

Liquidity Structure at Korean Virtual Asset Exchanges and Conditions for Introducing LPs

To narrow bid-ask spreads at smaller exchanges, dedicated providers must be brought in and safeguards against conflicts of interest established first.

Conflict-of-Interest Disclosure The publisher is a listed company holding bitcoin as a treasury asset and pursuing digital asset and AI/data center infrastructure businesses. It may have interests affecting topic selection and interpretation.

This issue's analysis and cases exclude the publisher, Bitplanet. Exchange bid-ask spreads are our estimates from public APIs; trading-cost scenarios are separate hypothetical calculations.

EXECUTIVE SUMMARY

WHAT HAPPENED

Digital Asset (디지털애셋) reported that on September 28, Financial Services Commission (FSC) Director General for Digital Finance Policy Yoo Young-joon said he would review the need for a virtual asset market-making framework^[1]. Market making supplies liquidity by continuously quoting bids and asks and acting as a counterparty. Rep. Min Byoungdug's bill introduced in the National Assembly would exempt temporary liquidity provision by exchange-contracted dealers from the market-manipulation ban^[2]. As of October 13, it remained under the relevant standing committee's review^[3].

WHY IT MATTERS

INTERPRETATION

Our analysis of 108 assets listed on all four major Korean won exchanges as of October 13 found that just 0.9% on Upbit versus 76.9% on Korbit had bid-ask price gaps (spreads) of at least 100bp (1%) (our estimates). Even if market making is permitted, assets with low trading volume and high inventory risk may offer providers insufficient incentives to participate readily. For smaller exchanges to benefit in practice, quoting obligations must be reasonably designed, considering providers' participation costs and risks.

WHAT TO WATCH

INTERPRETATION

After confirming which statutory provisions permit market making and which providers qualify, assess actually designated assets, execution costs by order size, and quote continuity during sharp market moves. Improved competitiveness can be expected if execution costs fall for less widely traded assets on smaller exchanges and quoting continues after exchange trading subsidies end. If market makers participate only on large exchanges or quotes disappear again once subsidies end, permission alone is unlikely to narrow gaps between exchanges.

Korbit 76.9%, Upbit 0.9%

Share of assets with spreads of at least 100bp

108 assets in the common listing set; median of 30 observations per asset; our estimates

2026-10-13 12:14–12:29

[4][5][6][7]

KRW 5,000 per KRW 1 million

One-way cost relative to the mid-price at a 100bp spread

Fixed quantity valued at the mid-price; full execution at the best quote assumed; fees excluded

2026-10-13; hypothetical calculation

Our estimates, Appendix ②

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The distinction between policy deliberations and a temporary market-making exemption

According to Edaily (이데일리), the ruling party and financial authorities are considering provisions in the Digital Asset Basic Act that would permit market making^[8]. On August 27, the FSC also stated that it was discussing a government proposal, but that details such as limits on exchange ownership had not been finalized^[9].

As of October 13, no government-submitted bill formally titled the Digital Asset Basic Act had been registered in the National Assembly Bill Information System^[10]. The bill led by Rep. Min Byoungdug (Bill No. 2210736) was referred to the Bill Review Subcommittee of the National Policy Committee in August 2025 and remained under committee review as of October 13^[3].

INTERPRETATION The policy proposals being prepared by the government should be distinguished from bills formally introduced in the National Assembly. Estimating when a framework could actually be introduced requires a combined assessment of who sponsors the bill, what it permits, its stage in parliamentary review, and the timetable for subordinate legislation.

The bill introduced by Rep. Min Byoungdug (Article 117(3)) explicitly distinguishes between ‘stabilization’ and ‘market making’^[2].

Category	Contracting party	Period proposed in the bill
Stabilization	A virtual asset issuer or exchange contracts a dealer	Within 6 months of the start of trading support (to be specified by Presidential Decree)
Market making	A virtual asset exchange contracts a dealer	Within 1 year (to be specified by Presidential Decree)

Source: Article 117(3)(1) and (2) of the bill introduced by Rep. Min Byoungdug^[2]. These are the periods proposed in the bill, not a framework currently in force.

