

The Theory of Optimal Life-Cycle Saving and Investing

Paul Willen (joint with Zvi Bodie and Jonathan Treussard)

Federal Reserve Bank of Boston

Q-Group Spring Seminar, March 31, 2008

Disclaimer

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- The do not necessarily reflect the views of
 - The Boston Fed
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 - Let's try to make life-cycle portfolio choice accessible.
 - Practitioners
 - Key lessons
 - Wide audience
- I said:
 - No problem!

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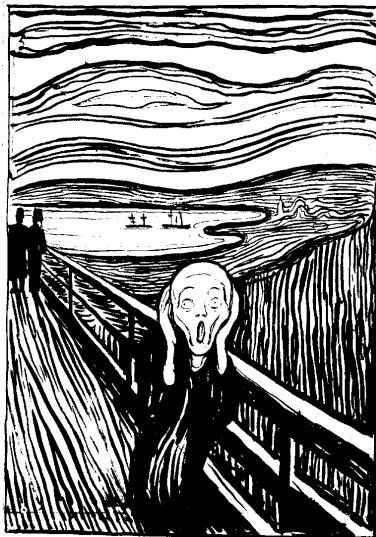
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- There are N states of the world indexed by $\omega \in \Omega$ and $T + 1$ time period $t = 0, 1, 2, \dots, T$. An event tree describes the information structure of the economy and $\{F_t; t = 0, \dots, T\}$ is the sequence of partitions of Ω corresponding to the tree. All stochastic processes are adapted to the filtration generated by the $\{F_t\}$.
- At each date there are $K + 1$ securities available for trading in frictionless markets, with $K \geq 0$. We use S_t^k to denote the price of security k at time t , $\{S_t = (S_t^0, S_t^1, \dots, S_t^K)'; t = 0, 1, \dots, T\}$ to denote the price of securities price process and assume that $|S_t^k| < +\infty$ for $t = 0, 1, \dots, T$ and $K = 0, 1, 2, \dots, k$. For convenience we assume that the securities pay no dividends. This affects nothing.

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Brief history

- Zvi, Jonathan and I wrote this paper in October of 2006.
- Mortgages were just part of my research agenda then...

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Today's presentation

- Do two things:
 - 1 Review the basic points of the paper
 - Describe the model
 - Focus on the key insights
 - 2 Life-cycle analysis and the subprime crisis
 - Understanding the crisis
 - Evaluating policy responses

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LC Model

- “Life-Cycle” or LC
 - Not really
 - No “re-birth”!
 - “Life Course”
- Not just time
 - Different outcomes
 - “Contingencies”

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(2) Prime Earning Years
(36-65)

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(3) Retirement (66-80)

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Start

Income: \$30,000 a year

(1) Youth (21-35)

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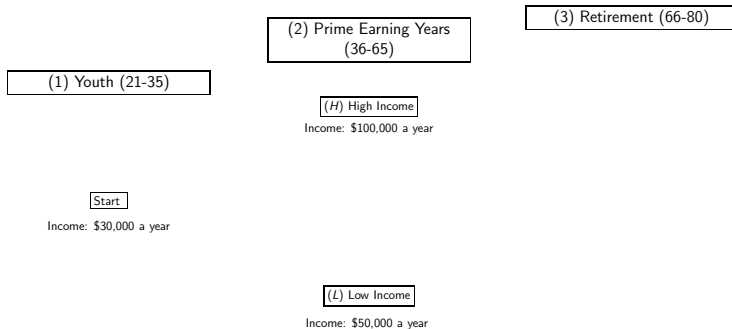
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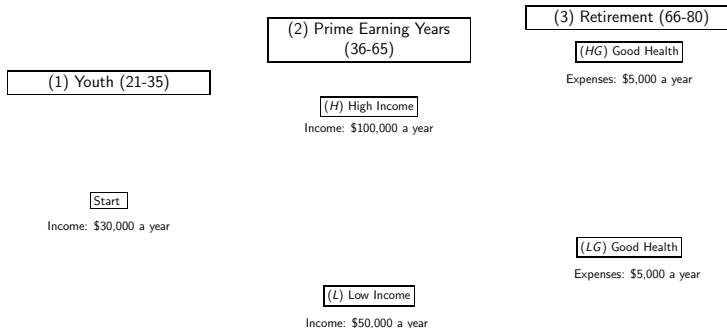
(H) High Income

Income: \$100,000 a year

Start

Income: \$30,000 a year





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Expenses: \$5,000 a year

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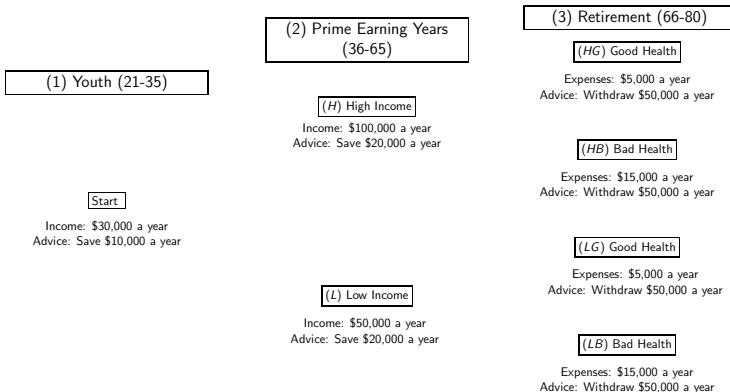
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- Consider a portfolio strategy



- Consider a portfolio strategy
- Don't care about accumulation, returns.

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- Consider a portfolio strategy
- Don't care about accumulation, returns.
- Key is implied consumption flow

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 - lots of consumption...
 - very little consumption...

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- Smooth consumption

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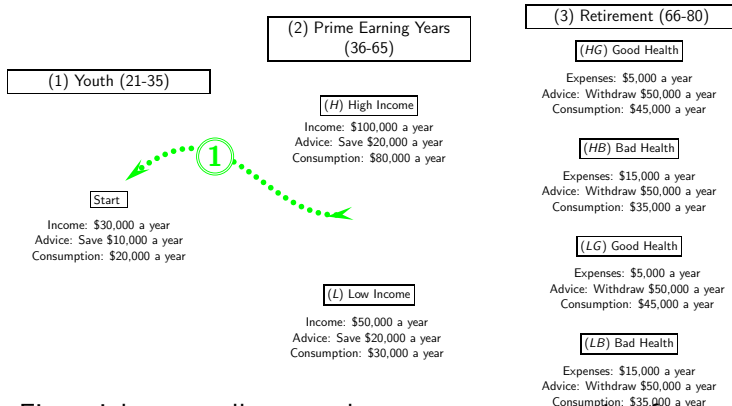
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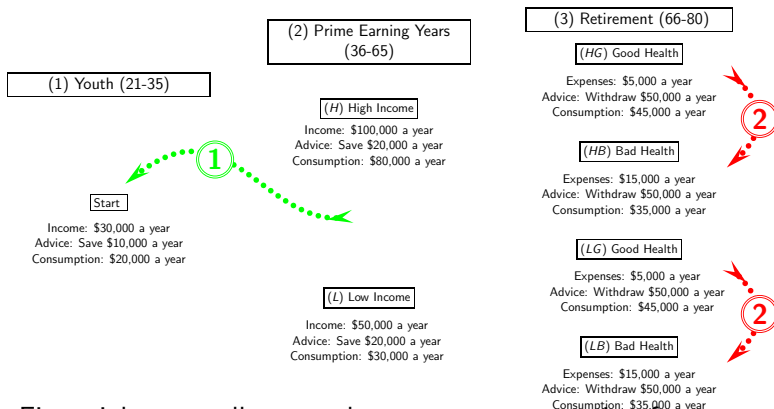
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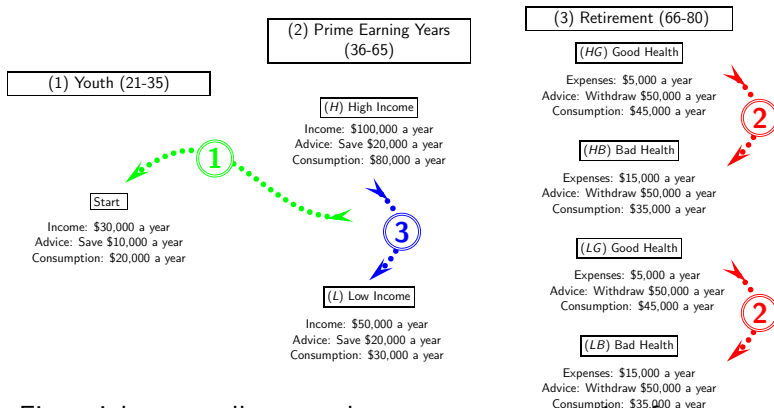
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- 2 Health insurance



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- 1 Borrowing
- 2 Health insurance
- 3 "Income Insurance"

Brief Overview

- Three insights from the LC model:
 - 1 The role of human capital
 - 2 Risky assets in the LC model
 - 3 Portfolio constraints

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The role of human capital

- How much money does an investor have to invest?
 - Financial wealth
 - + using financial assets, he can transfer all his future labor income to the present
 - We call that *human wealth*
- Total wealth

Total wealth = Financial wealth + Human wealth

The role of human capital

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- Human wealth is...

