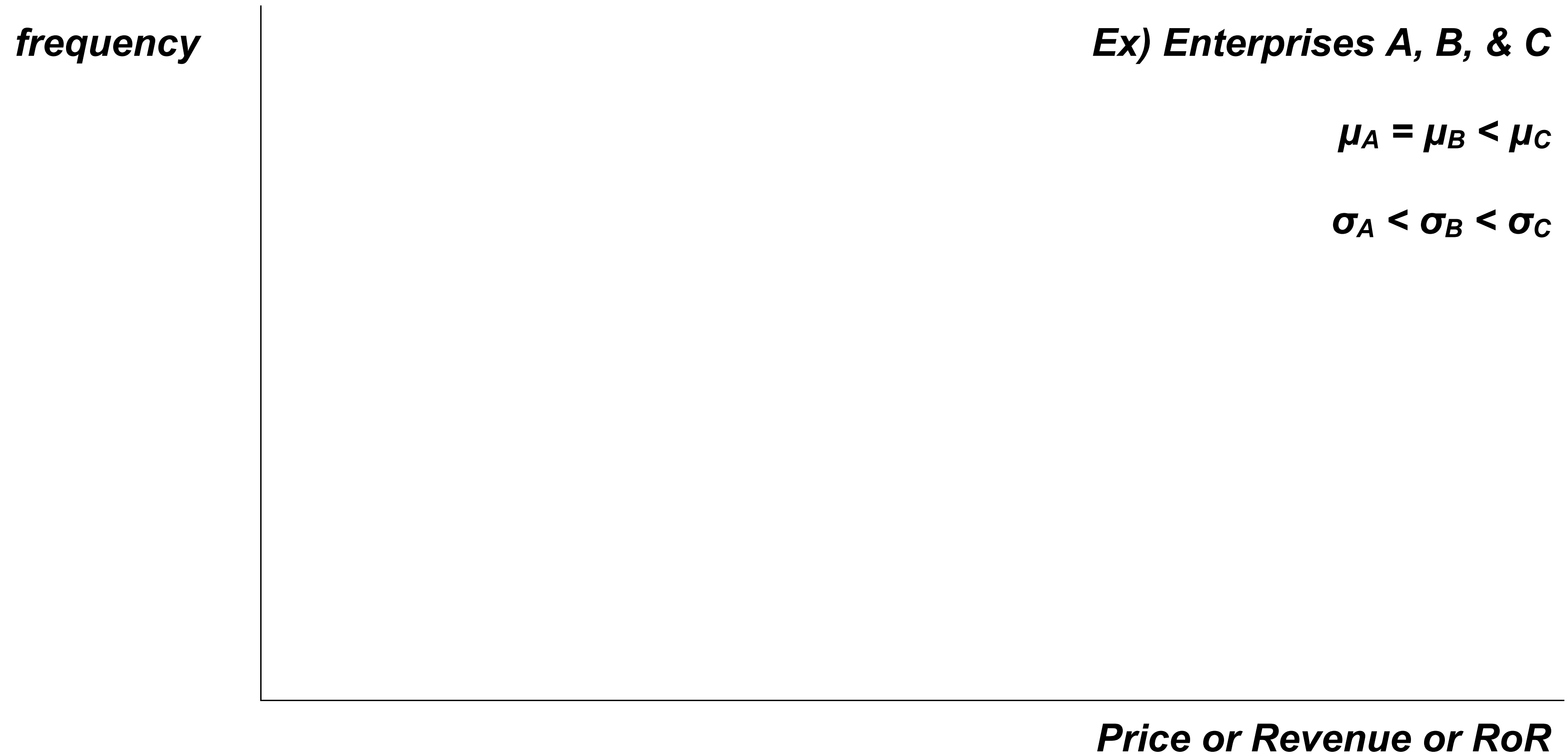
Reading Assignment

USDA ERS Publication. "Managing Risk in Farming: Concepts, Research, and Analysis." Ag Econ Report 774 (AER-774).

https://www.ers.usda.gov/publications/pub-details/?pubid=40971

How Do We Measure Risk?

First, we must answer – How do we measure return?
Then risk is like "experience..."

