FinOpt-Workflow

November 10, 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, 0.6, 1, 1.16,
                        1, 1.10, 0.50, 0.90, 0.85, 1]

monthly_contrib_fixed = [0.45, 0.45, 0.45, 0.45, 0.45, 0.45,
                         0.45, 0.45, 0.45, 0.45, 0.45, 0.3]

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_488_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, 6, 1): 400_000,   # +400k in Jun 2027
            date(2028, 6, 1): 300_000   # +300k in Jun 2028
        },
        name="fixed"
    ),
    variable=VariableIncome(
        base=60_000.0,         # Base variable income
        seasonality=seasonality_variable,
```

```
        sigma=0.10,             # 10% monthly noise
        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=1600000
    ),
    Account.from_annual(
        name="Conservative Clooney (Fintual)",
        annual_return=0.08,
        annual_volatility=0.09,
        initial_wealth=744747
    ),
    Account.from_annual(
        name="Risky Norris (Fintual)",
        annual_return=0.14,
        annual_volatility=0.15,
        initial_wealth=900000
    )
]

# --- 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)', 'Risky Norris (Fintual)'], cache=enabled)
```

4 Simulation parameters

[4]:
```
# --- Simulation parameters ---
n_sims = 500
months = 26
start_date = date(2025, 11, 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:

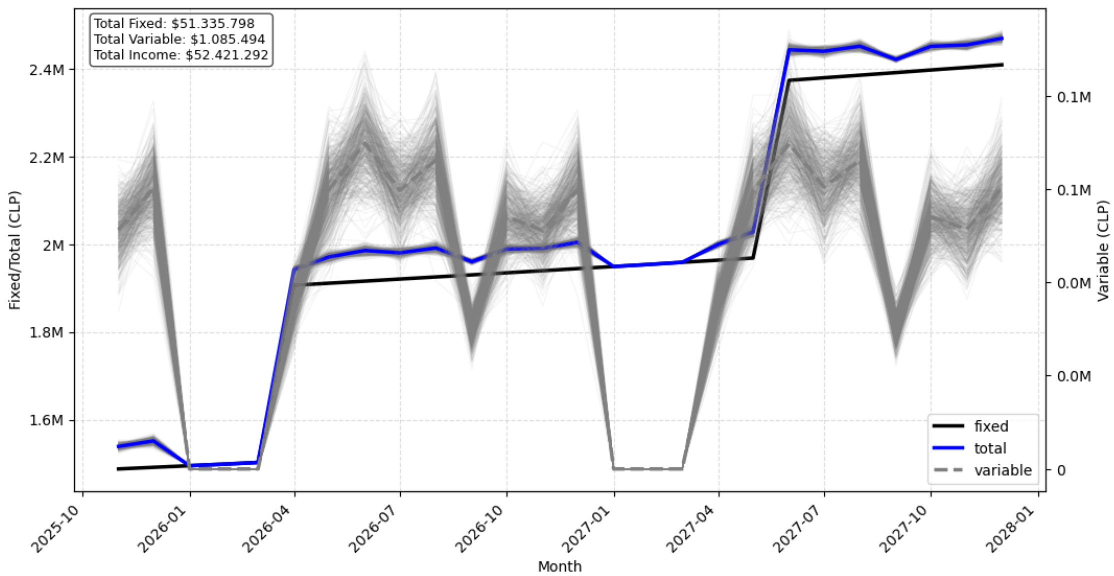
$$Y_t^{\text{variable}} = \begin{cases} 0 & \text{if } \tilde{Y}_t < 0 \\ \tilde{Y}_t & \text{if } 0 \le \tilde{Y}_t \le \text{cap} \\ \text{cap} & \text{if } \tilde{Y}_t > \text{cap} \end{cases}$$