- Human wealth is...

1 huge

	35
Men with high school degree	25.9 (= $\frac{1,483,295}{57,264}$)
Men with high school degree	19.1 (= $\frac{629,378}{33,005}$)
Women with college degree	20.1 (= $\frac{792,354}{39,424}$)

- Human wealth is...
 - huge
 - differs across people

	25	35	45	55
Men with high school degree	47.4 (= $\frac{1,483,412}{31,297}$)	25.9 (= $\frac{1,483,295}{57,264}$)	15.9 (= $\frac{1,212,542}{76,385}$)	8.7 (= $\frac{691,057}{79,566}$)
Men with high school degree	29.7 (= $\frac{718,530}{24,199}$)	19.1 (= $\frac{629,378}{33,005}$)	12.8 (= $\frac{439,494}{34,301}$)	8.2 (= $\frac{219,269}{26,814}$)
Women with college degree	32.9 (= $\frac{881,762}{26,808}$)	20.1 (= $\frac{792,354}{39,424}$)	13.3 (= $\frac{580,133}{43,506}$)	7.0 (= $\frac{266,430}{38,064}$)

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- How should we view a \$250,000 portfolio?

- Human wealth is...
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- How should we view a \$250,000 portfolio?
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- How should we view a \$250,000 portfolio?
 - As almost 40% of a 45-year old high-school grad's *total* wealth?
 - As < 20% of a 45-year old college grad's?

Risky assets in the LC model

- Risky assets not about accumulation – transfers across time
- Transfer money across outcomes.

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This year

Next year

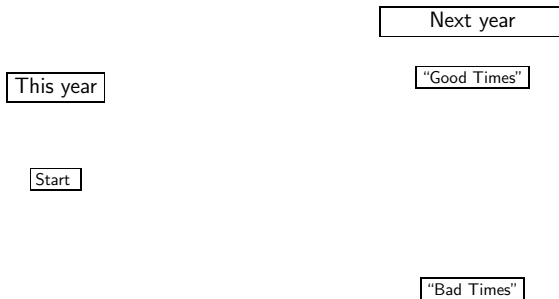
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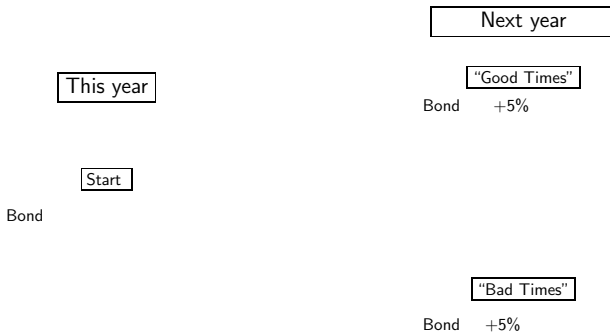
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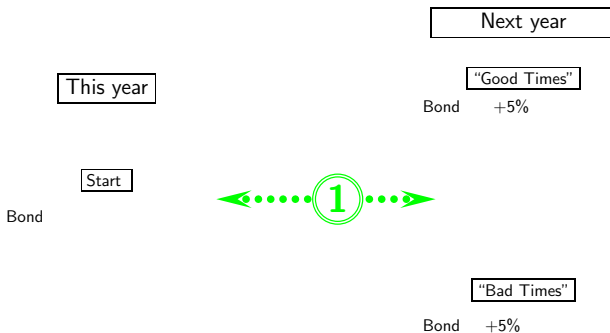




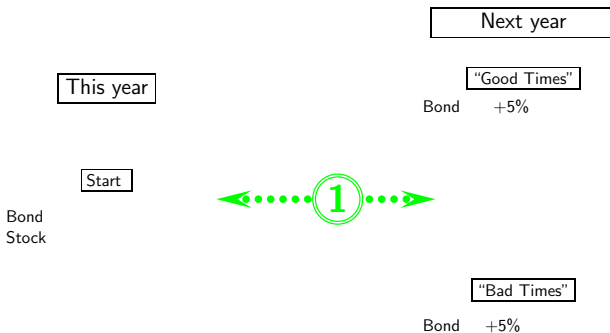




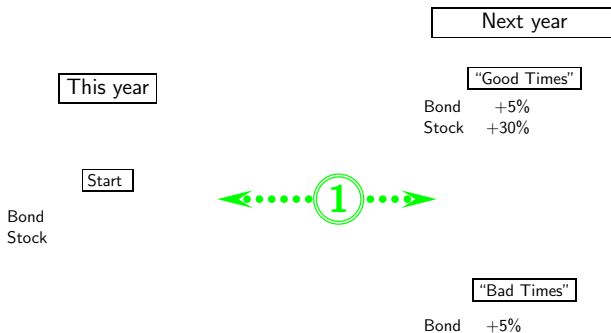




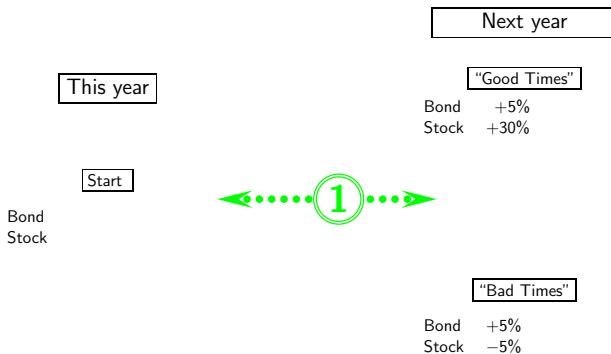
- 1 Bonds allow you to move money across time