INTERPRETATION The temporary exemptions specified in the bill do not, by themselves, imply automatic permission for continuous two-sided quoting. Eligible assets, permitted periods, and provider requirements will vary depending on whether the primary aim is price stabilization shortly after listing or the ongoing provision of liquidity. The timing of actual implementation is therefore also subject to change.

Spread differences and trading costs for the common set of listed assets

The bid-ask spread is the difference between the best ask and the best bid, divided by the average of the two prices (the mid-price)^[11]. We collected and analyzed data for 108 assets listed on all four major Korean won exchanges (Upbit, Bithumb, Coinone, and Korbit) at 30-second intervals over 15 minutes starting at 12:14 on October 13, for a total of 30 observations^{[4][5][6][7]}. Trading-value rankings were based on Upbit's 24-hour trading value at the start of the observation period.

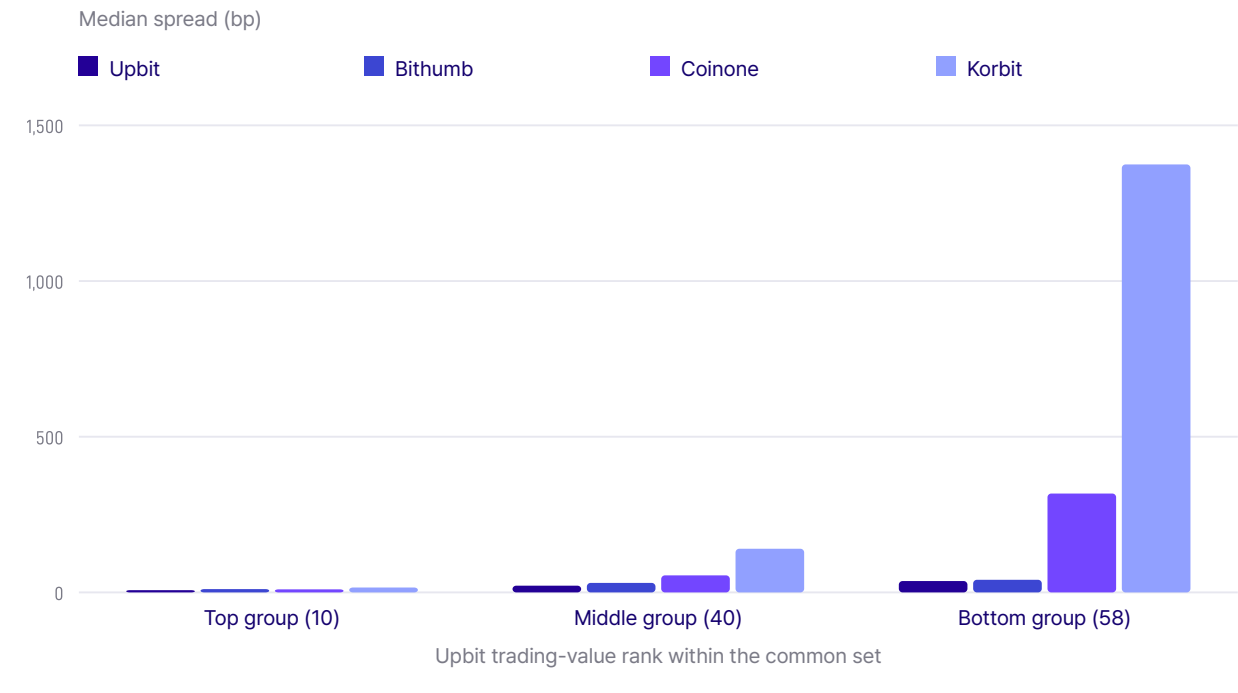
Trading-value rank within the common set	Asset count	Upbit	Bithumb	Coinone	Korbit
Top group (1–10)	10	7.2	10.6	9.8	15.7
Middle group (11–50)	40	21.6	30.5	54.7	140.2
Bottom group (51–108)	58	36.5	40.5	317.5	1,374.5

Unit: bp. We calculated the median spread across 30 observations for each asset, then the median for each asset group. 2026-10-13 12:14:05–12:28:36 KST; our estimates^{[4][5][6][7]}.

