ECON 7040 - Macroeconomic Theory

TA Session 8

March 15, 2024

Agenda for Next Few Weeks

1. Monopolistic Competition: Consumer Side
2. Monopolistic Competition: Firm Side
3. Monopolistic Competition: Equilibrium
4. New-Keynesian Model
   - 4.1 Consumer Problem
   - 4.2 Calvo Pricing and Firm Problem
   - 4.3 Canonical 3-equation New-Keynesian Model

Today's Agenda

1. Monopolistic Competition: Consumer Side
2. Monopolistic Competition: Firm Side (if time)

Monopolistic Competition

- Simple model with monopolistic competition has the following properties:
  1. A continuum of individual households
  2. A continuum of individual firms
  3. A continuum of differentiated goods
  4. Firms are monopoly producers of a single good (positive firm profits)
  5. Each household owns a uniform portfolio over firm profits
- We refer to monopolistic competition as a 'real rigidity'.

Household Problem

Household solves

$$\max_{C_t^i, N_t} \quad \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left[\frac{C_t^{1-\sigma}}{1-\sigma} - \frac{N_t^{1+\varphi}}{1+\varphi} \right]$$

$$s.t. \quad \int_0^1 P_t^i C_t^i di = W_t N_t + \int_0^1 \Pi_t^i di$$

Have aggregate consumption C_t in utility function and individual consumptions C_t^i in BC

How are they related?

Consumption Aggregator

We define aggregate consumption using the **Dixit-Stiglitz** aggregator:

$$C_t = \left[\int_0^1 C_t^{i\,\frac{\theta-1}{\theta}}\, di\right]^{\frac{\theta}{\theta-1}}$$

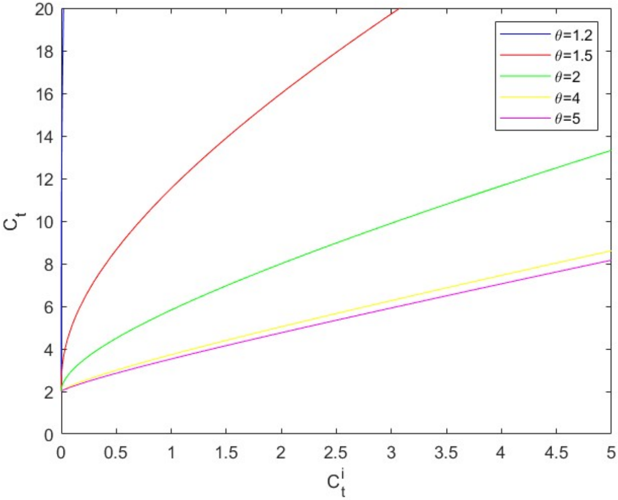
where $\theta > 1$ reflects consumers' **love for variety**

Households like variety because $\frac{\theta-1}{\theta} \in [0, 1]$ i.e. the aggregator is concave

- As $\theta \to \infty$ aggregator becomes linear (perfect substitutes)
- As $\theta \to 1$ aggregator converges to Leontief function (perfect complements, no substitutability)

Consumption Aggregator

Figure: Consumption Aggregator for Different Values of θ



Expenditure Minimization

Agents are now also solving an intratemporal problem:

$$\min_{C_t^i} \quad \int_0^1 P_t^i C_t^i di$$

$$s.t. \quad \left[\int_0^1 C_t^{i\,\frac{\theta-1}{\theta}} di\right]^{\frac{\theta}{\theta-1}} = C_t$$

they want to minimize their total expenditure subject to a level of total consumption C_t (from different optimization problem)

FOC:

$$[C_t^i]: \quad P_t^i - \mu_t \frac{\theta}{\theta-1}\left[\int_0^1 C_t^{i\,\frac{\theta-1}{\theta}} di\right]^{\frac{\theta}{\theta-1}-1} \frac{\theta-1}{\theta} C_t^{i\,\frac{\theta-1}{\theta}-1} = 0$$

Expenditure Minimization

Solving gives:

$$C_t^i = \left(\frac{P_t^i}{\mu_t}\right)^{-\theta} C_t$$

Plugging back in the constraint we get:

$$\mu_t = \left[\int_0^1 {P_t^i}^{1-\theta} di\right]^{\frac{1}{1-\theta}}$$

(Aggregate) Price Level

Okay, but what about P_t?

