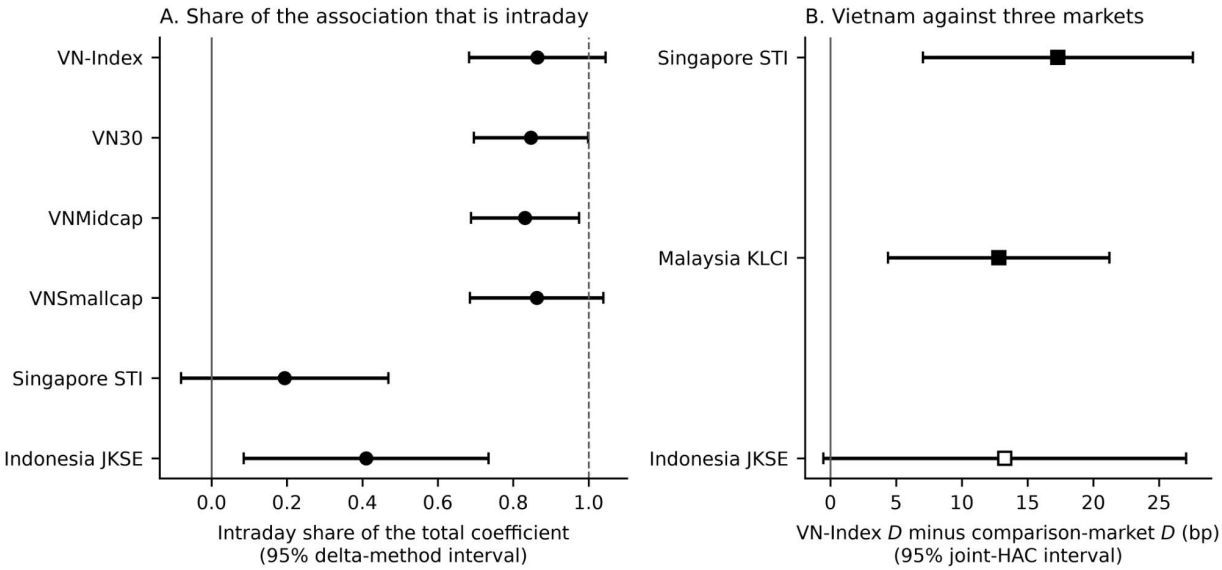

Figure 2: Intraday shares and differences across markets.

The Vietnam–Singapore and Vietnam–Malaysia differences remain similar after excluding stale sessions, at 16.3 and 11.7 bp (adjusted $p = 0.006$ and 0.015), and with independent Vietnamese opening observations, at 16.6 and 12.5 bp ($p = 0.004$ and 0.008). The Vietnam–Indonesia contrast remains less precise in both checks (11.4 and 12.3 bp; adjusted $p = 0.170$ and 0.130). Supplementary Table S3 reports positive contrasts of 13.4–22.0 bp for the nine additional comparisons involving VN30, VNMidcap and VNSmallcap; eight have Holm-adjusted $p < 0.05$ within their separate comparison family. The three additional Vietnamese indices reflect different segments of the same market.

4.4 Timing patterns and additional evidence

Table 1 provides three patterns against which to compare the observed coefficients. The opening and intraday point estimates are both negative in each market. Vietnam combines same-sign

coefficients with a larger intraday component, corresponding to the empirical configuration of intraday continuation. The STI has a larger opening coefficient, corresponding more closely to opening incorporation. The reversal configuration, which requires opposite signs, does not appear in the reported point estimates. Estimates are less precise for the STI intraday component and the two KLCI components (unadjusted $p = 0.248$, 0.055 and 0.391, respectively).

Leads and lags of CMDS provide a further description of the session timing. In 12 Vietnamese equations estimated without stale openings, the one-session lead coefficients have unadjusted $p \geq 0.215$, and one lag coefficient meets $p < 0.05$ (the VN30 allocation difference, $p = 0.029$). Lagged CMDS is associated with positive opening-return coefficients of 2.2–3.6 bp across the Vietnamese indices ($p = 0.052$–0.253) and negative intraday-return coefficients of -6.2 to -1.8 bp ($p = 0.132$–0.719). The strongest associations in these comparisons are observed for CMDS measured before the same session.