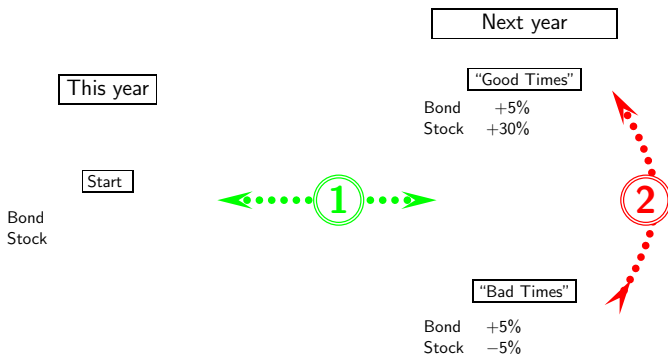
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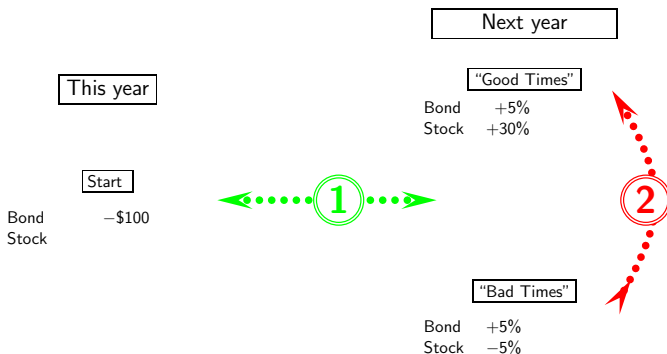
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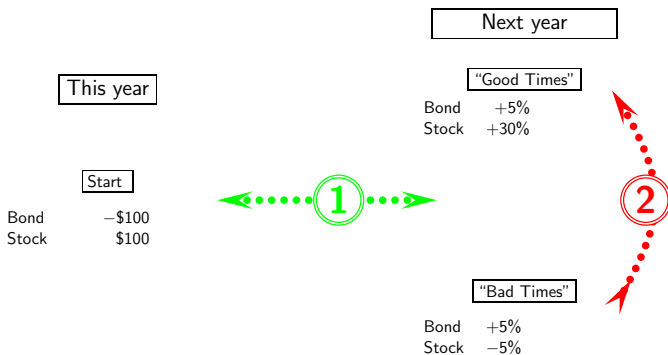
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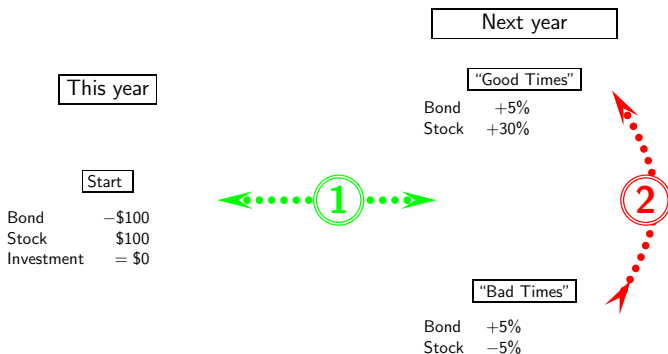
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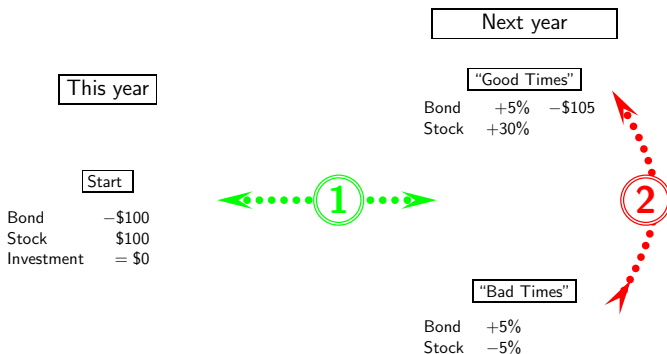
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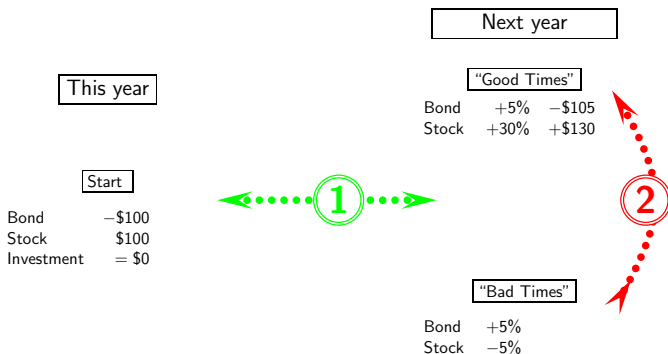
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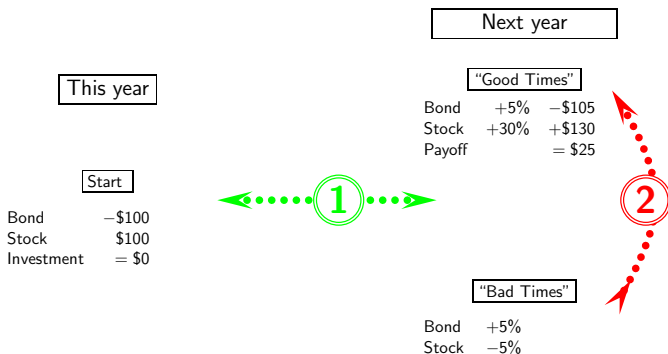
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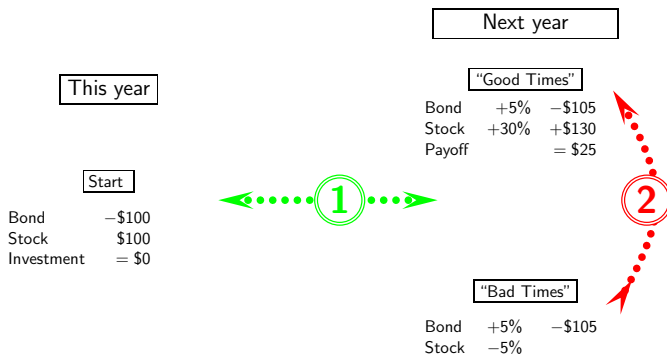
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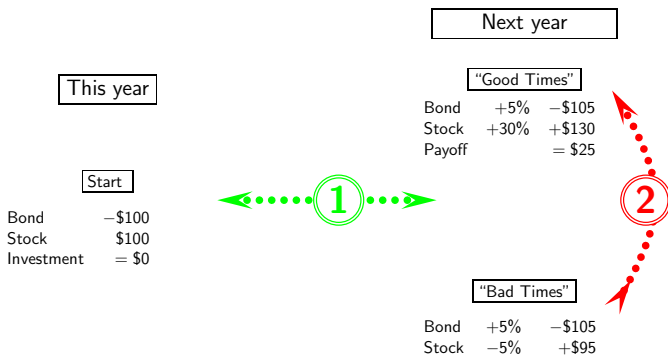
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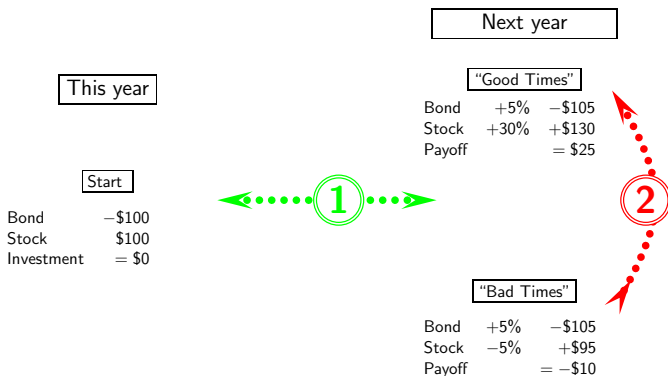
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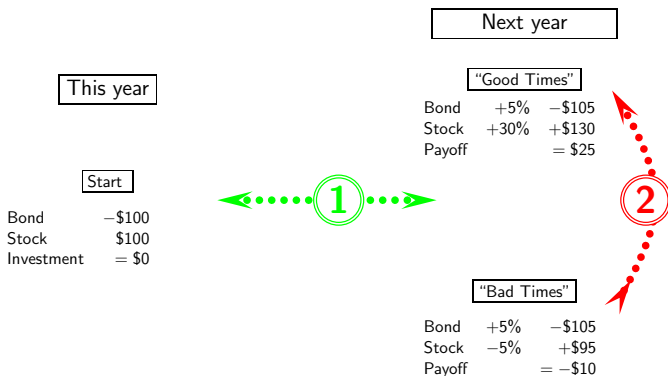
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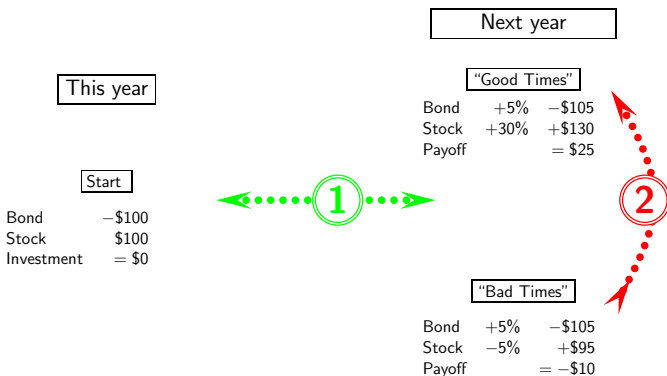
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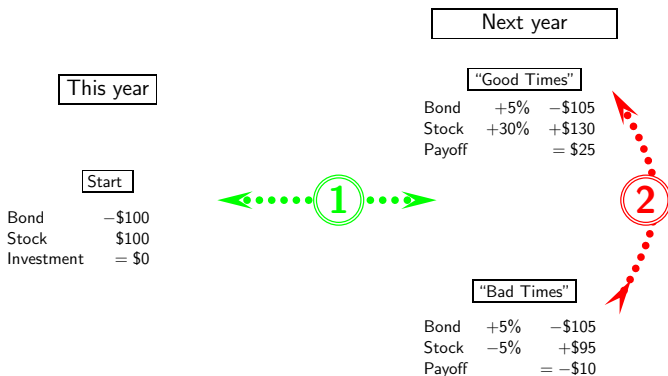
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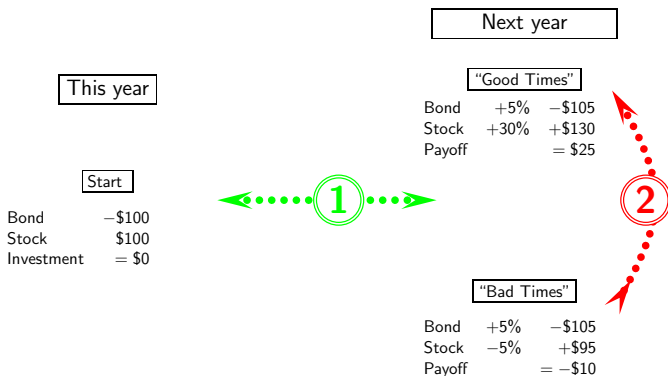
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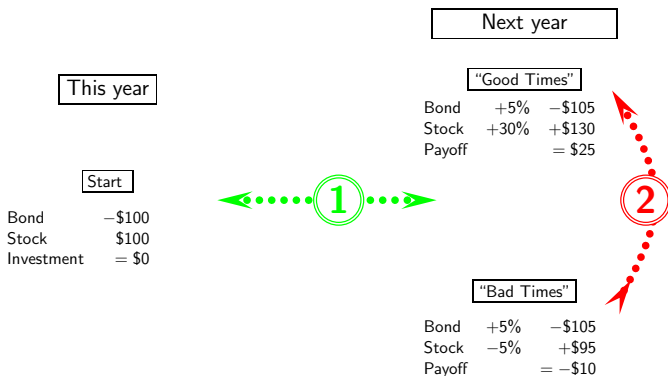
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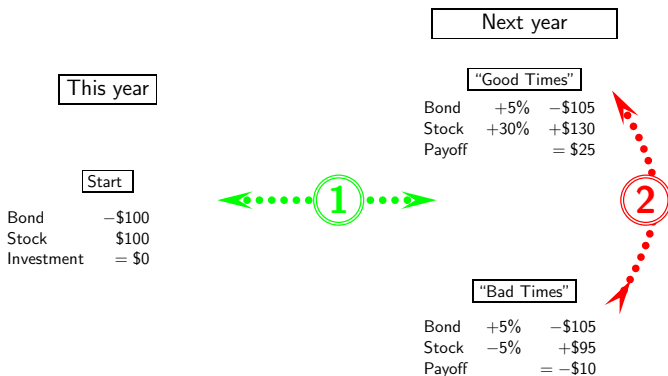
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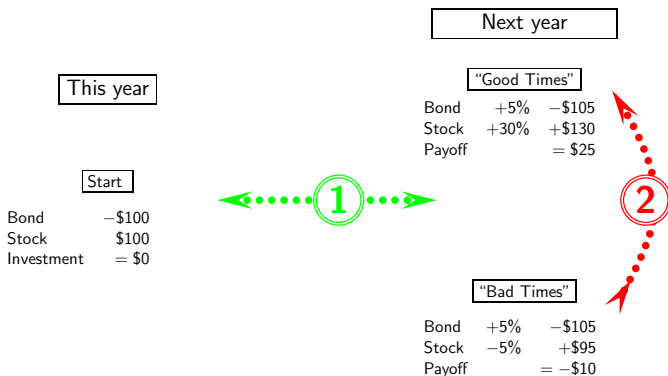
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- Makes sense for people if
 - Bad times aren't that bad – bankruptcy lawyer
- No free lunch.

