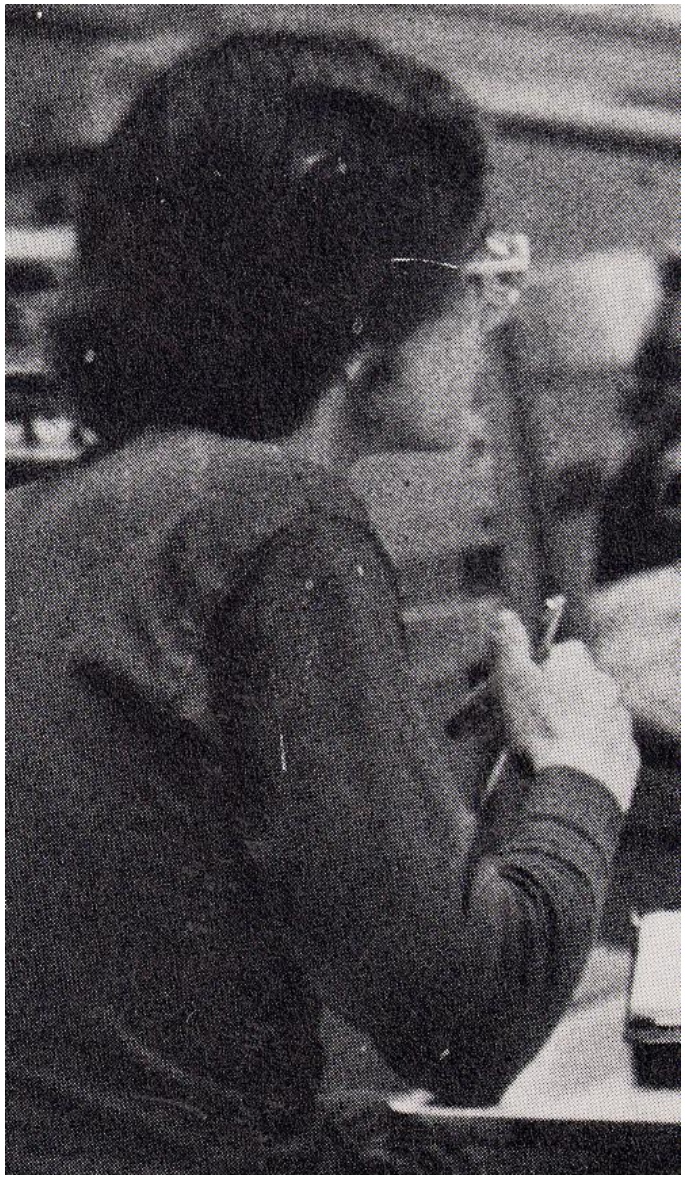
"Big Math"

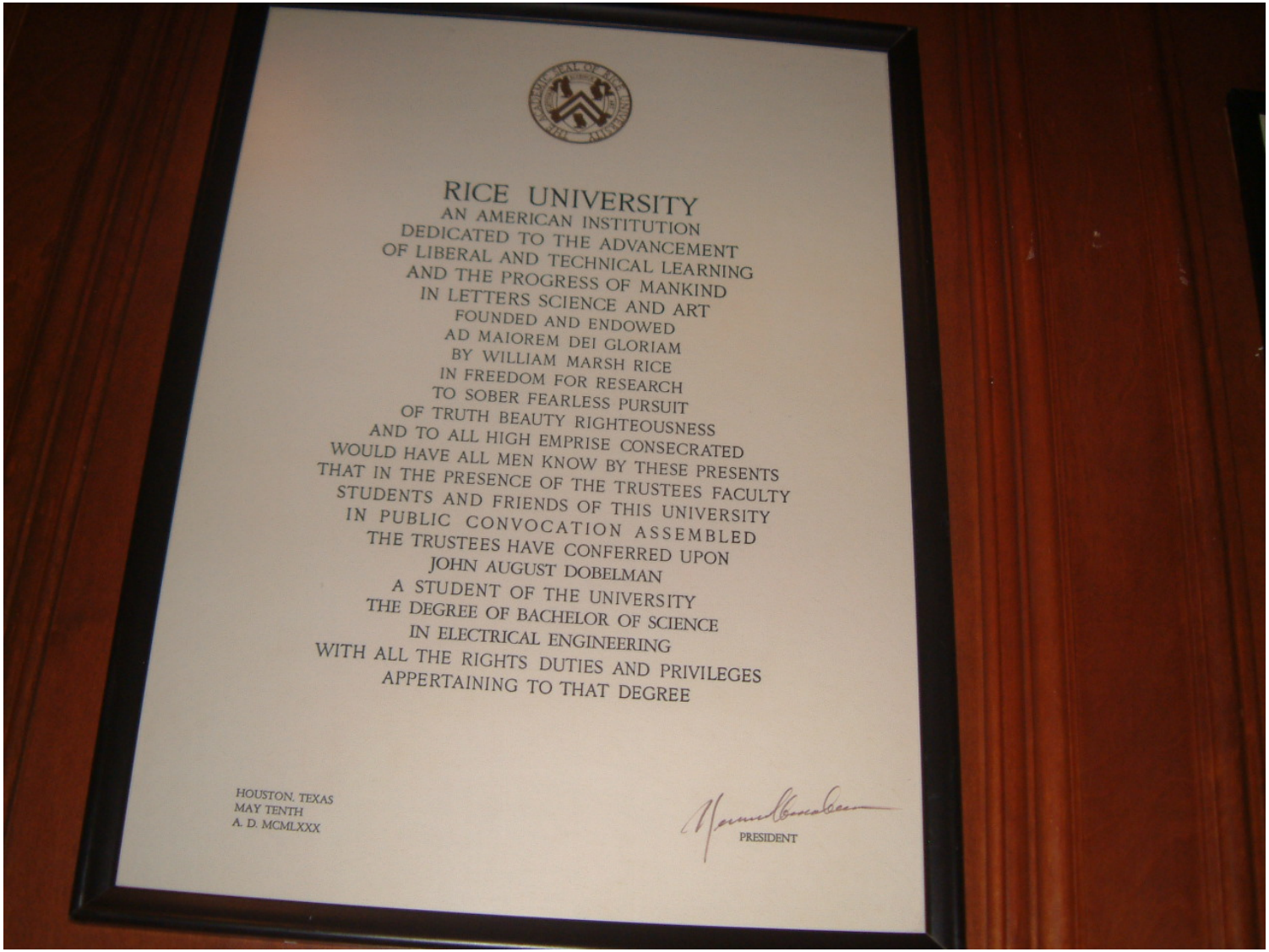
J.A. Dobelman

Math-Science Scholars Program

July 16th, 2015

RICHARD TAPIA CENTER
FOR EXCELLENCE & EQUITY





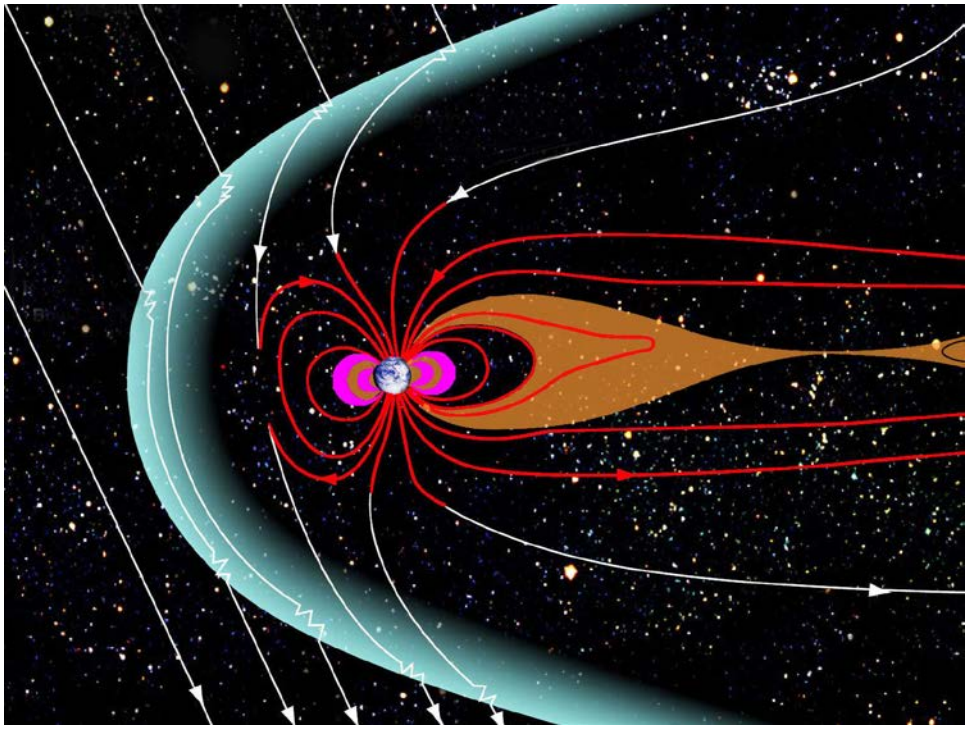
RICE UNIVERSITY
AN AMERICAN INSTITUTION
DEDICATED TO THE ADVANCEMENT
OF LIBERAL AND TECHNICAL LEARNING
AND THE PROGRESS OF MANKIND
IN LETTERS SCIENCE AND ART
FOUNDED AND ENDOWED
AD MAIOREM DEI GLORIAM
BY WILLIAM MARSH RICE
IN FREEDOM FOR RESEARCH
TO SOBER FEARLESS PURSUIT
OF TRUTH BEAUTY RIGHTEOUSNESS
AND TO ALL HIGH EMPRISE CONSECRATED
WOULD HAVE ALL MEN KNOW BY THESE PRESENTS
THAT IN THE PRESENCE OF THE TRUSTEES FACULTY
STUDENTS AND FRIENDS OF THIS UNIVERSITY
IN PUBLIC CONVOCATION ASSEMBLED
THE TRUSTEES HAVE CONFERRED UPON
JOHN AUGUST DOBELMAN
A STUDENT OF THE UNIVERSITY
THE DEGREE OF BACHELOR OF SCIENCE
IN ELECTRICAL ENGINEERING
WITH ALL THE RIGHTS DUTIES AND PRIVILEGES
APPERTAINING TO THAT DEGREE

