FinOpt-Workflow

October 19, 2025

1 FinOpt: Complete Workflow Validation

2 Configuration: Seasonality and Contribution

[2]:
```
# --- Seasonality pattern for variable income (12 months, Jan-Dec) ---

# Structure: months = ["Jan", "Feb", "Mar", "Apr", "May", "Jun",
#                       "Jul", "Aug", "Sep", "Oct", "Nov", "Dec"]

seasonality_variable = [0.00, 0.00, 0.00, 1.22, 1.22, 1.16,
                        1.24, 1.10, 0.50, 0.90, 1.00, 1.31]

monthly_contrib_fixed = [0.20, 0.20, 0.20, 0.22, 0.25, 0.25,
                         0.23, 0.23, 0.20, 0.20, 0.20, 0.10]

monthly_contrib_variable = [1.0] * 12

monthly_contribution ={"fixed": monthly_contrib_fixed, "variable":␣
 ↪monthly_contrib_variable}
```

3 Initialize FinancialModel

[3]:
```
# IncomeModel Instantiation
income = IncomeModel(
    fixed=FixedIncome(
        base=1_480_000.0,        # CLP/month
        annual_growth=0.03,      # 3% nominal annual growth
        salary_raises={
            date(2026, 4, 1): 400_000,  # +400k in April 2026
            date(2027, 4, 1): 400_000   # +400k in April 2027
        },
        name="fixed"
    ),
    variable=VariableIncome(
        base=140_000.0,          # Base variable income
        seasonality=seasonality_variable,
        sigma=0.10,              # 10% monthly noise
```

```python
        floor=0.0,                # No negative income
        cap=400_000.0,            # Maximum 400k/month
        annual_growth=0.0,        # No growth in variable
        name="variable"
    ),
    monthly_contribution = monthly_contribution
)

# --- Account configuration ---
accounts = [
    Account.from_annual(
        name="Cuenta Ahorro Vivienda (BE)",
        annual_return=0.025,
        annual_volatility=0.01,
        initial_wealth=0
    ),
    Account.from_annual(
        name="Conservative Clooney (Fintual)",
        annual_return=0.08,
        annual_volatility=0.09,
        initial_wealth=0
    ),
    Account.from_annual(
        name="Moderate Pitt (Fintual)",
        annual_return=0.12,
        annual_volatility=0.13,
        initial_wealth=0
    )
]

# --- Correlation matrix (2x2) ---
# UF portfolio have moderate positive correlation (rho = 0.2)
correlation_matrix = np.array([
    [1.0, 0.0, 0.0],
    [0.0, 1.0, 0.5],
    [0.0, 0.5, 1.0]
])

# --- Initialize FinancialModel ---
model = FinancialModel(income, accounts, default_correlation =␣
 ↪correlation_matrix)
model
```

[3]:
```
FinancialModel(M=3, accounts=['Cuenta Ahorro Vivienda (BE)', 'Conservative
Clooney (Fintual)', 'Moderate Pitt (Fintual)'], cache=enabled)
```

4 Simulation parameters

[4]:
```
# --- Simulation parameters ---
n_sims = 500
months = 48
start_date = date(2025, 10, 1)
```

5 Income Module

Total monthly income at time t is composed of fixed and variable parts:

$$Y_t = y_t^{\text{fixed}} + Y_t^{\text{variable}}$$

5.1 Fixed Income

The fixed component, y_t^{fixed}, reflects a baseline salary subject to compounded annual growth g and scheduled raises d_k, Δ_k (e.g., promotions or tenure milestones):

$$y_t^{\text{fixed}} = \text{current\_salary}(t) \cdot (1+m)^{\Delta t}$$

where $m = (1+g)^{1/12} - 1$ is the **monthly compounded rate**, and Δt represents time since the last raise.

5.2 Variable Income

The variable component, Y_t^{variable}, models irregular income sources (e.g., freelance work or bonuses) with:

- **Seasonality**: $s \in \mathbb{R}^{12}$ (multiplicative monthly factors),
- **Noise**: $\epsilon_t \sim \mathcal{N}(0, \sigma^2)$ (Gaussian shocks),
- **Growth**: same compounded rate m applied to a base income level,
- **Boundaries**: optional floor and cap constraints.

The underlying stochastic projection is:

$$\tilde{Y}_t = \max(\text{floor},\ \mu_t(1+\epsilon_t)), \quad \text{where } \mu_t = \text{base} \cdot (1+m)^t \cdot s_{(t \bmod 12)}$$

Then, guardrails are applied as:

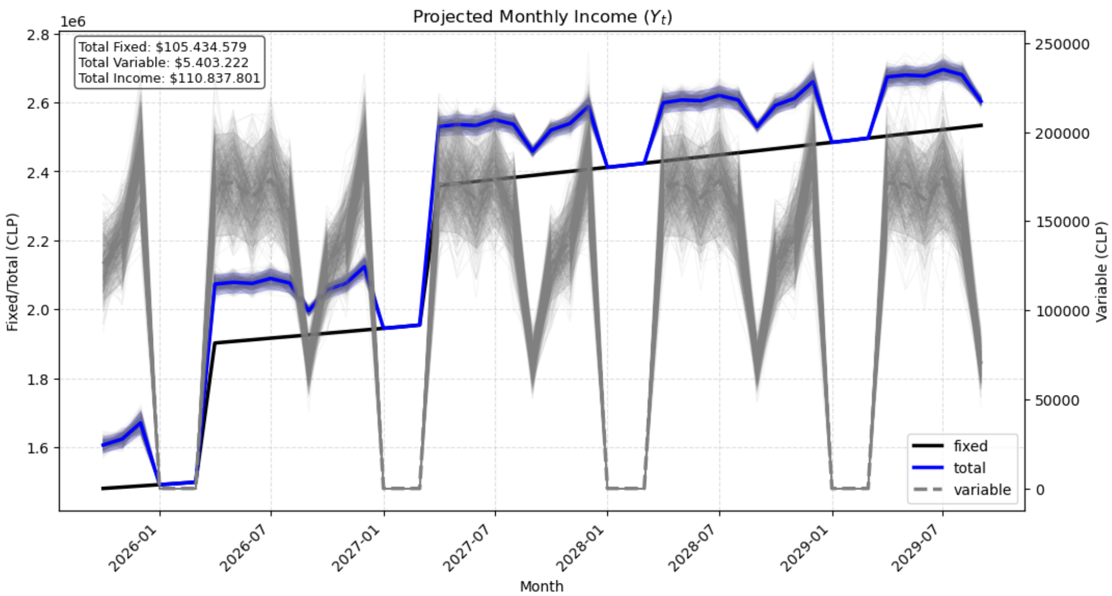
$$Y_t^{\text{variable}} = \begin{cases} 0 & \text{if } \tilde{Y}_t < 0 \\ \tilde{Y}_t & \text{if } 0 \le \tilde{Y}_t \le \text{cap} \\ \text{cap} & \text{if } \tilde{Y}_t > \text{cap} \end{cases}$$

