

The "Overbought 70" of RSI Belongs to the Bar Size You Chose

[F004]

The share of time the same 70 selects runs from 8.5015% on five-minute bars to 16.2095% on four-hour bars, a ratio of 1.6130 at the median — on series of independent increments the same ratio is flat, between 1.0921 and 1.0980 — and once overlapping windows are removed, the cells whose daily t reaches 2 in absolute value fall from 10 of 16 to 2

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Abstract

This paper asks what the number 70 in RSI belongs to — the answer is that it belongs not to the market but to the bar size one chose. It claims neither a new mathematical theorem nor a new law.

First, holding the thresholds at 30/70 and changing only the bar size, the share of time RSI sits outside them runs from 8.5015% on five-minute bars to 16.2095% on four-hour bars. The ratio across bar sizes has a median of 1.6130 (Section 3).

Second, and this is the core of the paper, on series built from independent normal increments the same ratio is flat, between 1.0921 and 1.0980. The dependence on bar size therefore does not come from the definition of RSI; it comes from the market (Section 6).

Third, moving the thresholds from 60 to 80 changes the share selected by a factor of 19.0345 to 36.6540. Choosing a threshold is choosing how rare an event to pick up (Section 4).

Fourth, measuring the directional information, the daily-clustered t reaches 2 in absolute value in 10 of the 16 cells. By chance about 0.7 would be expected, so stopping here reads as "it works" (Section 5).

Fifth, ⚠ but removing overlapping windows drops the same figure to 2 of 16. The count falls to 0.0244 of itself and the sign reverses in 4 of the 16 cells. The horizon was twenty-four hours while

entries were taken every five minutes, so adjacent observations shared 287 of their 288 minutes (Section 7).

Sixth, and the measured directional information falls **inside the range of the 20 synthetic realisations in all four series** (Section 7).

Scope of this paper (scope note): No new mathematical theorem and no new law is claimed — the definition of RSI, Wilder's smoothing and random walks are all known. **No particular product or proponent is discussed** — no real course, author, or vendor is the subject here, and none is named. What is treated is the public indicator itself. **Trading is not discussed** — what is measured is directional information, not trading performance including commissions, fills and money management. **The scope is intraday and a small number of instruments** — four series, six years, four bar sizes. Nothing is said about all markets or all time scales. In particular, this paper does not contradict results documented at longer holding periods, such as monthly time-series momentum. **Only the mean-reverting reading is measured** — the trend-following reading (buy at 70, sell at 30) is the same signal with its sign flipped, so its directional information is the same number with its sign flipped. **Divergence is not treated** — reading a disagreement between price and RSI is not a question about thresholds and lies outside this paper. **No forecast is claimed. Relation to earlier papers:** Paper 264 showed that a threshold belongs to its lattice — this paper measures that in a market indicator. Paper 422 showed that removing the condition named as the core of a rule does not move the result. F001 of this series showed that the period of a moving-average crossover comes from the ratio of the two periods, F002 that the forward shift of the Ichimoku cloud does not change the answer, and F003 that the multiplier of a Bollinger band moves only how often price leaves it — this paper stands beside them and measures the same thing for a number in a fourth indicator. What is added here is **declaring the bar size as the separator in advance and measuring it at four values, writing in advance the prediction that a series of independent increments should not depend on bar size and placing it beside the measurement, and placing the form with overlapping windows removed in the same table.**

1. Notation and the question

RSI is built as follows. Differences of closes are split into rises and falls, each is passed through Wilder's smoothing (with coefficient the reciprocal of the period), and their ratio is mapped to a value between 0 and 100. A period of 14 is widely used.

The common reading is that **70 or above is overbought and 30 or below is oversold**.

Observation 1.1: this number 70 **has no meaning until the bar size is fixed**. The 70 of a five-minute bar and the 70 of a four-hour bar are the same number but not the same event.

