Chapter 18: Nominal Frictions and Business Cycles

Graduate Macroeconomics Slides

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Outline

Motivation and Context

Key Historical Insight:

- The Great Depression (1930s): A pivotal event for macroeconomics.
- Mass unemployment spurred questions on market failure and policy responses.
- Keynesian economics emerged, focusing on:
  1. Possible underutilization of factors of production.
  2. The influence of nominal demand on real output.
- Nominal values may be irrelevant in the long run, but have short-run real effects if prices do not adjust instantly (Hume, 1752).

Chapter Overview

- **Objective:** Examine why imperfect price adjustment allows nominal demand factors to affect real outcomes.
- **Evidence:** Prices adjust infrequently; changes in nominal variables (like interest rates) impact real outcomes.
- **Model:** The modern "New Keynesian" framework.
- **Policy Insights:**
  - Why equilibrium may differ from efficient production.
  - How policy interventions can improve outcomes.

Micro-Level Evidence on Price Rigidity

Focus on nominal rigidities in individual prices:

- Classic studies in the U.S. ((Bils and Klenow, 2004); (Klenow and Kryvtsov, 2008); (Nakamura and Steinsson, 2008)).
- Use micro data underlying the Consumer Price Index (CPI).
- Wide range of price stickiness across goods:
  - Energy and food items: Frequent changes.
  - Magazines: Infrequent changes.

Micro-Level Evidence on Price Rigidity

Price Change Frequency:

- Mean duration: about 6.2 months; Median duration: about 3.4 months (U.S. data).
- Temporary discounts (sales) complicate measurement.
  - Sales frequency vs. true price flexibility.
- Excluding sales: median duration may rise to around 6.9 months or higher.
- Replacement of products (quality changes) also complicates price rigidity estimates.

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Implication: Across goods and countries, price rigidity is substantial. European economies often display even longer durations.

Sector-Specific vs. Aggregate Shocks

- Large price changes at the micro level (median absolute price change $\approx 11.5\%$).
- Suggests individual/sectoral factors dominate.
- **Possibility:** Quick/strong response to micro-level shocks, but *slower or partial* response to aggregate shocks (e.g., monetary policy).
- (Eichenbaum et al., 2011) find quick price response to cost shocks in a large retailer dataset.
- (Boivin et al., 2009) show sector-specific developments typically drive price changes; sluggish response to aggregate conditions.

Core Elements of the New Keynesian Model

Early Keynesian: Based on empirical relationships without strong microfoundations.
New Keynesian:

- **Microfoundations:** Decision-making from utility/profit maximization.
- **Monopolistic competition:** Firms have some pricing power.
- (Calvo, 1983) **price setting:** Prices updated randomly with probability $1 - \theta$ each period.
- **Short-run demand determination:** Because some firms cannot change prices, they fulfill demand at preset prices.

Environment: Households

Household Preferences:

$$U_0 = E_0 \sum_{t=0}^{\infty} \beta^t \left(\frac{C_t^{1-\sigma}}{1-\sigma} - \frac{L_t^{1+\psi}}{1+\psi} \right).$$

- C_t: Consumption; L_t: Labor supply.
- $\beta \in (0,1)$ is the discount factor, $\sigma > 0$, $\psi > 0$.
- Households save via nominal bonds paying interest i_t.

Key Optimality Conditions:

- **Euler Equation:**

$$C_t^{-\sigma} = \beta E_t \left[\frac{1+i_t}{1+\pi_{t+1}} C_{t+1}^{-\sigma} \right].$$

- **Intra-temporal Condition:**

$$C_t^{-\sigma} w_t = L_t^{\psi}.$$

Environment: Final and Intermediate Goods

Final Good Production:

$$Y_t = \left(\int_0^1 y_{j,t}^{\frac{\epsilon-1}{\epsilon}} \, dj \right)^{\frac{\epsilon}{\epsilon-1}}, \quad \text{with } \epsilon > 1.$$

- Intermediate inputs indexed by $j \in [0, 1]$.
- Price index:

$$P_t = \left(\int_0^1 P_{j,t}^{1-\epsilon} \, dj \right)^{\frac{1}{1-\epsilon}}.$$

- Final goods firm is competitive; sells output at price P_t.

Intermediate Goods:

$$y_{j,t} = A_t l_{j,t}, \quad \text{marginal cost } = \frac{w_t}{A_t}.$$

Nominal Rigidities and Calvo Pricing

Key Assumption: Monopolistic competition and sticky prices.

- Firm j resets price with probability $1-\theta$ each period.
- If no reset, price stays unchanged.
- **Demand:**

$$y_{j,t} = \left(\frac{P_{j,t}}{P_t}\right)^{-\epsilon} Y_t.$$

Firm's Problem:

$$\max_{P_{j,t}} E_0 \sum_{t=0}^{\infty} \beta^t \theta^t \left[u_r(C_t)\Pi_{j,t}\right],$$

subject to:

$$\Pi_{j,t} = \left(\frac{P_{j,t}}{P_t} - \frac{w_t}{A_t}\right)\left(\frac{P_{j,t}}{P_t}\right)^{-\epsilon} Y_t.$$

Key Aggregation Results

- **Price Level:**

$$P_t^{1-\epsilon} = \theta\, P_{t-1}^{1-\epsilon} \;+\; (1-\theta)\, P_t^{R\,1-\epsilon},$$

  where P_t^R is the *reset price*.

