Example 3: WTP for a Test

Formally: Value of Information or "VOI"

Strategy:

1. Replace **price** of test with variable **X**
2. Solve for highest value of X for which it's best to buy the test

Applying to previous car example:

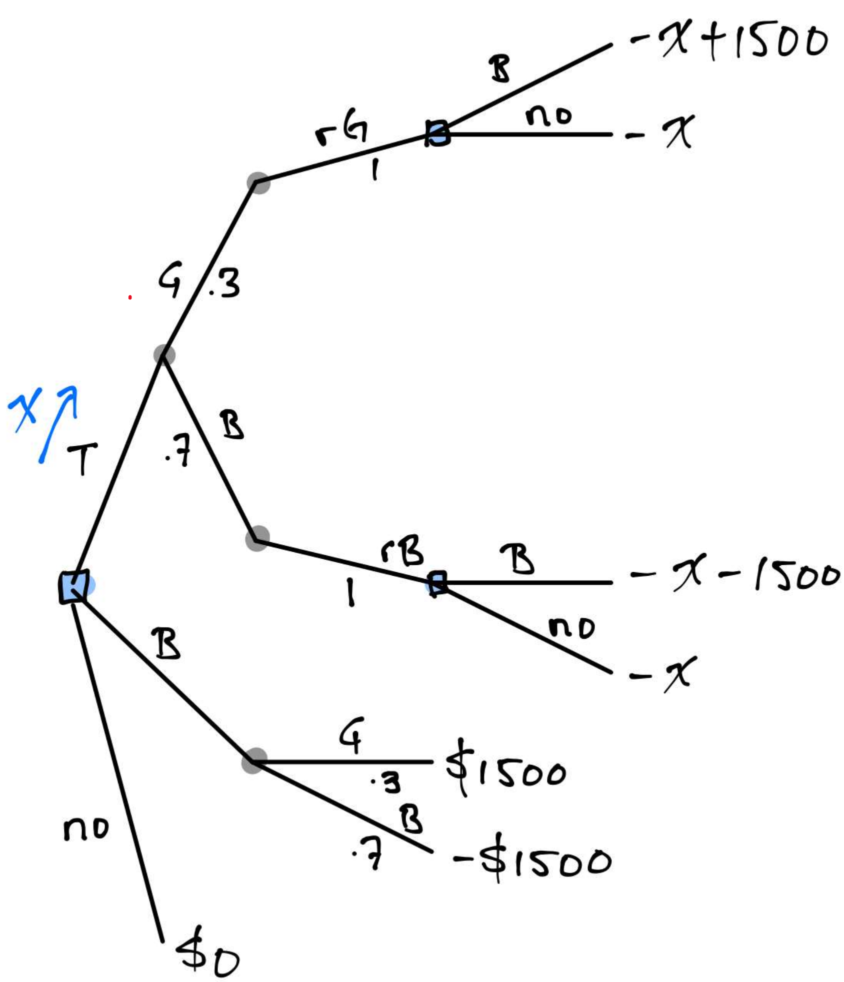
Car price: $2500

Condition	Value	Probability
Good (G):	$4000	30%
Bad (B):	$1000	70%

Infallible test:

Condition	Report rG	Report rB
G	100%	0%
B	0%	100%

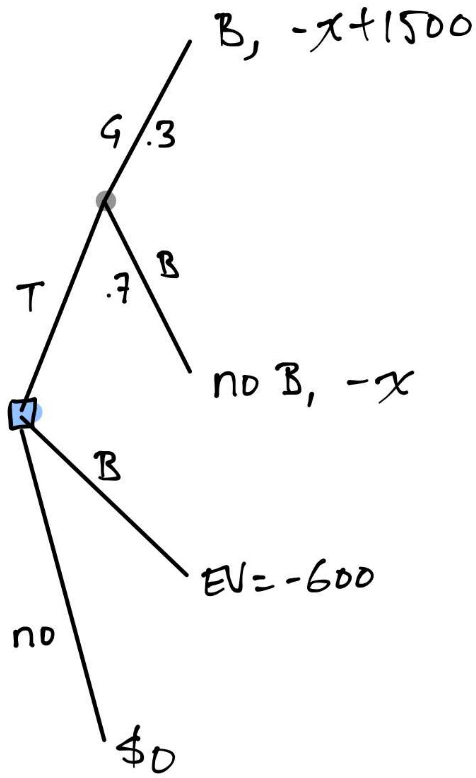
- Update: payoffs using **X** instead of $400
- Omit the impossible branches for clarity



