

Jonah Goes to College

A Decision Model



-Jonathan Cooper – “The Father”

-Carlos-Andres Lacayo – “The Godfather”



Where to Invest?

Exchange Traded Funds

- US Large Cap Equities
- US Small Cap Equities
- European Equities
- US Diversified Fixed Income
- Emerging Market Equities
- Commodities
- Global Real Estate

(Ticker: VTI)
(Ticker: VV)
(Ticker: VGK)
(Ticker: AGG)
(Ticker: VWO)
(Ticker: DBC)
(Ticker: VNQ)

Why? Ease and Friction

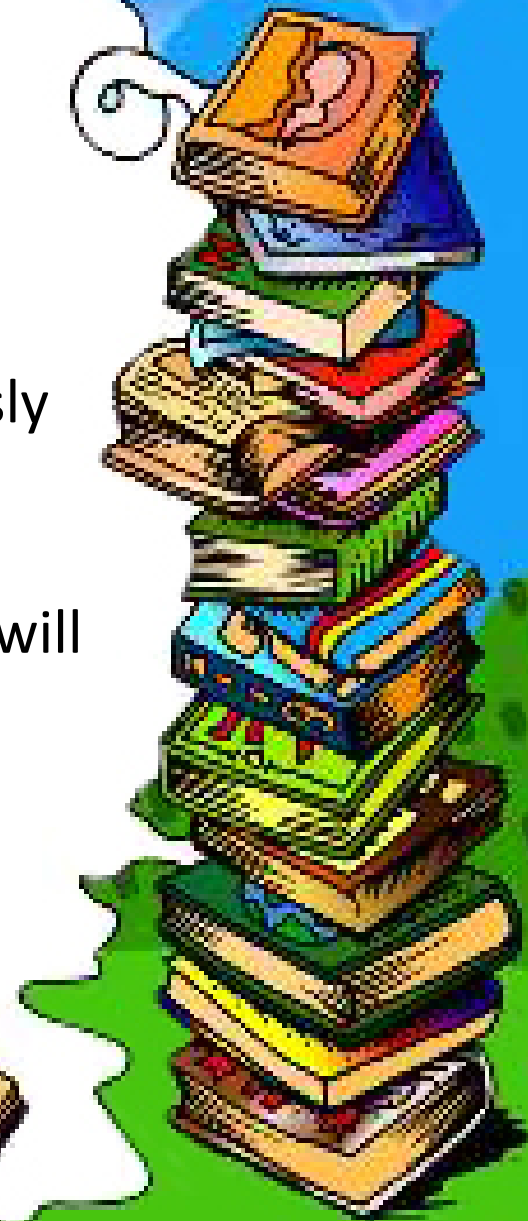
- Daddy can do this himself
- Low transaction costs (S*&t gets pricy)



What and When to Invest?

Assumptions

- Ignored tax consequences (i.e.: 529 plans)
- Daddy will make millions and become ridiculously wealthy
- Daddy will pay for school
- However, to relate to the common man, Daddy will invest as follows:
- Initially: \$5,000
- First of every month: \$200 (\$2,400/yr)
- Invest over 18 years (216 monthly periods)



What College?



Inf. Adj. Annual Cost (4 yrs):

\$83K/yr (\$334K)



\$78K/yr (\$313K)



\$73K/yr (\$291K)



\$51K/yr (\$204K)



\$23K/yr (\$94K)
(in-state)



Dual Model Structure

Optimization

- Many brokers have recommended asset allocation
- However, using solver, we can determine the optimal ETF allocation
- Based on historical returns

Crystal Ball

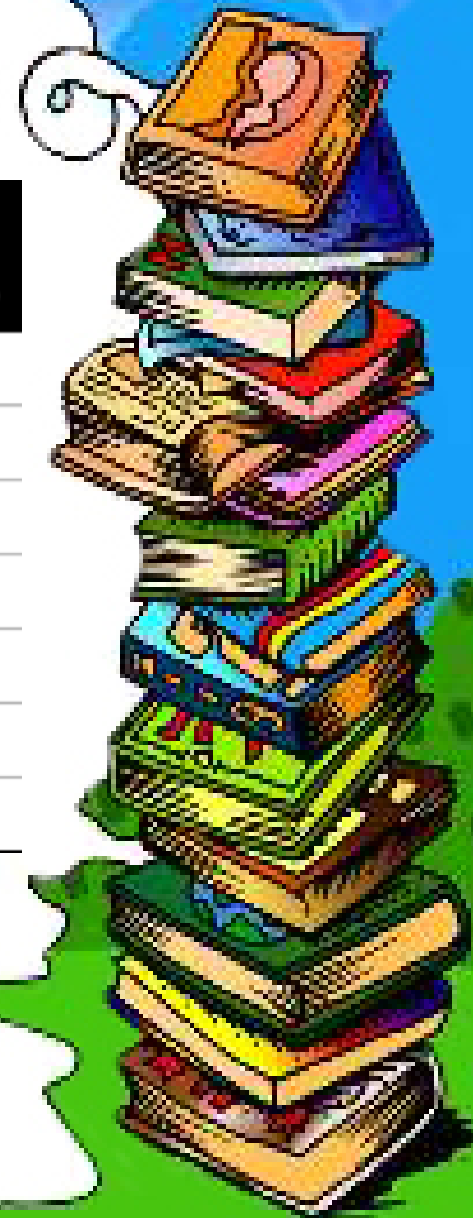
- Used 5 year historical returns
- Predicted each ETFs returns over next 216 months

