

## Investing vs. Paying Down the Mortgage

The Counterintuitive Math Behind a Popular and Controversial Subject

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**Executive Summary.** The popular heuristic of comparing one's mortgage interest rate against one's portfolio return to determine the cost or benefit of mortgage prepayments is flawed and misleading. This "napkin math"—commonly used by finance professionals, academics, and pop-finance gurus—fails to consider the impacts of leverage, volatility, and sequence of portfolio returns.

Using cash flow analysis, historical data, and Monte Carlo simulation, we demonstrate that an investor can benefit from paying down a mortgage in favor of additional portfolio contributions even when the investment return exceeds by a sizeable margin the cost of the mortgage. We also demonstrate how sensitive the economics are to seemingly minor changes in portfolio return, investment return sequence, tax matters, and other factors.

**Takeaways.** The economic advantage or disadvantage of paying down a mortgage is not as simple as legacy heuristics suggest. Stochastic (random) variables render the analysis deceptively complex.

Over the previous 30-year period (1992-2021), we have demonstrated that the difference in performance between pure equity investors with 15- and 30-year mortgages is quite small. Despite the S&P 500 providing an average annual return of 10.7% during this time frame—well in excess of prevailing mortgage rates over the same period—arbitrage value for the 30-year mortgage borrower was limited and dependent on taxation benefits.

When evaluating this tradeoff today, investors should consider that lower costs of capital (e.g., mortgage rates) have potential implications for future equity performance. Using equity return projections from three industry authorities, our analysis demonstrates that the economics are highly sensitive to minor changes in variables. The decision of whether to be a cash buyer, mortgage pre-payer, or full-term mortgagor might best be served by prioritizing factors other than perceived arbitrage investment opportunities, such as budgetary constraints, special or unusual tax implications, lifestyle preferences, risk aversion, and personal goals.

**Bad Math.** The question of whether or not an investor should use surplus money to either (a) pay down debt or (b) purchase investments, is often boiled down to the following: if the amount of your expected investment return exceeds the

interest rate on your debt, then investing the money provides a simple and profitable arbitrage opportunity:

Average Stock Market Return:	10.0%	Example of misleading "napkin math."
Mortgage Interest Rate:	3.50%	
Arbitrage Opportunity:	6.50%	

**Why Conventional Math Fails.** The math behind this popular and sometimes controversial topic seems intuitive and straightforward. Unfortunately, the simple arithmetic of comparing mortgage rates against average or projected investment returns is terribly misleading. This simple approach fails for reasons that many people are familiar with, but that are hard to fully appreciate without running the numbers and investigating the results:

- Paying off (or avoiding) a fixed rate mortgage is a fixed and guaranteed return on investment.
- Investing in stocks is volatile, and this volatility is compounded when you borrow money (for any reason) that allows you to increase (or avoid reducing) your exposure to the stock market.
- The source of leverage (mortgage) is itself a dynamic variable: it is reduced as the balance is paid down over time.
- This leverage, and the fact that it diminishes with time, amplifies sequence of return risk. All things being equal, investment performance during early years (while most leveraged) matters the most, while performance during later years (while least leveraged) matters surprisingly little.

**30-Year Look Back.** Our attached analysis demonstrates the counterintuitive and recent historical results on this subject. To summarize: take two individuals, each of which purchased a home 30 years ago (1992). One made timely mortgage payments over 30 years, while the other chose to finance their home with a 15-year mortgage. Each refinanced as interest rates fell, while investing all excess cash flow in the S&P 500, which achieved compound annual returns of 10.7% over this period. Oddly enough, the economics between both approaches—ignoring taxes—was remarkably similar, with the 15-year borrower slightly outperforming the 30-year borrower at the end of the 30-year timeline. After tax considerations are included, the advantage flips to the 30-year borrower, which slightly outperforms the 15-year borrower.

**Forward-Looking Analysis.** Historical analysis is simple: we know all of the components necessary to evaluate the tradeoff (i.e., stock market performance, mortgage rates, income tax implications). All that is required is to carefully model the result. But as a homebuyer and investor today, the past isn't necessarily helpful or actionable. After all, mortgage rates are

currently at unusually low levels. So, how does this impact the math?

Predicting the future is impossible, and forward-looking analysis is speculative and heavily dependent on the assumptions used. Our historical analysis demonstrates how volatility and the sequence of investment performance can significantly impact the results, so we've used Monte Carlo simulation and a variety of assumptions to enhance our understanding of the range and frequency of potential outcomes on a forward-looking basis.

**The Question Investigated.** A person owns a home. Perhaps this person has owned this home for a while and has one remaining mortgage payment, or perhaps they purchased this home last year; it doesn't matter. This person has been thinking about using available cash to pay off their mortgage. However, they recently overheard a conversation about near-record low interest rates for 30-year borrowers. Their curiosity is piqued, and they pose the following question, which serves as the basis for our forward-looking analysis:

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What are the economics between: (a) using cash to pay off my existing mortgage immediately, and (b) refinancing my mortgage over 30 years to keep more money invested in the stock market?

**Capital Market Assumptions.** Instead of trying to arrive at universal assumptions that everyone can agree are reasonable, we've performed our analysis several times using a variety of sources for future investment performance. Note: the break-even analysis uses historical volatility, and with the exception of BlackRock, our sources do not provide precisely 30-year outlooks. JP Morgan and Vanguard provide "long-term" assumptions, which we understand reflect 10- to 15-year outlooks.

## Notes

- Our forward-looking analysis ignores tax implications.
- For our historical analysis, dividend income is taxed at the marginal tax rate indicated (married, filing jointly), while taxes on long-term capital gains are deferred until the end of the 30-year period.
- The marginal income tax rate used corresponds with the median household income for each period.

- For our historical analysis, each investor is assumed to refinance their mortgage every five years, if the prevailing interest rate is lower than the existing interest rate.
- For our historical analysis, refinancing fees are rolled into the mortgage (added to the outstanding balance) at the end of the period immediately preceding the refinancing.
- For our historical analysis, additional after-tax portfolio contributions are included to demonstrate that they have no bearing on the differential in absolute value between each scenario. Excluding potential tax implications, whether or not mortgage payments are made from current income or investment proceeds is irrelevant to the analysis. These additional portfolio contributions are assumed to change annually at the historical rate of inflation.

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# Appendices

# Paying Off Your House: Fast vs. Slow

## 30-yr Look-Back

### TAXES EXCLUDED

#### Assumptions

Long-Term Capital Gain Tax Rate	
Refinancing Fees/Points	1.50%
Additional After-Tax Contributions	15,000
Marginal Tax Bracket	See Below

#### Economic Data & S&P 500 Performance

Period	Year	Inflation Rate	Income Tax	Dividend Yield	Price Return	Total Return
1	1992	3.00%		3.12%	4.48%	7.60%
2	1993	3.00%		3.10%	7.07%	10.17%
3	1994	2.60%		2.75%	-1.56%	1.19%
4	1995	2.80%		3.89%	34.13%	38.02%
5	1996	2.90%		2.80%	20.26%	23.06%
6	1997	2.30%		2.66%	31.01%	33.67%
7	1998	1.60%		2.06%	26.67%	28.73%
8	1999	2.20%		1.58%	19.53%	21.11%
9	2000	3.40%		1.03%	-10.14%	-9.11%
10	2001	2.80%		1.06%	-13.04%	-11.98%
11	2002	1.60%		1.10%	-23.37%	-22.27%
12	2003	2.30%		2.34%	26.38%	28.72%
13	2004	2.70%		1.83%	8.99%	10.82%
14	2005	3.40%		1.79%	3.00%	4.79%
15	2006	3.20%		2.14%	13.60%	15.74%
16	2007	2.90%		1.94%	3.52%	5.46%
17	2008	3.80%		1.27%	-38.49%	-37.22%
18	2009	-0.40%		3.46%	23.65%	27.11%
19	2010	1.60%		2.24%	12.63%	14.87%
20	2011	3.20%		1.97%	0.10%	2.07%
21	2012	2.10%		2.59%	13.29%	15.88%
22	2013	1.50%		3.00%	29.43%	32.43%
23	2014	1.60%		2.27%	11.54%	13.81%
24	2015	0.10%		2.04%	-0.73%	1.31%
25	2016	1.30%		2.39%	9.54%	11.93%
26	2017	2.10%		2.52%	19.42%	21.94%
27	2018	2.40%		1.83%	-6.24%	-4.41%
28	2019	1.80%		2.86%	28.88%	31.74%
29	2020	1.20%		2.12%	16.26%	18.38%
30	2021	4.80%		1.94%	26.89%	28.83%