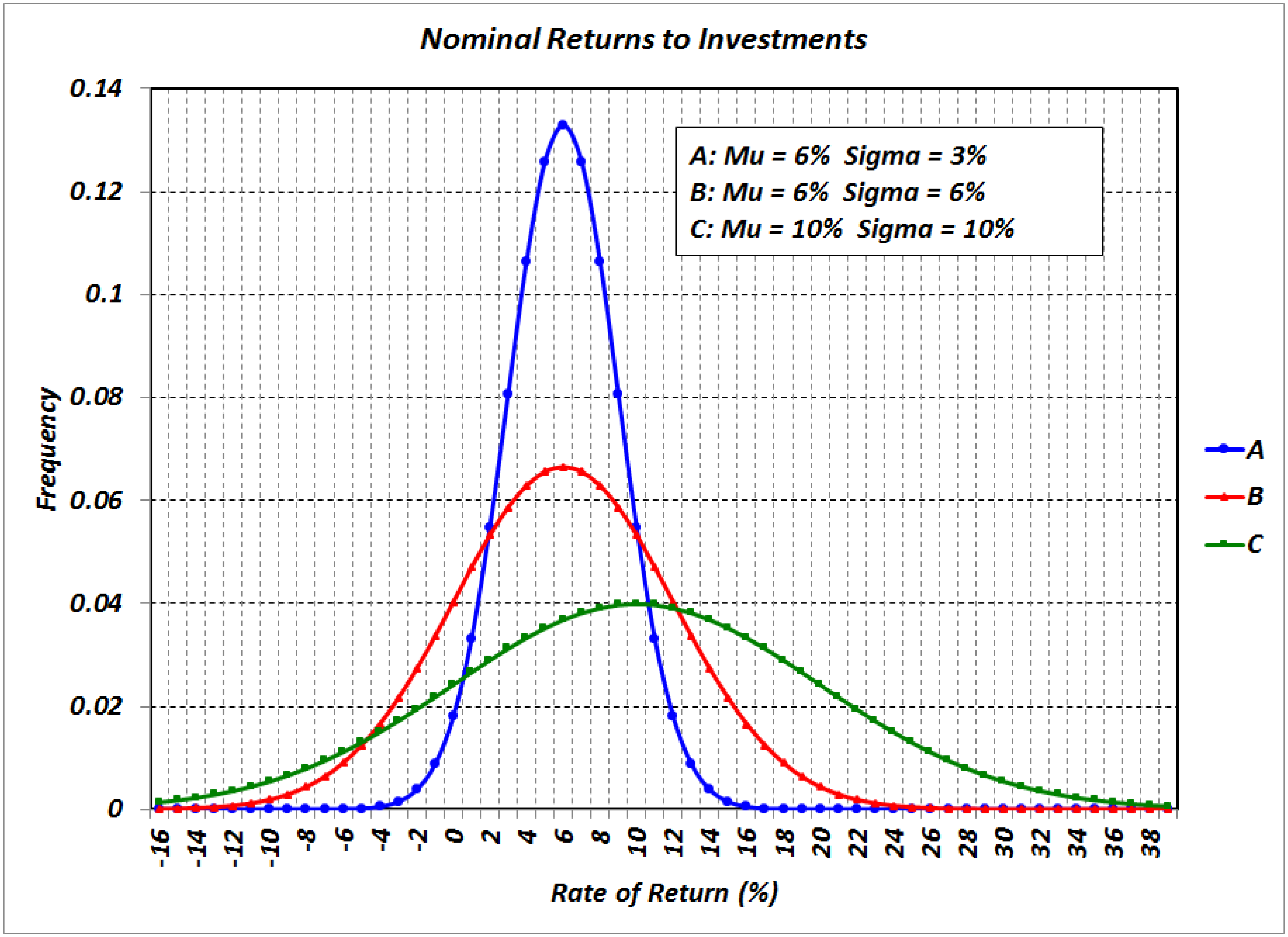


Ex) Enterprises A, B, & C

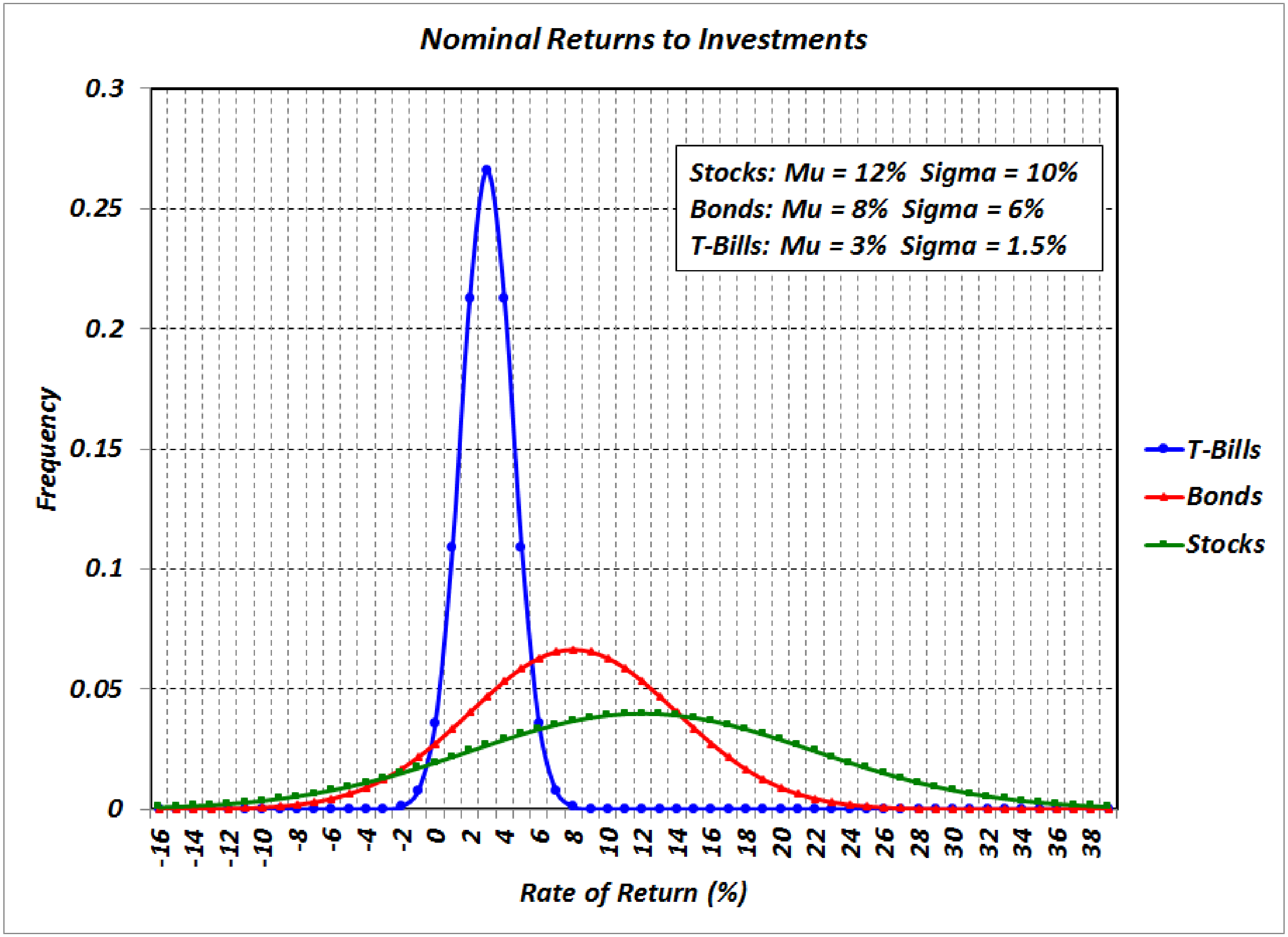
$\mu_A = \mu_B < \mu_C$

$\sigma_A < \sigma_B < \sigma_C$

Which enterprise is best? Which is worst? Can we eliminate one?
(See spreadsheet figure.)



Nominal Returns to Investments
A: Mu = 6% Sigma = 3%
B: Mu = 6% Sigma = 6%
C: Mu = 10% Sigma = 10%
Frequency
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
-16
-14
-12
-10
-8
-6
-4
-2
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
36
38
Rate of Return (%)
A
B
C


Nominal Returns to Investments
Stocks: Mu = 12% Sigma = 10%
Bonds: Mu = 8% Sigma = 6%
T-Bills: Mu = 3% Sigma = 1.5%
T-Bills
Bonds
Stocks
Frequency
0.3
0.25
0.2
0.15
0.1
0.05
0
-16 -14 -12 -10 -8 -6 -4 -2 0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38
Rate of Return (%)

Returns are some <u>expected value</u> – e.g., mean rate of return, profit, revenue, or price. Risk is some measure of <u>deviation from expected value</u> – e.g., standard dev.