Combining the models, we have a final fund value



Crystal Ball Projection

Ticker	Asset Class	Historical Return (mo.)	Historical Return (yr)
VTI	US Large Cap Equity	0.46%	5.61%
VV	US Small Cap Equity	0.50%	6.11%
VGK	European Equity	0.48%	5.92%
VWO	Emerg. Mrkts Equity	1.28%	16.52%
DBC	Commodities	0.70%	8.76%
AGG	US Fixed Income	0.50%	6.18%
VNQ	Global REITs	0.76%	9.57%



Optimization Model

Objective Function

- Minimize risk—the portfolio's standard deviation

Decision Variables

- Percent allocation towards each ETF

Constraints

- Total Allocation = 100%
- Each individual allocation was restrained
- Expected Return $\geq 0.833\%$ / month (10% /yr)



Optimization Model

Correlation Matrix

	AGG	DBC	REIT	VTI	VGK	VWO	VV
AGG	1	0.041694	0.290774	0.146973	0.277629	0.209988	0.999506
DBC	0.0416941	1	0.378536	0.561959	0.608608	0.665225	0.039901
REIT	0.2907737	0.378536	1	0.82072	0.754165	0.653977	0.289935
VTI	0.1469728	0.561959	0.82072	1	0.913181	0.848713	0.146863
VGK	0.2776287	0.608608	0.754165	0.913181	1	0.89666	0.275289
VWO	0.2099881	0.665225	0.653977	0.848713	0.89666	1	0.20943
VV	0.9995065	0.039901	0.289935	0.146863	0.275289	0.20943	1

Covariance Matrix

	AGG	DBC	REIT	VTI	VGK	VWO	VV
AGG	0.000174	3.64E-05	0.00036	0.000103	0.000256	0.000218	0.000174
DBC	3.64E-05	0.004382	0.002353	0.00197	0.002812	0.003467	3.48E-05
REIT	0.0003602	0.002353	0.008819	0.004083	0.004944	0.004836	0.000359
VTI	0.0001027	0.00197	0.004083	0.002806	0.003377	0.00354	0.000103
VGK	0.0002556	0.002812	0.004944	0.003377	0.004873	0.004929	0.000253
VWO	0.0002181	0.003467	0.004836	0.00354	0.004929	0.0062	0.000217
VV	0.0001737	3.48E-05	0.000359	0.000103	0.000253	0.000217	0.000174

	AGG	DBC	REIT	VTI	VGK	VWO	VV
Average	0.50%	0.70%	0.76%	0.46%	0.48%	1.28%	0.50%
Std Dev	1.33%	6.68%	9.47%	5.34%	7.04%	7.94%	1.33%



Optimization Model

Ticker	AGG	DBC	REIT	VTI	VGK	VWO	VV	
Allocation	57.42%	0.00%	0.00%	0.00%	0.00%	42.58%	0.00%	1 = 1
	<=	<=	<=	>=	>=	<=	<=	
	60%	10%	20%	10%	10%	40%	100%	