Median spreads for the top 10 assets were favorable at below 20bp (0.2%) on all four exchanges. For the bottom 58 assets, however, spreads were much wider on Coinone (317.5bp) and Korbit (1,374.5bp) than on Upbit (36.5bp) and Bithumb (40.5bp). Of the common set of 108 listed assets, the number and share with spreads of at least 100bp (1%) were 1 (0.9%) on Upbit, 9 (8.3%) on Bithumb, 60 (55.6%) on Coinone, and 83 (76.9%) on Korbit.

Spread Differences Across Exchanges in the Bottom Asset Group

2026-10-13 12:14:05–12:28:36 KST; 108 common assets; medians of 30 observations per asset, aggregated by group



[4][5][6][7] Public APIs; our estimates

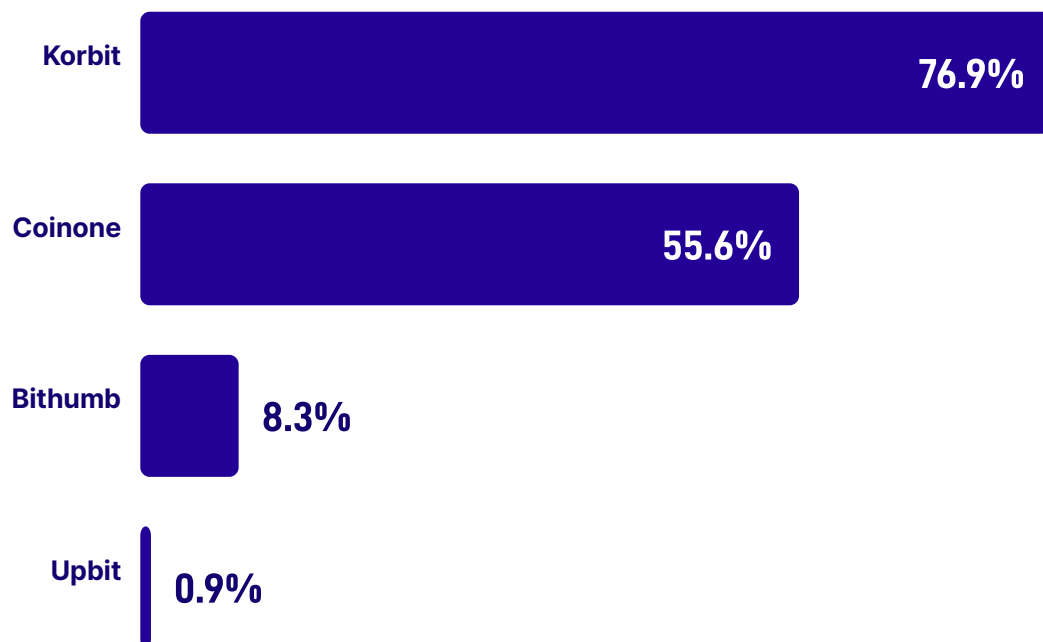
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Spread Differences Across Exchanges in the Bottom Asset Group · Data table

Upbit trading-value rank within the common set	Upbit (bp)	Bithumb (bp)	Coinone (bp)	Korbit (bp)
Top group (10)	7.2	10.6	9.8	15.7
Middle group (40)	21.6	30.5	54.7	140.2
Bottom group (58)	36.5	40.5	317.5	1,374.5

Share of Assets with Spreads of at Least 100bp

2026-10-13 12:14–12:29 KST; 108 common assets; median of 30 observations per asset; %



[4][5][6][7] Public APIs; our estimates

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Share of Assets with Spreads of at Least 100bp · Data table

Item	Value	Notes
Korbit	76.9%	
Coinone	55.6%	
Bithumb	8.3%	
Upbit	0.9%	

For Upbit's top 10 assets, the gap between bid and ask prices had narrowed to the minimum price increment (1 tick) in at least half of the observations (our estimates)^{[4][12]}. Even where spreads are difficult to narrow further, increasing order-book depth (the quantity in resting orders) can reduce execution costs for large orders. According to market analytics firm Kaiko Research, Upbit and Korbit also showed a pronounced difference in the quoted quantity within 1% of the mid-price^[13].

