# UNCERTAINTY AND CONSUMER BEHAVIOR (PINDYCK, CH. 5)

- DESCRIBING RISK
- PREFERENCES TOWARD RISK
- REDUCING RISK
- THE DEMAND FOR RISKY ASSETS

- PROBABILITY: LIKELIHOOD THAT " A GIVEN OUTCOME " WILL OCCUR.
- EXPECTED VALUE: PROBABILITY WEIGHTED AVERAGE OF " PAYOFFS " ASSOCIATED W/ ALL POSSIBLE OUTCOMES.
- PAYOFFS: VALUE ASSOCIATED W/ A POSSIBLE OUTCOME.

EX: W/ 2 POSSIBLE OUTCOMES,

THE EXPECTED VALUE $(E(x)) = Pr_1 \cdot x_1 + Pr_2 \cdot x_2$

W/ n POSSIBLE OUTCOMES,

$E(x) = Pr_1 \cdot x_1 + Pr_2 \cdot x_2 + \ldots + Pr_n \cdot x_n$.

- VARIABILITY: DEGREE OF WHICH POSSIBLE OUTCOMES OF " UNCERTAIN EVENT " DIFFER.

| | OUTCOME 1 | | OUTCOME 2 | | EXPECTED INCOME |
|---|---|---|---|---|---|
| | PROB. | INCOME (€) | PROB | INCOME (€) | |
| JOB 1 (SALE COMMISSION) | 0.5 | 2000 | 0.5 | 1000 | $0.5 \cdot 2000 + 0.5 \cdot 1000 = 1{,}500$ € |
| JOB 2 (FIXED SALARY) | 0.99 | 1510 | 0.01 | 510 | $0.99 \cdot 1510 + 0.01 \cdot 510 = 1{,}500$ € |

\# THE TWO JOBS SHARE THE SAME EXPECTED INCOME : 1500 €.

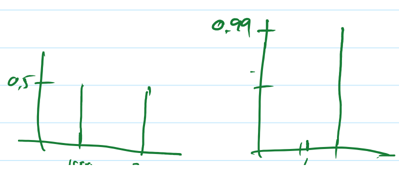
**STANDARD DEVIATION** $(\sigma)$

| | OUTCOME 1 | DEVIATION ($x_i - E(x)$) | OUTCOME 2 | DEVIATION ($x_i - E(x)$) |
|---|---|---|---|---|
| JOB 1 | 2000 | +500 | 1000 | −500 |
| JOB 2 | 1510 | +10 | 510 | −990 |

TO CALCULATE VARIANCE ( = THE AVG. OF THE SQUARED DEVIATION )

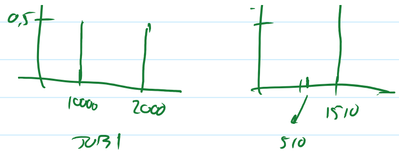
JOB 1:
$$\sigma^2 = 0.5\,(+500)^2 + 0.5\,(-500)^2$$
$$= 250{,}000$$
$$\sigma = \sqrt{250{,}000} = 500 \quad \text{( STANDARD DEVIATION )}$$

JOB 2:
$$\sigma^2 = 0.99\,(+10)^2 + 0.01\,(-990)^2$$
$$= 0.99\,(100) + 0.01\,(980{,}100)$$
$$= 9900$$
$$\sigma = \sqrt{9900} = 99.50 \quad \text{( STANDARD DEVIATION )}$$




**CONCLUSION**: EVEN THOUGH THE EXPECTED INCOME FROM JOB 1 AND JOB 2 ARE NO DIFFERENT, JOB 2 IS MUCH LESS

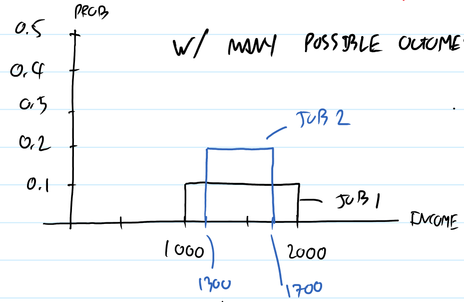
$\sigma = \sqrt{9900} = 99.50$ (STANDARD DEVIATION)



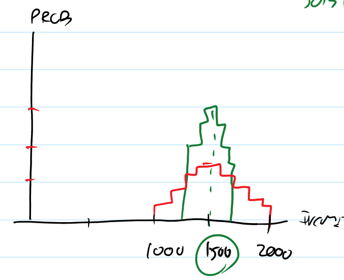

**CONCLUSION**

EVENTHOUGH THE EXPECTED OUTCOME FROM JOB 1 AND JOB 2 ARE NO DIFFERENT, JOB 2 IS MUCH LESS RISKY THAN JOB 1 (MEASURED BY S.D.)