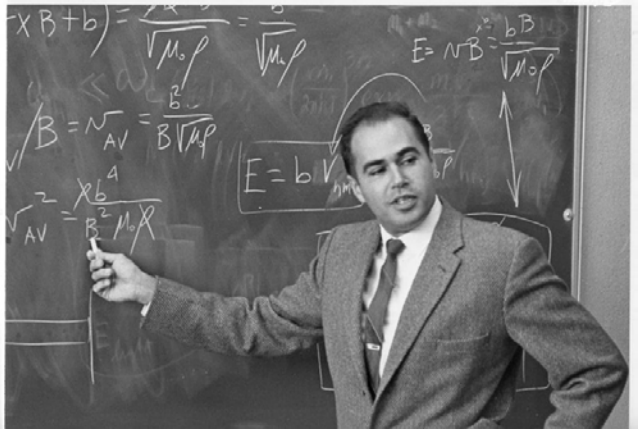
HOUSTON, TEXAS
MAY TENTH
A. D. MCMLXXX

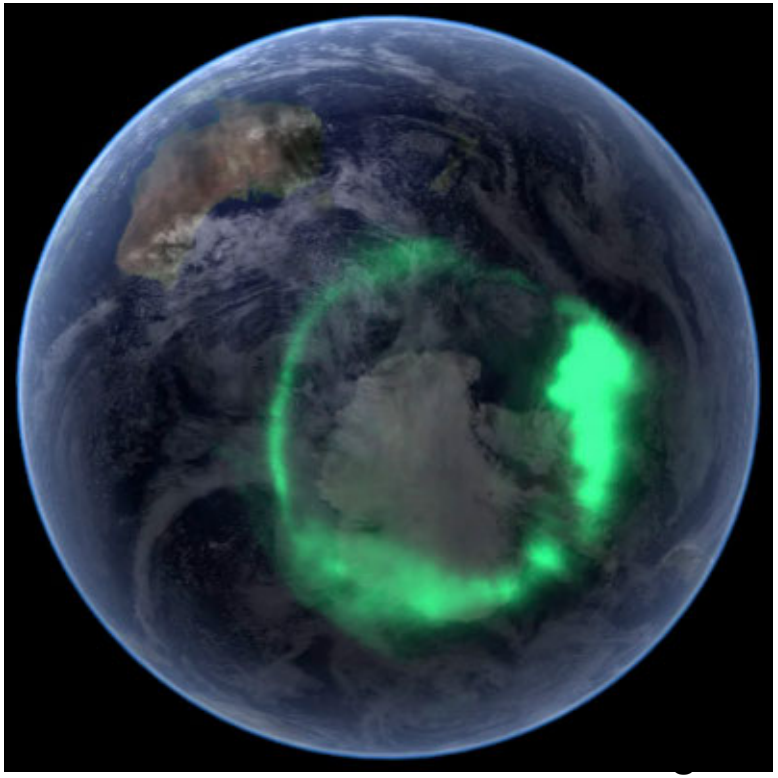
PRESIDENT

Old School S&E

First post-college job: Bindery Operator

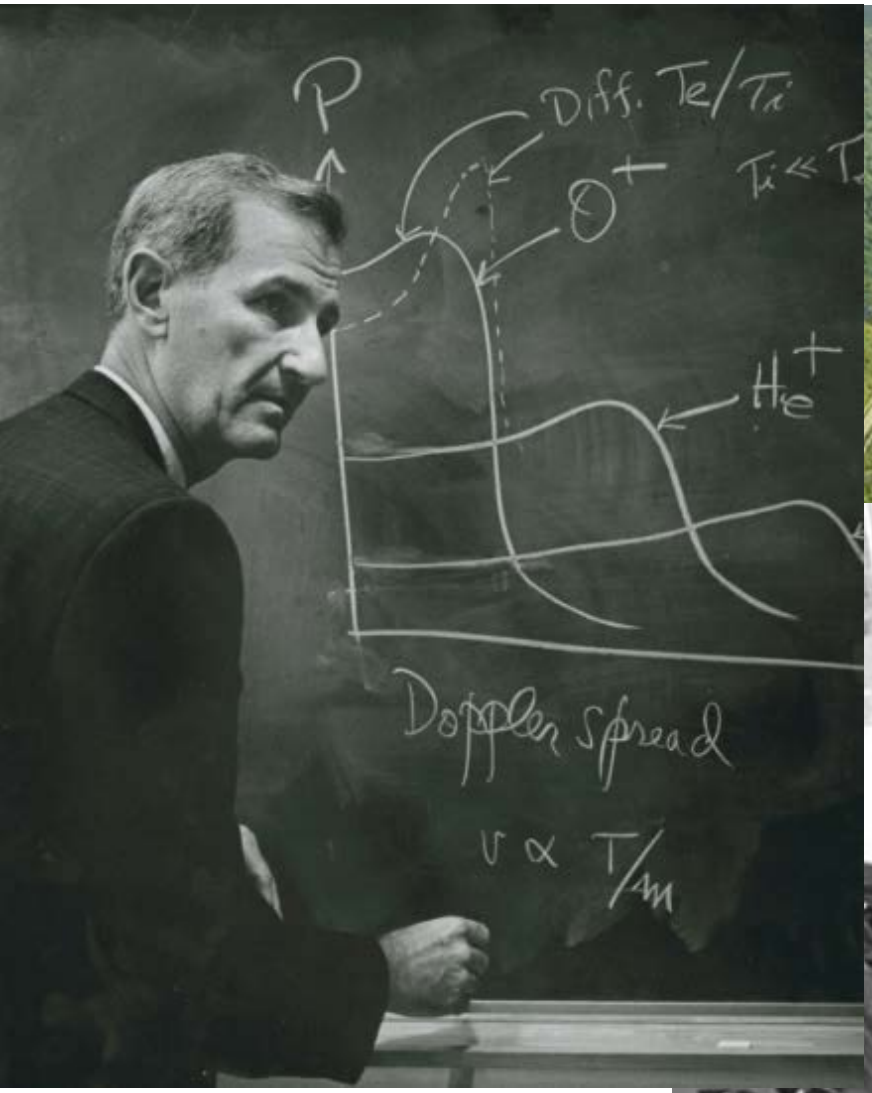




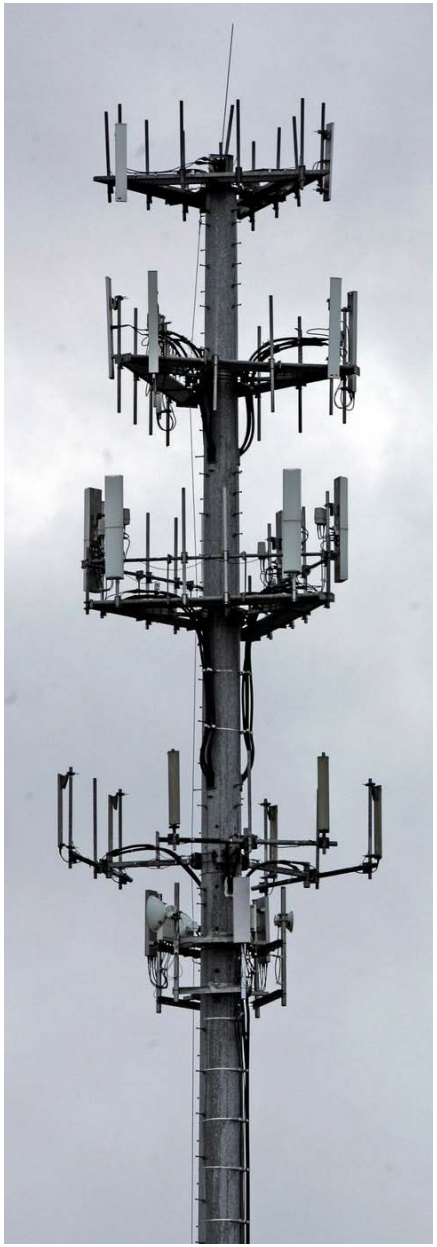



© Tommy Eliassen

W.E. Gordon



Down to Earth



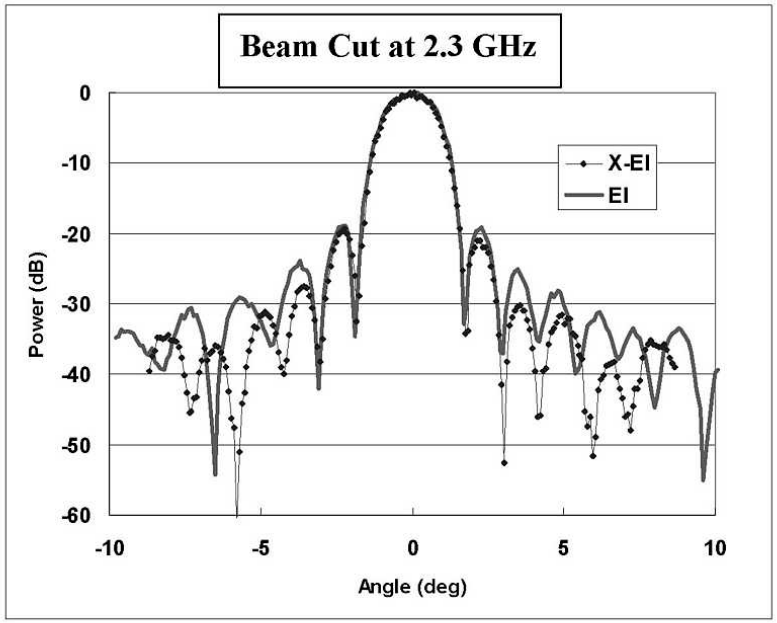
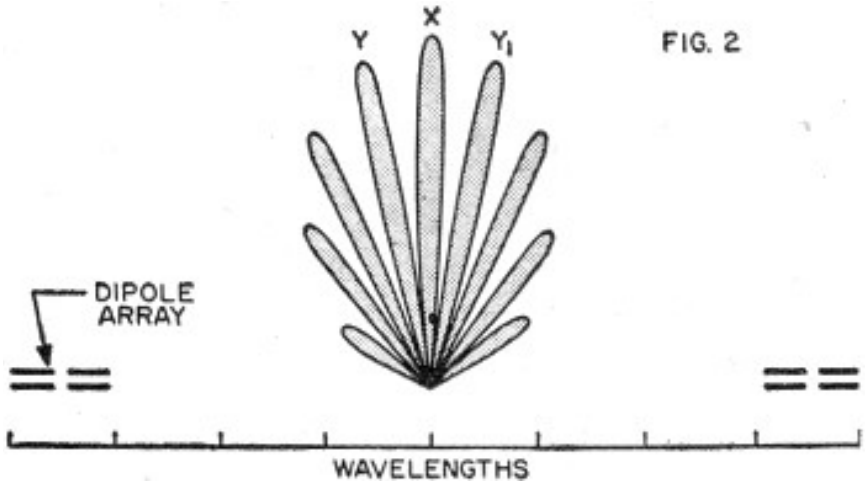


Figure 1: Two cuts through the primary beam pattern of one of the ATA dishes.



IAH RTR

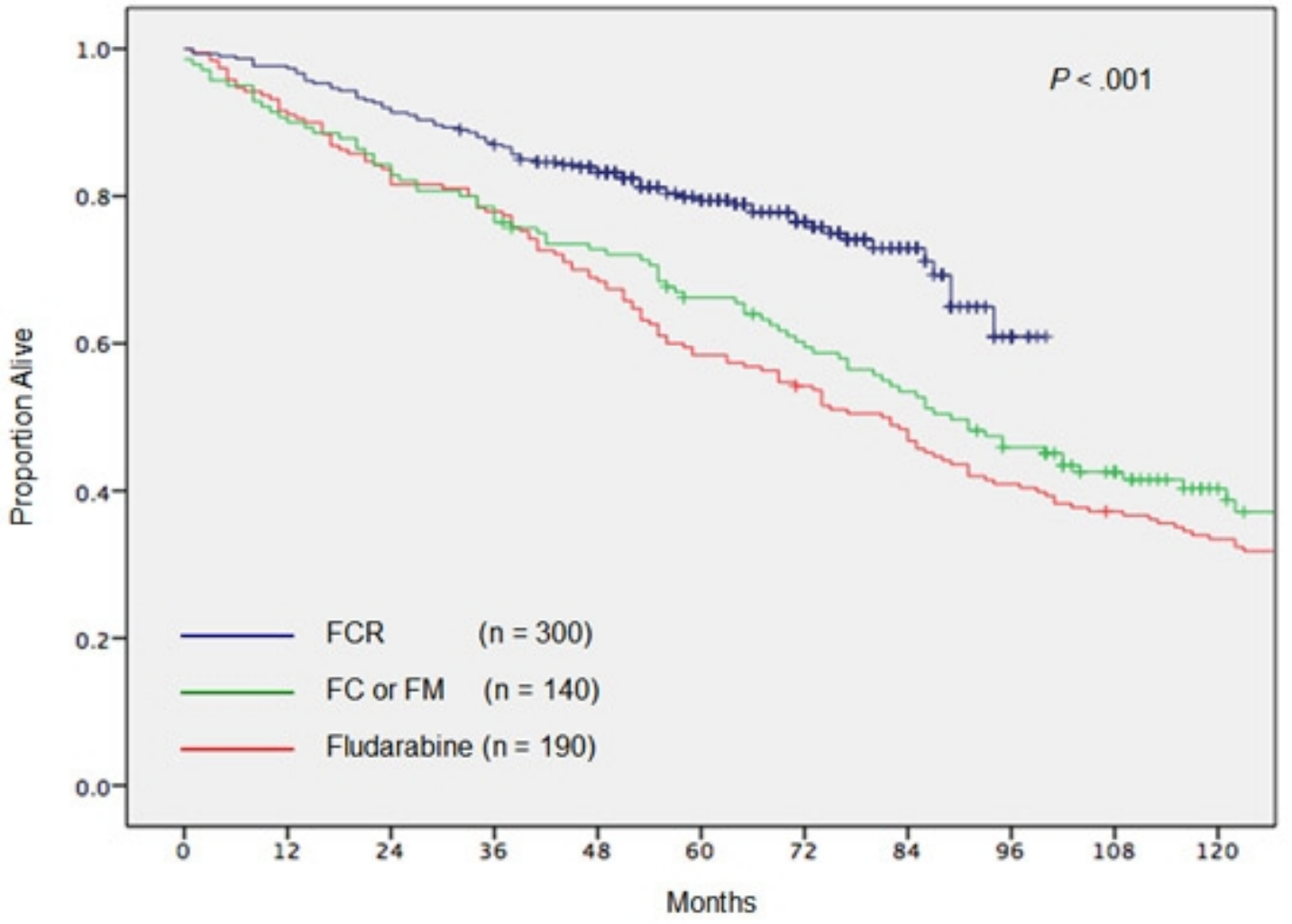
Terminal CNS

ATCT

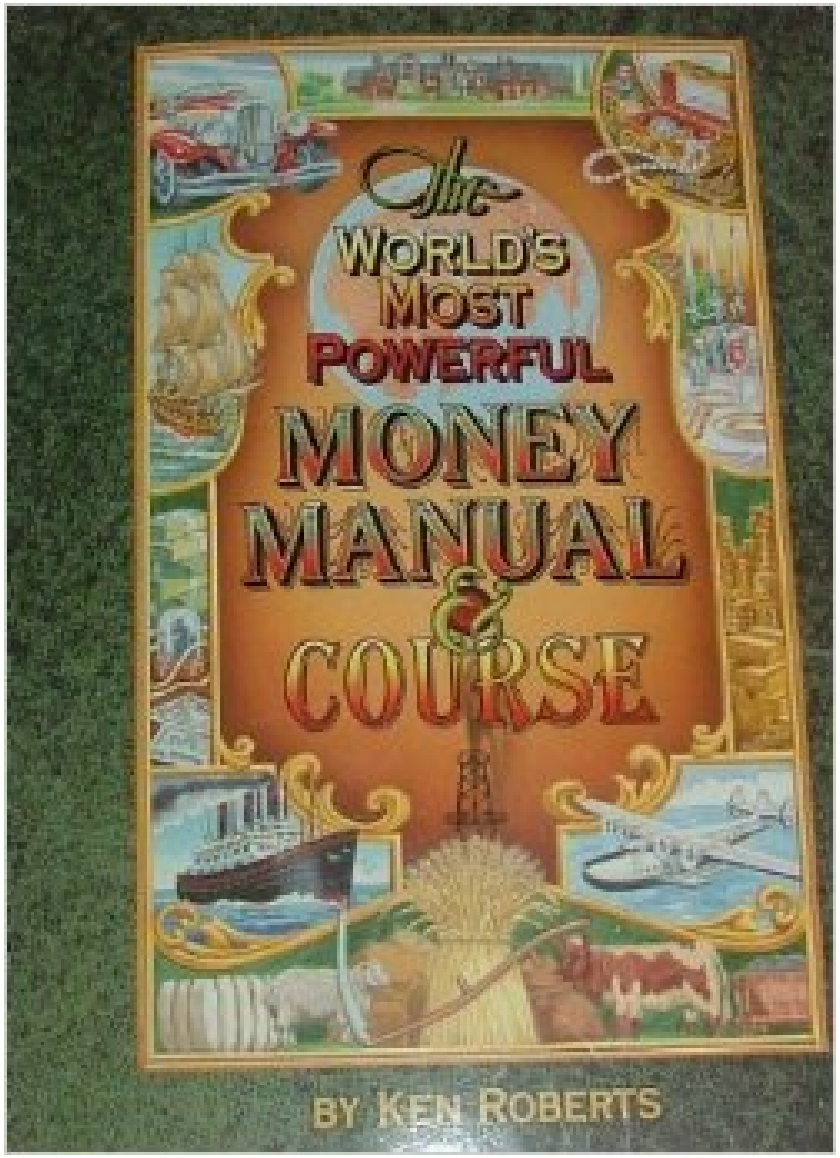
Surveillance

ILS/NAV

Catharsis/Epiphany



Quit your Day Job



$500 a week!

CC: 10T CT: 50k# JO: 15k# KC: 37.5k# (250 bags)

Back to Rice!

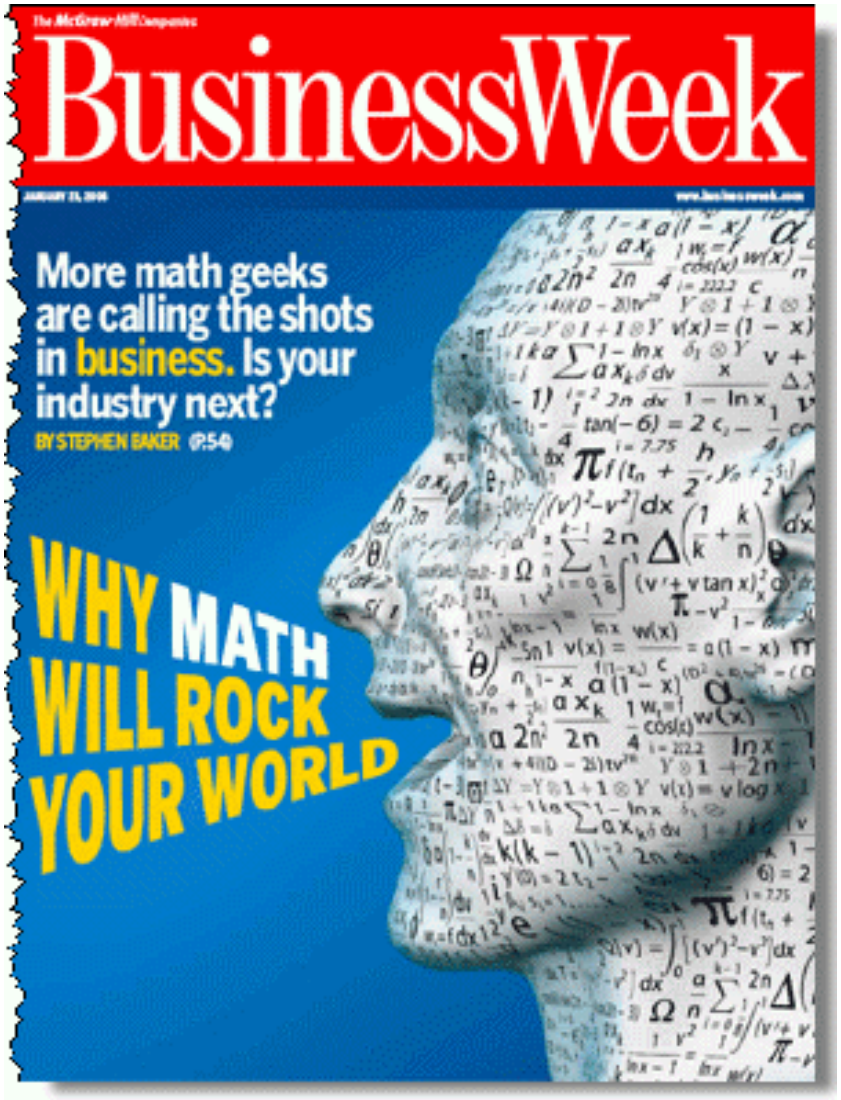
Research Program

- Investments analysis
- stochastic modeling for markets and finance
- simulation-based and quantitative portfolio selection and management
- display of quantitative information
- improved communication
- applications of engineering models to other statistical problems

2006-8 Predictions

ABC News

2006 Predictions



Why Math Will Rock

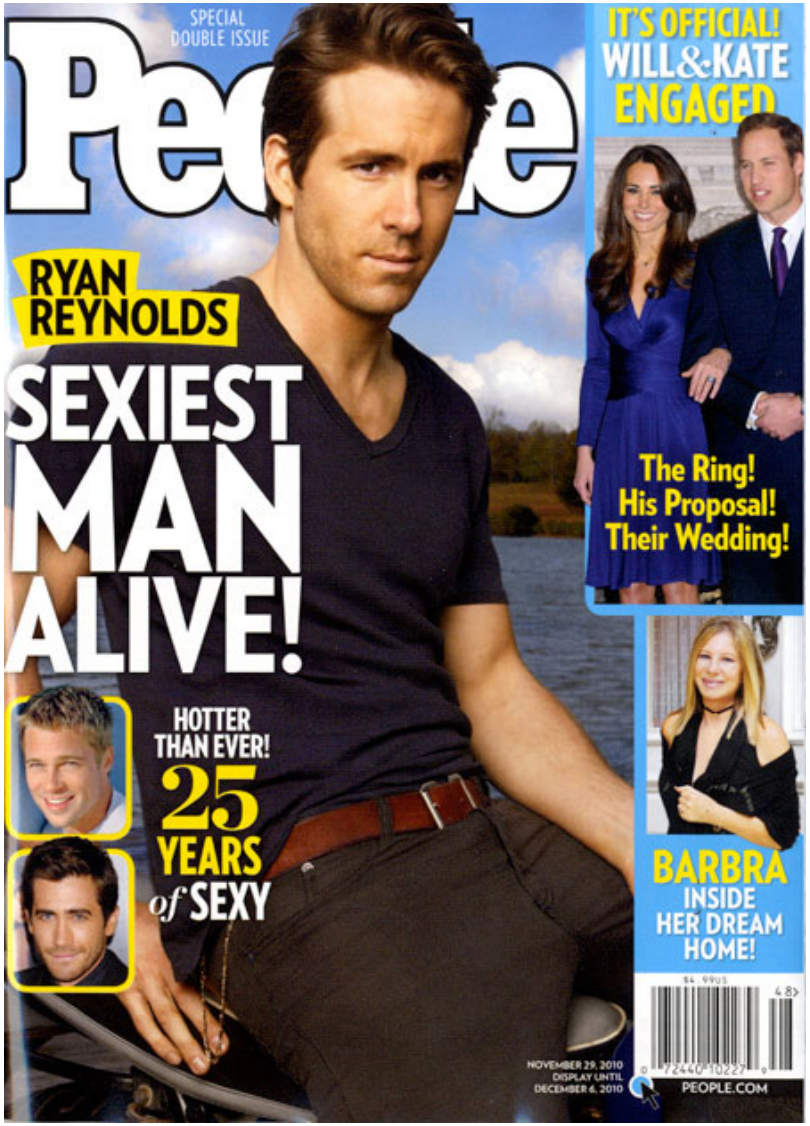
- "Quants" turned finance world upside down in 1973
- 30 years later "Data Mining" emerges
- Mathematics and computer science
- Modeling YOU as a customer, a specimen and a target
- Behavioral prediction
  - Revenue management and optimization
  - Surveillance