Observation 1.2: ⚠ it does **not follow**, however, that they must differ. RSI is built from the ratio of rises to falls, so it does not depend on the size of the moves. On a series of independent increments, **the distribution of RSI should not depend on bar size**.

Question: as the bar size changes, what does the same 70 select? And what happens in a market?

Observation 1.3: two predictions follow.

Prediction A (the threshold belongs to the lattice) — the same 70 selects a different share at a different bar size.

Prediction B (the threshold points at a state) — the share is about the same regardless of bar size.

A random walk should give Prediction B. The question is therefore settled by how far the measurement departs from it.

2. Writing the quantity and the design in advance

Two quantities are measured.

One is **the share of time RSI sits outside the thresholds**. The other is **directional information**.

...

$D = \text{mean}(\text{sign of the signal} \times \text{the price move over the next } h \text{ bars})$ in pips

...

The signal is -1 (sell) when RSI is 70 or above, $+1$ (buy) when 30 or below, and 0 between them. This is the mean-reverting reading. The trend-following reading is its sign flipped and is not measured.

Observation 2.1: ⚠ **the horizon is fixed at twenty-four hours of clock time.** The number of bars therefore differs by bar size (**288** on five-minute, **96** on fifteen-minute, **24** on one-hour, **6** on four-hour bars). Without this, four-hour bars would move more as a matter of course.

Design (declared before running and unchanged at run time)

Item	Decision
Indicator	RSI, period 14, Wilder's smoothing
Bars	mid price, closing value of completed bars only (the last tick in the bar)
Instruments	USDJPY, EURUSD, GBPUSD, XAUUSD
Period	2019–2024. Selection 2019–2021 / evaluation 2022–2024
Horizon	twenty-four hours of clock time (the number of bars varies by bar size)
Separator	bar size: 5 min, 15 min, 1 hour, 4 hours
Thresholds	40/60, 30/70, 20/80 (standard is 30/70)
Period n	7, 14, 21 (standard is 14)
Cost	the median spread of the same bars is always reported alongside

The bar counts are as follows.

Instrument	5 min	15 min	1 hour	4 hours
USDJPY	438,283	146,125	36,534	9,640
EURUSD	438,505	146,202	36,554	9,648
GBPUSD	438,199	146,127	36,535	9,644
XAUUSD	418,478	139,501	34,892	9,442

3. Changing the bar size — this is the separator

Calculation 3.1 The share the same 70 selects (evaluation period, thresholds fixed at 30/70)

Instrument	5 min	15 min	1 hour	4 hours	Max ÷ min
USDJPY	9.3756%	10.8310%	14.6152%	16.2095%	1.7289
EURUSD	8.6028%	9.5140%	11.8048%	12.8785%	1.4970
GBPUSD	8.7676%	9.2814%	11.4524%	11.1457%	1.3062
XAUUSD	8.5015%	9.8677%	12.6550%	15.3115%	1.8010

Observation 3.2: the ratio across bar sizes has a median of **1.6130** (minimum **1.3062**, maximum **1.8010**). The same 70 selects between 1.3 and 1.8 times as much time depending on the bar size.

Observation 3.3: the direction is consistent. In three of the four series the share grows with the bar size. Only GBPUSD has the four-hour figure slightly below the one-hour figure (**11.1457%** against **11.4524%**).

Observation 3.4: ⚠ at this point it is not yet known whether this is a property of the market or of the definition of RSI. **The baseline of Section 6 separates them.**

Calculation 3.5 The quantiles of RSI itself (evaluation period, USDJPY)

Bar size	5%	25%	50%	75%	95%
5 min	31.2984	43.1382	51.1103	58.9041	70.4023
15 min	30.9084	43.4603	51.6618	59.5808	71.7251
1 hour	29.8778	43.7160	53.0342	61.4222	74.2519
4 hours	30.2291	44.8420	54.3720	63.6487	76.0226

Observation 3.6: the distribution widens with the bar size. The 95th percentile rises from **70.4023** on five-minute bars to **76.0226** on four-hour bars. **The threshold 70 sits almost exactly at the 95th percentile on five-minute bars and well inside it on four-hour bars.** The same number points at a different place in the distribution.