Using a signed, standardised BTC–ETH closure return gives a similar relative ordering for Vietnam. On non-stale VN-Index sessions, the opening coefficient is 3.5 bp (unadjusted $p = 0.073$), and the intraday coefficient is 12.2 bp ($p < 0.001$); the opening-minus-intraday difference is -8.7 bp ($p = 0.011$). This signed measure captures the direction of cryptocurrency returns, whereas CMDS focuses on declines. Both specifications place the larger coefficient in the intraday return.

The Vietnamese allocation difference also changes little when contemporaneous regional index returns and in-session BTC–ETH returns are added as explanatory controls (Table 6, middle block). Across the four indices and these specifications, the contrasts remain at 96–103% of their matched-sample baseline values, with raw $p \leq 0.005$ on the 1,413-session common sample. Within samples excluding stale openings, the additional in-session BTC–ETH coefficients have unadjusted $p = 0.046$–0.127. The Vietnamese contrast remains similar after including these contemporaneous returns.

Finally, the VN-Index contrast is 12.5 bp in the first sample half through 3 August 2023 (744 sessions; unadjusted $p = 0.018$) and 11.9 bp in the second half (745 sessions; $p = 0.084$). The estimated intraday shares are 0.94 and 0.77, respectively. All four Vietnamese indices retain a larger intraday than opening coefficient in both halves (Table 6, lower block), although within-half precision differs. These are separate-period estimates; the study does not estimate an equality test between the halves.

5 Discussion

5.1 The timing differs across markets

In Vietnam, overnight cryptocurrency downside is associated more strongly with intraday than with opening returns. Across its four indices, the opening gap carries a relatively small part of the negative close-to-close coefficient, and the intraday return carries most of it. For the STI, the opening coefficient is larger in magnitude. Direct comparisons show that the VN-Index differs from Singapore and Malaysia. Alongside the US estimates of Song (2026), these results show that the timing of the association varies across markets.

The timing patterns offer an interpretation of this variation. Vietnam's same-sign opening and intraday estimates, with the intraday component dominating, resemble continuation; Singapore's point estimates resemble greater incorporation at the opening. Overnight investor demand, the opening auction, delayed responses to news and information arriving during trading may contribute to these patterns (Lou et al., 2019; Akbas et al., 2022; Gao et al., 2019; Barardehi et al., 2026). Distinguishing among these explanations would require finer data on trading and price formation.

5.2 Implications for measuring market adjustment

Separating opening and intraday returns reveals information hidden by the daily total. For the VN-Index, the opening coefficient represents approximately 14% of the total point estimate and the intraday coefficient approximately 86%, whereas a close-to-close regression reports their sum. An opening-only outcome would therefore give a materially different account of the observed association in Vietnam. Comparing the allocation contrast directly also avoids relying on differences in the statistical significance of two separately estimated coefficients.

The timing differences also matter when monitoring markets. A pre-opening cryptocurrency measure can be associated with returns that emerge after the cash session has started, and the location of that association differs among the markets studied. Monitoring and forecasting can distinguish between the opening gap and subsequent trading. The study estimates conditional return associations. The profitability of a trading strategy additionally depends on forecasts, liquidity and transaction costs.

5.3 Limitations

The timing decomposition was selected as the focus of the paper after comparison with four other analyses of the same dataset. Holm adjustment across the seven allocation tests addresses those tests, rather than the choice among five analyses. Multiplying the adjusted p values for the four

Vietnamese allocation differences by five yields 0.061–0.083; these sensitivity values describe the influence of outcome selection on statistical inference. The estimates describe the timing of the conditional association in this sample. Daily US controls capture some global conditions, but do not establish where the information recorded in overnight cryptocurrency prices originated.

