Macroeconomics I: Non-convex adjustment cost

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Introduction

1. Class overview.
2. Evidence fo Lumpy Behavior and Non-convex adjustment cost
3. Convex Adjustment Cost
4. Non-Convex Adjustment Cost

2. Evidence: Investment

- Doms and Dunne (1998)
- 12.000 firms in the LRD in 1972-1989
- Findings:
  - More than a half of firm's investment is explained bay one episode of large investmen
  - The number of spikes (defined as the year largest investment) explains aggregate investment much better than the average magnitude of spikes. (the **extensive** margin matters more than the intensive **margin**)

2. Evidence: Employment and Consumption of durables goods

- Employment: Davis and Haltiwanger (1999); Adda and Cooper ch. 9.
- Durable Consumption: Bar-Ilan and Blinder (1992); Eberly (1994); Adda and Cooper ch. 7.

2. Evidence: Prices

- Very important element in Neo-Keynesian Literature.
- Bils and Klenow (2004)
  - Monthly prices used to build the CPI covering almost the 70 % of consumers spending
  - Median frequency of price changes: 4.3 months.
  - Median frequency after adjusting for sales: 5.5
  - The frequency of adjustment differs dramatically across goods.

2. Evidence: Prices

- Nakamura and Steisson
  - Median duration of prices during 1998 - 2005 lies between 8 and 11 months.
  - Highly correlated with inflation
  - One third of regular prices changes are price decreases

3. Convex adjustment cost: Investment

Why one should consider adjustment cost (AC)

- A model without AC does not fit the data well.
- Implies excesive response of investment to shocks (Cooper and Haltiwanger (2000))
- Cannot replicate the inaction prediods found in microeconomic data

3. Convex Adjustment Cost

Suppose that firm has to solve a dynamic programming problem like

$$V(A,K,p) = \max_{K'}\{\Pi(A,K) - C(K',A,K) - p(K' - (1-\delta)K)$$
$$+\beta E_{A',p'|A,p} V(K',A',p')\}$$

Solving for $\frac{\partial V(A,K,p)}{\partial K'} = 0$ one can get

$$C_{K'}(K',A,K) + p = \beta \underbrace{V_{K'}(A',K',p')}$$

And from first expresion, one obtain a Euler Equation

$$C_{K'}(K',A,K) + p = \beta E_{A',p'|A,p}\{\Pi_K(K',A') + p'(1-\delta) - C_{K'}(K'',A'.K')\}$$

3. Convex Adjustment Cost: Quadratic adjustment cost

Consider that price if capital is constant over time and the adjustment cost fucntion is quadratic:

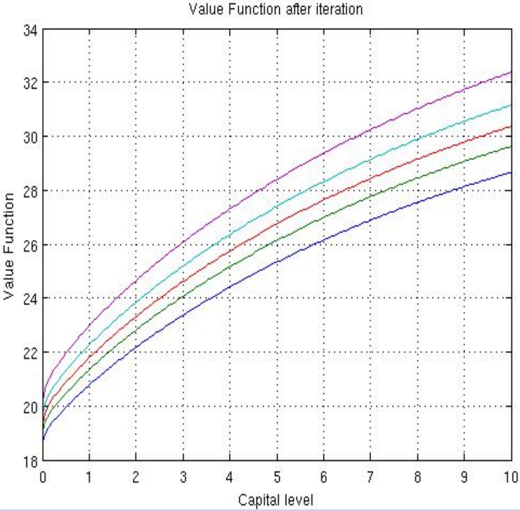
$$V(A,K) = \max_{K'} AK^{\alpha} - (K' - (1-\delta)K)^2 - p(K' - (1-\delta)K) + \beta E_{A',p'|A,p} V(K',A')$$

Assuming that A follows a first order markov process

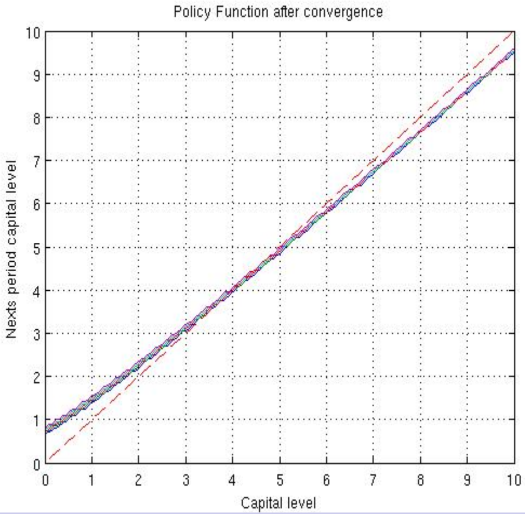
$$A' = \rho A + \varepsilon$$

We can solve firm's problems using `MATLAB` (how to do that?, tomorrow!!!)

