Macroeconomics III - Lecture 7

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Outline

- A quick introduction to New Keynesian economics
- The Blanchard-Kiyotaki model of monopolistic competition (slides + Romer 6.5-6.6)
- Nominal rigidities in the form of *menu costs* (slides)

An introduction to New Keynesian economics

- Main scope of New Keynesian economics:
  - Demonstrate the existence of involuntary unemployment
  - Money non-neutrality (or monetary policy effectiveness)
- From a methodological viewpoint this doctrine accepts:
  - *Microfoundations* (derivation of macroeconomic relationships from first principles)
  - *Rational Expectations*

An introduction to New Keynesian economics

- NK economics departs from the paradigm of perfect competition through the introduction of market imperfections
- Two main strands of analysis:
  - Market power imperfections (distortions of the competitive allocation mechanism)
  - Imperfections stemming from information frictions (limited and/or asymmetric information)

An introduction to New Keynesian economics

Market power imperfections and nominal rigidities

- In the Keynesian tradition rigidities in the price and/or wage setting mechanism were assumed to justify the real effects of money
- The absence of theoretical foundations supporting these ideas has stimulated various lines of enquiry
- Two main trends in the literature:
  1. The role of imperfections characterizing different markets (labor, consumption goods, physical capital) in contrast to the Walrasian paradigm (perfect competition, no externalities, complete information)
  2. Nominal variables can affect real variables in the short run
- To justify price rigidity on *microeconomic* grounds two conditions are seen as necessary:
  1. Producers (workers) are price (wage) setters
  2. Under certain conditions it may be more profitable to keep prices unchanged after exogenous disturbances occur

Today's perspective

- We need to bring agents with market power into the picture
- Imperfect competition is a key ingredient
- BK model as the cornerstone of New Keynesian thinking
- In contrast to the ad hoc IS-LM model the BK model stresses the role of the supply side no less than the demand side

The concept of monopolistic competition

Monopolistic competition is a market structure with the following properties:

1. There is a given, large number of firms and equally many differentiated goods
2. Each firm is price maker in the supply of its own good, which is an imperfect substitute of other goods
3. A price-change by one firm has only negligible effects on the demand faced any other firm
4. The (short-run) equilibrium is defined as a set of prices and quantities such that:
   - 4a Supply equals demand
   - 4b Each firm's profit is maximized, given a downward-sloping demand curve for its good and given other firms' prices

What should we expect from the model?

- No wage and/or price adjustment costs
- In the flexible price scenario, in spite of monopolistic competition, money is neutral
- In contrast to perfect competition, monopolistic competition leads to a Pareto-inferior general equilibrium with underutilization of resources

However, when adjustment/menu costs are introduced:

- Price setters may abstain from adjusting their price when demand changes
- Money may be non neutral
- Even small (price) adjustment costs can have large real consequences at the aggregate level

Model economy: baseline features

- Static model
- m firms, $i = 1, ..., m$, and m goods, with m large
- Goods are imperfect substitutes (think of different kinds or brands of cars, beer and toothpaste)
- A representative household (in the original BK setting: n households, each supplying its specific type of labor)
- Money acts as a numeraire and is accumulated due to its liquidity services

Representative household

$$\max_{C_i, N, \frac{M}{P}} U = (C)^{\gamma} \left(\frac{M}{P}\right)^{1-\gamma} - \frac{1}{\beta} N^{\beta}, \quad 0 < \gamma < 1, \;\; \beta > 1 \qquad (1)$$

s.t.

$$\sum_{i=1}^{m} P_i C_i + M = M_0 + WN + \sum_{i=1}^{m} \Pi_i \equiv I, \qquad (2)$$

Aggregate indices

$$\text{Consumption:} \qquad C = m^{\frac{1}{1-\theta}} \left(\sum_{i=1}^{m} C_i^{\frac{\theta-1}{\theta}} \right)^{\frac{\theta}{\theta-1}} \tag{3}$$

$$\text{Prices:} \qquad P = \left(\frac{1}{m} \sum_{i=1}^{m} P_i^{1-\theta} \right)^{\frac{1}{1-\theta}} \tag{4}$$

