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MONOPOLISTIC COMPETITION IN LABOR MARKETS AND MACROECONOMIC THEORY*

by

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ABSTRACT

This paper investigates macroeconomic implications of monopolistic competition in labor markets. Predetermined wage contracts with cost-of-living adjustment are assumed. Although full indexation always insulates a perfectly competitive economy from nominal shocks, it does not insulate a monopolistically competitive economy. In monopolistically competitive labor markets, complete insulation is achieved under less than full indexation. Price uncertainty affects nominal wages and thus output. Under full indexation, price uncertainty reduces the unconditional mean of output, while under no indexation price uncertainty is likely to increase the unconditional mean of output.

1. INTRODUCTION

In the past several years, considerable attention has been focused on monopolistically competitive macroeconomic models. Hart (1982), Blanchard and Kiyotaki (1987) and others investigate in a monopolistically competitive framework such macroeconomic problems as underemployment, multipliers, and optimal policy rules. They find that the monopolistically competitive macroeconomic models are characterized by "macroeconomic demand externality." This macroeconomic externality is sufficient to cause underemployment and "Keynesian-type multiplier effects" in such models.

Monopolistic competition under imperfect information is investigated in product markets by Andersen (1985) and Nishimura (1986, 1988a, 1988b). It is shown that product market monopolistic competition contributes to the rigidity of prices to demand shocks. Under imperfect information, increased competition among firms makes prices more rigid to demand shocks.

The purpose of this paper is to investigate labor market monopolistic competition under imperfect information. Following the literature of labor contracts and indexation (see Fischer (1977) and Gray (1976)), I assume labor contracts with predetermined wages and cost-of-living adjustment. This "long-run" nature of wage contracts is often observed in many industrialized economies and rationalized by the existence of substantial negotiation costs.

A macroeconomic model with differentiated products and differentiated labor is presented in Section 2 (a choice-theoretic microfoundation of the model is given in APPENDIX). In order to concentrate our attention on labor markets, I assume product markets are perfectly competitive under perfect information. Labor markets are under imperfect information because of the nature of the assumed labor contracts. I consider both of perfectly competitive labor markets and monopolistically competitive labor markets in this setting in order to distinguish the effect of monopolistic competition.

In Section 3 the effect of labor market monopolistic competition is investigated under fully indexed contracts. It is shown there that full indexation might not insulate an economy having monopolistically competitive unions from nominal shocks, while it completely insulates an economy having perfectly competitive labor markets. Moreover, the monopolistically competitive economy may have a negative correlation between money and output under full indexation.

The rate of cost-of-living adjustment that insulates the monopolistically competitive economy is derived in Section 4. The rate is is likely to be less than unity, and depends on the convexity of preference and technology. If the elasticity of marginal cost of production and that of marginal disutility of labor are large, then complete insulation is achieved by a small rate of cost-of-living adjustment. It is shown that the monopolistically competitive economy has a positive money-output correlation only if the actual rate is smaller than the rate of complete insulation.

The effect of monopolistic competition on the unconditional mean of output (which may be considered as the long-run level of output) is also investigated in Section 4. In an economy having monopolistically competitive unions, price uncertainty decreases wages and thus increases the unconditional mean of output if the actual rate of cost-of-living adjustment is smaller than the rate of complete insulation, while otherwise price uncertainty increases wages and decreases the unconditional mean of output. These results are compared with those in the case of perfectly competitive labor markets.

In Section 5 I consider alternative specifications of monopolistically competitive unions. The objective function of the unions in Sections 2 through 4 is derived from a specific assumption on the preference of consumers and workers. In this section, I investigate whether the results of Sections 3 and 4 are dependent on this particular assumption. I analyze two types of union behavior, which are commonly assumed in the literature. It is shown that the results of Sections 3 and 4 still hold with these more conventional specifications of union behavior. Finally, Section 6 includes some concluding remarks.

2. THE MODEL

Consider an economy with differentiated products and differentiated labor. In the following, the reduced-form model based on product and labor demand functions is analyzed, and the explicit analysis of its microfoundation is relegated to APPENDIX.

Throughout this paper I assume perfect competition and perfect information in product markets. On the contrary, labor markets are under imperfect information. Following Fischer (1977), I assume that (i) labor markets open before product markets, (ii) wage contracts are signed there, and (iii) employment is determined by firms after product markets open.[1]

I analyze both perfectly competitive labor markets and monopolistically competitive labor markets. In the perfectly competitive labor markets, workers are wage-takers. On the contrary, in the monopolistically competitive labor markets, one union controls one type of labor inputs, and determines its wage rate. In the following analysis, all variables if not otherwise stated are in logarithms.

Wage Contracts

I assume that the following wage contracts including cost-of-living adjustment are signed in labor markets.

$$(1) \qquad w = f + t\bar{p},$$

where w is the ex-post wage of individual labor, f is its base wage, $\bar{p}$ is the price level (the average price of differentiated products), and t is the exogenous cost-of-living adjustment parameter. The degree of indexation, t, is assumed to be historically given. Then the average ex-post wage $\bar{w}$ is

$$(2) \qquad \bar{w} = \bar{f} + t\bar{p},$$

where $\bar{f}$ is the average base wage.

Product Markets

The demand for individual products is given by

$$(3) \qquad q = - k(p - \bar{p}) + \bar{y} + u,$$

where $k > 2$ is the own-price elasticity of product demand, p the product's price, $\bar{y}$ the average product demand, and u the product-specific demand disturbance.