INTERPRETATION Wide bid-ask spreads today do not, on their own, establish how much spreads would narrow if a market-making framework were introduced. Observations from a specific period should not be generalized to all trading periods or to assets outside the common set. Nor can liquidity differences

between exchanges be attributed solely to the absence of market makers. Multiple factors should be examined together, including the user base, order flow, fee structures, and restrictions on deposits and withdrawals.

A simulation illustrates how spread size affects trading costs. If a quantity worth KRW 1 million at the mid-price is bought immediately at the best ask when the spread is 100bp (1%), the one-way cost relative to the mid-price is KRW 5,000. We calculated scenarios in which the spread narrows by 10%, 30%, and 50% in relative terms (our estimates, Appendix ②).

Scenario	Resulting spread	One-way cost on KRW 1 million	One-way cost on KRW 10 million
No reduction	100bp	KRW 5,000	KRW 50,000
10% reduction	90bp	KRW 4,500	KRW 45,000
30% reduction	70bp	KRW 3,500	KRW 35,000
50% reduction	50bp	KRW 2,500	KRW 25,000

Assumptions: Trade size is the value of a fixed quantity at the mid-price. Each scenario assumes an unchanged mid-price and full execution at the best quote. Fees and additional price impact are excluded. These figures do not predict policy effects or actual execution costs.

For a round-trip trade in which the same quantity is bought and immediately sold at unchanged quotes, the cost attributable to the bid-ask spread is twice the one-way cost relative to the mid-price. If an order is large enough to execute across several price levels (incurring slippage), additional costs arise. The actual total trading cost borne by an investor therefore needs to account for both execution prices and fees.

03

MARKET MAKING AND CONFLICTS

Conditions for market maker participation and exchange conflicts of interest

A market maker's profitability depends on the bid-ask spread, how often its orders are executed, and the risk of price changes in its inventory^[14]. Even a wide quoted spread generates no realized profit unless trades are executed.

INTERPRETATION

Market makers have less incentive to participate in assets with extremely low trading volume, even when liquidity provision is urgently needed. Exchanges need to assess whether the compensation or fee reductions they offer can cover market makers' inventory, hedging and operating

costs. If buy and sell orders concentrate on large exchanges, market makers are also likely to prefer those venues. To attract clients by narrowing bid-ask spreads, smaller exchanges need a basic level of trading volume and reliable deposit and withdrawal arrangements as well as a supply of quotes.

INTERPRETATION Contracts for market making must clearly establish who bears the risk of loss: the exchange, the issuer or the market maker. Where an exchange pays compensation, the payment terms and the market maker's required quote-maintenance ratio must be disclosed. If a virtual asset issuer provides funding or tokens, strict limits must prevent it from using that support to demand artificial price support. Even where an external provider uses its own capital, loss limits and conditions for suspending activity need to be set in advance.

INTERPRETATION Assessing the commercial viability of market making requires checking whether 'executed trading value × net margin + fixed compensation' exceeds fixed costs. The net margin must reflect valuation gains and losses associated with inventory risk, variable costs and trading fees. Treating the quoted bid-ask spread percentage as the rate of return would overstate market makers' incentive to participate.

Article 76(5) of the European Union's Markets in Crypto-Assets Regulation (MiCA) prohibits exchange operators from dealing on their own account on the platforms they operate^[15]. The European Commission (EC) has stated that market making conducted on one's own account without a client relationship is not a service requiring separate authorization under MiCA. This does not, however, amount to an unrestricted regulatory exemption for market making^[16].

Hong Kong's Securities and Futures Commission (SFC) likewise permitted external market making in 2023 while prohibiting proprietary trading by exchanges^{[17][18]}. In February 2026, it introduced limited, conditional permission for affiliated market makers to participate in order to address liquidity shortages^[19].

Operating model	Rules in major jurisdictions	Considerations for Korea
Direct trading by exchanges	Strictly restricted in both the EU and Hong Kong	Conflicts between handling client orders and the exchange's own interests
Independent external providers	Outsourced market making permitted	Oversight of compensation transparency, access to information and quote-maintenance obligations
Affiliated providers	Permitted subject to conditions in Hong Kong	Controls on early access to information and preferential order handling arising from control relationships

Sources: EU and Hong Kong rules^{[15][16][19][17][18]}. The considerations for introducing market making in Korea are our interpretation based on a comparison of the regulatory frameworks.