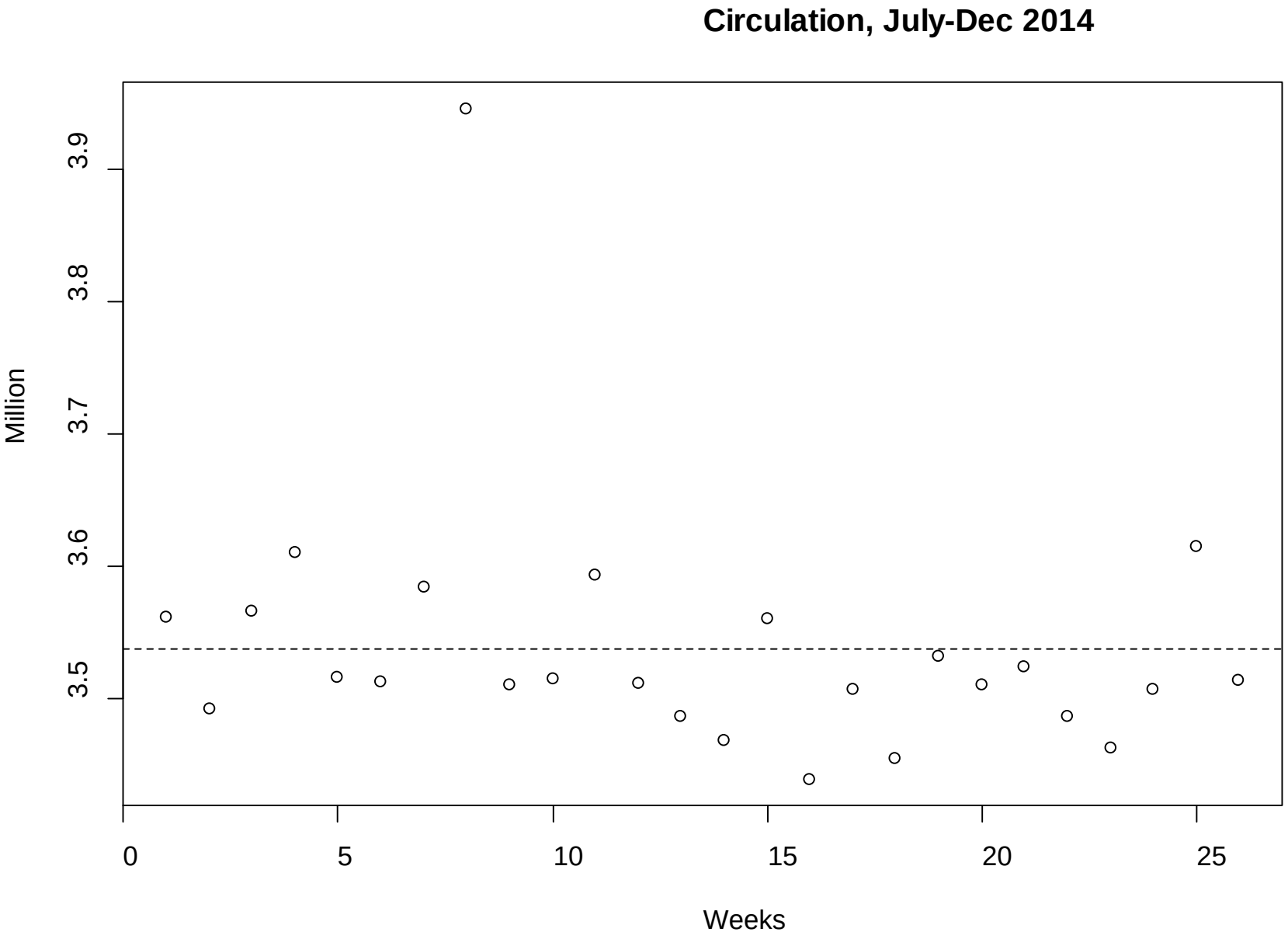
Security, Privacy & Convenience

Harrah's ENTERTAINMENT, INC.

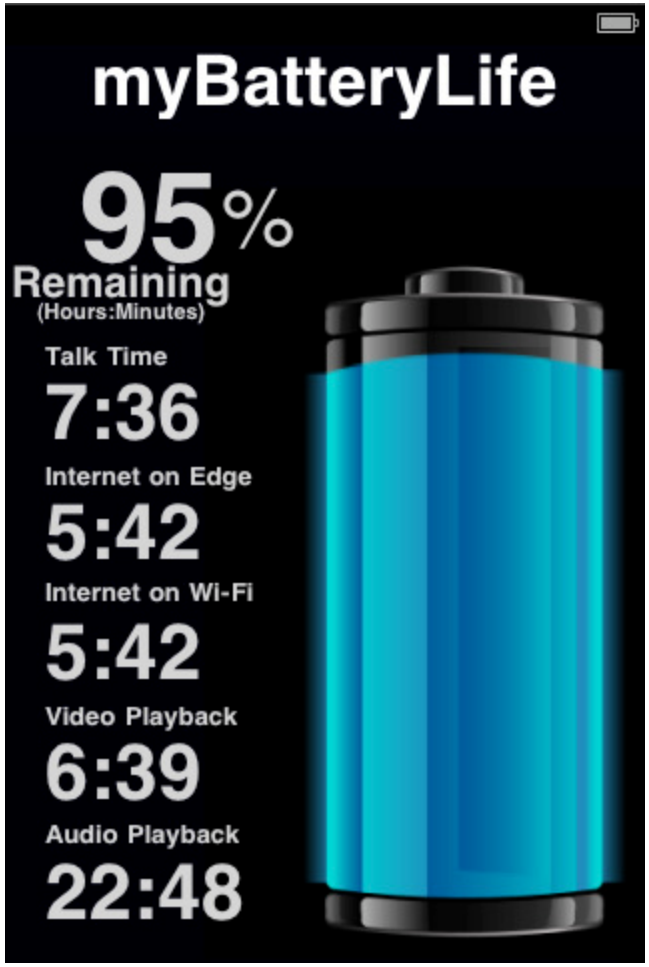
NATIONAL SECURITY AGENCY

More Your Cup of Tea?




Circulation, July-Dec 2014
Million
3.5
3.6
3.7
3.8
3.9
0
5
10
15
20
25
Weeks

Percent (%)


myBatteryLife
95%
Remaining
(Hours:Minutes)
Talk Time
7:36
Internet on Edge
5:42
Internet on Wi-Fi
5:42
Video Playback
6:39
Audio Playback
22:48

Percent (%)

- "Per Cent (hundred)"
- 90% is $\frac{90}{100}$
- We can also write it as 9/10, or 0.90
- Gives resulting balance: For example, 95% of $1,000 is $950. Or, 70% of $50 is $35
- 10% is easy to work with, just divide by ten or multiply by .10 E.g., 10% of 1,000,000 is 100,000
- ¼ of 400 is 25% of 400 which is 100

Percent Return

- *Return* is composed of
  - Return OF investment
  - Return ON investment

- Start a project or investment with $100
- At the end of one year you have $110
- $100 is the return “of” your investment
- $ 10 is the return “on” your investment

$$R = \frac{110}{100} = 1.10$$

$$r_{\%} = \frac{110 - 100}{100} = \frac{110}{100} - \frac{100}{100} = 1.1 - 1 = 0.10 = 10\%$$

$$r_{\%} = R - 1$$

Seneca Tribe Returns

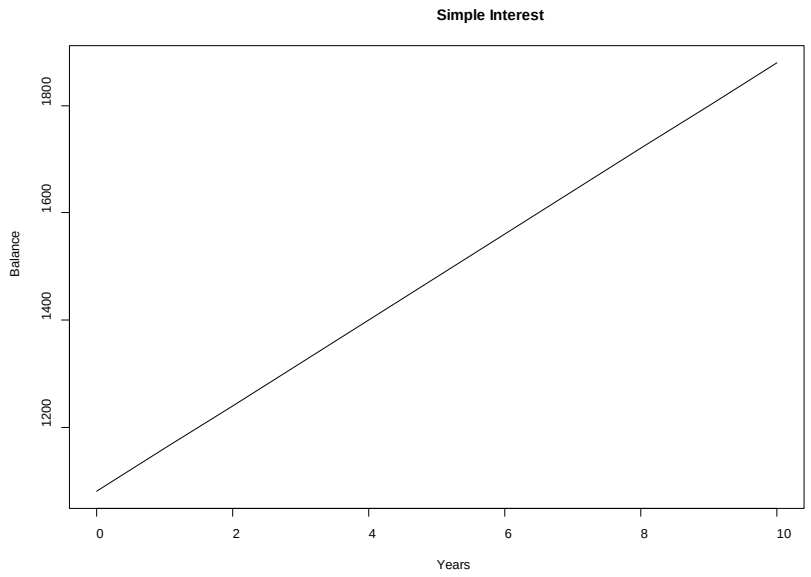
Amount Invested	Gross Return	Return OF	Return ON
$10	4/10=0.4	4	-60.0%
4	4/4 = 1.0	4	0.0%
3	4/3 = 1.33	3	33.0%
1	4/1 = 4.00	1	300.0%
50¢	4/.5 = 8.00	0.5	700.0%
1¢	4/.01= 400	0.01	39900.0%
Free	4/0 = ∞	0	∞

Large Percentages Tricky

- "Double your Money," or start with $200, end up with $400
  - 200% is a 100% gain (2.00-1)= 1 = 100%
- $200 grows to $300 represents 50% gain
  - R=300/200=1.5
  - $r_{\%}=R-1$=0.50 = 50% gain
- Make ten times your money:
  - $R=10$, $r_{\%}=10-1=9.0$ = *900%* gain

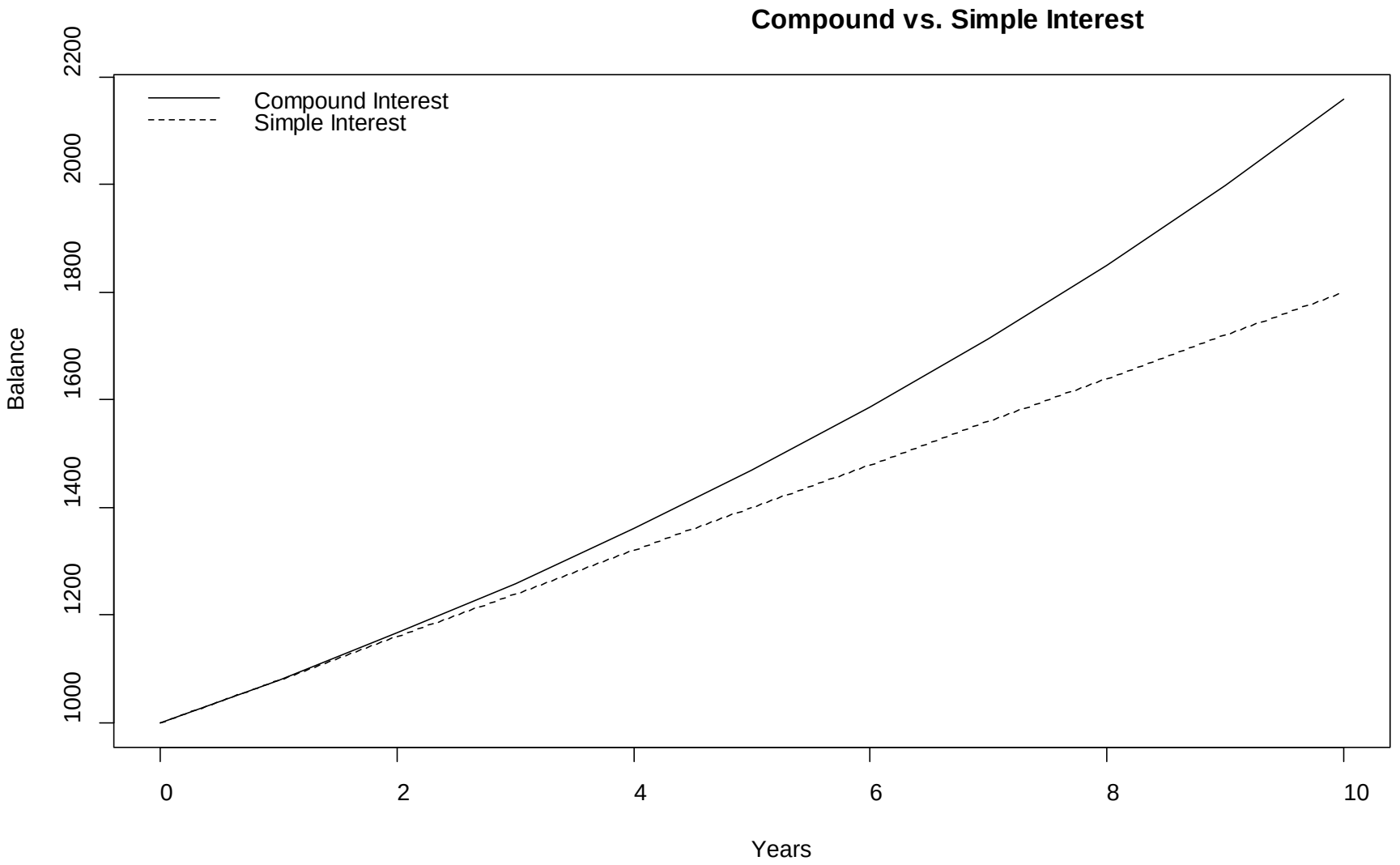
Simple Return

- Principal of $1,000, with 8% simple interest per year.
  - Yr 0: 1,000
  - Yr 1: 1,080
  - Yr 2: 1,160
  - Yr 3: 1,240 … Yr 10: 1,800



Compound Return

- Principal of $1,000, with 8% interest reinvested (compounded)
  - Yr 0: 1,000
  - Yr 1: $1,000x(1.08)=1,080$
  - Yr 2: $1,080x(1.08)=1,000x(1.08)^2=1,166$
  - Yr 3: $1,166x(1.08)=1,000x(1.08)^3=1,259$
  - …
  - Yr 9: $1,000x(1.08)^9= 1,999$
  - Yr 10: $1,000x(1.08)^{10}= 2,153$


Compound vs. Simple Interest
Compound Interest
Simple Interest
Balance
1000
1200
1400
1600
1800
2000
2200
0
2
4
6
8
10
Years

Experiment 1

- Which would you rather have?
  - A. $10 per day for one month
  - B. 10¢ on day 1, then 20¢ on day 2, then 40¢ on day 3, etc. for one month
- Option A gives you $310 for the month.
- Option B gives you…

