E: Policy uncertainty in depth, part 2

Key results from part 1:

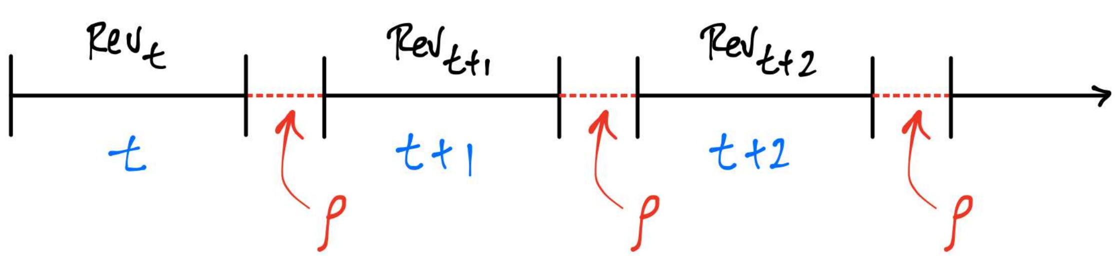
P = \$30/MWh
Q = 1752 MWh per year
r = 10%

	No FIT in effect	Permanent FIT with S=70
PV of revenue:	$V^{NF} = PQ\left(\frac{1+r}{r}\right)$	$V^{PF} = (P+S)Q\left(\frac{1+r}{r}\right)$
Evaluating:	$V^{NF} = 578{,}160$	$V^{PF} = 1{,}927{,}200$
PV of cost:	$PV_{cost} = 1.5M$	$PV_{cost} = 1.5M$
NPV:	$NPV = -921{,}840$	$NPV = +427{,}200$

Now suppose investors know FIT could be repealed:

- If FIT is **in effect at time t**, probability of **repeal before $t+1$** is ρ
- Repeal is permanent: no chance FIT will be reinstated

Time line:



Rev_t = revenue at t, known

Rev_{t+1} = revenue at $t+1$, uncertain

Rev_{t+2} = revenue at $t+2$, uncertain
Rev_{t+3} = …

Key question:
What's V_t, the **expected PV** of the revenue stream **from t on**?

Handy to treat V_t, the value of turbine at t, as sum of two components:

1. Revenue at t (**current** income)
2. PV of owning the turbine at $t+1$ (**asset** value of **future** income)

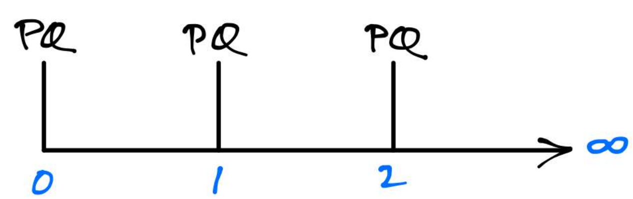
$$V_t = Rev_t + \frac{V_{t+1}}{1+r}$$

Rev_t is known at t

V_{t+1} is uncertain:

- Case 1: if FIT **repealed**, **year $t+1$'s** view:

  Revenue = **PQ** every year from $t+1$ on:



$$V_{t+1} = V^{NF}$$

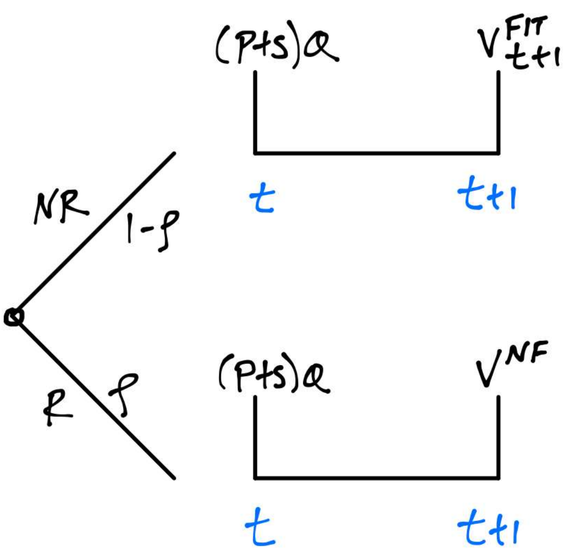
- Case 2: If FIT **NOT repealed**, **year $t+1$'s** view:

$$V_{t+1} = V_{t+1}^{FIT}$$

- Superscript indicates FIT still in place at $t+1$
- Value to be determined …

Constructing the tree at **year $\boldsymbol{t}$**:

State at $t+1$	Probability
Not repealed (NR)	$1-\rho$
Repeal (R)	ρ



$$V_t^{FIT} = \text{expected PV as of } t$$

$$V_t^{FIT} = (1-\rho)\left((P+S)Q + \frac{V_{t+1}^{FIT}}{1+r}\right) + \rho\left((P+S)Q + \frac{V^{NF}}{1+r}\right)$$

$$V_t^{FIT} = (P+S)Q + (1-\rho)\left(\frac{V_{t+1}^{FIT}}{1+r}\right) + \rho\left(\frac{V^{NF}}{1+r}\right)$$

$$V_t^{FIT} = \text{current revenue} + \text{expected PV of asset value}$$

Use two observations to simplify:

1. If FIT is **not** repealed, $t+1$ looks just like t:

   - Receive $(P+S)^{*}Q$ in current period (0)
   - Uncertain Rev in all future periods (1,2,...)

   Thus, period $t+1$'s value (in $t+1$) would look like t's:

   $$V_{t+1}^{FIT} = V_t^{FIT}$$

   Formally, the problem is *recursive*

2. If FIT **is** repealed, know V^{NF} from earlier:

   $$V^{NF} = PQ\left(\frac{1+r}{r}\right)$$

Applying the two observations:

$$V_t^{FIT} = (P+S)Q + (1-\rho)\left(\frac{V_t^{FIT}}{1+r}\right) + \rho\left(\frac{PQ\left(\frac{1+r}{r}\right)}{1+r}\right)$$

Simplifying:

$$V_t^{FIT} = (P+S)Q + (1-\rho)\left(\frac{V_t^{FIT}}{1+r}\right) + \rho\left(\frac{PQ}{r}\right)$$

$$V_t^{FIT} = PQ + SQ + \left(\frac{1-\rho}{1+r}\right)V_t^{FIT} + \frac{\rho}{r}PQ$$

$$V_t^{FIT}\left(\frac{r+\rho}{1+r}\right) = PQ\left(\frac{r+\rho}{r}\right) + SQ$$

$$V_t^{FIT} = PQ\left(\frac{1+r}{r}\right) + SQ\left(\frac{1+r}{r+\rho}\right)$$

Result is surprisingly compact:

$$V_t^{FIT} = V^{NF} + SQ\left(\frac{1+r}{r+\rho}\right)$$

Key question: how does it vary with ρ?

$V^{NF} = 578{,}160$
$S = 70$
$Q = 1752$
$r = 0.1$

$$V_t^{FIT} = 578{,}160 + 70*1752\left(\frac{1.1}{0.1+\rho}\right)$$

Extreme cases:

ρ	V_t^{FIT}	Description	NPV	Build?
0	1,927,200	Permanent subsidy	+427,200	yes
1	700,800	One year of subsidy	-799,200	no

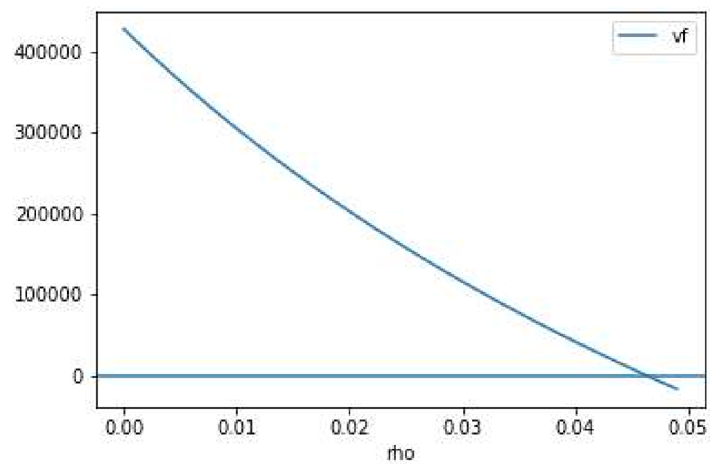
Between the two?

V_t^{FIT} drops **fast** as ρ rises even a **little**:

$\rho = 0.15$
$V_t^{FIT} = 1{,}117{,}776$
$NPV = -382{,}224$

A 15% chance of repeal is more than enough to kill the project

Graphing V_t as a function of ρ:



Fatal risk of repeal: $\rho = 4.6\%$