Time Value of Money: Inflation

Michael R. Roberts
William H. Lawrence Professor of Finance
The Wharton School, University of Pennsylvania

Last Time

Time Value of Money

- Taxes

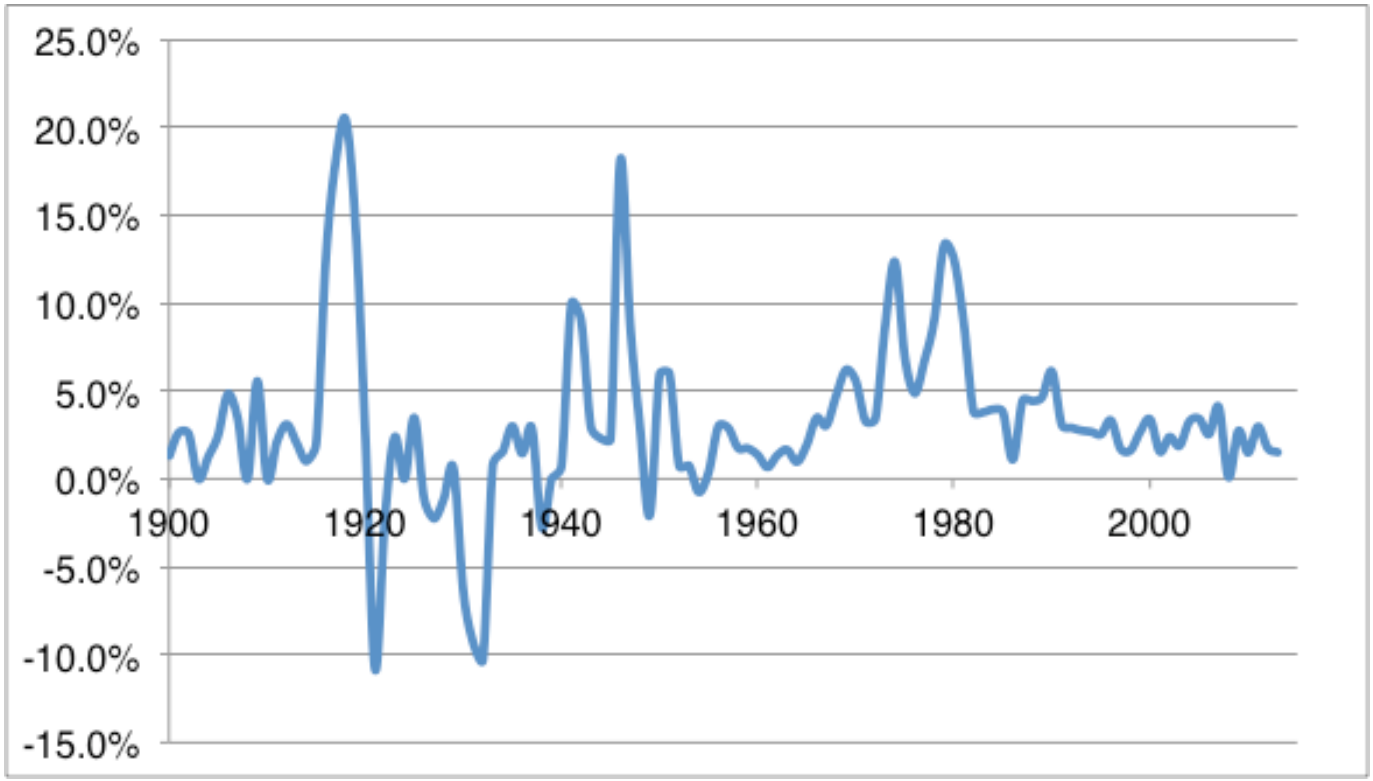
This Time

Time Value of Money

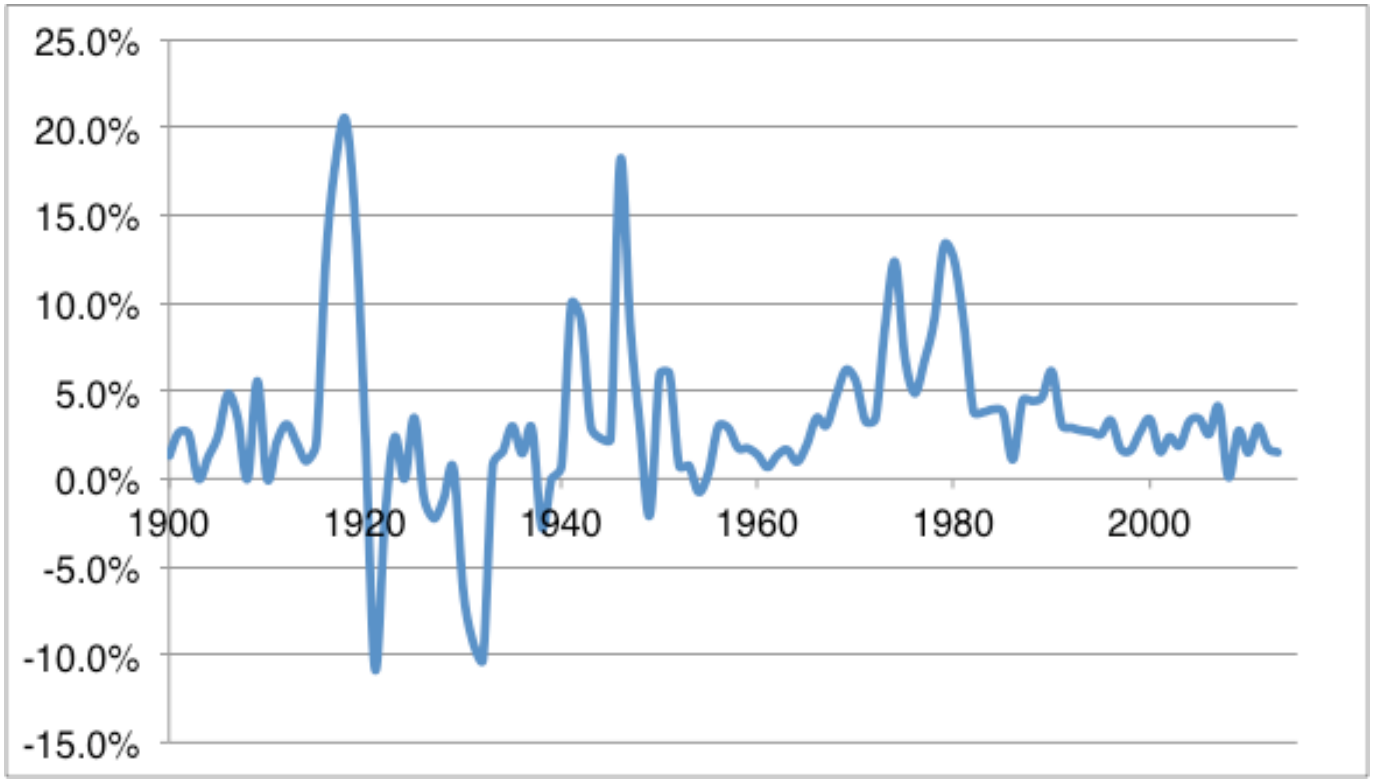
- Inflation

Inflation

Inflation



Inflation



How does inflation impact our returns?

Example – Savings (Account)

Year	Interest	Pre-Withdrawal Balance	Withdrawal	Post-Withdrawal Balance
0				$354.60
1	$17.73	$372.32	$100.00	$272.32
2	$13.62	$285.94	$100.00	$185.94
3	$9.30	$195.24	$100.00	$95.24
4	$4.76	$100.00	$100.00	$0.00

Example – Savings (Account)

Year	Interest	Pre-Withdrawal Balance	Withdrawal	Post-Withdrawal Balance
0				$354.60
1	$17.73	$372.32	$100.00	$272.32
2	$13.62	$285.94	$100.00	$185.94
3	$9.30	$195.24	$100.00	$95.24
4	$4.76	$100.00	$100.00	$0.00

Lesson: Inflation won't affect the money we earn

Example – Savings (Account)

Year	Interest	Pre-Withdrawal Balance	Withdrawal	Post-Withdrawal Balance
0				$354.60
1	$17.73	$372.32	$100.00	$272.32
2	$13.62	$285.94	$100.00	$185.94
3	$9.30	$195.24	$100.00	$95.24
4	$4.76	$100.00	$100.00	$0.00