The cross-market evidence also depends on the available market measures. The KLCI total coefficient is imprecise, the JKSE has a 26.1% rate of stale reported openings, and the STI's within-market allocation difference has an adjusted $p = 0.092$. The four Vietnamese indices represent segments of one exchange, and data providers differ between Vietnam and the other markets. The sample spans August 2020–July 2026, and its cryptocurrency measures come from one trading venue. More detailed auction records, constituent prices, transactions and futures prices aligned with overnight hours could help explain the timing differences.

6 Conclusion

Overnight cryptocurrency downside has different estimated associations with opening and intraday equity returns across Southeast Asian markets. For the VN-Index, the intraday coefficient is 14.9 bp in magnitude compared with 2.3 bp at the opening, accounting for an estimated 0.86 of the negative close-to-close coefficient. Similar allocations appear in the other Vietnamese indices. Direct contrasts distinguish the Vietnamese allocation from those observed for Singapore and Malaysia, while Singapore's own point estimates place more of the association at the opening. The results extend evidence on links between cryptocurrencies and equity markets by showing that the same overnight measure can be associated with different parts of the next trading session.

References

Akbas F, Boehmer E, Jiang C, Koch PD (2022) Overnight returns, daytime reversals, and future stock returns. *Journal of Financial Economics* 145(3):850–875. https://doi.org/10.1016/j.jfineco.2021.09.019

Amihud Y, Mendelson H (1987) Trading mechanisms and stock returns: an empirical investigation. *Journal of Finance* 42(3):533–553. https://doi.org/10.1111/j.1540-6261.1987.tb04567.x

Barardehi YH, Bogousslavsky V, Muravyev D (2026) What drives momentum and reversal? Evidence from day and night signals. *Review of Financial Studies* 39(10):3378–3411. https://doi.org/10.1093/rfs/hhag036

Binance (2026) Binance public data: spot monthly klines. https://data.binance.vision/. Accessed 1 Aug 2026.

Brauneis A, Mestel R, Theissen E (2025) The crypto world trades at tea time: intraday evidence from

centralized exchanges across the globe. *Review of Quantitative Finance and Accounting* 64:275–304. https://doi.org/10.1007/s11156-024-01304-1

Corbet S, Meegan A, Larkin C, Lucey B, Yarovaya L (2018) Exploring the dynamic relationships between cryptocurrencies and other financial assets. *Economics Letters* 165:28–34. https://doi.org/10.1016/j.econlet.2018.01.004

Eun CS, Shim S (1989) International transmission of stock market movements. *Journal of Financial and Quantitative Analysis* 24(2):241–256. https://doi.org/10.2307/2330774

Gao Y, Han X, Li Y, Xiong X (2019) Overnight momentum, informational shocks, and late informed trading in China. *International Review of Financial Analysis* 66:101394. https://doi.org/10.1016/j.irfa.2019.101394

Gu M, Lin J, Liu S (2026) Beyond conventional sentiment indicators: cryptocurrency's hidden potential in VIX forecasting. *Economic Modelling* 161:107648. https://doi.org/10.1016/j.econmod.2026.107648

Hamao Y, Masulis RW, Ng V (1990) Correlations in price changes and volatility across international stock markets. *Review of Financial Studies* 3(2):281–307. https://doi.org/10.1093/rfs/3.2.281

Holm S (1979) A simple sequentially rejective multiple test procedure. *Scandinavian Journal of Statistics* 6(2):65–70.