  .10

  .20

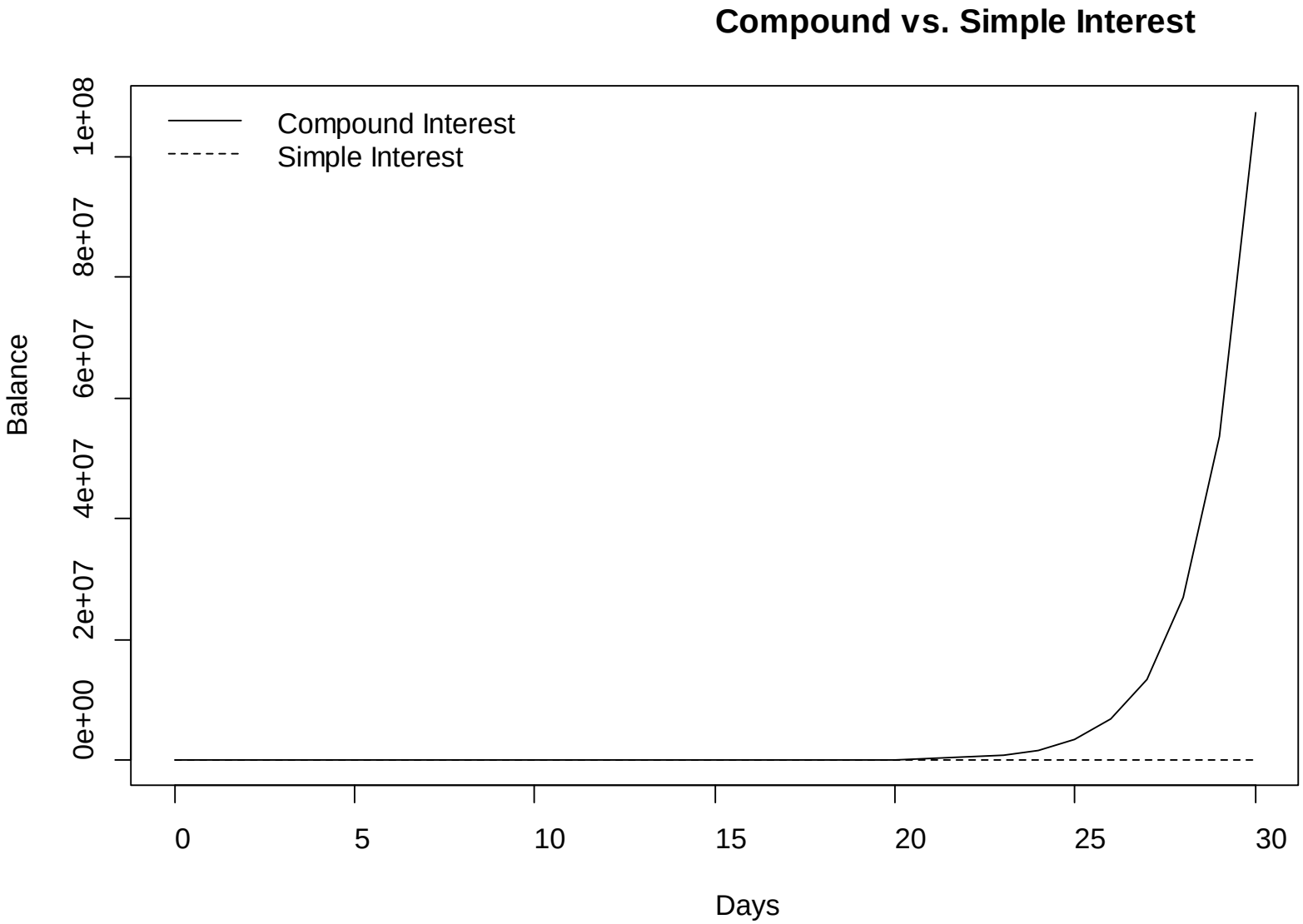
  .40

  .80

  1.60 …

Time is Key

- Option B give you $107,374,182!!



Large Numbers

1,000	Thousand	$1x10^{3}$	Kilo	K
100,000	Lakh	$1x10^{5}$		
1,000,000	Million	$1x10^{6}$	Mega	M
10,000,000	Crore	$1x10^{7}$		
1,000,000,000	Billion	$1x10^{9}$	Giga	G
1,000,000,000,000	Trillion	$1x10^{12}$	Tera	T
1,000,000,000,000,000	Quadrillion	$1x10^{15}$	Peta	P
1,000,000,000,000,000,000	Qunitillion	$1x10^{18}$	Exa	E
etc.	Sextillion	$1x10^{21}$	Zeta	Z
	Septillion	$1x10^{24}$	Yotta	Y
	Octillion	$1x10^{27}$	Hella*	X*
	Nontillion	$1x10^{30}$		W*
	Decilion	$1x10^{33}$		V*
ten duotrigintillion	Googol	$1x10^{100}$		

Experiment 2

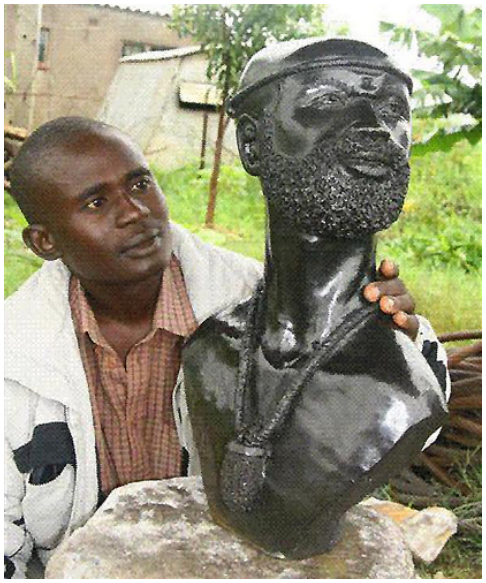
- “And there came a certain poor widow, and she threw in two mites, which make a farthing” Mk 12.42
- Worth one-half of a quadrans or 1/128 of a denarius, or about six minutes of an average daily wage
  - $15 x 8hrs = $120/day
  - 60x8=480 min.per day
  - 6/480 = .0125 = 1.25%
  - $120 x .0125 = $1.50

Give it Time

- Principal: $1.50 (in today's money)
- Interest: 6% per annum (typical)
- Yeshua to Muhammed: $13.9 Qn
- Time: 30 CE – 2015 CE (1,986 years)
- Taxrate: 0% 30%

  Value: 2.713×10^{50} 4.58×10^{35}
- 4.65×10^{10} years at light speed to get to edge of the observable universe

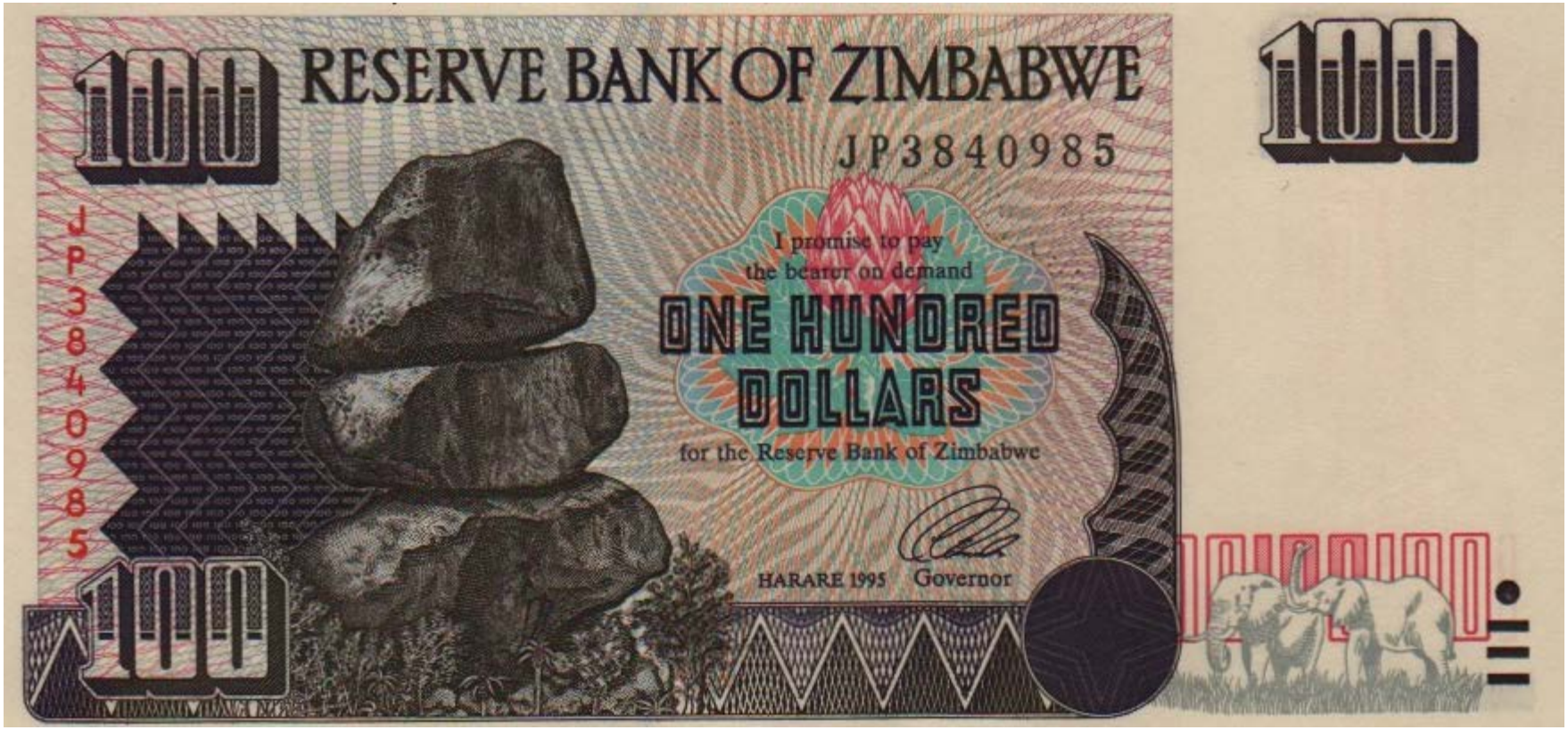
The Shona



Zimbabwe

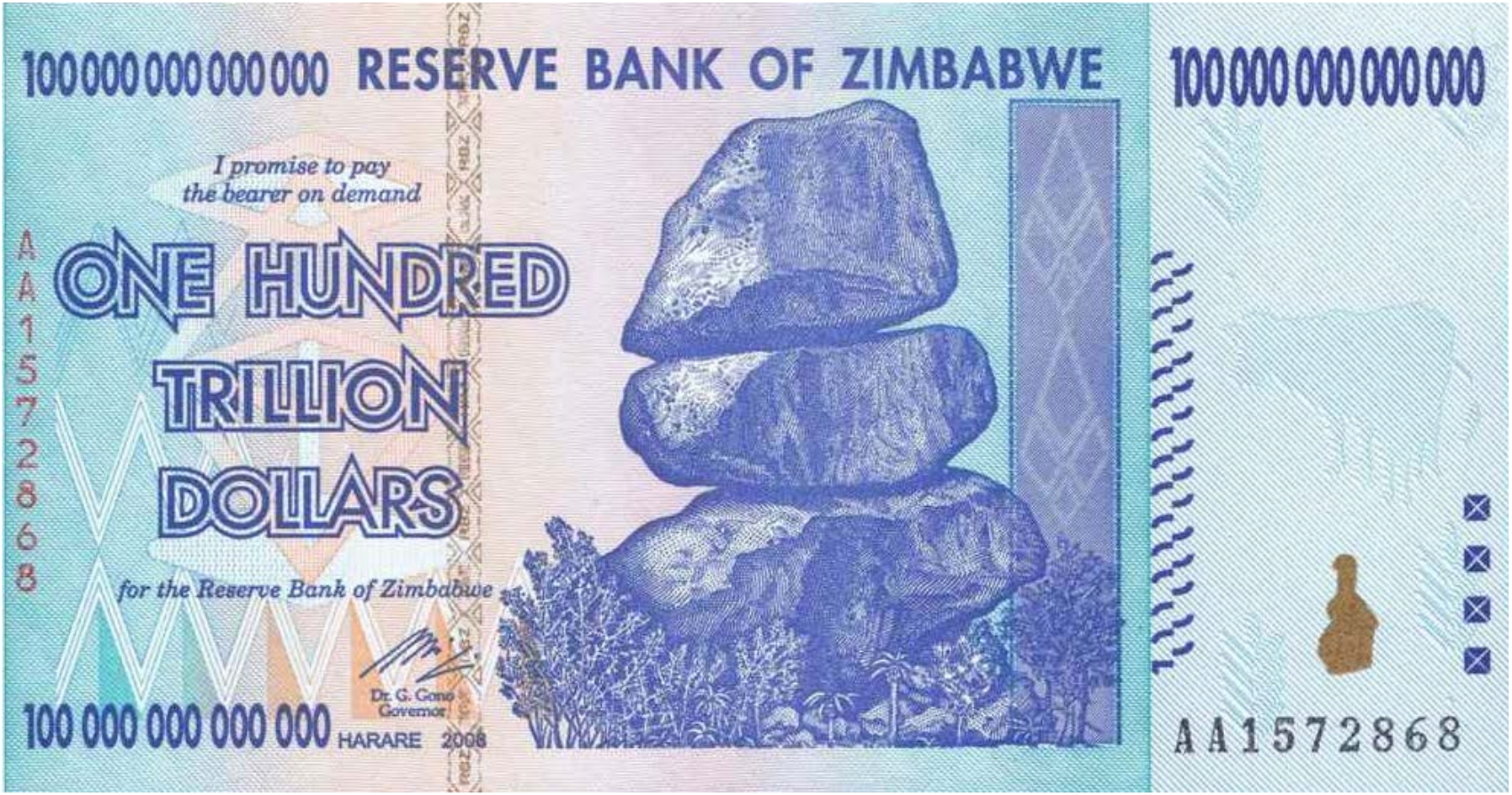

Southern Africa
Zambia
Angola
Victoria Falls
Harare
Chobe NP
Etosha NP
Okavango Delta
ZIMBABWE
Maun
Bulawayo
Mozambique
NAMIBIA
BOTSWANA
Swakopmund
Walvis Bay
Windhoek
Kruger NP
Gabarone
Pretoria
Kgalagadi Transfontier Park
Maputo
Johannesburg
Mbabane
Fish River Canyon
SWAZILAND
Bloemfontein
South Atlantic Ocean
SOUTH AFRICA
Maseru
Durban
LESOTHO
Indian Ocean
Cape Town
Port Elizabeth
N
200 Km
200 Miles