Lesson: Inflation will affect what we can buy with the money

Real Discount Rate

$$1+ RR = (1+R) / (1+\pi)$$

RR is the real discount rate

π is expected inflation

Real Discount Rate

$$1+ RR = (1+R) / (1+\pi)$$

RR is the real discount rate
π is expected inflation

- Commonly used approximation:

$$RR = R - \pi$$

Real Discount Rate

$$1+ RR = (1+R) / (1+\pi)$$

RR is the real discount rate
π is expected inflation

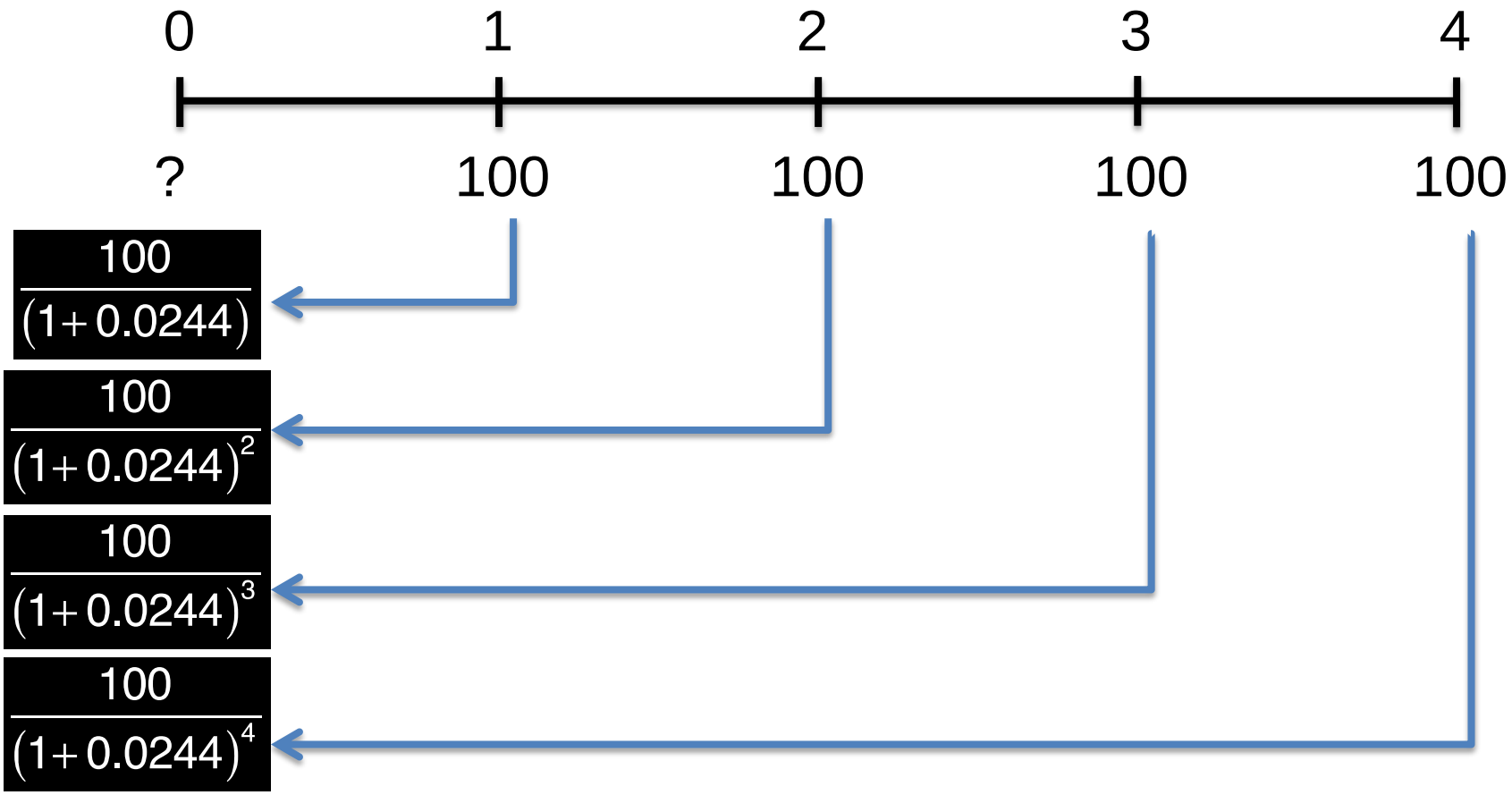
- Commonly used approximation:

$$RR = R - \pi$$

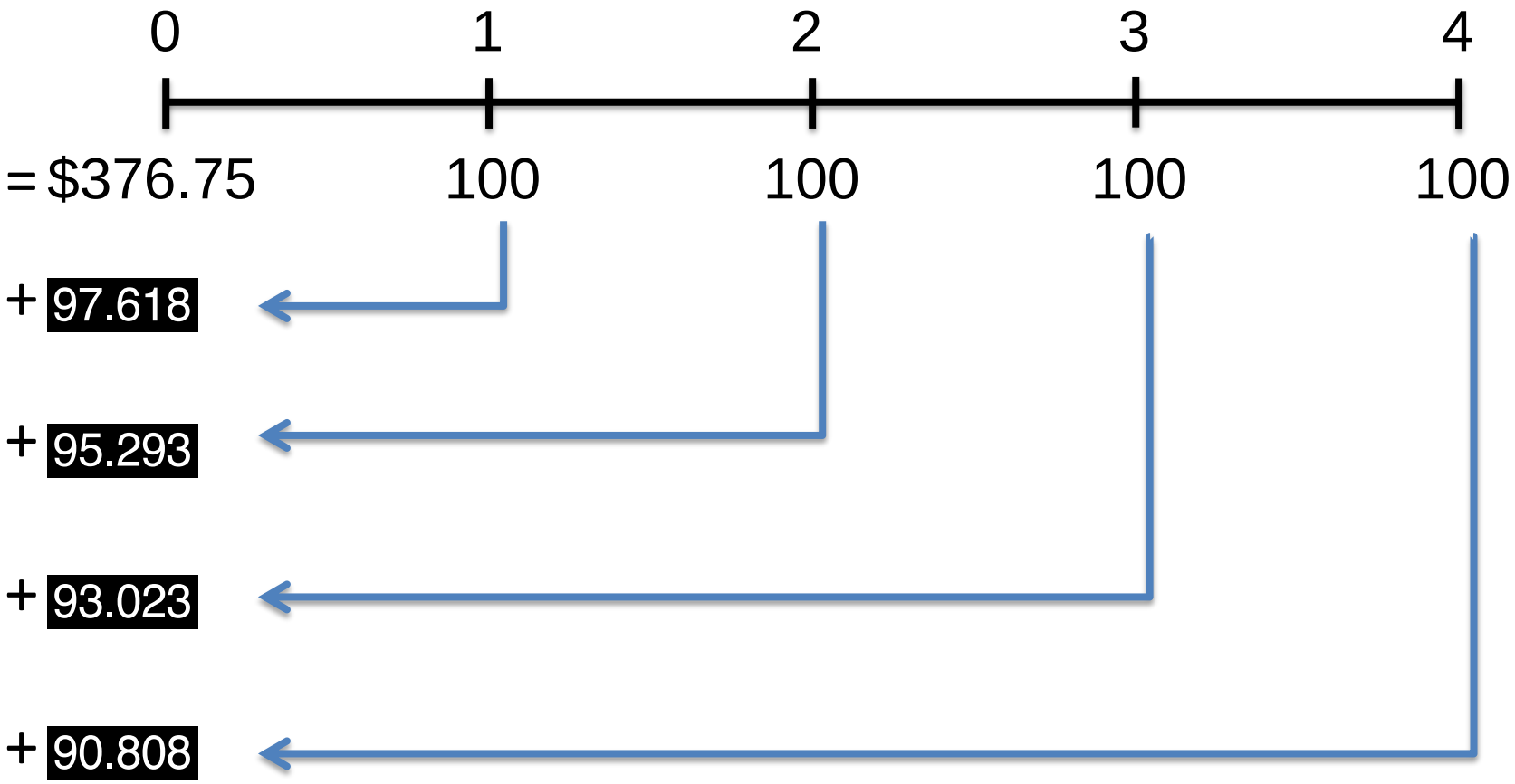
- For our example:

$$RR = (1+0.05) / (1+0.025) - 1 = 2.44\%$$

Savings with Inflation



Savings with Inflation



Savings with Inflation

- Difference:
  - –taxes affect $
  - –Inflation affects consumption, not $
    - Earn nominal return but can’t buy as much