Realistic constraints

- Assume move resources around at will.
 - Healthy to sick $\Leftarrow$ actuarially fair insurance
 - Good times to bad times $\Leftarrow$ unlimited short sales
 - Prime working years to youth $\Leftarrow$ unlimited borrowing
- Can we do this in real life? No.
- Research on portfolio choice with constraints
 - Short-sale constraints
 - Borrowing constraints
 - Collateral constraints

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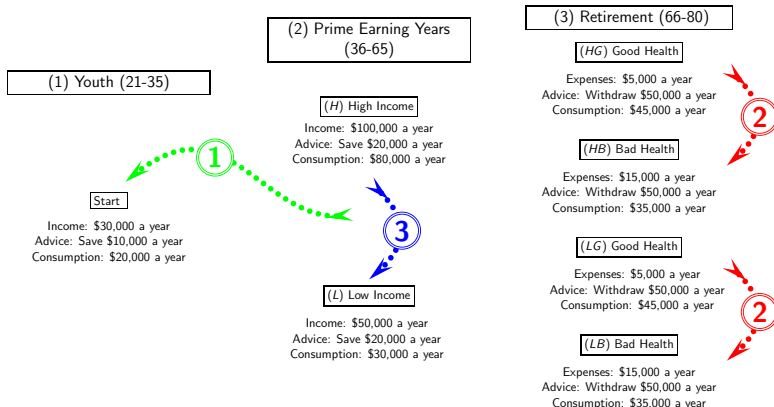
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Key issue: Cost of funds

- Source of funds:
 - Liquid assets
 - $\text{Cost} = \text{return on investments}$
 - Borrowing
 - $\text{Cost} = \text{borrowing interest rate}$
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 - $\text{Cost} = \text{relative value of consumption today and consumption in the future.}$
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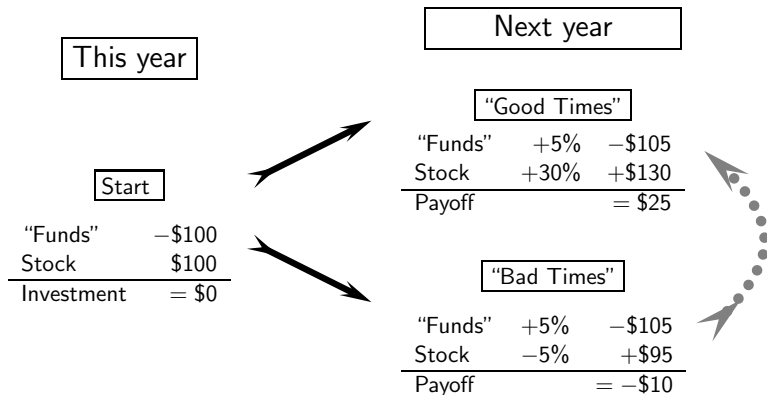
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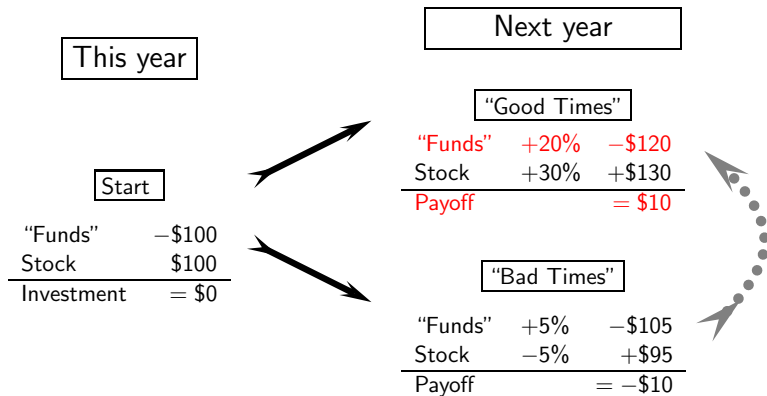
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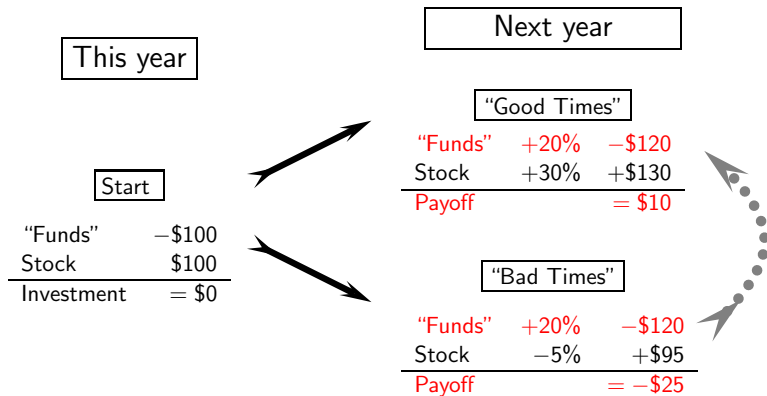
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Subprime!

- Do three things:
 - 1 Causes of the subprime crisis
 - 2 Life-cycle analysis of foreclosure decision
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Caveat

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We are learning new things every day

"Why, just fifty years ago, they thought a disease like your daughter's was caused by demonic possession or witchcraft. But nowadays we know that Isabelle is suffering from an imbalance of bodily humors, perhaps caused by a toad or a small dwarf living in her stomach."

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Figure: Theodoric of York, Medieval Barber (and intellectual)

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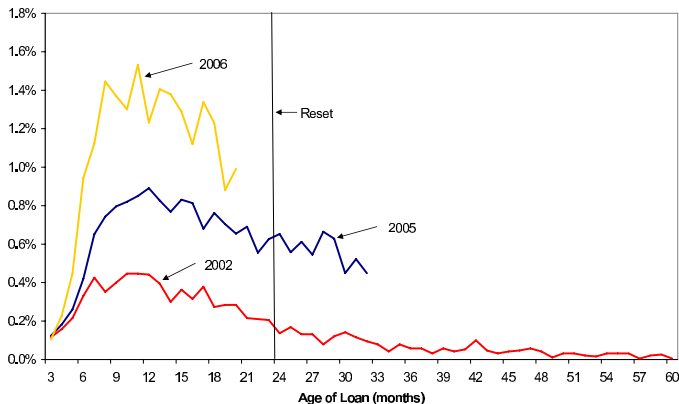
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Do borrowers default at ARM reset?

- Subprime 2/28s just in MA, CT and RI.

Default percentages - Subprime 2-28 ARMs



ARMs more generally

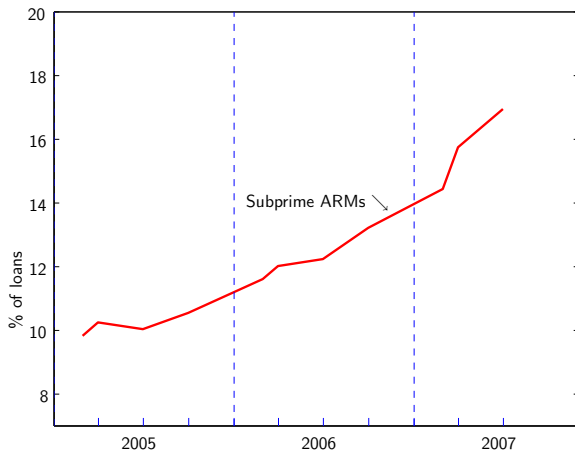
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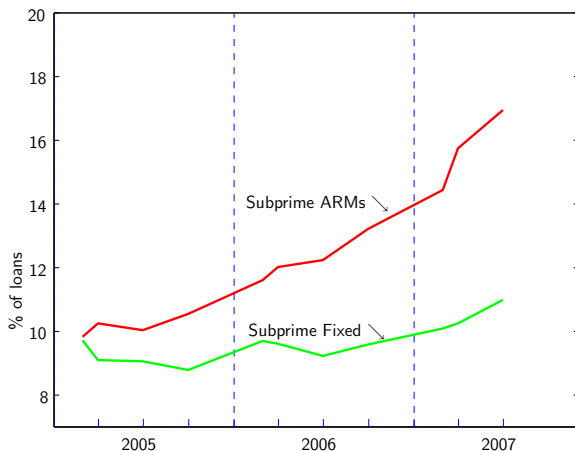
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- “Percentage of Loans Past Due”