Note: In expectation (ignoring noise truncation), $\mathbb{E}[Y_t] = y_t^{\text{fixed}} + \mu_t$

5.3 Income Projection

Dual-axis plot with: - **Left axis**: Fixed income (deterministic) + Total income - **Right axis**: Variable income (stochastic with trajectories) - **Trajectories**: Individual noise realizations (n=300) - **Confidence band**: 95% CI for variable income

[5]:
```
# Income Projection Simulation
model.plot(mode='income', T=months, start=start_date)
```



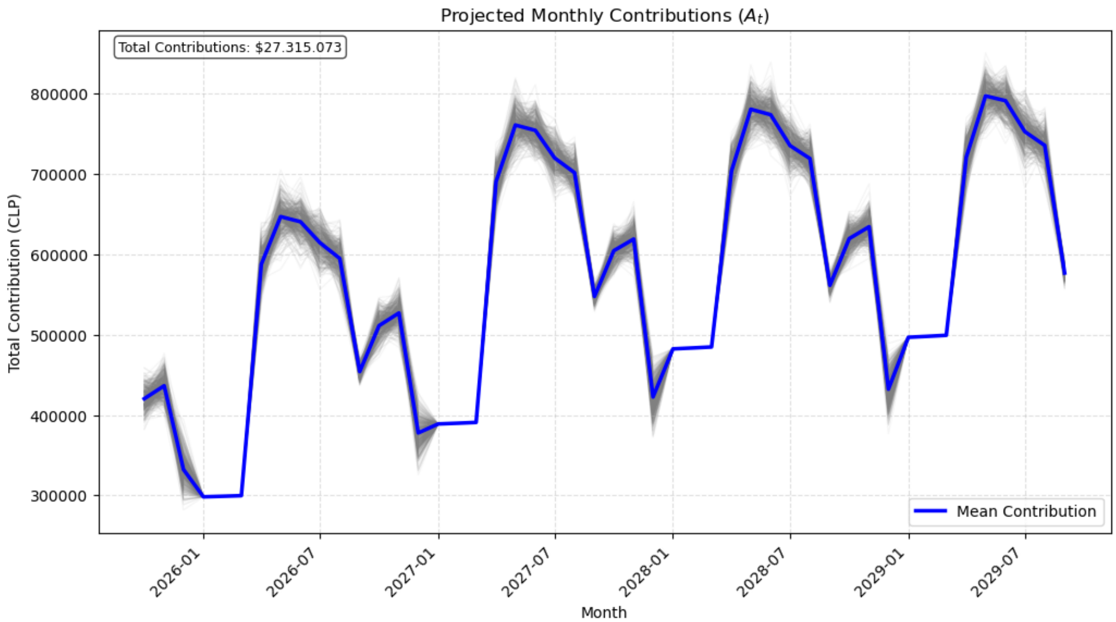
5.4 Contribution Projection

A fraction of income is allocated each month through calendar-rotating schedules:

$$A_t = \alpha^f_{(t \bmod 12)} \cdot y_t^{\text{fixed}} + \alpha^v_{(t \bmod 12)} \cdot Y_t^{\text{variable}}$$

where $\alpha^f, \alpha^v \in [0,1]^{12}$ control the fixed and variable contribution rates by applying the 12-month fractional arrays to projected incomes, rotated according to `start` date and repeated cyclically for horizons > 12 months.

[6]:
```
# Contribution Projection Simulation
model.plot(mode='contributions', T=months, start=start_date)
```



6 Return Module

6.1 Multi-Account Return Model

For M accounts with correlated returns:

$$1 + R_t^m \sim \text{LogNormal}(\mu_{\log}^m, \Sigma)$$

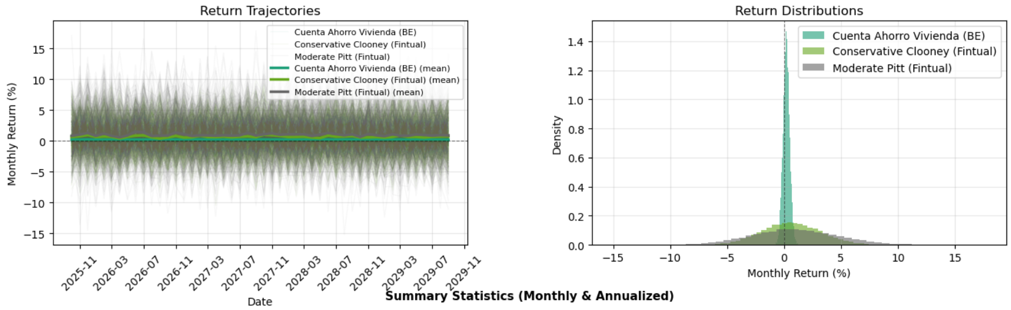
where $\Sigma = D \cdot \rho \cdot D$ is the covariance matrix: - $D = \text{diag}(\sigma_{\log}^1, \ldots, \sigma_{\log}^M)$ - $\rho \in \mathbb{R}^{M \times M}$ is the correlation matrix (symmetric, PSD)

6.2 Monthly Return Distribution (Marginal Analysis)

Visualizes IID monthly returns across both accounts with 4 panels: - **Trajectories**: Individual paths for each account - **Histograms**: Marginal distributions (overlaid) - **Statistics**: Mean, std, quantiles per account

[7]:
```
model.plot(mode = 'returns', T = months, start=start_date)
```

Monthly Return Distributions (R_t^m)



Summary Statistics (Monthly & Annualized)

