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6 Monopolistic Competition and Labor Market Adjustment in the Open Economy

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6.1 Introduction and Summary

The volatility of the real exchange rate exhibited in recent years has led to a growing concern regarding the need for labor market adjustment in the presence of misalignment. It is important to recognize that the potential role of policies stems not from the volatility per se but from the consequences of unanticipated shocks in the presence of an institutional structure that limits the flexibility of adjustment. In the absence of rigidities and with complete markets, volatility should not concern the policymaker. Thus, an assessment of the role of policies can be conducted after we specify a framework that allows for the presence of rigidities.

The purpose of this paper is to address the nature of adjustment and the role of policies in an economy characterized by labor contracts that limit the flexibility of wage adjustment. Specifically, I postulate a stochastic monopolistic competitive economy, where wage negotiations are carried out every several periods because of the presence of transaction costs.[1] These costs can reflect the expenses of collecting and processing information, as well as direct output losses associated with a time-consuming negotiation process. The wage negotiation periods are assumed to be distributed uniformly over time. This distribution results in wage and price paths that differ across firms according to the

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timing of their most recent pricing decision. Following the construction of the building blocks of the economy, we derive the optimal wage presetting rule. Such a rule is characterized by two elements. First, for a given frequency of wage negotiation, we derive the optimal path of wages to be preset at the beginning of each contract cycle. Second, we solve for the optimal frequency of wage negotiation.

Armed with the optimal wage presetting rule, I analyze the evolution of goods prices and the implication of the wage presetting rule for the aggregate economy. Specifically, I investigate the adjustment of output, exchange rate, prices, employment, and wages to nominal and real shocks. The discussion focuses on the dependency of the adjustment on the market power enjoyed by each producer. The analysis shows that unexpected monetary shocks can generate persistent aggregate output and relative price shocks whose nature is determined by the degree of substitutability between domestic and foreign goods. Greater substitutability induces a greater output and employment effects and smaller price effects in the short and the intermediate run. On the other hand, greater substitutability is shown to reduce the persistency and duration of the adjustment. These results follow from the observation that a larger substitutability is associated with shorter wage contracts. Thus, a greater degree of substitutability has two opposing effects—it raises the magnitude but reduces the duration of the output and employment shocks resulting from a given monetary innovation.

The details of the adjustment to real shocks are more involved, being determined by the magnitude of the income elasticity of the demand for money and the substitutability between domestic and foreign goods. If the income elasticity of the demand for money is less than unity (as is suggested by empirical studies) the presence of nominal wage contracts tends to magnify the responsiveness of the economy to real shocks, and a larger degree of substitutability will magnify the short-run and the intermediate-run adjustment of prices and output to real shocks and will reduce the needed adjustment of relative prices. The direction of the nominal exchange rate adjustment induced by real shocks is shown to be determined by the size of the income elasticity of the demand for money and by the substitutability between domestic and foreign goods. Large (small) elasticities are associated with a nominal appreciation (depreciation) in the presence of expansionary real shocks. An important feature of our staggered framework is that the speed of adjustment to real and nominal shocks accelerates during the adjustment. It is noteworthy that the result regarding the accelerated speed of adjustment differs from the one obtained applying linear models, where typically the speed of adjustment drops during the cycle.

Section 6.6 evaluates the potential role of labor market policies in the presence of misalignment. I distinguish between two sources of misalignment. The first is due to a large realization of the nominal or real shocks. The second is due to structural shocks that change the underlying parameters, like a change in the substitutability between various goods, a change in the share of labor in the GNP, changes in the covariance structure of the shocks, and so forth. The analysis demonstrates that a wage rule that will index the wage to nominal income will stabilize employment in the presence of the first type of shocks. Such a rule, however, will not stabilize employment in the presence of the second type of shocks: accommodation to structural shocks will necessitate wage renegotiation and a change in the frequency of wage adjustment.

Section 6.2 describes the model by formulating the goods, the money, and the labor market. Section 6.3 derives the long-run equilibrium where all prices and wages are flexible. Section 6.4 studies the dynamics of adjustment to monetary and real shocks. Section 6.5 discusses the factors determining contract length, and section 6.6 evaluates the role of labor market policies in the presence of misalignment. Section 6.7 closes the paper with concluding remarks.

6.2 The Model

In this section I outline the building blocks of the model. I start with the goods market specification and conclude with the labor and the money market.

6.2.1 The Goods Market

Consider an economy characterized by producers organized in a monopolistic competitive manner. There are two classes of goods—domestic and foreign. All domestic producers are facing the same demand function and share the same technology. Demand facing producer k is given by

$$D_k = (\bar{P}/P_k)^{\beta}\,(EP^*/P_k)^{\alpha},\ \alpha + \beta > 1, \tag{1}$$

where $\bar{P}$ is the average price of domestic goods, E is the exchange rate, P^* is the average price of foreign goods (in units of the foreign currency), and P_k is the price of good K.[2] I assume a large number of domestic producers (denoted by h), such that each of them treats $\bar{P}$ as given.[3] I denote by β the demand elasticity with respect to the competing domestic goods. The substitutability between domestic and foreign goods is measured by α, and for simplicity of exposition I invoke the law of one price for foreign goods.[4]

The production function of each domestic producer is characterized by

$$X_k = Q(L_k)^{\gamma}, \tag{2}$$

where L_k is the labor employed in the production of good k, and Q stands for labor productivity. Aggregate output is denoted by $\bar{X}$, where

$$\bar{X} = \Sigma\, P_k X_k / \bar{P}. \tag{3}$$

Suppose we start from an initial equilibrium. Let us use lowercase letters for the logarithm of the uppercase variable. Thus, for a variable Z, $z = \log Z$. For example, applying equations (1) and (3) yields that the (percentage) change in output is proportional to the change in the terms of trade:

$$\Delta\bar{x} = \alpha\Delta(e - \bar{p}). \tag{4}$$

6.2.2 The Labor and the Money Markets

For the purpose of my analysis I will distinguish between two types of labor markets. In the first case, I will consider a flexible prices economy where the labor market always clears. This corresponds to the case where wages are fully flexible and where the labor market is cleared in an auction manner. The usefulness of this environment stems from providing the benchmark economy for my subsequent discussion, where I will allow for the presence of nominal contracts in the labor market. In this benchmark economy money is neutral, because all prices are flexible to adjust fully to the state of liquidity. Thus, the benchmark economy serves to define the long-run equilibrium. The presence of nominal contracts will introduce a distinction between the long, the intermediate, and the short run. Among other topics, my analysis will study the factors determining the effective duration of the short and the intermediate run.