$10 US



Chiremba Balancing Rocks in Epworth, Harare

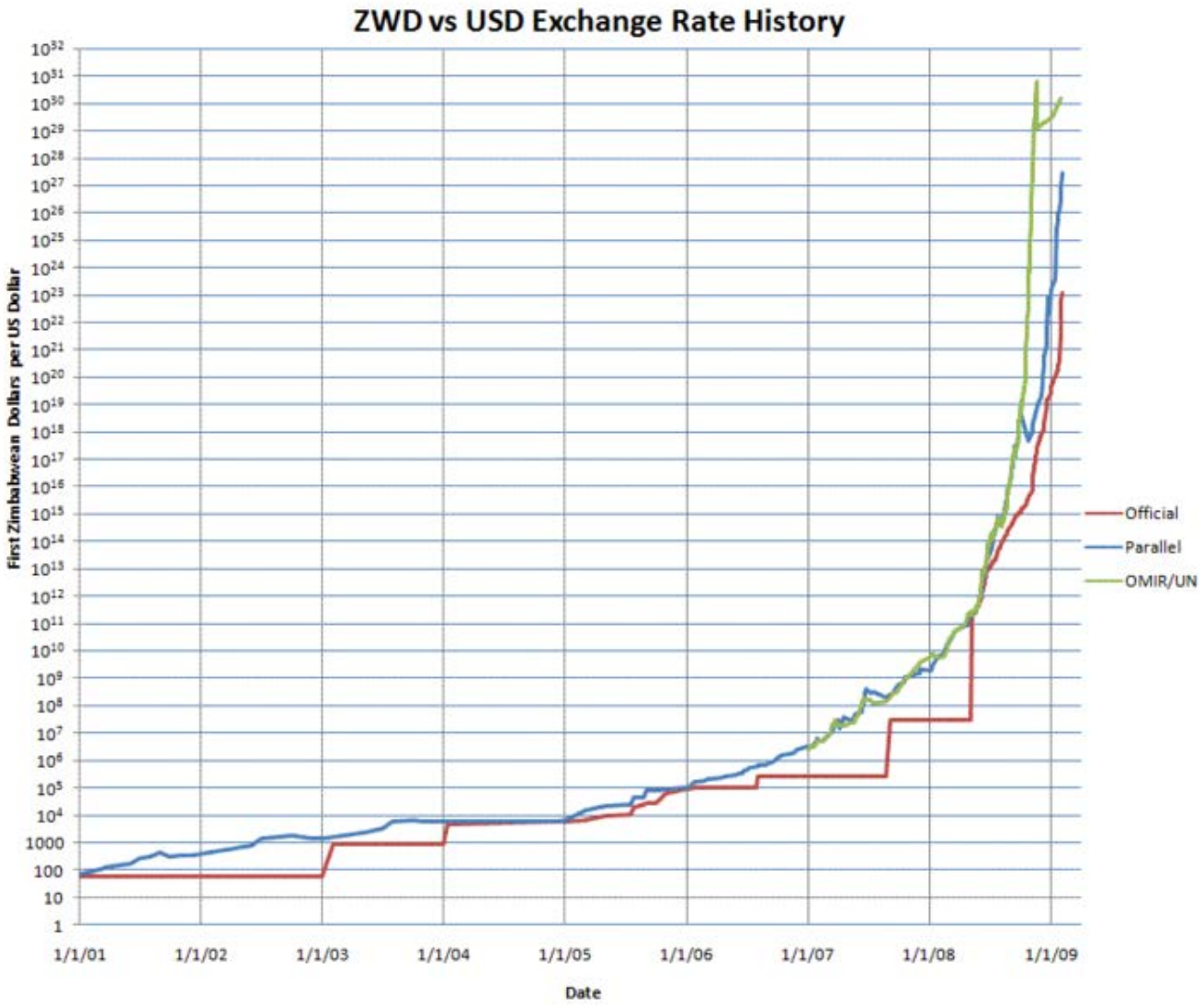
0.285¢ in 2015



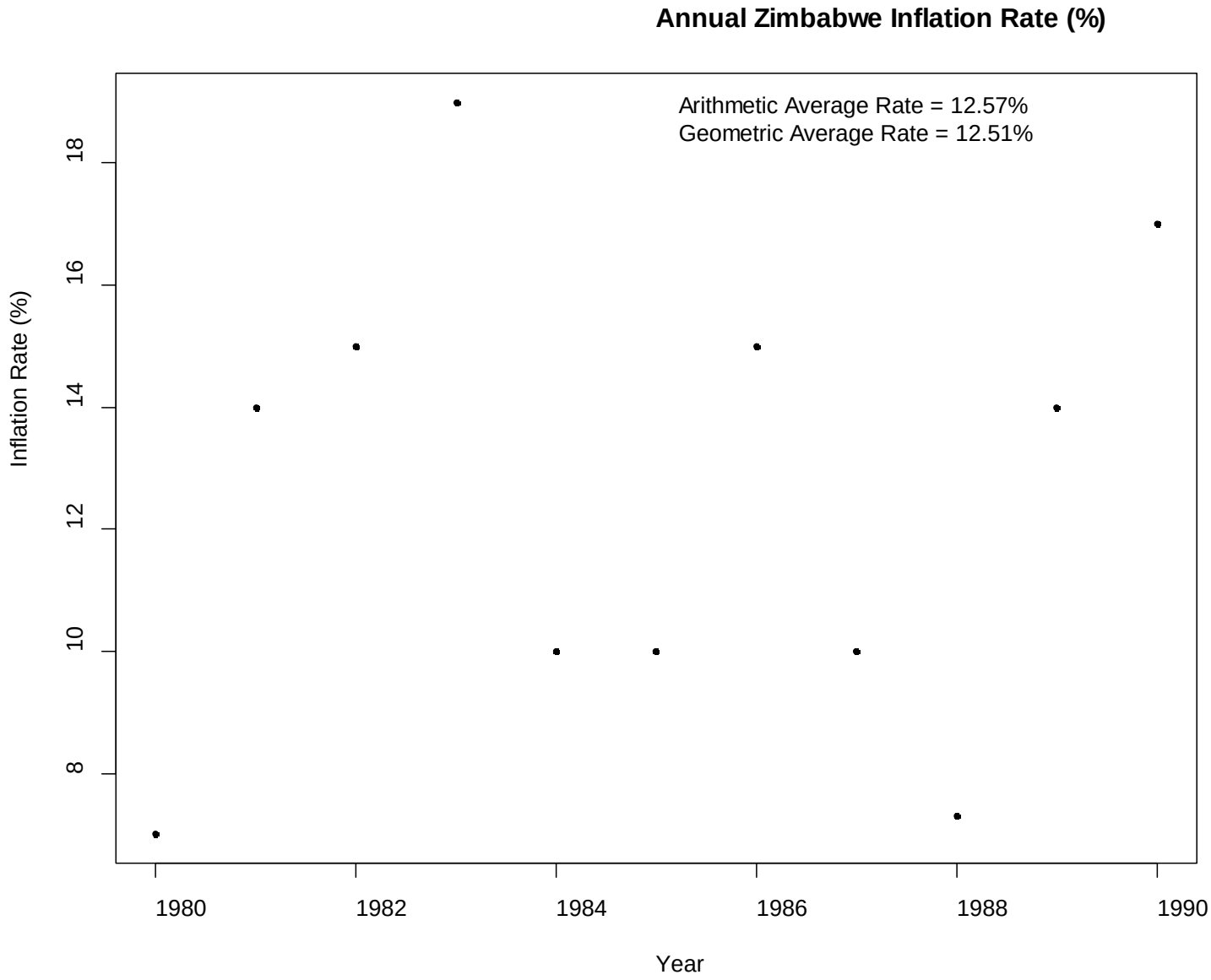
$$10 \cdot \$100\ Tn = 1000\ Tn = \$1\ Qn$$

$$35 \cdot 10 \cdot \$100\ Tn = \$35\ Qn$$

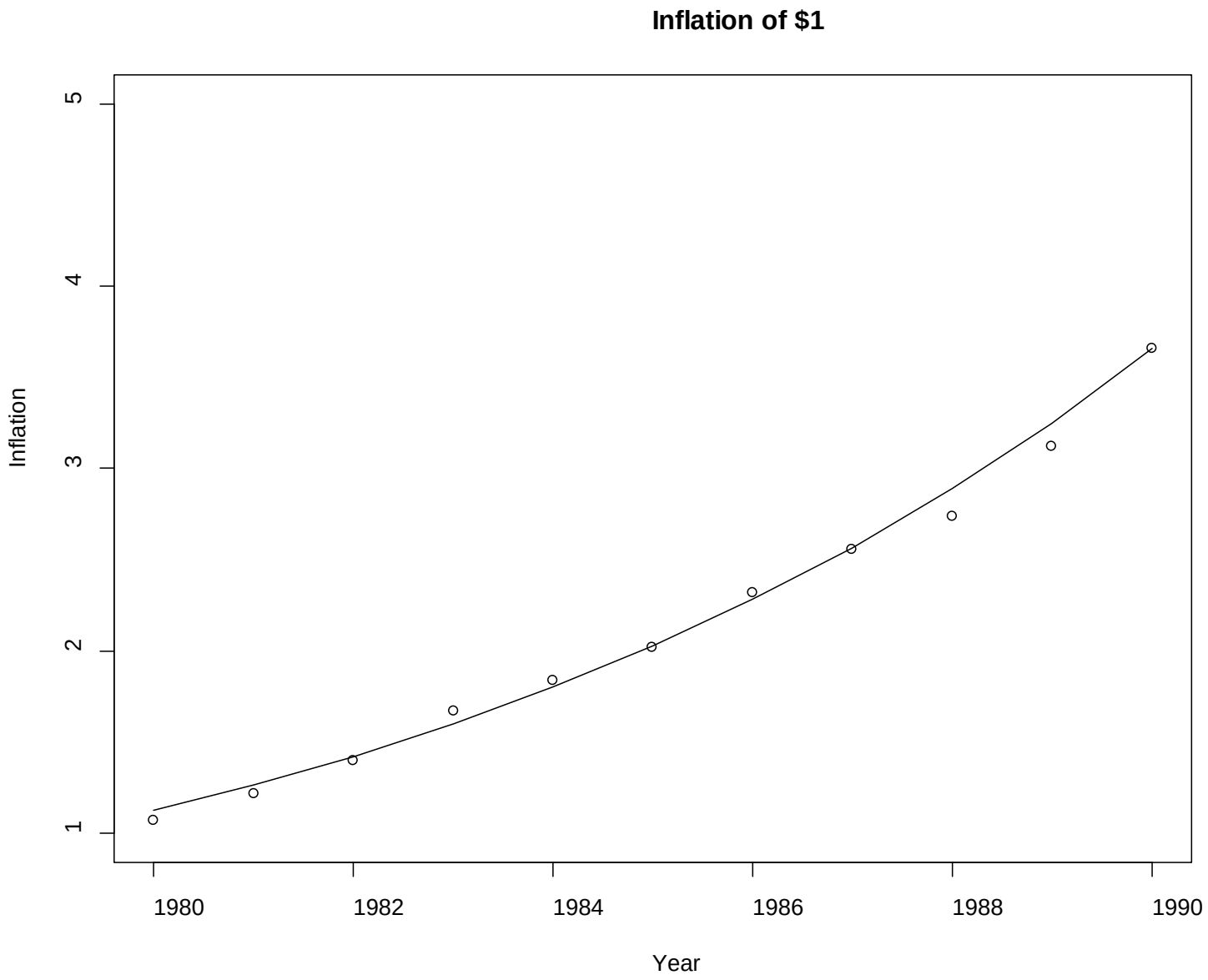
$$350 \cdot \$100\ Tn = \$35\ Qn = \$1\ US$$


ZWD vs USD Exchange Rate History
First Zimbabwean Dollars per US Dollar
10^{32}
10^{31}
10^{30}
10^{29}
10^{28}
10^{27}
10^{26}
10^{25}
10^{24}
10^{23}
10^{22}
10^{21}
10^{20}
10^{19}
10^{18}
10^{17}
10^{16}
10^{15}
10^{14}
10^{13}
10^{12}
10^{11}
10^{10}
10^{9}
10^{8}
10^{7}
10^{6}
10^{5}
10^{4}
1000
100
10
1
1/1/01
1/1/02
1/1/03
1/1/04
1/1/05
1/1/06
1/1/07
1/1/08
1/1/09
Date
Official
Parallel
OMIR/UN