Account	Mean	Std	Median	IQR (Q25-Q75)	Min	Max
Cuenta Ahorro Vivienda (BE)	0.21%	0.29%	0.21%	[0.01%, 0.40%]	-0.99%	1.41%
↳ *Annualized*	*2.52%*	*1.00%*	*2.49%*	*[0.16%, 4.91%]*	—	—
Conservative Clooney (Fintua	0.65%	2.61%	0.61%	[-1.14%, 2.40%]	-10.56%	11.98%
↳ *Annualized*	*8.05%*	*9.03%*	*7.55%*	*[-12.83%, 32.99%]*	—	—
Moderate Pitt (Fintual)	0.96%	3.75%	0.87%	[-1.60%, 3.47%]	-15.24%	17.85%
↳ *Annualized*	*12.11%*	*13.00%*	*11.01%*	*[-17.64%, 50.66%]*	—	—

T=48 months | n_sims=500 | seed=None

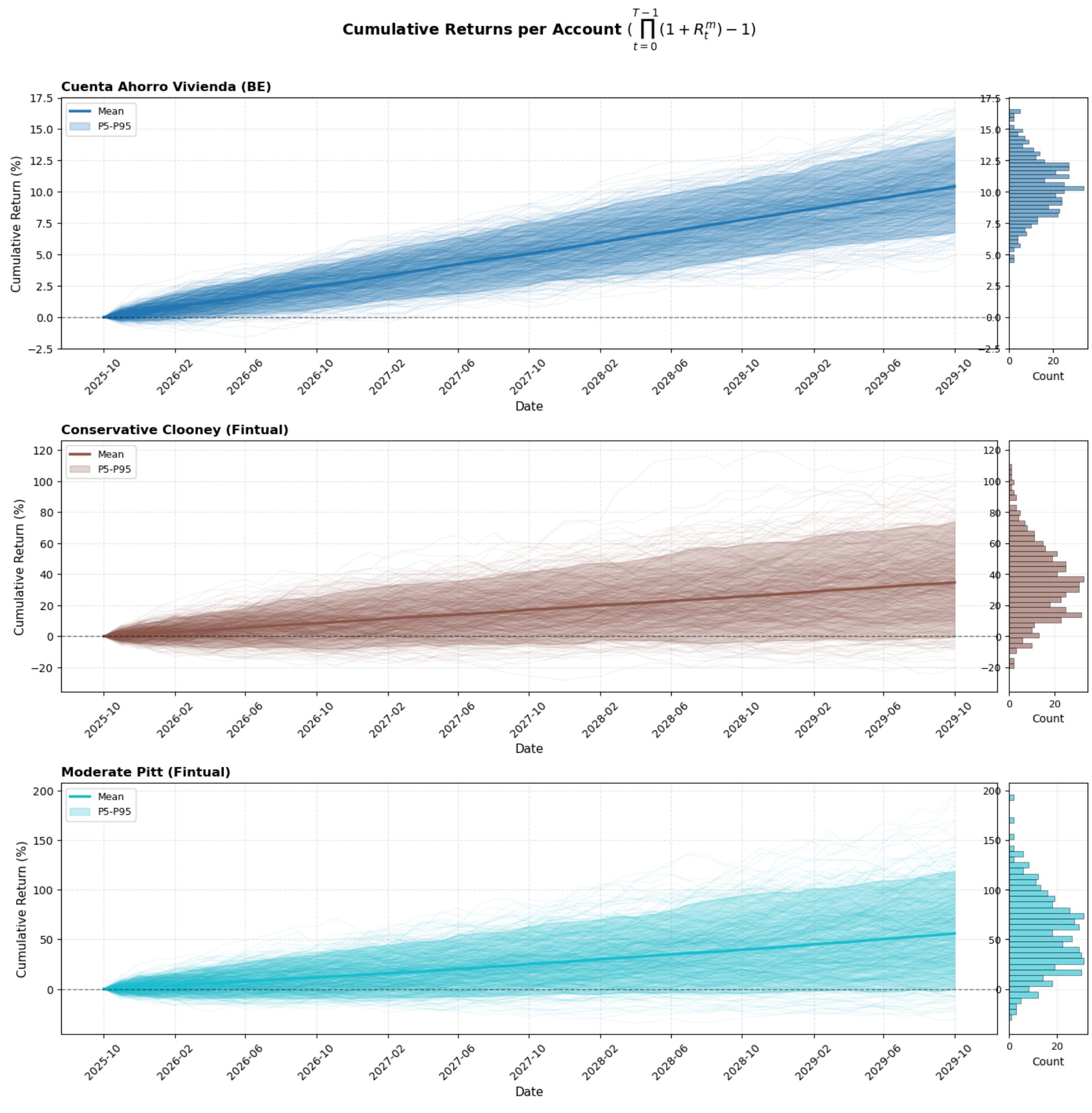
6.3 Cumulative Returns per Account

For M accounts with correlated returns:

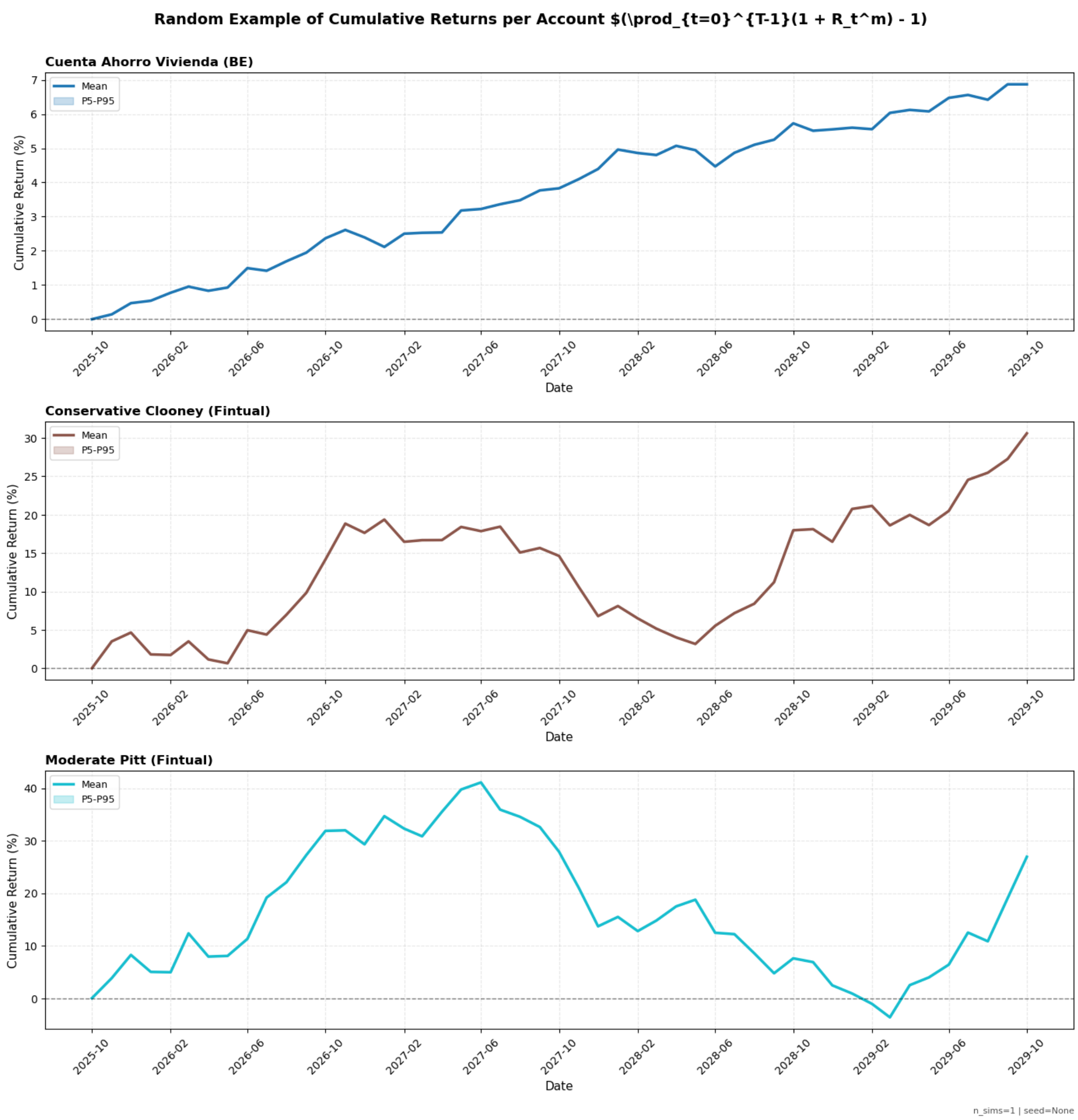
$$R_{\text{cm}}^m(T) = \prod_{t=0}^{T-1}(1 + R_t^m) - 1$$

Cross-sectional correlation persists through time but does not compound.

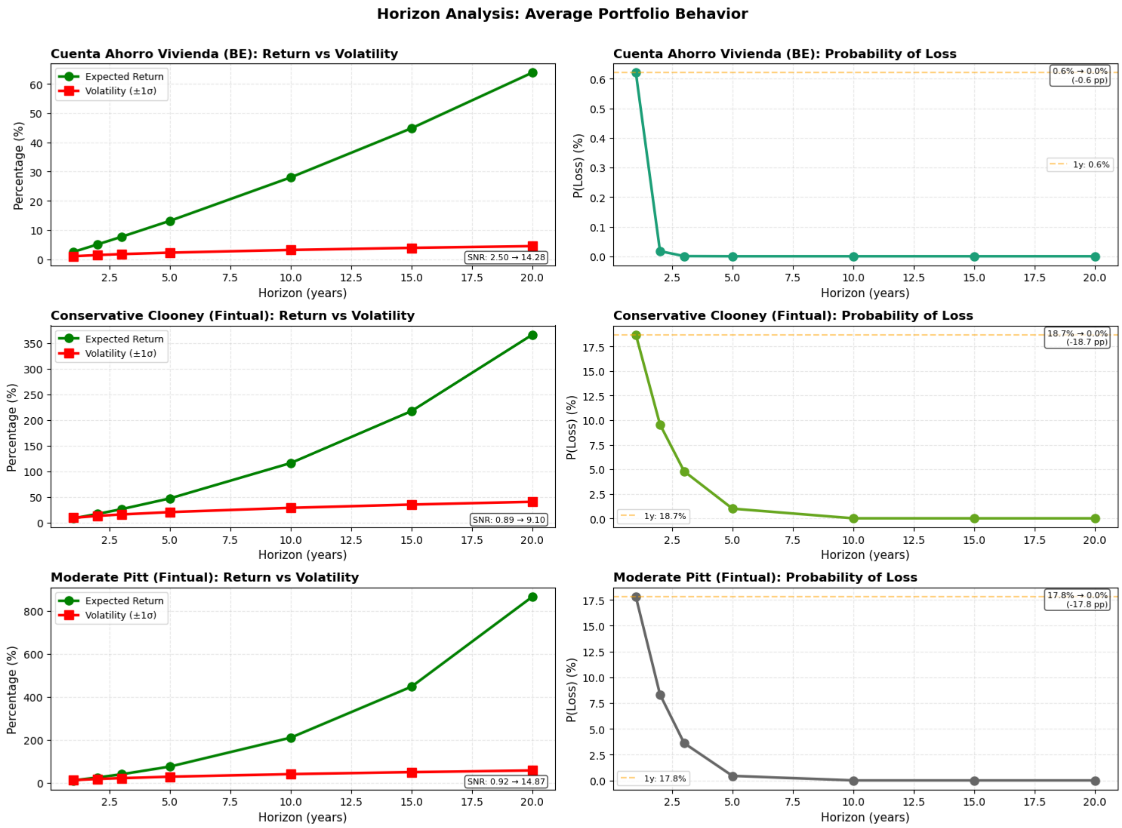
[8]:
```
model.plot(mode = 'returns_cumulative', T = months, start=start_date)
```




```
[9]: model.plot(mode = 'returns_cumulative', T = months, start=start_date, n_sims=1,␣
     ↪title= r'Random Example of Cumulative Returns per Account␣
     ↪$(\prod_{t=0}^{T-1}(1 + R_t^m) - 1)')
```


Random Example of Cumulative Returns per Account $(\prod_{t=0}^{T-1}(1 + R_t^m) - 1)
Cuenta Ahorro Vivienda (BE)
Mean
P5-P95
Cumulative Return (%)
Date
Conservative Clooney (Fintual)
Mean
P5-P95
Cumulative Return (%)
Date
Moderate Pitt (Fintual)
Mean
P5-P95
Cumulative Return (%)
Date
n_sims=1 | seed=None

6.4 Horizon Analysis: Time Diversification by Account



7 Portfolio Module

7.1 Wealth Projection Under Allocation Policy

Recursive dynamics: Wealth evolves as:

$$W_{t+1}^m = (W_t^m + A_t x_t^m)\,(1 + R_t^m)$$

We define $A_t^m = A_t \cdot x_t^m$ which is the contribution allocated to account m via policy $X = \{x_t^m\}_{t,m}$.