S&P CAGR (Geometric Mean): 10.66%

## Investor A

### 30-yr Home Mortgage + Investing in S&P 500

Period: 1992 to 2021

#### Beginning Net Worth

Brokerage Account Balance	200,000
Mortgage Balance	100,000
Net Worth	100,000

#### Cash Flow

Beg. Acct. Balance	Capital Gains	Dividend Income	Add'l Contrib	Mortgage Payment	Mortgage Tax Benefit	Taxes (Divid.)	Taxes (L/T Gain)	End. Acct. Balance
\$ 200,000	\$ 8,960	\$ 6,240	\$ 15,000	\$ (9,246)	\$ -	\$ -	\$ -	\$ 220,954
220,954	15,621	6,850	15,450	(9,246)	-	-	-	249,630
249,630	(3,894)	6,865	15,852	(9,246)	-	-	-	259,207
259,207	88,467	10,083	16,296	(9,246)	-	-	-	364,807
364,807	73,910	10,215	16,768	(9,246)	-	-	-	456,454
456,454	141,546	12,142	17,154	(8,911)	-	-	-	618,385
618,385	164,923	12,739	17,428	(8,911)	-	-	-	804,565
804,565	157,132	12,712	17,812	(8,911)	-	-	-	983,309
983,309	(99,708)	10,128	18,417	(8,911)	-	-	-	903,236
903,236	(117,782)	9,574	18,933	(8,911)	-	-	-	805,051
805,051	(188,140)	8,856	19,236	(8,496)	-	-	-	636,506
636,506	167,910	14,894	19,678	(8,496)	-	-	-	830,494
830,494	74,661	15,198	20,210	(8,496)	-	-	-	932,067
932,067	27,962	16,684	20,897	(8,496)	-	-	-	989,114
989,114	134,520	21,167	21,565	(8,496)	-	-	-	1,157,871
1,157,871	40,757	22,463	22,191	(8,071)	-	-	-	1,235,211
1,235,211	(475,433)	15,687	23,034	(8,071)	-	-	-	790,429
790,429	186,936	27,349	22,942	(8,071)	-	-	-	1,019,585
1,019,585	128,774	22,839	23,309	(8,071)	-	-	-	1,186,436
1,186,436	1,186	23,373	24,055	(8,071)	-	-	-	1,226,979
1,226,979	163,066	31,779	24,560	(7,150)	-	-	-	1,439,233
1,439,233	423,566	43,177	24,928	(7,150)	-	-	-	1,923,755
1,923,755	222,001	43,669	25,327	(7,150)	-	-	-	2,207,602
2,207,602	(16,115)	45,035	25,353	(7,150)	-	-	-	2,254,724
2,254,724	215,101	53,888	25,682	(7,150)	-	-	-	2,542,244
2,542,244	493,704	64,065	26,222	(7,150)	-	-	-	3,119,084
3,119,084	(194,631)	57,079	26,851	(7,150)	-	-	-	3,001,233
3,001,233	866,756	85,835	27,334	(7,150)	-	-	-	3,974,007
3,974,007	646,174	84,249	27,662	(7,150)	-	-	-	4,724,942
4,724,942	1,270,537	91,664	28,990	(7,150)	-	-	-	6,108,982

Beginning Account Balance	\$ 200,000
Capital Gains	4,618,468
Dividend Income	886,496
Wage Income	649,136
Mortgage Payments	(245,117)
Taxes on Dividends	-
Mortgage Tax Breaks	-
Deferred Capital Gains Taxes	-
Ending Net Worth	\$6,108,982

#### Mortgage Amortization

Interest Rate	After-Tax Rate	Beg. Balance	Principal Paid	Refi Fees	End. Balance	Ending Net Worth
8.43%	8.43%	\$ 100,000	\$ (816)	\$ -	\$ 99,184	\$ 121,770
8.43%	8.43%	99,184	(884)	-	98,300	151,330
8.43%	8.43%	98,300	(959)	-	97,341	161,865
8.43%	8.43%	97,341	(1,040)	-	96,302	268,505
8.43%	8.43%	96,302	(1,127)	1,428	96,602	359,852
7.82%	7.82%	96,602	(1,357)	-	95,245	523,140
7.82%	7.82%	95,245	(1,463)	-	93,783	710,782
7.82%	7.82%	93,783	(1,577)	-	92,206	891,104
7.82%	7.82%	92,206	(1,700)	-	90,505	812,731
7.82%	7.82%	90,505	(1,833)	1,330	90,002	715,049
7.00%	7.00%	90,002	(2,195)	-	87,807	548,699
7.00%	7.00%	87,807	(2,349)	-	85,458	745,036
7.00%	7.00%	85,458	(2,514)	-	82,944	849,123
7.00%	7.00%	82,944	(2,689)	-	80,255	908,859
7.00%	7.00%	80,255	(2,878)	1,161	78,538	1,079,333
5.97%	5.97%	78,538	(3,382)	-	75,156	1,160,055
5.97%	5.97%	75,156	(3,584)	-	71,572	718,857
5.97%	5.97%	71,572	(3,798)	-	67,774	951,811
5.97%	5.97%	67,774	(4,024)	-	63,750	1,122,686
5.97%	5.97%	63,750	(4,265)	892	60,377	1,166,602
3.20%	3.20%	60,377	(5,218)	-	55,159	1,384,075
3.20%	3.20%	55,159	(5,385)	-	49,773	1,873,981
3.20%	3.20%	49,773	(5,558)	-	44,216	2,163,387
3.20%	3.20%	44,216	(5,736)	-	38,480	2,216,244
3.20%	3.20%	38,480	(5,919)	-	32,561	2,509,683
3.20%	3.20%	32,561	(6,109)	-	26,452	3,092,631
3.20%	3.20%	26,452	(6,304)	-	20,148	2,981,084
3.20%	3.20%	20,148	(6,506)	-	13,643	3,960,365
3.20%	3.20%	13,643	(6,714)	-	6,929	4,718,013
3.20%	3.20%	6,929	(6,929)	-	(0)	6,108,982

Paying Off Your House: Fast vs. Slow  
30-yr Look-Back

Investor B  
**15-yr Home Mortgage + Investing in S&P 500**

Period: 1992 to 2021

**TAXES EXCLUDED**

**Assumptions**

Long-Term Capital Gain Tax Rate	
Refinancing Fees/Points	1.50%
Additional After-Tax Contributions	15,000
Marginal Tax Bracket	See Below

**Beginning Net Worth**

Brokerage Account Balance	200,000
Mortgage Balance	100,000
Net Worth	100,000

Economic Data & S&P 500 Performance

Period	Year	Inflation Rate	Income Tax	Dividend Yield	Price Return	Total Return
1	1992	3.00%		3.12%	4.48%	7.60%
2	1993	3.00%		3.10%	7.07%	10.17%
3	1994	2.60%		2.75%	-1.56%	1.19%
4	1995	2.80%		3.89%	34.13%	38.02%
5	1996	2.90%		2.80%	20.26%	23.06%
6	1997	2.30%		2.66%	31.01%	33.67%
7	1998	1.60%		2.06%	26.67%	28.73%
8	1999	2.20%		1.58%	19.53%	21.11%
9	2000	3.40%		1.03%	-10.14%	-9.11%
10	2001	2.80%		1.06%	-13.04%	-11.98%
11	2002	1.60%		1.10%	-23.37%	-22.27%
12	2003	2.30%		2.34%	26.38%	28.72%
13	2004	2.70%		1.83%	8.99%	10.82%
14	2005	3.40%		1.79%	3.00%	4.79%
15	2006	3.20%		2.14%	13.60%	15.74%
16	2007	2.90%		1.94%	3.52%	5.46%
17	2008	3.80%		1.27%	-38.49%	-37.22%
18	2009	-0.40%		3.46%	23.65%	27.11%
19	2010	1.60%		2.24%	12.63%	14.87%
20	2011	3.20%		1.97%	0.10%	2.07%
21	2012	2.10%		2.59%	13.29%	15.88%
22	2013	1.50%		3.00%	29.43%	32.43%
23	2014	1.60%		2.27%	11.54%	13.81%
24	2015	0.10%		2.04%	-0.73%	1.31%
25	2016	1.30%		2.39%	9.54%	11.93%
26	2017	2.10%		2.52%	19.42%	21.94%
27	2018	2.40%		1.83%	-6.24%	-4.41%
28	2019	1.80%		2.86%	28.88%	31.74%
29	2020	1.20%		2.12%	16.26%	18.38%
30	2021	4.80%		1.94%	26.89%	28.83%
S&P CAGR (Geometric Mean):						10.66%