Consider the case where labor is employed subject to nominal contracts that preset the wage path for several periods, where within the contract duration employment is demand determined. To simplify notation I normalize the labor force to h (the number of firms) and assume an inelastic long-run supply of labor.[5] The presetting rule is governed by the notion that wages are preset at a level that is expected to clear the labor market facing the producer. Let W denote the money wage rate. Application of equations (1) and (2) yields the dependency of the price charged by producer k on the money wage:

$$p_k = a_1 (p^* + e) + a_2\bar{p} + a_3 w + \theta(c - \tilde{\gamma}\, q) \tag{5}$$

where
$$\begin{aligned}
\tilde{\gamma} &= 1/\gamma \\
\theta &= 1/[1 + (\tilde{\gamma} - 1)(\alpha + \beta)] \\
c &= \log\{\tilde{\gamma}(\alpha + \beta)/(\alpha + \beta - 1)\} \\
a_1 &= \alpha(\tilde{\gamma} - 1)\theta \\
a_2 &= \beta(\tilde{\gamma} - 1)\theta \text{ and} \\
a_3 &= \theta.
\end{aligned}$$

Note that the sum of the elasticities of P_k with respect to foreign prices (a_1), the wage (a_2), and domestic competitors' prices (a_3) adds up to one: $a_1 + a_2 + a_3 = 1$. This is a reflection of the homogeneity postulate, implying that an equiproportional rise in all prices will not affect the real equilibrium. The relative importance of foreign prices in the determination of the domestic price P_k is characterized by the substitutability of domestic and foreign goods. As we approach perfect substitutability (i.e., as $\alpha \to \infty$), we approach an absolute purchasing power parity (PPP) pricing rule, where $p = p^* + e$.[6]

I conclude this section with the specification of the money market. Let us denote by M the supply of money and consider a simple money demand function:

$$m = \bar{p} + \xi \bar{x} \tag{6}$$

where ξ is the income elasticity of the demand for money.[7] We turn now to the characterization of the long-run, flexible price equilibrium.

6.3 The Long-Run Equilibrium

The long-run equilibrium is characterized by flexibility of wages and prices. In such an economy all domestic producers are facing the same demand and supply conditions. As a result, in this equilibrium all producers will employ $L = 1$ and will charge the same price ($p_k = \bar{p}$). Applying equations (1) and (2) yields that the long-run PPP ratio is equal to:

$$e + p^* - \bar{p} = q/\alpha. \tag{7}$$

The PPP ratio is determined by two factors—the measure of the efficiency of production (Q) and the substitutability between domestic and foreign goods (α). A rise in domestic efficiency ($d\,q > 0$) or a drop in the substitutability between domestic and foreign goods is associated with a deterioration in the terms of trade. As one might expect, the long-run equilibrium is independent of monetary considerations. Applying (7) to (5) we infer that the producer's real wage is

$$w - p = q - c. \tag{8}$$

The term c represents the markup pricing rule, where the price is a markup of wages. From the definition of c (see [5]), it follows that the markup rate drops with $\alpha + \beta$, which corresponds to the degree of substitutability. It can be also shown that as $\alpha + \beta \to \infty$ we approach the competitive outcome, where the labor bill share approaches γ. We turn now to an analysis of the short and the intermediate run.

6.4 The Short and the Intermediate Run

The purpose of this section is to design a framework that will allow assessment of the short- and intermediate-run adjustment to unanticipated monetary and real shocks and the evaluation of economic factors determining the effective duration of the intermediate run. I introduce nominal rigidities by assuming that pricing decisions in the labor market are carried out every several periods because of the presence of transaction costs associated with frequent wage negotiation.[8] I consider the case where labor is employed subject to contracts that preset the wage path for n periods, where within the contract duration, employment is demand determined. At the beginning of each contract cycle, the contract sets the wage path for the next n periods. I start this section with the assumption that n is exogenously given and conclude with an analysis of the endogenous determination of n.[9]

The wage in period d that was preset h periods ago is denoted by $W_{d,h}$, and the price charged by the producer who employs labor that is paid $W_{d,h}$ is denoted by $P_{d,h}$. For example, a producer who starts a contract cycle in t should negotiate at period t the path of $(W_{t,0}, w_{t+1,1}, \ldots; W_{t+n-1,n-1})$. Figure 6.1 describes the prices and wages prevailing in our economy. At time t we observe n prices and a corresponding n wages, as described by the vertical vector. A producer charging $p_{t,0}$ at period t is also presetting wages for the next $n - 1$ periods, as is described by the horizontal vector. The presetting rule is governed by the notion that wages are preset at a level that is expected to clear the labor market facing the producer. In doing so, labor and management are using all the information regarding the wages that have already been set, the expected path of the exchange rate and foreign prices, and the prices that other competitors are expected to set in the future.[10] Wages are set at time t for period $t + k$ such that the goods market at time $t + k$ is expected to clear at the full employment output ($L = 1$). Thus, applying equations (1), (2), we get:

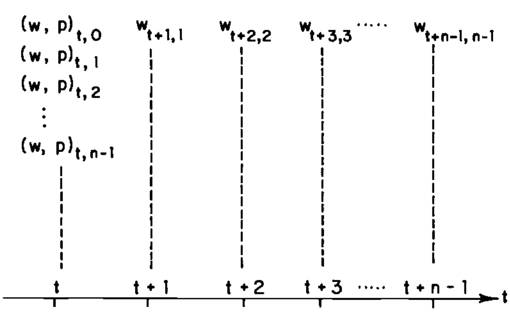

Fig. 6.1 Temporal arrangement of wages (W) and prices (P).