`=SQRT(MMULT(K27:Q27,MMULT(K14:Q20,TRANSPOSE(K27:Q27))))`

3.58880% Minimize Portfolio Standard Deviation

`=SUMPRODUCT(K27:Q27,K23:Q23)`

0.833% Expected Return

>=

0.833% Required Expected Return

Solver Used: GRG Non-Linear, Unchecked Box



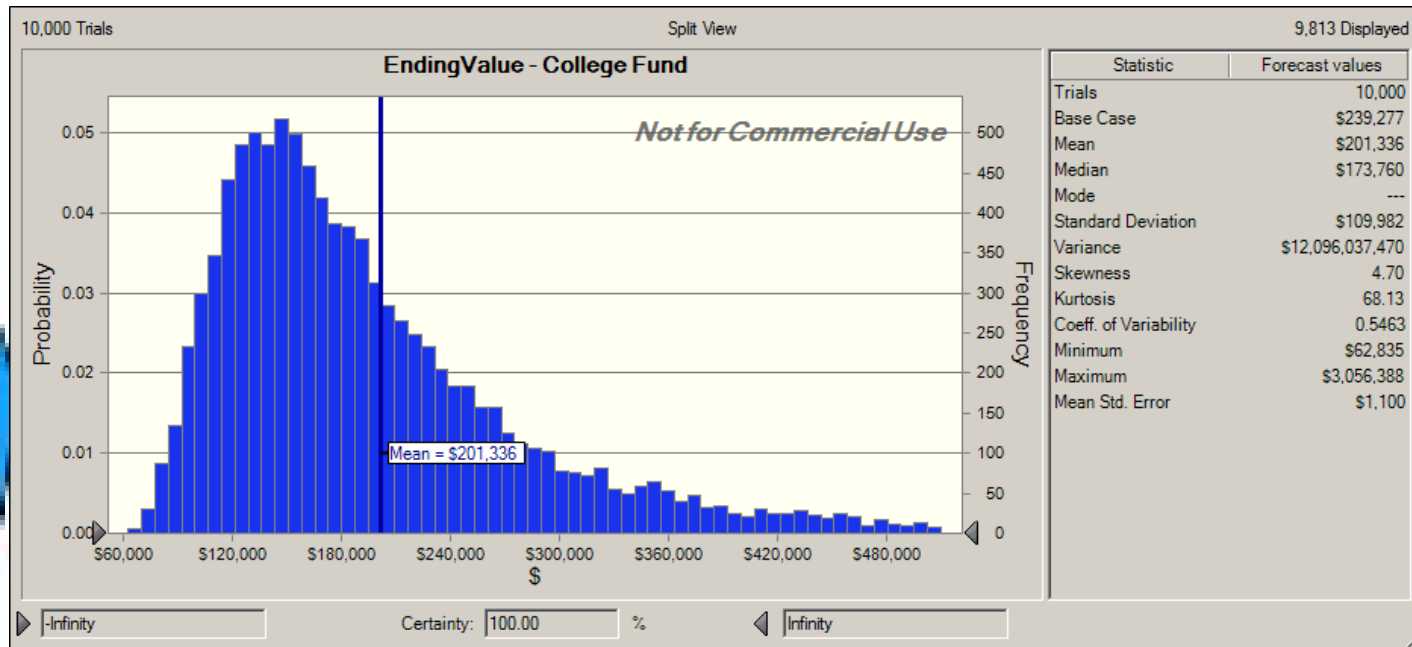
Asset Allocation Scenarios

Fund	Flat	Broker	Optimal	Best
US Large Cap Equity - VTI	14.29%	15.00%	0.00%	0.00%
US Small Cap Equity - VV	14.29%	10.00%	0.00%	0.00%
European Equity - VGK	14.29%	10.00%	0.00%	0.00%
Emerging Equity - VWO	14.29%	15.00%	42.58%	50.00%
Commodities - DBC	14.29%	10.00%	0.00%	20.00%
US Fixed Inc. - AGG	14.29%	30.00%	57.42%	30.00%
Global REITs - VNQ	14.29%	10.00%	0.00%	0.00%
Total:	100.00%	100.00%	100.00%	100.00%