Cash Flow

Beg. Balance	Capital Gains	Dividend Income	Add'l Contrib	Mortgage Payment	Mortgage Tax Benefit	Div Yield Taxes	Cap Gains Taxes	End. Acct. Balance
\$ 200,000	\$ 8,960	\$ 6,240	\$ 15,000	\$ (11,690)	\$ -	\$ -	\$ -	\$ 218,510
218,510	15,449	6,774	15,450	(11,690)	-	-	-	244,492
244,492	(3,814)	6,724	15,852	(11,690)	-	-	-	251,563
251,563	85,859	9,786	16,296	(11,690)	-	-	-	351,813
351,813	71,277	9,851	16,768	(11,690)	-	-	-	438,019
438,019	135,830	11,651	17,154	(11,504)	-	-	-	591,150
591,150	157,660	12,178	17,428	(11,504)	-	-	-	766,912
766,912	149,778	12,117	17,812	(11,504)	-	-	-	935,114
935,114	(94,821)	9,632	18,417	(11,504)	-	-	-	856,838
856,838	(111,732)	9,082	18,933	(11,504)	-	-	-	761,618
761,618	(177,990)	8,378	19,236	(11,414)	-	-	-	599,828
599,828	158,235	14,036	19,678	(11,414)	-	-	-	780,363
780,363	70,155	14,281	20,210	(11,414)	-	-	-	873,594
873,594	26,208	15,637	20,897	(11,414)	-	-	-	924,923
924,923	125,789	19,793	21,565	(11,414)	-	-	-	1,080,657
1,080,657	38,039	20,965	22,191	-	-	-	-	1,161,852
1,161,852	(447,197)	14,756	23,034	-	-	-	-	752,445
752,445	177,953	26,035	22,942	-	-	-	-	979,375
979,375	123,695	21,938	23,309	-	-	-	-	1,148,317
1,148,317	1,148	22,622	24,055	-	-	-	-	1,196,142
1,196,142	158,967	30,980	24,560	-	-	-	-	1,410,649
1,410,649	415,154	42,319	24,928	-	-	-	-	1,893,051
1,893,051	218,458	42,972	25,327	-	-	-	-	2,179,809
2,179,809	(15,913)	44,468	25,353	-	-	-	-	2,233,717
2,233,717	213,097	53,386	25,682	-	-	-	-	2,525,882
2,525,882	490,526	63,652	26,222	-	-	-	-	3,106,281
3,106,281	(193,832)	56,845	26,851	-	-	-	-	2,996,145
2,996,145	865,287	85,690	27,334	-	-	-	-	3,974,456
3,974,456	646,247	84,258	27,662	-	-	-	-	4,732,623
4,732,623	1,272,602	91,813	28,990	-	-	-	-	6,126,029

Mortgage Amortization

Interest Rate	After-Tax Rate	Beginning Balance	Principal Paid	Refi Fees	End. Balance	Ending Net Worth
8.01%	8.01%	\$ 100,000	\$ (3,680)	\$ -	\$ 96,320	\$ 122,190
8.01%	8.01%	96,320	(3,975)	-	92,345	152,147
8.01%	8.01%	92,345	(4,293)	-	88,052	163,512
8.01%	8.01%	88,052	(4,637)	-	83,415	268,399
8.01%	8.01%	83,415	(5,009)	1,176	79,582	358,437
7.33%	7.33%	79,582	(5,671)	-	73,911	517,239
7.33%	7.33%	73,911	(6,086)	-	67,825	699,087
7.33%	7.33%	67,825	(6,533)	-	61,292	873,822
7.33%	7.33%	61,292	(7,011)	-	54,281	802,557
7.33%	7.33%	54,281	(7,525)	701	47,457	714,161
6.48%	6.48%	47,457	(8,338)	-	39,118	560,709
6.48%	6.48%	39,118	(8,879)	-	30,240	750,123
6.48%	6.48%	30,240	(9,454)	-	20,786	852,809
6.48%	6.48%	20,786	(10,067)	-	10,719	914,204
6.48%	6.48%	10,719	(10,719)	-	-	1,080,657
-	-	-	-	-	-	1,161,852
-	-	-	-	-	-	752,445
-	-	-	-	-	-	979,375
-	-	-	-	-	-	1,148,317
-	-	-	-	-	-	1,196,142
-	-	-	-	-	-	1,410,649
-	-	-	-	-	-	1,893,051
-	-	-	-	-	-	2,179,809
-	-	-	-	-	-	2,233,717
-	-	-	-	-	-	2,525,882
-	-	-	-	-	-	3,106,281
-	-	-	-	-	-	2,996,145
-	-	-	-	-	-	3,974,456
-	-	-	-	-	-	4,732,623
-	-	-	-	-	-	6,126,029

Beginning Account Balance	\$ 200,000
Capital Gains	4,581,074
Dividend Income	868,858
Wage Income	649,136
Mortgage Payments	(173,039)
Taxes on Dividends	-
Mortgage Tax Breaks	-
Deferred Capital Gains Taxes	-
Ending Net Worth	\$6,126,029

# Paying Off Your House: Fast vs. Slow

## 30-yr Look-Back

### TAXES INCLUDED

**Assumptions**

Long-Term Capital Gain Tax Rate	15.00%
Refinancing Fees/Points	1.50%
Additional After-Tax Contributions	15,000
Marginal Tax Bracket	See Below

### Economic Data & S&P 500 Performance

Period	Year	Inflation Rate	Income Tax	Dividend Yield	Price Return	Total Return
1	1992	3.00%	15.00%	3.12%	4.48%	7.60%
2	1993	3.00%	15.00%	3.10%	7.07%	10.17%
3	1994	2.60%	15.00%	2.75%	-1.56%	1.19%
4	1995	2.80%	15.00%	3.89%	34.13%	38.02%
5	1996	2.90%	15.00%	2.80%	20.26%	23.06%
6	1997	2.30%	15.00%	2.66%	31.01%	33.67%
7	1998	1.60%	15.00%	2.06%	26.67%	28.73%
8	1999	2.20%	15.00%	1.58%	19.53%	21.11%
9	2000	3.40%	15.00%	1.03%	-10.14%	-9.11%
10	2001	2.80%	15.00%	1.06%	-13.04%	-11.98%
11	2002	1.60%	15.00%	1.10%	-23.37%	-22.27%
12	2003	2.30%	15.00%	2.34%	26.38%	28.72%
13	2004	2.70%	15.00%	1.83%	8.99%	10.82%
14	2005	3.40%	15.00%	1.79%	3.00%	4.79%
15	2006	3.20%	15.00%	2.14%	13.60%	15.74%
16	2007	2.90%	15.00%	1.94%	3.52%	5.46%
17	2008	3.80%	15.00%	1.27%	-38.49%	-37.22%
18	2009	-0.40%	15.00%	3.46%	23.65%	27.11%
19	2010	1.60%	15.00%	2.24%	12.63%	14.87%
20	2011	3.20%	15.00%	1.97%	0.10%	2.07%
21	2012	2.10%	15.00%	2.59%	13.29%	15.88%
22	2013	1.50%	15.00%	3.00%	29.43%	32.43%
23	2014	1.60%	15.00%	2.27%	11.54%	13.81%
24	2015	0.10%	15.00%	2.04%	-0.73%	1.31%
25	2016	1.30%	15.00%	2.39%	9.54%	11.93%
26	2017	2.10%	15.00%	2.52%	19.42%	21.94%
27	2018	2.40%	12.00%	1.83%	-6.24%	-4.41%
28	2019	1.80%	12.00%	2.86%	28.88%	31.74%
29	2020	1.20%	12.00%	2.12%	16.26%	18.38%
30	2021	4.80%	12.00%	1.94%	26.89%	28.83%

S&P CAGR (Geometric Mean): 10.66%

## Investor A

### 30-yr Home Mortgage + Investing in S&P 500

Period: 1992 to 2021

**Beginning Net Worth**

Brokerage Account Balance	200,000
Mortgage Balance	100,000
<b>Net Worth</b>	<b>100,000</b>

