

Kaufman Efficiency Ratio

Directionality measure + KAMA use — 2-page reference

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Kaufman Efficiency Ratio

Source: Perry J. Kaufman, *Trading Systems and Methods* (and subsequent editions). **Also called:** Efficiency Ratio (ER), Kaufman Efficiency Ratio.

1. Definition

The Efficiency Ratio (ER) measures the **directionality** of a price series over a rolling window of `n` periods. It answers one question:

Of the total price movement in this window, how much was signal (trending) vs. noise (chop)?

Formula (n-period lookback):

$$ER = |P_t - P_{t-n}| / \sum_{i=1}^n |P_i - P_{i-1}|$$

Symbol	Meaning
P_t	Price at the current bar
$P_{\{t-n\}}$	Price n bars ago
Numerator	Net price change over the window (absolute)
Denominator	Sum of every bar's absolute price change (total path length)

2. Interpretation

ER is bounded $[0, 1]$:

ER	Market state	Trading implication
1.0	Perfectly trending — every bar moved in the same direction	Strongest trend signal; widen stops, follow
0.8 – 1.0	Strong trend	Trend-following systems should be on
0.4 – 0.6	Mixed / chop with mild directional bias	No edge; mean-reversion or flat
0.2 – 0.4	Choppy with small net move	Stand down or mean-revert
≈ 0.0	Pure noise — net move ≈ 0	Do not trend-follow

Worked example ($n = 10$):

- Open 100, Close 102 $\rightarrow$ net change = 2
- Path 100 $\rightarrow$ 101 $\rightarrow$ 100 $\rightarrow$ 101 $\rightarrow$ 102 $\rightarrow$ sum of $|\text{deltas}| = 4$
- **ER = 2 / 4 = 0.50** $\rightarrow$ mixed signal
- Same net change (2) with path 100 $\rightarrow$ 100 $\rightarrow$ 100 $\rightarrow$ 100 $\rightarrow$ 102 $\rightarrow$ sum = 2 $\rightarrow$ **ER = 1.0** $\rightarrow$ perfect trend

3. KAMA — the most common use

The Efficiency Ratio is the **adaptive input** to Kaufman's Adaptive Moving Average (KAMA).

Why adapt? Fixed-period MAs either lag too much in trends (long period) or whipsaw in chop (short period). KAMA scales its smoothing constant between a **fast** EMA constant and a **slow** EMA constant based on ER:

$$KAMA_t = KAMA_{t-1} + \alpha^2_t \times (P_t - KAMA_{t-1})$$

where

$$\alpha_t = [ER_t \times (\text{fast} - \text{slow}) + \text{slow}]^2$$

Parameter	Typical value
<code>n</code> (ER lookback)	10
<code>fast</code> (fastest EMA constant, $\approx 2/(2+1)$)	0.6667
<code>slow</code> (slowest EMA constant, $\approx 2/(30+1)$)	0.0645

Effect:

- High ER (trending) → α close to fast → KAMA tracks price tightly (low lag)
- Low ER (choppy) → α close to slow → KAMA smooths aggressively (anti-whipsaw)

4. Implementation pseudocode

```
# Inputs: prices (array), n (lookback, default 10)
# fast, slow: EMA constants (e.g. 0.6667, 0.0645)

for each bar t >= n:
    direction = abs(prices[t] - prices[t-n])
    path      = sum(abs(prices[i] - prices[i-1]) for i in t-n+1 ..
t)
    er        = direction / path if path > 0 else 0
```

```
alpha    = (er * (fast - slow) + slow) ** 2
kama[t]   = kama[t-1] + alpha * (prices[t] - kama[t-1])
```

Edge cases:

- If `path == 0` (flat window) $\rightarrow ER = 0 \rightarrow \alpha = \text{slow}^2 \rightarrow$ KAMA holds steady
- Seed `kama[0]` with `prices[0]` (no lookback required at first bar)

5. Practical uses

1. **Adaptive MA / trend filter** (KAMA above)
2. **Position sizing** — scale size $\propto ER$ (full size in trends, half in chop, zero in noise)
3. **Entry gate** — only trend-follow when $ER > 0.4$
4. **Stop placement** — trail by $ATR \times (1 + ER)$ for trend-strength-sensitive stops
5. **Regime classifier** — high rolling ER (50-bar) = trending regime; low ER = mean-reverting regime

6. Common pitfalls

- **Window length `n`** : too short $\rightarrow$ ER noisy; too long $\rightarrow$ ER lags regime changes. Default 10; tune per timeframe (intraday 10–20, daily 10–30, weekly 5–15).
- **Gap risk**: if you use ER on a series with gaps (overnight, weekend), the numerator includes the gap but the denominator does not — this biases ER up.
- **Absolute value trap**: ER is unsigned — it cannot tell you uptrend from downtrend. Pair with a direction signal (sign of `P_t - P_{t-n}`) or a separate momentum indicator.