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Fixed Price Dynamics versus Flexible Price Dynamics

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Abstract -- This paper contrasts the dynamical behaviors of fixed and flexible price regimes for a monopolistically competitive manufacturing sector in which firms base decisions on expectations about product demands.

Keywords: dynamics, fixed prices, flexible prices

JEL Classification: C62, D43, L13

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1. Introduction

This paper compares the dynamical behaviors of fixed and flexible price regimes for an economy with a monopolistically competitive manufacturing sector in which firms base decisions on expectations about product demands. In the fixed price regime, manufacturers adhere to prices set at the beginning of each period, with disequilibria being manifested in divergences between outputs and demands. In the flexible price regime, outputs are sold at market-clearing prices, with disequilibria being manifested in differences between manufacturers’ planned prices and the market-clearing-prices.

Our analysis is in the spirit of Jin (2001), who examines the stability of a monopolistically competitive industry, where boundedly rational manufacturers follow simple strategies based on limited information. In contrast to Jin, we assume a technology and consumer preferences based on the famous Dixit-Stiglitz (1977) model. Given the widespread use of the Dixit-Stiglitz model in economic analysis [see Brakman and Heijdra (2004)], the lack of analyses of its short-run dynamics is surprising [an exception being Maussner (1992)].

2. Assumptions

The economy comprises a monopolistically competitive manufacturing sector with $n$ firms producing different varieties, where $n$ is sufficiently large that firms do not behave strategically, and a perfectly competitive residual sector. The invariant total labor supply is $L_s$ and labor is instantaneously mobile between sectors. Production in the residual sector involves constant returns to scale. In contrast, manufacturing operates under increasing returns: each firm requires a fixed labor input of $\alpha$ and has a constant marginal labor
requirement of $\beta$. Consumers devote an invariant share $\gamma$ of income to manufactures, with $\sigma > 1$ being the elasticity of substitution between varieties.

At the beginning of each time period, the duration of which corresponds to that of labor contracts, the labor market clears simultaneously with a forward market for the product of the residual sector, ensuring zero profits in that sector in each period. However, there are no forward markets for manufactures: labor demands are based on anticipated product demands. Faced by wage $w_t$ at the outset of period $t$, each manufacturer demands the labor needed to meet the product demand it expects at a price implied by the pricing routine $p_t = \theta w_t$, where $\theta = \beta \sigma / (\sigma - 1)$ is the familiar Dixit-Stiglitz wage-price mark-up. For each price regime, we consider two possible anticipated demand curves for a variety based on information the manufacturer has about the demand $d_{t-1}$ at price $p_{t-1}$. The first is the non-linear anticipated demand curve:

$$d_t^a (p_t) = \left( \frac{p_{t-1}}{p_t} \right)^\sigma d_{t-1}$$

(1)

where, in using the perceived price elasticity $-\sigma$ to determine the expected impact of an own price change, each manufacturer assumes that the prices of other varieties will remain unchanged. The second is the linear curve tangent to (1) at $(p_{t-1}, d_{t-1})$:

$$d_t^a (p_t) = (\sigma + 1) d_{t-1} - \sigma d_{t-1} \frac{p_t}{p_{t-1}}$$

(2)

which is defined for $p_t \leq p_{t-1}(\sigma + 1)/\sigma$. Given the same prices for all varieties, the actual demand curve per variety is:
\[ d_i(p_t) = \frac{\gamma Y}{np_t} \]  

(3)

where \( Y \) is aggregate income.

### 3. Temporary Equilibria and General Equilibrium

**Temporary equilibrium with fixed prices**

For the fixed price regime, once labor contracts are signed, each manufacturer maintains a fixed price throughout the ensuing period. At the temporary equilibrium (TE) wage \( \hat{w}_t \), each manufacturer sets price \( \hat{p}_t = \theta \hat{w}_t \) and hires the labor needed to produce \( \hat{s}_t = d^s_t(\hat{p}_t) \), where \( d^s_t(\hat{p}_t) \) is derived by substituting in (1) or (2) the previous period’s fixed price \( \hat{p}_{t-1} \) and the corresponding quantity demanded \( \hat{a}_{t-1} \). The quantity sold of each variety is determined by the minimum of the supply and of the quantity demanded at \( \hat{p}_t \); i.e., by \( \min \{ \hat{s}_t, \hat{a}_t \} \), where \( \hat{a}_t = d_t(\hat{p}_t) \) from (3). If there is excess demand, consumers are rationed. If there is excess supply, the surplus is destroyed (or, if firms identify the excess supply after entering into binding labor contracts but before actually using the labor, they simply reduce production).