### Cash Flow

Beg. Acct. Balance	Capital Gains	Dividend Income	Add'l Contrib	Mortgage Payment	Mortgage Tax Benefit	Taxes (Divid.)	Taxes (L/T Gain)	End. Acct. Balance
\$ 200,000	\$ 8,960	\$ 6,240	\$ 15,000	\$ (9,246)	\$ 1,265	\$ (936)	\$ -	\$ 221,283
221,283	15,645	6,860	15,450	(9,246)	1,254	(1,029)	-	250,217
250,217	(3,903)	6,881	15,852	(9,246)	1,243	(1,032)	-	260,012
260,012	88,742	10,114	16,296	(9,246)	1,231	(1,517)	-	365,632
365,632	74,077	10,238	16,768	(9,246)	1,218	(1,536)	-	457,151
457,151	141,763	12,160	17,154	(8,911)	1,133	(1,824)	-	618,626
618,626	164,988	12,744	17,428	(8,911)	1,117	(1,912)	-	804,081
804,081	157,037	12,704	17,812	(8,911)	1,100	(1,906)	-	981,917
981,917	(99,566)	10,114	18,417	(8,911)	1,082	(1,517)	-	901,535
901,535	(117,560)	9,556	18,933	(8,911)	1,062	(1,433)	-	803,182
803,182	(187,704)	8,835	19,236	(8,496)	945	(1,325)	-	634,673
634,673	167,427	14,851	19,678	(8,496)	922	(2,228)	-	826,828
826,828	74,332	15,131	20,210	(8,496)	897	(2,270)	-	926,633
926,633	27,799	16,587	20,897	(8,496)	871	(2,488)	-	981,803
981,803	133,525	21,011	21,565	(8,496)	843	(3,152)	-	1,147,100
1,147,100	40,378	22,254	22,191	(8,071)	703	(3,338)	-	1,221,217
1,221,217	(470,046)	15,509	23,034	(8,071)	673	(2,326)	-	779,990
779,990	184,468	26,988	22,942	(8,071)	641	(4,048)	-	1,002,909
1,002,909	126,667	22,465	23,309	(8,071)	607	(3,370)	-	1,164,517
1,164,517	1,165	22,941	24,055	(8,071)	571	(3,441)	-	1,201,737
1,201,737	159,711	31,125	24,560	(7,150)	290	(4,669)	-	1,405,603
1,405,603	413,669	42,168	24,928	(7,150)	265	(6,325)	-	1,873,158
1,873,158	216,162	42,521	25,327	(7,150)	239	(6,378)	-	2,143,879
2,143,879	(15,650)	43,735	25,353	(7,150)	212	(6,560)	-	2,183,818
2,183,818	208,336	52,193	25,682	(7,150)	185	(7,829)	-	2,455,235
2,455,235	476,807	61,872	26,222	(7,150)	156	(9,281)	-	3,003,860
3,003,860	(187,441)	54,971	26,851	(7,150)	102	(6,596)	-	2,884,595
2,884,595	833,071	82,499	27,334	(7,150)	77	(9,900)	-	3,810,527
3,810,527	619,592	80,783	27,662	(7,150)	52	(9,694)	-	4,521,772
4,521,772	1,215,904	87,722	28,990	(7,150)	27	(10,527)	(670,253)	5,166,485

### Mortgage Amortization

Interest Rate	After-Tax Rate	Beg. Balance	Principal Paid	Refi Fees	End. Balance	Ending Net Worth
8.43%	7.17%	\$ 100,000	\$ (816)	\$ -	\$ 99,184	\$ 122,099
8.43%	7.17%	99,184	(884)	-	98,300	151,917
8.43%	7.17%	98,300	(959)	-	97,341	162,670
8.43%	7.17%	97,341	(1,040)	-	96,302	269,330
8.43%	7.17%	96,302	(1,127)	1,428	96,602	360,549
7.82%	6.65%	96,602	(1,357)	-	95,245	523,381
7.82%	6.65%	95,245	(1,463)	-	93,783	710,298
7.82%	6.65%	93,783	(1,577)	-	92,206	889,711
7.82%	6.65%	92,206	(1,700)	-	90,505	811,030
7.82%	6.65%	90,505	(1,833)	1,330	90,002	713,180
7.00%	5.95%	90,002	(2,195)	-	87,807	546,867
7.00%	5.95%	87,807	(2,349)	-	85,458	741,371
7.00%	5.95%	85,458	(2,514)	-	82,944	843,689
7.00%	5.95%	82,944	(2,689)	-	80,255	901,548
7.00%	5.95%	80,255	(2,878)	1,161	78,538	1,068,562
5.97%	5.07%	78,538	(3,382)	-	75,156	1,146,061
5.97%	5.07%	75,156	(3,584)	-	71,572	708,418
5.97%	5.07%	71,572	(3,798)	-	67,774	935,135
5.97%	5.07%	67,774	(4,024)	-	63,750	1,100,768
5.97%	5.07%	63,750	(4,265)	892	60,377	1,141,360
3.20%	2.72%	60,377	(5,218)	-	55,159	1,350,445
3.20%	2.72%	55,159	(5,385)	-	49,773	1,823,385
3.20%	2.72%	49,773	(5,558)	-	44,216	2,099,663
3.20%	2.72%	44,216	(5,736)	-	38,480	2,145,338
3.20%	2.72%	38,480	(5,919)	-	32,561	2,422,674
3.20%	2.72%	32,561	(6,109)	-	26,452	2,977,408
3.20%	2.82%	26,452	(6,304)	-	20,148	2,864,447
3.20%	2.82%	20,148	(6,506)	-	13,643	3,796,884
3.20%	2.82%	13,643	(6,714)	-	6,929	4,514,843
3.20%	2.82%	6,929	(6,929)	-	(0)	5,166,485

Beginning Account Balance	\$ 200,000
Capital Gains	4,468,353
Dividend Income	863,773
Wage Income	649,136
Mortgage Payments	(245,117)
Taxes on Dividends	(120,387)
Mortgage Tax Breaks	20,982
Deferred Capital Gains Taxes	(670,253)
<b>Ending Net Worth</b>	<b>\$5,166,485</b>

Paying Off Your House: Fast vs. Slow  
30-yr Look-Back

Investor B  
**15-yr Home Mortgage + Investing in S&P 500**

Period: 1992 to 2021

**TAXES INCLUDED**

**Assumptions**

Long-Term Capital Gain Tax Rate	15.00%
Refinancing Fees/Points	1.50%
Additional After-Tax Contributions	15,000
Marginal Tax Bracket	See Below

**Beginning Net Worth**

Brokerage Account Balance	200,000
Mortgage Balance	100,000
Net Worth	100,000

Economic Data & S&P 500 Performance

Period	Year	Inflation Rate	Income Tax	Dividend Yield	Price Return	Total Return
1	1992	3.00%	15.00%	3.12%	4.48%	7.60%
2	1993	3.00%	15.00%	3.10%	7.07%	10.17%
3	1994	2.60%	15.00%	2.75%	-1.56%	1.19%
4	1995	2.80%	15.00%	3.89%	34.13%	38.02%
5	1996	2.90%	15.00%	2.80%	20.26%	23.06%
6	1997	2.30%	15.00%	2.66%	31.01%	33.67%
7	1998	1.60%	15.00%	2.06%	26.67%	28.73%
8	1999	2.20%	15.00%	1.58%	19.53%	21.11%
9	2000	3.40%	15.00%	1.03%	-10.14%	-9.11%
10	2001	2.80%	15.00%	1.06%	-13.04%	-11.98%
11	2002	1.60%	15.00%	1.10%	-23.37%	-22.27%
12	2003	2.30%	15.00%	2.34%	26.38%	28.72%
13	2004	2.70%	15.00%	1.83%	8.99%	10.82%
14	2005	3.40%	15.00%	1.79%	3.00%	4.79%
15	2006	3.20%	15.00%	2.14%	13.60%	15.74%
16	2007	2.90%	15.00%	1.94%	3.52%	5.46%
17	2008	3.80%	15.00%	1.27%	-38.49%	-37.22%
18	2009	-0.40%	15.00%	3.46%	23.65%	27.11%
19	2010	1.60%	15.00%	2.24%	12.63%	14.87%
20	2011	3.20%	15.00%	1.97%	0.10%	2.07%
21	2012	2.10%	15.00%	2.59%	13.29%	15.88%
22	2013	1.50%	15.00%	3.00%	29.43%	32.43%
23	2014	1.60%	15.00%	2.27%	11.54%	13.81%
24	2015	0.10%	15.00%	2.04%	-0.73%	1.31%
25	2016	1.30%	15.00%	2.39%	9.54%	11.93%
26	2017	2.10%	15.00%	2.52%	19.42%	21.94%
27	2018	2.40%	12.00%	1.83%	-6.24%	-4.41%
28	2019	1.80%	12.00%	2.86%	28.88%	31.74%
29	2020	1.20%	12.00%	2.12%	16.26%	18.38%
30	2021	4.80%	12.00%	1.94%	26.89%	28.83%