The first batch of equations...

<u>Return</u>: $E(x) = \hat{\mu} = \sum_{t=1}^{T} x_t / T$ ***or*** $E(y_t) = \hat{y}_t = \beta_0 + \beta_1 x_{1t} + \ldots + \beta_k x_{kt}$

<u>Risk</u>: $\hat{\sigma}^2 = \sum_{t=1}^{T} (x_t - \hat{\mu})^2 / (T-1)$ ***or*** $\hat{\sigma}^2 = \sum_{t=1}^{T} (y_t - \hat{y}_t)^2 / (T-(k+1))$ ***and*** $\sigma = \sqrt{\sigma^2}$

Measures of central tendency are measures of what we can expect – means or conditional means (i.e., regression predictions). Measures of dispersion are measures of departures from what we expect – how spread out are the realizations.

Interpret: 1) mean and 2) standard deviation?

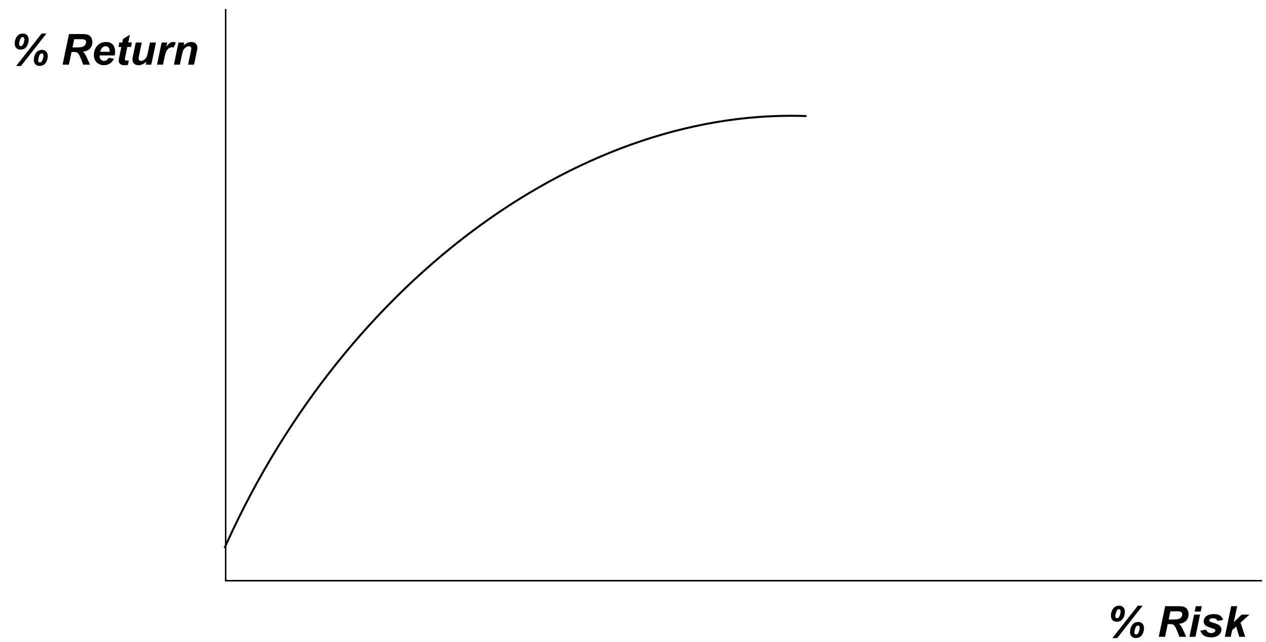
The mean is easy: "On average I can expect…"

Standard deviations measure dispersion or how spread-out the individual observations/outcomes (x_t's) are around the mean. Using σ with a Normal distribution, 68% of time what? 95% of the time what? And 99% of the time what?

Some real-world numbers

	Livestock	*Grains*	*Specialty*	*Stocks*	*Bonds*	*T-Bills*
Return (μ)	***5-8%***	***8-12%***	***15-25%***	***8-10%***	***5-7%***	***1-3%***
Risk (σ)	***10-20%***	***15-30%***	***25-50%***	***15-20%***	***10-15%***	***2-4%***
	Which enterprise is best?			***Which investment is best?***		

Evaluating Investment and Other Business Decisions – Using Efficient Frontier



A choice is efficient if has the highest return for a given risk or lowest risk for a given return. There are no wrong choices among the risk-efficient set.

Some Ideas About Measuring Risk

Deviation from what we expect...

Outcome = Expectation ± Departures from expectation (Outcome & Risk)

<u>Simple Expectations</u>

Yield: $Y_t = \mu + e_t$

Price: $P_t = \mu + e_t$ ***Alternative:*** $P_t = P_{t-1} + e_t$

(Where e_t is a random variable with zero mean and estimated variance, and possibly distributed Normal.)

<u>Better (or Smarter) Expectations</u>

Yield: $Y_t = \text{trend} + e_t = \beta_0 + \beta_1 t + e_t$

Price: $P_t = \beta_0 + \beta_1 P_{t-1} + e_t$

(See spreadsheet figures for yields and prices.)
(See spreadsheet figures for investment returns.)

It might not be on exams, but it will be on assignments…

Make sure you can do the following.

Calculate the yield forecast, or expected wheat yield, for 2024:

$$Y_t = \beta_0 + \beta_1 t + e_t$$

$$Y_t = 25.9640 + 0.2279\, t + e_t$$

where t = 50 for 2024 so $E(Yield_{2024}) = 25.9640 + 0.2279\,(50) =$ ***________ bu./ac.***

Now the unexplained variation in yields is measured by σ from the model above.

Given σ = 6.6 (find that in the spreadsheet table) then calculate the probability that the wheat yield is below 24.1 bushels/acre in 2024.

NORM.DIST(24.1, 37.4, 6.6, true) = ________ %.

Change 24.1 above to 30.7, calculate the new probability, and interpret.

The answers are on the table of yield and price data. Do the work above, find it on the table, and invest time in understanding the NORM.DIST function in MS Excel. We are measuring risk and I think that's important.

Similarly, on the price side, make sure you can do the following.

Calculate the price forecast, or expected wheat price, for 2024:

$$P_t = \beta_0 + \beta_1 P_{t-1} + e_t$$

$$P_t = 0.6006 + 0.8721\ P_{t-1} + e_t$$

where P_{2023} = 8.02 (price for 2023) so

$$E(P_{2024}) = 0.6006 + 0.8721\ (8.02) = \underline{\$\qquad\qquad /bu.}$$

Now the unexplained variation in price is measured by σ from the model above.