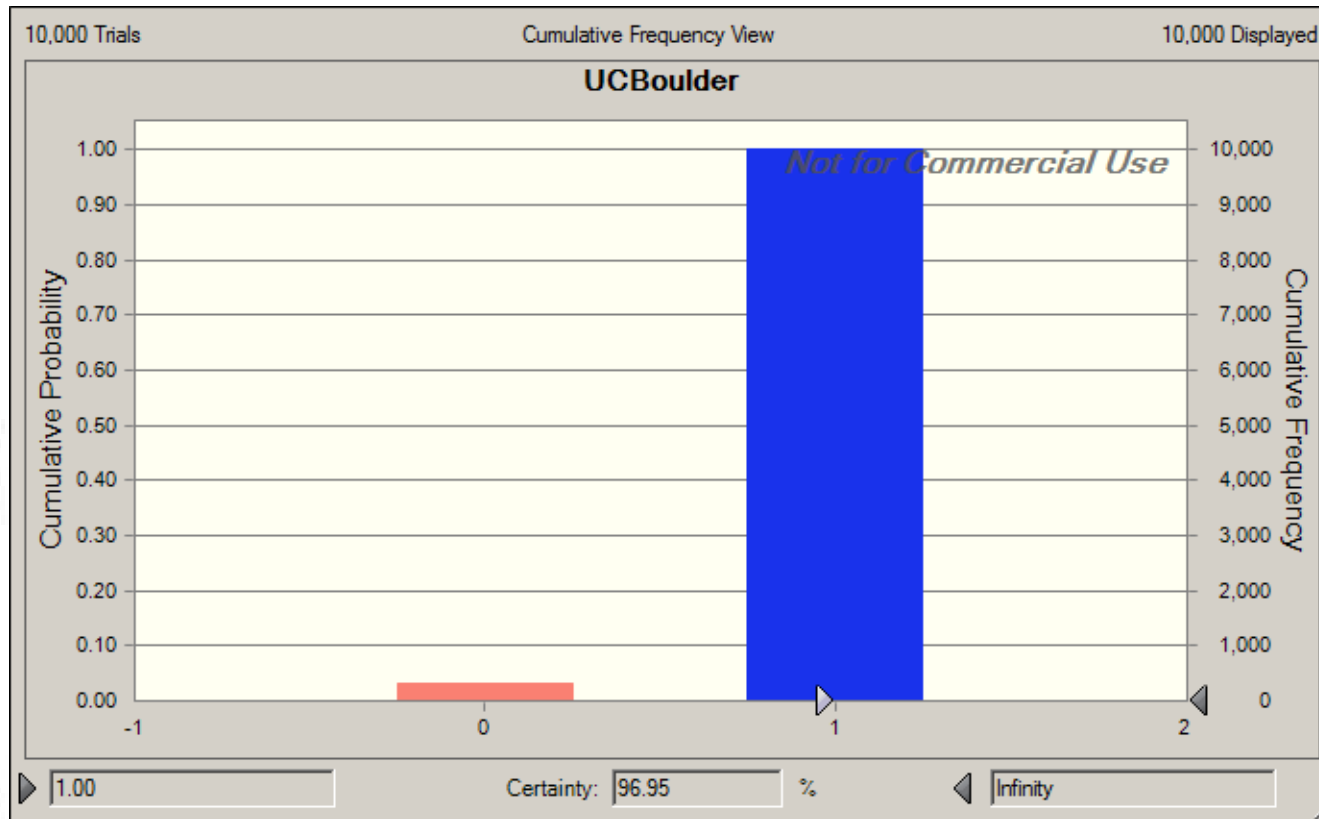
Results: Flat Allocation

Average Return: \$201,336



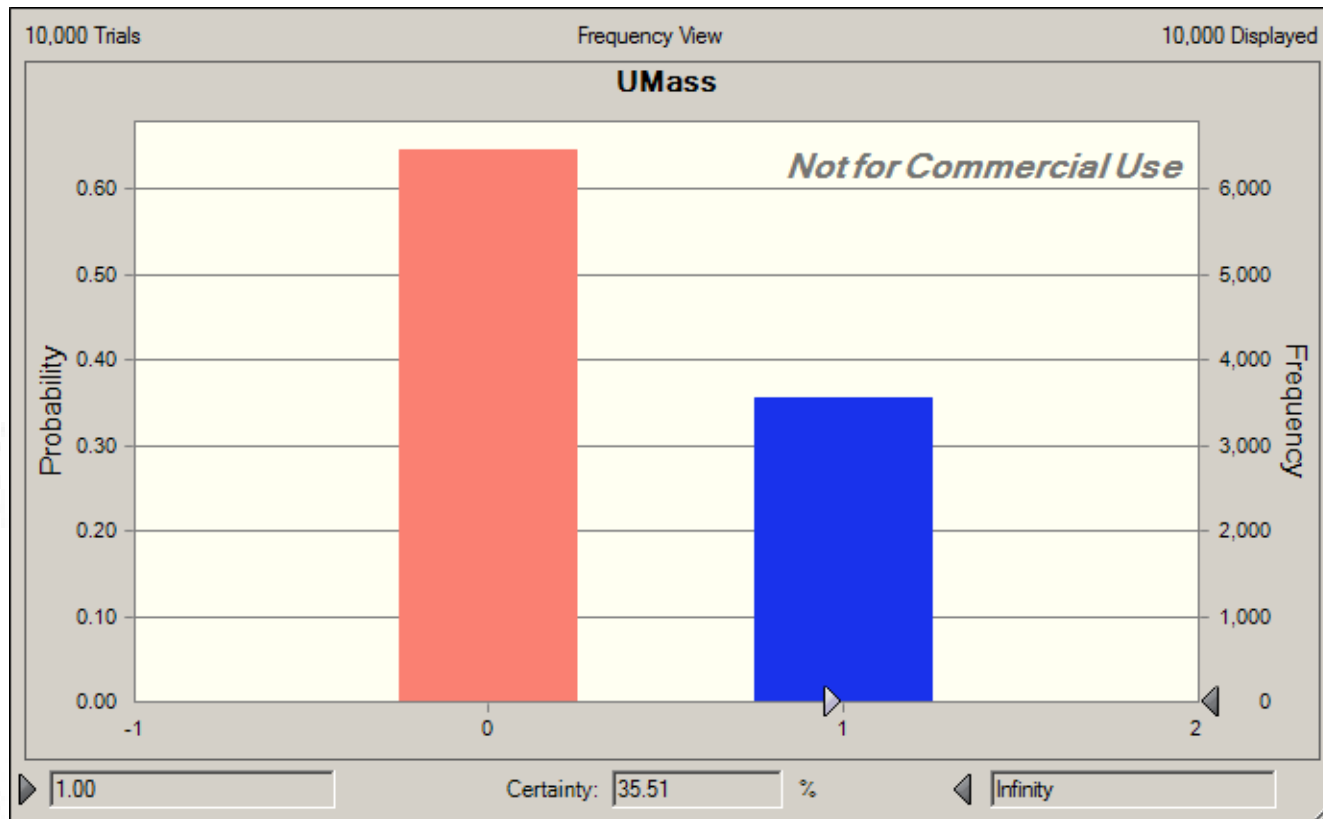
