A Note on Industry Dynamics and Countercyclical Markups

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In order to explain countercyclical markups, a simple two-period model of industry dynamics is constructed where output is produced potentially by two firms which are subject to idiosyncratic productivity shocks as well as aggregate productivity shocks. During booms, both firms with low and high productivity stay in the market and engage in a Bertrand-type competition to yield marginal-cost pricing, implying zero markups. During recessions, however, firm with low productivity shock decides to exit, allowing the high-productivity firm to enjoy positive markups as a monopolist in the output market.

Campbell(1988) documented that, in the U.S., (employment weighted) plant exit in the manufacturing sector is countercyclical. Also, Solon *et al*.(1994) and Murphy *et al*.(1989) claimed that real factor prices — wages and raw-material prices — are procyclical and more competitive behavior of firms during economic booms causes markups to fall. As a first step toward building a framework that can account for these facts altogether, this note constructs a simple model of industry dynamics over the business cycles which can account for countercyclical markups.

Specifically, we examine a two-period model with a single output produced potentially by two firms which are subject to idiosyncratic productivity shocks as well as aggregate productivity shocks (booms or recessions). We show that, during booms, both firms with low and high productivity stay in the market and engage in a Bertrand-type competition to yield marginal-cost pricing. This implies zero markups in equilibrium. During recessions, however, a firm with low productivity shock decides to exit, leaving the market to be dominated by the high-productivity firm. The single firm acts as a monopolist in the market for output and a monopsonist in the markets for input factors. This yields positive markups in the output market whose magnitude depends on the price elasticity of output demand and the factor price elasticities of demand for inputs (i.e., labor and capital).

Alternative explanations for the countercyclical markups are as follows. First, Bils(1989), Klemperer(1995), Okun(1981), and Stiglitz(1984) claimed that lower elasticities of demand during recessions lead imperfectly competitive firms to increase markups. Second, Rotemberg and Saloner(1986) and Rotemberg and Woodford(1991, 1992) attributed the countercyclical markups to the inability of firms to collude during booms. Finally, capital market imperfections are the main reason for the countercyclical markups according to Greenwald *et al.*(1984), Gottfries(1991), Klemperer(1995), and Chevalier and Scharfstein(1996). During recessions when firms have difficulty with external financing, they may try to increase profits by charging higher prices on their output at the expense of losing market share.

1. Environment

The model economy consists of consumers and firms, both of which exist for two periods.

1.1. Preferences

An agent born at period t consumes c_{1t} in period t (when young) and c_{2t+1} in period $t + 1$ (when old), and maximizes lifetime expected utility given by:

$$(1.1) \qquad\qquad u(c_{1t}) + \beta E_t u(c_{2t+1})$$

where the utility function $u(.)$ is strictly increasing and strictly concave, and $\beta \in (0, 1)$ is the discount factor.

Consumers work only in the first period of life, supplying inelastically one unit of labor to the firms. They consume part of their first-period income and save the rest for their second-period consumption.

The young in period t saves by investing in physical capital that is used to produce output in period $t + 1$ together with the labor supplied by the young generation of period $t + 1$.

1.2. Technology

There are two firms started in each period and they differ in the realization of the idiosyncratic productivity shocks $a_{it} \in \{a_l, a_h\}$ $(i = 1, 2)$, which are assumed to be independently and identically distributed (i.i.d.) over time. We assume that $0 \le a_l < a_h$.

Firm i produces output Y_{it} in period t using the constant-returns-to-scale technology given by:

(1.2)
$$Y_{it} = z_t a_{it} F(K_i, N_i)$$

where $F(.)$ is the production function net of capital depreciation, and $z_t \in \{z_g, z_b\}$ represents aggregate productivity shock where $z_g > z_b \geq 0$. Output per worker, $y_i \equiv Y_i / N_i$, is then given by the following production function:

$$y_{it} = z_t a_{it} f(k_{it})$$

where k_i is the capital-labor ratio.

1.3. Market

There are markets for capital services, output good, and one-period consumption loans. Each firm acts competitively or monopolistically in period t, depending on the market structure emerging from a possible exit of a firm after the realization of the aggregate shock z_t as well as the firm-specific productivity shock a_{it}. If there is no exit, then the two firms engage in the Bertrand-type competition: each firm maximizes profits, taking the wage rate and the rental rate on capital as given. If a firm exits following the productivity shocks, then the other firm will act as a monopolist in the both product and factor markets.

2. Equilibrium

We now examine the optimization problems of consumers and firms to characterize the market equilibrium.

2.1. Consumers

An individual consumer born at period t chooses consumption $\{c_{1t}, c_{2t+1}\}$ and saving s_t to maximize lifetime utility (1.1) subject to

(2.1)
$$c_{1t} + s_t = w_t,$$
$$c_{2t+1} = (1 + r_{t+1}) s_t$$

where w_t is the wage received in period t (when young) and r_{t+1} is the interest rate paid on saving held from period t to $t+1$.

The first-order condition is

(2.2) $$u'(c_{1t}) = \beta E_t \left[u'(c_{2t+1})(1 + r_{t+1}) \right]$$

Substituting for c_{1t} and c_{2t+1} (from the budget constraints) implies the saving function:

$$s_t = s\,(w_t, r_{t+1})$$

With a separable and concave utility function, saving is an increasing function of wage income w_t. In general, the effect of an increase in the interest rate depends on its substitution and income effects. Assuming that the substitution effect dominates, an increase in interest rates leads to an increase in saving.