**MODIFIED SITUATION**




W/ MANY POSSIBLE OUTCOMES




JOB 2 IS STILL LESS RISKY THAN JOB 1.

**DECISION MAKING**

LET'S MODIFY OUR EXAMPLE AGAIN ...

| | OUTCOME 1 | DEVIATION SQUARED | OUTCOME 2 | DEVIATION SQUARED | EXPECTED INCOME | S.D |
|---|---|---|---|---|---|---|
| JOB 1 | 2100 | 250,000 | 1100 | 250,000 | 1600 | 500 |
| JOB 2 | 1510 | $(1510-1500)^2 = (10)^2 = 100$ | 510 | $(510-1500)^2 = (-990)^2 = 980,100$ | 1,500 | 99.5 |

**IMPLICATION**

- IF THIS GUY WANTS TO MAXIMIZE THE EXPECTED INCOME, HE MAY TAKE JOB 1.
- HOWEVER, HIS FRIEND MAY DO IT DIFFERENTLY, DEPENDING ON "ATTITUDE TOWARD RISK"

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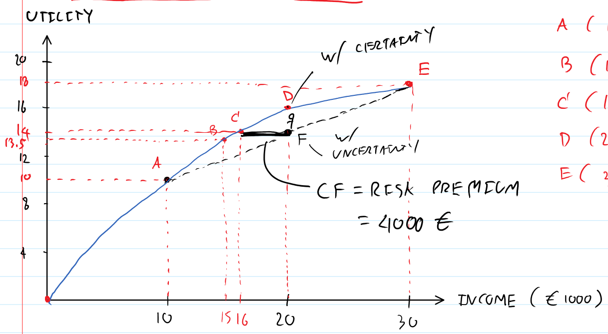
# PREFERENCES TOWARD RISK




A (10, 10)
B (15, 13.5)
C (16, 14)
D (20, 16)
E (30, 18)

FACT#1 AS INCOME INCREASES, UTILITY ALSO INCREASES BUT AT DIMINISHING RATE.

0 → 10 : MU = +10 (POINT 0 TO POINT A)

10 → 20 : MU = +6 (POINT A TO POINT D)

20 → 30 : MU = +2 (POINT D TO POINT E)

FACT#2 SUPPOSE HE IS NOW EARNING 15,000 €. AND THEN HE CONSIDERS TAKING A GAMBLE / A LOTTORY / A RISKY OPTION WHICH HE MAY EARN DOUBLE (15,000 → 30,000) W/ PROB. = 0.5 AND MAY EARN 10,000 € W/ PROB = 0.5.

- W/ THE CURRENT JOB THAT GIVE A CERTAIN INCOME OF 15,000€, HIS UTILITY = 13.5
- W/ THE RISKY JOB, EXPECTED UTILITY [E(U)]

$= \frac{1}{2} \cdot U(10{,}000) + \frac{1}{2} U(30{,}000)$

$= \frac{1}{2} \cdot 10 + \frac{1}{2} 18$

$= 14$

OBSERVE THAT THE RISKY JOB GIVES "HIGHER EXPECTED UTILITY" THAN "THE ORIGINAL UTILITY" OF 13.5.

IF THIS PERSON WANTS TO INCREASE HIS EXPECTED UTILITY, HE WILL TAKE THE RISKY JOB.

FACT 3 SUPPOSE THE CURRENT JOB GIVES HER 20,000 €.
THE RISKY JOB IS NOW OFFERED:

GOOD STATE : EARNS 30,000 € W/ PROB. = 0.5
BAD STATE : EARNS 10,000 € W/ PROB = 0.5.

ANALYSIS :
W/ CURRENT JOB: UTILITY = 16. (POINT D)

W/ RISKY JOB: $E(U) = \frac{1}{2} U(10) + \frac{1}{2} U(30)$

EXPECTED UTILITY

$= \frac{1}{2} \cdot 10 + \frac{1}{2} 18$

$5 + 9$

$= 14$

EXPECTED INCOME

$E(I) = \frac{1}{2} \cdot 10 + \frac{1}{2} \cdot 30$

$= 20 \ (\times 1000)$ €

$= 20{,}000$ €

RISK - AVERSE AGENT: GIVEN THE SAME LEVEL OF (EXPECTED) INCOME, UTILITY FROM A CERTAIN INCOME > EXPECTED UTILITY FROM AN UNCERTAINT INCOME. (POINT D IS ABOVE POINT F IN THE DIAGRAM)

IF SO, THIS PERSON, OF COURSE, WILL NOT WANT TO TAKE THE RISKY

DIAGRAM)

IF SO, THIS PERSON, OF COURSE, WILL NOT WANT TO TAKE THE RISKY CHOICE.