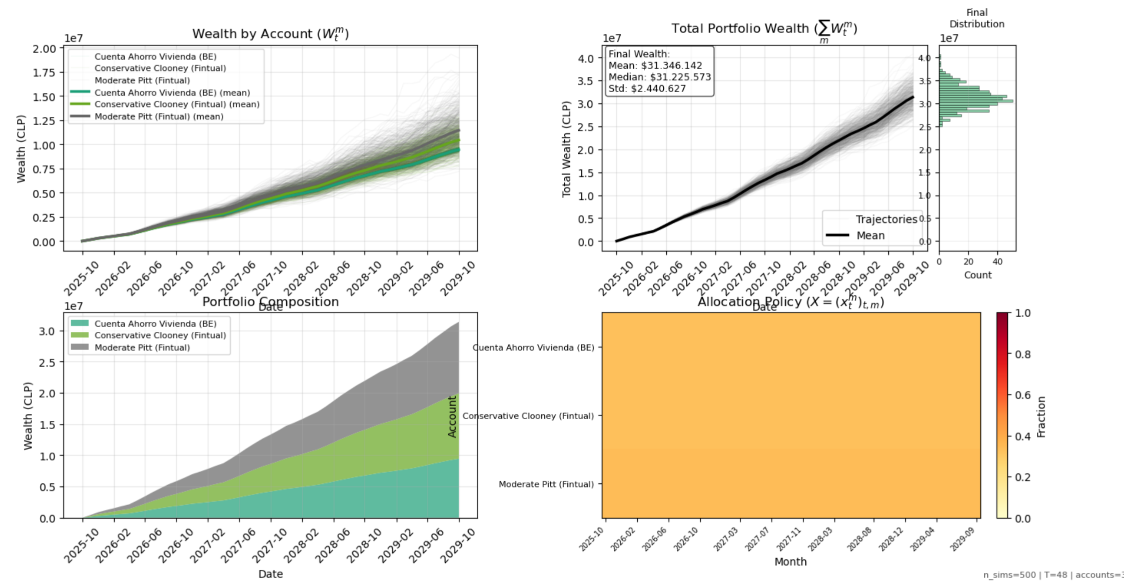
Closed-form representation:

$$W_t^m = W_0^m\, F_{0,t}^m + \sum_{s=0}^{t-1} A_s\, x_s^m\, F_{s,t}^m$$

with accumulation factor $F_{s,t}^m = \prod_{r=s}^{t-1}(1 + R_r^m)$.

Key insight: $W_t^m(X)$ is **linear affine in policy** X → analytical gradients enable convex optimization.

What to observe: - Top-left: wealth per account with Monte Carlo trajectories - Top-right: total wealth + final distribution histogram - Bottom-left: portfolio composition over time - Bottom-right: allocation policy heatmap



8 Goal-Driven Optimization

8.1 Problem Formulation

8.1.1 Non-Convex Chance Constraints

The **bilevel problem** seeks the minimum horizon T^* satisfying all goals:

$$\min_{T \in \mathbb{N}} \; T \; \max_{X \in \in \mathcal{F}_T} \; f(X)$$

where the **goal-feasible set** $\mathcal{F}_T$ contains all policies $X \in \mathcal{X}_T$ satisfying probabilistic constraints:

Intermediate goals (at fixed time $t < T$):

$$\mathbb{P}\big(W_t^m(X) \geq b_t^m\big) \geq 1 - \varepsilon_t^m, \quad \forall g \in \mathcal{G}_{\text{int}}$$

Terminal goals (at horizon T):

$$\mathbb{P}\big(W_T^m(X) \geq b^m\big) \geq 1 - \varepsilon^m, \quad \forall g \in \mathcal{G}_{\text{term}}$$

with decision space (simplex):

$$\mathcal{X}_T = \left\{ X \in \mathbb{R}^{T \times M} : x_t^m \geq 0, \; \sum_{m=1}^{M} x_t^m = 1, \; \forall t = 0, \ldots, T-1 \right\}$$

Challenge: Chance constraints involve indicator functions $\mathbb{1}[\cdot]$, which are discontinuous and non-convex. Standard approaches (MILP, sigmoid smoothing) either scale poorly or find local optima.

8.2 Convex Reformulation via CVaR

8.2.1 CVaR Reformulation: Convex Upper Bound

We replace each chance constraint with a **CVaR constraint** (Rockafellar & Uryasev, 2000):

$$\boxed{\mathbb{P}(W \geq b) \geq 1 - \varepsilon \quad \Longleftarrow \quad \mathrm{CVaR}_\varepsilon(b - W) \leq 0}$$

where the **Conditional Value-at-Risk** of shortfall $L = b - W$ is:

$$\mathrm{CVaR}_\varepsilon(L) = \mathrm{VaR}_\varepsilon(L) + \frac{1}{\varepsilon}\mathbb{E}[(L - \mathrm{VaR}_\varepsilon(L))_+]$$

Epigraphic formulation (convex, suitable for LP solvers):

$$\mathrm{CVaR}_\varepsilon(L) = \min_{\gamma \in \mathbb{R}} \left\{ \gamma + \frac{1}{\varepsilon N} \sum_{i=1}^{N} [L^i - \gamma]_+ \right\}$$

Introducing auxiliary variables $z^i \geq [L^i - \gamma]_+$:

$$\begin{aligned} \mathrm{CVaR}_\varepsilon(L) = \min_{\gamma, z} & \left\{ \gamma + \frac{1}{\varepsilon N} \sum_{i=1}^{N} z^i \right\} \\ \text{s.t.} \quad & z^i \geq L^i - \gamma, \quad \forall i \in [N] \\ & z^i \geq 0, \quad \forall i \in [N] \end{aligned}$$

Key property: If W^i is **affine in** X (as in our wealth dynamics), then $\mathrm{CVaR}_\varepsilon(b - W)$ is **convex in** X.