The average product demand is

$$(4) \qquad \bar{y} = m - \bar{p},$$

where m is the economy-wide nominal money supply disturbance. The disturbances m and u are assumed to be normally distributed, satisfying $Em = Eu = Emu = 0$, $Em^2 = \sigma_m^2$ and $Eu^2 = \sigma_u^2$. I assume perfect information, so that both m and u are observable.

The firm employs all types of labor in order to produce one type of products. The labor cost to the individual firm is given by

(5) $$c = \bar{w} + \ell, \text{ where } \ell = - \log(c_1 + 1) + (c_1 + 1)q,$$

in which $\bar{w}$ is the average wage determined in (2), ℓ the labor input index (total labor input) of the firm, and $c_1 > 0$, which implies decreasing returns to scale.

The firm's real profit, $\exp[\pi]$, is

(6) $$\exp[\pi] = \exp[- \bar{p}]\{\exp[p]\exp[q] - \exp[c]\}.$$

The firm maximizes (6) with respect to q subject to (5) and (1). This determines the supply of the products, q^s.

The equilibrium price is, from $q = q^s$,

(7) $$p = (1 + c_1k)^{-1}[\{t + c_1(k - 1)\}\bar{p} + \bar{f} + c_1m + c_1u].$$

Consequently the price level is

(8) $$\bar{p} = \frac{\bar{f}}{1 - t + c_1} + \delta^* m, \text{ where } \delta^* = \frac{c_1}{1 - t + c_1}.$$

Labor Markets

The demand for individual labor has the form:

$$n = -r(w - \bar{w}) + \bar{n} + v, \tag{9}$$

where r is the own-wage elasticity of labor demand, which satisfies $r > 2$, $\bar{n}$ the average labor demand, and v the type-specific labor demand disturbance. The disturbance v stems from productivity disturbances in the production function.

The average labor demand is

$$\bar{n} = -\log(c_1 + 1) + (c_1 + 1)\bar{y}. \tag{10}$$

Thus we have the following individual labor demand:

$$n = -r(w - \bar{w}) - \log(c_1 + 1) + (c_1 + 1)(m - \bar{p}) + v. \tag{11}$$

A worker supplying one type of labor has the following objective function:

$$\exp[\rho] = \exp[w - \bar{p}]\exp[n] - \exp[z]. \tag{12}$$

Here z represents the disutility of labor such as

$$z = -\log(z_1 + 1) + (z_1 + 1)n + \beta, \tag{13}$$

where z_1 is the elasticity of marginal disutility of labor. Here I assume that $z_1 > 0$, which implies increasing marginal disutility. The term β is the individual labor disturbance, which consists of the economy-wide labor supply disturbance, s, and the type-specific labor supply disturbance, x.

(14) $\beta = s + x.$

The random variables v, s, and x, together with m, are assumed to have the following characteristics. v, s, and x are normally distributed, satisfying $Ev = Es = Ex = Emv = Esx = Ems = Emx = Evx = Esv = 0$; $Ev^2 = \sigma_v^2$, $Es^2 = \sigma_s^2$, and $Ex^2 = \sigma_x^2$. I assume that σ_s^2 is sufficiently large compared with σ_m^2.[2]

(1) Perfect Competition

Because of the predetermined wage, $\bar{p}$ is not observable to the worker. However, information is perfect except for $\bar{p}$. The worker can observe β, f and $\bar{f}$.

The worker maximizes $\hat{E}\exp[\rho]$ with respect to n, where $\hat{E}$ is the expectation operator with respect to the worker's subjective distribution of $\bar{p}$. The worker is endowed with rational expectations. The worker assumes that $\bar{p}$ is normally distributed with mean $e(\bar{p}|\Omega)$ and variance $V(\bar{p}|\Omega)$, where $e(\bar{p}|\Omega)$ is the linear least squares regression of $\bar{p}$ on information Ω available to the worker, and $V(\bar{p}|\Omega)$ is its error variance. Ω includes β, f, and $\bar{f}$.

(2) Monopolistic Competition

I assume the union's objective function is the same as that of its workers. Thus the union's objective function is (12). Thus the union maximizes $\hat{E}\exp[\rho]$ with respect to f, where $\hat{E}$ is the expectation operator with respect to the union's subjective distribution of $\bar{p}$. The union is also endowed with rational expectations.

Let us now consider the information set Ω_u of the union at the time it determines its base wage. I assume that, in addition to β and $\bar{f}$, the following individual labor demand disturbance ξ is also observable.

(15) $$\xi = (c_1 + 1)m + v.$$

Thus Ω_u includes β, ξ and $\bar{f}$.

3. DOES FULL INDEXATION INSULATE THE ECONOMY FROM NOMINAL DISTURBANCES?

In this section I analyze the case of full indexation ($t = 1$). I show that, in a monopolistically competitive economy, the monetary disturbance affects real variables even under full indexation, while full indexation completely insulates a perfectly competitive economy.