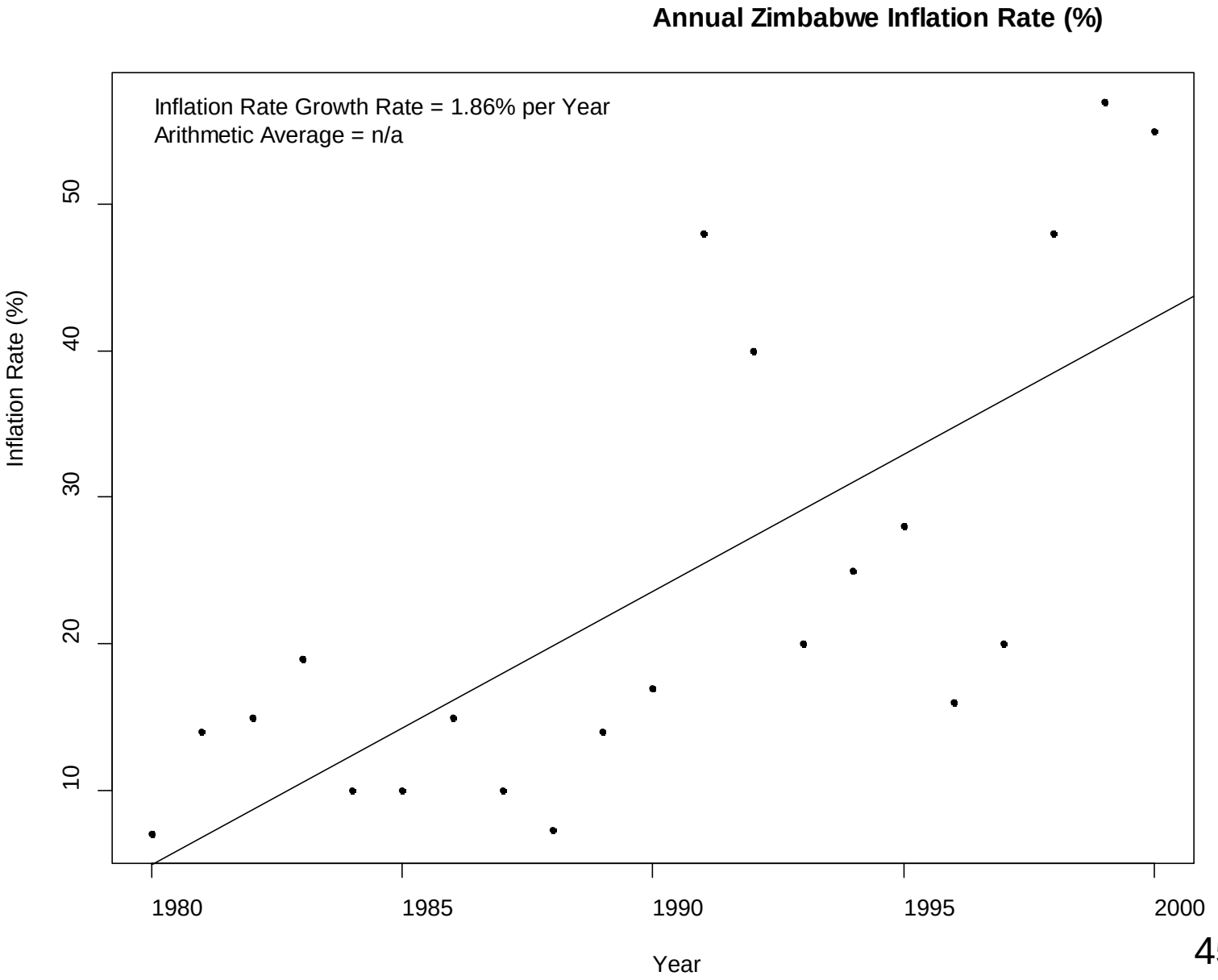
Constant Inflation



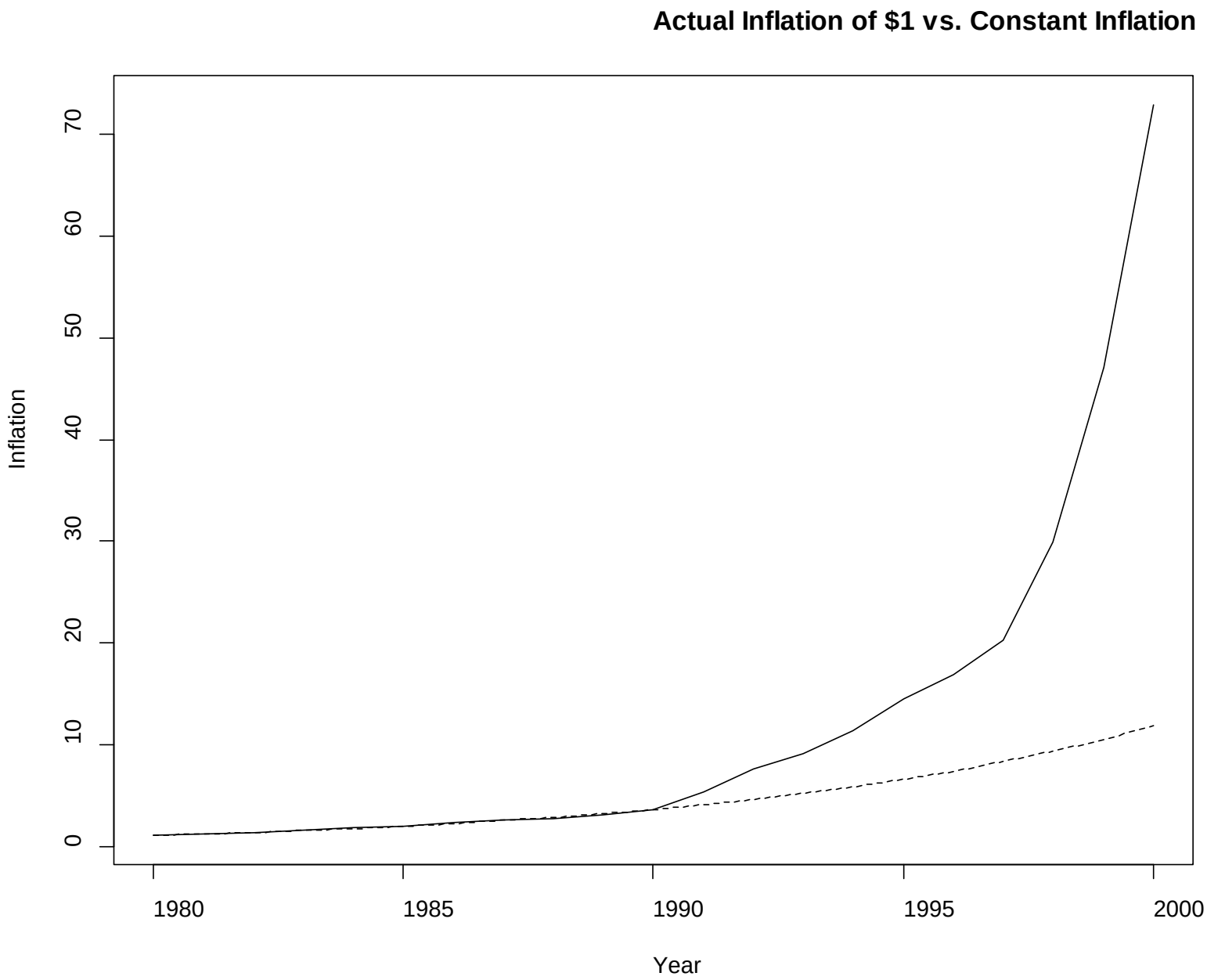
$1 Becomes


Inflation of $1
Inflation
1
2
3
4
5
1980
1982
1984
1986
1988
1990
Year

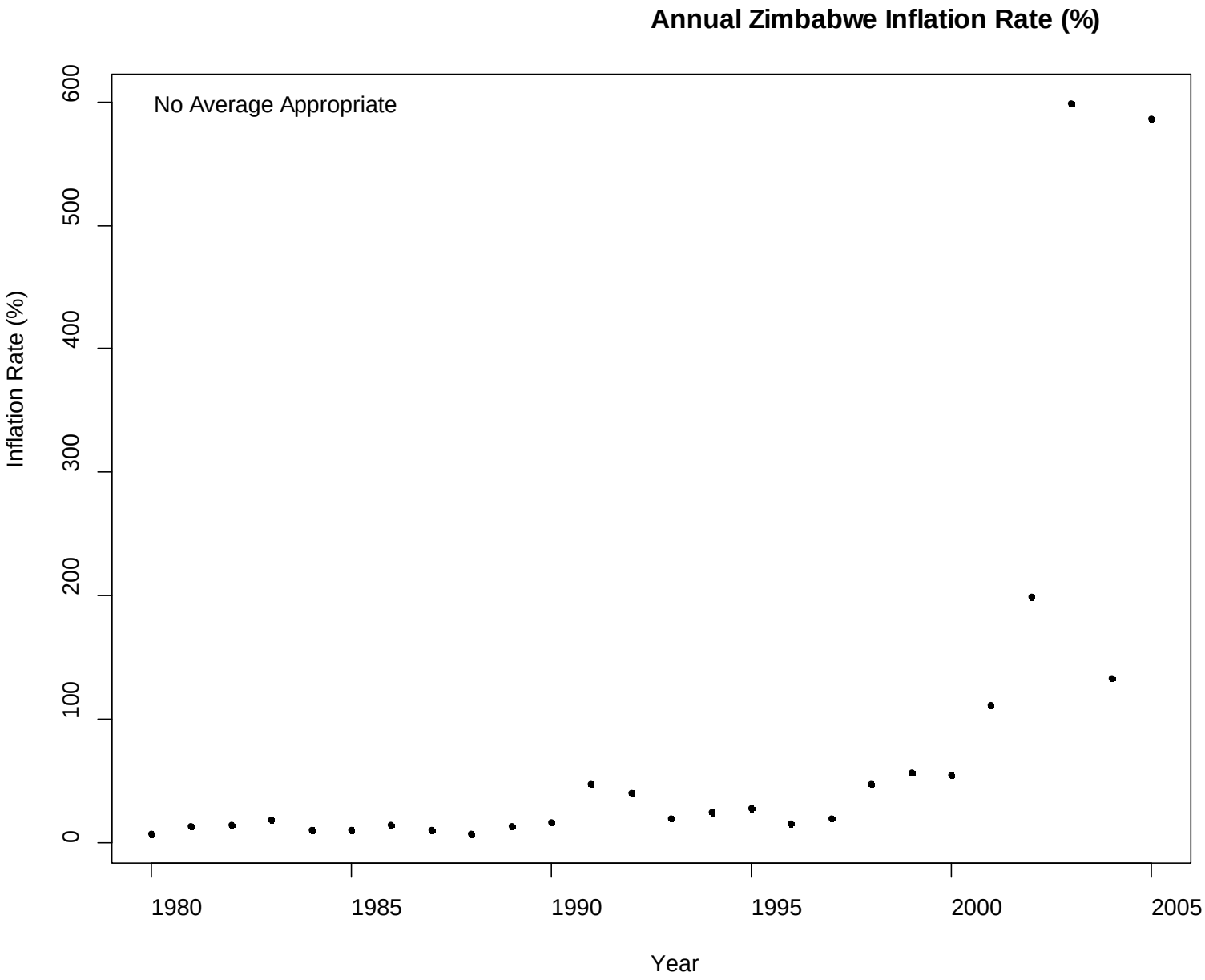
Linear Inflation Growth



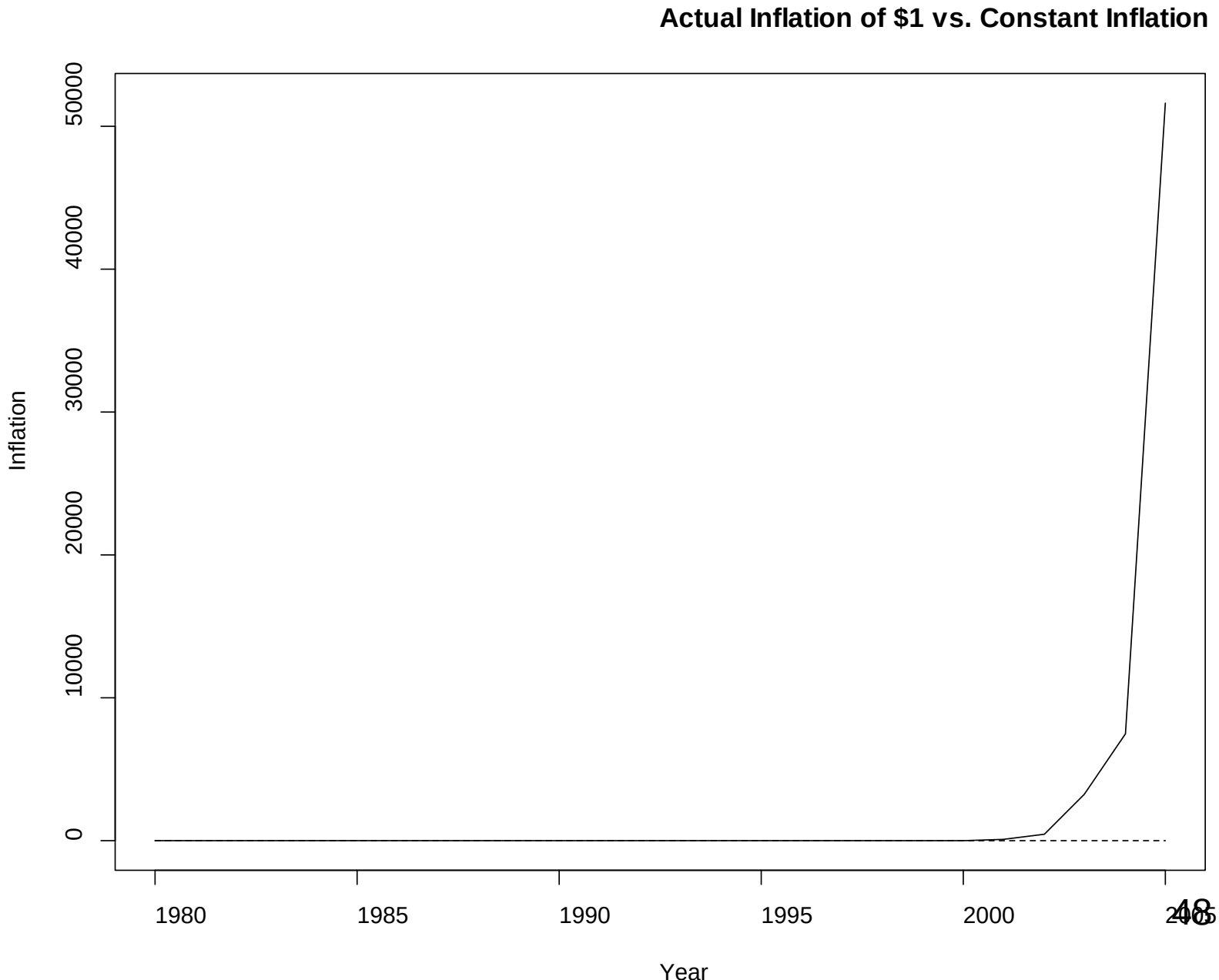
$1 Becomes


Actual Inflation of $1 vs. Constant Inflation
Inflation
0
10
20
30
40
50
60
70
1980
1985
1990
1995
2000
Year

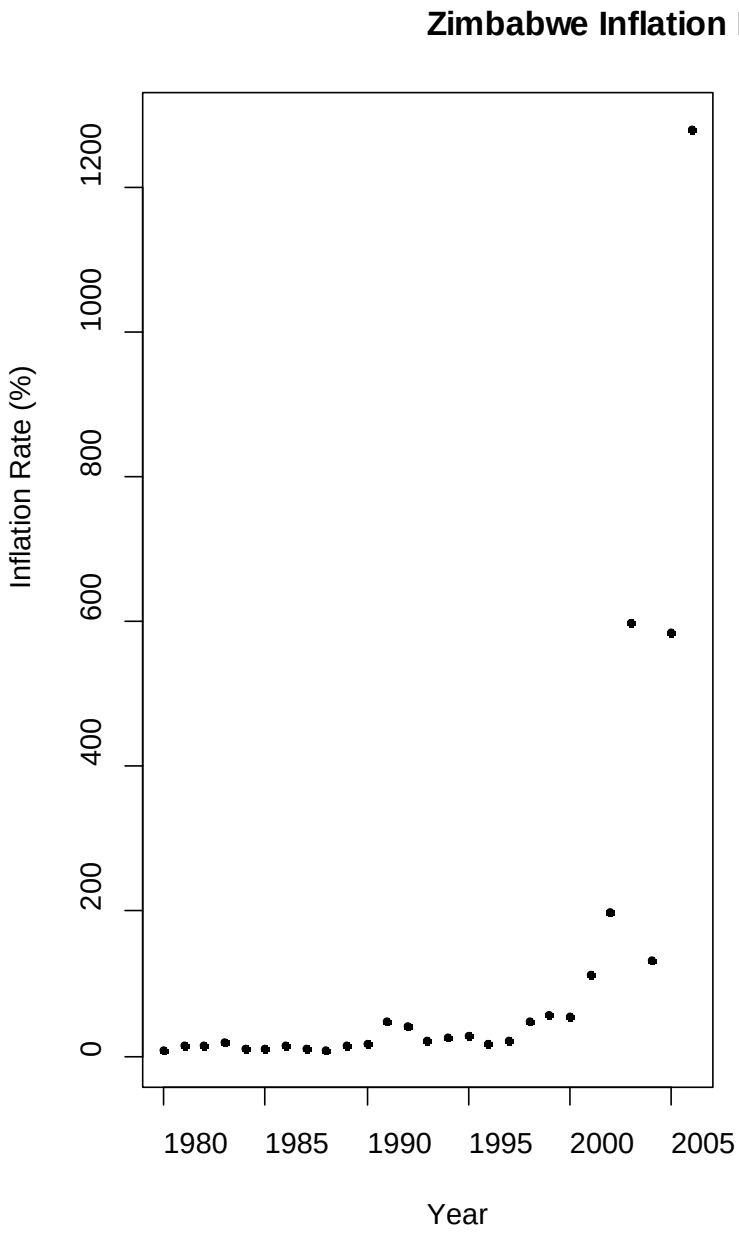
Exponential Growth

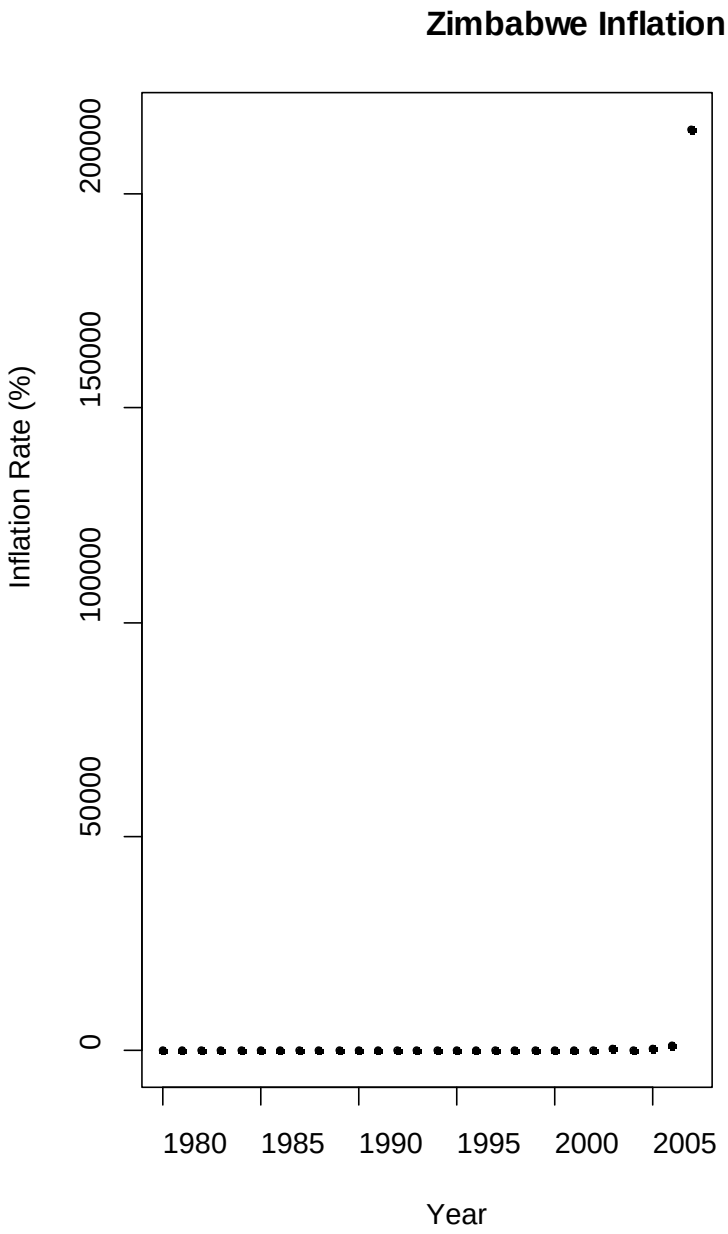


$1 Becomes

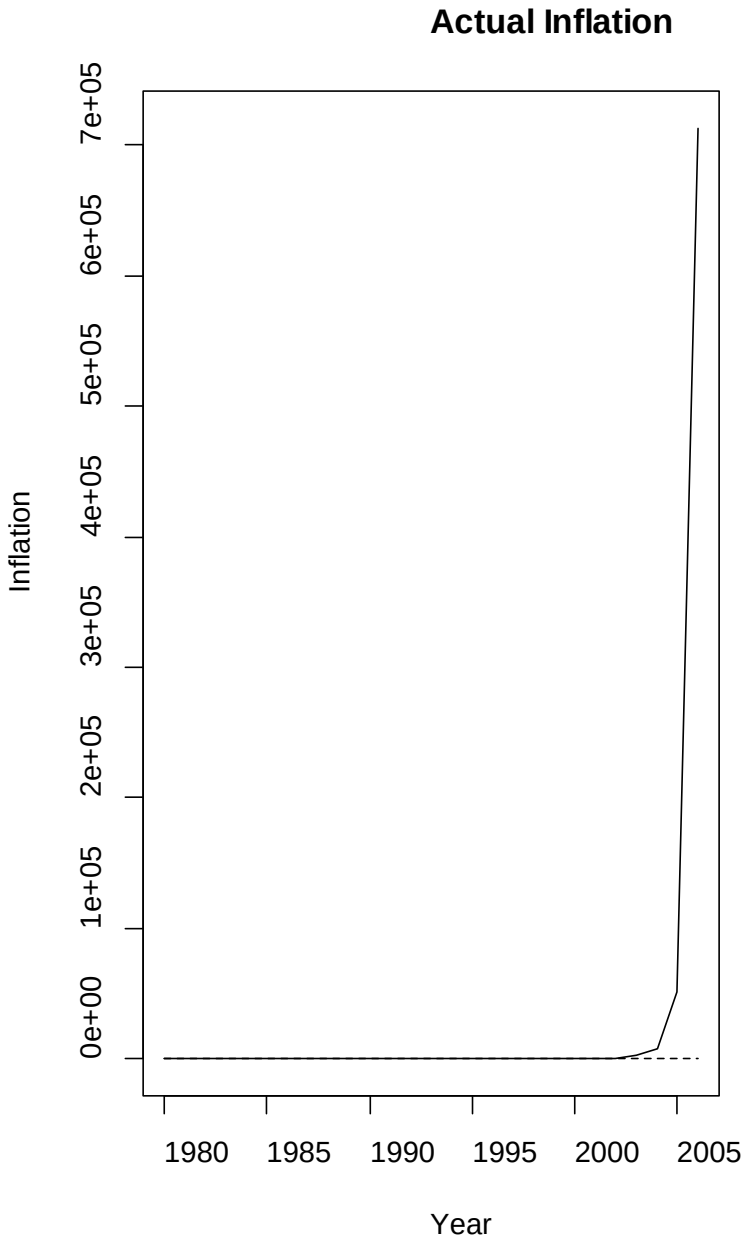

Actual Inflation of $1 vs. Constant Inflation
Inflation
0
10000
20000
30000
40000
50000
1980
1985
1990
1995
2000
2005
Year