S&P CAGR (Geometric Mean): 10.66%

Cash Flow

Beg. Balance	Capital Gains	Dividend Income	Add'l Contrib	Mortgage Payment	Mortgage Tax Benefit	Div Yield Taxes	Cap Gains Taxes	End. Acct. Balance
\$ 200,000	\$ 8,960	\$ 6,240	\$ 15,000	\$ (11,690)	\$ 1,202	\$ (936)	\$ -	\$ 218,775
218,775	15,467	6,782	15,450	(11,690)	1,157	(1,017)	-	244,925
244,925	(3,821)	6,735	15,852	(11,690)	1,110	(1,010)	-	252,100
252,100	86,042	9,807	16,296	(11,690)	1,058	(1,471)	-	352,141
352,141	71,344	9,860	16,768	(11,690)	1,002	(1,479)	-	437,946
437,946	133,807	11,649	17,154	(11,504)	875	(1,747)	-	590,180
590,180	157,401	12,158	17,428	(11,504)	813	(1,824)	-	764,651
764,651	149,336	12,081	17,812	(11,504)	746	(1,812)	-	931,310
931,310	(94,435)	9,592	18,417	(11,504)	674	(1,439)	-	852,616
852,616	(111,181)	9,038	18,933	(11,504)	597	(1,356)	-	757,143
757,143	(176,944)	8,329	19,236	(11,414)	461	(1,249)	-	595,561
595,561	157,109	13,936	19,678	(11,414)	380	(2,090)	-	773,161
773,161	69,507	14,149	20,210	(11,414)	294	(2,122)	-	863,785
863,785	25,914	15,462	20,897	(11,414)	202	(2,319)	-	912,526
912,526	124,104	19,528	21,565	(11,414)	104	(2,929)	-	1,063,484
1,063,484	37,435	20,632	22,191	-	-	(3,095)	-	1,140,647
1,140,647	(439,035)	14,486	23,034	-	-	(2,173)	-	736,959
736,959	174,291	25,499	22,942	-	-	(3,825)	-	955,866
955,866	120,726	21,411	23,309	-	-	(3,212)	-	1,118,100
1,118,100	1,118	22,027	24,055	-	-	(3,304)	-	1,161,996
1,161,996	154,429	30,096	24,560	-	-	(4,514)	-	1,366,567
1,366,567	402,181	40,997	24,928	-	-	(6,150)	-	1,828,523
1,828,523	211,012	41,507	25,327	-	-	(6,226)	-	2,100,143
2,100,143	(15,331)	42,843	25,353	-	-	(6,426)	-	2,146,581
2,146,581	204,784	51,303	25,682	-	-	(7,695)	-	2,420,655
2,420,655	470,091	61,001	26,222	-	-	(9,150)	-	2,968,819
2,968,819	(185,254)	54,329	26,851	-	-	(6,520)	-	2,858,225
2,858,225	825,455	81,745	27,334	-	-	(9,809)	-	3,782,950
3,782,950	615,108	80,199	27,662	-	-	(9,624)	-	4,496,295
4,496,295	1,209,054	87,228	28,990	-	-	(10,467)	(660,101)	5,150,999

Mortgage Amortization

Interest Rate	After-Tax Rate	Beginning Balance	Principal Paid	Refi Fees	End. Balance	Ending Net Worth
8.01%	6.81%	\$ 100,000	\$ (3,680)	\$ -	\$ 96,320	\$ 122,456
8.01%	6.81%	96,320	(3,975)	-	92,345	152,580
8.01%	6.81%	92,345	(4,293)	-	88,052	164,048
8.01%	6.81%	88,052	(4,637)	-	83,415	268,726
8.01%	6.81%	83,415	(5,009)	1,176	79,582	358,364
7.33%	6.23%	79,582	(5,671)	-	73,911	516,268
7.33%	6.23%	73,911	(6,086)	-	67,825	696,827
7.33%	6.23%	67,825	(6,533)	-	61,292	870,018
7.33%	6.23%	61,292	(7,011)	-	54,281	798,335
7.33%	6.23%	54,281	(7,525)	701	47,457	709,686
6.48%	5.51%	47,457	(8,338)	-	39,118	556,443
6.48%	5.51%	39,118	(8,879)	-	30,240	742,921
6.48%	5.51%	30,240	(9,454)	-	20,786	842,999
6.48%	5.51%	20,786	(10,067)	-	10,719	901,807
6.48%	5.51%	10,719	(10,719)	-	-	1,063,484
-	-	-	-	-	-	1,140,647
-	-	-	-	-	-	736,959
-	-	-	-	-	-	955,866
-	-	-	-	-	-	1,118,100
-	-	-	-	-	-	1,161,996
-	-	-	-	-	-	1,366,567
-	-	-	-	-	-	1,828,523
-	-	-	-	-	-	2,100,143
-	-	-	-	-	-	2,146,581
-	-	-	-	-	-	2,420,655
-	-	-	-	-	-	2,968,819
-	-	-	-	-	-	2,858,225
-	-	-	-	-	-	3,782,950
-	-	-	-	-	-	4,496,295
-	-	-	-	-	-	5,150,999

Beginning Account Balance	\$ 200,000
Capital Gains	4,400,672
Dividend Income	840,649
Wage Income	649,136
Mortgage Payments	(173,039)
Taxes on Dividends	(116,992)
Mortgage Tax Breaks	10,674
Deferred Capital Gains Taxes	(660,101)
Ending Net Worth	\$5,150,999

## Historical Analysis Summary (30-Year Look Back)

	Excluding Taxes		Including Taxes	
	30-yr Borrower	15-yr Borrower	30-yr Borrower	15-yr Borrower
Ending Net Worth	\$ 6,108,982	\$ 6,126,029	\$ 5,166,485	\$ 5,150,999
Relative Benefit (Cost) (Future Value)	\$ (17,047)	\$ 17,047	\$ 15,487	\$ (15,487)
Relative Benefit (Cost) (Present Value)	\$ (8,563)	\$ 8,563	\$ 7,780	\$ (7,780)
As % of Net Worth	-0.14%	0.14%	0.15%	-0.15%
As % of Original Mortgage Amount	-8.56%	8.56%	7.78%	-7.78%

**Advantage:**

**15-yr Borrower**

**30-yr Borrower**



# Mortgage or Nah? Crunching the Numbers.

Vanguard's Market Assumptions

Run Simulation

## Portfolio Statistics & Mortgage Assumptions

### Portfolio Allocation

U.S. Equity (S&P 500) 100.00%

### Long-Term Capital Market Assumptions

Expected Return 3.20%  
 Volatility (St. Deviation) 16.30%  
 Discount Rate (0% Indicates FV Dollars) 0.00%

Source indicated in the header, above.