Under full indexation, the price level and the demand for labor are, respectively,

(16) $$\bar{p} = (\bar{f}/c_1) + m \text{ and } n = -r(f - \bar{f}) - \log(c_1+1) - \{1+(1/c_1)\}\bar{f} + v.$$

In the perfectly competitive case, the worker's objective function is

(17) $$\exp[\rho] = \exp[f + n] - \exp[-\log(z_1 + 1) + (z_1 + 1)n + \beta].$$

Thus full indexation eliminates uncertainty. Then the equilibrium base wage is

$$(18)\quad f = (1+z_1r)^{-1}[a_u^* + z_1\{r-\frac{c_1+1}{c_1}\}\bar{f} + z_1v + \beta], \text{ where } a_u^* = -z_1\log(c_1+1).$$

Consequently the average base wage and the price level are

$$(19)\quad \bar{f} = (1+\frac{z_1(c_1+1)}{c_1})^{-1}[a_u^* + s] \text{ and } \bar{p} = \frac{a_u^*}{c_1+z_1+c_1z_1} + \frac{s}{c_1+z_1+c_1z_1} + m.$$

Thus full indexation makes the average base wage independent of m. Because the price level is completely flexible with respect to m for given $\bar{f}$, full indexation insulates the economy from the monetary disturbance.

In the monopolistically competitive case, the union's objective function is under full indexation

$$(20)\quad \exp[\rho] = \exp[f-r(f-\bar{f})-\log(c_1+1)-\{1+(1/c_1)\}\bar{f}+v]$$

$$- \exp\{-\log(z_1+1)+(z_1+1)[-r(f-\bar{f})-\log(c_1+1)-\{1+(1/c_1)\}\bar{f}+v]+\beta\}.$$

This shows that, although full indexation eliminates uncertainty about the real wage, uncertainty about v remains. Thus full indexation does not completely eliminate uncertainty in the union's objective function.

The optimal base wage is, from the first order condition of optimality,

$$(21)\qquad f = (1 + z_1r)^{-1}[a_u + z_1\{r - \frac{c_1+1}{c_1}\}\bar{f} + z_1e(v|\Omega_u) + \beta],$$

$$\text{where}\qquad a_u = a_u^* + \log\{r/(r-1)\} + \tfrac{1}{2}\{(z_1 + 1)^2 - 1\}V(v|\Omega_u).$$

Because $e(v|\Omega) = \{1 - (c_1+1)\phi\}\xi$, where $\phi = (c_1+1)\sigma_m^2/\{(c_1+1)^2\sigma_m^2 + \sigma_u^2\}$, we obtain

$$(22) \qquad \bar{f} = (1+\frac{z_1(c_1+1)}{c_1})^{-1}[a_u + z_1(1+c_1)\{1 - (c_1+1)\phi\}m + s].$$

Thus under full indexation, the average base wage is no longer independent of m. It increases if m increases.

The dependence of $\bar{f}$ on m stems from local-global confusion of the monopolistically competitive union. Unlike the worker in a perfectly competitive labor market, the monopolistically union has to form expectations about the local condition v relying on ξ. The optimal forecast of v thus depends on ξ. Because an increase in ξ is accompanied by an increase in m on the average, an increase in m raises the average forecast of v. Consequently the average wage $\bar{f}$ increases when m increases.

The dependence of the base wage on the monetary disturbance implies imperfect insulation of the economy from the monetary disturbance. From the average base wage equation we obtain

$$(23) \qquad \bar{p} = \frac{a_u}{c_1+z_1+c_1z_1} + \frac{s}{c_1+z_1+c_1z_1} + [1 + \frac{z_1(1+c_1)\{1 - (c_1+1)\phi\}}{c_1+z_1+c_1z_1}]m.$$

Consequently we get

$$(24) \qquad \bar{y} = - \frac{a_u}{c_1+z_1+c_1z_1} - \frac{s}{c_1+z_1+c_1z_1} - \frac{z_1(1+c_1)\{1 - (c_1+1)\phi\}}{c_1+z_1+c_1z_1}m.$$

Thus the monetary disturbance affects output under full indexation in an economy with monopolistically competitive unions.

The direction of the monetary effect, however, is different from other models of non-neutral money. We obtain a negative money-output correlation, instead of a positive one. Because of perfect competition and perfect information in product markets, the price level is perfectly flexible to the monetary disturbance for a given $\bar{f}$ (the coefficient of m in (9) is unity). Then a positive correlation between $\bar{f}$ and m makes the price level excessively sensitive to m (the coefficient of m in (23) is larger than unity). The local-global confusion due to monopolistic competition thus produces a negative money-output correlation.

4. REAL EFFECTS OF MONEY IN MONOPOLISTICALLY COMPETITIVE LABOR MARKETS

In this section, I investigate the effect of money on real variables under the general wage contract (1). First, I derive the rate of cost-of-living adjustment, t^*, that insulates the economy from nominal disturbances. Then I analyze the effect of monetary variance on the unconditional means of real variables.

In the general case, the optimal base-wage formula derived from the first-order condition is

$$(25)\quad f = \frac{z_1 r}{1+z_1 r}\left(\bar{f} + \frac{\hat{a}_u + \beta + z_1\xi}{z_1 r}\right) + \left(1-\frac{z_1 r}{1+z_1 r}\right)\{1 - t - z_1(c_1+1)\}e(\bar{p}|\Omega_u),$$

where

$$(26)\quad \hat{a}_u = a_u^* + \log\frac{r}{r-1} - \frac{1}{2}\{1 - t - z_1(c_1+1)\}\{(z_1+2)(c_1+1) + (1-t)\}V(\bar{p}|\Omega).$$

The above optimal base-wage formula implies that if $1 - t - z_1(c_1 + 1) > 0$, then the base wage is raised when $e(\bar{p}|\Omega_u)$ is increased. Otherwise, an increase in the expected price lowers the base wage. On the one hand, because the real wage is proportional to the reciprocal of the average price, its increase clearly puts upward pressure on the base wage. On the other hand, an increase in the average price implies a decrease in aggregate demand through a reduction in real balances, so that the base wage should be cut in order to maintain employment. The relative magnitudes of these conflicting forces determine whether an increase in the expected price raises the base wage or not.