NOTE FOR RISK-AVERSE AGENT, LOSSES ARE MORE IMPORTANT THAN GAINS (IN TERMS OF THE CHANGE IN UTILITY)

INCOME / UTILITY

$(20{,}000 \longrightarrow 30{,}000) \longrightarrow (16 \longrightarrow 18) \Rightarrow \Delta U = +2$

$(20{,}000 \longrightarrow 10{,}000) \longrightarrow (16 \longrightarrow 10) \Rightarrow \Delta U = -6$

FACT 4 A RISK-AVERSE AGENT MAY WANT TO PAY A RISK PREMIUM:

THE MAXIMUM AMOUNT OF MONEY THAT HE/SHE IS WILLING TO PAY TO AVOID TAKING A RISK.

POINT OF DEPARTURE SUPPOSE THIS GUY IS NOW AT POINT F, i.e, HE IS NOW TAKING A RISKY JOB. (PERHAPS A DICTATOR FORCES HIM TO BE HERE)

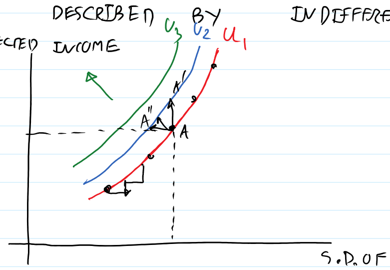
IN THE PICTURE, HE IS WILLING TO PAY THE RISK PREMIUM (SIZE = CF = 4000 €) TO BRING HIM FROM F TO C

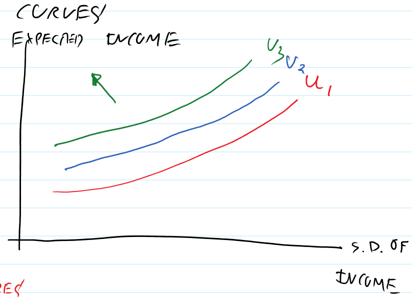
F: GAMBLE
C: CERTAIN INCOME & CERTAIN UTILITY (16,000, 14)

NOTE: OBSERVE THAT F AND C GIVE THE SAME "EXPECTED UTILITY" OF 14

FACT #5 RISK AVERSE AGENT'S PREFERENCES CAN BE DESCRIBED BY INDIFFERENCE CURVES

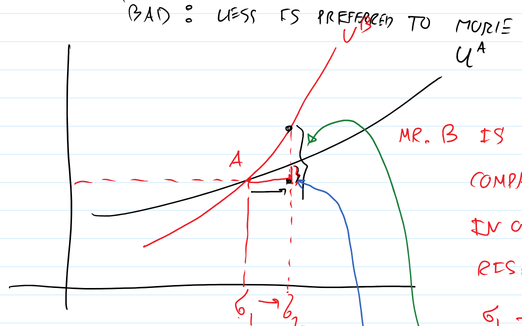
GOOD: MORE IS BETTER



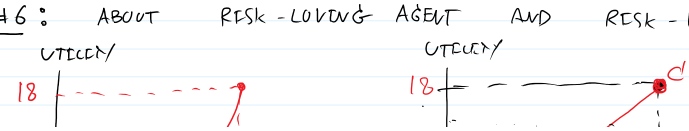

MEASURES (VARIABILITY OF INCOME)

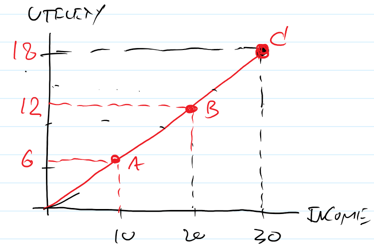
BAD: LESS IS PREFERRED TO MORE




MR. B IS HIGHLY RISK-AVERSE COMPARE TO MR. A: IN ORDER TO ACCEPT MORE RISKINESS IN INCOME (FROM $\sigma_1 \to \sigma_2$), B REQUIRES HIGHER COMPENSATION IN EXPECTED INCOME COMPARED TO MR. A