### Mortgage Assumptions

Size \$ 100,000  
 Interest Rate 3.500%  
 Closing Costs (% of Loan) 0.000%

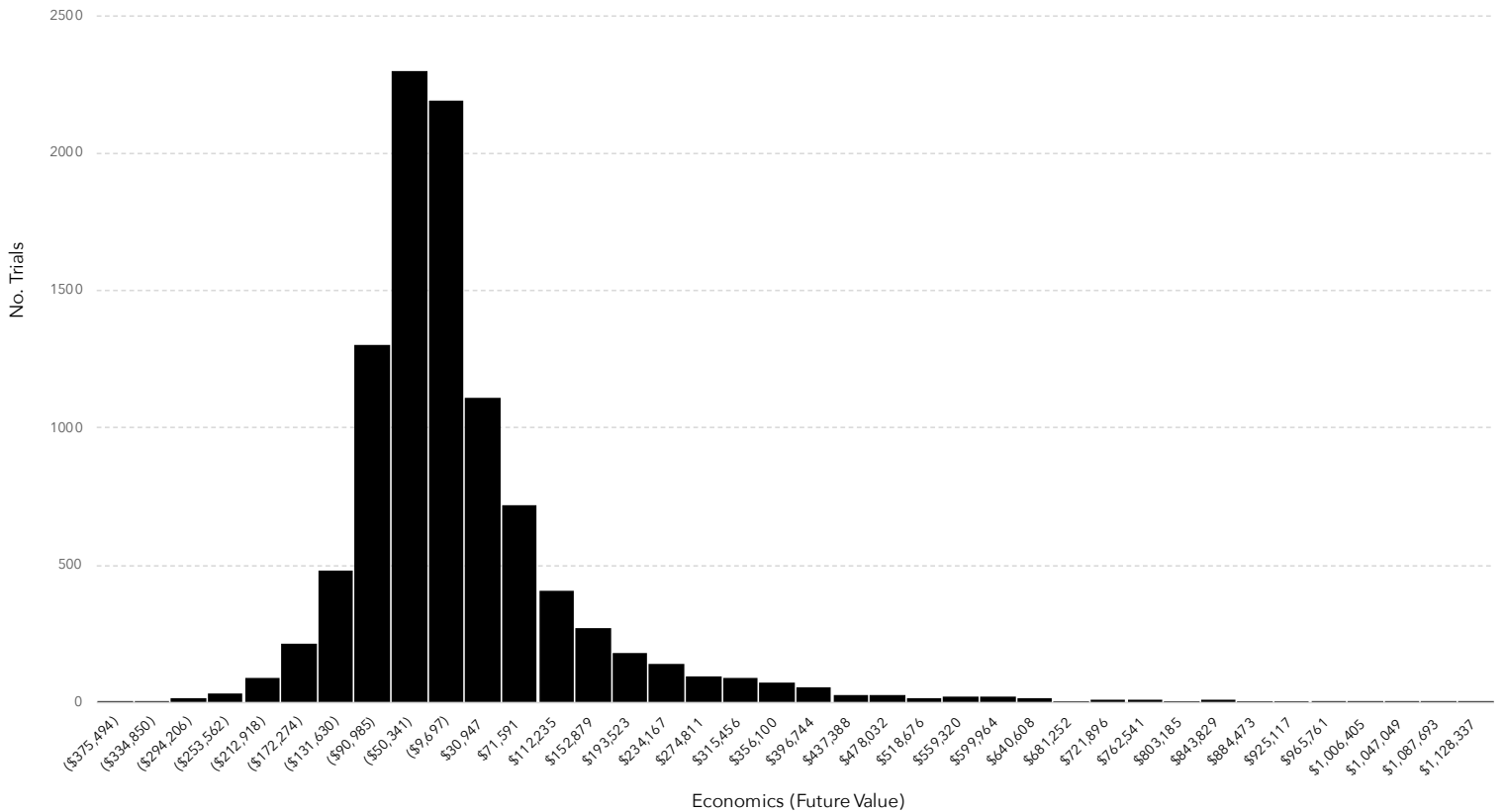
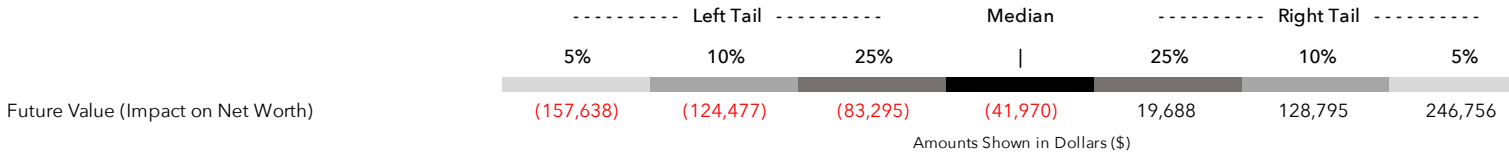
Mortgage is amortized over a 30-year period in equal principal and interest installments.

## Simulation (10,000 Trials) | Frequency of Success: Perspective of Mortgage Borrower

The percentage of simulation trials in which the individual was better off using a mortgage to maximize stock investments.



## Frequency Distribution | Perspective of Mortgage Borrower



Analytics performed in Kansas, the personal finance capital of the world.

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# Mortgage or Nah? Crunching the Numbers.

**JP Morgan's Market Assumptions**

Run Simulation

## Portfolio Statistics & Mortgage Assumptions

### Portfolio Allocation

U.S. Equity (S&P 500) 100.00%

### Long-Term Capital Market Assumptions

Expected Return 5.16%  
 Volatility (St. Deviation) 15.02%  
 Discount Rate (0% Indicates FV Dollars) 0.00%

Source indicated in the header, above.

### Mortgage Assumptions

Size \$ 100,000  
 Interest Rate 3.500%  
 Closing Costs (% of Loan) 0.000%

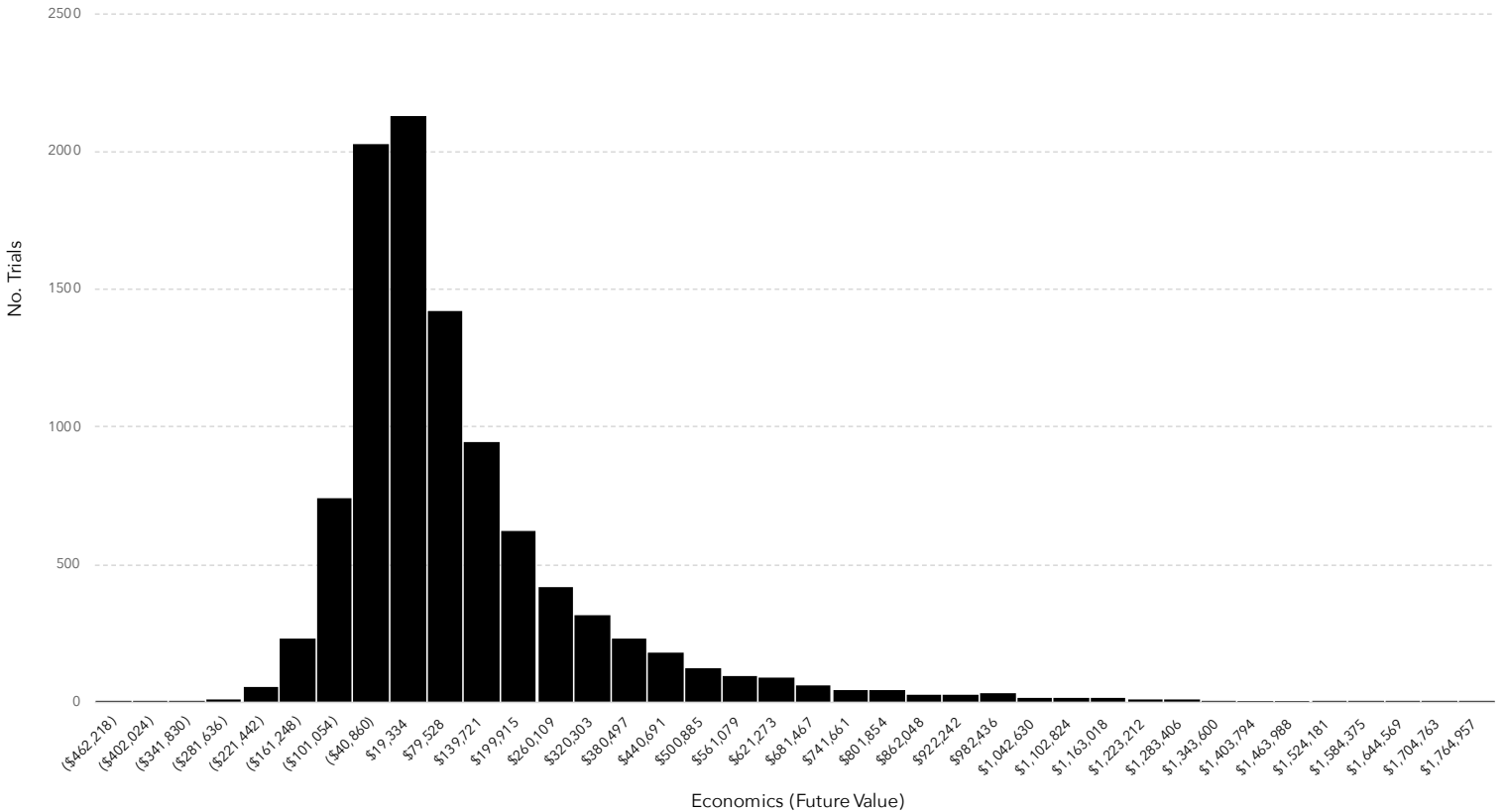
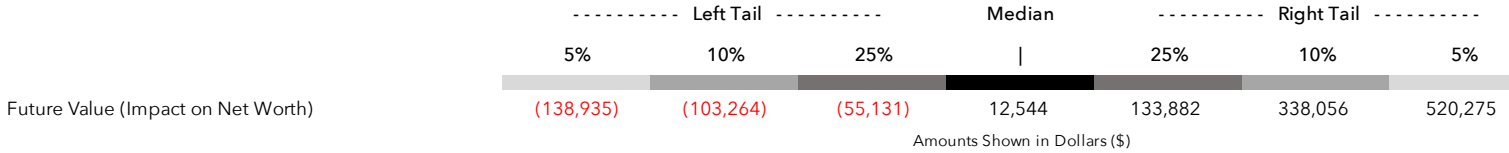
Mortgage is amortized over a 30-year period in equal principal and interest installments.