Given σ = 0.98 (find that in the spreadsheet table) then calculate the probability that the wheat price is below $5.64/bu. in 2024.

NORM.DIST(5.64, 7.59, 0.98, true) = ________%.

Change 5.64 above to 6.62 and calculate probability and interpret.

The answers are on the table of yield and price data. Do the work above, find it on the table, and make sure you understand the NORM.DIST function in MS Excel. We are measuring price risk and I think that's yeehaw-important.

More on

NORM.DIST(X, μ, σ, TRUE) or

NORM.DIST(Outcome, ExpectedValue, StandardDeviation, TRUE)

X is the specific event – the OUTCOME – for which we want the probability,

μ is the measure of central tendency or the mean or the expected value (or forecast) of the thing we are uncertain about,

σ is the measure of dispersion or the standard deviation of or the risk in the distribution of the thing we are uncertain about,

TRUE tells the function to do the integration for us so that we get the probability of X-or-less happening.

For example, what's the probability of wheat price being $7.00 or <u>below</u> in 2024? We need the forecast or expected value for 2024 (think of that as μ). We need the error associated with our forecast (think of that as σ).

So NORM.DIST(7.00, μ, σ, TRUE) and we are in the ballpark.

Likewise, what is the probability of the wheat price being <u>above</u> $9.00/bu?

Back to Expectations – and the Smartest Yet – Using Economics…

Demand: $P_t = a + b\, Q_t + c\, I_t + e_{1t}$ ***Supply:*** $Q_t = d + f\, P_{t-1} + g\, X_{t-1} + e_{2t}$

$$P_t = a + b\,(\,d + f\, P_{t-1} + g\, X_{t-1}\,) + c\, I_t + e_t$$

$$P_t = (a + bd) + bf\, P_{t-1} + bg\, X_{t-1} + c\, I_t + e_t$$

$$P_t = \beta_0 + \beta_1\, P_{t-1} + \beta_2\, X_{t-1} + \beta_3\, I_t + e_t$$

You can (build an econometric model – especially if you need to do a short research paper – to) predict this year's price with last year's price and variables that shift the supply curve and (predictions of) variables that shift the demand curve. This will work well. (The R-squared will be high and be difficult to make larger.)

The bottom line is – good agribusiness planners have a fact-based or an experience-based perception of what's going to happen before they act. Some use data & econometrics and some use years of experience. Outcomes are less surprising for those that are smart and plan. (But those that forward price are not surprised much.)

Potential Forecasting Exercise:

We need an expectation for (your choice commodity) this coming (your choice time).

We'll use past prices...

What are potential supply shifters?

What are potential demand shifters?

Better yet, let's work on that wheat price forecasting econometric model. The simple regression model has been quite wrong for the past few years. So, can we change it so that it sees the big price increase and decrease – coming?

We used last year's price to explain this year, which is a reasonable start but what else might we use? (Careful, the wheat price in this model is the national price and not the state price which we looked at in the handout.)

How about this year's production – or forecasted production – combined with the coming year's forecasted use which results in a wheat stock-to-use forecast?

$$P_t = \beta_0 + \beta_1 P_{t-1} + \beta_2 Q_t + e_t$$

$$P_t = 0.7745 + 0.6614 P_{t-1} - 1.5347 Q_t + e_t$$

$$P_t = 0.7745 + 0.6614 (7.50) - 1.5347 (\ln(0.325)) = \$\underline{\qquad\qquad}/\text{bu.}$$

with a standard error (σ) of \$0.94/bu & R^2 = 0.625.

What's the forecast for 2024 and what's the probability of \$7.00/bu or lower wheat?

(My most complicated but simple econometric model has an R^2 = 0.875, forecasts \$6.75/bu and has σ = \$0.65/bu. What are the chances of \$6.00/bu wheat or lower? Bottom line: we need forecasts but they will be wrong – they have risk – so we need measurements to access that risk.)

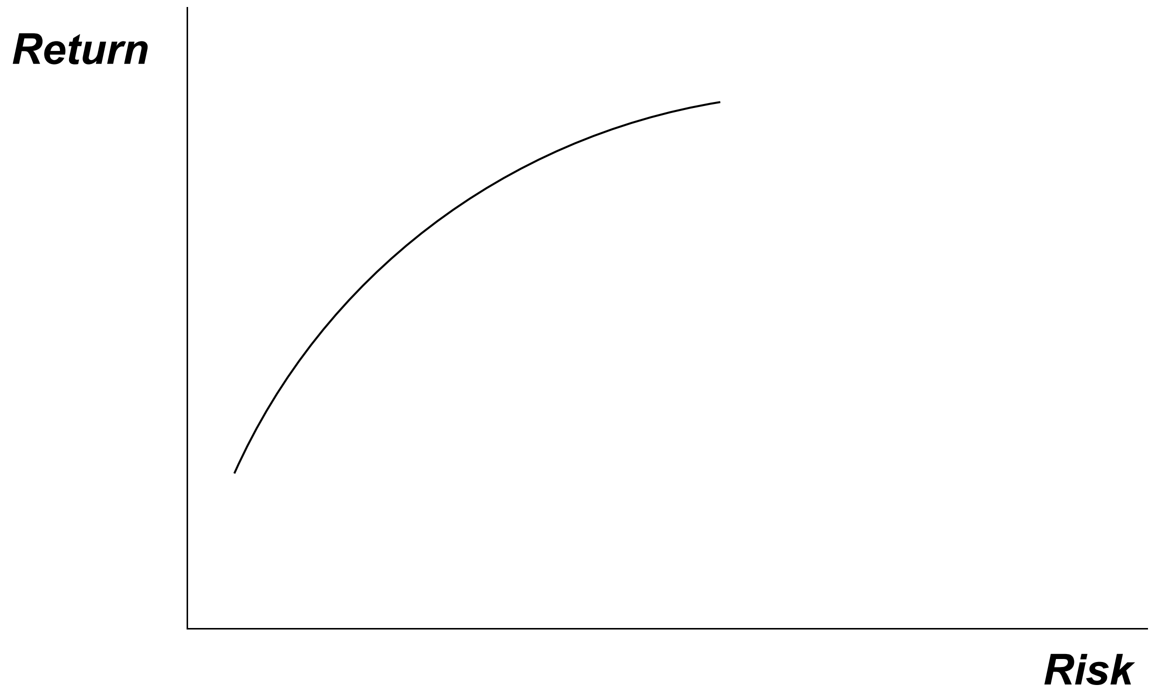
What can we do with measures of expectations and risk?

