

# Rounding Rules in Retail Foreign Exchange Interfaces: Evidence from CNY and HKD Quotes

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## Case Report

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**Additional Declarations:** Competing interest reported. Ruirui Deng completed an internship at the Industrial and Commercial Bank of China (ICBC) from July to September 2025. ICBC is one of the providers of the public calculators examined in this independent study. The internship was unrelated to this research.

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# Abstract

This paper studies cent-level rounding in retail foreign-exchange interfaces, using public calculators at two mainland Chinese banks and dated mobile quotes from Hong Kong. Controlled inputs to the Industrial and Commercial Bank of China (ICBC) calculator produced results consistent with half-up rounding. At its displayed rates for Japanese yen (JPY), Korean won (KRW) and Indonesian rupiah (IDR), the largest positive arithmetic residues within a common CNY 7.16–8.00 output band were CNY 0.004784, 0.004900 and 0.00499864. An independent test of the China Construction Bank (CCB) calculator found the same cent-level pattern in both directions. In its JPY purchase trial, 189 JPY at CNY 0.042562 per JPY gave an exact cost of CNY 8.044218 and a displayed cost of CNY 8.04. A simulation at the same reference rate gives CNY 8,040 for 1,000 separately rounded 189-JPY purchases, compared with the calculator's CNY 8,044.22 quote for one 189,000-JPY purchase. The CNY 4.22 difference illustrates how per-order rounding affects displayed purchase cost. Seven HSBC Hong Kong app captures provide a separate check on changing USD-to-HKD quotes; the displayed four-decimal rates do not identify that app's internal rounding rule. The evidence supports a repeatable method for examining retail FX display rules and their cumulative arithmetic effects.

## 1 Introduction

Retail FX systems multiply an exchange rate by a currency amount, then express the result in a settlement currency's smallest unit. Where the exact product contains fractions of a cent, the displayed value depends on the system's rounding convention. The author's earlier Chinese research examined this microstructure question through observations of commercial-bank interfaces and numerical examples. This English study tests two mainland bank calculators, compares three currencies on a common CNY scale, and checks dated mobile quotes in HKD. ICBC states that its calculator figures are for reference and that the actual transaction amount prevails.<sup>1</sup> The analysis concerns displayed amounts before execution.

The question matters because a deterministic difference of less than one cent may accumulate if orders are repeated, while the actual economics depend on spreads, fees and platform restrictions. Those distinctions are essential in banking risk analysis. The Basel Committee describes operational risk as inherent in banking products, processes and systems, and calls for regular identification and assessment.<sup>2</sup> A documented and consistently tested rounding policy is an example of an application control in this setting.

This paper asks how the two mainland calculators round sub-cent amounts, how JPY, KRW and IDR compare on a common CNY range, and how much per-order rounding changes a repeated JPY purchase trial. The HSBC Hong Kong captures offer an additional view of quote changes and the importance of displayed rate precision.

## 2 Public source and method

## 2.1 Calculator observations

The ICBC website offers a “settlement and sale of foreign exchange” calculator with automatic and manual rate fields for converting foreign currency to CNY.<sup>1</sup> On 25 September 2026, the accessible calculator listed JPY, KRW and IDR and displayed the per-unit rates shown in Table 1. The page did not display a timestamp for these embedded rate values. They are recorded here as values visible in the calculator on the access date, not as contemporaneous executable quotes. The separate official ICBC rate page displayed no data during this check and says that branch execution rates prevail.<sup>3</sup>

To test the rule without relying on an embedded quote, the author selected the manual-rate option. At CNY 0.000443 per IDR, entering 16,173 IDR produced CNY 7.16; entering 16,174 IDR produced CNY 7.17. The exact products are CNY 7.164639 and 7.165082. A boundary test at CNY 0.0005 per IDR and 14,330 IDR, whose exact product is CNY 7.165, displayed CNY 7.17. Together these observations are consistent with half-up rounding to cents in the tested calculator. The test does not establish how a live buy or sell order would be booked.

## 2.2 Comparable CNY scenario

Let  $x$  be a positive integer number of foreign-currency units,  $r$  the calculator's displayed CNY price per unit, and  $v = rx$  the exact CNY product. Define half-up settlement as  $H(v) = \text{floor}(100v + 0.5) / 100$ . For a foreign-to-CNY conversion, define the signed display residue  $g = v - H(v)$ . A positive  $g$  means that the two-decimal calculator result is lower than the exact product; a negative  $g$  means it is higher. This sign convention is for arithmetic comparison only and does not assign an economic gain to either side of a live trade.