FACT #6: ABOUT RISK-LOVING AGENT AND RISK-NEUTRAL AGENT




**RISK AVERSE**

$U(x) = x^a$

WHERE $a < 1$

EX: $U(x) = x^{\frac{1}{2}}$

SUPPOSE $x_1 = 100$

$x_2 = 400$

$Pr(x_1) = 0.5$

$Pr(x_2) = 0.5$

- $E(x) = 0.5(100) + 0.5(400)$

$= 50 + 200$

$= 250$

EXPECTED INCOME

SUPPOSE $U(100) = 10$

$U(400) = 20$

- $E[U(x)] = \frac{1}{2}U(100) + \frac{1}{2}U(400)$

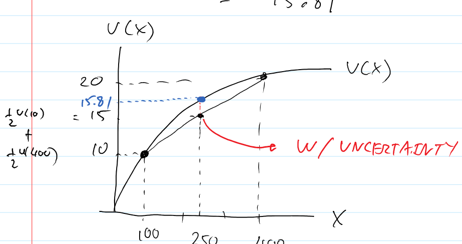
$= \frac{1}{2} \cdot 10 + \frac{1}{2} \cdot 20$

$= 15$

EXPECTED UTILITY OF INCOME

- $U(250) = (250)^{\frac{1}{2}}$ OR $\sqrt{250}$

$= 15.81$




AT THE SAME EXPECTED INCOME (250),

= 250 · 1

PROB OF GETTING 250 BAHT IN THIS SCENARIO IS EQUAL TO 1

**RISK NEUTRAL**

$U(x) = 2x$

GENERAL FORM: $U(x) = Ax^a$

WHERE $a = 1$

SUPPOSE $x_1 = 100$

$x_2 = 400$

$Pr(x_1) = 0.5$

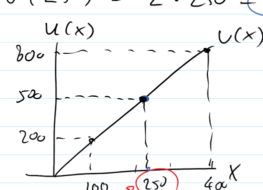
$Pr(x_2) = 0.5$

- $E(x) = 250$
- $E[U(x)] = \frac{1}{2}U(100) + \frac{1}{2} \cdot U(400)$

$= \frac{1}{2}(2 \cdot 100) + \frac{1}{2}(2 \cdot 400)$

$= 500$

- $U(250) = 2 \cdot 250 = 500$




HERE $U[E(x)] = E[U(x)]$

THIS GUY IS INDIFFERENT BETWEEN CERTAIN EVENT AND UNCERTAIN EVENT, GIVEN THE SAME EXPECTED INCOME.

**RISK LOVING**

$U(x) = Ax^a$

WHERE $a > 1$

SUPPOSE $x_1 = 100$

$x_2 = 400$

$Pr(x_1) = 0.5$

$Pr(x_2) = 0.5$

$\boxed{U(x) = x^2}$

- $E(x) = 250$
- $E[U(x)] = \frac{1}{2}U(100) + \frac{1}{2}U(400)$

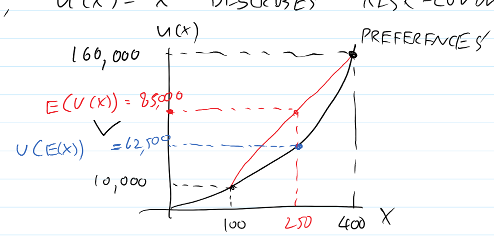
$= \frac{1}{2}(100)^2 + \frac{1}{2}(400)^2$

$= 85,000.$

- $U(250) = (250)^2 = 62,500,$

HERE $\underbrace{U[\overset{=250}{E(x)}]}_{62,500} < \underbrace{E[U(x)]}_{85,000}.$

SO, $U(x) = x^2$ DESCRIBES RISK-LOVING PREFERENCES

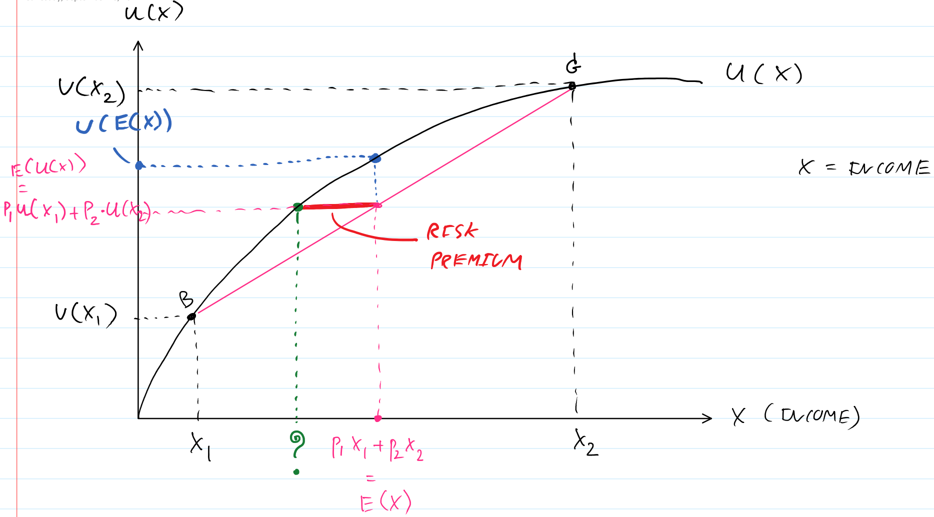


$$\underbrace{U[E(x)]}_{\text{UTILITY FROM EXPECTED INCOME OF 250} \; 15.81} > \underbrace{E[U(x)]}_{\text{EXPECTED UTILITY OF INCOME} \; 15}$$