Lagrangian

$$
\begin{aligned}
\max_{C_i, N, \frac{M}{P}} L \quad = \quad & \left[m^{\frac{1}{1-\theta}} \left(\sum_{i=1}^{m} C_i^{\frac{\theta-1}{\theta}} \right)^{\frac{\theta}{\theta-1}} \right]^{\gamma} \left(\frac{M}{P} \right)^{1-\gamma} - \frac{1}{\beta} N^{\beta} \\
& - \frac{\lambda}{P} \left(\sum_{i=1}^{m} P_i C_i + M - M_0 - WN - \sum_{i=1}^{m} \Pi_i \right)
\end{aligned}
$$

FOC's

$$
\begin{aligned}
\frac{\partial U}{\partial C_i} &= 0 \Rightarrow \left(\frac{M}{P}\right)^{1-\gamma} \frac{\gamma\theta}{\theta-1} m^{\frac{\gamma}{1-\theta}} \left(\sum_{i=1}^{m} C_i^{\frac{\theta-1}{\theta}}\right)^{\frac{\gamma\theta}{\theta-1}-1} \frac{\theta-1}{\theta} C_i^{-\frac{1}{\theta}} = \lambda \frac{P_i}{P} \\
\frac{\partial U}{\partial (M/P)} &= 0 \Rightarrow (1-\gamma)\left(\frac{M}{P}\right)^{-\gamma} C^{\gamma} = \lambda \\
\frac{\partial U}{\partial N} &= 0 \Rightarrow N^{\beta-1} = \lambda \frac{W}{P}
\end{aligned}
$$

Goods demand function

To obtain the demand function for the ith good, combine the first two FOCs:

$$
\begin{aligned}
\left(\frac{M}{P}\right)^{1-\gamma} \frac{\gamma\theta}{\theta-1} m^{\frac{\gamma}{1-\theta}} \left(\sum_{i=1}^{m} C_i^{\frac{\theta-1}{\theta}}\right)^{\frac{\gamma\theta}{\theta-1}-1} \frac{\theta-1}{\theta} C_i^{-\frac{1}{\theta}} &= (1-\gamma)\, C^{\gamma} \left(\frac{M}{P}\right)^{-\gamma} \frac{P_i}{P} \\
\left(\frac{M}{P}\right)^{1-\gamma} \gamma \frac{m^{\frac{\gamma}{1-\theta}} \left(\sum_{i=1}^{m} C_i^{\frac{\theta-1}{\theta}}\right)^{\frac{\gamma\theta}{\theta-1}}}{\sum_{i=1}^{m} C_i^{\frac{\theta-1}{\theta}}} C_i^{-\frac{1}{\theta}} &= (1-\gamma)\, C^{\gamma} \left(\frac{M}{P}\right)^{-\gamma} \frac{P_i}{P} \\
\left(\frac{M}{P}\right)^{1-\gamma} \gamma \frac{C^{\gamma}}{m^{\frac{1}{\theta}} \left[m^{\frac{1}{1-\theta}} \left(\sum_{i=1}^{m} C_i^{\frac{\theta-1}{\theta}}\right)^{\frac{\theta}{\theta-1}}\right]^{\frac{\theta-1}{\theta}}} C_i^{-\frac{1}{\theta}} &= (1-\gamma)\, C^{\gamma} \left(\frac{M}{P}\right)^{-\gamma} \frac{P_i}{P} \\
\frac{M}{PC} \frac{\gamma}{1-\gamma} \left(\frac{C}{mC_i}\right)^{\frac{1}{\theta}} &= \frac{P_i}{P}
\end{aligned}
$$