If marginal disutility of labor increases rapidly as output increases ($z_1(c_1+1)$ is large), the union gives employment stability the highest priority. Then the incentive to reduce the base wage dominates the incentive to increase it, so that an increase in $e(\bar{p}|\Omega_u)$ decreases the base wage. In this case, the union is more concerned with the level of employment than the base wage (employment-concerned union). On the contrary, if $z_1(c_1+1)$ is small, then it puts more weight on the base wage than employment (base-wage-concerned union).

In addition to z_1 and c_1, the degree of indexation (t) also determines whether the union is employment-concerned or base-wage-concerned. If t is increased, pressure on the base wage to keep the real wage is decreased. Then the union has more leeway to keep the level of employment. Thus the overall effect depends on the sign of $1 - t - z_1(c_1 + 1)$. If this is positive, then the union is base-wage-concerned. Otherwise, it is employment-concerned. Note that in the completely indexed case ($t = 1$), the union is unambiguously employment-concerned.

Using the above structure of the economy and (29), the firm can calculate $e(\bar{p}|\Omega_u)$ from (8) such as

$$(27) \qquad e(\bar{p}|\Omega_u) = \frac{\bar{f}}{1 - t + c_1} + \delta^{*}\phi\xi.$$

Then we obtain the following average price and quantity equations for the economy.

$$(28)\ \bar{p} = \Xi(\hat{a}_u) + \Upsilon(t)\cdot m + \Theta\cdot s, \text{ and } \bar{y} = -\Xi(\hat{a}_u) + \{1 - \Upsilon(t)\}\cdot m - \Theta\cdot s, \text{ where}$$

$$(29) \qquad \Xi(\hat{a}_u) = \hat{a}_u/(c_1 + z_1 + c_1 z_1),$$

$$(30) \qquad \Upsilon(t) = 1 - \frac{\{1 - t - z_1(c_1 + 1)\}\{1 - \phi(c_1 + 1)\}c_1}{(1 - t + c_1)(c_1 + z_1 + c_1 z_1)}, \text{ and}$$

$$(31) \qquad \Theta = \frac{1}{c_1+z_1+c_1 z_1}.$$

Complete Insulation

It can be shown that the level of output becomes independent of m if

$$(32) \qquad t = t^* \equiv 1 - z_1(1 + c_1),$$

because $\Upsilon(t^*) = 1$ from (30). Thus t^* is the rate of cost-of-living adjustment that completely insulates the economy from the monetary disturbance.

Note that if $t = t^*$, we have $1 - t - z_1(1 + c_1) = 0$. Then the optimal base wage becomes independent of $e(\bar{p}|\Omega)$. Because ε is observable, the union's maximization problem is reduced to the one under complete information. Thus there is no room for local-global confusion making the base wage erroneously dependent on the monetary disturbance. Because under perfect information all real variables are determined by relative prices, the price level varies in order to completely offset any change in purely nominal variables (see (8)). Thus the economy is completely insulated if $t = t^*$.

Because $z_1 > 0$ and $c_1 > 0$, t^* is always smaller than unity. Thus complete insulation needs less than full cost-of-living adjustment. Moreover, if z_1 and c_1 are large, t^* is small. In the extreme, if $z_1(1+c_1) > 1$, t^* is negative. Complete insulation needs a negative rate of cost-of-living adjustment in this case.

The sign of the correlation between money and output depends on whether t is greater or smaller than t^*. Note that under complete information, money is neutral. Under complete information, the individual base wage is

$$(33)\quad f = \frac{z_1 r}{1+z_1 r}\left(\bar{f} + \frac{\hat{a}_u^* + \beta + z_1\varepsilon}{z_1 r}\right) + \left(1-\frac{z_1 r}{1+z_1 r}\right)\{1 - t - z_1(c_1+1)\}\bar{p}, \text{ where}$$

$$(34)\qquad \hat{a}_u^* = a_u^* + \log\{r/(r-1)\}.$$

Consequently the price level is

$$(35)\qquad \bar{p} = \Xi(\hat{a}_u^*) + m + \Theta\cdot s.$$

Under complete information, the base wage f is always adjusted in such a way to make $\bar{p}$ just offset any change in m. Under incomplete information, however, the actual average price $\bar{p}$ in the above formula is replaced by the union's expectations $e(\bar{p}|\Omega_u)$. Because of local-global confusion, $e(\bar{p}|\Omega_u)$ is less sensitive to m than $\bar{p}$. If $t < t^*$, or equivalently, $1 - t - z_1(c_1+1) > 0$, an increase in the price level increases the base wage. Local-global then implies that an increase in $\bar{p}$ induces a smaller increase in f under incomplete information than under complete information. Thus $\bar{p}$ becomes less sensitive to m, and we obtain a positive correlation between money and output. On the contrary, if $t > t^*$ $(1 - t - z_1(c_1+1) < 0)$, local-global confusion implies a larger increase in f because the base-wage-reducing effect of the average price is now smaller under incomplete information. Thus the price level increases more under incomplete information than under complete information. Then money and output are negatively correlated.

