Econ 314

Monday, April 6

Quantitative Implications of Price Stickiness and Dynamic Price Setting

Reading: Romer's Sections 6.6 – 6.8 and 7.1

Coursebook: Chapter 12

Class notes: Pages 117 to 122

Today's Far Side offering

"You have to prime it, you know."

You may have noticed that the board outside my office tends to have a lot of dog comics, while Noel's has a lot of cat comics. I'm especially fond of comics in which dogs are asserting their obvious superiority to cats.

Context and overview

- In the last class (April 3), we applied the ideas of strategic complementarity, multiple equilibria, and coordination failure to price setting in the macroeconomy
- We concluded with the idea that the social costs of price stickiness to the overall economy could be larger than the private costs to firms
- **How much larger**? We start by calibrating the model and examining whether the social/private cost gap is important
- Then we begin the analysis of **dynamic price setting** by laying the foundation of a model in which the price set in each period is the baseline price for the next

Reviewing the optimal pricing equation

- Profit-maximization implies $\frac{P_i}{P} = \left(\frac{\eta}{\eta-1}\right)\left(\frac{W}{P}\right)$ or $\frac{P_i}{P} = \frac{\eta}{\eta-1} Y^{\gamma-1}$
- In log terms: $p_i^* - p = c + \phi y$, with $c \equiv \ln\left(\frac{\eta}{\eta-1}\right)$ and $\phi = \gamma - 1 > 0$
- Since $y = m - p$, can also write as $p_i^* = c + \phi m + (1-\phi)p$
- If there is **greater real rigidity** → smaller value of ϕ
- Optimal price is more sensitive to others' price and less sensitive to AD shocks

Calculating profit with fixed/flexible price

- We can derive the expression in the model for firm's profit as a function of its own price, its rivals' price, and aggregate demand:

$$\Pi\left(P_i, P; M\right) = \frac{M}{P}\left(\frac{P_i}{P}\right)^{1-\eta} - \left(\frac{M}{P}\right)^{\frac{1+\nu}{\nu}}\left(\frac{P_i}{P}\right)^{-\eta}, \quad \nu \equiv \frac{1}{\gamma - 1}$$

- This is the profit function that we used in the last class when we derived the thresholds for price adjustment when others do and do not adjust
- We can substitute in $P_i = P^*$ or P_0 and $P = P^*$ or P_0 to compute the thresholds as the difference between profit when adjusting price and profit when keeping price fixed

Calibrating profit thresholds

- Details of equations are on pages 117 and 118 of notes
- In Chapter 6, Romer calibrates
  - $\eta = 5$ (which is a markup ratio of 1.25, or 25%)
  - $\nu = 0.1$ (because labor supply is not very elastic)

- With this calibration, menu cost would have to be 25% of total revenue for firm to keep prices sticky when AD changes 3%
  - Not enough stickiness to matter
  - Social externality from stickiness is also small, so low social costs

Ball and Romer (1990) Table 1

TABLE 1

Baseline Model

Labour supply elasticity $(1/(\gamma-1))$	Private cost/R			
	Markup $(1/(\varepsilon-1))$			
	5%	15%	50%	100%
0·05	2·38/1·05	2·16/1·16	1·64/1·55	1·22/2·10
0·15	0·79/1·06	0·71/1·19	0·53/1·65	0·39/2·31
0·50	0·23/1·10	0·20/1·30	0·14/2·04	0·10/3·13
1·00	0·11/1·15	0·10/1·47	0·06/2·67	0·04/4·50

Note. Private cost is for a 5% change in money, and is measured as a percentage of revenue when prices are flexible.