Some algebraic manipulations

Plug the demand function into the definition of P to obtain (prove it):

$$P = \frac{\gamma}{1-\gamma}\frac{M}{C}$$

and plugging this back into $\frac{P_i}{P} = \frac{\gamma}{1-\gamma}\frac{M}{PC}\left(\frac{C}{mC_i}\right)^{\frac{1}{\theta}}$:

$$C_i = \left(\frac{P_i}{P}\right)^{-\theta}\frac{C}{m}$$

Let us express the demand for consumption and money as a function of the endowment (I):

$$\sum_{i=1}^{m} P_i C_i + M \equiv I$$

Real consumption expenditure:

$$\sum_{i=1}^{m}\frac{P_i}{P}C_i = C$$

Some algebraic manipulations

We need to show that $\sum_{i=1}^{m} \frac{P_i}{P} C_i = C$. To this end, recall that $C_i = \left(\frac{P_i}{P}\right)^{-\theta} \frac{C}{m} \Rightarrow \frac{P_i}{P} = \left(m \frac{C_i}{C}\right)^{-\frac{1}{\theta}}$, which implies the following

$$
\begin{aligned}
\sum_{i=1}^{m} \frac{P_i}{P} C_i &= \sum_{i=1}^{m} \left(m \frac{C_i}{C}\right)^{-\frac{1}{\theta}} C_i \\
&= \left(\frac{m}{C}\right)^{-\frac{1}{\theta}} \sum_{i=1}^{m} (C_i)^{\frac{\theta-1}{\theta}} \\
&= \left(\frac{m}{C}\right)^{-\frac{1}{\theta}} \left(\frac{m^{\frac{1}{1-\theta}}}{m^{\frac{1}{1-\theta}}} \left(\sum_{i=1}^{m} (C_i)^{\frac{\theta-1}{\theta}} \right)^{\frac{\theta}{\theta-1}} \right)^{\frac{\theta-1}{\theta}} \\
&= \left(\frac{m}{C}\right)^{-\frac{1}{\theta}} \left(\frac{1}{m^{\frac{1}{1-\theta}}} \right)^{\frac{\theta-1}{\theta}} \left(m^{\frac{1}{1-\theta}} \left(\sum_{i=1}^{m} (C_i)^{\frac{\theta-1}{\theta}} \right)^{\frac{\theta}{\theta-1}} \right)^{\frac{\theta-1}{\theta}} \\
&= \left(\frac{m}{C}\right)^{-\frac{1}{\theta}} \left(\frac{1}{m^{\frac{1}{1-\theta}}} \right)^{-\frac{1-\theta}{\theta}} C^{\frac{\theta-1}{\theta}} \\
&= \left(\frac{m}{C}\right)^{-\frac{1}{\theta}} m^{\frac{1}{\theta}} C^{\frac{\theta-1}{\theta}} \\
&= C^{\frac{1}{\theta}} C^{\frac{\theta-1}{\theta}} \\
&= C
\end{aligned}
$$

Some algebraic manipulations (contd.)

So, we know that

$$\sum_{i=1}^{m} P_i C_i = PC$$

Thus, aggregate consumption and money are functions of aggregate wealth (standard result):

$$\begin{aligned} C &= \gamma \frac{I}{P} \\ M &= (1-\gamma)\, I \end{aligned}$$

Some algebraic manipulations (contd.)

As $C = Y$ in general equilibrium:

$$Y = \frac{\gamma}{1-\gamma}\frac{M}{P}$$

As for labour supply:

$$N^{\beta-1} = \frac{W}{P}(1-\gamma)\left(\frac{M}{PC}\right)^{-\gamma} = \frac{W}{P}(1-\gamma)\left(\frac{\gamma}{1-\gamma}\right)^{-\gamma}$$

which in turn provides us with the labor supply schedule:

$$N^S = \left[(1-\gamma)^{1-\gamma}\gamma^{\gamma}\right]^{\frac{1}{\beta-1}}\left(\frac{W}{P}\right)^{\frac{1}{\beta-1}}$$

Firms

The decision problem of firm i is to choose a vector $\{P_i/P, Y_i, N_i\}_{i=1}^{N}$:

$$
\begin{aligned}
\max_{\frac{P_i}{P}, N_i, Y_i} \Pi_i &= P_i Y_i - W N_i \quad \text{s.t.} && (5) \\
Y_i &= C_i = \left(\frac{P_i}{P}\right)^{-\theta} \frac{C}{m}, && (6) \\
Y_i &= N_i^{\alpha}, \quad 0 < \alpha < 1 && (7)
\end{aligned}
$$