$$E_t\,(q_{t+k}) = \beta\, E_t(\bar{p}_{t+k} - p_{t+k,k}) + \alpha\, E_t(e_{t+k} + p^*_{t+k} - p_{t+k,k}) \tag{9}$$

where E_t denotes the conditional expectation operator, when expectations are conditional on the information at time t. Applying (9) to (5) we obtain

$$w_{t+k,k} = E_t\,(p_{t+k} + q_{t+k} - c). \tag{10}$$

We assume a stable stochastic structure, and unsynchronized price setting—that is, that the contracts decision periods are distributed uniformly over time. Within this assumption the complexity of the problem is reduced significantly. This assumption breaks the symmetry of all domestic producers that is observed in the flexible pricing equilibrium, while at the same time it imposes enough structure to allow a tractable solution. Within each period a fraction $1/n$ of the producers determines the time path of prices. The result is pricing decisions for each period that differ across firms, according to the timing of their most recent wage contract negotiation. Consequently, the domestic price level is given by

$$\bar{p}_t = \sum_{i=1}^{n} (p_{t,n-i}/n). \tag{11}$$

Consider the case where we start at time zero in the long-run equilibrium, with contracts that are fully adjusted to all the past shocks. I would now like to study adjustment to real and nominal shocks. To simplify notation I assume that by the choice of units, all prices and aggregate output in the initial equilibrium are one (or zero in logarithmic terms). My subsequent analysis will focus on deriving the changes in all variables relative to this benchmark. Consequently, I will use the logarithmic notation to denote the percentage changes relative to this benchmark. I allow for two stochastic shocks: a monetary (m) and a real shock (q). Applying equations (4), (5), (6), (10), and (11) yields

$$\begin{aligned} p_{t,n-k} = \theta[\, & E_{t-(n-k)}p_{t,n-k} + q_{t-k} - \bar{\gamma} q_t + (\bar{\gamma} - 1) \\ & (\alpha + \beta - 1/\xi)\bar{p}_t + (\bar{\gamma} - 1)m_t/\xi]. \end{aligned} \tag{12}$$

Equation (12) describes the actual price at time t charged by a producer that negotiated the labor contract $n - k$ periods ago. This price is a function of three types of variables: the expected producer price at the time of the wage negotiation, the price level at time t, and the realization of the nominal and the real shocks.

To gain further insight it is useful to impose restrictions on the stochastic structure in order to allow a reduced-form solution of the time path of the key variables. For example, consider the case where both liquidity m and productivity q follow a random walk:

$$m_t = m_{t-1} + \eta_t. \tag{13}$$

$$q_t = q_{t-1} + \epsilon_t. \tag{14}$$

To simplify exposition I proceed by analyzing two polar cases. I start with an economy where all shocks are nominal, and continue with an economy where all shocks are real. The general case where both types of shocks are present is obtained as a linear combination of these two polar cases.

6.4.1 Short-Run Adjustment to Monetary Shocks

I start my analysis by providing the general solution for prices and quantities and proceed by studying the dynamics of adjustment to a nominal shock starting from a long-run equilibrium.

Following some tedious steps, I can show that the wage setting rule and the corresponding prices are given by

$$w_{t,n-k} = \sum_{j=1}^{k} A_j \eta_{t-(n-j)} + \{m_{t-n} - (\xi - 1)q_{t-n} - c\}. \tag{15}$$

$$p_{t,n-k} = \sum_{j=1}^{k} A_j \eta_{t-(n-j)} + \sum_{j=k+1}^{n} B_j \eta_{t-(n-j)} + \{m_{t-n} - (\xi - 1)q_{t-n} - c\} \tag{16}$$

$$\text{where } A_j = \frac{1 + (\bar{\gamma} - 1)(\beta + \alpha)}{(n - j + 1)/n + (\bar{\gamma} - 1)(\beta + \alpha) + (j - 1)(\beta + \alpha)\xi/n}$$

and

$$\text{where } B_j = \frac{(\bar{\gamma} - 1)(\beta + \alpha)}{(n - j + 1)/n + (\bar{\gamma} - 1)(\beta + \alpha) + (j - 1)(\beta + \alpha)\xi/n}.$$

Note that A_j equals the elasticity of the wage for period t that was set at period $t - (n - k)$ with respect to innovations at period $t - (n - j)$ for $j = 1, \ldots, k$. Thus, smaller values of j are associated with older innovations. From (15) it follows that innovations that took place in or before period $t - (n - 1)$ affect the wage with a unitary elasticity. The logic of this result stems from the observation that equations (6), (7), and (8) imply that the long-run wage is given by $m - (\xi - 1)q - c$. Because in our economy there are staggered contracts whose duration is n, it takes $n - 1$ periods to accomplish the adjustment to a given innovation. Once the adjustment is accomplished, it affects nominal wages with a unitary elasticity.

To gain further insight it is useful to consider the adjustment path to shocks starting from a long-run equilibrium at time $t - 1$. For example, suppose that at time t, $\eta_t = 1$. With the exception of the producers that negotiate at period t ($1/n$ of all producers), all the other producers do not adjust wages to reflect η_t. Applying (15) and (16) yields that

$$(17)\quad w_{t,0} = p_{t,0} = \frac{1 + (\bar{\gamma} - 1)(\beta + \alpha)}{1/n + (\bar{\gamma} - 1)(\beta + \alpha) + (n - 1)(\beta + \alpha)\xi/n} \text{ and}$$

$$(18)\quad p_{t,1} = p_{t,2} = \ldots = p_{t,n-1} = \frac{(\bar{\gamma} - 1)(\beta + \alpha)}{1/n + (\bar{\gamma} - 1)(\beta + \alpha) + (n - 1)(\beta + \alpha)\xi/n}.$$

$$(19)\quad \bar{p}_t = \frac{(\bar{\gamma} - 1)(\beta + \alpha) + 1/n}{1/n + (\bar{\gamma} - 1)(\beta + \alpha) + (n - 1)(\beta + \alpha)\xi/n} < 1.$$

The result of the increase in liquidity is to raise all prices. Note that if all domestic prices rise at the same rate we will obtain an excess supply of goods produced by producers that preset wages for time t in the past, because they enjoy a cost advantage relative to the producers that set their wage at time t. Thus, the presetters will increase prices by less than the producers that are setting wages at time t(i.e., $p_{t,1} < p_{t,0}$). The overall effect of the presetting of wages is that the aggregate price level rises by less than the implied long-run adjustment (i.e., $\bar{p}_t < 1$). Note also that if $(\beta + \alpha)\xi < 1$, the price and the wage of producers that negotiate the contract at time t will overshoot the long-run adjustment (i.e., $w_{t,0} = p_{t,0} > 1$). Applying (4) and (6) we infer that

$$(20)\quad e_t = \bar{p}_t + (1 - \bar{p}_t) / (\alpha\xi) = 1 + (1 - \bar{p}_t)(1 - \alpha\xi)/(\alpha\xi).$$