Determine efficient and inefficient choices. (Efficient frontier)
Risk preferences determine "best" choice among efficient choices.

Calculate probabilities of good and bad outcomes.
Might also need to assume a distribution – or we could use the histogram.
Illustrates downside risks – how much financing might be needed.

Simulate results of different strategies. (Stochastic simulation)
Dynamics or time is important.
Illustrates differences in mean and variability of returns.

Risk and Return – Making Investment and Other Business Decisions



Plan	Return	Std Dev
A	12%	10%
B	8%	2%
C	8%	10%
D	50%	2%

What are efficient Plans? What Plan can we rule out as inefficient? How to choose among remaining Plans?

Figuring out your risk preferences...

Choose a decision and flip coin for outcome. Monthly take-home pay...

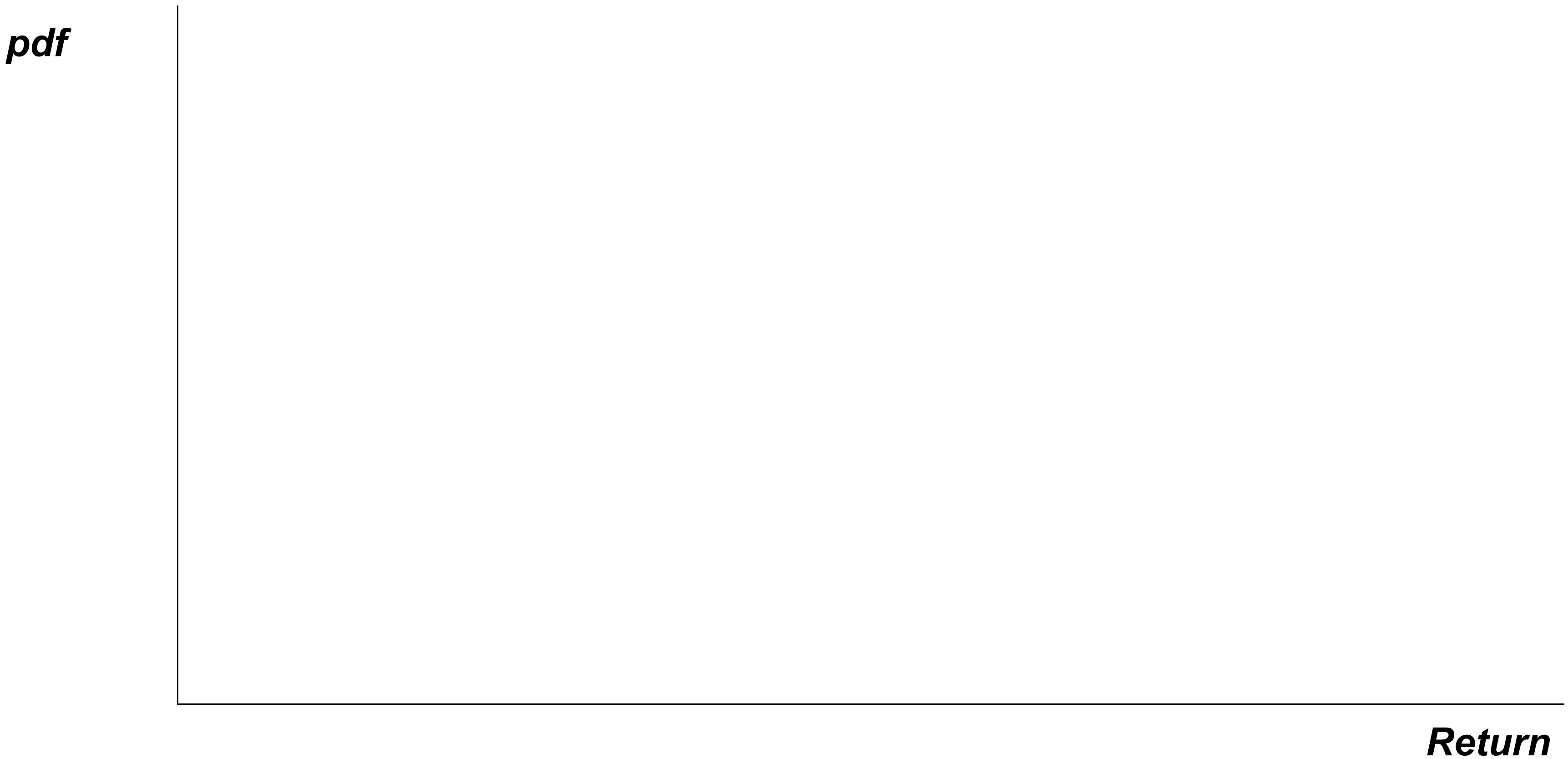
	Decision				
Outcome	**A**	**B**	**C**	**D**	**E**
μ & (σ)	**\$1000 (\$100)**	**\$1100 (\$250)**	**\$1200 (\$400)**	**\$1000 (\$250)**	**\$900 (\$250)**
Heads	**\$1100**	**\$1350**	**\$1600**	**\$1250**	**\$1150**
Tails	**\$900**	**\$850**	**\$800**	**\$750**	**\$650**

What decision letter do you want?