Profit maximization

Profit maximization:

$$\max_{P_i} \frac{P_i}{P} \left(\frac{P_i}{P} \right)^{-\theta} \frac{C}{m} - \frac{W}{P} \left[\left(\frac{P_i}{P} \right)^{-\theta} \frac{C}{m} \right]^{\frac{1}{\alpha}}$$

FOC (price-setting rule):

$$\frac{P_i}{P} = \left[\frac{\theta}{\theta - 1} \frac{1}{\alpha} \frac{W}{P} \left(\frac{C}{m} \right)^{\frac{1-\alpha}{\alpha}} \right]^{\frac{\alpha}{\alpha + \theta(1-\alpha)}}$$

Homogeneity assumption

We impose price homogeneity:

$$P_i = P \quad \forall i$$

Firm specific equilibrium production, from $C_i = \left(\frac{P_i}{P}\right)^{-\theta} \frac{C}{m} = Y_i$:

$$C_i = Y_i = \frac{C}{m} \quad \forall i$$

Aggregate demand for labor:

$$N^D = \sum_{i=1}^{m} N_i^D = mY_i^{\frac{1}{\alpha}} = m\left(\frac{C}{m}\right)^{\frac{1}{\alpha}} = m^{\frac{\alpha-1}{\alpha}} \left(\frac{\gamma}{1-\gamma}\frac{M}{P}\right)^{\frac{1}{\alpha}}$$

Labour market equilibrium

$$
\begin{aligned}
N^S &= N^D \\
\Rightarrow \quad \frac{W}{P} &= \underbrace{\left[\frac{m^{\frac{(\alpha-1)(\beta-1)}{\alpha}}}{1-\gamma} \left(\frac{\gamma}{1-\gamma} \right)^{\frac{\beta-1}{\alpha}-\gamma} \right]}_{K_L} \left(\frac{M}{P} \right)^{\frac{\beta-1}{\alpha}}
\end{aligned}
$$

Taking logs:

$$
\ln\left(\frac{W}{P}\right) = \ln K_L + \frac{\beta-1}{\alpha} \ln\left(\frac{M}{P}\right)
$$

Goods market equilibrium

We impose symmetry in the production sector and set the relative price to one in the pricing rule ($P_i/P = 1$):

$$\frac{W}{P} = \frac{\theta - 1}{\theta}\alpha \left(\frac{\gamma}{1-\gamma} \frac{M}{mP} \right)^{\frac{\alpha-1}{\alpha}}$$

Note that we can express the same relationship in terms of mark-up pricing:

$$P = \frac{\theta}{\theta - 1} MC$$

where $MC = \left(\frac{\gamma}{1-\gamma} \frac{M}{mP} \right)^{\frac{1-\alpha}{\alpha}} \frac{W}{\alpha}$.
As the distortion due monopolistic competition vanishes ($\theta \to \infty$), the pricing rule becomes:

$$P = \frac{W}{\alpha} \left(\frac{Y}{m} \right)^{\frac{1}{\alpha} - 1} \Leftrightarrow P = MC$$

In the general case, we take logs:

$$\ln \left(\frac{W}{P} \right) = \ln K_P - \frac{1-\alpha}{\alpha} \ln \left(\frac{M}{P} \right)$$

General equilibrium

To sum up, general equilibrium is given by:

$$\begin{aligned} \text{LME} \quad &: \quad \ln\left(\frac{W}{P}\right) = \ln K_L + \frac{\beta - 1}{\alpha} \ln\left(\frac{M}{P}\right) \\ \text{APR} \quad &: \quad \ln\left(\frac{W}{P}\right) = \ln K_P - \frac{1 - \alpha}{\alpha} \ln\left(\frac{M}{P}\right) \end{aligned}$$

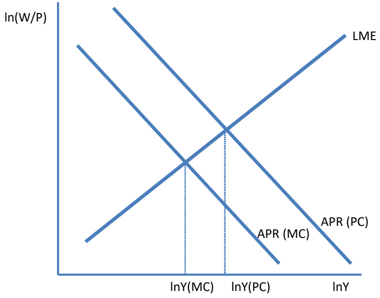
In the absence of price adjustment costs the model has the classical features:

- Real variables (output and real wage) are determined by technology and preferences, independent of the supply of money
- Price and wage levels are proportional to the supply of money (money neutrality)

Then, what's new?