## Simulation (10,000 Trials) | Frequency of Success: Perspective of Mortgage Borrower

The percentage of simulation trials in which the individual was better off using a mortgage to maximize stock investments.



## Frequency Distribution | Perspective of Mortgage Borrower



Analytics performed in Kansas, the personal finance capital of the world.

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# Mortgage or Nah? Crunching the Numbers.

**BlackRock's Market Assumptions**

Run Simulation

## Portfolio Statistics & Mortgage Assumptions

### Portfolio Allocation

U.S. Equity (S&P 500) 100.00%

### Long-Term Capital Market Assumptions

Expected Return 7.20%  
 Volatility (St. Deviation) 16.50%  
 Discount Rate (0% Indicates FV Dollars) 0.00%  
Source indicated in the header, above.

### Mortgage Assumptions

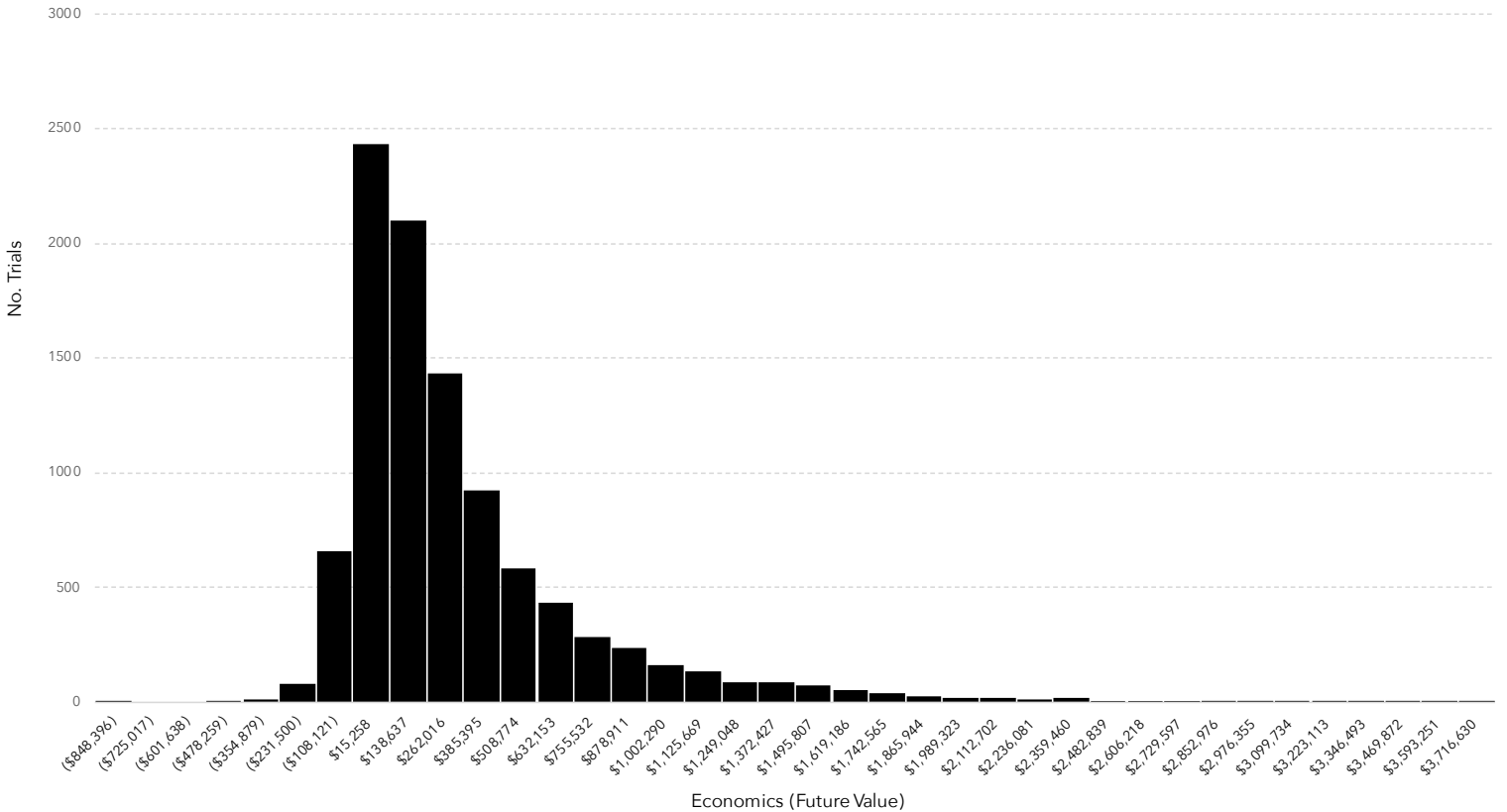
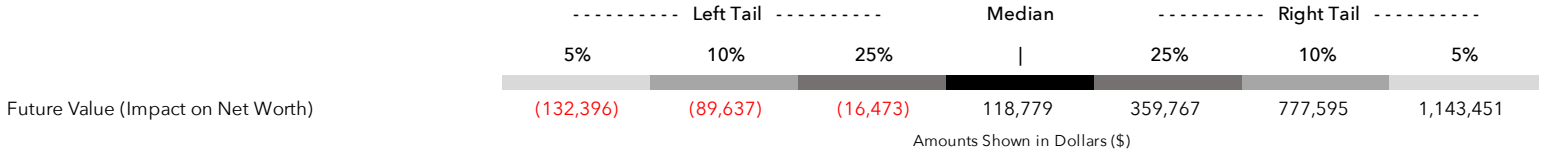
Size \$ 100,000  
 Interest Rate 3.500%  
 Closing Costs (% of Loan) 0.000%  
Mortgage is amortized over a 30-year period in equal principal and interest installments.

## Simulation (10,000 Trials) | Frequency of Success: Perspective of Mortgage Borrower

The percentage of simulation trials in which the individual was better off using a mortgage to maximize stock investments..



## Frequency Distribution | Perspective of Mortgage Borrower



Analytics performed in Kansas, the personal finance capital of the world.

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# Mortgage or Nah? Crunching the Numbers.

**Break-Even Analysis**

**5.25% market return**

Run Simulation

## Portfolio Statistics & Mortgage Assumptions

### Portfolio Allocation

U.S. Equity (S&P 500) 100.00%

### Long-Term Capital Market Assumptions

Expected Return 5.25%  
 Volatility (St. Deviation) 17.35%  
 Discount Rate (0% Indicates FV Dollars) 0.00%  
Source indicated in the header, above.