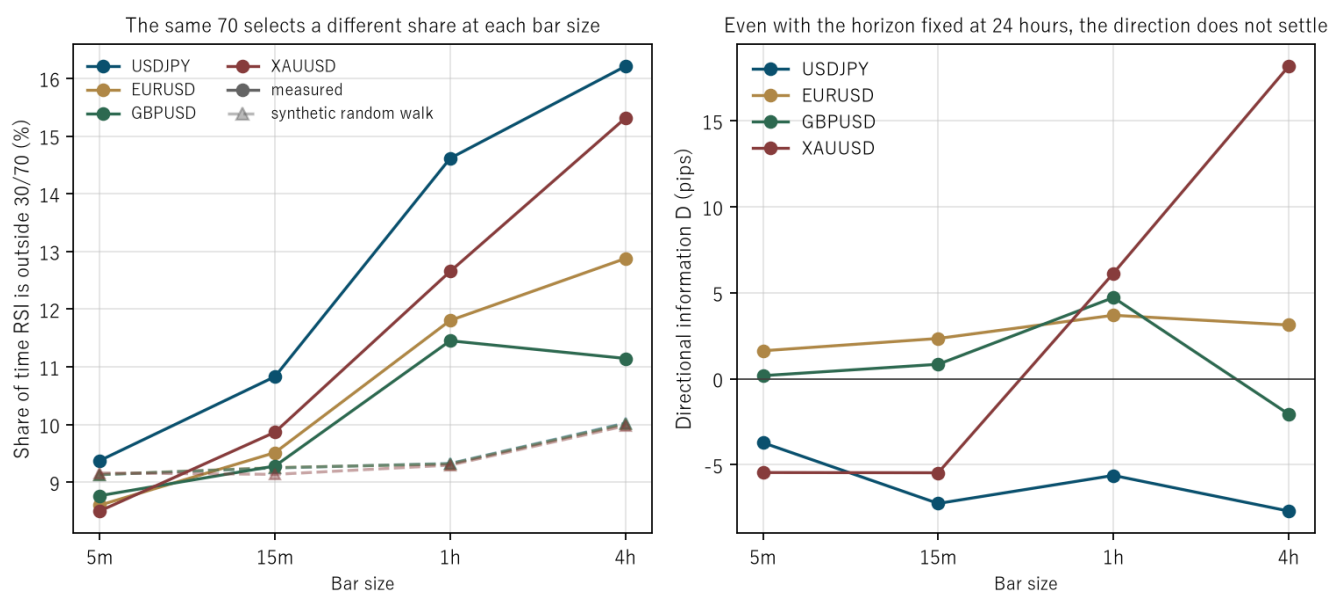


Figure 1: on the left the share of time outside the thresholds (circles measured, dashed triangles the synthetic random walk); on the right the directional information. **The random-walk lines are nearly**

flat and only the measurement rises.