8.2.2 Mathematical Relationship: Implication, Not Equivalence

Theorem (Rockafellar & Uryasev, 2000):

$$\mathrm{CVaR}_\varepsilon(L) \leq 0 \quad \Longrightarrow \quad \mathbb{P}(L \leq 0) \geq 1 - \varepsilon$$

Proof sketch: CVaR averages the worst ε-tail of the distribution. If this mean is non-positive, then at least $(1 - \varepsilon)$ of scenarios satisfy $L \leq 0$.

The converse is NOT true: $\mathbb{P}(L \leq 0) \geq 1 - \varepsilon$ does NOT imply CVaR ≤ 0 if the tail is heavy.

Interpretation: CVaR is a **conservative approximation** controlling both: 1. **Frequency** of violations (at most $\varepsilon \times 100\%$ scenarios fail) 2. **Severity** of violations (average loss in tail is non-positive)

The original chance constraint only controls frequency.

8.2.3 Convex Reformulated Problem - Multiple Objectives

Inner problem (for fixed T):

$$\begin{aligned}
\max_{X,\gamma,z} \quad & f(X) \\
\text{s.t.} \quad & \sum_{m=1}^{M} x_t^m = 1, \quad \forall t = 0, \dots, T-1 \quad \text{(simplex)} \\
& x_t^m \geq 0, \quad \forall t, m \quad \text{(non-negativity)} \\
& z_g^i \geq (b_g - W_{t_g}^{i,m_g}(X)) - \gamma_g, \quad \forall g, i \quad \text{(epigraph)} \\
& z_g^i \geq 0, \quad \forall g, i \\
& \gamma_g + \frac{1}{\varepsilon_g N} \sum_{i=1}^{N} z_g^i \leq 0, \quad \forall g \quad \text{(CVaR constraint)}
\end{aligned}$$

where: - $W_t^{i,m}(X) = W_0^m F_{0,t,m}^i + \sum_{s=0}^{t-1} A_s^i \cdot x_s^m \cdot F_{s,t,m}^i$ **(affine in X)** - g indexes goals (both intermediate and terminal) - $t_g, m_g, b_g, \varepsilon_g$ are parameters of goal g - $f(X)$ is a convex objective function (see supported objectives below)

Global optimality guaranteed via convex programming (interior-point methods).

8.2.4 Comparison: Original vs. CVaR

Observed conservativeness (empirical): - CVaR constraint: $\text{CVaR}_\varepsilon(L) \leq 0$ - Resulting violation rate: typically $(0.5 - 0.8) \times \varepsilon$ (better than required)

Example (from our results): - Goal: $\mathbb{P}(W_T \geq 1\text{M}) \geq 80\%$ (i.e., $\varepsilon = 20\%$) - CVaR solution: violation rate = 9% (margin of 11%)

The 11% buffer is the "price" of convexity, buying us certified global optimality and numerical stability.

References: - Rockafellar, R.T. & Uryasev, S. (2000). "Optimization of conditional value-at-risk." *Journal of Risk*, 2, 21-42. - Nemirovski, A. & Shapiro, A. (2006). "Convex approximations of chance constrained programs." *SIAM J. Optim.*, 17(4), 969-996.

8.3 Goal Specification

```
======================================================================
FINANCIAL GOALS SUMMARY
======================================================================

1.
   Type: Terminal (horizon T to be optimized)
   Account: Cuenta Ahorro Vivienda (BE)
   Threshold: $6,000,000
   Confidence: 70% ( =30%)
```

```
2.
   Type: Terminal (horizon T to be optimized)
   Account: Conservative Clooney (Fintual)
   Threshold: $5,000,000
   Confidence: 75% ( =25%)

3.
   Type: Terminal (horizon T to be optimized)
   Account: Moderate Pitt (Fintual)
   Threshold: $15,000,000
   Confidence: 70% ( =30%)

4.
   Type: Intermediate (month 24)
   Account: Cuenta Ahorro Vivienda (BE)
   Threshold: $2,200,000
   Confidence: 80% ( =20%)
======================================================================
```

8.4 Bilevel Optimization

8.4.1 Supported Convex Objectives

CVaROptimizer supports 7 convex objectives exploiting affine wealth structure: $W_t^{i,m}(X) = W_0^m F_{0,t,m}^i + \sum_{s=0}^{t-1} A_s^i \cdot x_s^m \cdot F_{s,t,m}^i$

1. terminal_wealth — Growth maximization

$$\max_X \quad \mathbb{E}\left[\sum_{m=1}^{M} W_T^m\right] = \frac{1}{N}\sum_{i=1}^{N}\sum_{m=1}^{M} W_T^{i,m}(X)$$

2. min_cvar — Downside protection

$$\min_{X,\gamma,z} \quad \sum_{g\in\mathcal{G}} \left(\gamma_g + \frac{1}{\varepsilon_g N}\sum_{i=1}^{N} z_g^i\right)$$

3. low_turnover — Tax efficiency (`lambda=0.1`)

$$\max_X \quad \mathbb{E}\left[\sum_{m=1}^{M} W_T^m\right] - \lambda \sum_{t=1}^{T-1}\sum_{m=1}^{M} |x_t^m - x_{t-1}^m|$$

4. risk_adjusted — Markowitz mean-variance (`lambda=0.5`)

$$\max_X \quad \mathbb{E}\left[\sum_{m=1}^{M} W_T^m\right] - \lambda \cdot \mathrm{Var}\left(\sum_{m=1}^{M} W_T^m\right)$$

where $\mathrm{Var}(W_T) = \dfrac{1}{N}\sum_{i=1}^{N}\left(W_T^i - \mathbb{E}[W_T]\right)^2$

5. **balanced** — Multi-objective (`lambda_risk=0.3`, `lambda_turnover=0.05`)

$$\max_{X} \quad \mathbb{E}\left[\sum_{m=1}^{M} W_T^m\right] - \lambda_r \cdot \mathrm{Var}\left(\sum_{m=1}^{M} W_T^m\right) - \lambda_t \sum_{t=1}^{T-1}\sum_{m=1}^{M} |x_t^m - x_{t-1}^m|$$