- **Price Dispersion:**

$$D_t = \int_0^1 \left(\frac{P_{j,t}}{P_t}\right)^{-\epsilon} dj \;\; \text{causes inefficiency if } D_t > 1.$$

- **Goods Market Clearing:**

$$Y_t = C_t.$$

Flexible-Price Benchmark

Case: $\theta = 0$ (fully flexible).

- Firms reset prices each period, choosing a constant markup $\mu = \frac{\epsilon}{\epsilon - 1}$.
- Real wage $w_t / A_t = 1/\mu$.
- **Natural Output:**

$$Y_t^n = \frac{A_t}{\mu} \quad \text{(if labor supply elasticity is unitary, for example).}$$

- **Output Gap:**

$$x_t = \ln Y_t - \ln Y_t^n.$$

Interest Rate Rules (Taylor Rules)

- Monetary policy sets i_t: Nominal rate.
- A simple interest rate rule (Taylor-type):

$$i_t = \bar{i} + \phi_\pi(\pi_t - \pi^*) + \phi_x x_t.$$

- $\phi_\pi > 1$ often crucial for determinacy (Taylor Principle).
- **Monetary Policy Shock:** An unanticipated deviation from systematic behavior.

New Keynesian Phillips Curve (NKPC)

Linearization yields the "three-equation" system:

1. **IS Curve:**
$$x_t = E_t[x_{t+1}] - \frac{1}{\sigma}\left(\hat{i}_t - E_t[\pi_{t+1}] - r_t^n\right).$$
2. **NKPC:**
$$\pi_t = \beta\, E_t[\pi_{t+1}] + \kappa\, x_t.$$
3. **Interest Rate Rule:**
$$\hat{i}_t = \phi_\pi(\pi_t - \pi^*) + \phi_x\, x_t + \text{shock}.$$

Key Parameter: $\kappa = (1-\theta)(1-\beta\theta)\frac{(1+\psi)}{\theta}$ (assuming certain forms of labor supply).

Determinacy & Taylor Principle

- Multiple equilibria can arise if monetary policy does not react *strongly* to inflation.
- **Taylor Principle:** $\phi_\pi > 1$ ensures uniqueness of equilibrium.
- Failure to satisfy it can lead to *self-fulfilling* inflation expectations.

Why Do Nominal Shocks Matter?

Classical dichotomy: In frictionless models, money/nominal variables don't affect real outcomes.

With Nominal Stickiness:

- An increase in nominal demand (e.g., an expansionary monetary policy) lowers real interest rates (if inflation doesn't immediately adjust), stimulating aggregate demand.
- Firms with preset prices see higher demand, ramp up production.
- Over time, prices gradually adjust, but there is a transitory real effect.

Policy Objectives in the New Keynesian Model

Two inefficiencies:

1. Level of production can deviate from optimum (markups μ).
2. Misallocation due to price dispersion D_t.

Policy Targets:

- Stabilize inflation around a target π^* (minimize $D_t - 1$).
- Stabilize output around its *natural* level Y_t^n (or possibly an *efficient* level Y_t^* if other distortions exist).

The Divine Coincidence

- *Baseline NK model:* No trade-off between stabilizing inflation and the output gap.
- Always feasible to set $x_t = 0$ and $\pi_t = 0$ (in theory).
- **Interpretation:** Model is too simple.
- In practice, cost-push shocks, wage stickiness, or other real rigidities create policy trade-offs.

Inflation vs. Price-Level Targeting

Inflation Targeting:

$$\min_{policy} \sum_{t=0}^{\infty} \beta^t \left[(\pi_t - \pi^*)^2 + \lambda (x_t)^2 \right].$$

Flexible inflation targeting: balance between inflation and output gap stabilization.
Price-Level Targeting:

$$i_t = \bar{i} + \phi_P (P_t - P_t^*).$$

- Implies *history dependence*: if the price level overshoots, future policy offsets it.
- Can help anchor expectations more firmly.

Commitment vs. Discretion

- **Forward-Looking Model:** Expected future policy affects today's outcomes.
- **Commitment (Time-Consistency)**:
    - Central bank promises a future path of policy, even if not optimal later.
    - Often leads to lower inflation with smaller output gaps now.
- **Discretion:**
    - Re-optimize each period.
    - Worse short-run trade-off because future policy is not credibly locked in.