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



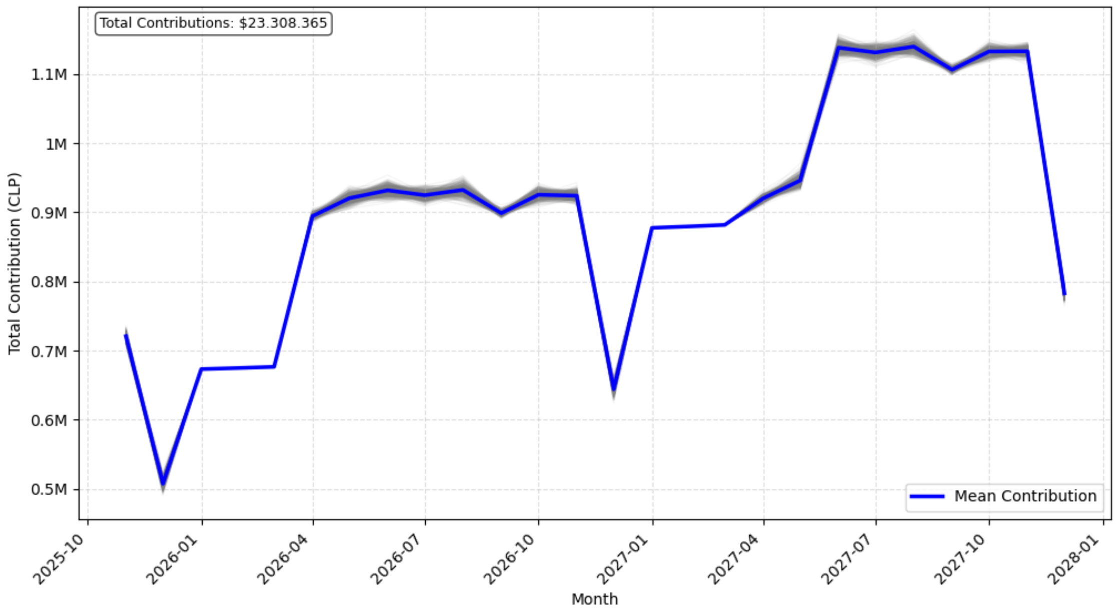
5.4 Contribution Projection

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

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

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]:
```python
# 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:

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

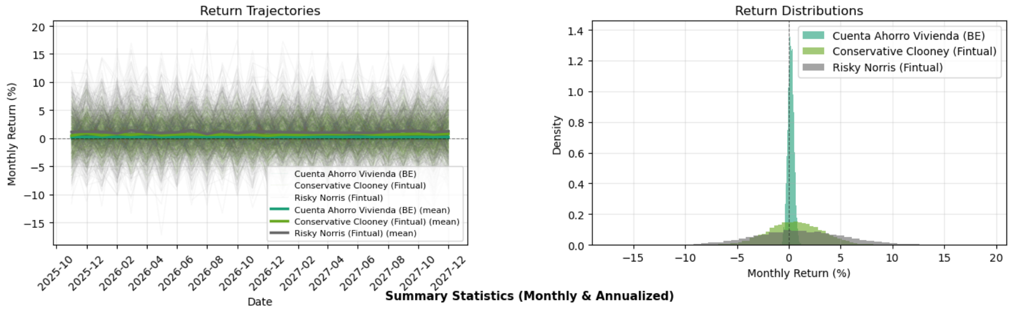