Actual Inflation Growth





$1 Becomes


Actual Inflation
Inflation
0e+00
1e+05
2e+05
3e+05
4e+05
5e+05
6e+05
7e+05
1980
1985
1990
1995
2000
2005
Year

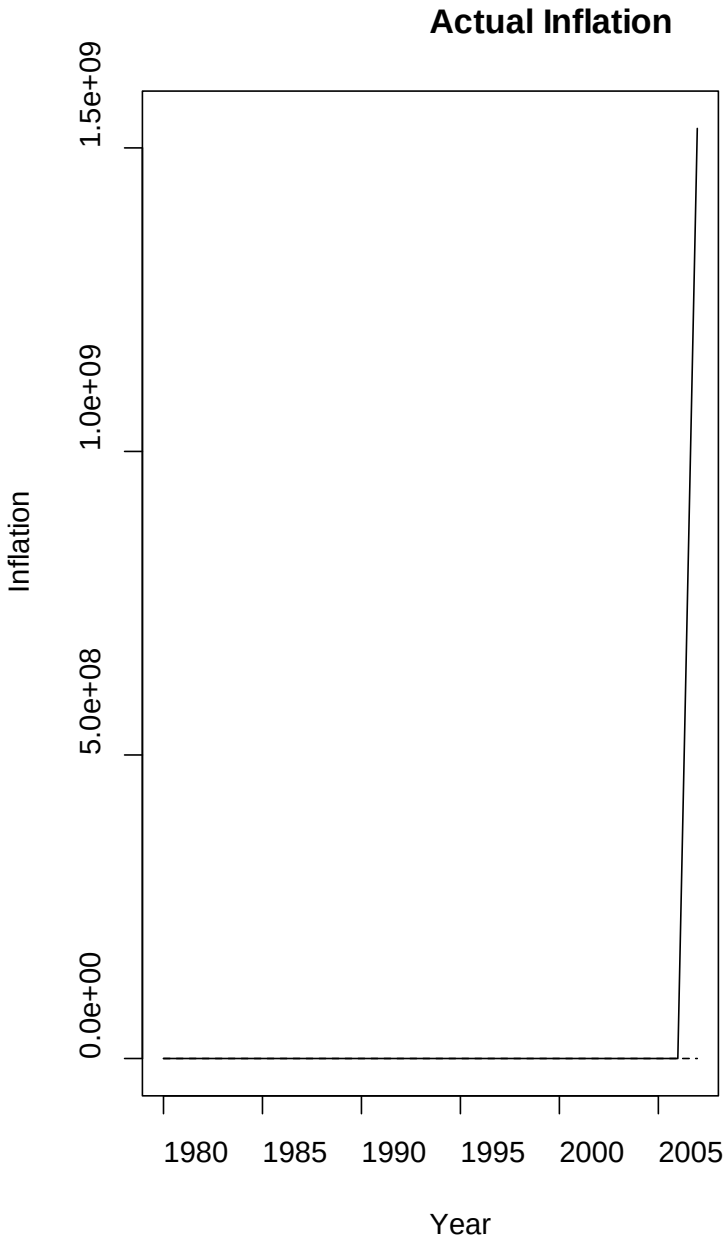

Actual Inflation
Inflation
0.0e+00
5.0e+08
1.0e+09
1.5e+09
1980
1985
1990
1995
2000
2005
Year

TABLE 2
HIGHEST MONTHLY INFLATION RATES IN HISTORY

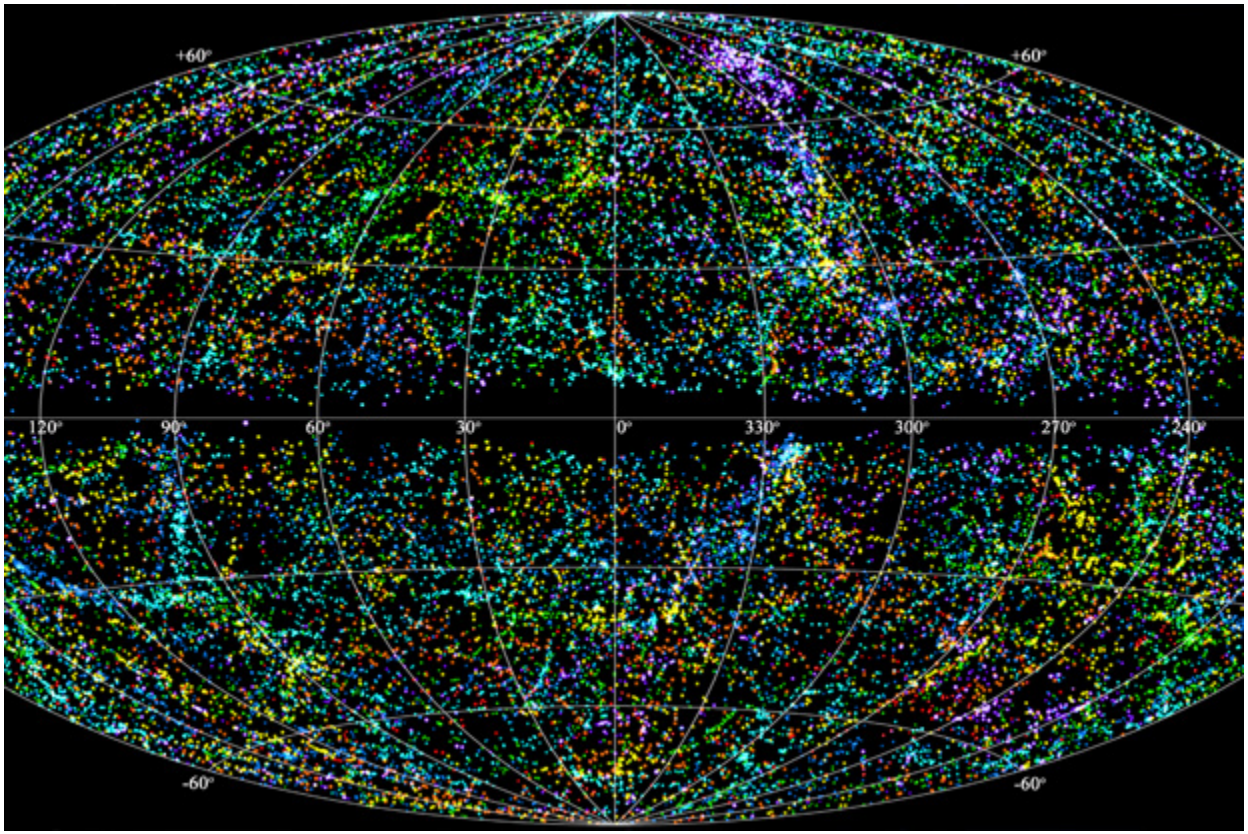
Country	Month with highest inflation rate	Highest monthly inflation rate	Equivalent daily inflation rate	Time required for prices to double
Hungary	July 1946	$4.19 \times 10^{16}\%$	207%	15.0 hours
Zimbabwe	Mid-November 2008	79,600,000,000%	98.0%	24.7 hours
Yugoslavia	January 1994	313,000,000%	64.6%	1.4 days
Germany	October 1923	29,500%	20.9%	3.7 days
Greece	October 1944	13,800%	17.9%	4.3 days
China	May 1949	2,178%	11.0%	6.7 days

NOTES: The authors calculated "equivalent daily inflation rate" and "time required for prices to double."
SOURCES: Hungary (Nogaro 1948); Zimbabwe (authors' calculations); Yugoslavia (Petrović , Bogetić , and Vujošević 1999); Germany (Sargent 1986); Greece (Makinen 1986); China (Chou 1963).

Date	Inflation Rate (%)	
2006	1,281	
2007	215,000	K
2008.07	317,000,000	M
2008.08	9,690,000,000	B
2008.09	471,000,000,000	B
2008.10	3,840,000,000,000,000,000	Qin
2008.11	593,000,000,000,000,000,000	Qin
2008.12	89,700,000,000,000,000,000,000	Sx

$1 in 1980 Becomes

Date	Inflation Value	
2006	712,911	
2007	1,533,470,716	1.5 Bn
2008.07	4,861,103,703,354,600	4.8 Qn
2008.08	471,040,953,716,164,000,000,000	471 Sxtn
2008.09	2,218,602,892,474,170,000,000,000,000,000,000	2.2 Dcn
2008.10	85,194,351,071,008,300,000,000,000,000,000,000,000,000,000,000	85 15n
2008.11	505,202,501,851,079,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000	505 21n
2008.12	453,166,644,160,418,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000	4.53 E89




SO WHAT?
NOW
WHAT?

Student Debt

- Rice University – 4 years

	Tuition	Fees	Room & Board	Telecomm Fee	Total
2014-2015	$39,800	$2,795	$13,400	$30	$56,025
2013-2014	38,260	2,743	13,000	30	54,033
2012-2013	36,610	2,536	12,600	30	51,776
2011-2012	34,900	2,194	12,270	30	49,394
2010-2011	33,120	2,137	11,750	48	47,055

- 4-year increase: 19%
- Compound annual growth rate: 4.5%
- 4-year total: $211,288

- 30-year loan, 7%
  - Monthly payment of $1,405.70
  - 1st payment 9/1/2020
  - last payment 9/1/2050
- Principal repaid: $211,288
- Total Interest paid: 294,756
- Principal and Interest: 505,994
- If left unpaid for 30 years: total principal and interest due $1,714,918
- If left unpaid 60 years: $13,919,132

Why Not?

Lets Go to Work

22-32 (2020-2030, 10 years)

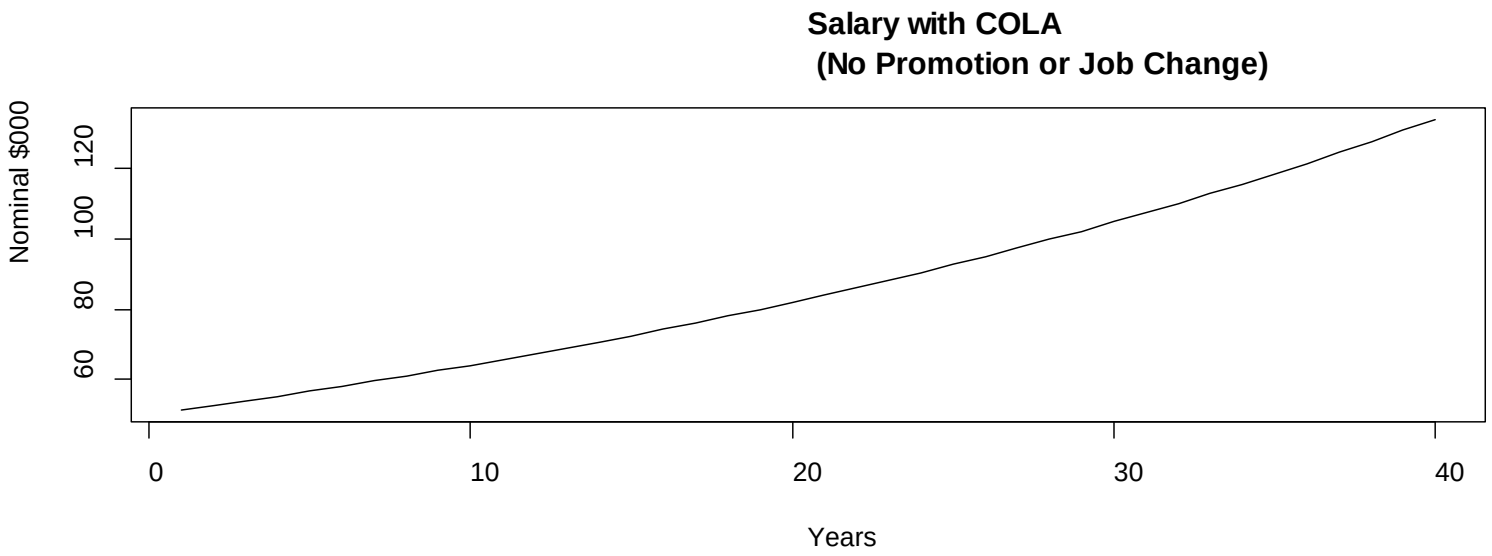
32-42 (2030-2040, 10 years)

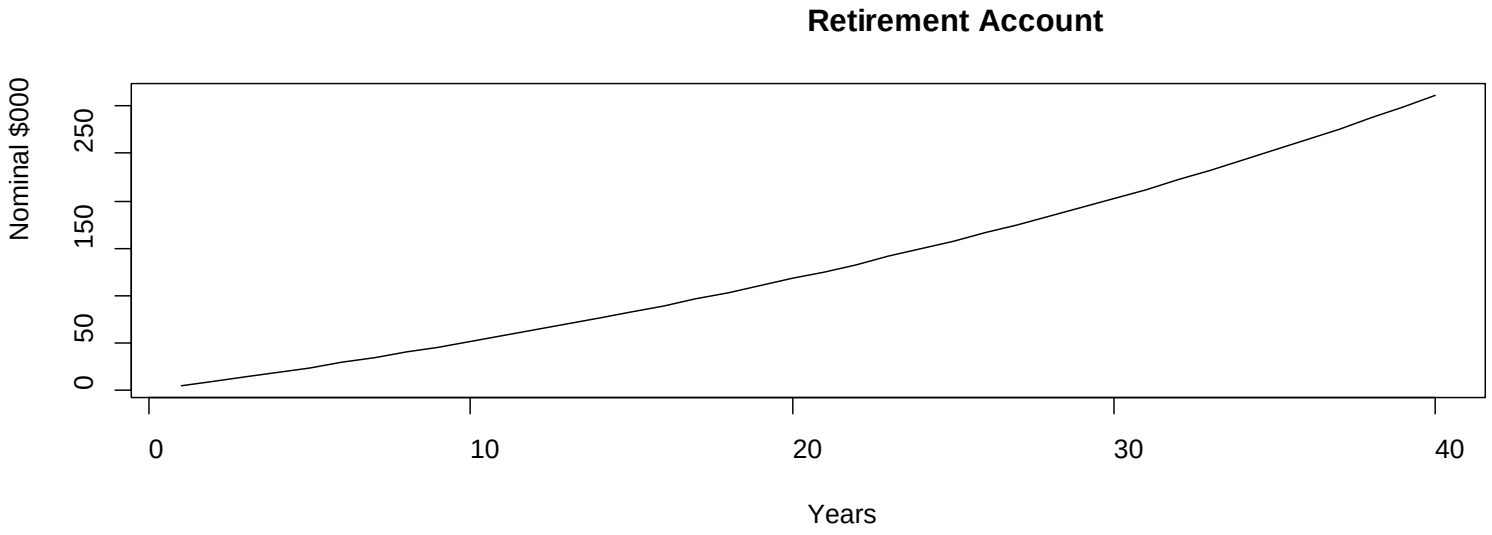
42-52 (2040-2050, 10 years)