Kostika E, Laopodis NT (2020) Dynamic linkages among cryptocurrencies, exchange rates and global equity markets. *Studies in Economics and Finance* 37(2):243–265. https://doi.org/10.1108/SEF-01-2019-0032

Liu Y, Tsyvinski A (2021) Risks and returns of cryptocurrency. *Review of Financial Studies* 34(6):2689–2727. https://doi.org/10.1093/rfs/hhaa113

Lou D, Polk C, Skouras S (2019) A tug of war: overnight versus intraday expected returns. *Journal of Financial Economics* 134(1):192–213. https://doi.org/10.1016/j.jfineco.2019.03.011

Madhavan A, Panchapagesan V (2000) Price discovery in auction markets: a look inside the black box. *Review of Financial Studies* 13(3):627–658. https://doi.org/10.1093/rfs/13.3.627

Mourey M, Shahrour MH, Şoiman F (2025) A crypto-stock weekend effect: predicting Monday stock returns using weekend cryptocurrency returns. *Finance Research Letters* 86:108661. https://doi.org/10.1016/j.frl.2025.108661

Newey WK, West KD (1987) A simple, positive semi-definite, heteroskedasticity and autocorrelation consistent covariance matrix. *Econometrica* 55(3):703–708. https://doi.org/10.2307/1913610

Politis DN, Romano JP (1992) A circular block-resampling procedure for stationary data. In: LePage R, Billard L (eds). *Exploring the Limits of Bootstrap*. Wiley, New York, pp 263–270.

Song M (2026) Overnight Bitcoin losses and the timing of US equity repricing. SSRN working paper 7579278, manuscript dated 7 October 2026, posted 8 October 2026. https://doi.org/10.2139/ssrn.7579278

Tran MH, Tran NM (2025) High-frequency dynamics of the Vietnam stock market. *VNU Journal of Economics*

and Business 5(2):51–59. https://doi.org/10.57110/vnu-jeb.v5i2.395

Tables

Table 1: Three patterns for the timing of the response to a pre-opening signal

Pattern	Account in the literature	Sign of β^{ID} relative to β^{ON}	Intraday share s
Opening incorporation	Information accumulated during the closure is priced by the opening auction (Madhavan and Panchapagesan, 2000; Song, 2026)	No sign restriction; close to zero	Near 0
Intraday reversal	Overnight-clientele pressure at the opening is corrected by daytime arbitrageurs (Lou et al., 2019; Akbas et al., 2022)	Opposite	Below 0
Intraday continuation	Underreaction to information revealed through trading, late-informed trading, slow diffusion, or additional common information after the open (Barardehi et al., 2026; Gao et al., 2019; Tran and Tran, 2025; Song, 2026)	Same	Above 0 (above 0.5 if concentrated within the session)

Notes: β^{ON} and β^{ID} are the coefficients of a pre-opening signal on the opening return (previous close to open) and the intraday return (open to close); $s = \beta^{ID}/(\beta^{ON} + \beta^{ID})$.

Table 2: Estimation samples, closures and stale opening levels

Market	First session	Last session	N	Mean (%)	SD (%)	Long closures (%)	Stale openings, n (%)
VN-Index	2020-08-12	2026-07-31	1,489	0.048	1.245	21.0	84 (5.6)
VN30	2020-08-12	2026-07-31	1,489	0.058	1.322	21.0	135 (9.1)
VNMidcap	2020-08-12	2026-07-31	1,489	0.051	1.515	21.0	133 (8.9)
VNSmallcap	2020-08-12	2026-07-31	1,489	0.032	1.354	21.0	170 (11.4)
Singapore STI	2020-08-12	2026-07-31	1,502	0.053	0.736	22.0	19 (1.3)
Malaysia KLCI	2020-08-12	2026-07-31	1,459	0.007	0.691	24.0	23 (1.6)
Indonesia JKSE	2020-08-12	2026-07-31	1,432	0.013	1.061	23.4	374 (26.1)

Notes: Returns are log close-to-close returns of the index. N is the number of model observations, n is the count of stale opening levels, and SD denotes standard deviation. The sample is the complete-case sample of the main model. A stale opening level is one that equals the previous close within 0.5 basis points, so that the opening return is zero by construction. Long closures are sessions whose closure window contains a weekend or a public holiday. All sessions, including those with stale openings, form the primary sample.
Source: Authors' calculations from the v5 pipeline outputs.