6. **min_variance** — Capital preservation (`target` **required**)

$$\begin{aligned} \min_{X} \quad & \mathrm{Var}\left(\sum_{m=1}^{M} W_T^m\right) \\ \text{s.t.} \quad & \mathbb{E}\left[\sum_{m=1}^{M} W_T^m\right] \geq W_{\text{target}} \end{aligned}$$

[13]:
```python
# --- Execute Optimization ---

print("\n" + "=" * 70)
print("STARTING BILEVEL OPTIMIZATION")

optimizer = CVaROptimizer(n_accounts=model.M, objective='risk_adjusted')
opt_result = model.optimize(
    goals=goals,
    optimizer=optimizer,
    T_max=120,
    n_sims=300,
    seed=42,
    verbose=True,
    solver='ECOS',  # O 'SCS', 'CLARABEL'
    max_iters=10000
)

print(opt_result.summary())

# Display optimization summary
print("\n" + "=" * 70)
print(opt_result.summary())
print("=" * 70)
```

```
======================================================================
STARTING BILEVEL OPTIMIZATION

=== GoalSeeker: BINARY search T   [24, 120] ===
[Iter 1] Binary search: testing T=72 (range=[24, 120])…

/home/mlioi/anaconda3/envs/finance/lib/python3.11/site-
packages/cvxpy/problems/problem.py:1539: UserWarning: Solution may be
inaccurate. Try another solver, adjusting the solver settings, or solve with
verbose=True for more information.
  warnings.warn(
```

```
    Feasible, obj=-2791158943700.42, time=2.752s

[Iter 2] Binary search: testing T=48 (range=[24, 72])…
    Feasible, obj=-2459398695375.02, time=1.363s

[Iter 3] Binary search: testing T=36 (range=[24, 48])…
    Infeasible, obj=0.00, time=0.136s

[Iter 4] Binary search: testing T=42 (range=[37, 48])…
    Infeasible, obj=0.00, time=0.173s

[Iter 5] Binary search: testing T=45 (range=[43, 48])…
    Feasible, obj=-2845265330067.62, time=0.529s

[Iter 6] Binary search: testing T=44 (range=[43, 45])…
    Infeasible, obj=0.00, time=0.203s

=== Optimal: T*=45 (binary search converged) ===

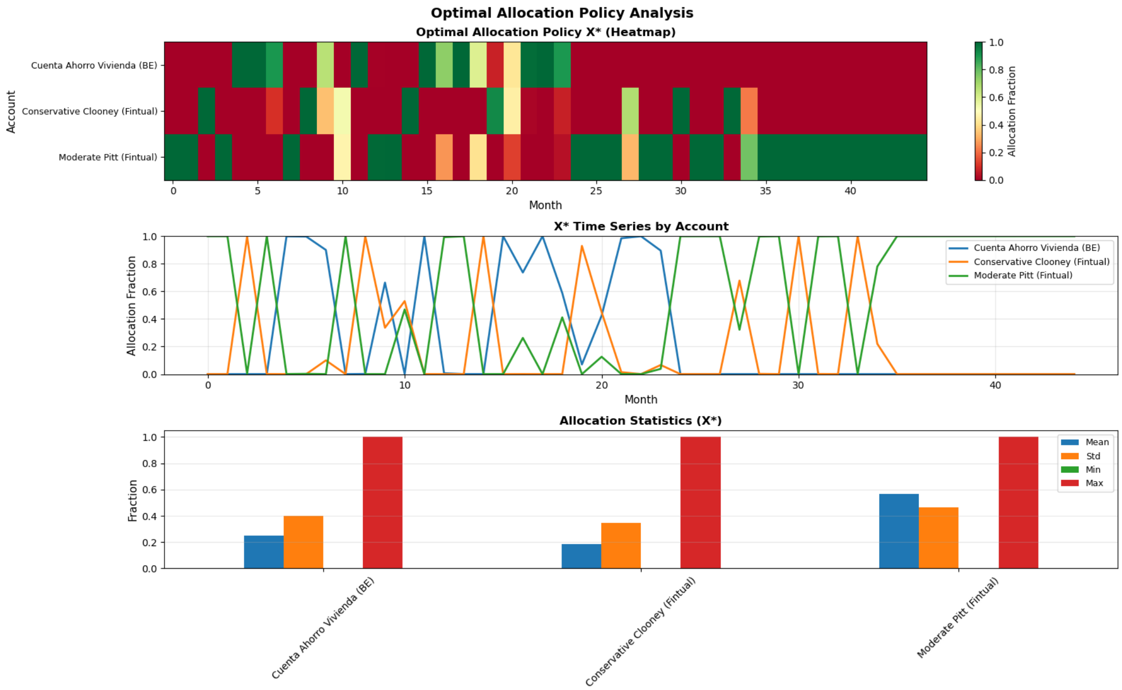
OptimizationResult(
  Status:   Feasible
  Horizon: T=45 months
  Objective: -2845265330067.62
  Goals: 4 (1 intermediate, 3 terminal)
  Solve time: 0.529s
  Iterations: 0
)

======================================================================
OptimizationResult(
  Status:   Feasible
  Horizon: T=45 months
  Objective: -2845265330067.62
  Goals: 4 (1 intermediate, 3 terminal)
  Solve time: 0.529s
  Iterations: 0
)
======================================================================
```