2.2. Firms

Following the realizations of both aggregate and idiosyncratic shocks at the beginning of period t, each firm makes an exit decision. Given the aggregate productivity shock z_t, firm i with a_{it} will decide to exit if it is to experience a negative profit by staying in the market:

$$\Pi_i \equiv \max_{K_{it}, N_{it}} \left[z_t a_{it} F\,(K_{it}, N_{it}) - r_t K_{it} - w_t N_{it} - C \right] < 0$$

where $C > 0$ is the fixed cost associated with production activity.

For simplicity, we assume that the two realizations of the idiosyncratic productivity shocks, $\{a_l, a_h\}$ where $a_h > a_l$ are such that if $z_t = z_g$, then $\Pi_i \geq 0$ for $i = l, h$; while if $z_t = z_b$, then $\Pi_i \geq 0$ for $i = h$. That is, the low idiosyncratic productivity shock (a_l) during the "recession" (z_b) is sufficiently bad that a firm experiencing a_l decides to exit; whereas during the "boom" (z_g) both firms find it in their interests to stay in the market.

2.2.1. Economic boom

In the boom, both firms act competitively taking the output price and input factor prices — wage and rental rate — as given. That is, they hire labor to the point where the marginal product of labor is equal to the real wage, and rent capital from consumers to the point where the marginal product of capital is equal to its rental rate:

(2.3)
$$z_t a_{it} \left[f(k_t) - k_t f'(k_t) \right] = w_t,$$
$$z_t a_{it} f'(k_t) = r_t$$

In order to have a markup interpretation, these can be expressed as:

(2.4)
$$\frac{w_t}{z_t a_{it}[f(k_t) - k_t f'(k_t)]} = \frac{r_t}{z_t a_{it} f'(k_t)} = 1$$

This equates marginal cost of single output with its price, which is normalized to unity. This essentially implies marginal-cost pricing due to the Bertrand competition, and hence zero markup.

2.2.2. Economic recession

In the recession, however, a firm with the high productivity shock acts as a monopolist in the product market and as a monopsonist in the factor markets, following the exit of the other firm experiencing the low productivity shock. Now, the market is dominated by a single firm that sells a single output. Such a monopolistic firm does no longer take the output price, wage, and rental rate as given. Instead, it chooses the price for its own output, while the capital rental rate depends on the demand for capital by the monopolist and the wage on its demand for labor.

Let $r(K_t)$ and $w(N_t)$ denote respectively the capital rental rate as a function of the single firm's demand for capital and the wage as a function of its demand for labor. The firm now solves the following:

$$\max_{K_t, N_t} [p_t z_b a_h F(K_t, N_t) - r(K_t)K_t - w(N_t)N_t - C]$$

where p_t is the output price charged by the monopolist. Let k_t^* and N_t^* denote the solutions to this problem. Then, they satisfy the following first-order conditions:

(2.5)
$$\left[1 + \frac{1}{\eta(y_t^*)} \right] z_b a_h \left[f(k_t^*) - k_t^* f'(k_t^*) \right] = w(N_t^*) + w'(N_t^*)N_t^*,$$

$$\left[1 + \frac{1}{\eta(y_t^*)} \right] z_b a_h f'(k_t^*) = r(k_t^*) + r'(k_t^*)k_t^*$$

where $\eta(y_t^*)$ denotes the price elasticity of output demand, which is always negative since the demand for output decreases in the price.

Further, using the price elasticities of demand for labor and capital, these can be rewritten as:

(2.6)

$$\left[1+\frac{1}{\eta(y_t^*)}\right]z_b a_h\left[f(k_t^*)-k_t^*f'(k_t^*)\right]=w(N_t^*)\left[1+\frac{1}{\varepsilon(N_t^*)}\right]$$

$$\left[1+\frac{1}{\eta(y_t^*)}\right]z_b a_h f'(k_t^*)=r(k_t^*)\left[1+\frac{1}{\varepsilon(k_t^*)}\right]$$

where $\varepsilon(N_t^*)$ and $\varepsilon(k_t^*)$ denote respectively the wage and rental-rate elasticities of demand for labor and capital, which are always negative numbers since the demand for labor and capital decreases respectively in the wage and rental rate.

Note that in period t the monopolist's marginal cost of production (using the single good as numeraire) is

$$\frac{w(N_t^*)}{z_b a_h\left[f(k_t^*)-k_t^*f'(k_t^*)\right]}$$

Comparing this with (2.6), therefore, we observe that the firm's markup (ratio of price to marginal cost) will equal

(2.7)

$$\gamma\equiv\left[1+\frac{1}{\eta(y_t^*)}\right]^{-1}\left[1+\frac{1}{\varepsilon(N_t^*)}\right]$$

That is, the level of the markup depends on the price elasticity of output demand and the factor-price elasticities of labor demand. Notice that the markup becomes positive ($\gamma>1$) as long as the output demand is sufficiently inelastic relative to the labor demand so that $|\eta(y_t^*)|<|\varepsilon(N_t^*)|$.

2.3. Market equilibrium

The goods market equilibrium requires that the demand for goods in each period be equal to the supply, or equivalently that investment be equal to saving (which is also the market-clearing condition for the one-period consumption loan market):

(2.8)

$$k_{t+1}=s\,(w_t,r_{t+1})$$

Finally, the factor market equilibrium conditions are given by equations (2.3) in an economic boom period, whereas in a recession period they are given by equations (2.5).

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