Applying (19) and (20), we infer that the exchange rate depreciation exceeds the aggregate price adjustment, implying that the monetary shock induces real depreciation in the short run at a rate of

$$(21)\quad e_t - \bar{p}_t = \frac{(n - 1)(\beta + \alpha)/n}{\alpha[1/n + (\bar{\gamma} - 1)(\beta + \alpha) + (n - 1)(\beta + \alpha)\xi/n]}.$$

Another implication of equation (20) is that exchange-rate overshooting will occur if $1 > \alpha\xi$. Note that (4) and (6) imply that the elasticity of the demand for money with respect to the exchange rate is $\alpha\xi$, and overshooting will occur if this elasticity falls short of unity.[11] We turn now to an assessment of the short-run output effect of the monetary innovation. Note that (1) implies that for any producer k

$$(22)\quad x_k = \alpha(e - \bar{p}) + (\alpha + \beta)(\bar{p} - p_k).$$

The first term reflects the common effect due to the real depreciation, whereas the second term reflects the producer-specific effect due to deviations of his prices from the economy's average price. As my analysis indicates, the common effect implies that output will rise. The producer-specific effect works towards output contraction for "flexible" producers (i.e., producers that are setting wages at time t). In fact, because of the inelastic supply of labor we obtain that the two effects cancel each other for the flexible producers and that $x_{t,0} = 0$. On the other hand, the producer-specific effect works towards output expansion for the producers that preset wages before period t. Direct application of (17)–(20) reveals that

(23) $$x_{t,o} = 0.$$

(24) $$x_{t,1} = \ldots = x_{t,n-1} = (\alpha + \beta)/ [1/n + (\bar{\gamma} - 1)(\beta + \alpha) + (n - 1)(\beta + \alpha)\xi/n].$$

(25) $$\bar{x}_t = (n - 1)(\alpha + \beta)/ [1 + n(\bar{\gamma} - 1)(\beta + \alpha) + (n - 1)(\beta + \alpha)\xi].$$

(25′) $\bar{l}_t = \bar{\gamma}\,\bar{x}_t$ where $\bar{l}_t$ is the change in aggregate employment.

Figure 6.2 plots the dependency of prices and output on the substitutability between domestic and foreign goods (α). Notice that greater substitutability induces greater output and employment effects and smaller price effects. Similar results apply for the variances of the variables plotted in figure 6.2 for the case where only monetary shocks are affecting the economy. Direct calculation reveals that the degree of staggering (i.e., the contract length n) affects the adjustment in the following way

(26) $$\frac{\partial \bar{x}_t}{\partial n} > 0$$

$$\frac{\partial (e_t - \bar{p}_t)}{\partial n} > 0$$

$$\frac{\partial e_t}{\partial n} > 0$$

$$\frac{\partial \bar{p}_t}{\partial n} < 0$$

$$\frac{\partial \bar{l}_t}{\partial n} > 0.$$

Longer contracts magnify the exchange rate, the output, and the relative price effects induced by monetary shocks in the short run, while they dampen the price level adjustment.

6.4.2 Intermediate-Run Adjustment to Monetary Shocks

We turn now to the adjustment observed in the intermediate run. Over time, more wage contracts are renegotiated to reflect the liquidity shock. Because the impact effect of the shock is to cause output ex-

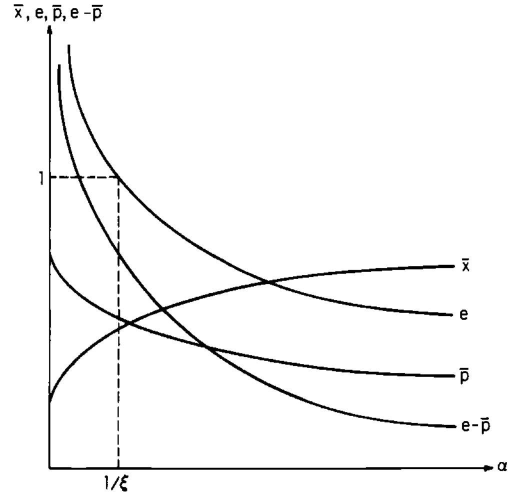

Fig. 6.2 Substitutability (α) and the adjustment of prices ($\bar{p}$), output ($\bar{x}$), nominal and real exchange rates (e and $e - \bar{p}$) to a monetary shock.

pansion at the previously preset wages, forces of excess demand in the labor market will raise wages in the renegotiated contracts at a rate that will reduce output and employment to the preshock level. This in turn will enable other producers to raise prices. Thus, over time aggregate prices will rise, while aggregate output will drop. This adjustment in turn will reduce the real depreciation implied by the initial shock. More formally, applying equations (4), (6), (15), and (16), we obtain that after k periods the monetary shock $\eta_t = 1$ will result in:

$$(19') \quad \bar{p}_{t+k} = \frac{(\bar{\gamma} - 1)(\beta + \alpha) + (k + 1)/n}{(1 + k)/n + (\bar{\gamma} - 1)(\beta + \alpha) + (n - (k + 1))(\beta + \alpha)\xi/n} < 1.$$

$$(20') \quad e_{t+k} = \bar{p}_{t+k} + (1 - \bar{p}_{t+k})/(\alpha\xi) = 1 + \frac{(1 - \alpha\xi)(n - (k + 1))(\beta + \alpha)\xi/[n\alpha\xi]}{(1 + k)/n + (\bar{\gamma} - 1)(\beta + \alpha) + (n - (k + 1))(\beta + \alpha)\xi/n}$$

$$(21') \quad e_{t+k} - \bar{p}_{t+k} = \frac{(n - (k + 1))(\beta + \alpha)/n}{\alpha[(1 + k)/n + (\bar{\gamma} - 1)(\beta + \alpha) + (n - (k + 1))(\beta + \alpha)\xi/n]}.$$

$$(25'') \quad \bar{x}_{t+k} = \frac{(n - (k + 1))(\beta + \alpha)/n}{(1 + k)/n + (\bar{\gamma} - 1)(\beta + \alpha) + (n - (k + 1))(\beta + \alpha)\xi/n}.$$