Savings with Inflation

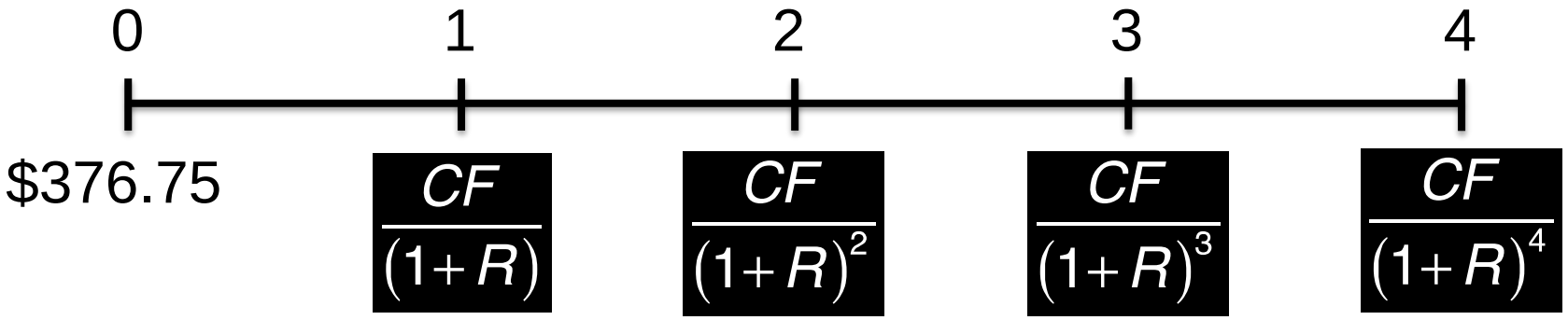
Year	Interest	Pre-Withdrawal Balance	Withdrawal	Post-Withdrawal Balance
0				$376.75
1	$18.84	$395.59	$100.00	$295.59
2	$14.78	$310.37	$100.00	$210.37
3	$10.52	$220.89	$100.00	$120.89
4	$6.04	$126.93	$100.00	$26.93

Savings with Inflation

Year	Interest	Pre-Withdrawal Balance	Withdrawal	Post-Withdrawal Balance
0				$376.75
1	$18.84	$395.59	$100.00	$295.59
2	$14.78	$310.37	$100.00	$210.37
3	$10.52	$220.89	$100.00	$120.89
4	$6.04	$126.93	$100.00	$26.93

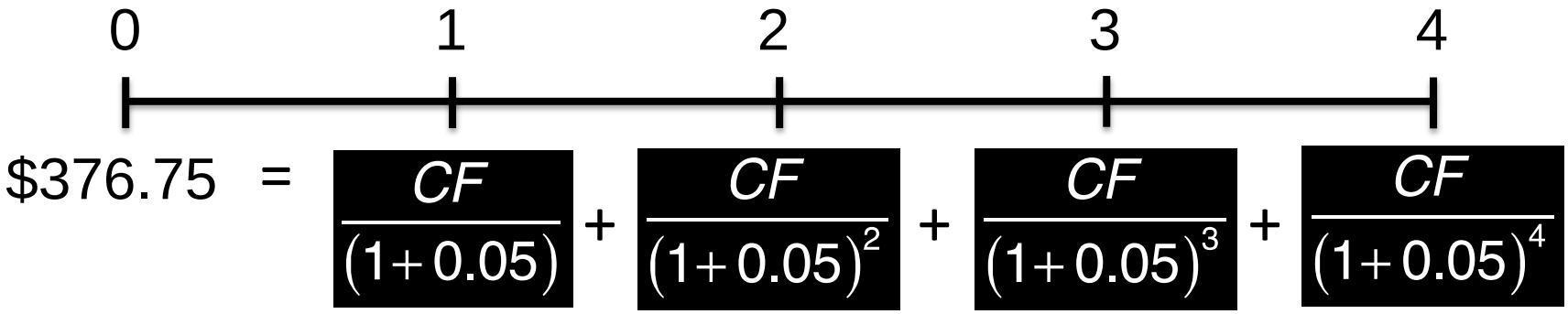
Implication: We have extra money(?). We need to change withdrawal amount. (Increase to buy costlier goods.)