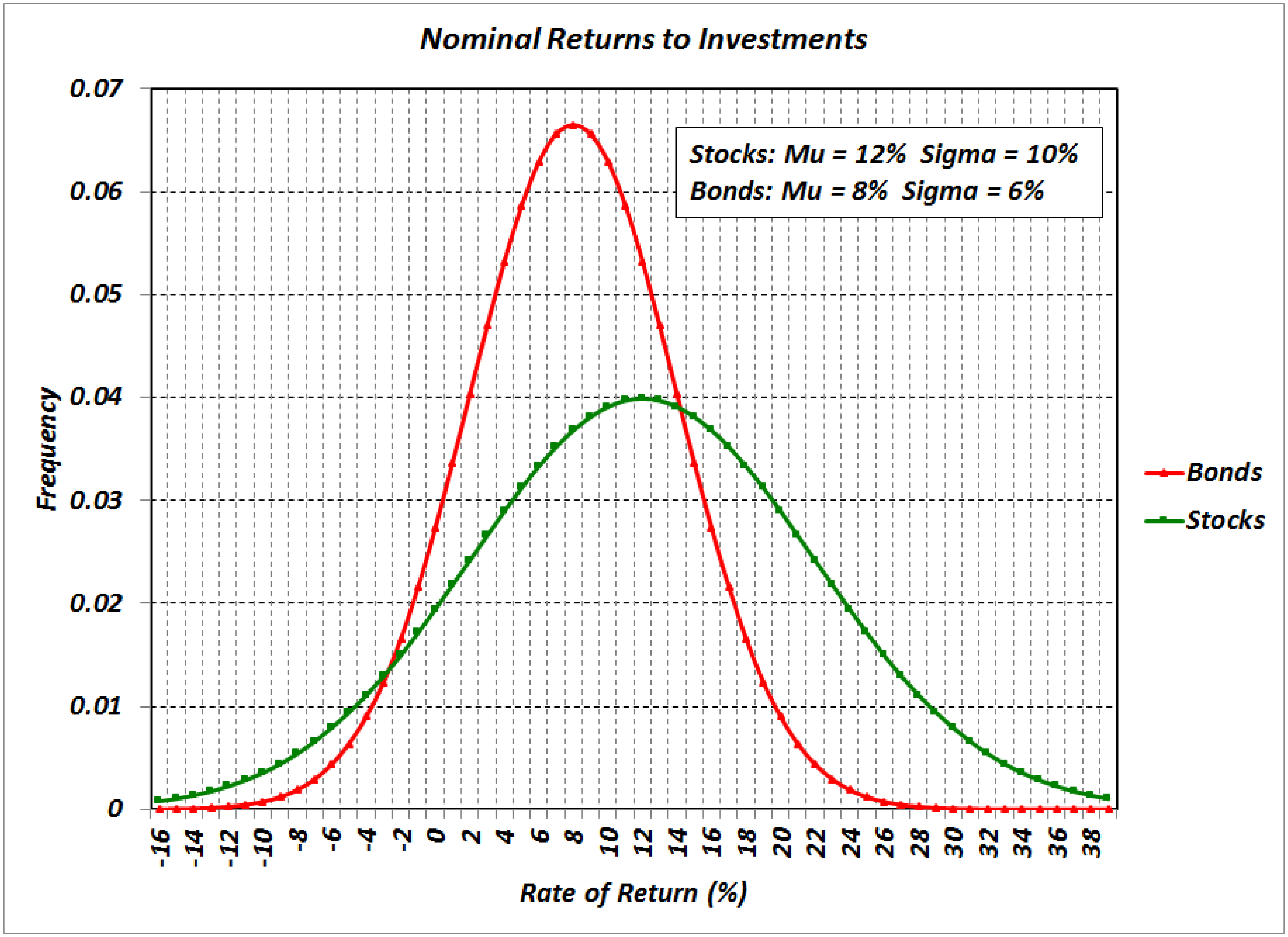
Are D and E efficient? Is there a best choice between A, B, and C?

Simulation of Risky Decisions

In concept: Taking a random draw from a distribution (pdf). Outcomes are more likely from the sample space of the pdf where the function is higher.

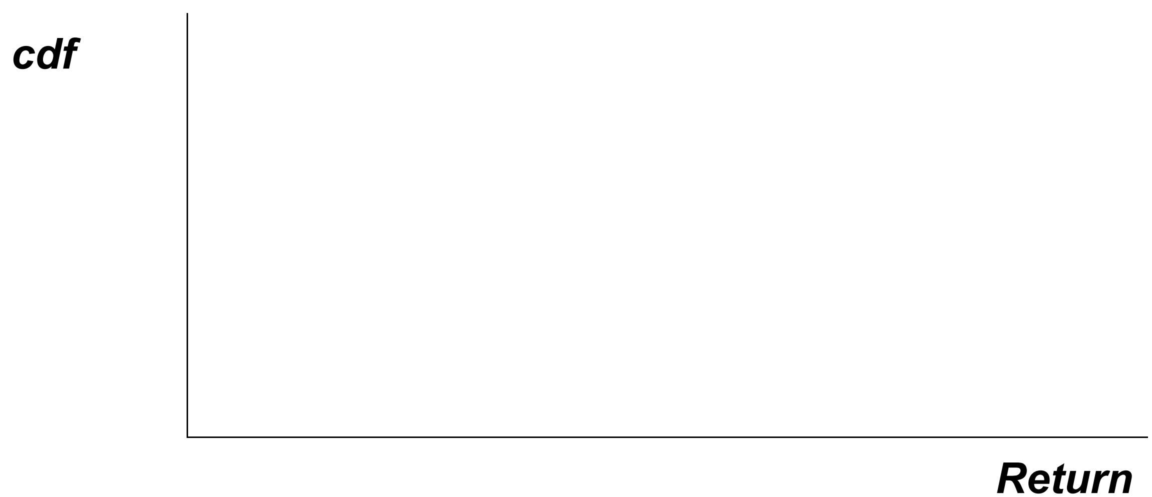


(See spreadsheet figure.)


Nominal Returns to Investments
Stocks: Mu = 12% Sigma = 10%
Bonds: Mu = 8% Sigma = 6%
Frequency
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
-16
-14
-12
-10
-8
-6
-4
-2
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
36
38
Rate of Return (%)
Bonds
Stocks