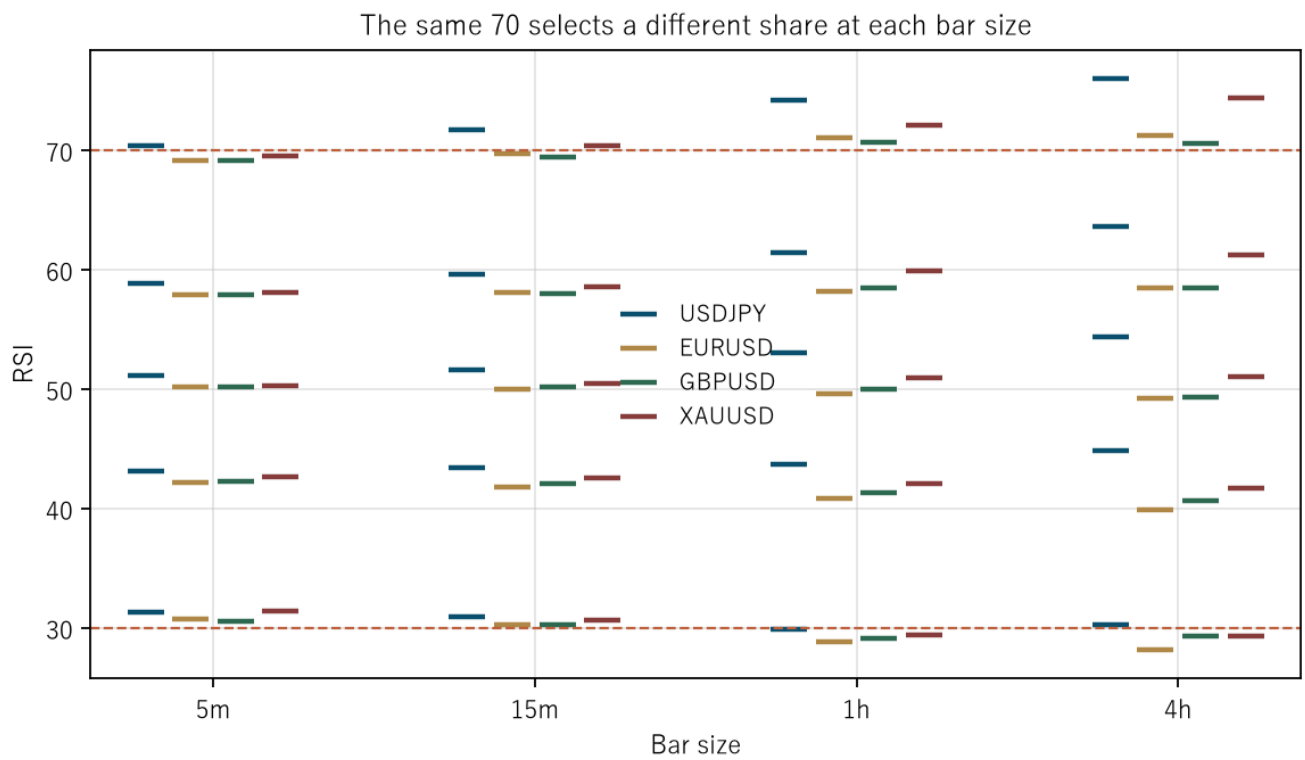


Figure 2: the five quantiles of RSI at each bar size, for the four series. The dashed lines mark 30 and 70. As the bar grows, the distribution widens and the thresholds move inward relative to it.

4. Moving the thresholds and the period

Calculation 4.1 Moving the thresholds (bar size fixed at one hour, evaluation period)

Instrument	40/60 share	40/60 D	30/70 share	30/70 D	20/80 share	20/80 D
USDJPY	46.3476%	− 3.5395	14.6152%	− 5.6184	2.4349%	− 3.7672
EURUSD	43.7147%	1.9198	11.8048%	3.6954	1.5594%	3.1672
GBPUSD	43.2696%	2.0151	11.4524%	4.7249	1.1805%	− 5.9047
XAUUSD	45.0014%	− 1.5155	12.6550%	6.1395	1.5090%	27.3643

Observation 4.2: moving the thresholds from 60 to 80 changes the share selected by a factor of **19.0345** (USDJPY) to **36.6540** (GBPUSD). **Choosing a threshold is choosing how rare an event to pick up.**

Observation 4.3: ⚠ the **27.3643 pips** at 20/80 for XAUUSD looks large, but the share behind it is only **1.5090%**. **Values where the share is small come from few observations.**

Calculation 4.4 Moving the period (one-hour bars, thresholds 30/70, evaluation period)

Instrument	n=7 share	n=7 D	n=14 share	n=14 D	n=21 share	n=21 D
USDJPY	28.3179%	− 5.6936	14.6152%	− 5.6184	8.3347%	− 2.4805
EURUSD	26.5217%	3.8828	11.8048%	3.6954	5.9192%	5.3601
GBPUSD	26.1217%	2.0488	11.4524%	4.7249	5.2423%	3.5941
XAUUSD	26.8420%	− 1.7255	12.6550%	6.1395	6.4876%	6.8582

Observation 4.5: a shorter period makes RSI move more easily and increases the share outside. **Bar size, threshold and period all move the share.** All three are quantities set by the person choosing.