For affiliated market makers, Hong Kong's SFC requires ① functional independence, ② information barriers (firewalls), ③ priority execution of client orders at the same price, and ④ separate identification of market-making accounts^[20]. It also requires identical technical access to that available to ordinary external providers, notification by the manager in charge, and submission of a report by an independent professional firm^{[19][20]}.

INTERPRETATION A phased introduction in Korea, beginning with outsourcing to independent external providers, is a reasonable way to prevent the conflicts of interest at issue. Affiliates pose substantial concerns over preferential treatment, such as early access to information or preferential order handling, so their indirect participation must be strictly controlled. There is little justification for allowing affiliates to participate without restriction from the outset. Limited participation should be considered only if external providers alone are unable to supply liquidity and complete information barriers and an independent verification framework have been established.

04 REGULATORY CONDITIONS

Rules and performance assessment aligned with the permitted scope

Article 10(3) of the Act on the Protection of Virtual Asset Users prohibits trading that changes or fixes prices for the purpose of inducing trades, among other conduct^[21]. Labeling an activity 'market making' neither legitimizes every order nor automatically makes it unlawful. Whether a statutory exemption applies and whether an individual order constitutes unfair trading must be assessed separately.

Article 10-20, subparagraph 5(c), of the Enforcement Decree of the Act on Reporting and Using Specified Financial Transaction Information requires virtual asset service providers to establish and implement standards restricting cases in which they become the actual counterparty while brokering, arranging or acting as agents for transactions^[22].

INTERPRETATION Different statutory provisions apply to market-making transactions by independent external providers and trading by exchanges themselves. Once the eligible participants and permitted scope have been defined, policymakers should examine whether legislation needs to be amended or whether changes to subordinate regulations or an interpretation of existing provisions would suffice. There is no need to assume that both provisions must be amended simultaneously.

Past supervisory decisions in the stock market also merit consideration. In July 2022, the Securities and Futures Commission under Korea's Financial Services Commission ruled that alleged unfair trading by securities firms designated as market makers did not constitute a violation of law. Its decision took into account, among other factors, the unavoidable need to modify and cancel orders for risk management given the nature of algorithmic trading, and the absence of prior guidelines^[23].

INTERPRETATION

Supervisors should assess the purpose of order modifications and cancellations and their effects on market prices from multiple perspectives, rather than focusing solely on how often orders are canceled. Market-making contracts should set maximum bid-ask spreads, minimum quoted quantities and the proportion of time for which quotes must be maintained, with requirements varying by asset volatility and trading volume. Clear criteria for relaxing obligations during sharp price movements would make it easier to distinguish legitimate risk management from unfair trading. A two-part framework is preferable: contracts should provide for reduced compensation when obligations are not met, while laws and regulations should sanction artificial price manipulation.

The risk of price manipulation disguised as market making also requires vigilance. The Korea Capital Market Institute has identified cases of price manipulation through activities resembling market making in the virtual asset market in a previous report^[24]. Digital Asset (디지털애셋) reported that financial authorities cited a price surge following the listing of JPYC, an overseas-issued yen-linked stablecoin, and concerns over harm to users as reasons for tightening exchange rules^[1].

Deposit and withdrawal arrangements did in fact change around the listing. When Upbit announced trading support for JPYC on September 17, it initially supported deposits only through the Ethereum network, then added support for deposits through the Kaia and Polygon networks that evening^{[25][26]}.

INTERPRETATION

If restrictions on deposit and withdrawal routes or differences in circulating supply across networks prevent assets from moving, it is difficult to stabilize prices merely by submitting quotes. In the JPYC case, one should likewise not conclude that the price surge would have been prevented simply by assuming that a market maker had been present. In the early stages of a new listing, circulating supply and the management of deposits and withdrawals must be reviewed alongside quote provision.

INTERPRETATION

To evaluate a market-making framework properly, assets covered by market making should be compared with a control group of assets without it, measuring changes in trading volume, volatility and slippage each quarter. Publishing detailed results for each metric, rather than combining them into a single score, is necessary for an objective assessment of liquidity improvements.