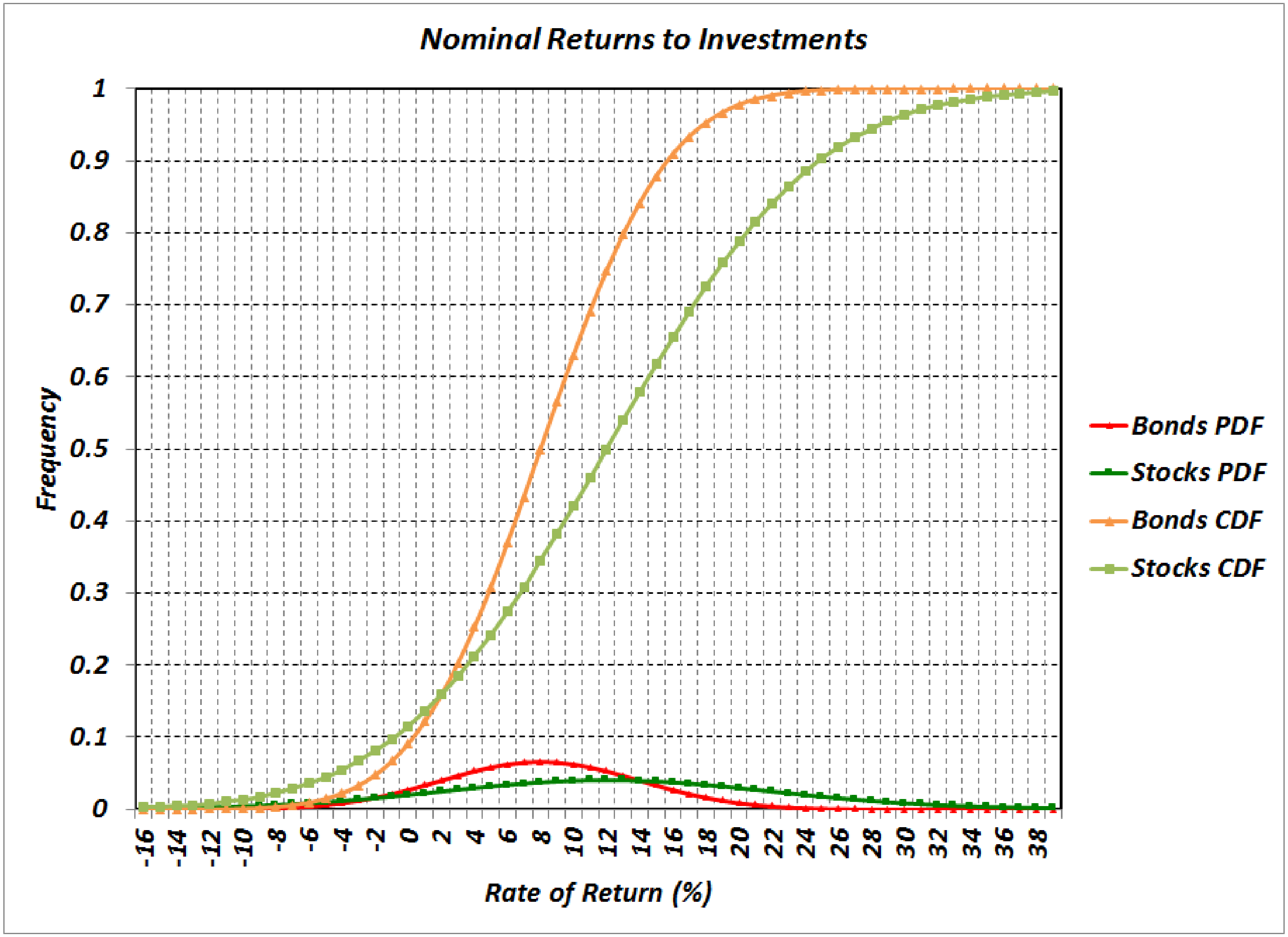
In Practice: using a spreadsheet.

The probability is the area under curve from point to the left.

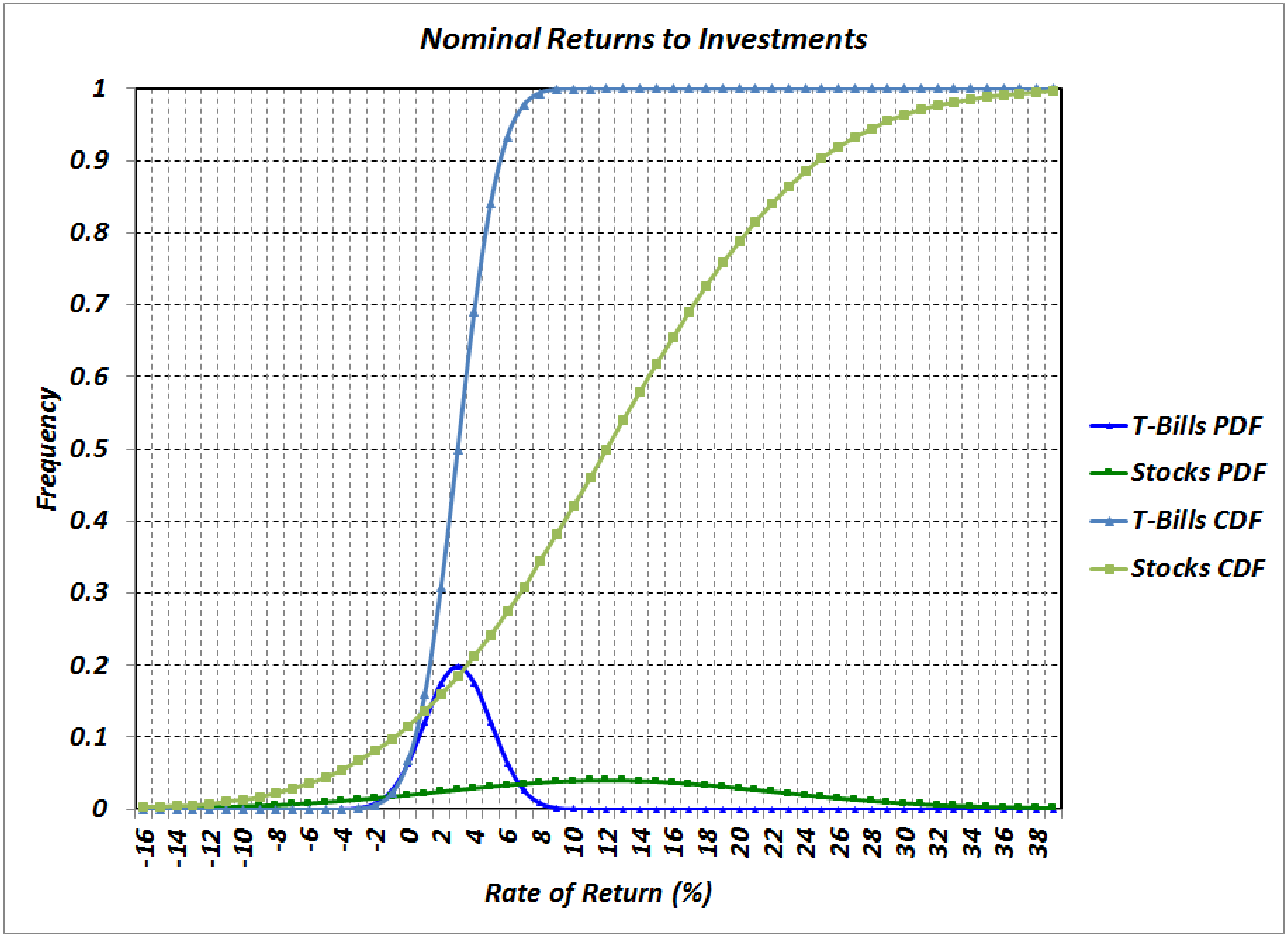


The probability can be found by reading the number off the curve – the integration is already done.