Table 3: Next-session returns and overnight cryptocurrency downside, all sessions

Market	Coef. (bp)	SE (bp)	95% CI	p	Holm p	Without US controls (bp)	N
VN-Index	−17.2*	5.4	[−27.7, −6.7]	0.001	0.004	−23.7	1,489
VN30	−18.3*	5.3	[−28.8, −7.9]	<0.001	0.003	−25.6	1,489
VNMidcap	−26.3*	6.4	[−38.8, −13.7]	<0.001	<0.001	−31.7	1,489
VNSmallcap	−23.3*	5.6	[−34.3, −12.2]	<0.001	<0.001	−28.0	1,489
Singapore STI	−8.9*	2.7	[−14.1, −3.7]	<0.001	0.003	−17.7	1,502
Malaysia KLCI	−3.9	2.8	[−9.4, 1.5]	0.160	0.160	−11.1	1,459
Indonesia JKSE	−16.6*	5.5	[−27.3, −5.8]	0.003	0.005	−22.6	1,432

Notes: Each row is a separate regression of the close-to-close index return on one-standard-deviation consensus-weighted market downside severity (CMDS), the six US daily controls observable before the market opens, the lagged index return, weekday and month-year fixed effects. Newey–West HAC standard errors with five lags; Holm adjustment over the seven indices; * marks Holm-adjusted $p < 0.05$. Coef. denotes coefficient, SE standard error, CI confidence interval, bp basis points and N the number of observations; HAC denotes heteroskedasticity- and autocorrelation-consistent. The four Vietnamese indices are nested views of one exchange.
Source: Authors' calculations from the v5 pipeline outputs.

Table 4: Allocation of the association between the opening return and the intraday return

Market	Opening (bp)	Intraday (bp)	Total (bp)	$D = \beta^{ON} - \beta^{ID}$ (bp)	95% CI of D	Holm p of D	Intraday share [95% CI]
Panel A. All sessions							
VN-Index	−2.3 (1.9)	−14.9 (4.4)	−17.2	12.5* (4.2)	[4.3, 20.7]	0.014	0.86 [0.68, 1.05]
VN30	−2.8 (1.7)	−15.5 (4.6)	−18.3	12.7* (4.4)	[4.0, 21.4]	0.017	0.85 [0.70, 1.00]
VNMidcap	−4.4 (2.2)	−21.8 (5.6)	−26.3	17.4* (5.7)	[6.2, 28.6]	0.014	0.83 [0.69, 0.97]
VNSmallcap	−3.2 (2.3)	−20.0 (5.0)	−23.3	16.8* (5.4)	[6.3, 27.4]	0.012	0.86 [0.69, 1.04]
Singapore STI	−7.2 (2.1)	−1.7 (1.5)	−8.9	−5.5 (2.5)	[−10.4, −0.5]	0.092	0.19 [−0.08, 0.47]
Malaysia KLCI	−1.8 (1.0)	−2.1 (2.5)	−3.9	0.3 (2.5)	[−4.5, 5.1]	1.000	–
Indonesia JKSE	−9.8 (4.8)	−6.8 (3.0)	−16.6	−3.0 (5.8)	[−14.4, 8.4]	1.000	0.41 [0.09, 0.73]
Panel B. Sessions without a stale opening level							
VN-Index	−2.3 (2.0)	−14.2 (4.5)	–	11.9* (4.2)	[3.5, 20.2]	0.026	0.86
VN30	−3.2 (1.8)	−16.5 (4.6)	–	13.3* (4.7)	[4.2, 22.5]	0.026	0.84
VNMidcap	−4.5 (2.3)	−21.8 (6.1)	–	17.2* (6.1)	[5.2, 29.2]	0.026	0.83
VNSmallcap	−2.7 (2.6)	−19.9 (5.3)	–	17.2* (5.7)	[5.9, 28.4]	0.020	0.88
Singapore STI	−7.3 (2.1)	−2.1 (1.5)	–	−5.2 (2.5)	[−10.1, −0.3]	0.113	0.22
Malaysia KLCI	−1.8 (1.0)	−2.1 (2.5)	–	0.3 (2.5)	[−4.6, 5.1]	0.957	–
Indonesia JKSE	−11.1 (5.5)	−6.4 (3.4)	–	−4.8 (6.7)	[−17.9, 8.4]	0.957	0.36