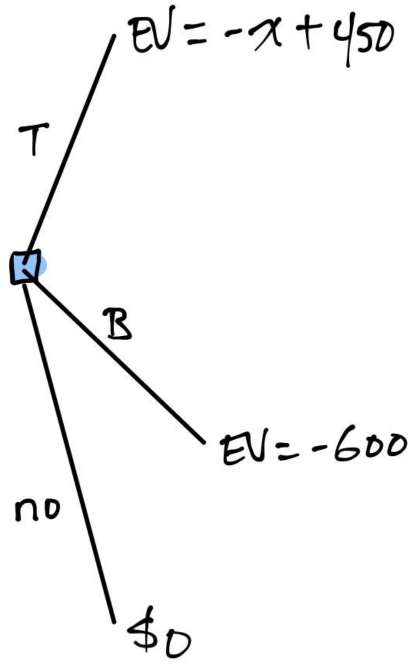
(4000-2500 = 1500)

(1000-2500 = -1500)

Evaluate the right-most nodes and simplify:



Evaluate and simplify again:



EV = 0.3(-X+1500) + 0.7*(-X)
EV = -X + 0.3*(1500)
EV = -X + 450

Finally:

- N (no action) beats B since \$0 > -\$600
- If X=0 T (test) beats N (next best option) since \$450 > \$0

- What's the maximum X where T is at least as good as N?

    Payoff from T = payoff from next best option

    Payoff from T = payoff from N

    $$-X + 450 = 0$$

    $$X = \$450$$

  Maximum WTP for the test: \$450
    Thus, value of information: \$450

Connecting to previous example with \$400 test:

WTP = \$450
P = \$400
CS = WTP - P = \$50

EV and Insurance Premiums

EV also shows the premium needed to buy an actuarially fair insurance policy

Actuarially fair:

- Premium matches expected claim
- Insurance company breaks even on average

Very useful when evaluating Pareto efficiency

Example:

Two people:	Alice (A), Bob (B)
Different times:	A lives now, B lives in the future
One good:	Barrel of oil **owned by B**
Interest rate:	0% for simplicity

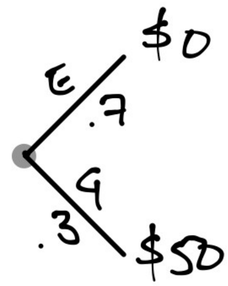
A's WTP now:

$20

B's WTA in future depends on future car technology:

State	Probability	WTA
Electric cars (E) in use	70%	$0
Gas cars (G) in use	30%	$50

Graphing:



Dilemma: should A use the oil?

State	WTP_A	WTA_B	ΔSS	
E	20	0	+$20	**Gain** if A uses
G	20	50	-$30	**Loss** if A uses

Now add an insurance company

Offers policy that pays out **if G occurs**:

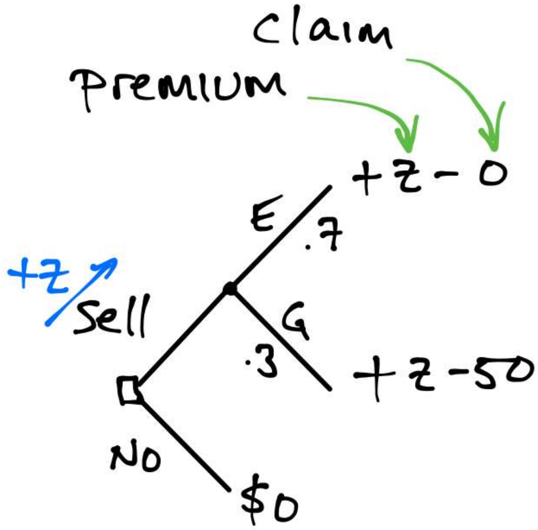
Price:	Z	*premium*
Pays if G:	$50	*coverage* or *claim* if G occurs
Pays if E:	$0	claim if E occurs