where $\Sigma = D \cdot \rho \cdot D$ is the covariance matrix: - $D = \text{diag}(\sigma_{\text{log}}^1, \ldots, \sigma_{\text{log}}^M)$ - $\rho \in \mathbb{R}^{M \times M}$ is the correlation matrix (symmetric, PSD)

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%]	-0.89%	1.61%
↳ *Annualized*	*2.49%*	*1.01%*	*2.51%*	*[0.09%, 4.91%]*	—	—
Conservative Clooney (Fintua	0.65%	2.60%	0.62%	[-1.13%, 2.40%]	-8.35%	10.86%
↳ *Annualized*	*8.12%*	*9.02%*	*7.69%*	*[-12.72%, 32.98%]*	—	—
Risky Norris (Fintual)	1.09%	4.37%	0.97%	[-1.89%, 3.99%]	-17.20%	19.15%
↳ *Annualized*	*13.89%*	*15.14%*	*12.25%*	*[-20.48%, 59.93%]*	—	—

T=26 months | n_sims=500 | seed=None

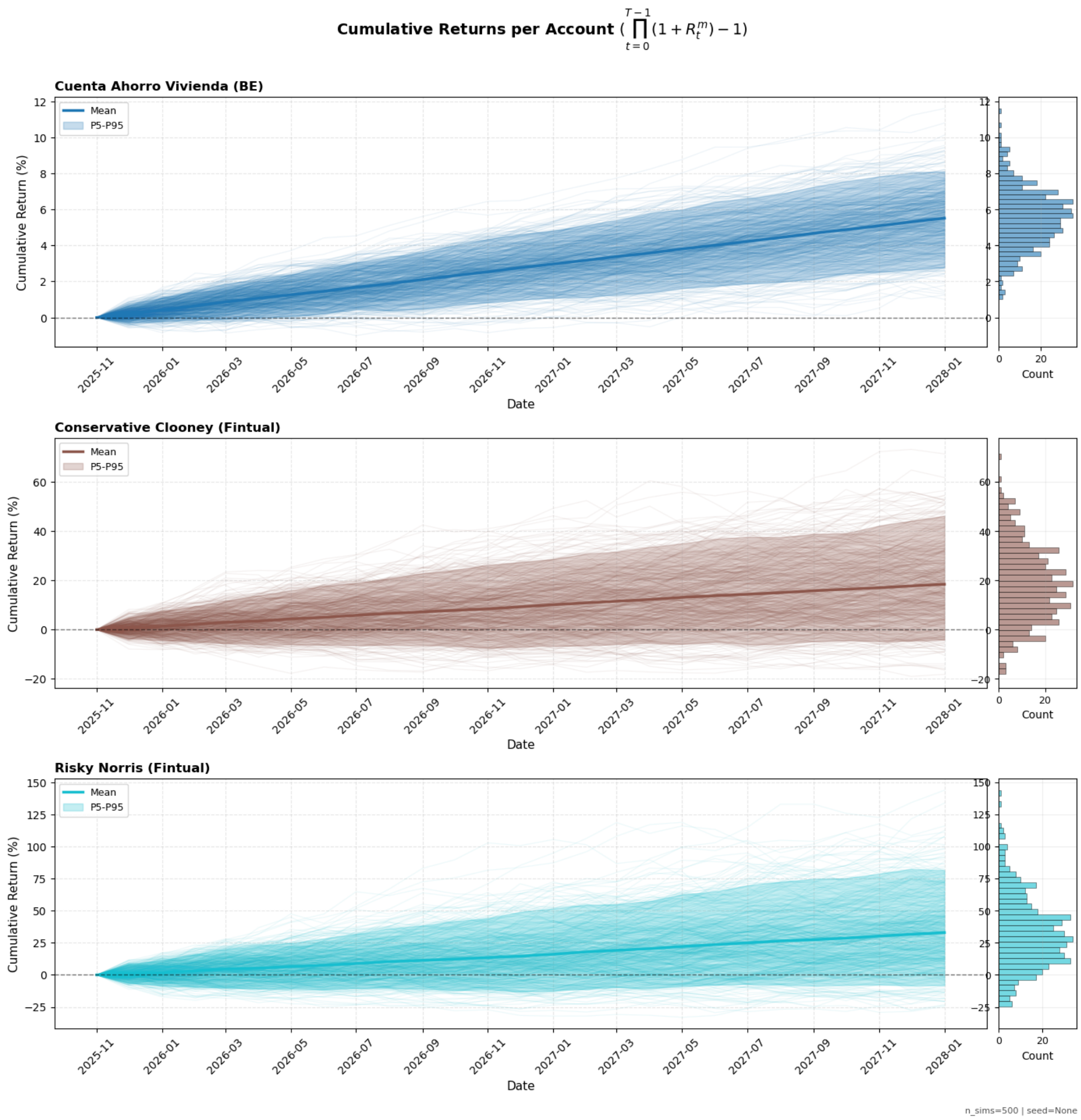
6.3 Cumulative Returns per Account

For M accounts with correlated returns:

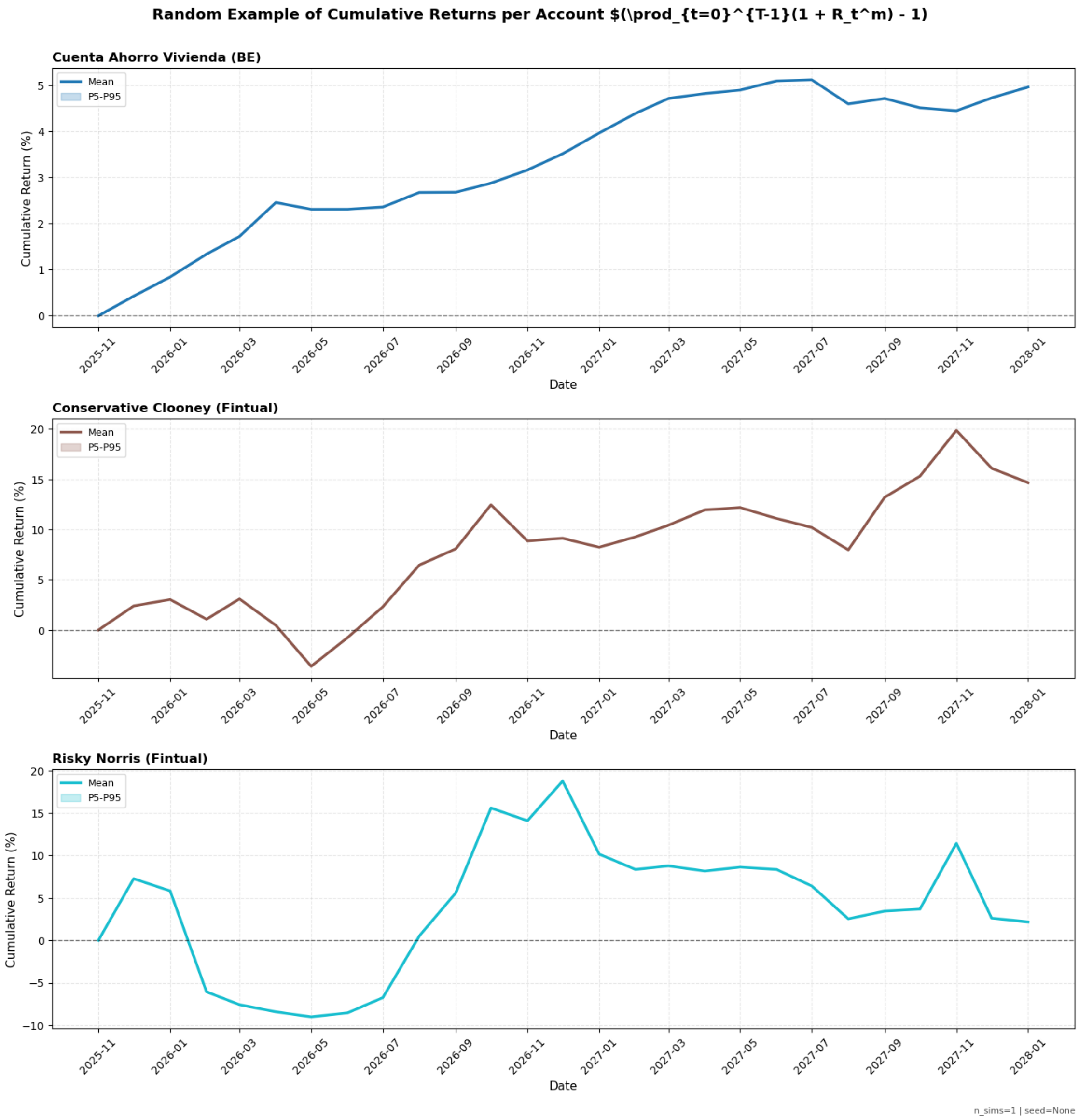
$$R_{\mathrm{cm}}^m(T) = \prod_{t=0}^{T-1}(1 + R_t^m) - 1$$

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

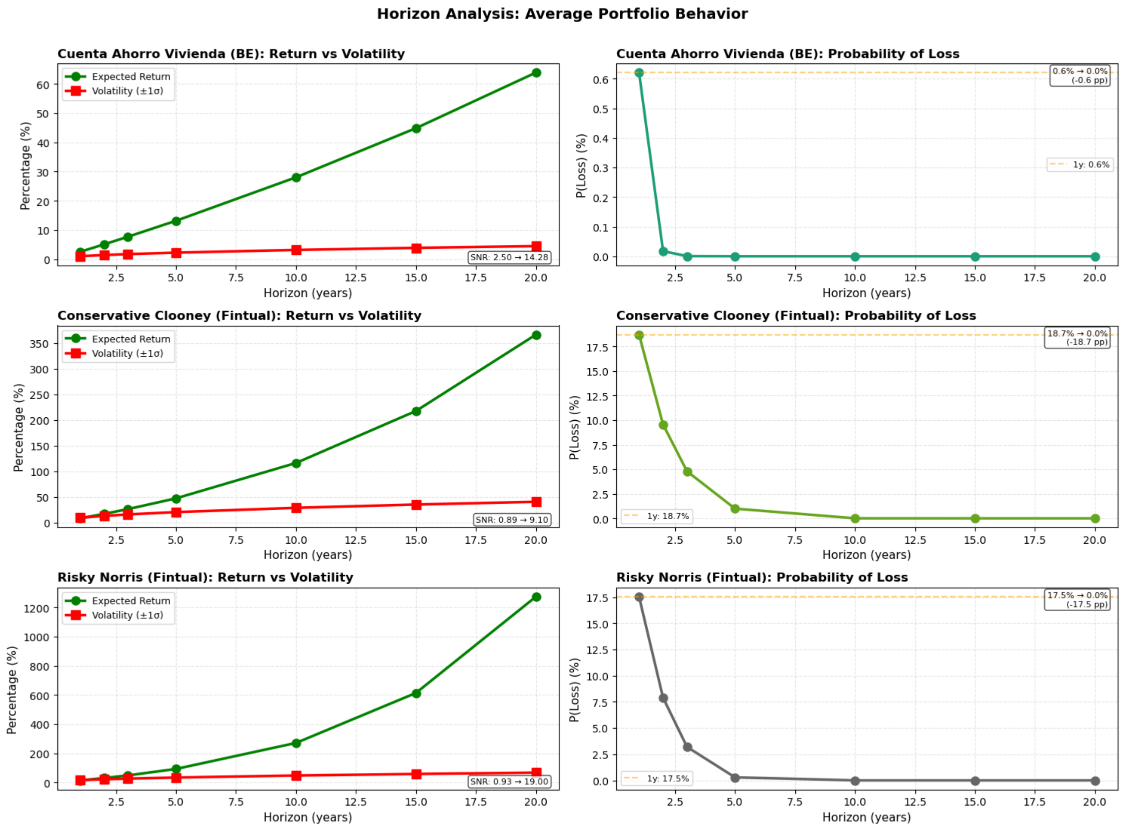
[8]:
```
model.plot(mode = 'returns_cumulative', T = months, start=start_date)
```