For each currency, the analysis searches all integer  $x$  for which the displayed CNY result lies between CNY 7.16 and CNY 8.00, inclusive. The search maximizes positive  $g$ . This narrow, common output range avoids comparing a tiny JPY order with an arbitrarily large IDR order. It is an illustrative research design, not a stated bank minimum. Exact decimal arithmetic was used throughout. The comparison does not assume that every integer quantity is operationally available through a bank account.

A third rule, ceiling to cents, is defined as  $U(v) = \text{ceil}(100v) / 100$ . It always makes a positive, non-cent-exact amount up to one cent higher. This rule is tested as an alternative explanation of the HSBC Hong Kong app outputs. Truncation to cents,  $T(v) = \text{floor}(100v) / 100$  for positive  $v$ , provides another comparator. None of these formulas by itself establishes the amount that would be booked after a transaction is confirmed.

## 2.3 Dated mobile-app observations

Seven screen captures supplied by the author show the HSBC Hong Kong mobile FX interface on 25 September 2026, between 11:52 and 11:53 Hong Kong time. The direction is sell USD, buy HKD. Each image contains the USD input, the displayed HKD output and the displayed rate for one USD. The quote changes from one image to the next, so each input is multiplied only by the rate in the same image. The

resulting decimal product is compared with half-up, ceiling and truncation to HKD cents. These are pre-trade screen observations; the “exchange now” button was not used in this test. A displayed four-decimal rate may hide further digits. Under a conventional nearest-four-decimal display, the internal rate may differ from the visible number by almost HKD 0.00005 per USD; around USD 10, this changes the exact product by almost HKD 0.0005. The rule comparisons in Table 3 therefore assume, for illustration, that the visible rate is exact. Original screen captures are retained in the research folder; Table 3 transcribes their numerical content.

## 2.4 Independent mainland calculator test

The CCB public website provides separate reference calculators for selling foreign currency into CNY and purchasing foreign currency with CNY.<sup>4</sup> On 25 September 2026, the JPY-to-CNY reference rate shown for the first direction was 0.042240; the CNY cost per JPY shown for the second was 0.042562. The author entered quantities on either side of cent-rounding boundaries and recorded the displayed rate and CNY result. The purchase trial also compared a 189-JPY quote with a 189,000-JPY quote at the same displayed rate. These paired calculations allow a direct comparison between 1,000 separately rounded reference amounts and one combined reference amount.

## 3 Results

Table 1  
Comparable positive calculator residues using the rates displayed on the ICBC website

| Currency | Calculator rate, CNY/unit | Quantity, units | Exact CNY product | Calculator CNY result | Positive residue, CNY |
|----------|---------------------------|-----------------|-------------------|-----------------------|-----------------------|
| JPY      | 0.042048                  | 183             | 7.694784          | 7.69                  | 0.004784              |
| KRW      | 0.004850                  | 1,634           | 7.924900          | 7.92                  | 0.004900              |
| IDR      | 0.00035956                | 20,094          | 7.22499864        | 7.22                  | 0.00499864            |

Source: ICBC online FX calculator,<sup>1</sup> accessed 25 September 2026; the listed inputs and displayed outputs were checked in the web interface, and exact products were recalculated independently. The rate values had no visible quote timestamp. Search domain: integer currency quantities giving displayed CNY results from 7.16 to 8.00 inclusive. The calculator states that its results are for reference.

As Table 1 shows, the highest positive residue found within the common CNY band was smallest for JPY and largest for IDR. In the IDR example the exact product is CNY 7.22499864, while the page displays CNY 7.22. This supports the author's intuition for this selected range and these rates: smaller unit increments can permit a closer approach to the half-cent boundary. It does not establish a universal ranking of currencies. The attainable fractions also depend on quote precision, denomination rules and the size range allowed. Across a sufficiently broad set of integer quantities, a high-priced currency can approach its own arithmetic maximum.

The half-up rule limits a positive residue to less than CNY 0.005 unless an exact half-cent tie is treated differently. By contrast, truncation to cents can generate a positive difference approaching CNY 0.01, while ceiling to cents produces a negative g for every positive non-cent-exact product. For example, at  $v = \text{CNY } 7.22499864$ , truncation yields CNY 7.22, half-up rounding also yields CNY 7.22, and ceiling yields CNY 7.23. The rule matters most when the product lies on the other side of the half-cent threshold. At  $v = \text{CNY } 7.165$ , half-up rounding and ceiling both yield CNY 7.17, whereas truncation yields CNY 7.16.