C CONCLUSION

Conclusion

INTERPRETATION Permitting market making will not automatically resolve liquidity shortages at smaller exchanges. For assets with wider bid-ask spreads and subdued trading, the priority is to develop compensation and quoting obligations that market makers can accept. A virtuous cycle of liquidity can be expected only if the fee reductions and compensation borne by exchanges are realistic.

INTERPRETATION We recommend starting with outsourcing to independent external providers, with transparent disclosure of fees and compensation terms. Exchanges should assess performance by the quantities investors can actually trade and the reduction in execution costs, rather than simply counting quotes. Financial authorities should provide clear guidelines that strictly control unfair trading and conflicts of interest while protecting legitimate risk-management trades.

KEY CONCLUSION

The central objective of a virtual asset market-making framework is to encourage a sustained supply of meaningful quotes for assets that lack liquidity. Its success should be judged by whether actual execution costs fall for less prominent assets on smaller exchanges, and whether quotes remain available after support measures end.

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Appendix

① Limitations of the Analysis and Data

Limits of Interpretation and Performance Evaluation

- ◆ Sample and measurement scope: This sample does not represent other times of day or periods of sharp price movements. The 30 consecutive observations are not treated as 30 independent samples, and quotes that briefly disappear between sampling intervals are not captured. Assets outside the common sample were not combined with it because their composition differs by exchange. These results are new measurements from October 13, not a recalculation of the 107-asset aggregate from October 7.
 - ◆ Source characteristics: The Kaiko materials include a report produced in collaboration with Upbit^[11]. External analyses covering different dates or using different units are not compared directly with our measurements. The illustrative spread-narrowing assumptions and business viability model are not estimates of actual policy effects or business profit and loss.
 - ◆ Policy effects and evaluation scope: **INTERPRETATION** Evaluating the framework requires recording bid-ask spreads, execution costs by order size, order-book depth within $\pm 1\%$ of the mid-price, and quote-maintenance rates for both participating and non-participating assets. Changes in trading volume, volatility, and fees, along with the dates on which support ends, must also be compared to assess whether liquidity improvements persist. These measurements contain no pre- and post-implementation data or periods of sharp price movements, so they cannot establish causal policy effects or liquidity resilience.
 - ◆ Applicability of overseas frameworks: Supervisory systems in the EU, Hong Kong, and Korea differ. The existence of overseas rules alone does not demonstrate the effectiveness of enforcement in Korea. Regulatory publications, original legislative texts, and official APIs were prioritized, while news coverage was attributed to the reporting outlet. The legal and regulatory comparisons do not constitute official approval of any specific entity or transaction. This report is for informational purposes and does not constitute an investment recommendation.
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② Formulas for Our Own Estimates

Metric	Formula / Inputs	Date / Source
Bid-ask spread (bp)	(Best ask – best bid) / mid-price × 10,000. The median of 30 observations for each asset; the median of asset-level medians for each group	2026-10-13 12:14–12:29, public APIs ^{[4][5][6][7]}
Share at or above 100bp	Number of assets with a median bid-ask spread of at least 100bp / 108 × 100. Shown to one decimal place	As above
Official one-tick check	Whether best ask – best bid equals the official tick size for the price band containing the best bid	Upbit observations ^[4] and tick-size rules by price band ^[12]
Sample / Asset groups	108 assets common to all four KRW markets at the start of collection. Ranked 1–10, 11–50, and 51–108 within the common sample by 24-hour trading value on Upbit	2026-10-13; raw data and asset list provided separately
Assumed spread	Initial spread of 100bp × (1 – reduction rate). Reduction rates of 0%, 10%, 30%, and 50%	2026-10-13, illustrative assumptions
One-way cost relative to the mid-price	Trade size N valued at the mid-price × spread (bp) / 20,000. N is KRW 1 million or KRW 10 million. The round-trip cost of executing the same quantity in both directions is twice the one-way cost	Assumptions above; price and quantity held constant; fees and additional price impact excluded
Savings from spread narrowing	One-way cost before narrowing – one-way cost after narrowing. For KRW 1 million, reductions of 10%, 30%, and 50% yield savings of KRW 500, KRW 1,500, and KRW 2,500	Our estimates under the assumptions above
Business viability model	Market maker's actual executed trading value V × expected net margin m + fixed compensation R – fixed costs F. V, R, and F cover the same period. m reflects inventory and hedging profit and loss and variable costs; F includes operating and capital costs. When m>0, break-even trading value is max(0, (F–R)/m)	Illustrative model; no numerical estimates are made without actual contract and profit-and-loss inputs