```
[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)
Conservative Clooney (Fintual)
Risky Norris (Fintual)
Mean
P5-P95
Cumulative Return (%)
Date
2025-11
2026-01
2026-03
2026-05
2026-07
2026-09
2026-11
2027-01
2027-03
2027-05
2027-07
2027-09
2027-11
2028-01
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:

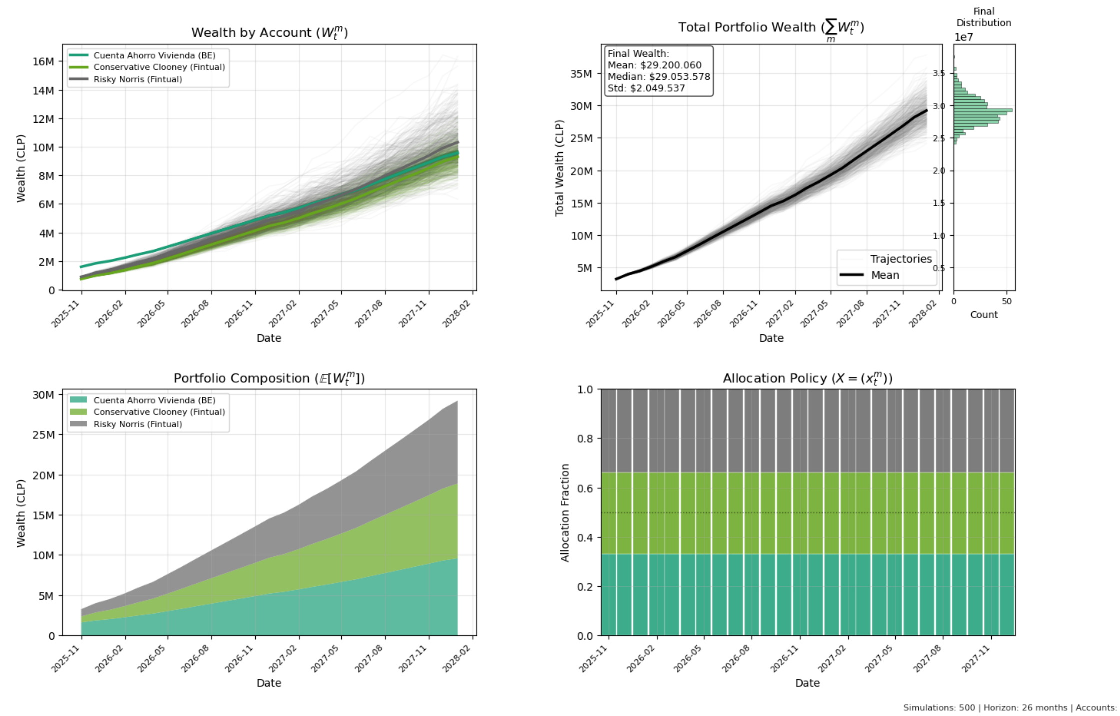
$$W_t^m = W_0^m\, F_{0,t}^m + \sum_{s=0}^{t-1} A_s\, x_s^m\, F_{s,t}^m$$

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

```
/home/mlioi/fin-opt/src/portfolio.py:1148: UserWarning: This figure includes
Axes that are not compatible with tight_layout, so results might be incorrect.
  fig.tight_layout(rect=[0, 0.01, 1, 0.96 if title else 1])
```



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):

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

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.