52-62 (2050-2060, 10 years) → 40 Years

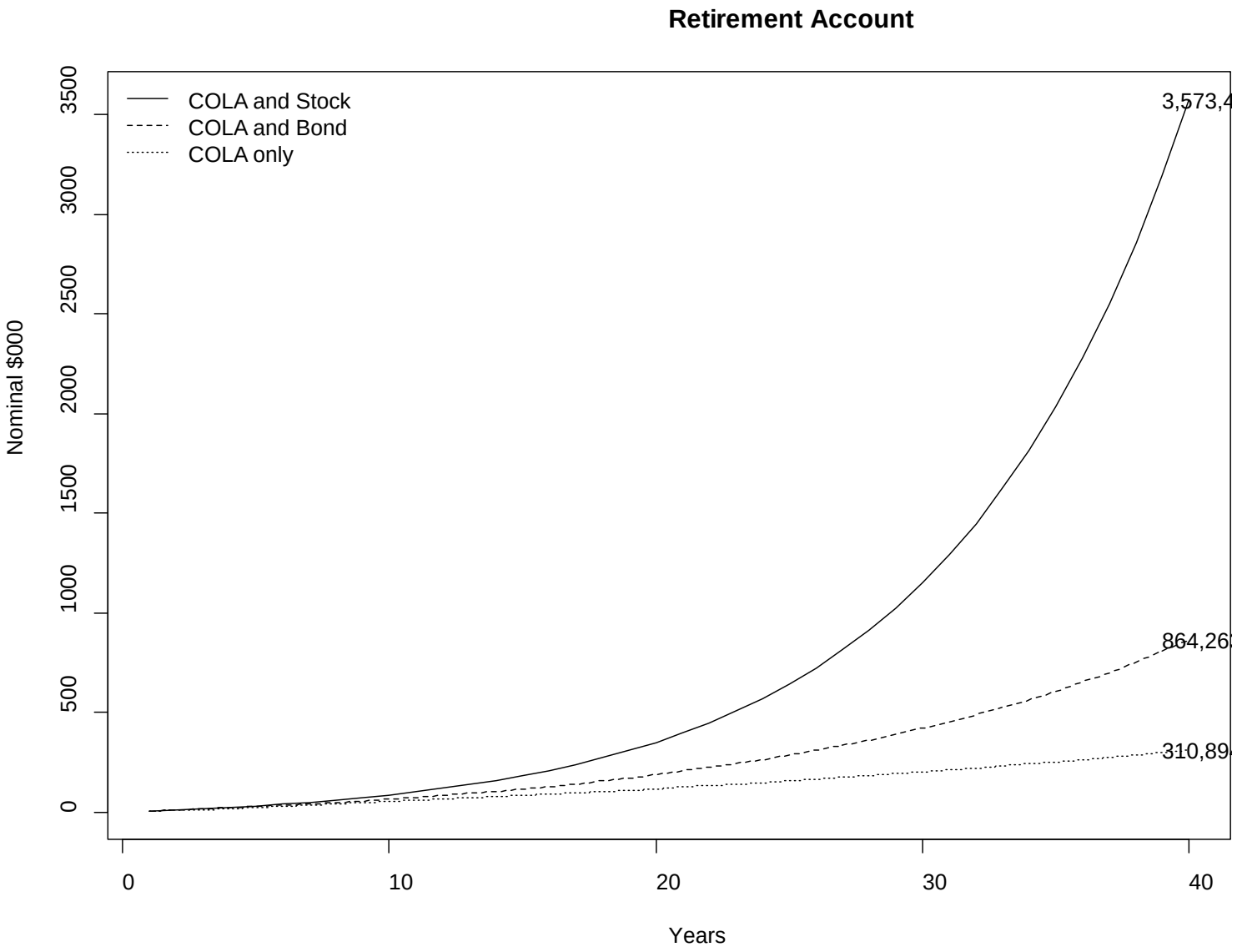
Accumulation Model

- Starting salary (2020)
  - $17,680 minimum wage (+ SNAP)
  - $50,000 Rice undergraduate degree BA/BS
- Cost of living raises (COLA) = 2.5% per yr.
- Investment rates of return ✓
  - Bonds rate of return = 4% per year
  - Stocks rate of return = 9% per year
- 401k retirement savings account
  - Employee contributes 5% of salary
  - Employer matches 4%
  - Total contributions 9% of salary (off top)


Salary with COLA
(No Promotion or Job Change)
Nominal $000
60
80
100
120
0
10
20
30
40
Years


Retirement Account
Nominal $000
0
50
150
250
0
10
20
30
40
Years

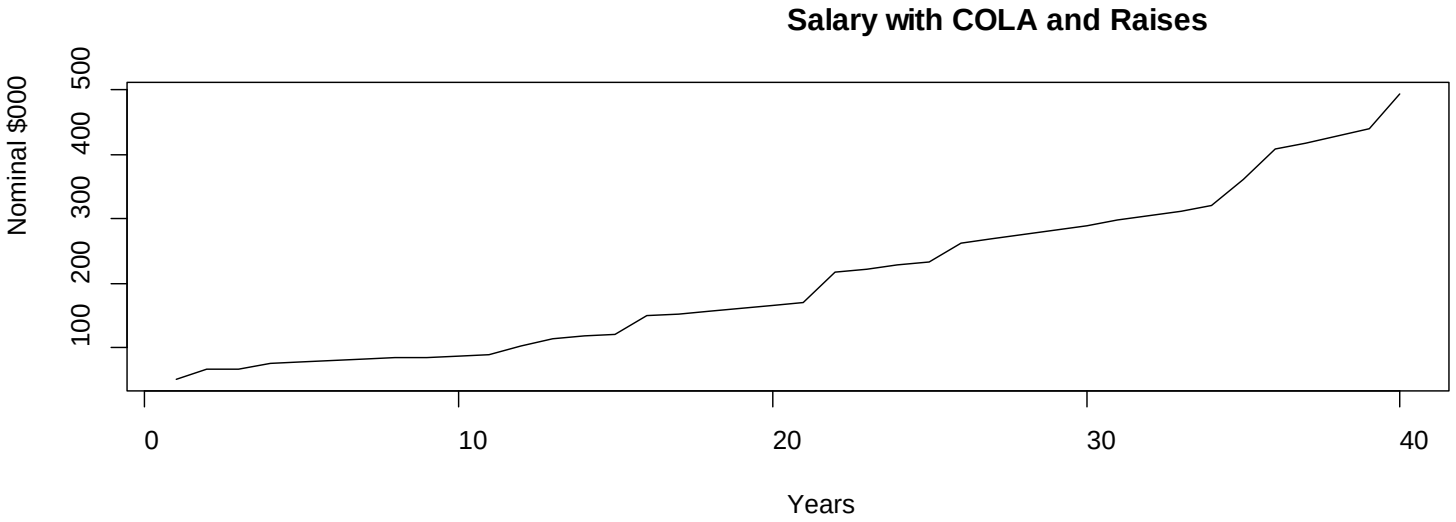
Investment Options

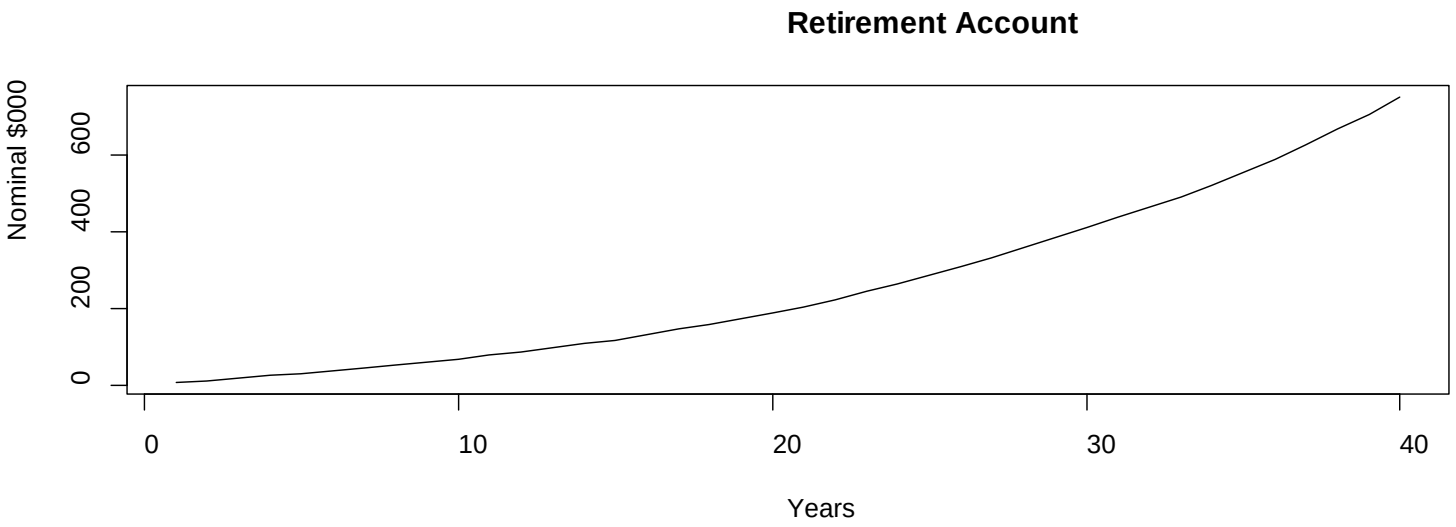


Add Some Variability

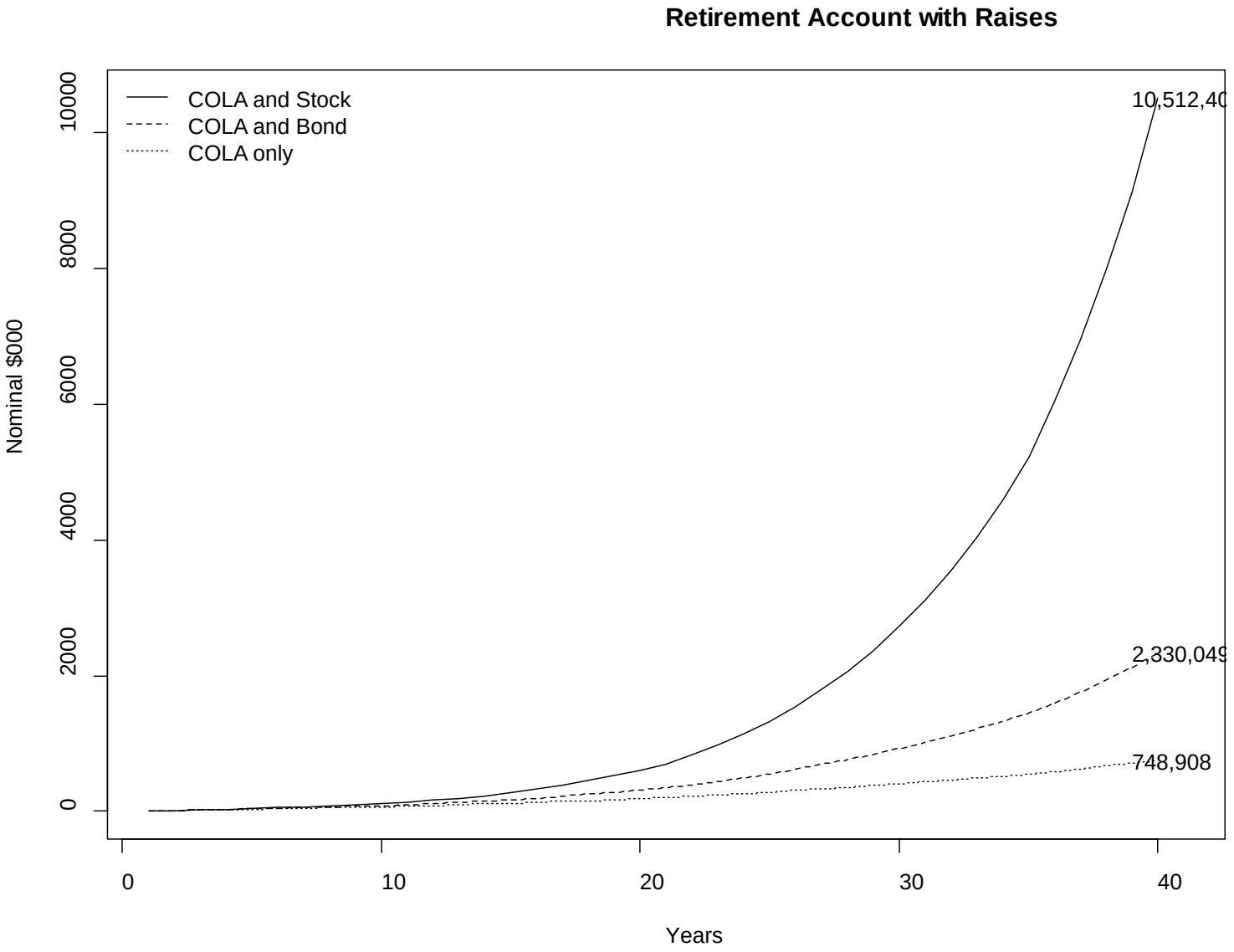
- Promotion model
  - 10% promotion/raise on average every 5 years
- Job change model
  - 25% salary increase upon job change average every 10 years
- Focus on at terminal value of retirement account after 40 years

Just one Path

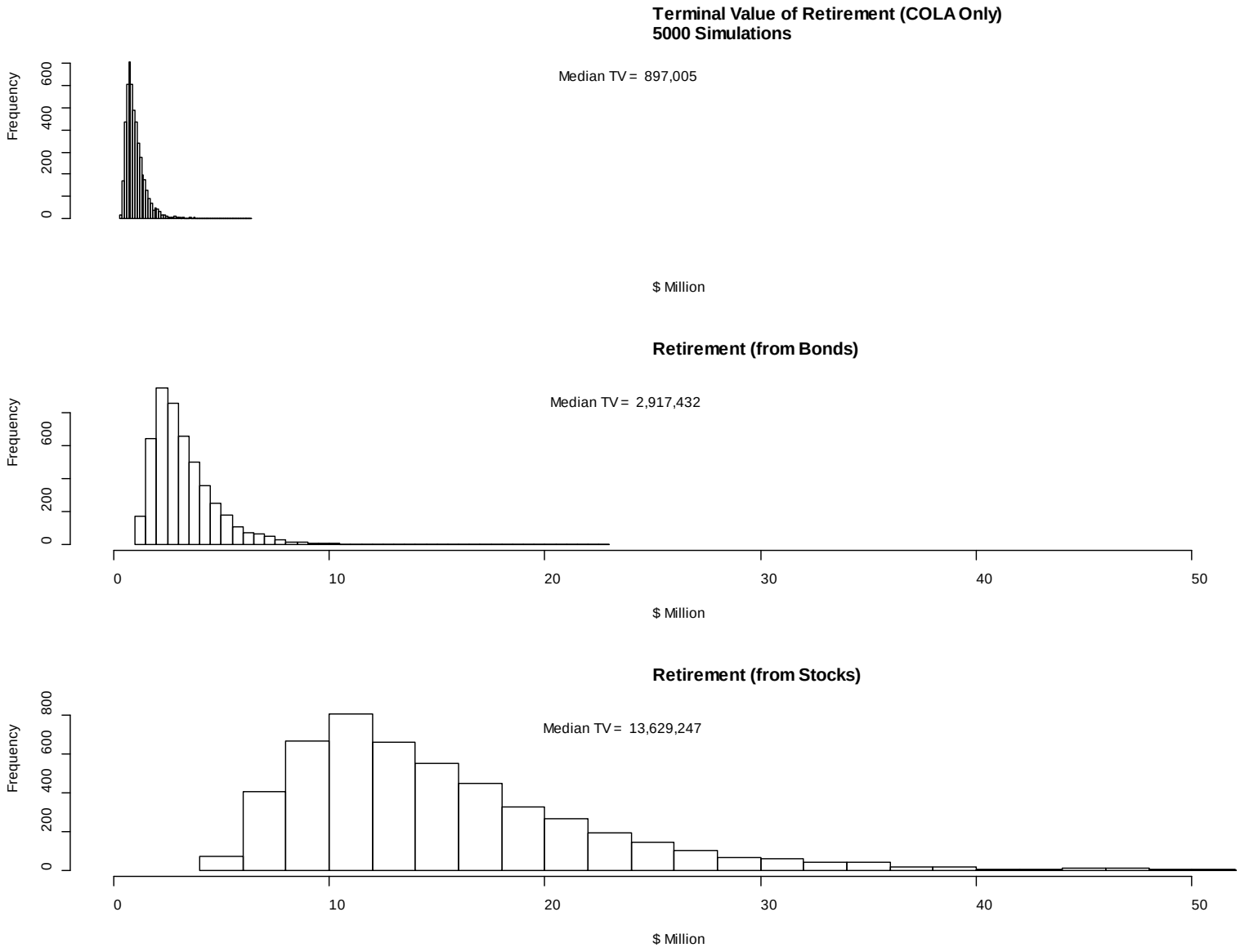




Investment Options



Do this 5,000 Times



Make it Happen!

Discussions