W/O RISK          W/ RISK

SO, THIS UTILITY FUNCTION: $U(x) = x^{\frac{1}{2}}$
DESCRIBES RISK-AVERSE BEHAVIOR

NOTICE THAT: MU OF INCOME IS DIMINISHING.




# HOW TO AVOID OR REMOVE RISK?

SINCE UNCERTAINTY AND RISK IS PERVASIVE,
A RISK-AVERSE AGENT WILL TRY TO REMOVE OR AVOID RISK
BY...

1. DIVERSIFICATION: DO NOT PUT ALL YOUR EGGS IN ONE BASKET.
2. BUYING INSURANCE
3. INVESTING TO OBTAIN INFORMATION

1. DIVERSIFICATION: PRATICE OF REDUCING RISK BY "ALLOCATING" RESOURCES TO A VARIETY OF ACTIVITIES WHOSE OUTCOMES ARE NOT RELATED.

Ex

| | Pr.(H) = 0.5 STATE 1 HOT WEATHER | Prob(C) = 0.5 STATE 2 COLD WEATHER | $E(\pi)$ | S.D: $\sigma(\pi)$ |
|---|---|---|---|---|
| AIR CON | 30,000 | 12,000 | 21,000 | $\sqrt{\frac{1}{2}(30{,}000 - 21{,}000)^2 + \frac{1}{2}(12{,}000 - 21{,}000)^2} = 9000$ |
| HEATER | 12,000 | 30,000 | 21,000 | 9000 |
| SELL BOTH | $= \frac{1}{2} \cdot 30000 + \frac{1}{2} \cdot 12000 = 21{,}000$ | $= \frac{1}{2} 12{,}000 + \frac{1}{2}(30{,}000) = 21{,}000$ | | 0 |

COEFFICIENT OF VARIATION

$C.V. = \dfrac{S.D \text{ OF } \pi}{E(\pi)}$

$\dfrac{9000}{21000} = \dfrac{9}{21}$

$\dfrac{9}{21}$

0

WHEN HE SELLS BOTH BY ALLOCATING HIS TIME EQUALLY HIS PROFIT WILL BE 21,000 CERTAINLY, REGARDLESS OF WEATHER!

WHEN WEATHER IS HOT, HE GETS 15,000 FROM SELLING AIRCON AND GET 6000 FROM SELLING HEATER.

WHEN WEATHER IS COLD, HE GETS 6000 FROM SELLING AIRCON AND GETS 15,000 FROM SELLING HEATER.

THEREFORE, RISK DIVERSIFICATION IN THIS CASE "ELIMINATES" ALL RISK!

IT WORKS WELL WHEN OUTCOMES ARE PERFECTLY NEGATIVELY CORRELATED.

(2) BUYING INSURANCE

EX
- YOUR MACBOOK 'S VALUE = 50,000 BAHT
- COST OF BUYING APPLE CARE = 1000 BAHT
- ANY DAMAGE WILL REDUCE THE VALUE OF YOUR MAC BY 10,000 BAHT,
- PROB ( DAMAGE ) = 0.1 OR 10 %

| | GET DAMAGED | NO DAMAGE | E (x) | S.D. | C.V. = $\frac{S.D.}{E(x)}$ |
|---|---|---|---|---|---|
| DON'T BUY | 40,000 | 50,000 | 0.1 (40,000) + 0.9 (50,000) = 49,000 | $\sqrt{0.1(\ -\ )^2 + 0.9(\ -\ )^2}$ = 3,000 | $\frac{3000}{49,000}$ |
| BUY | 50,000 − 1000 − 10,000 + 10,000 = 49,000 | 50,000 − 1000 = 49,000 | 49,000 | 0 | 0 |

BUYING INSURANCE HELPS REMOVING ALL RISK!

(3) BUYING INFORMATION TO REDUCE / AVOID RISK.

D - I - Y

Friday, September 22, 2017 11:10 AM

# THE DEMAND FOR RISKY ASSETS

ASSETS : SOMETHING THAT PROVIDES A FLOW OF MONEY OR SERVICES TO ITS OWNER.