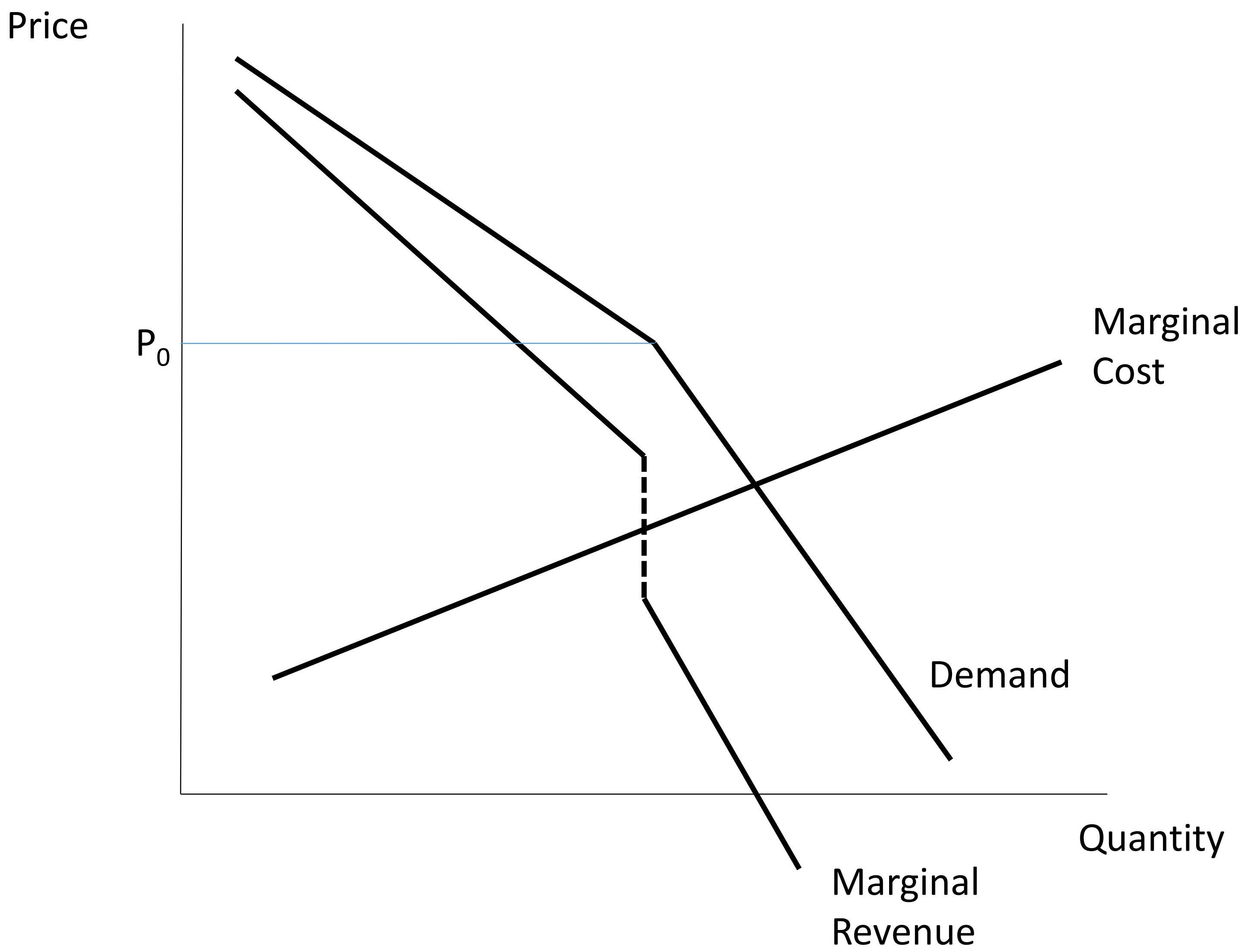
Alternative models

- Ball and Romer propose two alternative models that would increase rigidity and social externalities
  - Customer markets model
    - Leads to something like a kinked demand curve at current price
    - Rivals more likely to follow a price cut than a price increase
    - We'll look at this one in a little more detail
  - Real-wage function
    - Replacing market-clearing labor market with sluggish wage adjustment based on output gap
    - Equivalent to having higher labor supply elasticity

Customer markets

- Each customer has a current "home" market, will probably shop there unless induced to change
- Price information is imperfect: customer knows his home market, but not others (without search)
- Increase in price at home market may induce search for new home market: lowers quantity demanded
- Decrease in price does not affect home customers and few others see it: doesn't raise demand much
- Conclusion: Demand is elastic above current price, inelastic below

Kinked demand curve?



Ball and Romer's implementation

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Note. Private cost is for a 5% change in money, and is measured as a percentage of revenue when prices are flexible.