Note that the condition generating short-run overshooting (i.e., $1 > \alpha\xi$) implies also intermediate-run overshooting, where over time we will observe nominal appreciation. Applying the above equations we obtain that the dynamics of intermediate-run adjustment are characterized by

$$\begin{aligned}
&(27) \qquad \Delta\bar{p}_{t+k}/\Delta k > 0 \\
&\Delta^2\bar{p}_{t+k}/\Delta k^2 > 0 \\
&\bar{p}_{t+n-1} = 1 \\
&\Delta\bar{x}_{t+k}/\Delta k < 0 \\
&\Delta^2\bar{x}_{t+k}/\Delta k^2 < 0 \\
&\bar{x}_{t+n-1} = 0 \\
&\Delta(\bar{e}_{t+k} - \bar{p}_{t+k})/\Delta k < 0 \\
&\Delta^2(\bar{e}_{t+k} - \bar{p}_{t+k})/\Delta k^2 < 0 \\
&\Delta\bar{e}_{t+k}/\Delta k < 0 \\
&\Delta^2 e_{t+k}/\Delta k^2 < 0 \text{ if } 1 > \alpha\xi \text{ and} \\
&\Delta\bar{e}_{t+k}/\Delta k > 0 \\
&\Delta^2 e_{t+k}/\Delta k^2 > 0 \text{ if } 1 < \alpha\xi.
\end{aligned}$$

Figure 6.3 summarizes the dynamics of adjustment of aggregate prices and output.[12] An important feature of my staggered framework is that

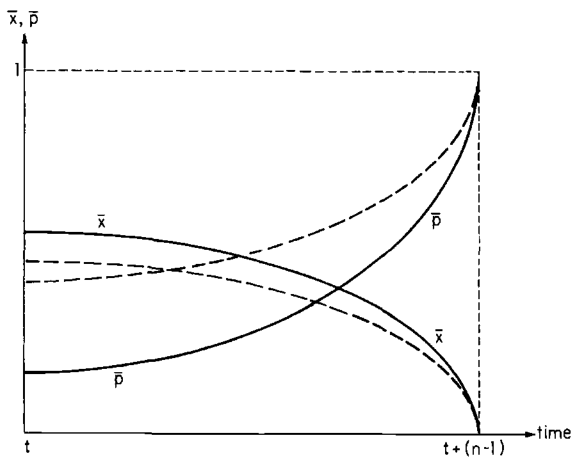

Fig. 6.3 The dynamics of price ($\bar{p}$) and output ($\bar{x}$) adjustment to a monetary shock.

the speed of adjustment accelerates during the adjustment. Following the shock at time t, the monetary shock triggers persistent relative price and output shocks. Over time the shocks to relative prices and output will die down at an accelerated rate, and the rise in liquidity is absorbed via accelerated aggregate price adjustment. It can be shown that smaller substitutability α will raise the curvature of the adjustment path. This in turn implies greater persistency of prices and output during the first phase of the adjustment and a more abrupt adjustment towards the end of the adjustment cycle. In terms of figure 6.3 we will observe that a drop in α is associated with adjustment on the dotted (instead of on the solid) curves. It is noteworthy that the result regarding the accelerated speed of adjustment differs from the one obtained applying linear models, where typically the speed of adjustment drops during the cycle.[13]

6.4.3 Adjustment to Real Shocks

We turn now to the case of productivity shocks. We follow a procedure similar to our analysis of nominal shocks. Suppose that we start in a long-run equilibrium in period $t - 1$ and consider the adjustment to a productivity shock at time t, given by $\epsilon_t = 1$. Applying the characteristics of a long-run equilibrium and the corresponding money market equilibrium (equations [2], [4], and [6]) we obtain that the long-run effects of the productivity shock are

$$\begin{aligned} \Delta\bar{x} &= 1 \\ \Delta\bar{p} &= -\xi \\ \Delta e &= (1 - \xi\alpha)/\alpha \\ \Delta(e - \bar{p}) &= 1/\alpha \\ \Delta w &= 1 - \xi. \end{aligned} \tag{28}$$

The productivity shock implies a rise in output and a corresponding drop in prices. To clear the induced excess supply of domestic goods we need a real depreciation. There is ambiguity regarding the induced exchange rate and wage adjustment. Notice that low substitutability (α) or low output elasticity of demand for money tends to be associated with nominal depreciation, and low income elasticity of the demand for money (i.e., $\xi < 1$) implies that money wages will go up.[14]

Following some tedious steps, it can be shown that the wage-setting rule and the corresponding prices are given by

$$w_{t,n-k} = \sum_{j=1}^{k} F_j \eta_{t-(n-j)} + \{m_{t-n} - (\xi - 1)\, q_{t-n} - c\}. \tag{15'}$$

(16′)
$$p_{t,n-k} = \sum_{j=1}^{k} F_j \epsilon_{t-(n-j)} + \sum_{j=k+1}^{n} G_j \epsilon_{t-(n-j)} + \{m_{t-n} - (\xi - 1)\, q_{t-n} - c\}$$

where F_j
$$= -\xi \frac{1 + (\bar{\gamma} - 1)(\beta + \alpha) + (j - 1)\{\beta + \alpha - 1/\xi\}/n}{1 + (\bar{\gamma} - 1)(\beta + \alpha) + (j - 1)\{(\beta + \alpha)\xi - 1\}/n}$$

and

where $G_j = F_j - (F_j + 1)/\{1 + (\bar{\gamma} - 1)(\beta + \alpha)\}$.