Results: Flat Allocation

UC Boulder: 97% chance



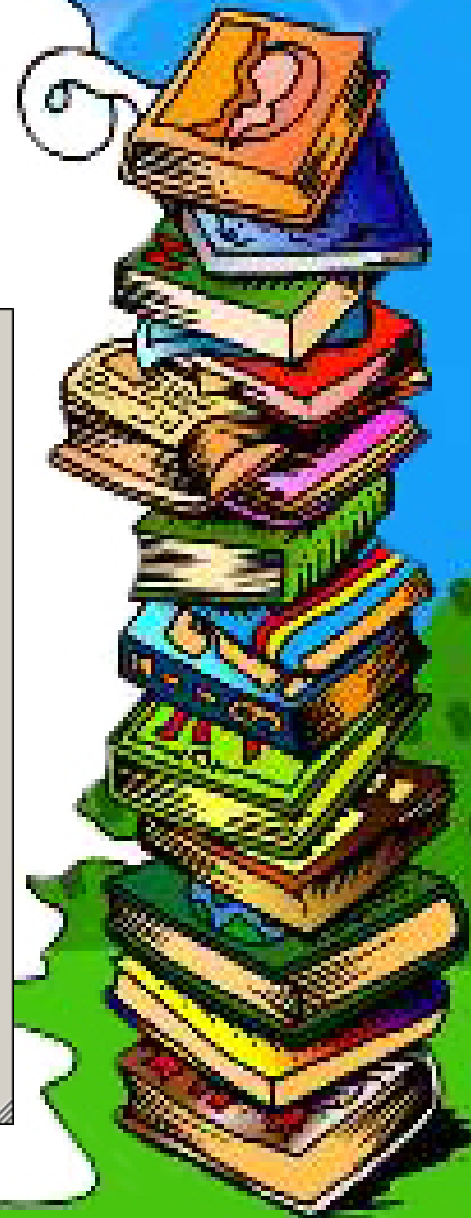
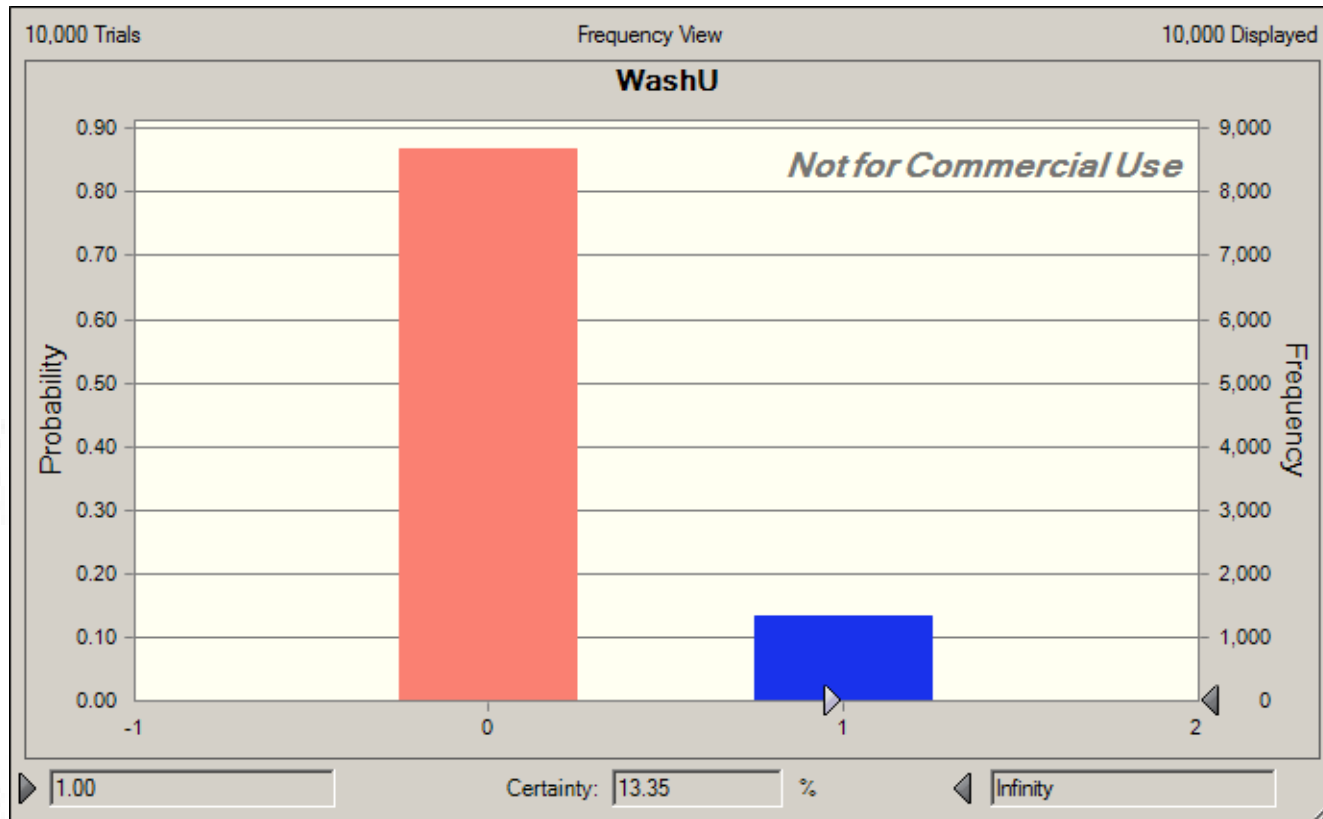
Results: Flat Allocation