③ Methodology Notes

- ◆ Source priority: Official company and regulatory materials → raw data and databases maintained by data aggregators → specialist media → syndicated media → community materials.
- ◆ Source classification: A source is classified as primary only when the original has been checked directly. Information relayed through news coverage is attributed to the reporting outlet.
- ◆ Reference dates and access dates: Values fixed at a specific point in time are assigned a reference date; dashboard figures that change in real time are assigned an access date.
- ◆ Conflicting figures: When different figures are identified, both are presented. If a reference value must be selected, priority is given to disclosure of the calculation scope, clarity of the access time, and whether individual components can be separated, rather than the prominence of the outlet. The basis for the selection is stated in the main text.
- ◆ Our estimates: The formula, reference date, and limitations for each of our estimates are presented individually in Appendix ②.
- ◆ Legal and regulatory interpretation: Regulatory materials are cited only to explain how general structures are classified and how the rules may apply. They are not interpreted as an official classification or approval of a specific product. Descriptions of product structures and regulatory interpretations are presented in separate paragraphs.
- ◆ Conflict-of-interest disclosure: The same disclosure appears in a fixed position at the top of every report.

Sample and Measurement Methods

The sample comprises the 108 assets traded in KRW on all four exchanges at the start of collection. Rankings within the common sample were fixed by 24-hour trading value on Upbit, dividing the assets into the top 10, middle 40, and bottom 58. Data were collected over 30 rounds from 2026-10-13 12:14:05 to 12:28:36 KST. All 12,960 exchange-asset-round observations had positive bid and ask prices, with the ask above the bid. The common sample had no missing values, inverted quotes, or HTTP errors.

The best bid and ask with positive quoted quantities were selected from the Upbit and Bithumb order books and the best_bids and best_asks fields in the Coinone ticker^{[4][5][6][27]}. In 119 Bithumb asset-round observations within the common sample, the first quote on one side had zero quoted quantity, so that price was excluded. For Korbit, bestBidPrice and bestAskPrice from the ticker were used; this endpoint does not provide quoted quantities^{[7][28]}. The start and receipt times of each request and the raw responses were stored. The maximum time from the start of a collection round to receipt of its final response was 2.92 seconds; this does not mean that quotes across exchanges were updated at exactly the same time. The Coinone ticker creation time and Korbit last-trade time were not treated as quote update times.

The maximum difference between response receipt time and the timestamp shown by the API was 800.13 seconds for Upbit and 30.38 seconds for Coinone. The Upbit maximum occurred when the quote information timestamp for USDS remained unchanged across several rounds. API timestamp definitions, update methods, and clock differences between servers may also contribute to this difference, so it does not signify pure communication latency or the disappearance of quotes.