5. Measuring the directional information

Calculation 5.1 Directional information by bar size (evaluation period, horizon twenty-four hours)

Instrument	Bar size	Count	D (overall)	Dd (daily)	Daily t	Per day	spr
USDJPY	5 min	20,035	− 3.7140	1.7842	0.88	20.5	0.60
USDJPY	15 min	7,717	− 7.2479	5.6572	1.99	8.0	0.60
USDJPY	1 hour	2,602	− 5.6184	9.2014	2.32	4.0	0.60
USDJPY	4 hours	780	− 7.6892	1.9489	0.36	3.0	0.60
EURUSD	5 min	18,443	1.6300	1.6324	1.55	19.0	0.30
EURUSD	15 min	6,794	2.3461	7.5878	5.34	7.0	0.30
EURUSD	1 hour	2,107	3.6954	11.7607	5.46	3.0	0.30
EURUSD	4 hours	621	3.1291	8.2494	2.85	2.0	0.30
GBPUSD	5 min	18,791	0.1821	2.3702	1.55	20.0	0.90
GBPUSD	15 min	6,635	0.8455	10.8318	5.44	7.0	0.90
GBPUSD	1 hour	2,047	4.7249	16.9740	5.29	3.0	0.90
GBPUSD	4 hours	537	− 2.0528	10.1360	2.42	2.0	0.90
XAUUSD	5 min	17,815	− 5.4496	2.7598	0.66	19.0	3.50
XAUUSD	15 min	6,894	− 5.4632	20.5919	3.89	7.0	3.50
XAUUSD	1 hour	2,214	6.1395	39.6301	5.12	3.0	3.54
XAUUSD	4 hours	725	18.1759	41.0519	3.75	2.0	3.57

Observation 5.2: the daily-clustered t reaches 2 in absolute value in **10 of the 16** cells. By chance about **0.7** would be expected, so **stopping here reads as "the mean-reverting use of RSI works"**.

Observation 5.3: ⚠ and the daily means are large: **41.0519 pips** for XAUUSD on four-hour bars, **16.9740 pips** for GBPUSD on one-hour bars. They greatly exceed the spread (**0.30** to **3.57**).

Observation 5.4: ⚠ yet the overall mean and the daily mean **disagree in sign in 7 of the 16** cells. USDJPY on one-hour bars is **−5.6184** overall and **9.2014** daily. **Something already fails to line up here.**

Observation 5.5: and the shape that should prompt suspicion of overlap is present. On five-minute bars there are **20.5** entries a day and the horizon is twenty-four hours. **Adjacent observations share 287 of their 288 minutes.**

6. The baseline — a random walk should not depend on bar size

As written in Section 1, on a series of independent increments the distribution of RSI should not depend on bar size. Whether it does is measured.

Calculation 6.1 The share on synthetic random walks (median of 20 realisations, evaluation period)

Instrument	5 min	15 min	1 hour	4 hours	Max ÷ min
USDJPY	9.1317%	9.2489%	9.3255%	10.0270%	1.0980
EURUSD	9.1335%	9.2568%	9.3147%	10.0062%	1.0955
GBPUSD	9.1316%	9.2492%	9.3208%	10.0145%	1.0967
XAUUSD	9.1616%	9.1371%	9.2969%	9.9789%	1.0921

Observation 6.2: on random walks the ratio is between 1.0921 and 1.0980, essentially flat.

