

## Lucas's Investment Tax Credit Example

The key idea: It is 1975 and you have just been hired by the Council of Economic Adviser's to estimate the effects of an investment tax credit. This policy is being considered to stimulate the economy,

Your response: Write down a model of investment demand, estimate the parameters of the investment demand function, and analyze policy change.

Lucas critique – this is incorrect – it does not incorporate transitory nature of tax credit.

# Deriving the Investment Demand Function

Must satisfy two key conditions:

1. Firm's investment choices are consistent with maximizing expected profits.
2. Market is in equilibrium: Supply = Demand.

## Features of Model

Demand:

$$y_t^d = a_t - bp_t$$

The intercept term is random – so demand shifts over time.

Supply:

$$y_t^s = \lambda k_t$$

Output is a linear function of beginning of period capital.

# Key Aspects of Firm's Decision

Output in period  $t$  is determined by capital stock – no decisions involved.

Revenue is determined by the location of the demand curve – this determines the price of output.

Therefore – the ONLY decision faced by the firm each period is how much to invest. This is influenced by two factors:

1. The expected level of demand next period.
2. The current and expected investment tax credit.

## Some key equations

The law of motion for capital:

$$k_{t+1} = k_t (1 - \delta) + i_t$$

Revenue in period  $t+1$ :

$$p_{t+1}y_{t+1} = p_{t+1}\lambda k_{t+1} = p_{t+1}\lambda (k_t (1 - \delta) + i_t)$$

Taxes in period  $t$ :

$$\theta (p_t y_t - \delta k_t) - \psi_t i_t$$

## Critical implication of tax credit

The price of investment is:  $(1 - \psi_t)$

This implies that the value of the firm's capital stock (post production) is:

$$(1 - \psi_t) k_t (1 - \delta)$$

Example: suppose IBM wants to reduce its capital stock – it can sell this to Dell (from Dell's perspective, this is investment). Hence, the price of existing capital sells at the current price of investment.

## The firm's present discounted value of net revenue

$$\sum_{i=1}^{\infty} \left(\frac{1}{1+r}\right)^i [p_{t+1}y_{t+1} (1 - \theta) + \theta\delta k_{t+1} - (1 - \psi_t) i_t + (1 - \psi_{t+1}) k_{t+1} (1 - \delta)]$$

In making investment plans, the firm does not know future prices or future investment tax credit. So it chooses investment in order to maximize EXPECTED future net revenues:

$$E_t \left\{ \sum_{i=1}^{\infty} \left(\frac{1}{1+r}\right)^i [p_{t+1}y_{t+1} (1 - \theta) + \theta\delta k_{t+1} - (1 - \psi_t) i_t + (1 - \psi_{t+1}) k_{t+1} (1 - \delta)] \right\}$$

Replace k using the law of motion for capital

## Necessary Condition associated with optimal investment

$$\max_{\{i_t\}} E \left\{ \sum_{t=0}^{\infty} \left( \frac{1}{1+r} \right)^t \left[ \begin{array}{l} p_{t+1} \lambda (k_t (1 - \delta) + i_t) (1 - \theta) + \theta \delta [k_t (1 - \delta) + i_t] \\ -(1 - \psi_t) i_t + (1 - \psi_{t+1}) [k_t (1 - \delta) + i_t] (1 - \delta) \end{array} \right] \right\}$$

The first-order condition is:

$$(1 - \psi_t)$$

$$= \left( \frac{1}{1+r} \right) \left\{ \underbrace{\lambda (1 - \theta) E_t (p_{t+1})}_{\text{revenue}} + \underbrace{\theta \delta}_{\text{depreciation}} + \underbrace{(1 - \delta) [1 - E_t (\psi_{t+1})]}_{\text{capital gains or losses}} \right\}$$

This represents MC = E(MB).

AND is the first of our key conditions (firm is maximizing expected profit).

Now use the other condition (equilibrium in output market) to derive the industry investment demand function as a function of investment tax credit.

This involves three steps:

1. Supply equals demand.
2. Use this to forecast next period's price. (Rational Expectations!!)
3. Use FOC from investment decision to eliminate price.

## Recap –

1. Policy analysis typically involves situations in which forecasts matter.
2. Estimates of households and firms behavior represents forecasts based on the previous policy regime.
3. These forecasts will not be helpful in assessing the impact of new policy

As was the case in the discussion of consumer behavior, estimation of a policy effect along the above lines presupposes a policy generated by a fixed, relatively simple *rule*, known by forecasters (ourselves) and by the agents subject to the policy (an assumption which is not only convenient but consistent with Article 1, Section 7 of the US Constitution).

To go beyond the kind of order-of-magnitude calculations used here to an accurate assessment of the effects of the 1962 credit, one would have to infer the implicit rule which generated that policy, a task made difficult, or perhaps impossible, by the novelty of the policy at the time it was introduced.

Similarly, there is no reason to hope that we can accurately forecast the effects of future ad hoc tax policies on investment behavior.

On the other hand, there is every reason to believe that good quantitative assessments of counter-cyclical fiscal rules, which are built into the tax structure in a stable and well understood way can be obtained.

“The only scientific quantitative policy evaluations available to us are comparisons of the consequences of alternative policy rules.”

This argument is one reason why most central banks have now characterized their policies in terms of rules.