RISKY ASSET : ASSET THAT PROVIDES AN UNCERTAIN FLOW OF MONEY OR SERVICES TO ITS OWNER.

RISK-FREE ASSET : ASSET THAT PROVIDES A FLOW OF MONEY OR SERVICES THAT IS KNOWN W/ CERTAINTY.

EXPECTED RETURN : RETURN THAT AN ASSET SHOULD EARN ON AVERAGE.

ACTUAL RETURN : RETURN THAT AN ASSET EARNS.

## # BASIC CONCEPT ABOUT A RANDOM VARIABLE

A RANDOM VARIABLE (RV), $w$ TAKES VALUE $w_1, w_2, \dots, w_s$ WITH PROBABILITIES $\pi_1, \pi_2, \pi_3, \dots, \pi_s$

NOTE: $\sum_{i=1}^{s} \pi = 1$

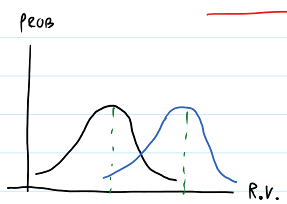
⇒ MEAN (EXPECTED VALUE) OF THE DISTRIBUTION IS...
AVERAGE VALUE OF THE R.V.

$$E(w) = \mu_w = \pi_1 w_1 + \pi_2 w_2 + \dots + \pi_s w_s = \sum_{i=1}^{s} \pi_i w_i .$$

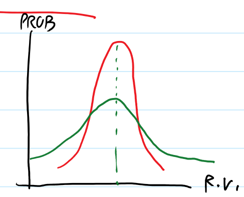
⇒ THE DISTRIBUTION'S VARIANCE IS THE R.V.'S AVERAGE SQUARED DEVIATION FROM THE MEAN.

$$S.D. = \sigma_w \quad \sqrt{\sum_{i=1}^{s} (w_i - \mu_w)^2 \cdot \pi_i}$$

IT MEASURES THE R.V.'S VARIABILITY.




TWO DISTRIBUTIONS W/ THE SAME VARIANCE AND DIFFERENT MEANS




THE TWO DISTRIBUTIONS W/ THE SAME MEAN BUT DIFFERENT VARIANCES.

## # PREFERENCE OVER RISKY ASSETS

FACT#1 AN INVESTOR'S UTILITY FUNCTION IS DESCRIBED BY

$$U(\text{EXPECTED RETURN}, \text{RISK})$$

FACT#2 THE HIGHER "MEAN (OR EXPECTED) RETURN" IS PREFERRED, GIVEN A LEVEL OF RISK.

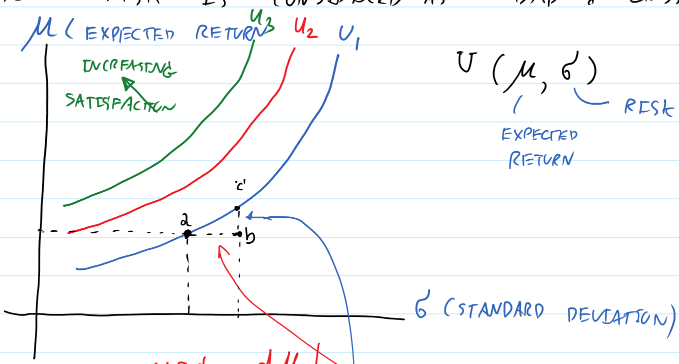
FACT#3 LESS VARIATION IN RETURN IS PREFERRED. (LESS RISK)

SO RISK IS CONSIDERED AS "BAD": LESS IS PREFERRED TO MORE.

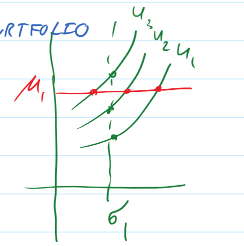
$\mu$ (EXPECTED RETURN) $u_3$ $u_2$ $u_1$

(LESS RISK)

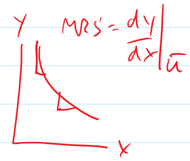
SO RISK IS CONSIDERED AS " BAD ": LESS IS PREFERRED TO MORE.