### 3.1 A second mainland calculator and a repeated-purchase example

Table 2  
JPY-to-CNY reference calculations on the CCB public website, 25 September 2026

| Direction        | JPY quantity | Displayed rate, CNY/JPY | Exact CNY product | Displayed CNY amount |
|------------------|--------------|-------------------------|-------------------|----------------------|
| Sell JPY for CNY | 170          | 0.042240                | 7.180800          | 7.18                 |
| Sell JPY for CNY | 172          | 0.042240                | 7.265280          | 7.27                 |
| Buy JPY with CNY | 170          | 0.042562                | 7.235540          | 7.24                 |
| Buy JPY with CNY | 189          | 0.042562                | 8.044218          | 8.04                 |
| Buy JPY with CNY | 189,000      | 0.042562                | 8,044.218000      | 8,044.22             |

Source: CCB public FX trial calculator,<sup>4</sup> accessed 25 September 2026. Inputs, displayed rates and displayed amounts were recorded in the web interface; products were recomputed with exact decimal arithmetic.

Table 2 shows the same half-up pattern in a second mainland bank's customer-facing calculator. A 170-JPY sale gives CNY 7.180800 and displays 7.18, while 172 JPY gives CNY 7.265280 and displays 7.27. In the purchase direction, 170 JPY gives CNY 7.235540 and displays 7.24; 189 JPY gives CNY 8.044218 and displays 8.04. The last pair distinguishes half-up rounding from ceiling to cents, which would show CNY 8.05. Across these tested inputs, both mainland interfaces follow half-up rounding to CNY cents.

The purchase numbers also make the cumulative effect concrete. In a simulation at a fixed CNY 0.042562 per JPY, repeating the displayed 189-JPY purchase quote 1,000 times gives  $1,000 \times \text{CNY } 8.04 = \text{CNY } 8,040$ . A single 189,000-JPY purchase displays CNY 8,044.22. The difference is CNY 4.22 for the same 189,000 JPY at the same reference rate. Measured against the exact arithmetic cost, each small order is CNY 0.004218 lower; over 1,000 orders that is CNY 4.218. This is a purchase-cost difference produced by where the calculator rounds, rather than a gain from an exchange-rate movement.

### 3.2 HSBC Hong Kong USD-to-HKD app quotes

Table 3  
Paired mobile-app quotes and cent-level rounding tests, 25 September 2026

| Hong Kong time | USD sold | Displayed HKD per USD | Exact HKD product | App HKD output | Half-up | Ceiling | Truncation |
|----------------|----------|-----------------------|-------------------|----------------|---------|---------|------------|
| 11:52:35       | 10.01    | 7.8098                | 78.176098         | 79.66          | 78.18   | 78.18   | 78.17      |
| 11:52:43       | 10.02    | 7.8104                | 78.260208         | 78.26          | 78.26   | 78.27   | 78.26      |
| 11:52:50       | 10.03    | 7.8096                | 78.330288         | 78.33          | 78.33   | 78.34   | 78.33      |
| 11:52:59       | 10.04    | 7.8098                | 78.410392         | 78.41          | 78.41   | 78.42   | 78.41      |
| 11:53:05       | 10.05    | 7.8100                | 78.490500         | 78.49          | 78.49   | 78.50   | 78.49      |
| 11:53:12       | 10.06    | 7.8101                | 78.569606         | 78.57          | 78.57   | 78.57   | 78.56      |
| 11:53:18       | 10.07    | 7.8103                | 78.649721         | 78.65          | 78.65   | 78.65   | 78.64      |

*Source: Seven author-supplied screen captures of the HSBC Hong Kong mobile FX quote interface, archived with this study. Products and rule predictions use the displayed four-decimal rates as if they were exact. The first row is reported for completeness but excluded from the six matched-rate comparisons because its visible input, rate and output do not reconcile.*

The exchange rate varies between captures, but each displayed rate is paired with its own amount. Six results match half-up rounding when that displayed rate is used in the calculation. For example,  $USD\ 10.03 \times 7.8096 = HKD\ 78.330288$  and the app shows HKD 78.33. The four-decimal quote does not disclose the internal calculation rate, however: an internal 7.80956 would appear as 7.8096 and could also produce HKD 78.33 under a ceiling rule. The mobile data therefore illustrate the importance of rate precision without changing the stronger mainland calculator finding.