We turn now to the analysis of the short- and intermediate-run adjustment. Formally, the time path of the variables of interest is given by

(29)
$$\bar{p}_{t+k} = -\xi - \frac{(1 - \xi)\xi(\alpha + \beta)(n - (k + 1))/n}{1 + (\bar{\gamma} - 1)(\beta + \alpha) + (n - (k + 1))\{(\beta + \alpha)\xi - 1\}/n}$$
$$= -\xi \frac{(k + 1)/n + (\alpha + \beta)(\bar{\gamma} - (k + 1)/n)}{1 + (\bar{\gamma} - 1)(\beta + \alpha) + (n - (k + 1))\{(\beta + \alpha)\xi - 1\}/n} < 0.$$

(30)
$$e_{t+k} = \bar{p}_{t+k}(\xi\alpha - 1)/(\xi\alpha).$$

(31)
$$e_{t+k} - \bar{p}_{t+k} = -\bar{p}_{t+k}/(\xi\alpha).$$

(32)
$$\bar{x}_{t+k} = -\bar{p}_{t+k}/\xi > 0.$$

(33)
$$\bar{l}_t = \bar{\gamma}[\bar{x}_{t+k} - 1] = \bar{\gamma}[\alpha(e_{t+k} - \bar{p}_{t+k}) - 1]$$
$$= \frac{(1 - \xi)\bar{\gamma}(n - (k + 1))(\beta + \alpha)/n}{1 + (\bar{\gamma} - 1)(\beta + \alpha) + (n - (k + 1))\{(\beta + \alpha)\xi - 1\}/n}.$$

The impact effect of the gain in productivity is a drop in prices, a rise in output, and real depreciation. This real depreciation is needed to clear the incipient excess supply induced by the rise in productivity. As can be seen from (29)–(33), the dynamics of adjustments to the new long-run equilibrium are determined by the magnitude of the income elasticity of the demand for money (ξ). Note that (29) implies that if that elasticity is smaller than unity, the short-run drop in domestic goods prices will exceed the long-run adjustment. This will also be the case where employment will increase in the short run (see [33]). Henceforth we will assume that this condition is satisfied (i.e., that $\xi < 1$). As is evident from (30), the path of the nominal exchange rate is determined by the sign of $(1 - \alpha\xi)/\alpha$. In general, small elasticities (i.e., $\alpha\xi < 1$) are associated with a nominal depreciation and large elasticities with a nominal appreciation. The relative complexity of the nominal exchange rate adjustment stems from the fact that the nominal exchange rate serves both as a component of the real exchange rate and as a factor determining the price level. The expansion of output calls for appreciation to accommodate the drop in domestic prices that is needed to clear the money market and for a depreciation needed to make domestic goods cheaper in order to clear the domestic goods market. It is the balance of these two forces that determines the path of the nominal exchange rate.

Direct calculation reveals that the degree of staggering (i.e., the contract length n) affects the adjustment according to the relative size of the income elasticity of the demand for money. Specifically, I demonstrated before that if $\xi < 1$, nominal contracts will magnify the response to real shocks (relative to the long-run adjustment). Consequently, we expect that for $\xi < 1$ a longer presetting horizon will increase the short-run impact of the shock on prices, the exchange rate, output, and employment. This can be verified by equation (29), which implies that:

$$\text{(34)} \qquad \operatorname{sign} \frac{\partial \bar{p}_{t+k}}{\partial n} = \operatorname{sign} (\xi - 1).$$

Figure 6.4 summarizes the dynamics of adjustment. It is drawn for the case where $\xi < 1$. As in the previous discussion, the effect of a staggered price path is that we observe an accelerating adjustment to

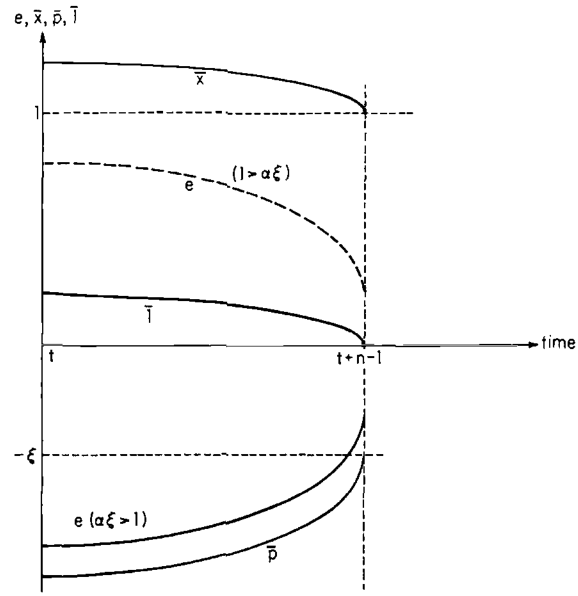

Fig. 6.4 The dynamics of price ($\bar{p}$), exchange rate (e), employment ($\bar{l}$), and output ($\bar{x}$) adjustment to a real shock (drawn for $\xi < 1$).

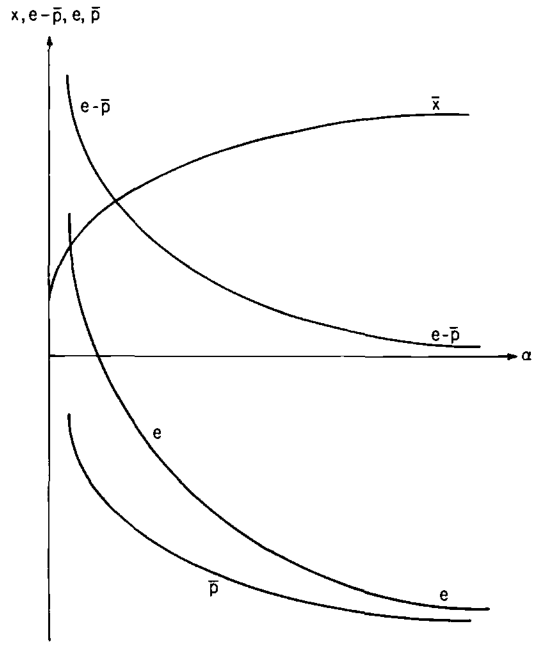

Fig. 6.5 Substitutability (α) and the adjustment of prices ($\bar{p}$), output ($\bar{x}$), nominal and real exchange rates (e and $e - \bar{p}$) to a real shock (drawn for $\xi < 1$).

the new long-run equilibrium. It is noteworthy that for $\xi < 1$, a larger degree of substitutability has the effect of magnifying the short- and intermediate-run adjustment of prices and output to real shocks, reducing the needed adjustment of relative prices.[15] These results are summarized in figure 6.5 (drawn for $\xi < 1$).