Effect of Monetary Variance

An increase in monetary variance affects the unconditional mean of income by increasing price uncertainty in an economy with monopolistically competitive unions. From (28) we obtain

$$\bar{y}|_{m=s=0} = - \Xi(\hat{a}_u). \tag{36}$$

Because $\partial\hat{a}_u/\partial V(\bar{p}|\Omega_u) \neq 0$ (except for the case that $1 - t - z_1(c_1 + 1) = 0$) and $\partial\Xi/\partial\hat{a}_u > 0$, we have $\partial[\bar{y}|_{m=s=0}]/\partial V(\bar{p}|\Omega_u) \neq 0$. Thus uncertainty about the absolute price level affects the unconditional mean of income. The direction of the effect depends on whether the union is base-wage-concerned or employment-concerned. If the union is base-wage-concerned ($1 - t - z_1(c_1 + 1) > 0$), increased uncertainty about the price level increases the unconditional mean of income. On the contrary, if the union is employment-concerned ($1 - t - z_1(c_1 + 1) < 0$), the increased uncertainty decreases the unconditional mean of income.

The price level affects the union's objective function in two ways. First, it determines the real wage. Because the real wage is a convex function of the average price, an increase in the variance of the average price increases the expected real wage. This reduces the upward pressure on the base wage, leading to a lower optimal base-wage. This is translated into a lower price, which implies a higher output. Because the major concern of the base-wage-concerned union is the real wage, price uncertainty increases the unconditional mean of income.

Second, the price level alters aggregate demand through the real balance effect. Increased uncertainty about the price level implies increased volatility of labor demand, through the real balance effect. This volatility reduces the benefit of supplying additional labor. Consequently the base wage is raised to induce a lower level of employment. This increase in the base wage means a higher price, so that the economy produces a smaller output. Because the employment-concerned union prefers stability of employment because of increasing marginal disutility of labor, price uncertainty reduces the unconditional mean of income.

If the stochastic structure of the economy is the same for a long time, the unconditional mean of income is equal to the long-run average of income. In this case the above argument implies that monetary variance affects the long-run level of income.

It may be worthwhile at this point to compare monopolistically competitive labor markets with perfectly competitive labor markets. Under imperfect information, competitive labor supply is

$$(37) \qquad n^s = \frac{1}{z_1}\{f - (1 - t)e(\bar{p}|\Omega) + \frac{1}{2}(1 - t)^2 V(\bar{p}|\Omega) - \beta\}.$$

This is a familiar Lucas supply function if $t = 0$. The usual practice is to ignore the variance term in the above function.[3] However, this conceals the importance of price uncertainty on labor supply. Using this labor supply function, we obtain the unconditional mean of the perfectly competitive output such as

$$(38) \quad \bar{y}|_{m=s=0} = - \Xi(\hat{a}_u^{\,c}), \text{ where } \hat{a}_u^{\,c} = a_u^{*} - \frac{1}{2}(t - 1)^2 V(\bar{p}|\Omega).$$

Thus an increase in price uncertainty unambiguously <u>increases</u> the unconditional mean of output (except for the case of full indexation $t = 1$). The major determinant of competitive labor supply is the real wage. Because of the convexity of the real wage in the price level, an increase in price uncertainty increases labor supply.[4] This is translated into an increase in the unconditional mean of output.

5. ALTERNATIVE SPECIFICATIONS OF LABOR UNION BEHAVIOR

The objective function of the unions in previous sections is not conventional in the recent union-literature, though it can be derived as the utility of its members (see APPENDIX). In this section I analyze more conventional objectives of the unions, and discuss whether the same results would be found with such objectives. I consider the case of full indexation in this section.

Following Oswald (1985), I consider two major specifications of union preferences. The first approach adopts the Stone-Geary functional form

$$(39) \qquad \exp[\rho] = \{\exp[w - \bar{p}] - \exp[\hat{h}]\}^{b}\{\exp[n + \beta] - \exp[\hat{n}]\}^{d},$$

where $0 < b < 1$ and $0 < d < 1$. Here $\hat{h}$ and $\hat{n}$ are "reference" levels of real wages and employment. As in the previous sections, β represents a shock in the union preference. The second specification of union preferences is the expected utility with the possibility of random layoffs such as

$$(40) \quad \exp[\rho] = \exp[g(w - \bar{p})]\exp[n - \hat{\Omega}]\exp[\beta] + \exp[\hat{z}]\{1 - \exp[n - \hat{\Omega}]\exp[\beta]\},$$

where $0 < g < 1$. Here $\exp[g(w - \bar{p})]$ is the utility of an employed worker, n is the number of employed workers, $\hat{\Omega}$ is the membership of the union, and $\exp[\hat{z}]$ is the utility of an unemployed worker. Thus $\exp[n - \hat{\Omega}]$ is the probability of employment if layoff is distributed purely randomly, so long as the constraint $n \leq \hat{\Omega}$ is not binding. Here again β represents a shock in the union preference.[5]

Let us first consider the Stone-Geary union preference (39). Suppose that $\exp[\hat{h}] = 0$ and $b > dr$. Then the optimal base wage is approximately[6]

$$(41) \qquad f = \frac{1}{r}[\log\frac{b-dr}{b} - \log(1+c_1) + \{r-(1+\frac{1}{c_1})\bar{f} + \beta - \log\hat{n} + e(v|\Omega_u)].$$

Because $e(v|\Omega_u)$ appears in the base wage formula, full indexation does not insulate the economy. A qualitatively similar result is also obtained in the general case with $\exp[\hat{h}] > 0$ as well as $\exp[\hat{n}] > 0$. Thus the results in the previous sections hold true in this specification of union preferences.