One capture warrants separate attention. USD 10.01 at the displayed 7.8098 rate gives HKD 78.176098, while the image shows HKD 79.66. This difference is much larger than cent-level rounding. The original image is preserved in Table 3, and its source is left open for further checking.

### 3.3 Economic interpretation

For the CCB purchase trial, the simulated repeated-order comparison holds the foreign-currency quantity and reference selling rate fixed. The CNY 4.22 lower displayed total is therefore a rounding-location effect: it measures the difference between rounding each small purchase and rounding the combined purchase once. In ordinary language, the calculator quotes less CNY for the same JPY quantity when the amount is divided into these 1,000 small lines. The arithmetic does not require selling the JPY back. It represents a possible purchase-cost reduction if a bank accepts and books each small order at that quote and rounds each line separately.

The amount remains small because a half-up rule can reduce a positive exact CNY cost by less than half a cent per line. Even at 1,000 lines, the benefit is measured in yuan, not hundreds of yuan. The price may

change before all orders are entered, and a bank may impose order limits or aggregate settlements. Rime, Schrimpf and Syrstad show more generally that an FX strategy's economics depend on the prices available to the actual trader.<sup>5</sup> Here the same point calls for separating the observed reference-quote arithmetic from the cost actually booked.

## 4 Banking control implications

The two mainland calculators demonstrate a repeatable rule in customer-facing interfaces. It does not reveal whether that rule was intentionally selected for a live product, which internal account is affected, or whether another step in the production system changes the final amount. Those are questions for documented product terms and transaction-level system testing. The simplest control test would record the rate, entered quantity, exact product, displayed amount and booked amount at values immediately below, at and above each half-cent threshold.

The Basel Committee's FX-settlement guidance calls for accurate and resilient operational processes, including controls over data flowing from execution to settlement.<sup>6</sup> Its principal concern is settlement risk between counterparties, not a claim that sub-cent retail rounding is itself a systemic risk. Applied at the application level, the relevant lesson is to reconcile the customer display, accepted order and ledger posting under a documented rule. Such a reconciliation would also establish whether rounding occurs once on the final amount or separately at intermediate steps; those alternatives can produce different totals when transactions are aggregated.

A bank could then aggregate signed rounding differences by product, currency, period and customer behavior. Repeated small orders close to a favorable boundary may be worth operational monitoring, but an exception report should distinguish routine customer behavior from genuine policy violations. The concept of materiality also needs care. IFRS guidance defines material information in relation to its ability to influence decisions of primary users of general-purpose financial statements.<sup>7</sup> An individual sub-cent display difference is not automatically a financial-reporting misstatement, and this paper supplies no evidence that any bank's aggregate figure is material. It provides a method for checking the total before making that judgment.

The HSBC mobile captures provide a useful contrast in measurement. Each changing rate is paired with its output, but four-decimal quote display conceals enough precision to leave the underlying cent rule unresolved. The seven captures therefore belong in the study as a case of quote verification, while the two mainland public calculators carry the main rounding finding.

## 5 Conclusion

Two mainland bank public calculators produced results consistent with half-up rounding to CNY cents in controlled tests. The ICBC JPY, KRW and IDR examples show how the size of a positive residue changes within a common CNY range. The CCB purchase test shows the cost effect directly: at the displayed JPY

selling rate, simulating 1,000 separately rounded 189-JPY purchases yields CNY 8,040, whereas one quote for the same 189,000 JPY displays CNY 8,044.22. The CNY 4.22 difference is small in this illustration but arises from a clear arithmetic mechanism. The HSBC Hong Kong app captures show why a changing quote must be recorded with each output and why a rate shown to only four decimal places cannot settle a finer rounding question. These cases provide a practical framework for checking retail FX pricing displays and for measuring how repeated cent-level rounding changes the stated cost of acquiring foreign currency.

## Declarations

### Competing Interests

Ruirui Deng completed an internship at the Industrial and Commercial Bank of China (ICBC) from July to September 2025. ICBC is one of the providers of the public calculators examined in this independent study. The internship was unrelated to this research.

## Author Contribution

R.D. conceived and designed the study, collected and analysed the data, interpreted the findings, and wrote and revised the manuscript.

## Acknowledgement

An AI tool was used only to identify and correct English grammar errors in the manuscript.

## Data Availability

All numerical observations supporting the findings, including the calculator inputs, displayed rates, displayed amounts and independently calculated products, are reported in Tables 1–3. The public calculator pages are identified in the references. The original mobile quote screenshots used to transcribe Table 3 are retained by the author.

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