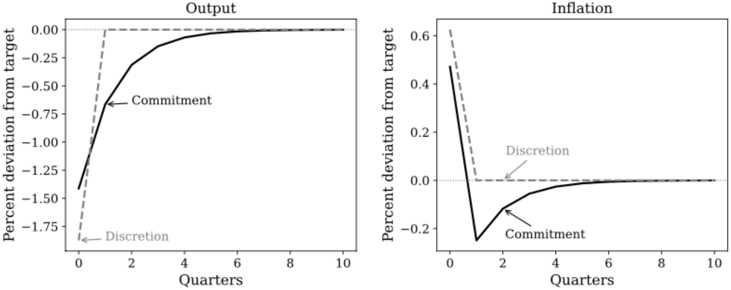

Figure 18.1: Response of output and inflation to a transitory cost push shock under commitment and discretionary policies.

Notes: These paths are simulated using the parameters $\beta = 0.99$, $\kappa = 0.2$, $\varepsilon = 3$.

Monetary Policy Shocks: Empirical Evidence

- Many studies use exogenous (unexpected) changes in the policy rate to identify the causal effect of monetary policy.
- (Romer and Romer, 2004) approach: Regress interest rate changes on Fed forecasts to isolate policy surprises.
- Typical findings of a **contractionary shock**:
  1. Output falls (persistently).
  2. Inflation eventually falls.
  3. Real interest rate rises (by more than the nominal rate initially).

Monetary Policy Shocks: Empirical Evidence

Consistency with NK Model: Nominal shocks do affect real variables.

- However, the **speed and persistence** in the data often differ:
  - Empirical evidence: Output and inflation respond with a *delay* and show *hump-shaped* dynamics.
  - Baseline NK model: Tends to produce immediate jumps; less persistence.

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Extensions Needed: Habit formation, investment frictions, wage stickiness, etc.

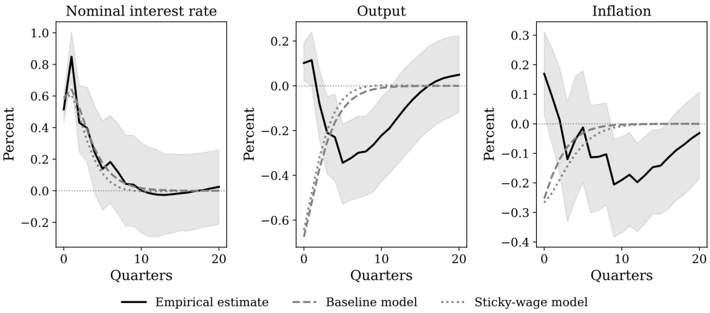

Figure 18.2: Empirical and simulated responses to a monetary policy shock.

Estimating the New Keynesian Phillips Curve

- Direct estimation of
$$\pi_t = \beta E_t[\pi_{t+1}] + \kappa x_t + \text{shock}$$
- (Galí and Gertler, 1999):
  - Use labor share as proxy for marginal cost.
  - Found evidence of sticky prices but estimates vary over sample periods.
- Potential issues: measurement error, time-varying parameter instability, low-frequency shifts.

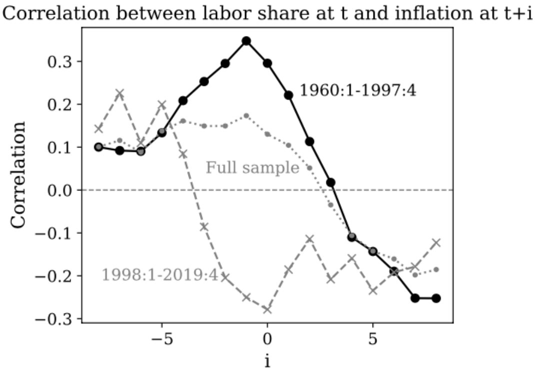

Figure 18.3: Dynamic Correlations

Notes: The figure shows the dynamic correlation function between the labor share and lags and leads of the inflation rate. The data have been HP-filtered.

Sticky Wages

- Traditional Keynesian emphasis on wage rigidities.
- Evidence: Many wages change infrequently (annual wage contracts).
- Overlapping contracts (Taylor) or Calvo wage setting.
- Can cause involuntary unemployment (labor demand too low at preset nominal wages).

Sticky-Price and Sticky-Wage Model

- Combines both frictions.
- Two Phillips curves:
    1. Price Phillips curve: π_t depends on real wage w_t.
    2. Wage Phillips curve: π_t^w depends on output gap and w_t.
- Interaction can generate more inflation *persistence* and slower adjustment of real wages.

Other Model Augmentations

- **Consumption habits:** Smooth consumption responses, more persistence.
- **Capital & investment adjustment costs:** Reduce excessive investment volatility.
- **Variable capacity utilization:** Allows smoother marginal cost dynamics.
- **Heterogeneity:** Borrowers *vs.* savers; precautionary savings; distributional impacts.

Concluding Remarks

- Nominal rigidities are empirically crucial: Price and wage stickiness prolong and magnify real effects of nominal shocks.
- The New Keynesian framework provides microfoundations for Keynesian ideas:
  - Sticky prices/wages $\implies$ demand matters in the short run.
  - Monetary policy can stabilize (or destabilize) output and inflation.
- Ongoing research refines these models to match empirical persistence and microdata on heterogeneity.

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Thank you!

Questions or comments?

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