Savings with Inflation



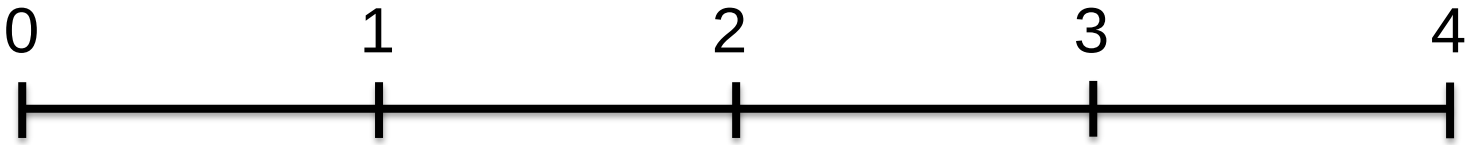
What is *CF*, the amount of money we can withdraw each year?

Savings with Inflation



Use nominal rate since that reflects $ we earn

Savings with Inflation



$$\$376.75 = \frac{CF}{(1+0.05)} + \frac{CF}{(1+0.05)^2} + \frac{CF}{(1+0.05)^3} + \frac{CF}{(1+0.05)^4}$$

$$CF = \$376.75\left(\frac{1}{(1+0.05)} + \frac{1}{(1+0.05)^2} + \frac{1}{(1+0.05)^3} + \frac{1}{(1+0.05)^4}\right)^{-1}$$

$$= \$106.25$$

Savings with Inflation

Year	Interest	Pre-Withdrawal Balance	Withdrawal	Post-Withdrawal Balance
0				$376.75
1	$18.84	$395.59	$106.25	$289.34
2	$14.47	$303.81	$106.25	$197.56
3	$9.88	$207.44	$106.25	$101.19
4	$5.06	$106.25	$106.25	$0.00

Savings with Inflation

Year	Interest	Pre-Withdrawal Balance	Withdrawal	Post-Withdrawal Balance
0				$376.75
1	$18.84	$395.59	$106.25	$289.34
2	$14.47	$303.81	$106.25	$197.56
3	$9.88	$207.44	$106.25	$101.19
4	$5.06	$106.25	$106.25	$0.00

Ideally withdrawals grow each year to accommodate inflation

Savings with Inflation

Year		Withdrawal
0		
1	$100 \times (1 + 0.025)^1 =$	$102.50
2	$100 \times (1 + 0.025)^2 =$	$105.06
3	$100 \times (1 + 0.025)^3 =$	$107.69
4	$100 \times (1 + 0.025)^4 =$	$110.38

This sequence of withdrawals maintains purchasing power of $100 in today's terms

Savings with Inflation

Year		Withdrawal
0		
1	$100 \times (1 + 0.025)^1 =$	$102.50
2	$100 \times (1 + 0.025)^2 =$	$105.06
3	$100 \times (1 + 0.025)^3 =$	$107.69
4	$100 \times (1 + 0.025)^4 =$	$110.38

These are “nominal” values corresponding to the real $100 purchasing power in year 0.

Savings with Inflation

Year	Withdrawal
0	
1	$102.50
2	$105.06
3	$107.69
4	$110.38
PV at 5% discount rate =	$376.75

We discount nominal cash flows by the nominal rate to get the price.

Savings with Inflation

Year	Withdrawal
0	
1	$102.50
2	$105.06
3	$107.69
4	$110.38
PV at 5% discount rate =	$376.75

Note: PV of nominal CFs at nominal discount rate = PV of real cash flows at real rate

Savings with Inflation

Year	Withdrawal
0	
1	$102.50
2	$105.06
3	$107.69
4	$110.38
PV at 5% discount rate =	$376.75

Intuition: The inflation term in the numerator and denominator cancel

Savings with Inflation

Year	Interest	Pre-Withdrawal Balance	Withdrawal	Post-Withdrawal Balance
0				$376.75
1	$18.84	$395.59	$102.50	$293.09
2	$14.65	$307.74	$105.06	$202.68
3	$10.13	$212.81	$107.69	$105.13
4	$5.26	$110.38	$110.38	$0.00

Summary

Lessons

- Inflation does not affect $ return
- Inflation does purchasing power of $
- Real return, *RR*

$$1 + RR = \frac{1 + R}{1 + \pi} \approx R - \pi$$

where R is the nominal return and π is the rate of inflation

Lessons

- Discount real cash flows by the real rate of return, nominal cash flows by the nominal rate of return.

Coming up next

- Interest Rates
  - How do we value non-annual and irregular cash flows streams?
  - How do different compounding periods affect our valuations?