UMass: 36% chance



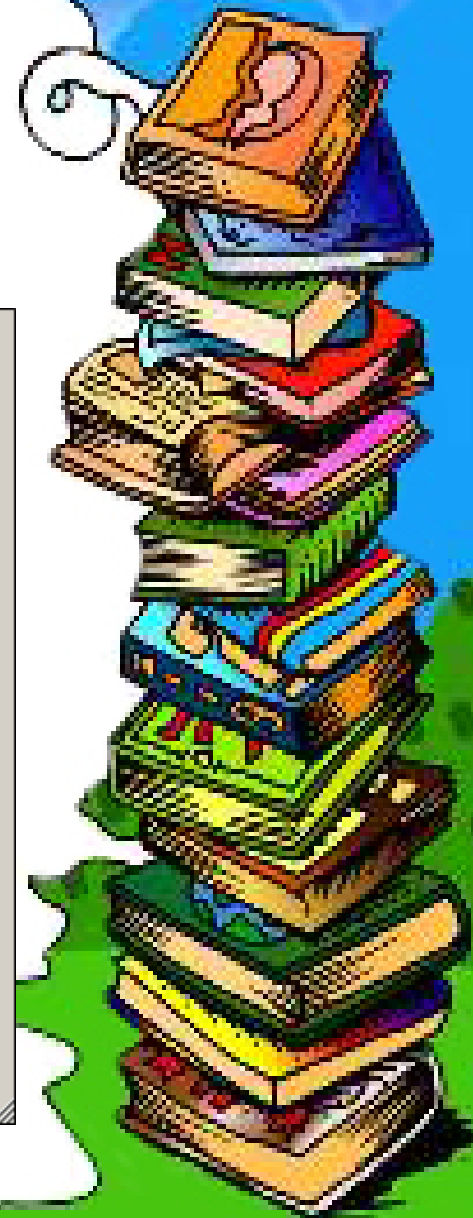
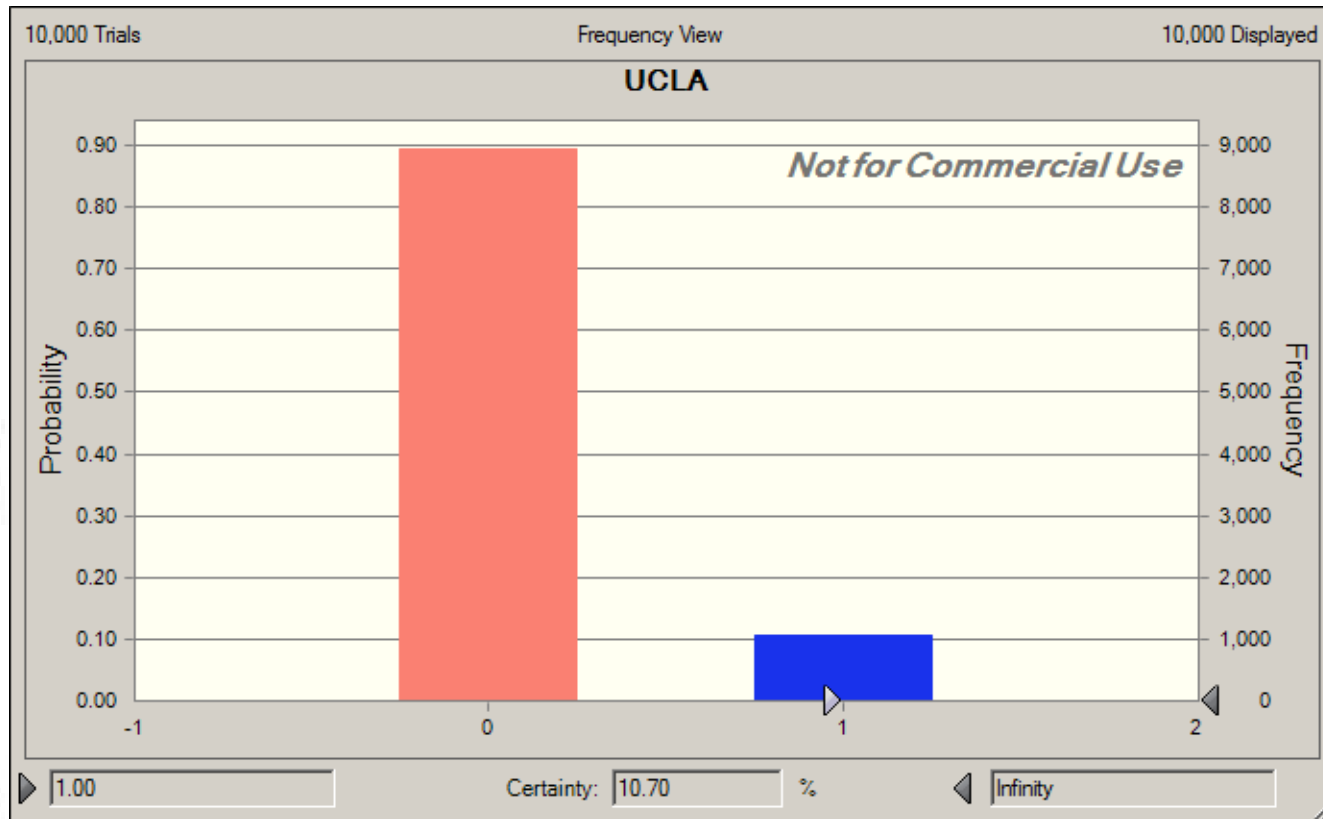
Results: Flat Allocation