$$= \frac{\text{Loans Past Due}}{\text{Total Loans}}$$

- What could make this number go up?
 - Higher delinquencies
 - Lower number of loans
- Problem here
 - Suppose a current borrower with a subprime ARM
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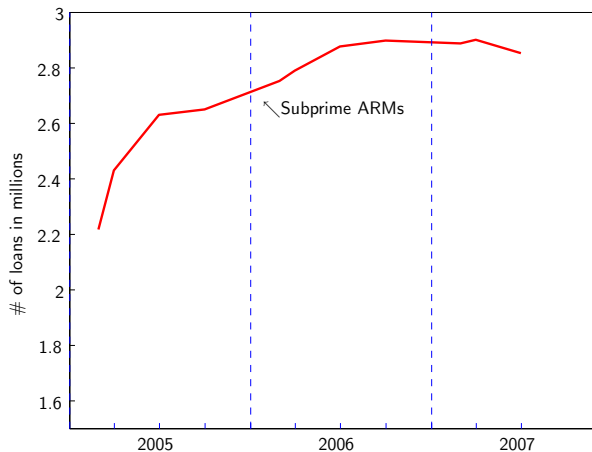
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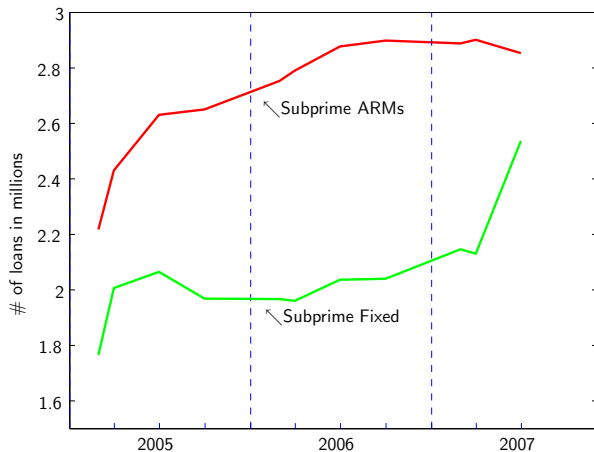
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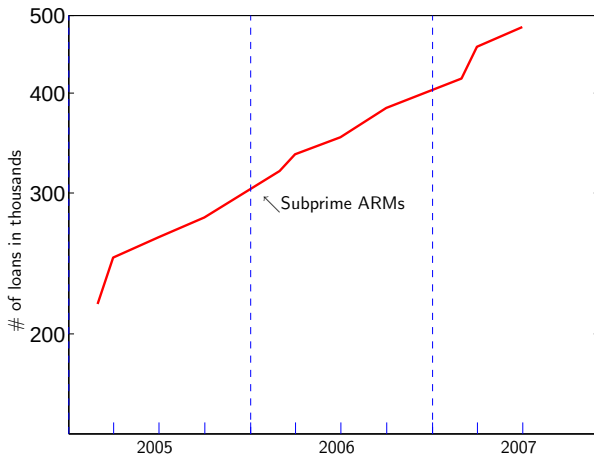
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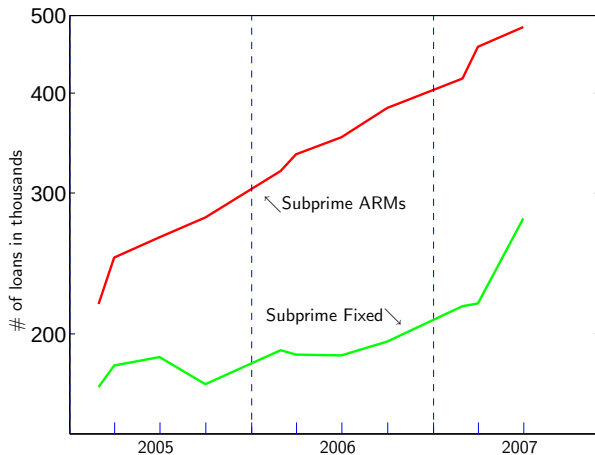
Simple adjustment

- Correct for the changing denominator
- By just looking at the numerator

Total number of past due loans

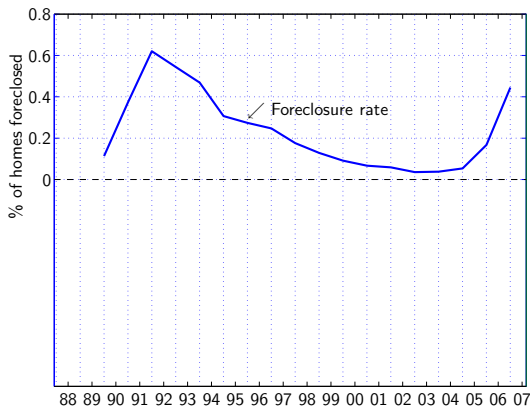


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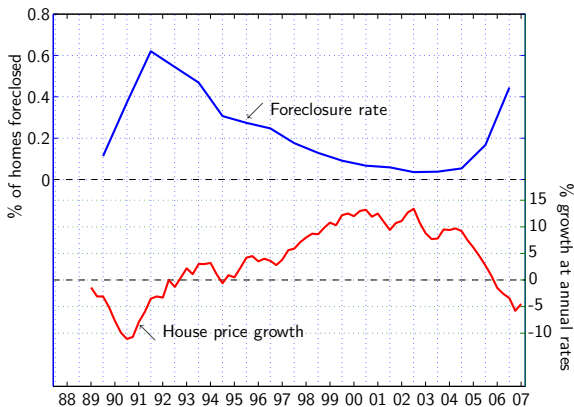
It's the house prices

Figure: Foreclosures and house prices in Mass., 1989-present. Source: Boston Fed and The Warren Group.



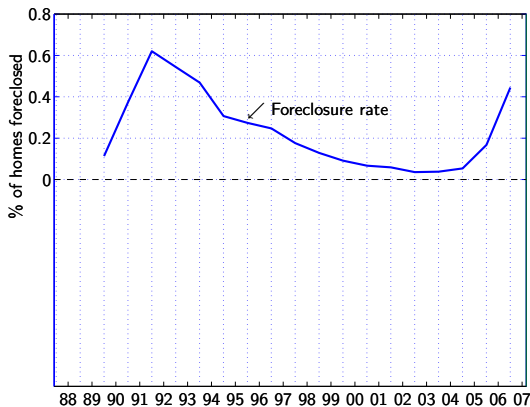
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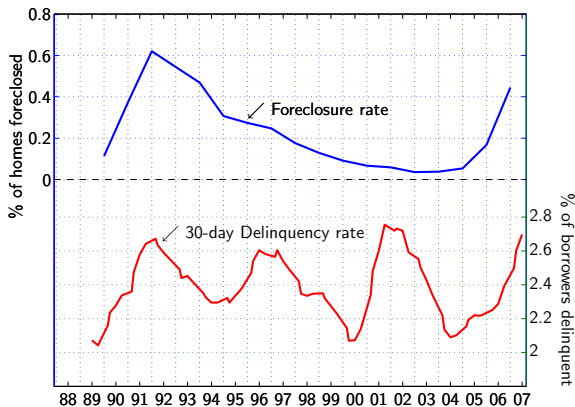
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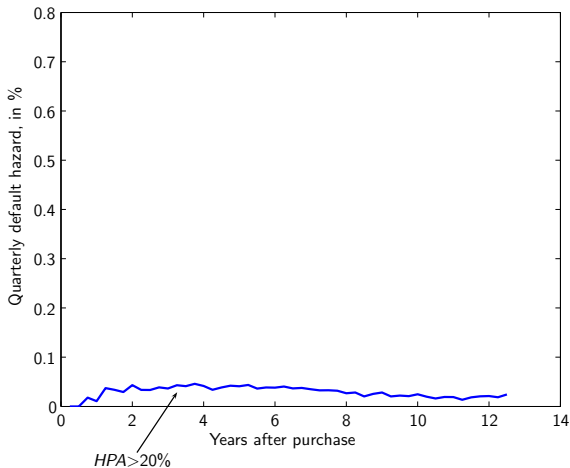


