Market Whisperer

Deterministic Risk Engine — Mathematical Specification

1. Architectural Principle

The system is separated into two strictly independent layers:

- **Extraction Layer:** converts raw information into a validated `StructuredEvent`.
- **Deterministic Risk Engine:** consumes structured inputs only and applies fixed mathematical rules.

No statistical fitting, learning, or text interpretation occurs inside the Risk Engine.

2. Event Processing Pipeline

For each event k and ticker i the following deterministic sequence is applied.

Step 1 — Economic Variable Mapping

$$v_k = f(\text{event\_type}_k)$$

Each event maps to a unique macroeconomic driver.

Step 2 — Market Direction

$$direction_{i,k} = g(v_k, \text{variable\_direction}_k)$$

Lookup table mapping to $\{\text{positive}, \text{negative}, \text{uncertain}\}$ pressure.

Step 3 — Confidence Score

$$Confidence_k = 0.35R_k + 0.25D_k + 0.20C_k + 0.20F_k$$

Where reliability R, directness D, clarity C, confirmation $F \in [0, 1]$.

Step 4 — Relevance Filter

$$Rel_{i,k} = E_{s_i,v_k} \cdot G_{r_i,r_k}$$

If:

$$Rel_{i,k} < 0.20$$

the event is ignored for ticker i.

Step 5 — Base Risk

$$BaseRisk_{i,k} = E_{s_i,v_k} \cdot S_{s_i,v_k} \cdot M_k \cdot I_k \cdot U_k$$

Step 6 — Geographic Spillover

$$R_{i,k} = BaseRisk_{i,k} \cdot G_{r_i,r_k}$$

$$0 < R_{i,k} < 1$$

Step 7 — Ticker Aggregated Risk

$$R_i = 1 - \prod_{k \in K_i} (1 - R_{i,k})$$

Probability interpretation: at least one material shock affects the asset.

3. Cross-Asset Dependence

Correlation proxy based on shared affecting events:

$$\rho_{ij} = \frac{|K_i \cap K_j|}{|K_i \cup K_j|} \quad \in [0, 1]$$

$$\rho_{ii} = 1$$

4. Portfolio Risk

Let w_i be normalized portfolio weights:

$$w_i \leftarrow \frac{w_i}{\sum_j w_j}$$

Variance-like aggregation:

$$\sigma_p^2 = \sum_i \sum_j w_i w_j R_i R_j \rho_{ij}$$

$$PortfolioRisk = \sqrt{\sigma_p^2}$$

Display bounding:

$$PortfolioRisk = \min(\max(PortfolioRisk, 0.01), 0.99)$$

5. Diversification Metrics

Herfindahl Diversification

$$HD = 1 - \sum_i w_i^2$$

Effective Independent Bets

$$EIB = \frac{1}{\sum_i \sum_j w_i w_j \rho_{ij}}$$

Concentration Exposure

$$CE = \max_i (w_i R_i)$$

Diversification Efficiency

$$DI = 1 - \frac{PortfolioRisk}{\sum_i w_i R_i + 10^{-9}}$$

Geographic Fragility

$$GF = \mathrm{mean}_{i,j} \left(regional\_overlap_{ij} \cdot \frac{w_i R_i + w_j R_j}{2} \right)$$

6. Numerical Rules

- All outputs rounded to 2 decimals (ROUND_HALF_UP)
- No displayed value equals 0.00 or 1.00

- Missing exposure or sensitivity $\rightarrow$ 0.5 fallback
- All weights normalized

7. Determinism Guarantee

$$Input_t = Input_{t+1} \Rightarrow Output_t = Output_{t+1}$$

The engine contains:

- No randomness
- No adaptive parameters
- No hidden inference

Outputs are fully reproducible and auditable.

End of specification.