Notes: Opening and intraday are coefficients on a one-standard-deviation increase in consensus-weighted market downside severity (CMDS) in the regressions of the opening return (previous close to open) and of the intraday return (open to close), estimated on the same sessions with the same controls; they add up to the close-to-close coefficient. Standard errors in parentheses (HAC, five lags). D is tested with the joint HAC covariance of the two equations; positive D means that the intraday coefficient is more negative than the opening coefficient. Holm adjustment over seven markets; * marks Holm-adjusted $p < 0.05$. The intraday share is $\beta^{ID}/(\beta^{ON} + \beta^{ID})$ with a delta-method interval from the joint covariance; it is a ratio of coefficients, can lie outside 0 to 1, and is not reported for the KLCI, whose total coefficient is not distinguishable from zero. Panel B shows the share for the same samples without its interval. HAC denotes heteroskedasticity- and autocorrelation-consistent; CI denotes confidence interval; bp denotes basis points.
Source: Authors' calculations from the v5 pipeline outputs.

Table 5: Differences in the allocation between Vietnam and three other markets

Comparison	N common	Difference (bp)	Joint-HAC SE	Bootstrap SE	95% CI	p	Holm p (3)
VN-Index minus Singapore STI	1,455	17.3*	5.2	5.2	[7.0, 27.6]	<0.001	0.003
VN-Index minus Malaysia KLCI	1,413	12.8*	4.3	4.5	[4.4, 21.2]	0.003	0.006
VN-Index minus Indonesia JKSE	1,385	13.3	7.0	7.4	[−0.5, 27.1]	0.059	0.059
Sessions without a stale opening level							
VN-Index minus Singapore STI	1,355	16.3*	5.3	–	[5.9, 26.7]	0.002	0.006
VN-Index minus Malaysia KLCI	1,309	11.7*	4.4	–	[3.1, 20.3]	0.008	0.015
VN-Index minus Indonesia JKSE	949	11.4	8.3	–	[−4.9, 27.6]	0.170	0.170
VN-Index opening replaced by an independent source where it contradicts the provider							
VN-Index minus Singapore STI	1,414	16.6*	5.2	–	[6.4, 26.8]	0.001	0.004
VN-Index minus Malaysia KLCI	1,367	12.5*	4.3	–	[4.0, 21.0]	0.004	0.008
VN-Index minus Indonesia JKSE	1,005	12.3	8.1	–	[−3.6, 28.2]	0.130	0.130

Notes: Each difference is D of the VN-Index minus D of the comparison market on the dates on which both markets traded, with the cross-market covariance in the joint HAC covariance (five lags); the bootstrap standard error is from a circular moving-block bootstrap on the same dates (blocks of five sessions, 2,999 draws). The three comparisons are the planned family (Holm adjustment over three); * marks Holm-adjusted $p < 0.05$. The other nine pairs formed with VN30, VNMidcap and VNSmallcap are in Supplementary Table S3. N is the common-date sample size; SE denotes standard error, CI confidence interval, bp basis points and HAC heteroskedasticity- and autocorrelation-consistent.
Source: Authors' calculations from the v5 pipeline outputs.

Table 6: Allocation in the Vietnamese indices under alternative samples, controls and sub-periods