8.3 Goal Specification

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

1.
```

```
   Type: Terminal (horizon T to be optimized)
   Account: Conservative Clooney (Fintual)
   Threshold: $5,000,000
   Minimum Confidence: 50% ( =50%)

2.
   Type: Terminal (horizon T to be optimized)
   Account: Risky Norris (Fintual)
   Threshold: $15,000,000
   Minimum Confidence: 50% ( =50%)

3.
   Type: Intermediate (month 6)
   Account: Cuenta Ahorro Vivienda (BE)
   Threshold: $3,100,000
   Minimum Confidence: 50% ( =50%)

4.
   Type: Intermediate (month 18)
   Account: Conservative Clooney (Fintual)
   Threshold: $3,000,000
   Minimum Confidence: 50% ( =50%)
======================================================================
```

8.4 Bilevel Optimization

8.4.1 Supported Convex Objectives

CVaROptimizer supports 7 convex objectives exploiting affine wealth structure: Consider $W_t^{i,m}(X) = W_0^m F_{0,t,m}^i + \sum_{s=0}^{t-1} A_s^i \cdot x_s^m \cdot F_{s,t,m}^i$ and $\mathbb{E}\left[\sum_{m=1}^M W_T^m\right] = \frac{1}{N}\sum_{i=1}^N \sum_{m=1}^M W_T^{i,m}(X)$.

1. risky — Growth maximization

$$\max_X \quad \mathbb{E}\left[\sum_{m=1}^M W_T^m\right]$$

2. balanced — Equal contribution across time

$$\max_X \quad -\sum_{t=1}^{T-1}\sum_{m=1}^M (x_t^m - x_{t-1}^m)^2$$

3. risky_turnover — Growth maximization with penalty over contributions across time

$$\max_X \quad \mathbb{E}\left[\sum_{m=1}^M W_T^m\right] - \sum_{t=1}^{T-1}\sum_{m=1}^M (x_t^m - x_{t-1}^m)^2$$

4. conservative — Minimize variance, chose conservative portfolio

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

[43]:
```python
# --- Execute Optimization ---

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

objective_params = {'lambda' : 50000}
optimizer = CVaROptimizer(n_accounts=model.M, objective='balanced',␣
 ↪objective_params=objective_params)
opt_result = model.optimize(
    goals=goals,
    optimizer=optimizer,
    T_max=120,
    n_sims=400,
    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   [18, 120] ===
[Iter 1] Binary search: testing T=69 (range=[18, 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=-0.00, time=0.755s

[Iter 2] Binary search: testing T=43 (range=[18, 69])…
     Feasible, obj=-0.00, time=0.353s

[Iter 3] Binary search: testing T=30 (range=[18, 43])…
     Feasible, obj=-0.01, time=0.122s

[Iter 4] Binary search: testing T=24 (range=[18, 30])…
     Feasible, obj=-0.20, time=9.364s
```

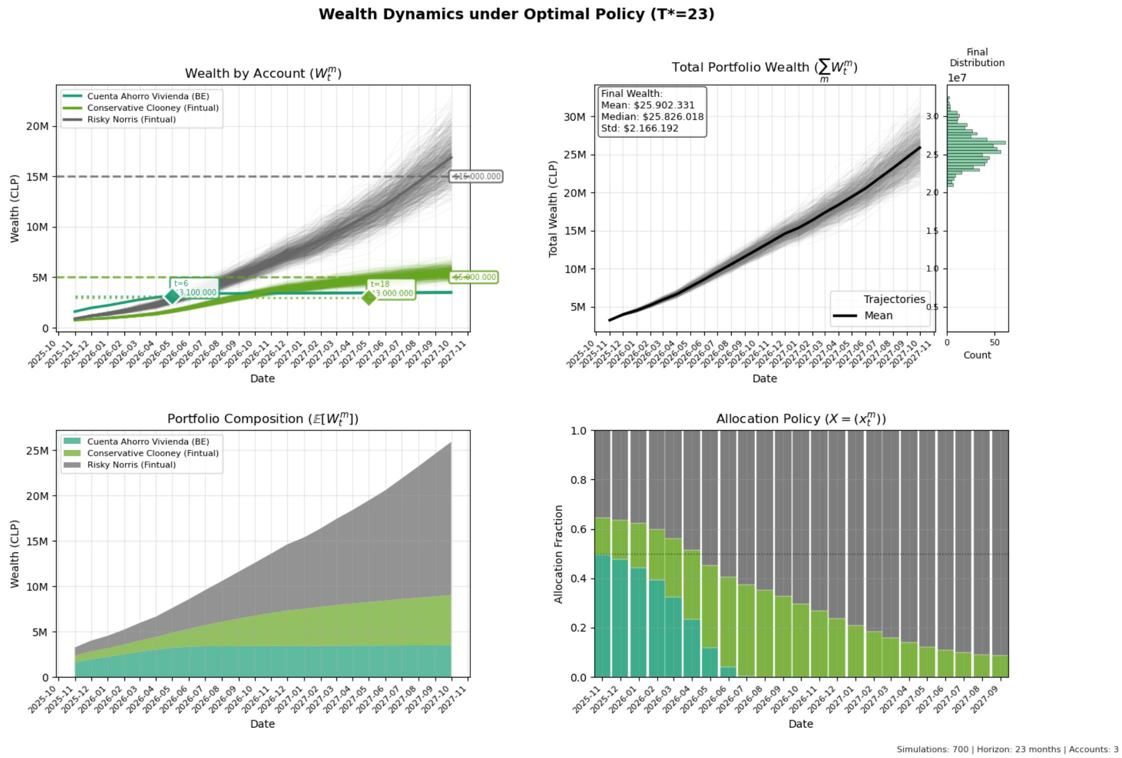
```
[Iter 5] Binary search: testing T=21 (range=[18, 24])…
     Infeasible, obj=0.00, time=0.149s