6.5 Contract Length

Our previous discussion was conducted for the case where the contract length was exogenously given. We turn now to the analysis of the determinants of contract length.[16] Consider the case where each contract negotiation involves a cost. Negotiating the contract every n periods ($n > 1$) is associated with deadweight losses in the labor market, because the employment subject to the preset wage is suboptimal. More frequent wage negotiation will reduce the net present value of the expected deadweight losses in the labor market, but will raise the net present value of the negotiation costs. The contract length is set to balance these two effects at the margin, such that the rise in the net present value of expected losses resulting from extending the contract by one period equals the drop in the net present value of the negotiation costs.[17] Among the factors determining the contract horizon are the substitutability between goods and the volatility of the shocks affecting the economy. It can be shown that a higher volatility of the shocks and a greater goods substitutability will raise the deadweight losses in the labor market for a given contract length, implying thereby a shortening of the contract horizon.[18] Denoting the optimal n by n^* and the variances of the shocks by V_ϵ, V_η, we can summarize the factors determining n^* by: $n^* = n^*(\alpha, \beta, V_\epsilon, V_\eta)$,

where $\partial n^* / \partial \alpha < 0$; $\partial n^* / \partial \beta < 0$; $\partial n^* / \partial V_\epsilon < 0$; $\partial n^* / \partial V_\eta < 0$.

6.6 Labor Market Adjustment in the Presence of Misalignment

The purpose of this section is to review the role of labor market adjustment in the presence of exchange rate misalignment. We define exchange rate misalignment as a major change in the real exchange rate to a level that is not consistent with full employment in the presence of existing labor contracts. This misalignment can be the result of large shocks. We start our discussion by classifying these shocks into several categories. The first type of shocks is the result of a large realization of the nominal or real shocks specified before. The second type is structural shocks that change the underlying parameters, like a change in the substitutability between various goods, a change in the share of labor in the GNP, changes in the covariance structure of the shocks, and so forth.

Our previous discussion specified a framework that is applicable for an economy where the shocks are small enough to operate with contracts that preset the wage path for several periods. Such a framework can be modified to reduce the welfare consequences of the first type of shocks significantly. Throughout our discussion we have assumed simple noncontingent labor contracts. The implicit rationale for this assumption is that some of this information may be costly or unobservable, or may be adversely affected by the producer. This rationale suggests that priority should be given to contingencies that use public information that is available in a frequency that exceeds the frequency of wage negotiation. A possible candidate that should enhance adjustment to the first type of shocks is wage indexation to the nominal GNP.[19] To verify this point, note that (1) and (5) imply that if we start from a long-run equilibrium, the effect of various shocks is given by:[20]

$$\Delta l = \Delta(\bar{x} + \bar{p}) - \Delta c - \Delta w. \tag{35}$$

The change in employment can be approximated as the change in nominal GNP (the first term) plus the change in the markup ($-\Delta c$) minus the change in wage. Equation (35) implies that whenever there are no structural shocks affecting the markup rate, a wage rule that will index the wage to nominal income (i.e., $\Delta w = \Delta(\tilde{x} + \tilde{p})$) will stabilize employment.

Suppose now that the economy is subjected to the second type of shocks, that is, structural shocks that affect the markup. Equation (35) suggests that if these shocks are public information in the short run, wage adjustment at a rate equal to the change in the markup will stabilize employment (i.e., $\Delta w = -\Delta c$). Unlike the case where shocks are of the first type, however, one expects structural shocks to be harder to identify, and indexation to a simple aggregate like nominal GNP will not suffice. In these circumstances, adjustment can be enhanced by changing the frequency of wage negotiation. For example, as analyzed in 6.4.4, a structural shock in the form of a rise in the substitutability between domestic and foreign goods or a rise in the volatility of real and monetary shocks calls for more frequent wage negotiations.

6.7 Concluding Remarks

This paper analyzed dynamics of adjustment in the presence of staggered labor contracts in a monopolistic competitive economy. One of the key assumptions of this paper concerns the timing of contracts decisions. It was assumed that the various producers are distributed uniformly over time, so that at each point in time an equal fraction of the producers ($1/n$) determines the time path of wages. With this assumption, the complexity of the problem was reduced significantly. In practice, however, it is evident that in many industries the pricing decisions are made at specific periods of time that are determined frequently by industry-specific considerations (like the season of the year, the end and the beginning of the school year, and the like). Furthermore, it was assumed that each producer sets wages for precisely n periods. Again, in reality one typically observes that the length of the wage cycle differs across sectors in the economy. Such considerations were not allowed in the present analysis, and their incorporation would constitute a useful extension.

Notes

1. Dixit and Stiglitz (1977) revived the interest in monopolistic competition. A growing body of research has recognized the importance of a limited degree of goods substitutability in explaining transmission of macro shocks. See, for example, Rotemberg (1982), Dornbusch (1985), Flood and Hodrick (1985), Giovannini (1985), Aizenman (1986), Svennson (1986), and Svennson and van Wijnbergen (1986). On monopolistic competition in the context of trade models, see Helpman and Krugman (1985).

2. To simplify exposition we consider here the case where the demand is a function only of relative prices. Our analysis can be extended to the case where income effects are added without affecting the main results.

3. Formally, $\bar{P}$ is defined as $\bar{P} = \sum_{k=1}^{h} [P_k/h]$. To simplify notation we assume that h is large enough to imply that $\partial \bar{P}/ \partial P_k \approx 0$. See Aizenman (1986) for an alternative analysis (though in a different context) that does not impose this assumption.

4. My analysis could be conducted for the symmetric case where the "foreign good" is composed of a large number of differentiated products. See, for example, appendix B in Aizenman (1986).

5. My analysis can be extended to the case where the supply of labor is dependent on real wages without affecting the main results. My analysis applies to economies with limited mobility of labor. In my model, wages are equated across producers only on average, and within each period wages will differ across producers according to the time of the recent wage negotiation.

6. Note that as $\alpha \to \infty$, $a_1 \to 1$, $a_2 \to 0$, $a_3 \to 0$ and $\theta[c - \bar{\gamma} q] \to 0$. For a discussion on the PPP doctrine, see Frenkel (1981).

7. Allowing for a dependency of the demand for money on the interest rate and foreign prices will complicate the reduced-form solutions for all variables, but it will not affect the main results regarding the determinants of contract lengths and the nature of the adjustment to shocks.