Expected claim: $0.7 * (\$0) + 0.3 * (\$50) = \$15$

Solve for company's WTA:

- Minimum Z for which it would sell the policy

Insurance company's decision tree:

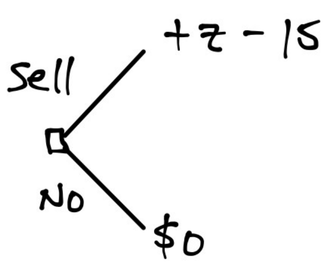


Evaluating the right-most node:

$$EV = 0.7 * (Z - 0) + 0.3 * (Z - 50)$$

$$EV = (0.7 + 0.3) * Z - (0.7 * 0 + 0.3 * 50)$$

$$EV = Z - 15$$



Minimum Z to sell the policy (WTA):

$$Z - 15 = 0$$

$$Z = 15$$

Premium equals the *expected claim*

Aside on backing out the probability implicit in a premium:

Z Premium

C Coverage if the event occurs, pays 0 otherwise

ρ Probability of the event

$Z = \rho C + (1-\rho) * 0 = \rho C$ Premium for fair insurance

$$\rho = \frac{Z}{C}$$

SU supplemental life insurance

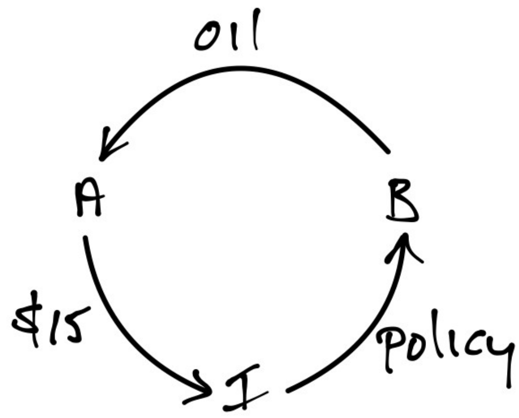
Z = annual cost per $1000 coverage

Age	Z	$Z/1000$	ρ (%)
30	$0.61	0.00061	0.06
40	$0.92	0.00092	0.09
50	$2.08	0.00208	0.21
60	$5.59	0.00559	0.56
70	$17.29	0.01729	1.73

Back to oil example:

With insurance, an efficient trade is possible

1. Alice buys policy for $15 and names Bob as the beneficiary
2. Alice trades policy to Bob for the oil



Welfare impacts?

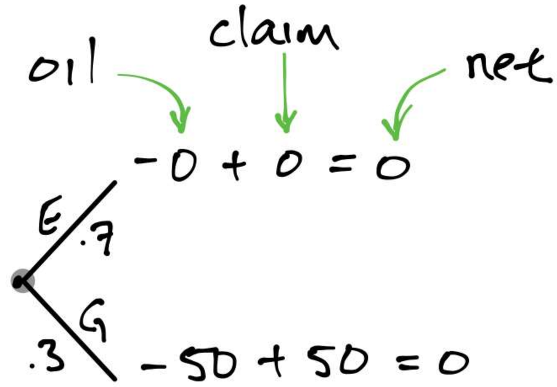
Alice: $WTP = \$20, P = \$15$ $CS_A = \$5$

Insurer: $P = \$15, WTA = \$15$ $PS_I = \$0$

Bob's payoff is more complicated since it depends on the state:

Variable	State E	State G
Payment for oil	$0	$0
Insurance claim	$0	$50
Total payments, P_T	**$0**	**$50**
WTA	$0	$50
$PS_B = P_T - WTA$	**$0**	**$0**

Graphing:



Bob *comes out even either way*:

No change **in either state of the world**

Overall:

$$\Delta SS = CS_A + PS_I + PS_B$$

$$\Delta SS = \$5 + \$0 + \$0 = \$5$$

Summary:

- EV shows the premium for a fair insurance policy
- Can use to evaluate efficiency under uncertainty

Daily exercise on Google Classroom