Specification	VN-Index	VN30	VNMidcap	VNSmallcap
All sessions (baseline)	12.5 (0.014)	12.7 (0.017)	17.4 (0.014)	16.8 (0.012)
Without stale openings	11.9 (0.026)	13.3 (0.026)	17.2 (0.026)	17.2 (0.020)
Excluding months with clustered stale openings	12.0 (0.023)	12.0 (0.029)	17.2 (0.023)	20.0 (0.012)
Opening replaced by an independent source	12.2 (0.011)	13.1 (0.011)	17.2 (0.011)	17.2 (0.010)
Sessions with the contemporaneous controls available; D in bp, raw p in parentheses				
Baseline on the same sessions	12.8 (0.002)	12.9 (0.004)	17.3 (0.003)	17.2 (0.002)
Adding regional in-session index returns	12.5 (0.003)	12.4 (0.005)	16.9 (0.003)	16.6 (0.002)
Adding in-session BTC–ETH return	13.1 (0.001)	13.3 (0.002)	17.9 (0.001)	17.7 (<0.001)
Adding both	12.8 (0.002)	12.8 (0.002)	17.5 (0.002)	17.2 (0.001)
Halves of the sample; D in bp, raw p in parentheses				
First half (to 2023-08-03)	12.5 (0.018)	12.6 (0.030)	18.1 (0.022)	18.2 (0.023)
Second half	11.9 (0.084)	11.4 (0.106)	15.3 (0.079)	14.5 (0.032)

Notes: Entries are $D = \beta^{ON} - \beta^{ID}$ in basis points per one-standard-deviation CMDS; in the first four rows the Holm-adjusted p is in parentheses (over seven markets in the first three rows; over the four Vietnamese indices in the fourth row, the only one in which just those four are re-estimated). The control rows use the sessions for which the same-date open-to-close returns of the STI, KLCI and JKSE (at least two of three, each with a non-stale opening) and the in-session BTC–ETH return are available; the regional and in-session returns are contemporaneous explanatory controls, not predictors. CMDS denotes consensus-weighted market downside severity, and bp denotes basis points. The two halves are split at the median session date of each market and are estimated separately; the outputs contain no test of equality between the halves, so differences between them are descriptive, and they are a stability check on the same data, not independent validation.
Source: Authors' calculations from the v5 pipeline outputs.

Data availability

The study uses publicly accessible cryptocurrency and equity market data obtained from third-party providers identified in the Methods section. Derived cryptocurrency measures and statistical results will be made available where permitted by the applicable data licences. Underlying market data and derived series subject to third-party redistribution restrictions will not be redistributed. The data sources, retrieval procedures, processing scripts, and variable definitions will be documented to facilitate independent reconstruction, subject to the providers' terms of use.

Code availability

The end-to-end scripts are provided as Supplementary Code. They retrieve publicly accessible market data, align market calendars and time zones, construct the variables, estimate the models, run validation checks, and generate the tables and figures. The code package includes the analysis specifications, software dependencies, source identifiers and checksums. The accompanying data files are retrieved from the original providers, subject to their terms of use.

Author contributions

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Ethics declarations

Ethical approval and informed consent are not applicable because this study analyses financial-market observations and does not involve human participants or personal data.

Supplementary information

Supplementary Tables S1 to S5 are provided in a separate file.

Figure legends

Figure 1. Opening and intraday associations with overnight cryptocurrency downside. Markers give the coefficients (basis points per one-standard-deviation increase in consensus-weighted market downside severity, CMDS) with 95% heteroskedasticity- and autocorrelation-consistent (HAC) intervals. Open circles denote previous-close-to-open returns and filled squares denote open-to-close returns. The right-hand labels report $D = \widehat{\beta}^{ON} - \widehat{\beta}^{ID}$ and Holm-adjusted p values over the seven indices. The dotted line separates the four Vietnamese indices from the three other countries. Source: authors' calculations from the v5 pipeline outputs.

Figure 2. Intraday shares and differences across markets. Panel A plots $\widehat{s} = \widehat{\beta}^{ID}/\widehat{\beta}^{TOT}$ with 95% delta-method intervals; the dashed vertical line marks one and the KLCI is omitted because its total coefficient is not distinguishable from zero. Panel B plots the difference between the VN-Index allocation contrast D and the contrast in each comparison market, with 95% joint-HAC intervals on common trading dates. Filled squares indicate Holm-adjusted $p < 0.05$ over the three comparisons between Vietnam and the other countries; the open square indicates $p \geq 0.05$. Source: authors' calculations from the v5 pipeline outputs.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

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