New Keynesian (NK) Model

Advanced Macro

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Introduction

- RBC model assumes perfect competition in goods and input markets
  - Classical tradition: Fluctuations are natural and efficient responses
  - Implication: Fiscal and monetary policies ineffective for macro conditions
- In MIUF model, money is neutral
- New-Keynesian economics embrace imperfect competition
  - Keynesian principles: Fluctuations are the result of market failures
  - Implication: Fiscal and monetary policies can improve macro conditions
- Over time, convergence in approach, so less fights about methodology
  - Micro foundations, nominal rigidities, shocks to demand and supply
  - See: Woodford (2003), Galí (2008), Blanchard (2025)

Assumptions: Economy

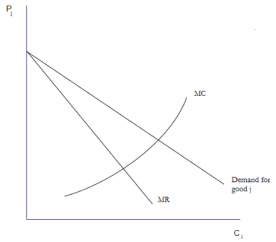
- Same assumptions about economy as in RBC model
- HHs: Same behavior as in RBC model
- Firms: Significant changes to supply side
  - Production now done in two steps
  - New ingredients: Monopolistic competition and price stickiness (friction)
- Central bank: New agent that conducts monetary policy
  - In practice, monetary policy influences economic activity in short run
  - In model, price stickiness makes monetary policy non-neutral
  - CB follows a Taylor (1993) rule to stabilize inflation and output gap
  - New shock: Monetary policy shock (in Taylor rule)

Assumptions: Firms

- Production side consists of two sectors (instead of one)
- **Wholesalers**: Producers of (differentiated) intermediate goods
  - Markets with **imperfect** competition: Similar but not identical goods
  - Optimize in two steps
    - Minimize TC (taking factor prices as given) by choosing production factors
    - Maximize profits by setting price of good
  - No fixed costs and constant returns to scale, so MC = average TC
- **Retailers**: Producers of (identical) final goods
  - Markets with **perfect** competition: A single bundle for consumption
  - Aggregators of a continuum ($j \in [0, 1]$) of wholesale goods (inputs)
  - Maximize profits by choosing wholesale goods (taking prices as given)

Wholesalers: Monopolistic Competition

- Firms produce differentiated goods having some degree of market power
  - Price setters, not price takers
- At optimum,
  - Profit-maximizing firms choose output so that MR = MC
  - Since demand curve above MR curve, price > MC (i.e., markup > 0)



Wholesalers: Price Stickiness

- Prices do not adjust immediately to changes in demand and/or supply
  - Rationale: Costs to adjust prices (e.g., menu cost)
- Price stickiness derived from behavior of optimizing agents
  - Rotemberg (1982) pricing: Firms face quadratic costs to change prices
  - Calvo (1983) pricing: Staggered price contracts
    - Every period, firms keep prices fixed ($p_{jt} = p_{jt-1}$) with probability θ
    - Price-setting is forward looking (b/c may not be able to adjust in future)
- Calvo pricing was key to derive NK Phillips curve (Roberts, 1995)
- With nominal rigidities, price response to a shock spreads out over time

Retailers: Aggregation Technology

- Common aggregators: Dixit and Stiglitz (1977), Kimball (1995)
  - Harding, Lindé and Trabandt (2022) discuss differences
- Dixit-Stiglitz uses a constant elasticity of substitution (CES) function

$$Y_t = \left(\int_0^1 Y_{jt}^{\frac{\psi-1}{\psi}} dj \right)^{\frac{\psi}{\psi-1}}$$

- CES function nests others as special cases
  - $\psi \to 1$: Cobb-Douglas case
  - $\psi > 1$: Wholesale goods are imperfect substitutes, firms are price setters
  - $\psi \to \infty$: W goods are perfect substitutes (linear case), no market power

Variables: Firm

- Y_t: Aggregate output (by retailers) at time t
- Y_{jt}: Output by intermediate firm j at time t, $\forall j \in [0, 1]$
- p_t: Aggregate price level at time t
- p_{jt}: Price for intermediate good j at time t
- μ_{jt}: Marginal cost for intermediate good j at time t
- s_t: Monetary policy shock
- ψ: Parameter for elasticity of substitution between wholesale goods
- θ: Parameter for price stickiness (higher when $\theta \approx 1$)
- ϕ_Y, ϕ_π: Sensitivities of interest rate to output and inflation in Taylor rule
- ϕ_r: Interest rate persistence or smooting parameter in Taylor rule

Traditional NK Model

- Dynamic IS curve:

$$\tilde{X}_t = \mathbb{E}_t \tilde{X}_{t+1} - \frac{1}{\gamma}(\tilde{i} - \mathbb{E}_t \tilde{\pi}_{t+1}) + \left[\frac{1+\varphi}{\gamma+\varphi}\right] \mathbb{E}_t \Delta \tilde{A}_{t+1}$$

- NKPC:

$$\tilde{\pi}_t = \beta \mathbb{E}_t \tilde{\pi}_{t+1} + \left[\frac{(\gamma+\varphi)(1-\theta)(1-\beta\theta)}{\theta}\right] \tilde{X}_t + \tilde{u}_t$$

- Taylor rule:

$$\tilde{i}_t = \bar{i} + \phi_\pi \tilde{\pi}_t + \phi_Y \tilde{X}_t + \tilde{s}_t$$

Dynamic IS (DIS) Curve

$$\tilde{X}_t = \mathbb{E}_t \tilde{X}_{t+1} - \frac{1}{\gamma}(\tilde{i} - \mathbb{E}_t \tilde{\pi}_{t+1}) + \lambda \mathbb{E}_t \Delta \tilde{A}_{t+1}$$

- AD equation:
  - Negative relationship between real interest rate and real activity
- DIS determines output gap given a path for real interest rate
- NK mechanism:
  - If monetary policy influences real rate, it can affect AD

NK Phillips Curve (NKPC)

$$\tilde{\pi}_t = \beta \mathbb{E}_t \tilde{\pi}_{t+1} + \kappa \tilde{X}_t + \tilde{u}_t$$

- AS equation:
  - Positive relationship between inflation dynamics and real activity
  - Inflation increases when output is larger than its natural level
  - Key role for inflation expectations
- NKPC determines inflation given a path for output gap
- Optimally derived from firms with market power and sticky prices
  - Price stickiness governs slope of NKPC (Dynare)
  - When $\theta \to 0$ (flexible prices), $\kappa \to \infty$ (monetary policy is neutral)

Taylor Rule

$$\tilde{i}_t = \bar{i} + \phi_\pi \tilde{\pi}_t + \phi_Y \tilde{X}_t + \tilde{s}_t$$

- It closes model and determines its behavior
- How monetary policy reacts to deviations in inflation and output gap
- A role for central banks
  - A contractionary shock lowers both inflation and output gap
- Single mandate central bank: $\phi_Y = 0$
  - Blanchard-Kahn condition (Dynare): $\kappa(\phi_Y - 1) > 0 \implies \phi_Y > 1$
  - Taylor principle: CB must react to inflation more than proportionally

(Positive) Shocks

- Technology shock:
  - Persistent decline in output gap (output increases less than natural level)
  - More productive firms, so real marginal cost and inflation fall
  - Central bank partly accommodates shock by lowering rates
  - Economy moves along DIS curve (AS curve shifts): output and inflation
- Cost push shock:
  - Inflation goes up, CB responds, real activity contracts
  - Fall in output gap due to output (natural level unaffected by nominal)
- Monetary policy shock:
  - Inflation (expectations) and output (gap) decline, real rate rises
  - Larger effect on output as degree of price stickiness increases (Dynare)