$U(\mu, \sigma)$ — $\mu$: EXPECTED RETURN; $\sigma$: RISK OF THE PORTFOLIO




$$MRS = \left.\frac{d\mu}{d\sigma}\right|_{\bar{U}}$$




PROOF: HOW IS THE MRS COMPUTED ?

$$U = f(\mu, \sigma)$$

$$dU = \frac{dU}{d\mu} d\mu + \frac{dU}{d\sigma} d\sigma = 0 \quad \text{(TOTAL DERIVATIVE)}$$

TRAVELLING FROM $b \to c$     TRAVELLING FROM $a \to b$

$$\frac{dU}{d\mu} d\mu = -\frac{dU}{d\sigma} \cdot d\sigma$$

$$\frac{d\mu}{d\sigma} = -\frac{\frac{dU}{d\sigma}}{\frac{dU}{d\mu}}$$

$\frac{dU}{d\sigma}$: MARGINAL UTILITY OF $\sigma$

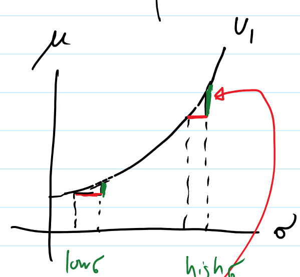
$\frac{dU}{d\mu} \rightarrow$ MARGINAL UTILITY OF $\mu$

W/ GOOD X & Y

$$MRS = -\left.\frac{dy}{dx}\right|_{\bar{U}}$$

$$MRS = -\frac{MU_x}{MU_y} = -\frac{\frac{dU}{dx}}{\frac{dU}{dy}}$$

$$\boxed{MRS = \frac{d\mu}{d\sigma} = -\frac{MU_\sigma}{MU_\mu}}$$




MRS IN INCREASING $\sigma$ B/C ...

AT LOW LEVEL OF $\sigma$ COMPARED TO A HIGH LEVEL OF $\sigma$, THE INVESTOR WOULD REQUIRE MORE EXPECTED RETURN ($\mu$) TO BE COMPENSATED WHEN HIS PORTFOLIO IS W/ HIGH RISK ALREADY.

# BUDGET CONSTRAINT FOR RISKY ASSETS

CONSIDER TWO ASSETS
- RISK-FREE ASSET
- STOCK (≈ RISKY ASSET)

- RISK-FREE ASSET'S RETURN = $r_f$
- RISKY STOCK'S RATE OF RETURN = $m_s$ IF STATE $s$ OCCURS.

SO RISKY STOCK'S MEAN RATE-OF-RETURN IS

$$r_m = \sum_{s=1}^{S} m_s \pi_s .$$

- A BUNDLE CONTAINING SOME OF THE RISKY STOCK AND SOME OF RISK-FREE ASSET IS SO CALLED "PORTFOLIO."

SUPPOSE $b$ = FRACTION OF WEALTH USED TO BUY THE RISKY STOCK.

$1-b$ = FRACTION OF WEALTH USED TO BUY NON-RISKY ASSET.

W/ A GIVEN VALUE OF $b$, THE AVERAGE RATE-OF-RETURN OF THE PORTFOLIO :

$$\boxed{r_b = b \cdot r_m + (1-b)\cdot r_f}$$

IF $b=0$, $r_b = r_f$ ( WHEN PUTTING ALL MONEY INTO RISK-FREE ASSET )

IF $b=1$, $r_b = r_m$ ( WHEN PUTTING ALL MONEY INTO RISKY ASSET )

OBSERVE THAT THE PORTFOLIO'S EXPECTED RATE-OF-RETURN $(r_b)$ RISES AS $b$ RISES. ( = INVESTING MORE ON STOCK INCREASES HIS EXPECTED RATE OF RETURN )

$$\sigma_b^2 = \sum_{s=1}^{S} \left\{ [ b\cdot m_s + (1-b) r_f ] - r_b \right\}^2 \cdot \pi_s \qquad \sigma^2 = E[x-\bar{x}]^2$$

$$\sigma_b^2 = \sum_{s=1}^{S} \left\{ b m_s + (1-b) r_f - [ b r_m + (1-b) r_f ] \right\}^2 \cdot \pi_s$$

$$= \sum_{s=1}^{S} [ b m_s + \cancel{(1-b) r_f} - b r_m - \cancel{(1-b) r_f} ]^2 \cdot \pi_s$$

$$= \sum_{s=1}^{S} ( b m_s - b r_m )^2 \cdot \pi_s$$

$$= b^2 \sum_{s=1}^{S} (m_s - r_m)^2 \cdot \pi_s$$

$$\sigma_b^2 = b^2 \cdot \sigma_m^2$$

SO $\boxed{\sigma_b = b \cdot \sigma_m}$

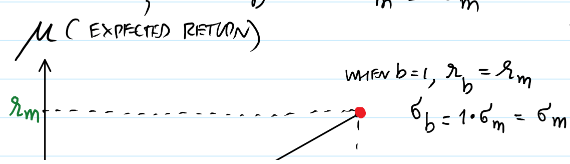
$\sigma_b$: RISKINESS OF THE PORTFOLIO

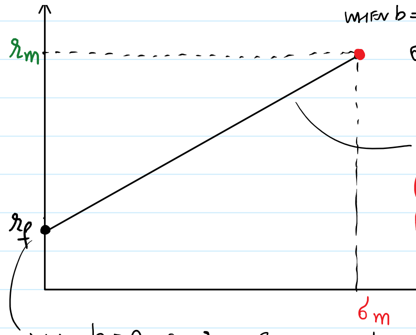
$\sigma_m$: VARIABILITY OF THE-RATE-OF-RETURN ON STOCK.