Prediction B holds there.

Observation 6.3: the measured ratio had a median of 1.6130. The dependence of the share on bar size therefore **does not come from the definition of RSI; it comes from the market.**

Observation 6.4: ⚠ it is tempting to read this as "so there is structure in the market". **That reading is correct, and it says nothing about direction.** The share depending on bar size and the direction being right are different things.

7. Removing the overlap — and the baseline on the directional side

Calculation 7.1 Measuring again with non-overlapping windows (evaluation period)

Keeping one observation every h bars so that the windows examined do not overlap.

Instrument	Bar size	Count with overlap	D	Daily t	Count without	D
USDJPY	5 min	20,035	− 3.7140	0.88	47	− 13.817
USDJPY	15 min	7,717	− 7.2479	1.99	97	− 15.082
USDJPY	1 hour	2,602	− 5.6184	2.32	86	− 17.250
USDJPY	4 hours	780	− 7.6892	0.36	129	− 10.370
EURUSD	5 min	18,443	1.6300	1.55	83	4.907
EURUSD	15 min	6,794	2.3461	5.34	107	13.362
EURUSD	1 hour	2,107	3.6954	5.46	82	5.041
EURUSD	4 hours	621	3.1291	2.85	94	2.100
GBPUSD	5 min	18,791	0.1821	1.55	64	− 0.2133
GBPUSD	15 min	6,635	0.8455	5.44	65	− 20.380
GBPUSD	1 hour	2,047	4.7249	5.29	89	6.342
GBPUSD	4 hours	537	− 2.0528	2.42	81	− 6.9747
XAUUSD	5 min	17,815	− 5.4496	0.66	68	− 5.2005
XAUUSD	15 min	6,894	− 5.4632	3.89	74	4.573
XAUUSD	1 hour	2,214	6.1395	5.12	93	− 3.0142
XAUUSD	4 hours	725	18.1759	3.75	120	14.643



Observation 7.2: the cells whose daily t reaches 2 in absolute value fall from 10 of 16 to 2 of 16. The count falls to a median of **0.0244** of itself.

Observation 7.3: the sign reverses in 4 of the 16 cells. GBPUSD on fifteen-minute bars goes from 0.8455 to −20.3808, and its t still exceeds 2 in absolute value **with the opposite sign**.

Observation 7.4: ⚠ clustering by day folds only the overlap within a day. With a twenty-four-hour horizon, **the overlap across days remains**. The t values of Section 5 were failing to count it.

Observation 7.5: ⚠ removing the overlap, however, leaves between 47 and 129 observations. The power of the test falls sharply. "Down to 2" is not "there is none"; it is **not visible at this count**.

Calculation 7.6 The baseline on the directional side (one-hour bars, evaluation period)

Instrument	Measured D	Measured Dd	Median random D	Random minimum	Rando
USDJPY	− 5.6184	9.2014	− 0.7568	− 10.2575	
EURUSD	3.6954	11.7607	− 0.4668	− 6.7974	
GBPUSD	4.7249	16.9740	− 0.7607	− 9.9501	
XAUUSD	6.1395	39.6301	1.5722	− 21.7173	

Observation 7.7: in all four series the measured value falls inside the range of the 20 realisations.

On the share side the measurement and the random walk separated clearly (Section 6); on the directional side they do not.

Observation 7.8: placing those two side by side gives the answer of this paper. Changing the bar size **moves the share selected** (it separates from the random walk) but **does not move the direction** (it does not).

8. Splitting by session

Design: five **non-overlapping** bins in Coordinated Universal Time — Tokyo 0–7, London 7–12, overlap 12–16, late New York 16–21, and night 21–24. Bars are one hour.