Next, in the case of expected-utility specification (40), the union's optimal base wage is approximately

$$(42) \qquad f = \frac{1}{b}\log\frac{r}{r-b} + \frac{1}{b}\hat{z}.$$

Because f is independent of $e(v|\Omega_u)$, full indexation completely insulates the economy.

This complete-insulation result, however, stems from the rather restrictive assumption that the constraint $n \leq \hat{\Omega}$ is never binding. In this case, the union's utility (40) is linear in labor supply. This property is essential to obtain complete insulation.[7]

If we allow the case that the constraint $n \leq \hat{\Omega}$ is binding in some cases,[8] the union's objective function is

$$\exp[\rho] = \exp[\hat{z}] + \exp[g(w - \bar{p})]\cdot\min[1, \exp(n - \hat{\Omega})\exp(\beta)]. \tag{43}$$

This shows that the union's utility is generally strictly concave in labor supply even under the random layoff scheme. We obtain in general incomplete insulation for utility functions which are strictly concave in labor supply. Thus except for the case in which the union is certain that n is always less than $\hat{\Omega}$, insulation is likely to be incomplete.

6. CONCLUDING REMARKS

In this paper I have compared under the framework of predetermined wages an economy having monopolistically competitive labor markets with an economy having perfectly competitive labor markets. It has been shown that full indexation might not insulate the monopolistically competitive economy from nominal disturbances, though it completely insulates the perfectly competitive economy. Price uncertainty has also been shown to influence the determination of nominal wages and hence output.

Monopolistic competition in labor markets, however, makes prices more sensitive to nominal demand shocks than perfect competition. Because of this property, output is negatively correlated to money under full indexation. Thus complete insulation under monopolistic competition needs less than full indexation. In this sense, monopolistic competition in labor markets is not likely to contribute the observed rigidity of prices and wages to nominal shocks. This result is in sharp contrast to the effect of monopolistic competition in product markets in Nishimura (1986) and Andersen (1985). They show that monopolistic competition in product markets does contribute to the rigidity of prices to nominal shocks.

Monopolistic competition in labor markets, however, makes wages and thus prices rigid to nominal shocks if the informational separation of monopolistically competitive unions is introduced as an additional source of imperfect information. In this case, the average wage is assumed to be unobservable. Then local-global confusion makes individual wages less sensitive to labor demand conditions, and ultimately, aggregate nominal demand conditions. Consequently, prices become insensitive to nominal shocks. This type of labor markets is analyzed in Nishimura (1987). It is shown there that if competition among labor unions is strong, then the rigidity-enhancing effect of monopolistic competition dominates its flexibility-enhancing effect.

Finally a remark on the rational expectations assumption may be due. First, the assumption that unions have information about the structure of the economy may seem a heroic assumption in the first glance. However, what we need in the analysis is not complete knowledge, but some reliable knowledge about others (uncertainty surrounding such knowledge can be treated by adding observation errors). In the real world in which imperfect competition is the name of the game, knowledge about rivals is vital in competition. In this case it is reasonable to assume unions have some reliable knowledge about other unions. In such an economy this assumption is not so unreasonable.

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APPENDIX: MICROFOUNDATION

The Representative Household

Suppose that there are (1) T_1 kinds of products, and (2) T_2 kinds of labor inputs. There are identical households owning firms' stocks and supplying labor inputs to the firms. The structure of household preferences is assumed to be such that (1) the products can be grouped into n_1 types, within which products are symmetric, and (2) the labor inputs can be grouped into n_2 types, within which labor inputs are symmetric. Specifically, I assume that the representative household's utility function is

$$\text{(A1)} \qquad \Psi = T_1^{-1/(k-1)} (\bar{Y})^{\zeta} (\frac{\tilde{M}}{\bar{P}})^{1-\zeta} - T_2^{-1} \Sigma_{j=1}^{n_2} g_j \Delta_j N_j^{\mu},$$

where $\bar{Y}$ is the aggregate consumption index such as

$$\text{(A2)} \qquad \bar{Y} = (\Sigma_{i=1}^{n_1} f_i \; U_i^{1/k} \; Q_i^{(k-1)/k})^{k/(k-1)}.$$

Thus the utility function is a composite of CES and Cobb-Douglas functions. In (A1), f_i is the number of the i-th type products, satisfying $\Sigma_{i=1}^{n_1} f_i = T_1$; Q_i is the consumption of each of the i-th type products; g_j is the number of the j-th type labor inputs, satisfying $\Sigma_{j=1}^{n_2} g_j = T_2$; N_j is the supply of each of the j-th type labor; $\tilde{M}$ is the end-of-the-period nominal money holdings; and $\bar{P}$ is the price level associated with $\bar{Y}$, such as:

$$\text{(A3)} \qquad \bar{P} = \{(\Sigma_{i=1}^{n_1} f_i U_i \; P_i^{1-k})/T_1\}^{1/(1-k)},$$

in which P_i is the price of the i-th type products. The parameters k, θ and μ satisfy $k > 2$, $1 > \zeta > 0$, and $\mu > 1$.