### Mortgage Assumptions

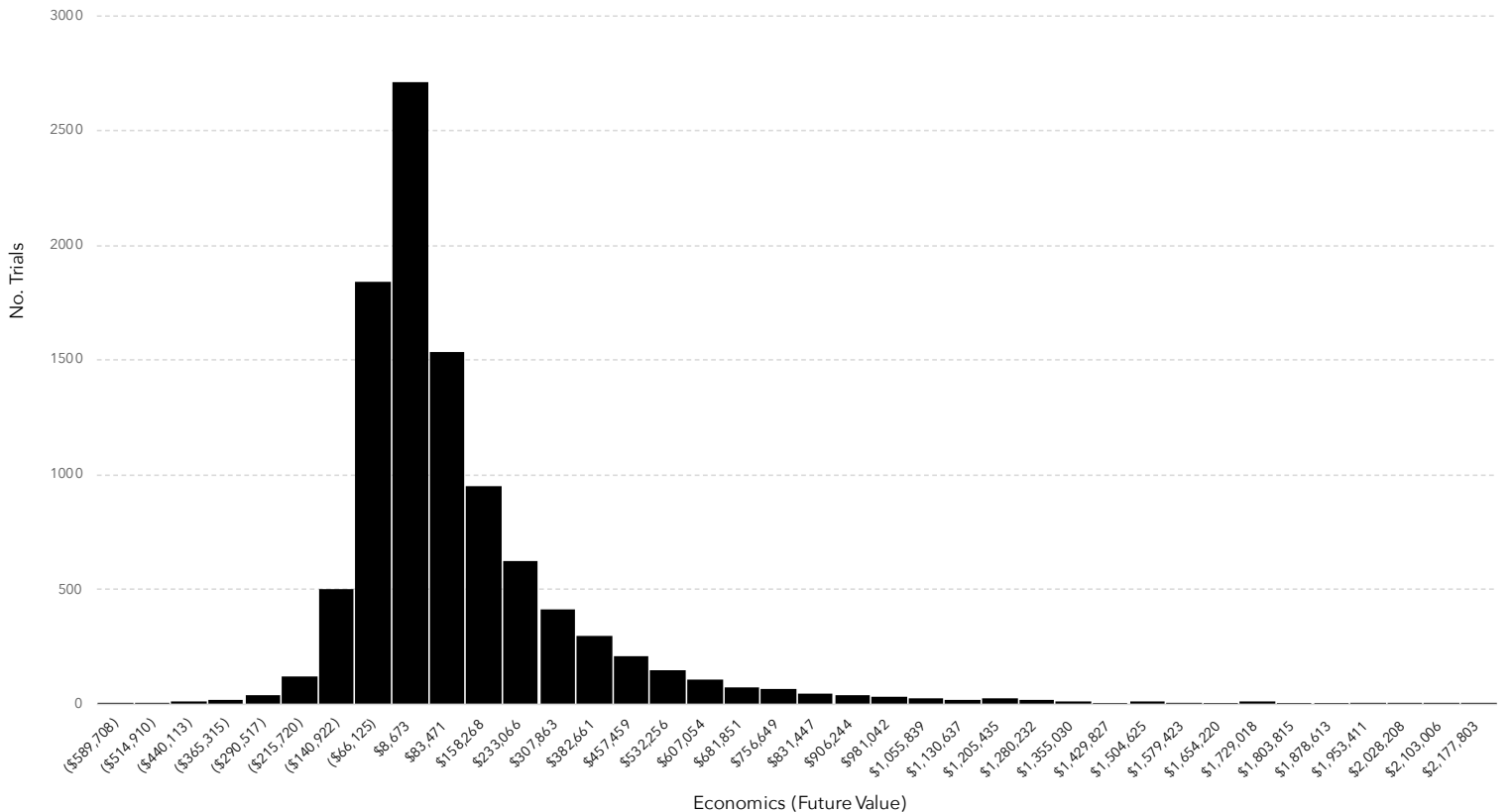
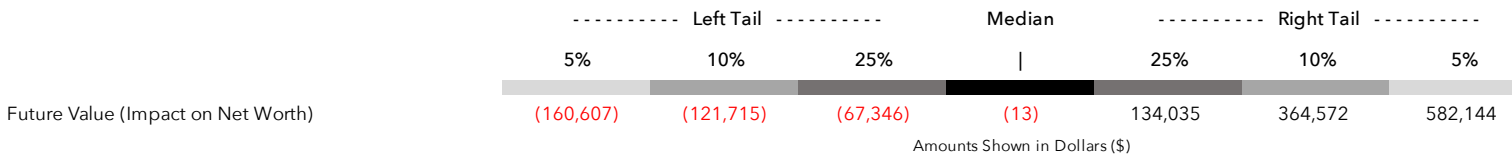
Size \$ 100,000  
 Interest Rate 3.500%  
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# Mortgage or Nah? Crunching the Numbers.

## Historical Market Performance

Run Simulation

### Portfolio Statistics & Mortgage Assumptions

#### Portfolio Allocation

U.S. Equity (S&P 500) 100.00%

#### Long-Term Capital Market Assumptions

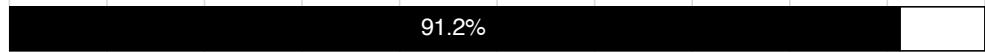
Expected Return 10.66%  
 Volatility (St. Deviation) 17.35%  
 Discount Rate (0% Indicates FV Dollars) 0.00%  
Source indicated in the header, above.

#### Mortgage Assumptions

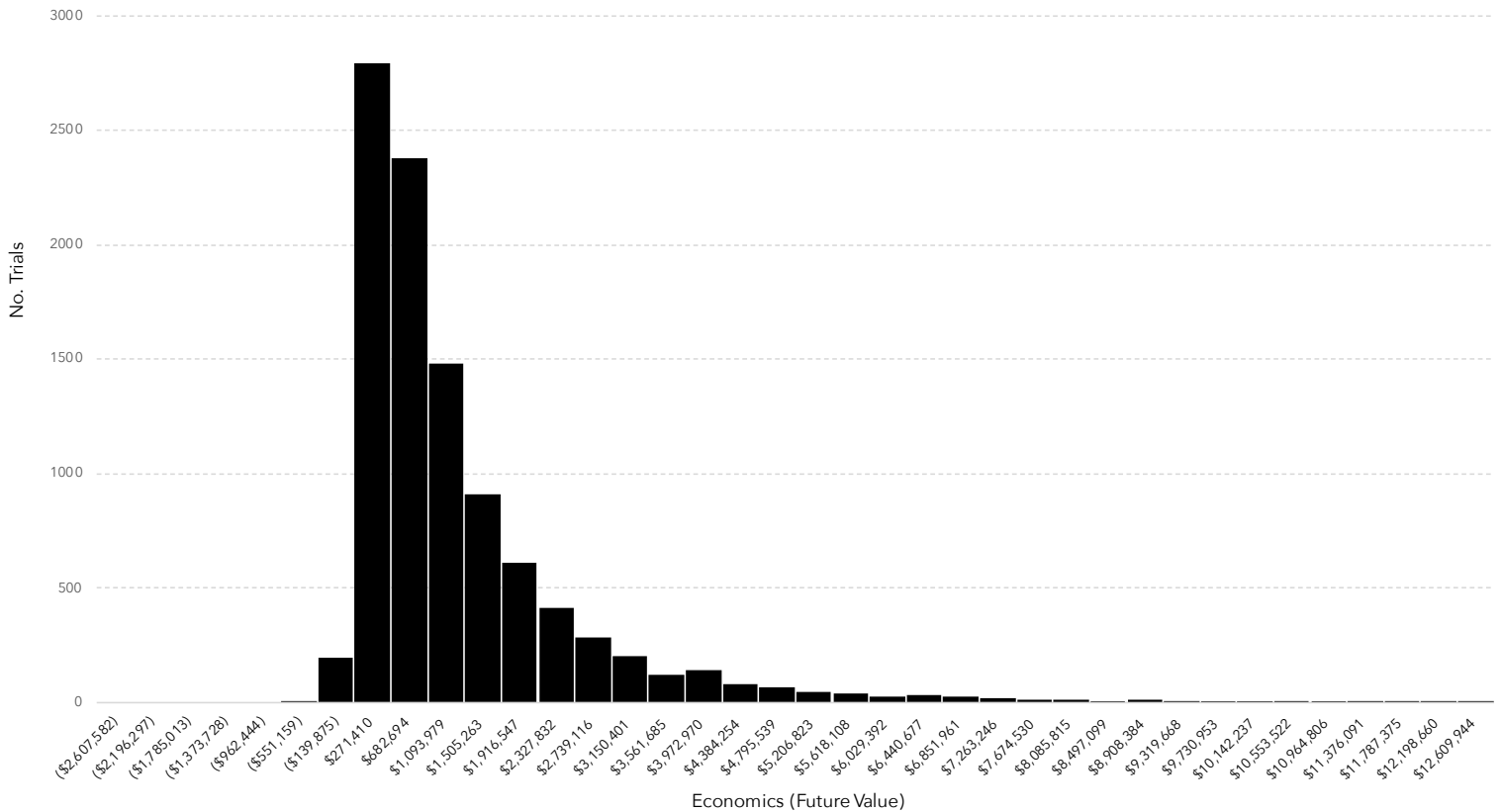
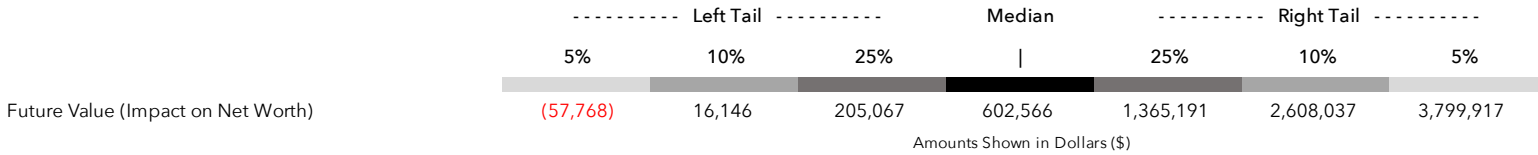
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### Frequency Distribution | Perspective of Mortgage Borrower



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