WashU: 13% chance



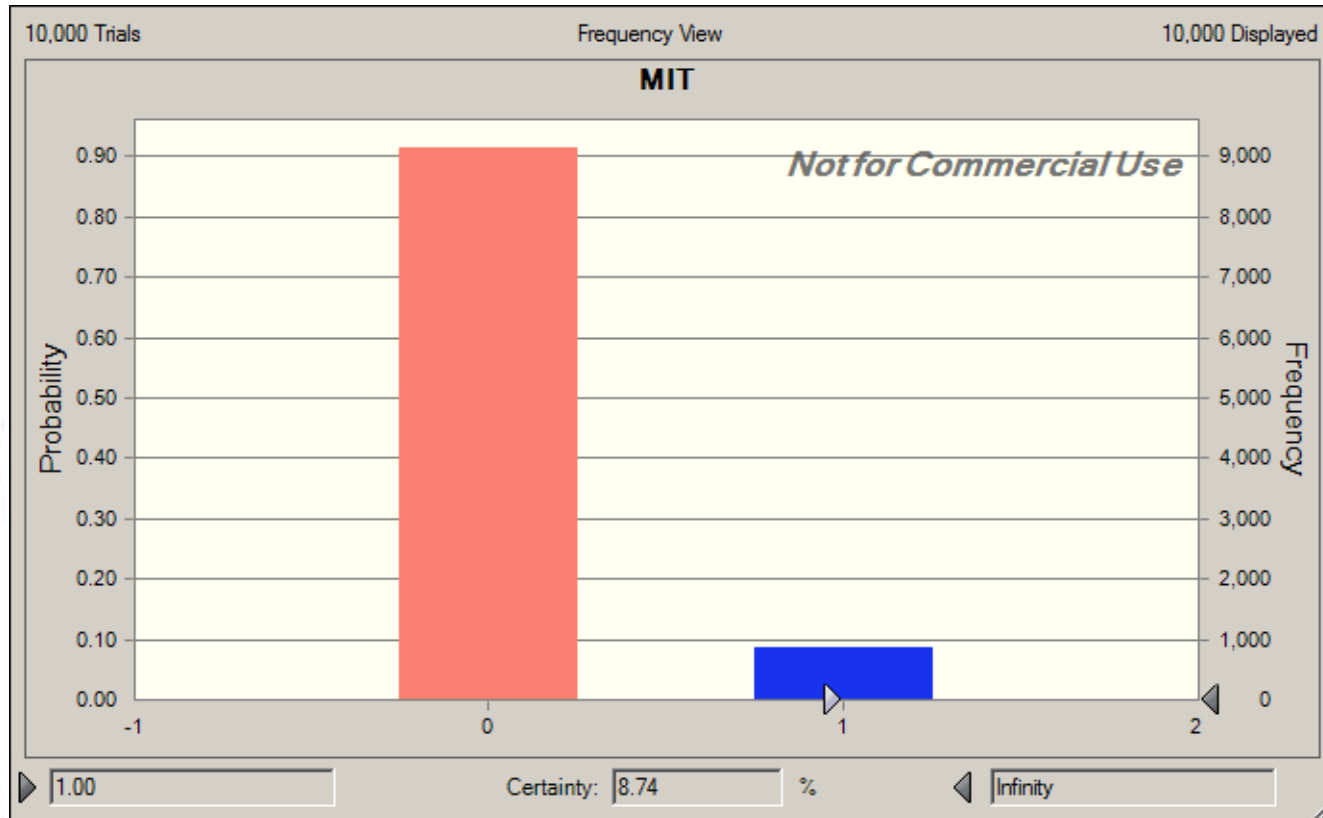
Results: Flat Allocation

UCLA: 11% chance



Results: Flat Allocation

MIT: 9% chance



Results: Flat

- Average Return: \$201,336
- But, Is it affordable?

% Chance Fund Meets Cost

UC Boulder:	97%
UMass:	36%
WashU:	13%
UCLA:	11%
MIT:	9%



Results: Broker's Advice

- Average Return: \$188,106
- But, Is it affordable?

