**Part 1 — RV Screening (now includes Carry/Roll-Down)**

**Objective:** for each candidate pair (bond i vs bond j), compute:

* **Spread z-score** (divergence signal)
* **Correlation health** (stability filter)
* **Carry-to-Vol ratio** (expected carry+roll vs realized spread vol)
* **Composite score** to rank pairs

**Inputs (CSV-friendly)**

* yields.csv — daily decimals; columns = ISINs (or tickers); index = dates
* dv01.csv — per-bond DV01 per €100 (latest row or static map)
* repo.csv — per-bond repo rate (pa, decimal)
* rolldown.csv — per-bond **RollDown\_bp\_pa** (manual input; you’ve used this before)
* (optional) coupon.csv if you want coupon accrual in carry; otherwise skip for now

**Core formulas**

1. **Spread & z-score**

S\_{i,j}(t)=Y\_i(t)-Y\_j(t)

Z\_{i,j}(t)=\dfrac{S(t)-\mu\_{w}(S)}{\sigma\_{w}(S)}  (e.g., w=120 days)

1. **Correlation health**

Long-term \rho\_{\text{LT}} (e.g., 1y) and short-term \rho\_{\text{ST}} (e.g., 60d).

Penalty if \rho\_{\text{LT}}<\rho\_{\min} or if |\rho\_{\text{ST}}-\rho\_{\text{LT}}| is large.

1. **Spread P&L vol (per €100)**

Use *P&L* spread (not just yield spread), with a DV01-neutral hedge by default:

* Hedge ratio on yields: h=\dfrac{\text{DV01}\_i}{\text{DV01}\_j}
* Daily ΔP per €100:

\Delta P(t)=\text{DV01}\_i\,\Delta Y\_i(t)-h\cdot \text{DV01}\_j\,\Delta Y\_j(t)

* Realized vol \sigma\_{\text{spread}}=\text{stdev}[\Delta P] over window w.

1. **Carry + Roll-down (per €100 over horizon** \tau **years)**

Use your **manual RollDown\_bp\_pa** and repo rate:

* Roll-down P&L for leg k:

\text{RollPnL}\_k = \big(\text{RollDown\\_bp\\_pa}\_k/10\,000\big)\cdot \text{DV01}\_k \cdot \tau

* Funding drag (simplified) for leg k:

\text{FundPnL}\_k \approx -\,\text{Repo}\_k \cdot \text{DirtyPrice}\_k/100 \cdot 100 \cdot \tau

(If you don’t have DirtyPrice, use a **manual carry input** or set \text{FundPnL}=0 to start.)

* Net carry for pair (long i, short j with DV01-neutral hedge h):

\text{CarryPair} = (\text{RollPnL}\_i + \text{FundPnL}\_i)\;-\;h\cdot(\text{RollPnL}\_j + \text{FundPnL}\_j)

1. **Carry-to-Vol ratio**

R = \dfrac{\text{CarryPair}}{\sigma\_{\text{spread}}}

(Choose \tau that matches your review horizon — e.g., 21d/63d; keep it consistent across pairs.)

1. **Composite score** (example, tune weights)

\text{Score} = w\_1\cdot |Z\_{i,j}| \;+\; w\_2\cdot R \;+\; w\_3\cdot \rho\_{\text{LT}} \;-\; w\_4\cdot |\rho\_{\text{ST}}-\rho\_{\text{LT}}|

Hard filters: \rho\_{\text{LT}}\ge 0.5, min liquidity, data completeness, etc.

Output: Best pair per “anchor” bond (and/or top N pairs overall) with score breakdown.

**Part 2 — Sizing (reuse the ratio)**

* **Base vol-unit:** choose target daily σ per risk unit (e.g., €200k/day on £50m equity).
* Compute current \sigma\_{\text{spread}} for the chosen pair (per €100).
* **Position per risk unit** (notional per €100 → scale to € face):

\text{Size}{1\text{RU}} = \dfrac{\text{TargetDailyσ}}{\sigma{\text{spread}}}

* **Overlays:**
  + **Carry-to-Vol bucket**: map R into 0.5–2.0× multiplier (protective carry ⇒ bigger size).
  + **Conviction 1–5**: linear or nonlinear multiplier (cap total ≤ 5 risk units).
* Apply hard limits: gross usage, per-ISIN cap, net DV01, futures margin budget.

**Part 3 — Portfolio Vol (unchanged)**

* Build trade-level ΔP series (per € face), then scale by actual notionals.
* Covariance matrix \Sigma of trade ΔP.
* Portfolio daily vol \sigma\_p=\sqrt{w^\top \Sigma w}.
* Enforce limits & re-opt if needed.

**How you’ll use it (flow)**

1. Load data → y = load\_yields(); dv01, repo, rd = load\_static\_maps().
2. Pick a basket (e.g., all OATs + EU supras) and optional anchor.
3. tbl = screen\_pairs(y, dv01, repo, rd, basket, anchor="FRTR\_10Y")
4. Take top rows by Score. For the chosen pair, use sigma\_dP to size:

units, notional = size\_trade(target\_daily\_sigma\_eur=200\_000, sigma\_per100=tbl.loc[idx, "sigma\_dP"], carry\_ratio\_bucket=f(R), conviction=4)

(define f(R) as your bucketizing function, e.g., R≤0 →0.75×, 0–0.5→1.0×, 0.5–1.0→1.25×, >1.0→1.5×)

**Notes & knobs you can tune fast**

* **Windows**: start with 120d for z/vol, 252d for LT corr, 60d for ST corr.
* **Horizon** \tau: pick 21d for monthly review; keep consistent when comparing pairs.
* **Funding drag**: if you don’t want to model coupon/dirty price yet, set both dirty prices ≈100 (neutral approximation) or zero out funding and only use **RollDown\_bp\_pa** at first (cleaner).
* **Score weights**: begin with (w1,w2,w3,w4) = (1.0,1.5,0.5,0.5); then backtest.
* **Hedge choice**: DV01-neutral is default. You can also test yield-1:1 hedges as a robustness check.

If you want, I can plug this into your existing CSV layout and return a ready-to-run rv\_screen\_and\_size.ipynb that prints the **Top 10 pairs with full score decomposition** and a **one-click sizing table**.