If U_i is the same for i, all products are perfectly symmetric. Thus U_i can be called the product-specific demand condition. Similarly, the term Δ_j represents the labor supply condition, which I assume consists of the economy-wide condition S and the type-specific one X_j.

$$\Delta_j = S \cdot X_j.$$

U_i and X_j are assumed to satisfy

$$\Sigma_{i=1}^{n_1}(\frac{f_i}{T_1})\log U_i = \Sigma_{j=1}^{n_2}(\frac{g_j}{T_2})\log X_j = 0.$$

The representative household's demand for each product is derived from the maximization of Ψ with respect to Q_i and $\tilde{M}$ subject to the budget constraint

$$\text{(A4)} \qquad \Sigma_{i=1}^{n_1} f_i P_i Q_i + \tilde{M} = B,$$

where B is such that

$$\text{(A5)} \qquad B = \Sigma_{j=1}^{n_2} g_j \Lambda_j + \Sigma_{i=1}^{n_1} f_i \Pi_i + M.$$

Here, M is the beginning-of-the-period money holdings, Λ_j is wages of each of the j-th type labor, and Π_i is dividends from firms producing each of the i-th type products. Using the property of the CES and Cobb-Douglas functions, we can derive the demand for the i-th product Q_i and the demand for real balances. They are

(A6) $$Q_i = U_i\left(\frac{P_i}{\bar{P}}\right)^{-k} \bar{Y}\left(\frac{1}{T_1}\right), \quad \bar{Y} = \zeta\frac{B}{\bar{P}}, \text{ and } \frac{\tilde{M}}{\bar{P}} = (1 - \zeta)\frac{B}{\bar{P}}.$$

Substituting them into (A1), we obtain the representative household's indirect utility in money terms:

(A7) $$\psi^* \equiv \bar{P}\psi = B - \bar{P}\left(\frac{1}{T_2}\right)\Sigma_{j=1}^{n_2} g_j\Delta_j{}^* N_j{}^{\mu},$$

where

(A8) $$\Delta_j{}^* = \zeta^{-\zeta}(1 - \zeta)^{-(1-\zeta)}\Delta_j.$$

<u>Product Markets</u>

I assume perfect competition and perfect information in product markets. The firm is a price taker, and all prices and wages are known. Without loss of generality, I assume that one product is produced by one firm.

(1) The Firm

The production function of the firm is

(A9) $$Q_i = [T_2{}^{-1/(r-1)}(\Sigma_{j=1}^{n_2} g_j V_j{}^{1/r} L_{ij}{}^{(r-1)/r})^{r/(r-1)}]^{\phi},$$

where L_{ij} is the firm i's labor input of type j, $r > 2$, and $0 < \phi < \mu$. Thus the production function is also a composite of CES and Cobb-Douglas functions. The productivity condition V_j is assumed to satisfy

$$\Sigma_{j=1}^{n_2}\left(\frac{g_j}{T_2}\right)\log V_j = 0.$$

The firm maximizes the real benefits of its stockholders. Because the firm's stocks are owned by the representative household, the firm's objective is to maximize the representative household's utility with respect to its decision variables, Q_i and L_{ij}. Consequently, the firm's objective function is

$$\text{(A10)} \qquad \frac{\Psi^*}{\bar{P}} = \frac{1}{\bar{P}}\{P_iQ_i - \Sigma_{j=1}^{n_2} g_jW_jL_{ij}\} + D$$

where D is the term given to the firm. Thus the firm maximizes (A10) subject to (A9) and the wage rate W_j, taking D as given.

As is well-known, this maximization takes two steps. The first step is to minimize wage payments taking Q_i as given. This yields

$$\text{(A11)} \qquad L_{ij} = V_j\left(\frac{W_j}{\bar{W}}\right)^{-r}Q_i^{1/\phi}\left(\frac{1}{T_2}\right) \quad \text{and} \quad \Sigma_{j=1}^{n_2} g_jW_jL_{ij} = \bar{W}Q_i^{1/\phi},$$

where

$$\text{(A12)} \qquad \bar{W} = [(\Sigma_{j=1}^{n_2}\ g_jV_jW_j^{(1-r)})/T_2]^{1/(1-r)}.$$

The second step is to maximize

$$\text{(A13)} \qquad \frac{1}{\bar{P}}[P_iQ_i - \bar{W}Q_i^{1/\phi}]$$

with respect to Q_i. This maximization determines the supply of the i-th product, Q_i^s, such as $Q_i^s = [(\phi P_i)/(\bar{P}\bar{W})]^{\phi/(1-\phi)}$.

(2) Equilibrium

The equilibrium conditions in product markets consist of (a) the monetary equilibrium condition $\tilde{M} = M$, and (b) the individual product market equilibrium condition $Q_i^s = Q_i$. Because the firm does not retain profits, we obtain from the monetary equilibrium condition

$$\text{(A14)} \qquad \bar{Y} = \frac{\theta}{1-\theta}\frac{M}{\bar{P}}.$$

Thus the aggregate demand is proportional to initial real money holdings. The individual product market condition determines the price as a function of $\bar{P}$, $\bar{W}$, U_i and $\bar{Y}$.

Labor Markets

Labor markets open before products markets. Thus the participants in labor markets have only imperfect information about the condition of product markets. However, the firm is given the right to determine its employment level after product markets open. I consider (i) the perfectly competitive case and (ii) the monopolistically competitive case.