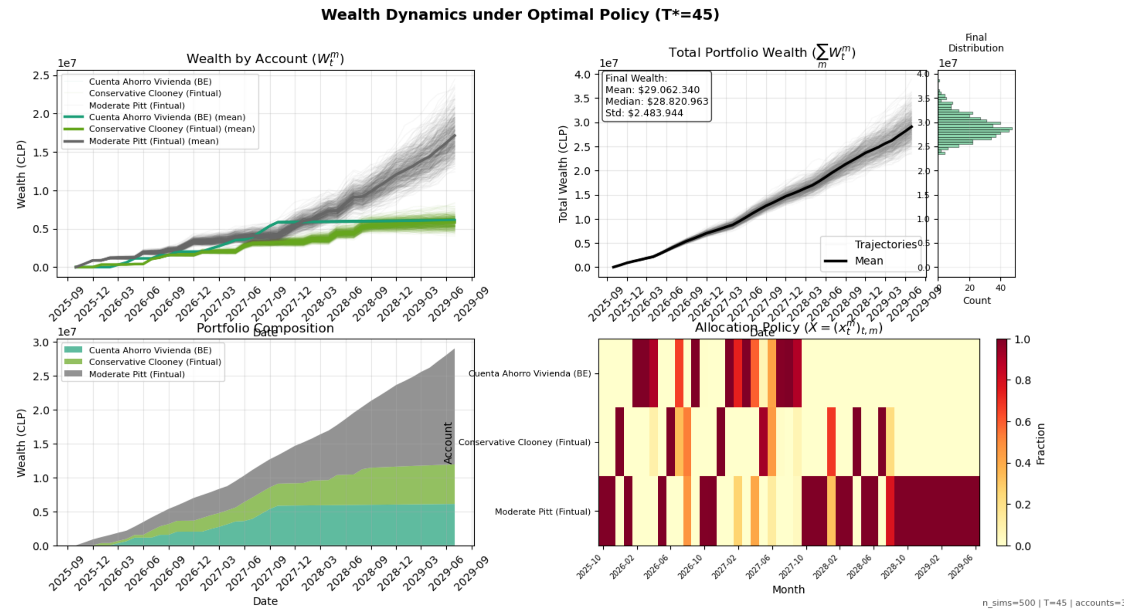
[14]:
```
optimizer.objective
```

[14]:
```
'risk_adjusted'
```

8.5 Optimal Policy Analysis




```
=====================================================================
OPTIMAL ALLOCATION SUMMARY
=====================================================================
                                Mean    Std  Min  Max
Cuenta Ahorro Vivienda (BE)    0.250  0.402  0.0  1.0
Conservative Clooney (Fintual)  0.185  0.347  0.0  1.0
Moderate Pitt (Fintual)        0.565  0.467  0.0  1.0
=====================================================================
```



8.6 Goal Verification

8.6.1 In-Sample Verification

```
======================================================================
GOAL VERIFICATION: IN-SAMPLE
======================================================================
Using optimization scenarios (n=300, seed=42)
Expected: All goals satisfied ( )

  Account: Cuenta Ahorro Vivienda (BE)
  Threshold: $6,000,000
  Confidence: 70%
  ---
  Status:   SATISFIED
  Violation rate: 12.33% (required   30.00%)
  Margin: 17.67%
  Median shortfall: $29,467
  N violations: 37 / 300
  Account: Conservative Clooney (Fintual)
  Threshold: $5,000,000
  Confidence: 75%
  ---
  Status:   SATISFIED
  Violation rate: 10.67% (required   25.00%)
  Margin: 14.33%
  Median shortfall: $233,420
  N violations: 32 / 300
```

```
  Account: Moderate Pitt (Fintual)
  Threshold: $15,000,000
  Confidence: 70%
  ---
  Status:  SATISFIED
  Violation rate: 14.33% (required  30.00%)
  Margin: 15.67%
  Median shortfall: $575,870
  N violations: 43 / 300
  Account: Cuenta Ahorro Vivienda (BE)
  Month: 24
  Threshold: $2,200,000
  Confidence: 80%
  ---
  Status:  SATISFIED
  Violation rate: 0.00% (required  20.00%)
  Margin: 20.00%
  Median shortfall: $0
  N violations: 0 / 300

======================================================================
```

8.6.2 Out-of-Sample Verification

```
======================================================================
GOAL VERIFICATION: OUT-OF-SAMPLE
======================================================================
Using fresh scenarios (n=1000, seed=999)
Expected: All goals satisfied with safety margin

  Account: Cuenta Ahorro Vivienda (BE)
  Threshold: $6,000,000
  Confidence: 70%
  ---
  Status:  SATISFIED
  Violation rate: 13.10% (required  30.00%)
  Margin: 16.90%
  Median shortfall: $33,620
  N violations: 131 / 1000
  Account: Conservative Clooney (Fintual)
  Threshold: $5,000,000
  Confidence: 75%
  ---
  Status:  SATISFIED
  Violation rate: 10.90% (required  25.00%)
  Margin: 14.10%
  Median shortfall: $194,851
```

```
  N violations: 109 / 1000
  Account: Moderate Pitt (Fintual)
  Threshold: $15,000,000
  Confidence: 70%
  ---
  Status:  SATISFIED
  Violation rate: 13.80% (required  30.00%)
  Margin: 16.20%
  Median shortfall: $593,255
  N violations: 138 / 1000
  Account: Cuenta Ahorro Vivienda (BE)
  Month: 24
  Threshold: $2,200,000
  Confidence: 80%
  ---
  Status:  SATISFIED
  Violation rate: 0.00% (required  20.00%)
  Margin: 20.00%
  Median shortfall: $0
  N violations: 0 / 1000

======================================================================

======================================================================
IN-SAMPLE vs OUT-OF-SAMPLE COMPARISON
======================================================================
   In-Sample (n=300)  Out-of-Sample (n=1000)  Required ( )
0             0.1233                   0.131          0.30
1             0.1067                   0.109          0.25
2             0.1433                   0.138          0.30
3             0.0000                   0.000          0.20
======================================================================

[NbConvertApp] Converting notebook FinOpt-Workflow.ipynb to pdf
[NbConvertApp] Support files will be in FinOpt-Workflow_files/
[NbConvertApp] Making directory ./FinOpt-Workflow_files
[NbConvertApp] Writing 56166 bytes to notebook.tex
[NbConvertApp] Building PDF
[NbConvertApp] Running xelatex 3 times: ['xelatex', 'notebook.tex', '-quiet']
[NbConvertApp] Running bibtex 1 time: ['bibtex', 'notebook']
[NbConvertApp] WARNING | bibtex had problems, most likely because there were no
citations
[NbConvertApp] PDF successfully created
[NbConvertApp] Writing 2254492 bytes to FinOpt-Workflow.pdf

[NbConvertApp] Converting notebook FinOpt-Workflow.ipynb to html
[NbConvertApp] WARNING | Alternative text is missing on 9 image(s).
[NbConvertApp] Writing 3677141 bytes to FinOpt-Workflow.html
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[ ]:
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