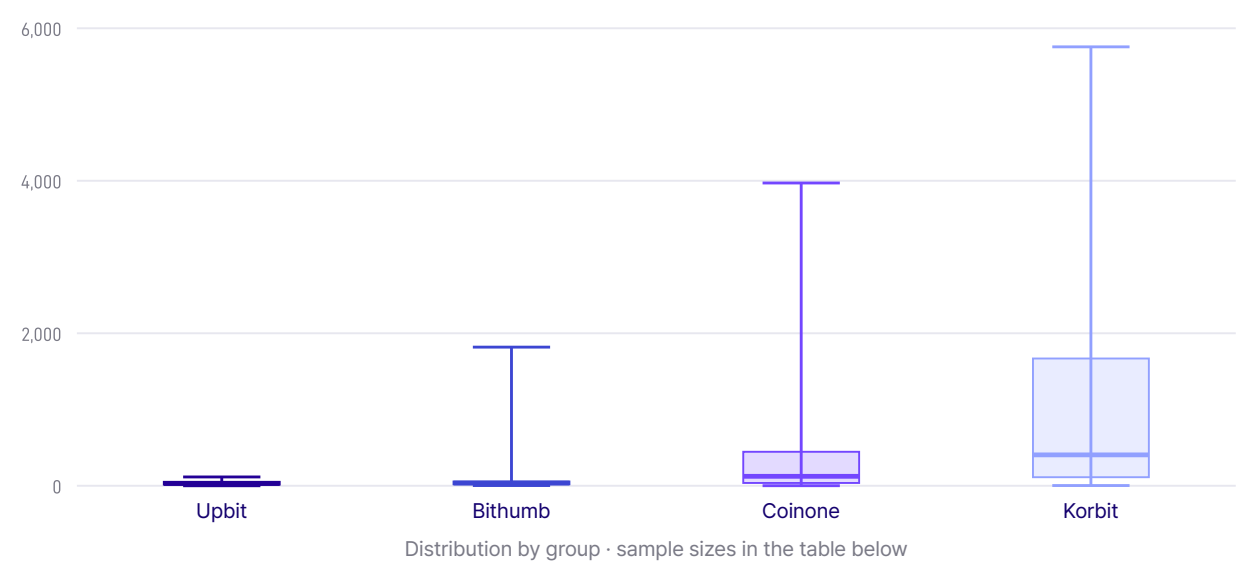
Distribution Across Assets and Order-Book Depth

The box plots use the median spread across 30 observations for each of the 108 assets. Quartiles use Type 7 linear interpolation, and the whiskers show the minimum and maximum. They do not show variation over time or confidence intervals. Extreme values were not clipped outside the plot range.

Spread Distribution Across 108 Common Assets

2026-10-13 12:14-12:29 KST; distribution of asset-level medians from 30 observations; n=108 per exchange

Unit: bp · whiskers: minimum to maximum · Type 7 linear interpolation



[4][5][6][7] Public APIs; our estimates. Whiskers: minimum to maximum

Spread Distribution Across 108 Common Assets · Data table (bp) · whiskers=minimum/maximum

Statistic	Upbit	Bithumb	Coinone	Korbit
Sample size	108	108	108	108
Minimum	0.08900162434309379	2.9598937031513977	0.8890469434352873	2.8887680163404865
Q1	15.41540835847171	19.747427722576216	36.65802183930494	112.07279542680928
Median	29.39093178539653	35.22684742620054	123.90657428351417	405.06903101459255
Q3	51.561640066042926	55.7492102519413	445.5740983300795	1,668.9410631490366
Maximum	115.53311553311553	1,818.18181818182	3,970.7383463763185	5,756.230795493342

Order-book prices and quantities for the same 108 assets were also collected separately on October 13 from 12:19:27 to 12:20:03 KST^{[4][5][29][30]}. For quantities valued at KRW 1 million and KRW 10 million at the mid-price, we simulated fills through successive ask levels and counted the assets for which the full purchase cost could be calculated using only the returned depth (our estimates).

Exchange	KRW 1 million at mid-price	KRW 10 million at mid-price
Upbit	108/108 assets	108/108 assets
Bithumb	108/108 assets	102/108 assets
Coinone	100/108 assets	35/108 assets
Korbit	106/108 assets	29/108 assets

Table basis: Number of assets for which the cost of buying the full quantity can be calculated within the order book returned by the API. Quantities were determined using each exchange’s mid-price, so the actual purchase amount differs from the valuation shown in the table. Fees and order cancellations or price changes after collection were excluded. The number of returned quote levels differed: 30 for Upbit, 15 for Bithumb, 16 for Coinone, and 30 for Korbit. Asset counts therefore cannot be read directly as a liquidity ranking. Empty entries with zero prices/quantities were excluded. Insufficient depth was treated as exceeding the returned range, rather than as evidence that actual trading was impossible. Cost medians covering different sets of assets at each amount were not compared directly.

Order-book depth was calculated by summing price $\times$ quantity within $\pm 1\%$ of the mid-price. If the returned quotes did not extend to the $\pm 1\%$ boundary, the total was retained as a lower bound rather than treated as the full depth. The asset list, observations, rankings, calculation code, and error logs are included in the separate verification materials.

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WRITTEN BY **Taewon Kim**

REVIEWED BY **Sooyoung Kim**

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