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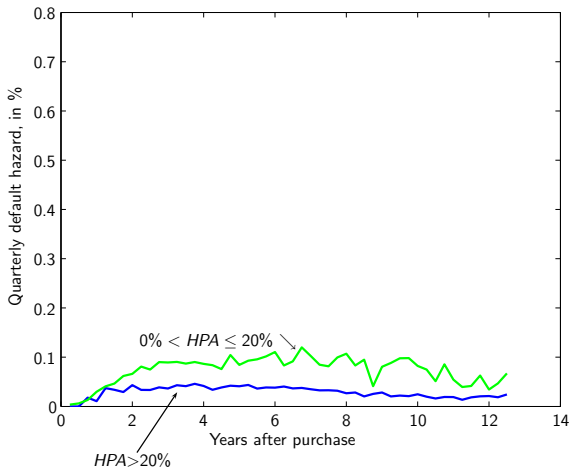
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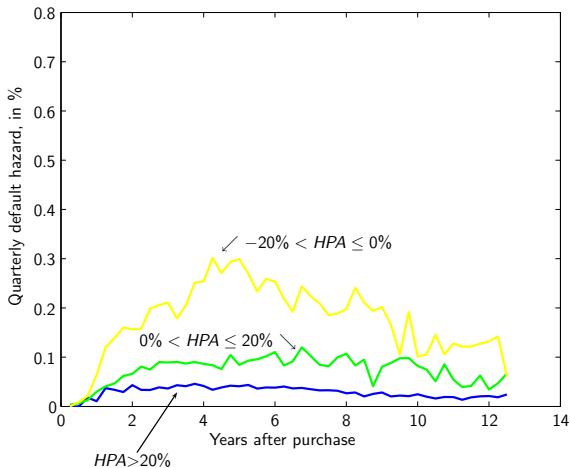
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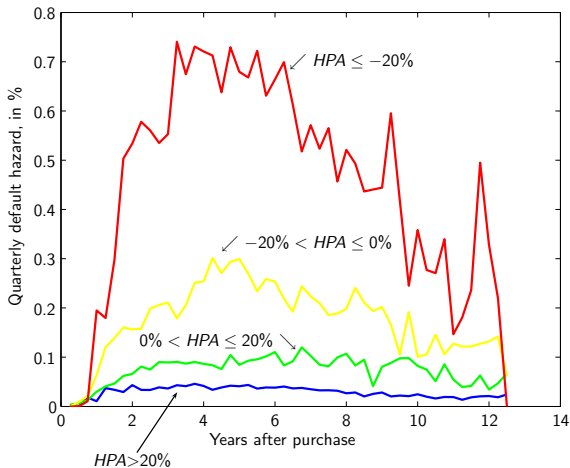
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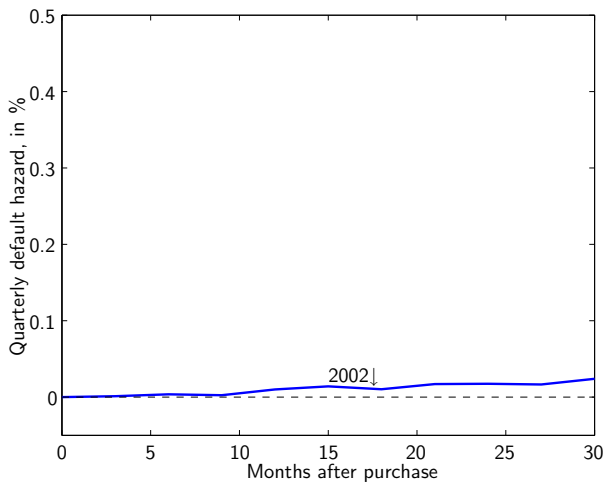
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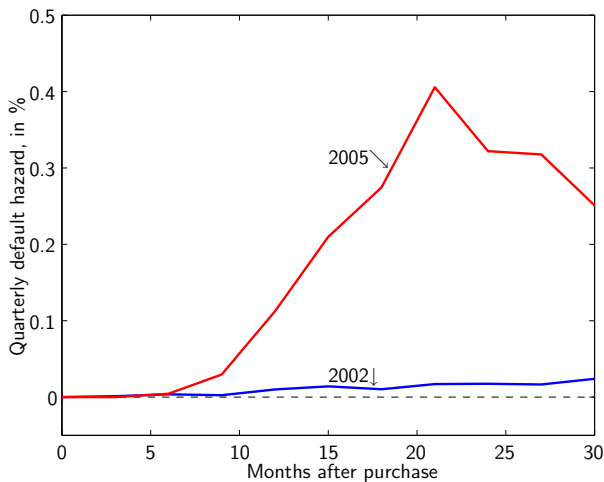
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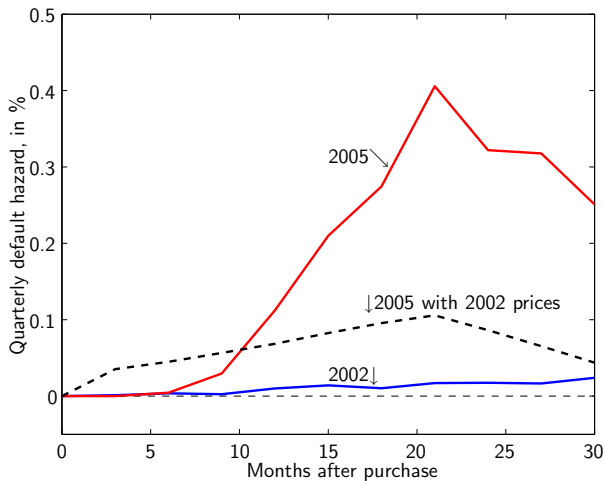
Bottom Line



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House prices and default

- Why does default when house prices fall?
- House price falls reduce equity:
 - $\text{Equity} = \text{House Price} - \text{Mortgage Balance}$
- Theory says:
 - Positive equity $\Rightarrow$ No foreclosures
 - borrower can sell the house
 - Almost no borrowers with positive equity default ($< 0.1\%$ at quarterly frequency)
- Does negative equity $\Rightarrow$ foreclosure?
 - NO!
 - Recall $< 1\%$ at quarterly frequency

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House prices and default

- Why does default when house prices fall?
- House price falls reduce equity:
 - $\text{Equity} = \text{House Price} - \text{Mortgage Balance}$
- Theory says:
 - Positive equity $\Rightarrow$ No foreclosures
 - borrower can sell the house
 - Almost no borrowers with positive equity default ($< 0.1\%$ at quarterly frequency)
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Table: Negative Equity Homeowners and Subsequent Foreclosures

# Negative Equity Homeowners in Q4, 1991			100,288
<i>who ended up in foreclosure in...</i>			
1	1992	Q1	618
2		Q2	542
3		Q3	610
4		Q4	606
5	1993	Q1	606
6		Q2	535
7		Q3	490
8		Q4	516
9	1994	Q1	490
10		Q2	543
11		Q3	480
12		Q4	417
Total			6,453
% of Negative Equity Homeowners			6.4

Why would someone with negative equity keep a house?

Price of House	\$200K
Mortgage balance	-\$225K

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Moving costs

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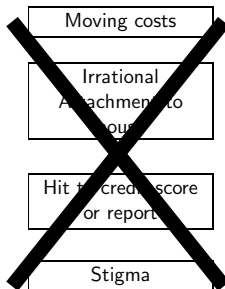
Irrational
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Stigma

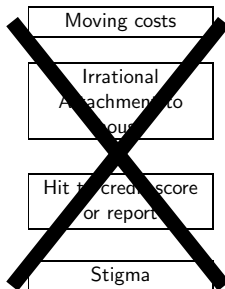
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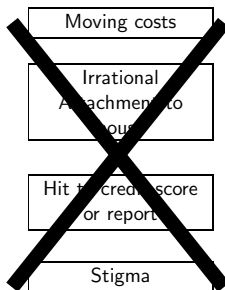
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You have a
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You have a zero-percent interest only mortgage

50% chance that the the price rises by 25% to \$250K in next year

“Asset K ”

2008

2013

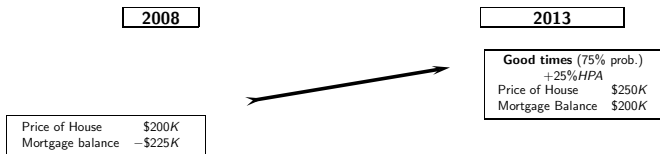
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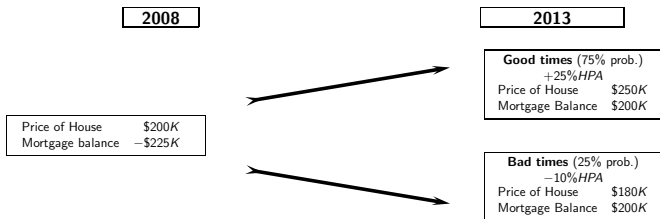
2013

Price of House	\$200 <i>K</i>
Mortgage balance	−\$225 <i>K</i>

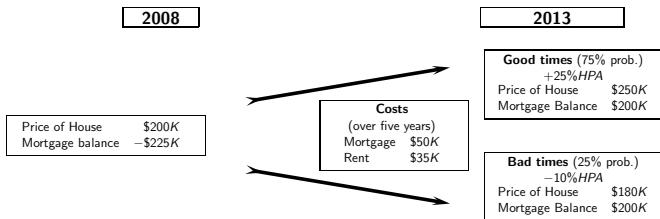
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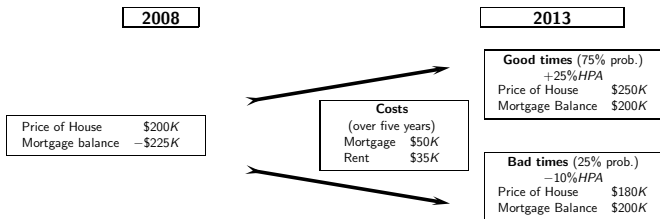
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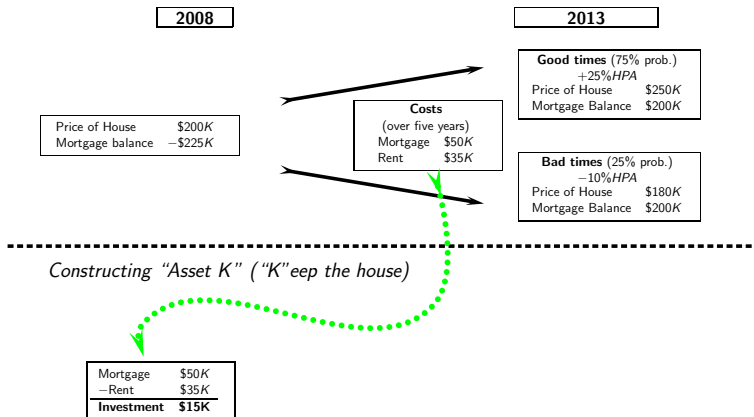