**Temporary equilibrium with flexible prices**

For the flexible price regime, each manufacturer, having based labor hiring on a planned price, sells its output at the market-clearing price. At the TE wage \( \tilde{w}_t \), each supplies the demand it expects at its planned price \( \tilde{p}_t^p = \theta \tilde{w}_t \). That is, \( \tilde{s}_t = d^s_t(\tilde{p}_t^p) \), where \( d^s_t(\tilde{p}_t^p) \) is derived from (1) or (2) by substituting the previous period’s market-clearing price \( \tilde{p}_{t-1} \) and
the corresponding demand $\hat{d}_{t-1}$. Market-clearing in period $t$ implies that the (inelastic)
supply of each variety is sold at price $\hat{p}_t = \frac{\gamma Y}{nS_t}$.

**General equilibrium**

A *general equilibrium* (GE) is a state of rest for the dynamical process concerned. For the
fixed price regime, a TE is a GE iff $\hat{d}_t = \hat{s}_t$; this requires $d_i(\hat{p}_t) = d_i^w(\hat{p}_t)$ where $\hat{p}_t = \theta \hat{w}_t$.

For the flexible price regime, a TE is a GE iff $\hat{p}_t = \hat{p}_t^\rho$ where $\hat{p}_t^\rho = \theta \hat{w}_t$; this requires
$d_i(\hat{p}_t) = d_i^w(\hat{p}_t^\rho)$. That is, for both regimes, GE requires that each manufacturer correctly
anticipates the quantity demanded at the price implied by the pricing routine. The GE wage,
necessarily the same for both regimes, is identified in Figure 1. The curve $S_M$ shows the
labor supply to the manufacturing sector after the derived labor demand of the residual
sector is met. The curve $\hat{M}$ shows what the manufacturing sector’s labor demand would be
at each wage, if manufacturers were to have *correct* product demand expectations at the
price implied by applying the pricing routine to that wage. Derived from (3), $\hat{M}$ is also
what the sector’s derived labor demand curve would have been if there had been a forward
market for manufactures, synchronized with the labor market. The intersection of $\hat{M}$ and $S_M$
determines the GE wage $\hat{w}$, the corresponding price being $\hat{p} = \theta \hat{w}$. In the GE, the
anticipated demand curve would be $\hat{m}'$ for (1) and $\hat{m}''$ for (2).

**4. Dynamics Compared**

The dynamical behaviors of the two regimes are dramatically different. Figure 2 shows this
difference for the non-linear anticipated demand curve (1), assuming, for the purpose of the
argument, that for both regimes $\hat{w}_{t-1} = \hat{w}_{t-1} > \hat{w}$, so that $\hat{L}_{M,t-1} = \hat{L}_{M,t-1} > \hat{L}_M$. 
Fixed price regime

In Figure 2, manufacture’s labor demand curve in period $t$ is $\hat{m}_t$. Based on information on product demand $\hat{d}_{t-1}$ at the previous period’s fixed price $\hat{p}_{t-1} = \theta \hat{w}_{t-1}$, $\hat{m}_t$ must intersect $\bar{M}$ at $w_t = \hat{w}_{t-1}$; at that wage, manufacturers would set the same price as in period $t-1$ and their demand expectations would be correct. Therefore, there would be excess labor supply at $w_t = \hat{w}_{t-1}$. However, at $w_t = \bar{w}$, there would be excess labor demand since, for a fall in the wage from $\hat{w}_{t-1}$ to $\bar{w}$, manufacturers, who do not anticipate that others would also change their prices, would overestimate the impact of the corresponding price fall on demand and would demand too much labor at $\bar{w}$. Consequently, $\hat{w}_t$ must lie between $\hat{w}_{t-1}$ and $\bar{w}$. It follows that the sequence of TEs necessarily converges monotonically on the GE. This proposition carries over to the linear anticipated demand curve (1). It can be shown, for both (1) and (2), that:

$$0 < \frac{d\hat{w}_{t+1}}{d\hat{w}_t} (\hat{w}_t = \bar{w}) = \frac{\gamma \sigma^2 - 2 \gamma \sigma + \gamma}{\gamma \sigma^2 - 2 \gamma \sigma + \sigma} < 1$$

(4)

Flexible price regime

In Figure 2, manufacture’s labor demand curve in period $t$ is $\hat{m}_t$. Based on information on product demand $\tilde{d}_{t-1}$ at the previous period’s market-clearing price $\tilde{p}_{t-1}$, $\hat{m}_t$ must intersect $\bar{M}$ at $\tilde{L}_{M,t-1}$. Since $\tilde{L}_{M,t-1} > \bar{L}_M$, the market-clearing price in $t-1$ was necessarily below the GE price: $\tilde{p}_{t-1} < \bar{p}$. At a current wage $w_t = \bar{w}$, there would necessarily be excess labor supply: manufacturers, who do not anticipate that others would change their prices, would overestimate the reduction in demand resulting from a price increase from $\tilde{p}_{t-1}$ to $\bar{p} = \theta \bar{w}$.
and would demand too little labor at $\bar{w}$. Consequently, the TE wage necessarily overshoots the GE wage, i.e., $\bar{w}_{t-1} > \bar{w}$ implies $\bar{w}_t < \bar{w}$. For the linear anticipated demand curve (2), the TE wage always moves in the direction of the GE wage but it need not overshoot it.

It can be shown that for both ADCs:

$$\frac{\partial \bar{w}_{t+1}}{\partial \bar{w}_t} (\bar{w}_t = \bar{w}) = \frac{(\sigma - 1)(\gamma - 1)}{\gamma(\sigma - 1) + (1 - \gamma)} < 0$$

(5)

The stability condition, $(2\gamma - 1)\sigma > 3\gamma - 2$, is always satisfied for $\gamma \geq 0.5$. However, for $\gamma < 0.5$, a period-doubling bifurcation occurs as $\sigma$ increases through:

$$\sigma_B = 1 + \frac{1 - \gamma}{1 - 2\gamma}$$

(6)

For (1), since the map $\bar{w}_t = f(\bar{w}_{t-1})$ is always monotonically declining, the system is always attracted to a period-two cycle for $\sigma > \sigma_B$. In contrast, the dynamics of (2) exhibits complex behavior for $\sigma > \sigma_B$. Figure 3 shows the map $\bar{w}_t = g(\bar{w}_{t-1})$ for $\gamma = 0.25$, $Y = 10000$, $L_s = 10000$, $n = 600$, $\alpha = \beta = 1$, and $\sigma = 4.58$. The map is only defined for a wage above $\bar{w} = (1 - \gamma)Y/(L_s - \alpha n)$; for a lower wage, there would be no labor available for production by the manufacturing sector after its own fixed labor requirements $\alpha n$ and the derived demand of the residual sector have been met. The attracting period-three cycle is the hallmark of a chaotic dynamical system.

5. A Final Comment

We have compared the dynamical implications of alternative manufacturers’ routines, assuming an invariant number of firms. With free entry and exit of manufacturers,
a long-run general equilibrium would require a zero rate of profit. With entry and exit dependent on the anticipated rate of profit, complex dynamical behavior could arise even with a forward market for manufactures, synchronized with the labor market.

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**Legends**

Figure 1: Labor market in general equilibrium.

Figure 2: Comparison of fixed price and flexible price dynamics with labor demands based on non-linear anticipated product demand curves.

Figure 3: Period-three cycle for the flexible price regime with labor demands based on linear anticipated product demand curves.
Figure 1
Figure 2
Figure 3
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