% Chance Fund Meets Cost

UC Boulder:	96%
UMass:	29%
WashU:	10%
UCLA:	8%
MIT:	7%



Results: Optimal Allocation

- Average Return: \$250,841
- But, Is it affordable?

% Chance Fund Meets Cost

UC Boulder:	90%
UMass:	42%
WashU:	26%
UCLA:	22%
MIT:	20%



Results: Best

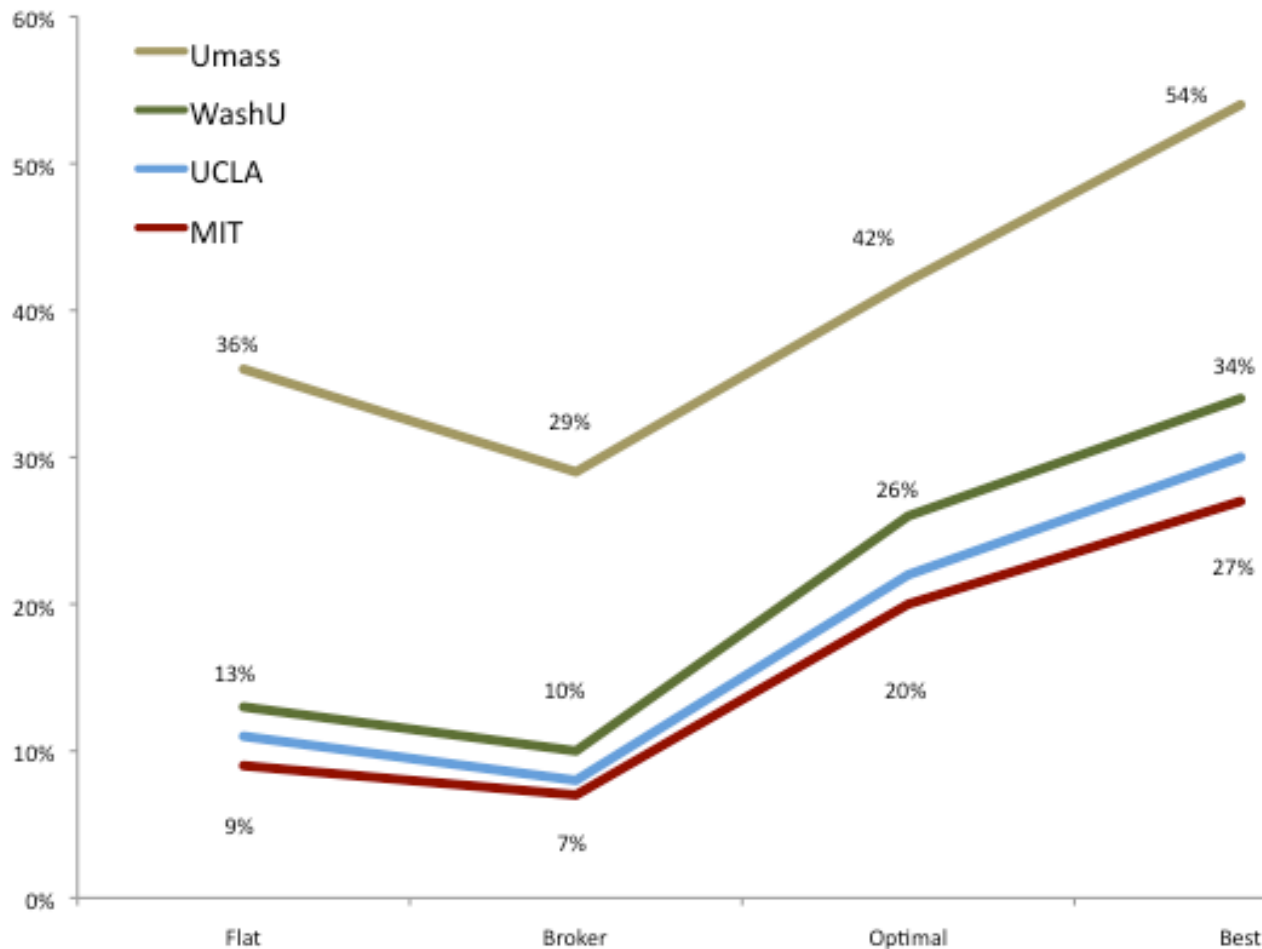
- Average Return: \$304,271
- But, Is it affordable?

% Chance Fund Meets Cost

UC Boulder:	94%
UMass:	54%
WashU:	34%
UCLA:	30%
MIT:	27%



What's the best scenario?



-UC Boulder is not here, as it has virtually 100% affordability, no matter the scenario



So, What's "best?"

Whatever makes Jonah happiest!



No really...it depends on:

Quantity

- Increase per month investment
- Time the market with varied investing?

Quality

- Dynamically changing allocation
- Be careful of historical returns
- Flexibility with risk profile
- Pick better securities

Finally, that's what student loans are for



Questions?