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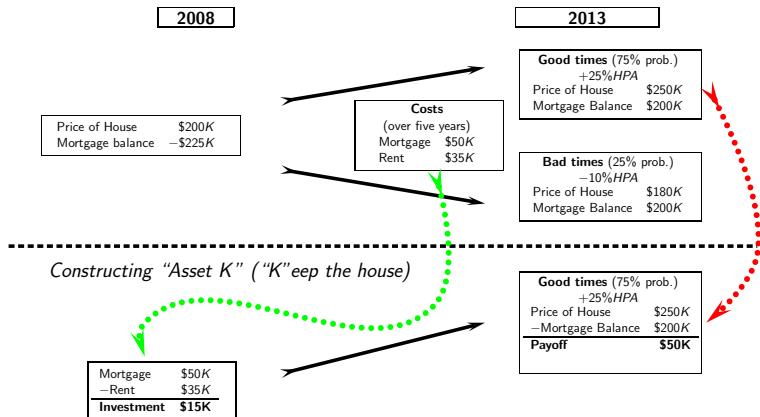


Constructing “Asset K” (“K”EEP the house)

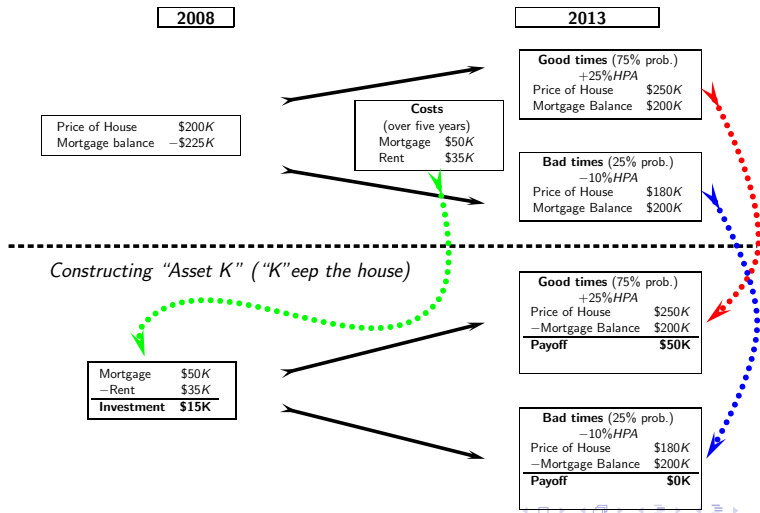
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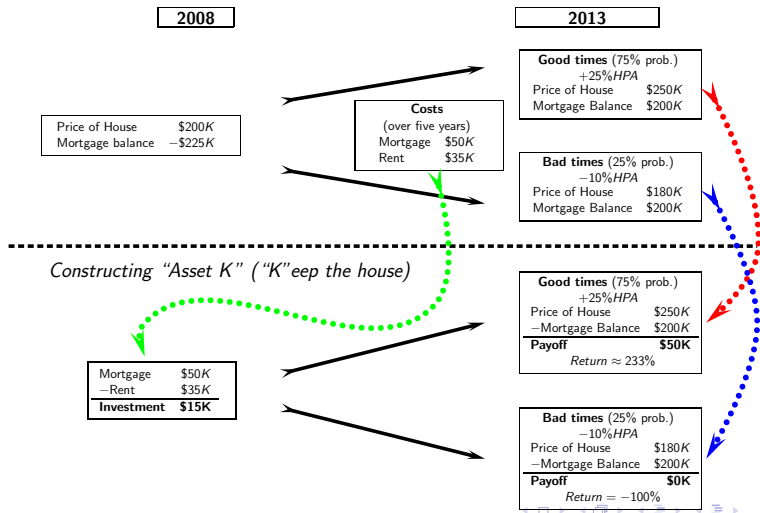
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Eric Rosengren's Homeownership Experience

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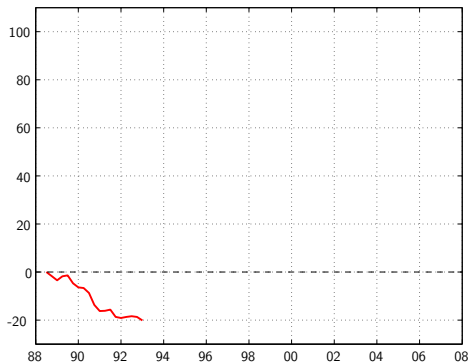
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- He bought his house in the summer of 1988.

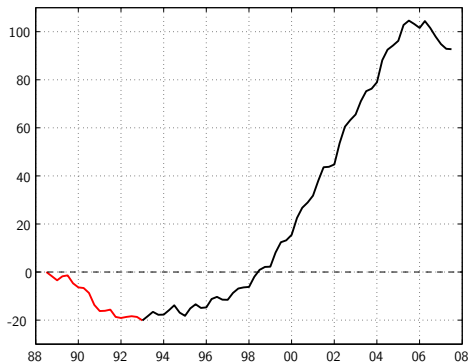
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Figure: Cumulative appreciation for Massachusetts homeowner who bought in Q3, 1988.