Calculation 8.1 Directional information in each of the five bins (evaluation period)

Instrument	Tokyo 0–7	London 7–12	Overlap 12–16	NY late 16–21	Night 21–24
USDJPY	− 9.78 (t − 0.01)	− 3.97 (t 0.46)	− 0.10 (t 0.55)	− 3.43 (t − 0.14)	− 15.41 (t − 1.58)
EURUSD	10.51 (t 2.40)	4.65 (t 2.11)	− 0.50 (t 1.53)	1.11 (t 0.98)	2.77 (t − 0.01)
GBPUSD	11.15 (t 1.46)	0.65 (t 0.99)	3.25 (t 2.80)	5.83 (t 1.69)	− 0.27 (t 0.59)
XAUUSD	13.92 (t 2.37)	25.57 (t 1.16)	− 3.16 (t 1.35)	− 9.61 (t 0.83)	18.50 (t 1.50)

Observation 8.2: the daily t reaches 2 in absolute value in **4 of the 20** cells. By chance about **0.9** would be expected, so the measured figure exceeds it.

Observation 8.3: ⚠️ **but this table does not remove the overlap.** In Section 7, removing it dropped the same kind of t from **10 to 2**. **The t values split by session must be discounted by the same amount.**

Observation 8.4: ⚠️ trying five bins, finding one that looks significant is the ordinary case. What is read is whether the number of significant cells exceeds chance. **And comparing a figure that has not been corrected for overlap against chance means little.**

9. Limitations

1. **Removing the overlap cuts the count by two orders of magnitude.** At 47 to 129 observations, even an effect several times the spread would not be visible. **"Not significant" is not "not there"**.
 2. **Only one way of removing the overlap is used.** The grid taking one observation every h bars is placed one way; versions with a shifted start are not measured.
 3. **The measurement uses a fixed horizon.** It does not use an exit that cuts at a take-profit or a stop-loss.
 4. **Only the mean-reverting reading is measured.** The trend-following reading is read off by flipping the sign, but **divergence** — a disagreement between price and RSI — is not a question about thresholds and is not treated.
 5. **The synthetic baseline uses independent normal increments.** Volatility clustering is not included. Part of the separation on the share side may come from there, but that has not been measured.
 6. **The session table is not corrected for overlap** (Observation 8.3).
 7. **Four instruments over six years.** Nothing is said about other markets or other periods.
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Conclusion

The 70 of RSI looks as though it points at a state of the market. But the share the same 70 selects runs from **8.5015%** on five-minute bars to **16.2095%** on four-hour bars. **Since that ratio is a flat 1.09 on a series of independent increments, what moves is the market side.**

That much is a fact about the market. **It says nothing about direction.** On the directional side, removing overlapping windows dropped the cells with a daily t above 2 from **10 to 2**, and all four series fell inside the range of the random walk.

One thing separates the cases — when the bar size moved, was it the share selected that moved or the direction? Only the share moved.

And the heaviest lesson of this paper is the gap between Sections 5 and 7. **Measuring twenty-four hours ahead while entering every five minutes counts the same event many times over.** Averaging

within days is not enough. **Write the horizon and the interval between entries side by side.**

Data and reproduction

Data	Currency ticks from Dukascopy (agreement to the millisecond, bid and ask, verified from 2019 onward). Gold from Dukascopy
Period	2019–2024 (six years). Selection 2019–2021 / evaluation 2022–2024
Instruments	USDJPY, EURUSD, GBPUSD, XAUUSD
Bars	5 min, 15 min, 1 hour, 4 hours. Mid price, closing value of completed bars only. Bars with no ticks are not created
Verification	<code>検算/F004.py</code> (with <code>--zu</code> it also writes the figures). Every number in the text is taken from <code>検算/F004_output.txt</code>
Figures	<code>図/F004_zu1</code> , <code>図/F004_zu2</code> (png, svg, English versions)
Random seeds	Fixed at 0–19. Re-running gives the same values
Audit of the foundation	<code>_ツール/audit_bars.py</code> (look-ahead in the bars, daylight saving, the day boundary). The record is <code>_土台の検査.txt</code>

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