Aggregate price level should be average of individual prices weighted by consumption basket shares:

$$P_t = \frac{\int_0^1 P_t^i C_t^i di}{C_t}$$

Use expression for C_t^i:

$$P_t = \frac{\int_0^1 P_t^i \left(\frac{P_t^i}{\mu_t}\right)^{-\theta} C_t di}{C_t} = \mu_t^\theta \int_0^1 {P_t^i}^{1-\theta} di$$

and then the expression for μ_t:

$$P_t = \left[\int_0^1 {P_t^i}^{1-\theta} di\right]^{\frac{1}{1-\theta}}$$

Expenditure Minimization

This implies:

$$P_t = \mu_t$$

Plug into individual demand function:

$$C_t^i = \left(\frac{P_t^i}{P_t}\right)^{-\theta} C_t$$

Check intuition remembering this is a demand function

Notice this also implies:

$$\int_0^1 P_t^i C_t^i di = P_t C_t$$

Rewritten Household Problem

Can rewrite the HH problem as:

$$\max_{C_t, N_t} \quad \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left[\frac{C_t^{1-\sigma}}{1-\sigma} - \frac{N_t^{1+\varphi}}{1+\varphi} \right]$$

$$s.t. \quad P_t C_t = W_t N_t + \int_0^1 \Pi_t^i di$$

Now we have C_t in both utility function and BC!

The HH can solve this problem to get C_t and then solve the expenditure minimization problem, **given aggregate consumption**, to get individual consumptions C_t^i

Rewritten Household Problem

Standard FOCs:

$$\begin{aligned} [C_t]: \quad & C_t^{-\sigma} = \lambda_t P_t \\ [N_t]: \quad & N_t^{\varphi} = \lambda_t W_t \end{aligned}$$

Consumption-labor decision characterized by:

$$C_t^{\sigma} N_t^{\varphi} = \frac{W_t}{P_t}$$

Firm Problem

For each good i there is a monopolistic firm that produces subject to a production function $Y_t^i = A_t N_t^i$

Each firm solves:

$$\max_{P_t^i} \quad P_t^i Y_t^i - W_t N_t$$
$$s.t. \quad Y_t^i = A_t N_t^i$$

Why is the firm choosing P_t^i? What does that imply?

Firm Problem

Rewrite firm problem as:

$$\max_{P_t^i} \quad P_t^i Y_t^i(P_t^i) - \frac{W_t}{A_t} Y_t^i(P_t^i)$$

Being a monopolist, the firm faces the demand curve:

$$Y_t^i = C_t^i = \left(\frac{P_t^i}{P_t}\right)^{-\theta} C_t$$

Then firm problem is:

$$\max_{P_t^i} \quad P_t^i \left(\frac{P_t^i}{P_t}\right)^{-\theta} C_t - \left(\frac{P_t^i}{P_t}\right)^{-\theta} C_t \frac{W_t}{A_t} = \underbrace{\left(P_t^i - \frac{W_t}{A_t}\right)}_{p-mc} \underbrace{\left(\frac{P_t^i}{P_t}\right)^{-\theta} C_t}_{y^d}$$

Firm Problem

FOC:

$$[P_t^i]: \quad (1-\theta)P_t^{i\,-\theta}\frac{C_t}{P_t^{-\theta}} + \theta P_t^{i\,-\theta-1}\frac{C_t}{P_t^{-\theta}}\frac{W_t}{A_t} = 0$$

Simplify to get:

$$P_t^i = \frac{\theta}{\theta-1}\frac{W_t}{A_t} = \frac{\theta}{\theta-1}MC_t$$

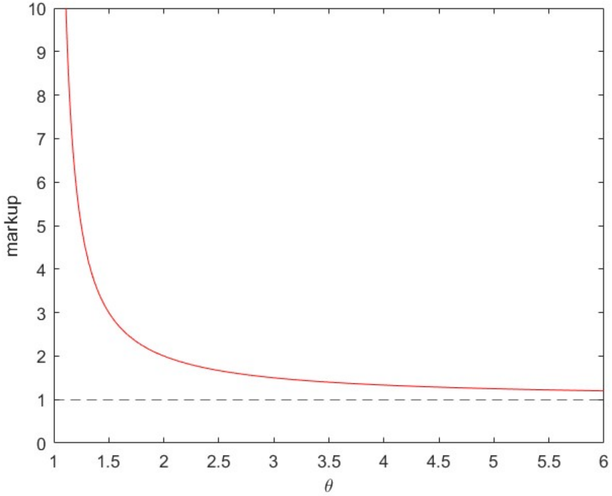
or

$$\frac{P_t^i}{P_t} = \frac{\theta}{\theta-1}mc_t, \quad mc_t \equiv \frac{W_t}{P_t A_t}$$

$\frac{\theta}{\theta-1} > 0$ (recall $\theta > 1$) is the mark-up firms charge over their marginal cost (decreasing in θ)

Markup

Figure: Firm Markup as a Function of Consumers' Love for Variety



Next Class

Next time we will look at the equilibrium of this monopolistic competition setup:

1. Optimality (HH+Firm)
2. Market clearing

and compare the CE with the SP solution

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