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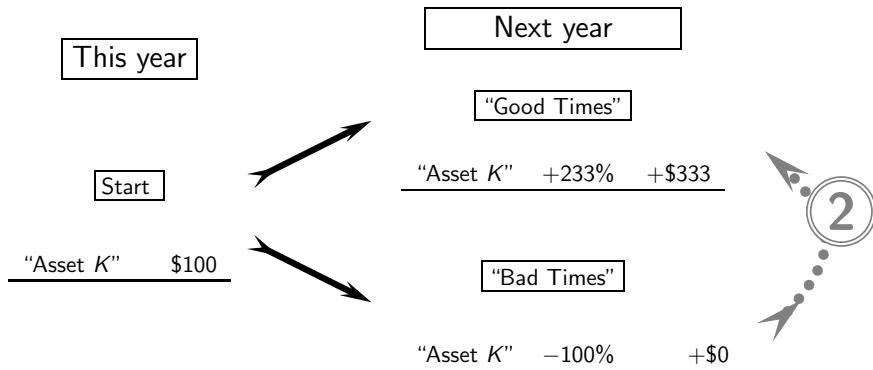
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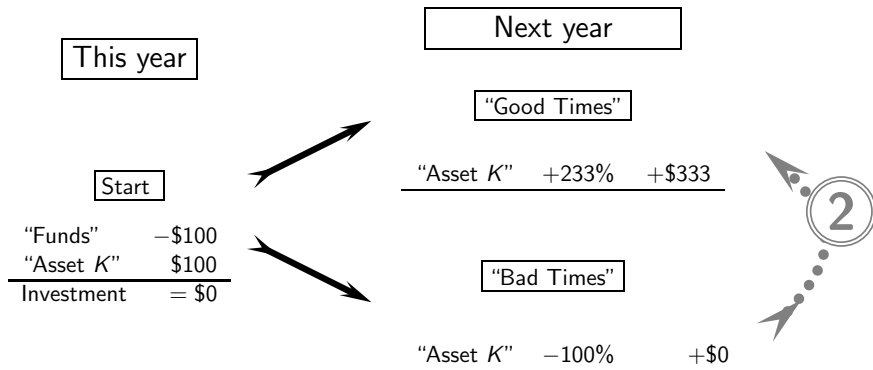
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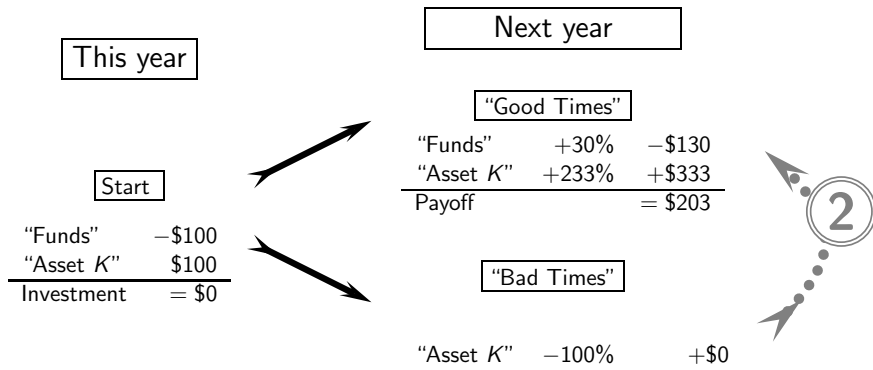
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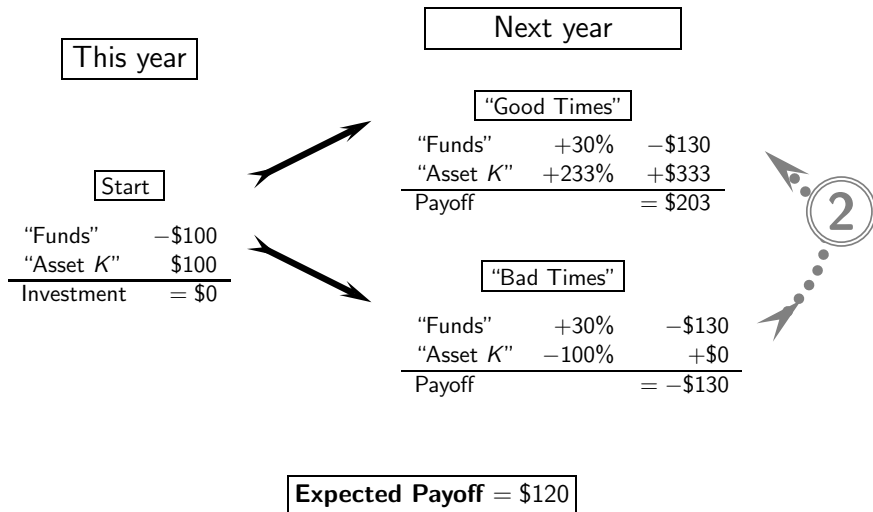
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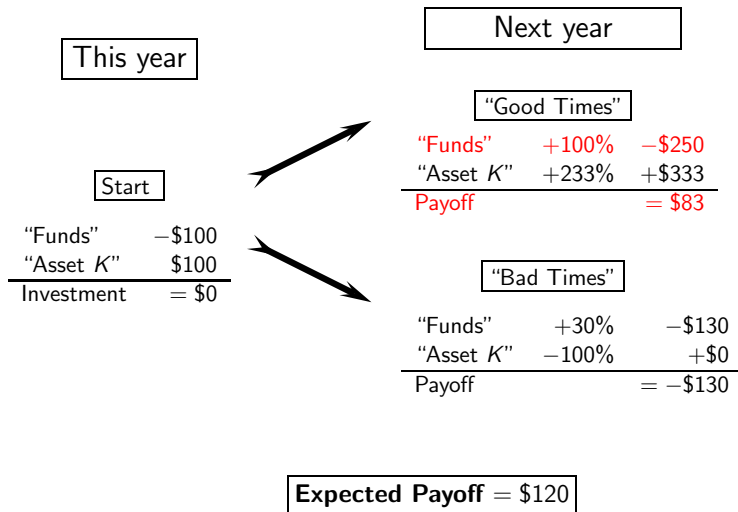
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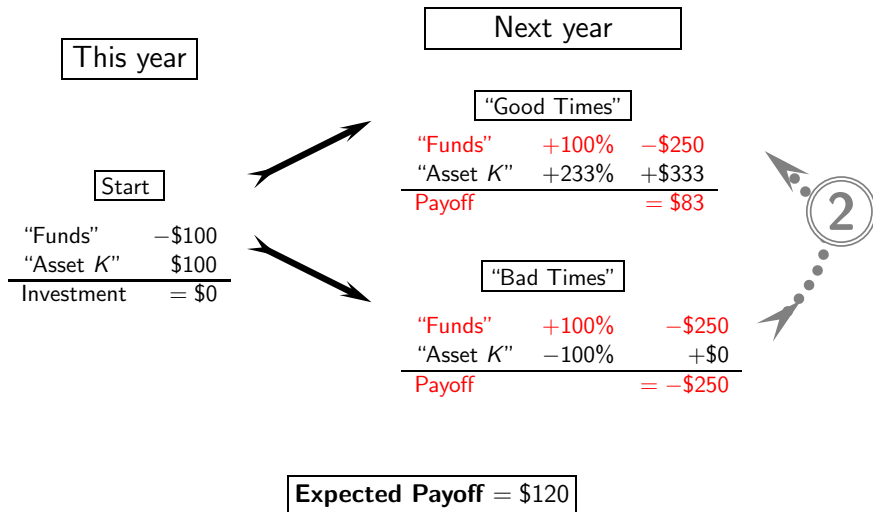


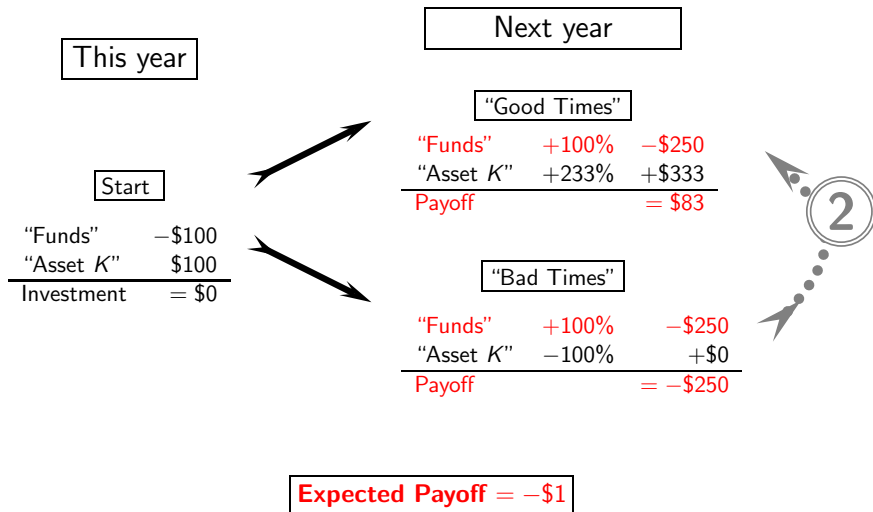












Policy Analysis

- Many policy proposals floating around
- Basic idea
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- Let
 - m = the outstanding balance on the mortgage.
 - p^H = the price of the house
 - λ = deadweight loss of foreclosure
 - a = principal reduction
- Logic for principal reduction

$$\underbrace{a}_{\text{principal reduction}} < m - \underbrace{(p^H - \lambda)}_{\text{expected recovery}}$$

$$a < m - (p^H - \lambda)$$

- So long as condition holds, principal reduction is win/win.
- If recovery value $m - (p^H - \lambda) = 50\%$, then lender can forgive 50% and win/win.

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- Condition becomes

$$\underbrace{a}_{\text{principal reduction}} < m - \underbrace{\left[\alpha(p^H - \lambda) + (1 - \alpha)m \right]}_{\text{Expected repayment}}$$

- Or:

$$a < \alpha \cdot [m - (p^H - \lambda)]$$

- Suppose recovery is 50% but foreclosure probability is 10%, then $a < 5\%$.

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- To design a program that works, you need to:
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Recreating HOLC

- Created in 1933.
- Offered new mortgages to everyone.
- In 1934
 - 43 percent of all first mortgages were in default
 - Arrears an average of eighteen months
- In other words, α was 43% (at least)
- Worst forecasts right now put population α at 3%.

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Barney Frank's scheme

- Offers to “subprime” borrowers with negative equity
 - “short-repayment”
 - new mortgage for 85% of current balance
 - current lender accepts that as payoff for current loan.
- So for our borrower

	Before	After	Δ
Mortgage	\$225K	\$170K	-\$55K
House value	\$200K	\$200K	0
Equity	-\$25K	+\$30K	

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- $\alpha = 20\%$
- Has potential to increase dramatically the losses
- My guess is that lenders will not go for it.

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- Has potential to increase dramatically the losses
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- Offers to “subprime” borrowers with negative equity
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 - new mortgage for 85% of current balance
 - current lender accepts that as payoff for current loan.
- So for our borrower

	Before	After	Δ
Mortgage	\$225K	\$170K	-\$55K
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- Many variations on the same theme
- This plan:
 - Borrower gets new loan for 97.5% of appraised value of house (FHA mortgage)
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 - *Principal* stays the same
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 - Interest accrues.
- Will this work?

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2008

Price of House	\$200K
Mortgage balance	-\$225K

Costs

(over five years)
Mortgage \$50K
Rent \$35K

2013

Good times (75% prob.)
+25% HPA
Price of House \$250K
Mortgage Balance \$200K

Bad times (25% prob.)
-10% HPA
Price of House \$180K
Mortgage Balance \$200K

Constructing "Asset K" ("K" eep the house)

Mortgage	\$50K
-Rent	\$35K
Investment	\$15K

Good times (75% prob.)
+25% HPA
Price of House \$250K
-Mortgage Balance \$200
Payoff \$50
Return $\approx 233\%$

Bad times (25% prob.)
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Price of House \$180K
-Mortgage Balance \$200
Payoff \$0K

Return = -100%

2008

Price of House	\$200K
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Costs

(over five years)
Mortgage **\$40K**
Rent **\$35K**

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Constructing "Asset K" ("K" eep the house)

Mortgage	\$40K
- Rent	\$35K
Investment	\$5K

Good times (75% prob.)
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Price of House \$250K
- Mortgage Balance \$200
Payoff \$50
Return $\approx 233\%$

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Good times (75% prob.)
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Return ≈ 600%

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 - Higher leverage makes asset attractive to borrower with high cost of funds

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- Think about financial assets as transferring resources across time and outcomes
- Can help with all financial decisions
 - Including whether to “walk away” from a mortgage

Contact Information

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