IF $b=0$, $\sigma_b = 0$.

IF $b=1$, $\sigma_b = 1 \cdot \sigma_m = \sigma_m$ → RISKINESS OF THE PORTFOLIO IS DETERMINED BY RISKINESS OF THE STOCK

VARIABILITY IN THE-RATE-OF-RE...



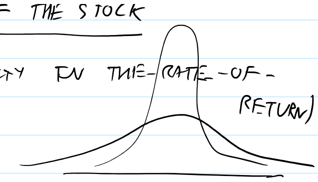



WHEN $b=1$, $r_b = r_m$

$\sigma_b = 1 \cdot \sigma_m = \sigma_m$

RISKINESS OF THE STOCK

VARIABILITY IN THE-RATE-OF-RETURN



THE BUDGET LINE

$R_b = b \cdot r_m + (1-b) \cdot r_f$

$R_p$ IN PINDYCK

$\sigma_\mu$ (STANDARD DEVIATION OF EXPECTED RETURN)

WHEN $b = 0$, SO $r_b = r_f$. AND $\sigma = 0$

FROM
$$r_b = b r_m + (1-b) r_f$$
$$= r_f + b(r_m - r_f)$$
$$= r_f + \frac{\sigma_b}{\sigma_m} (r_m - r_f)$$

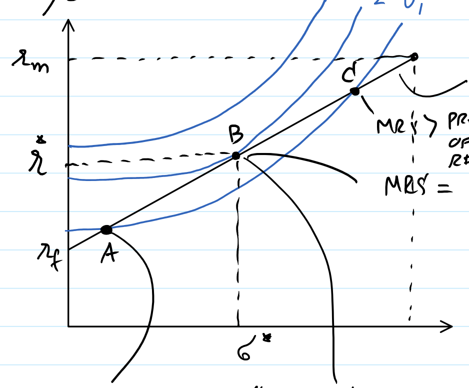
[RECALL THAT $\sigma_b = b\sigma_m$]

SO
$$\boxed{\frac{d r_b}{d \sigma_b} = \frac{(r_m - r_f)}{\sigma_m}}$$

→ SLOPE OF THE BUDGET LINE WHICH REFLECTS "PRICE OF RISK":

EXTRA RISK AN INVESTOR "MUST INCUR" TO "ENJOY" HIGHER (EXPECTED) RETURN.

NOTE $\frac{d r_b}{d \sigma_b} > 0$.




BL MEASURES TRADE-OFF BETWEEN THE EXPECTED RETURN ($\mu$) AND ITS RISKINESS ($\sigma_\mu$):

THE HIGHER THE $\sigma_\mu$, THE HIGHER THE $\mu$.

MRS > PRICE OF RISK

MRS = PRICE OF RISK

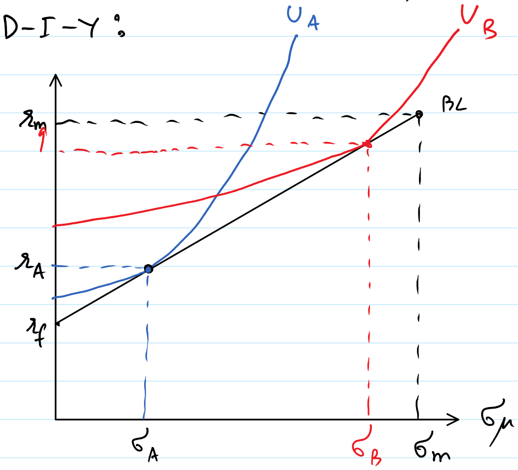
MRS < PRICE OF RISK

$\sigma$ → S.D. OF EXPECTED RETURN

"THE UTILITY MAXIMIZING CHOICE OF AN INVESTOR"

$(r^*, \sigma^*)$

D-I-Y:




TWO DIFFERENT CHOICES BY TWO DIFFERENT INVESTORS:

A IS HIGHLY RISK-AVERSE; HIS PORTFOLIO CONSISTS OF MORE RISK-FREE ASSET. HIS $r_A$ IS A BIT HIGHER THAN $r_f$. HOWEVER, HIS $\sigma_A$ IS SMALL.

B ______