[Iter 6] Binary search: testing T=23 (range=[22, 24])…
     Feasible, obj=-0.07, time=8.518s

[Iter 7] Binary search: testing T=22 (range=[22, 23])…
     Infeasible, obj=0.00, time=0.291s

=== Optimal: T*=23 (binary search converged) ===

OptimizationResult(
  Status:   Feasible
  Horizon: T=23 months
  Objective: -0.07
  Goals: 4 (2 intermediate, 2 terminal)
  Solve time: 8.518s
  Iterations: 0
)

======================================================================
OptimizationResult(
  Status:   Feasible
  Horizon: T=23 months
  Objective: -0.07
  Goals: 4 (2 intermediate, 2 terminal)
  Solve time: 8.518s
  Iterations: 0
)
======================================================================
```

[44]:
```python
optimizer.objective
```

[44]:
```
'balanced'
```

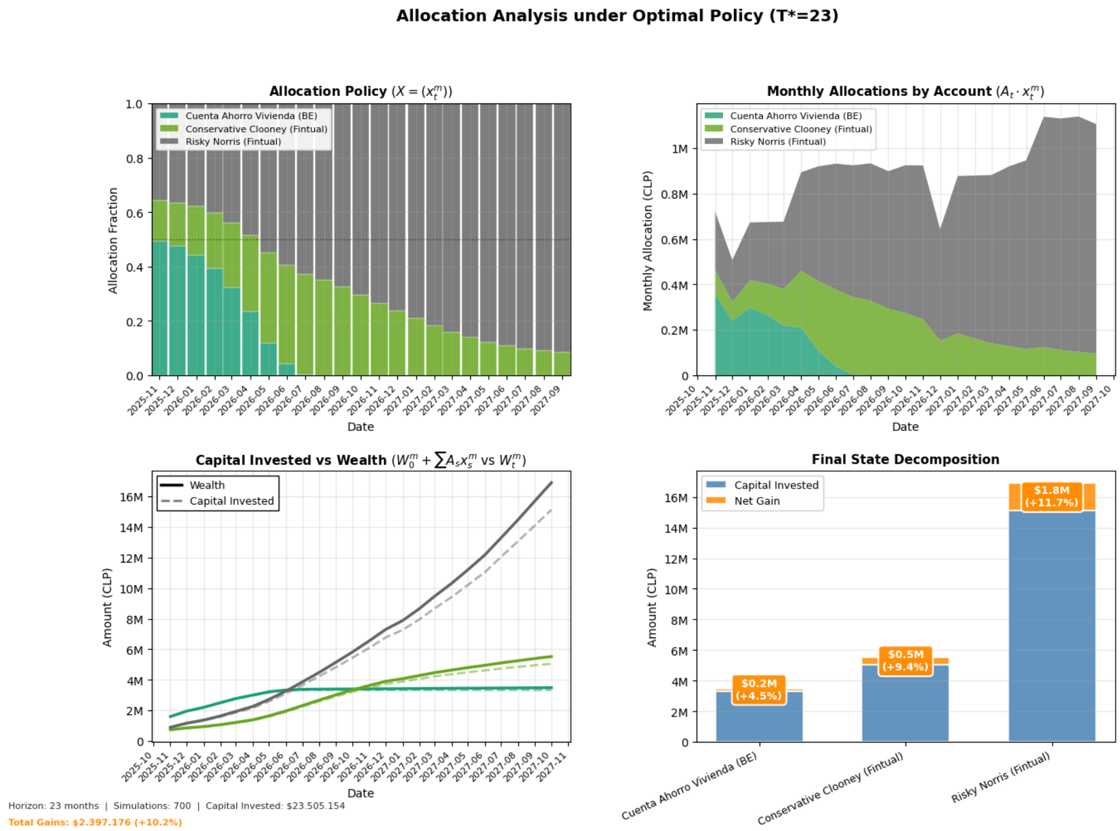
8.5 Optimal Policy Analysis