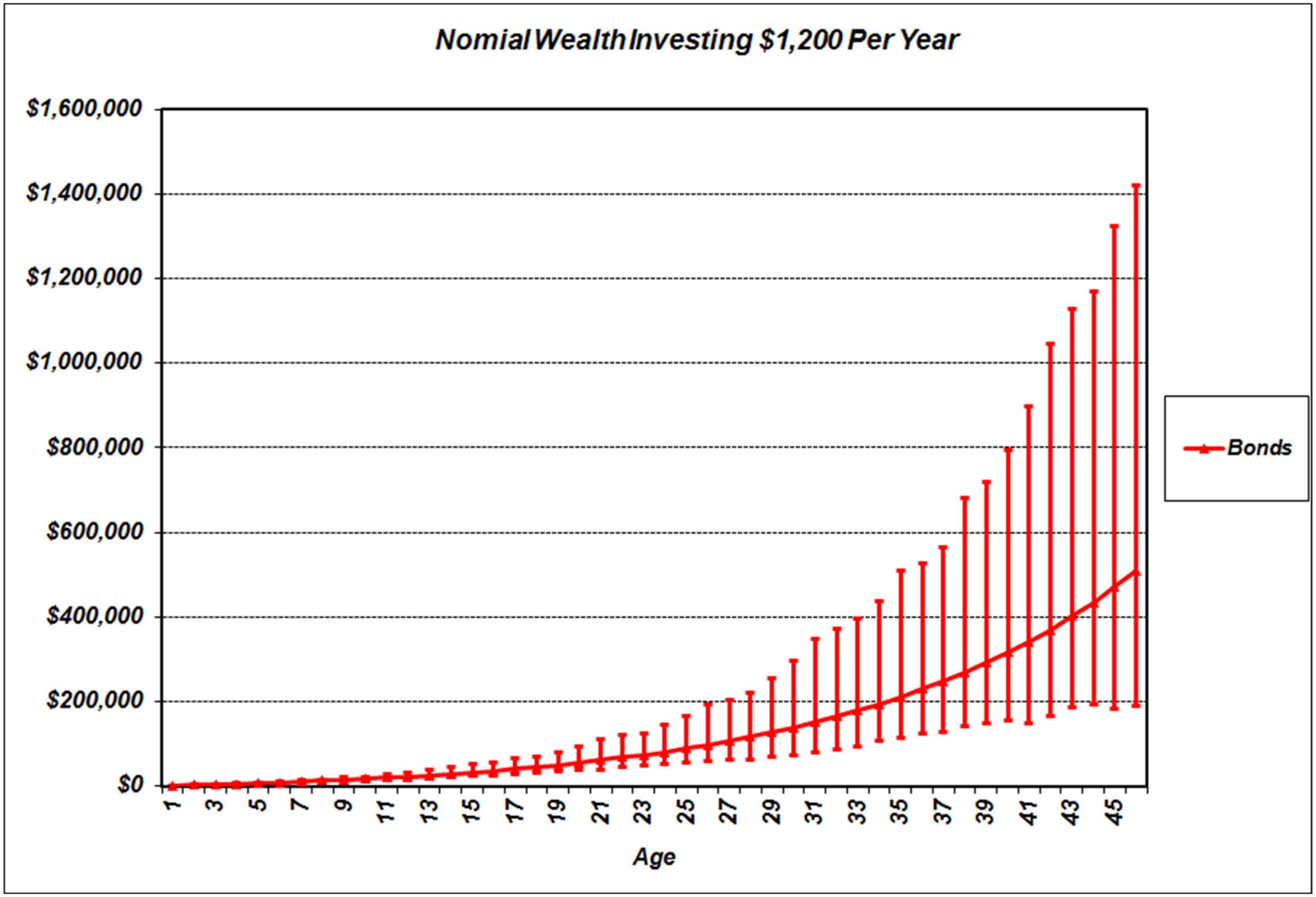
(See spreadsheet figures.)



Nominal Returns to Investments
Frequency
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
-16
-14
-12
-10
-8
-6
-4
-2
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
36
38
Rate of Return (%)
Bonds PDF
Stocks PDF
Bonds CDF
Stocks CDF



Nominal Returns to Investments
Frequency
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
-16 -14 -12 -10 -8 -6 -4 -2 0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38
Rate of Return (%)
T-Bills PDF
Stocks PDF
T-Bills CDF
Stocks CDF


Nomial Wealth Investing $1,200 Per Year
$1,600,000
$1,400,000
$1,200,000
$1,000,000
$800,000
$600,000
$400,000
$200,000
$0
1
3
5
7
9
11
13
15
17
19
21
23
25
27
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31
33
35
37
39
41
43
45
Age
Bonds

Simulate investment decision outcomes.

Contribute money at the end of year. Next year, draw a return (%), grow the saving that amount. And again, contribute money at the end of year. Do that for 45 years…

Repeat for 250 different possible lifetimes…

Retirement after saving $1,200 per year for 45 years. (250 replications & take average across.) (Blend: 70-20-10.)

	Decision			
Outcome	Stocks	Bonds	T-Bills	Blend
Best	$10.8 million	$1.4 million	$144 thou	$4.6 million
μ	$1.9 million	$509 thou	$116 thou	$1.1 million
Worst	$323 thou	$190 thou	$94 thou	$256 thou

Average-Stocks are better than Best-Bonds.
Worst-Stocks are better than Best-T-Bills – Worst-Bonds are better than Best-T-Bills.
Best-Blend and Worst-Blend are better than all but stocks.

Invest, take risk, and diversify but within high-risk choices.

Observation and Commentary

The firms that succeed and grow in the commodity production and marketing businesses are the firms that:

1) ***Aggressively manage risk***
2) ***and are willing to live with the smallest rate of return (RoR).***

Applies to cattle feeding, hog production, corn, wheat, oilseeds...

Thought Example – two cattle feeding firms:
A – aggressively manages risk and willing to take a $25/head profit.
B – wants a $50/head profit and takes risk to get it.

Who's still there after 10, 15, and 25 years? Who's most likely to have experienced a market event that has bankrupted, or seriously setback, the firm?

Who is a better risk in the eyes of their lender? And can borrow more $?

Who has grown?