3. Convex Adjustment Cost: Quadratic adjustment cost



3. Convex Adjustment Cost: Quadratic adjustment cost



4. Introducing non-convexities

- Micro-evidence: there are frequent periods of inactivity and also bursts of investment activity
- Research in the field: Caballero et al. (1995), Cooper et al. (1999), Cooper and Haltiwanger (2000).
- The lumpy behavior is difficult to reconcile with convex adjustment cost

Goal: build a model that can reproduce that investment behavior

4. A model with non-convex adjustmet cost

Consider a firm that have to choose between two value function.

$$V(A,K,p) = \text{máx}\{V^i(A,K,p), V^a(K,A,p)\}$$

Where i implies inactive firm and a implies an active firm. The firm's options are defined as,

$$V^i(A,K,p) = \Pi(A,K) + \beta E_{A',p'|A,p} V(A', K(1-\delta), p')$$

$$V^a(A,K,p) = \underset{K'}{\text{máx}}\{\Pi(A,K) - F - p(K' - (1-\delta)K) + \beta E_{A',p'|A,p} V(A', K', p')\}$$

This formulation only assumes that firm pay a fixed adjustment cost, independent of the adjustment level, the firm size and other characateristics that may affect the adjustment cost.

4. A model with non-convex adjustmet cost

Some charasteristics of the model:

- There is time-to build
- The solution is the superior envelope of two concave Value Functions
- This differs with a model with automatic adjustment (with out time to build)

Again, we can solve this problem using `MATLAB` (but not today!!!)

4. A model with non-convex adjustmet cost

For finding the solution we are going to assume that:

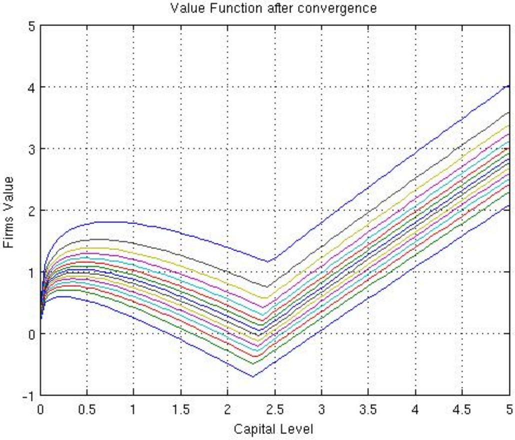
- The rental price of capital is fixed over time.
- The current undepreciated capital increases firm's profits but it has to repurchase capital (or rent capital) every period.
- The only source of uncertainty is the aggregate productivity level.

So that, the model can be written as:

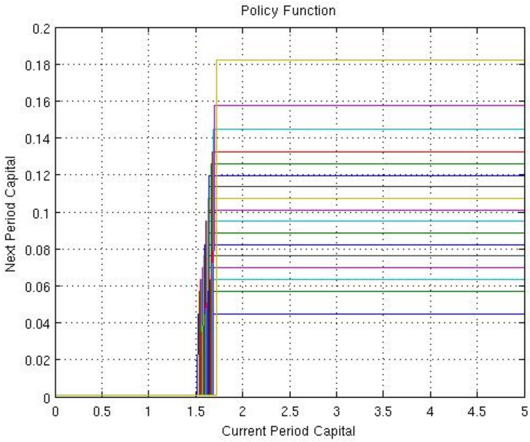
$$V(K,A) = \text{máx}\{AK^{\alpha} + (1-\delta)K + \text{máx}\{-\kappa + \underset{K'}{\text{máx}}(-K' + \beta E_{A'|A} V(A',K'))$$

$$-(1-\delta)K + \beta E_{A',p'|A,p} V(A',(1-\delta)K)\}$$

4. A model with non-convex adjustmet cost



4. A model with non-convex adjustmet cost



4. A model with non-convex adjustmet cost

Some conclusions:

- The model generate periods of inaction, as one can see in the data.