```
/home/mlioi/fin-opt/src/portfolio.py:1148: UserWarning: This figure includes
Axes that are not compatible with tight_layout, so results might be incorrect.
  fig.tight_layout(rect=[0, 0.01, 1, 0.96 if title else 1])
```



[46]:
```python
# Plot allocation analysis with investment gains
model.plot(
    mode='allocation',
    result=opt_sim,
    X=opt_result.X,
    title=f"Allocation Analysis under Optimal Policy (T*={opt_result.T})",
    show_trajectories=False
)
```

```
/home/mlioi/fin-opt/src/model.py:1895: UserWarning: This figure includes Axes
that are not compatible with tight_layout, so results might be incorrect.
  fig.tight_layout(rect=[0, 0.05, 1, 0.97 if title else 0.99])
```



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: Conservative Clooney (Fintual)
  Threshold: $5,000,000
  Minimum Confidence: 50%
  ---
  Status:   SATISFIED
  Violation rate: 20.00% (required   50.00%)
  Margin: 30.00%
  Median shortfall: $142,229
  N violations: 60 / 300
  Account: Risky Norris (Fintual)
  Threshold: $15,000,000
  Minimum Confidence: 50%
```

```
  ---
  Status:  SATISFIED
  Violation rate: 10.67% (required  50.00%)
  Margin: 39.33%
  Median shortfall: $858,666
  N violations: 32 / 300
  Account: Cuenta Ahorro Vivienda (BE)
  Month: 6
  Threshold: $3,100,000
  Minimum Confidence: 50%
  ---
  Status:  SATISFIED
  Violation rate: 33.67% (required  50.00%)
  Margin: 16.33%
  Median shortfall: $10,347
  N violations: 101 / 300
  Account: Conservative Clooney (Fintual)
  Month: 18
  Threshold: $3,000,000
  Minimum Confidence: 50%
  ---
  Status:  SATISFIED
  Violation rate: 19.00% (required  50.00%)
  Margin: 31.00%
  Median shortfall: $73,644
  N violations: 57 / 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: Conservative Clooney (Fintual)
  Threshold: $5,000,000
  Minimum Confidence: 50%
  ---
  Status:  SATISFIED
  Violation rate: 24.30% (required  50.00%)
  Margin: 25.70%
  Median shortfall: $119,661
  N violations: 243 / 1000
  Account: Risky Norris (Fintual)
```

```
  Threshold: $15,000,000
  Minimum Confidence: 50%
  ---
  Status:   SATISFIED
  Violation rate: 10.60% (required   50.00%)
  Margin: 39.40%
  Median shortfall: $514,734
  N violations: 106 / 1000
  Account: Cuenta Ahorro Vivienda (BE)
  Month: 6
  Threshold: $3,100,000
  Minimum Confidence: 50%
  ---
  Status:   SATISFIED
  Violation rate: 27.40% (required   50.00%)
  Margin: 22.60%
  Median shortfall: $9,355
  N violations: 274 / 1000
  Account: Conservative Clooney (Fintual)
  Month: 18
  Threshold: $3,000,000
  Minimum Confidence: 50%
  ---
  Status:   SATISFIED
  Violation rate: 22.30% (required   50.00%)
  Margin: 27.70%
  Median shortfall: $74,219
  N violations: 223 / 1000

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

======================================================================
IN-SAMPLE vs OUT-OF-SAMPLE COMPARISON
======================================================================
   In-Sample (n=300)  Out-of-Sample (n=1000)  Required ( )
0             0.2000                   0.243          0.5
1             0.1067                   0.106          0.5
2             0.3367                   0.274          0.5
3             0.1900                   0.223          0.5
======================================================================

[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 55069 bytes to notebook.tex
[NbConvertApp] Building PDF
[NbConvertApp] Running xelatex 3 times: ['xelatex', 'notebook.tex', '-quiet']
[NbConvertApp] Running bibtex 1 time: ['bibtex', 'notebook']
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[NbConvertApp] WARNING | bibtex had problems, most likely because there were no
citations
[NbConvertApp] PDF successfully created
[NbConvertApp] Writing 2084057 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 3451002 bytes to FinOpt-Workflow.html
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[ ]:

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