- Underutilization of resources: primarily an effect of market power
- Pareto-inferior underemployment arising under monopolistic competition as an example of coordination failure
- Any agent does the best, given what the others do, but the outcome is socially inefficient
- A coordinated action could improve the outcome for everybody

A graphical inspection



Aggregate demand externality

- On the one hand: if $P_i \downarrow$, the demand faced by the ith producer increases
- On the other hand: if $P_i \downarrow$, this should have a feedback effect on P (through the price index), which should also go down and determine an increase in the demand faced by all producers
- These elements should allow to increase production and welfare in the economy, but:
    - The latter effect is not considered by the single producer when setting her price. Recall that

$$\max_{P_i} \Pi_i = P_i \left(\frac{P_i}{P}\right)^{-\theta} \frac{C}{m} - W\left[\left(\frac{P_i}{P}\right)^{-\theta} \frac{C}{m}\right]^{\frac{1}{\alpha}}$$

and NOT

$$\max_{P_i} \Pi_i = P_i \left(\frac{P_i}{P\left(P_1, ..., P_i, ...\right)}\right)^{-\theta} \frac{C}{m} - W\left[\left(\frac{P_i}{P\left(P_1, ..., P_i, ...\right)}\right)^{-\theta} \frac{C}{m}\right]^{\frac{1}{\alpha}}$$

    - The first effect at the equilibrium price is null (appeal to the envelope theorem to prove it...)

The menu cost theory

- Menu costs are typically modeled as fixed costs of changing price
- Direct examples:
  - Costs faced by restaurants when they have to reprint the menu
  - Costs faced by stores when they have to remark the commodities with new price labels and reprint price lists and catalogues

The menu cost theory (contd.)

We could also consider indirect costs associated with:

- Information-gathering
- Recomputing optimal prices
- Conveying the new directives to the sales force
- Offending customers by frequent price changes
- Search for new customers willing to pay a higher price
- Renegotiations

The model

- Demand function (in real terms) faced by the monopolist:

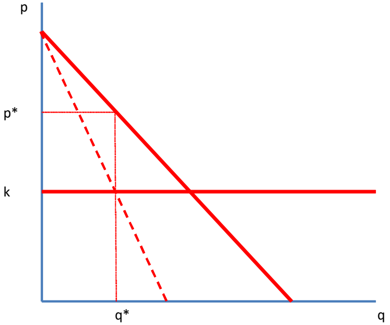
$$p = f(q), \quad f'(q) < 0$$

- Real profits (assuming linear costs kq, $k > 0$):

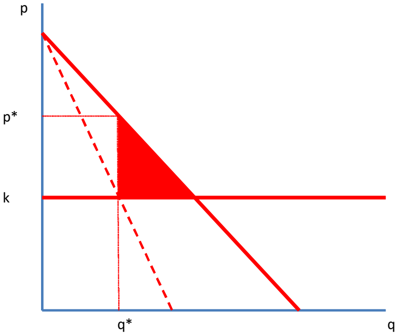
$$\Pi = pq - kq = [f(q) - k]\, q$$

- Profits are maximized at (p^*, q^*) such that $MR(q) = MC$

A graphical representation (equilibrium)



A graphical representation (deadweight loss)



Introducing menu costs

- Let us express the problem in nominal terms
- Where P is the nominal price of the monopolist and $\mathbf{P}$ is the general price level (es., GDP deflator), so that

$$P = p\mathbf{P}$$

- Nominal costs are

$$C = kq\mathbf{P}$$

- If $\mathbf{P}$ is known when the monopolist sets P, then this situation is equivalent to the problem above
- However, if the monopolist sets its price before $\mathbf{P}$ is known, expectations need to be formed ($E[\mathbf{P}]$)

Introducing menu costs (contd.)