(1) Labor Demand

Let N_j be the demand for the j-th type of labor such that $N_j = \Sigma_{i=1}^{n_1} f_i L_{ij}$. Define the aggregate labor demand index $\bar{N}$ as:

$$\text{(A15)} \qquad \bar{N} = \{\Sigma_{i=1}^{n_1} f_i (\Sigma_{j=1}^{n_2} g_j W_j L_{ij})\}/\bar{W}.$$

Then we obtain

(A16) $$N_j = V_j\left(\frac{W_j}{\bar{W}}\right)^{-r}\bar{N}\left(\frac{1}{T_2}\right) \quad \text{and } \bar{N} = \Sigma_{i=1}^{n_1} f_i Q_i^{1/\phi}.$$

(2) Perfectly Competitive Labor Markets

The supply of the j-th type labor is determined by the representative household. The household maximizes its utility with respect to the j-th type labor. Thus the supply of the j-th type labor, N_j^s, is the solution of the maximization of the following expected utility

(A17) $$\hat{E}\,\frac{\Psi^*}{\bar{P}} = \hat{E}\,\frac{1}{\bar{P}}\{W_j N_j\} - \frac{1}{T_2}\Delta_j^* N_j^{\mu} + D',$$

where $\hat{E}$ is the expectation operator with respect to the worker's subjective distribution of $\bar{P}$, and D' is a constant term. Then equilibrium is determined by $N_j^s = N_j$.

(3) Monopolistically Competitive Labor Markets

In the monopolistically competitive case, the supply of one type of labor is controlled by one union. The j-th union, which controls the j-th type labor, sets the wage rate for the j-th type labor in order to maximize the real benefits of its workers. Because labor inputs are supplied by the representative household, the union maximizes the representative household's utility. Consequently the j-th union's objective is to maximize (A17) with respect to W_j subject to the labor demand function (A16), where $\hat{E}$ is the expectation operator with respect to the union's subjective distribution.

<u>Log-linear Log-normal Approximation</u>

Retaining the above structure of the model, I use two types of approximation in this paper. The first is a log-linear approximation to the aggregate indices $\bar{P}$, $\bar{W}$, and $\bar{N}$. In the following let the lower case term be the log of the corresponding upper case term, for example, $\bar{p} = \log \bar{P}$, $p_i = \log P_i$, etc. Consequently, we have from (A3) that $\bar{p} = \{1/(1-k)\} \cdot [\log\{(1/T_1)\Sigma_{i=1}^{n_1} f_i \exp(u_i)\exp((1-k)p_i)\}]$. Take the first-order Taylor's expansion of this expression around $u_i = 0$ and $p_i = 0$ for all i. From this we obtain

$$\bar{p} = \Sigma_{i=1}^{n_1} \left(\frac{f_i}{T_1}\right)p_i, \text{ because } \Sigma_{i=1}^{n_1}\left(\frac{f_i}{T_1}\right)u_i = 0.$$

Similar procedures on (A11), (A2), and (A16) yield,

$$\bar{w} = \Sigma_{j=1}^{n_2} \left(\frac{g_j}{T_2}\right)w_j, \; \bar{y} = \Sigma_{i=1}^{n_1} \left(\frac{f_i}{T_1}\right)q_i, \text{ and } \bar{n} = (1/\phi)\Sigma_{i=1}^{n_1} \left(\frac{f_i}{T_1}\right)q_i = (1/\phi)\bar{y}.$$

The second approximation is a log-normal approximation to the distribution of u_i and x_j. Instead of assuming a discrete distribution for them, I assume that u and x are continuous variables, whose distributions are normal. Thus we obtain (omitting subscripts) $\bar{p} = Ep$, $\bar{w} = Ew$, $\bar{y} = Eq$, and $\bar{n} = (1/\phi)\bar{y}$. Then we get the log-linear log-normal model of the text with $c_1 = (1/\phi) - 1$ and $z_1 = \mu - 1$, except for constant terms.

NOTES

1. Although such contracts are widely observed, they are ex post inefficient under imperfect information. The analysis of this paper, like other studies assuming this type of contracts, depends on the existence of this inefficiency. However, the use of such contracts may be justified under asymmetric information between the firm and the union, because wage contracts are incentive compatible.

2. Formally, I assume $\sigma_s^2 << \sigma_s^2$, so that the average base wage, which is observable in the labor markets, give little information about m.

This assumption is made only for the sake of analytic simplicity. The results of this paper do not depend on this rather unrealistic assumption. The main results of this paper still hold with little modification so long as σ_s^2 is positive. However, the derivation of rational expectations in general cases becomes complicated because we have to consider information about m contained in $\bar{f}$.

3. Usually, logEexp[x] is approximated by Ex.

4. However, the effect of uncertainty on the long-run level of output is in general ambiguous in general models allowing the intertemporal substitution effect.

5. The way β enters the utility functions (39) and (40) is only one of many possibilities of describing labor supply disturbances. However, the results of this section hold true so long as β influences the optimal base wage.

6. Let $\hat{E}f(v) = 0$ be the first order condition of optimality, where $\hat{E}$ is the expectation operator with respect to the union's subjective distribution of v. If $\hat{E}f(v)$ is approximated by $f(\hat{E}v)$, then we obtain the base wage formula in the text. This method yields relatively good approximation to the short-run behavioral equations, though it may give misleading results in analyzing

the long-run effect of price variability as explained earlier in the discussion of the Lucas supply function.

7. In fact, even in the framework of the previous sections, we obtain complete insulation if the union's utility is linear in labor supply. t^* is equal to unity if z_1 is equal to zero.

8. Under the assumption of the log-normal distributions of m and v, there always exists a possibility of very large labor demand. In this case, the constraint $n \leq \ell$ is likely to be binding.