TABLE 2

Customer markets model

Private cost/R for various degrees of real rigidity

$1/(\eta-1)=0{\cdot}15,\ 1/(\gamma-1)=0{\cdot}15$		$1/(\eta-1)=0{\cdot}15,\ 1/(\gamma-1)=1{\cdot}00$	
π	PC/R	π	PC/R
0·127*	0·71/1·19	0·115*	0·10/1·47
0·050	0·28/3·04	0·050	0·04/3·37
0·025	0·14/6·09	0·025	0·02/6·75
0·010	0·06/15·2	0·010	0·01/16·9
0·005	0·03/30·4	0·005	0·00/33·7
0·002	0·01/76·1	0·002	0·00/84·3
0·001	0·01/152·1	0·001	0·00/168·6

$1/(\eta-1)=1{\cdot}00,\ 1/(\gamma-1)=0{\cdot}15$		$1/(\eta-1)=1{\cdot}00,\ 1/(\gamma-1)=1{\cdot}00$	
π	PC/R	π	PC/R
0·474*	0·39/2·31	0·333*	0·04/4·50
0·200	0·17/5·37	0·200	0·03/7·50
0·050	0·04/21·5	0·050	0·01/30·0
0·025	0·02/43·0	0·025	0·00/60·0
0·010	0·01/107·5	0·010	0·00/150·0
0·005	0·00/214·9	0·005	0·00/300·0
0·002	0·00/537·3	0·002	0·00/750·0

* Real rigidity when $\rho=0$

Note. Private cost is for a 5% change in revenue, and is measured as a percentage of revenue when prices are flexible.

Dynamic price setting

- What is the dynamic-optimal price to set if that price is likely to be in effect for multiple periods instead of just one?
- Intuitive answer: "an average of the expected static-optimal price for each future period, weighted by the probability that the price is in effect for that period."
- Romer's model in Section 7.1
  - Mostly similar to our earlier model, but with discounting β and tradeoffs for intertemporal consumption λ
  - These aspects are less quantitatively important, so we'll focus on others to get intuition

Dynamic optimal pricing

- Static optimal price at *t*: $p_t{}^* = p_t + \phi(m_t - p_t) = \phi m_t + (1-\phi) p_t$
- How likely is price set at time 0 to be still in effect after *t* periods?
  - Let that probability be q_t
  - For fixed-price contract, $q_t = 1$ for life of contract, $q_t = 0$ after expiration
- Dynamic optimal price to set at 0 is weighted average of expected future optimal prices, with weights determined by *q*:

$$p = \sum_{t=0}^{\infty} q_t E_0\left(p_t^*\right) \times \frac{1}{\sum_{\tau=0}^{\infty} q_\tau}$$

- Last denominator makes sure that weights add up to one

Dynamic optimal pricing

- Let $\omega_t = \dfrac{q_t}{\sum_{\tau=0}^{\infty} q_\tau}$

- **Dynamic optimal price**, then, is

$$p = \sum_{t=0}^{\infty} \omega_t E_0\left(p_t^*\right) = \sum_{t=0}^{\infty} \omega_t E_0\left(\phi m_t + (1-\phi) p_t\right)$$

- Optimal price is weighted average of expected future AD and expected future prices set by overall market
  - More real rigidity → smaller ϕ and more weight to market price, less to AD

Some common models

- Fixed-price contracts of length n:

$$\omega_t = \frac{1}{n}$$

- Calvo's model with fixed probability α of changing price:

$$q_t = (1-\alpha)^t$$

$$\omega_t = \frac{(1-\alpha)^t}{\sum_{\tau=0}^{\infty}(1-\alpha)^\tau} = \frac{(1-\alpha)^t}{1/\left(1-(1-\alpha)\right)} = \alpha(1-\alpha)^t$$

Review and summary

- We began by considering the **empirical importance** of coordination failures due to real rigidities
  - **Not too important** in standard model
  - Much more important if we augment the model for **customer markets** or **wage adjustment** other than market clearing
- We considered how a firm in a dynamic environment would set prices taking into account that **prices might be in place more than one period**
  - Set price at **average optimal price** over the future
  - **Weight the average by the probability** that today's price will still be in place in each future period

Something different: A puzzle

Given that this is a quantitative class, a numerical puzzle seems appropriate:

What is the pattern in the following numerical sequence?

8, 5, 4, 9, 1, 7, 6, 10, 3, 2

[Using the Internet to find the solution is cheating!]

What's next?

- We next turn to several models of price fixity that apply the principle of dynamic price setting
  - Fischer's **predetermined-price** model (April 8)
  - Taylor's **fixed-price model** (April 10)
  - Calvo's **probabilistic model** of price setting (April 10)