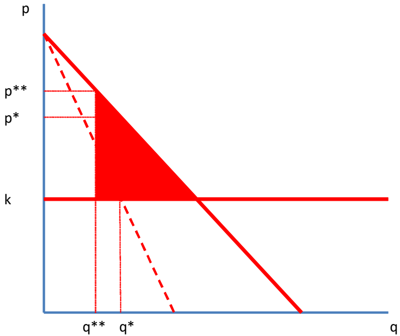
- Whenever $\mathbf{P} \neq E[\mathbf{P}]$, pricing is suboptimal and the monopolist needs to decide whether to adjust her price
- We assume that price-adjustment comes at a fixed cost z
- Assume an unexpected reduction in $\mathbf{P}$
- If P remains fixed then p has to change:

$$p \uparrow = \frac{P}{\mathbf{P} \downarrow}$$

and quantities will change accordingly $(q \downarrow)$

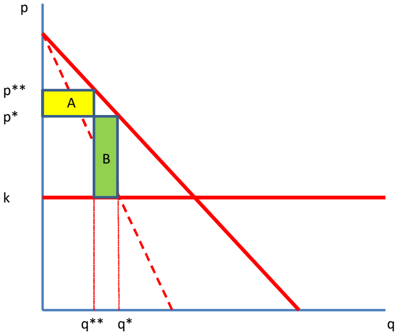
A graphical representation (higher deadweight loss)

If P is not adjusted and $\{p, q\}$ are left free to change:



A graphical representation (change in firm profits)

Trade-off



Comparative statics

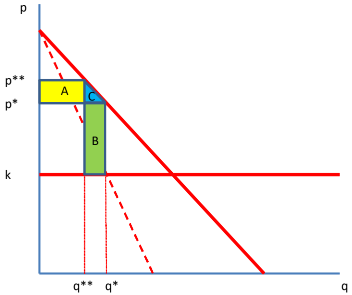
- Assume that changing the prices is not frictionless: cost z
- If $B - z > A$ it is convenient to adjust the nominal price, so as to keep the real price unchanged
- If $B - z < A$ it is not profitable to change the nominal price

Some quick observations

- If we had ruled out price-setting (which can be justified in light of the assumption of market power), $p = k$
- In this situation welfare cannot be augmented further
- If adjusting prices is not possible (or desirable) quantity would be rationed, as selling at a price $p < k$ would produce a loss at the margin

Firm-specific vs. economy-wide welfare

If the monopolist evaluates $B - z \lesseqgtr A - C$ as compared to $B - z \lesseqgtr A$, the manu cost should have lower relevance, as it is more likely that leaving prices unchanged is not profitable



A short recap of this lecture

- NK economics as a (partial) formalization of the Keynesian thought that stresses money non neutrality and market imperfections
- Price-setting embodied in the BK monopolistic competition model, as a prerequisite to introduce nominal rigidities
- BK show that monopolistic competition cannot generate money non neutrality, but only underutilization of resources
- Menu costs as a suitable tool to induce money non neutrality

Future directions

- Stick to a general equilibrium view
- Other sources of nominal rigidity: imperfect information, staggered contracts, price setting à la Calvo
- Monetary policy implications: analysis of the trade-off between inflation and output stabilization

Additional reading list

- Blanchard O.J. and N. Kiyotaki (1987) "Monopolistic competition and the effects of aggregate demand", American Economic Review, 77, pp. 647-666
- Mankiw (1985), "Small Menu Costs and Large Business Cycles", Quarterly Journal of Economics, pp.529-537.
- Akerlof and Yellen (1985), "Can Small Deviations from Rationality Make Significant Differences to Economic Equilibria?", American Economic Review, pp.708-721.