8. To highlight the role of wage contracts, we assume that prices in the goods market are flexible. Alternative modeling strategy can focus on price rigidities in the goods market, as in Sheshinski and Weiss (1977), Mussa (1981), Rotemberg (1982), and Aizenman (1986).

9. The present formulation is related to that of Fischer (1977), who studies the determinations of contracts in the presence of two-period staggered contracts. The new aspect of the present discussion is in allowing for endogenous determination of the extent of staggering prices, focusing on the role of substitutability between various goods and the stochastic structure in explaining the nature of the resultant equilibrium. My approach is closer to that of Fischer (1977) than to that of Taylor (1980) and Calvo (1983), who consider a staggered equilibrium that sets one price for the presetting horizon, which is taken to be exogenously given. This paper applies Fischer's formulation because it allows for a more tractable analysis regarding the role of goods substitutability in the determination of wages and final prices.

10. I start my formulation with the case where I do not allow for preset wages contingent on future (presently unavailable) information. At the extreme case, where I would make optimal use of all future information in a contingent wage contract, I would converge on the flexible equilibrium economy described earlier. This paper does not attempt to provide a theoretical justification for noncontingent contracts (for further discussion on this issue see Blanchard 1979). Rather, their existence is taken for granted. In section 6.6 I will allow for limited contingencies by considering wage indexation to nominal income.

11. This condition is similar to the one derived in Dornbusch (1976). It is noteworthy that the condition for overshooting of the wage and the price of the "flexible" producers (i.e., producers that set wages at time t) is more stringent than the condition for exchange rate overshooting.

12. Note that equation (4) implies that the PPP ratio (i.e., $e - \bar{p}$) follows a time path similar to that of output ($\tilde{x}$).

13. See, for example, Dornbusch (1976).

14. Formally, depreciation requires that $1 > \alpha\xi$, which is also the condition for exchange rate overshooting to nominal shocks.

15. This follows from the fact that sign $\partial \bar{p}_{t+k}/ \partial \alpha$ = sign $(\xi - 1)$.

16. I sketch here the framework described in Aizenman (1966, appendix A). The analysis there refers to the determination of the desired presetting horizon of goods prices in a staggered equilibrium. For a related analysis see Gray (1978).

17. Note that I assume no coordination among the various producers in their contract negotiation. Thus, in calculating the desired contract length from the point of view of a producer k (denoted by n_k), the producer balances the marginal costs and benefits, assuming that other producers are following a policy of contract length n. In his calculation the producer is using the information regarding the characteristics of the economy in an equilibrium where all producers follow a policy of contract length n. The "equilibrium" n is obtained where the desired n_k for each producer coincides with the "market" n.

18. This is the result of the fact that a higher substitutability magnifies the output effects (and consequently the change in the demand for labor) of a given shock (as can be seen from [25′] and [33]).

19. For a discussion of wage indexation to nominal GNP, see Marston and Turnovsky (1985) and Aizenman and Frenkel (1986).

20. Equation (5) implies that $\bar{\gamma}\,[\alpha(p^* + e - \bar{p}) - q] - \alpha(p^* + e - \bar{p}) + w - \bar{p} + c = 0$. Applying equation (1) to this result, we infer that for small deviations from the initial long-run equilibrium $\bar{\gamma}\,[\Delta\bar{x} - \Delta q] - \Delta\bar{x} + \Delta w - \Delta\bar{p} + \Delta c = 0$. Applying equation (2) to this result we obtain equation (35) for small deviations from the initial long-run equilibrium.

References

Aizenman, Joshua. 1986. Monopolistic competition, relative prices, and output adjustment in the open economy. NBER Working Paper no. 1787, January.

Aizenman, Joshua, and Jacob A. Frenkel. 1986. Supply shocks, wage indexation, and monetary accommodation. *Journal of Money, Credit, and Banking* 18: 304–22.

Blanchard, Olivier J. 1979. Wage indexation rules and the behavior of the economy. *Journal of Political Economy* 87.

Calvo, Guillermo A. 1983. Staggered contracts and exchange rate policy. In Jacob A. Frenkel, ed., *Exchange rates and international macroeconomics*. Chicago: University of Chicago Press.

Dixit, Avinash, and Joseph Stiglitz. 1977. Monopolistic competition and optimal product diversity. *American Economic Review* 67:297–308.

Dornbusch, Rudiger. 1976. Expectations and exchange rate dynamics. *Journal of Political Economy* 84:1161–76.

———. 1985. Exchange rate and prices. NBER Working Paper no. 1769.

Fischer, Stanley. 1977. Wage indexation and macroeconomic stability. In Karl Brunner and Allan H. Meltzer, eds., Stabilization of domestic and international economy. *Carnegie-Rochester Conference on Public Policy, Journal of Monetary Economics*, Suppl. 5, pp. 107–47.

Flood, Robert P., and Robert J. Hodrick. 1985. Optimal price and inventory adjustment in an open economy model of the business cycle. *Quarterly Journal of Economics* 100:887–914.

Frenkel, Jacob A. 1981. The collapse of purchasing power parity during the 1970s. *European Economic Review* 16:145–65.
Giovannini, Alberto. 1985. Exchange rates and traded goods prices. Working paper, Columbia University.
Gray, J. A. 1978. On indexation and contract length. *Journal of Political Economy* 86 (February): 1–18.
Helpman, Elhanan, and Paul Krugman. 1985. *Market structure and foreign trade*. Cambridge: MIT Press.
Marston, Richard C., and Stephen J. Turnovsky. 1985. Imported material prices, wage policy, and macro-economic stabilization. *Canadian Journal of Economics* 18:273–84.
Mussa, Michael. 1981. Sticky prices and disequilibrium adjustment in a rational model of the inflationary process. *American Economic Review* 71:1020–27.
Rotemberg, Julio J. 1982. Sticky prices in the United States. *Journal of Political Economy* 90:1187–1211.
Sheshinski, Eytan, and Yoram Weiss. 1977. Inflation and costs of price adjustment. *Review of Economics Studies* 44:287–304.
Svennson, Lars E. O. 1986. Sticky goods prices, flexible asset prices, monopolistic competition, and monetary policy. *Review of Economic Studies* 53:385–405.
Svennson, Lars E. O., and Sweder van Wijnbergen. 1986. International transmission of monetary policy. Working paper no. 362, University of Stockholm.
Taylor, John B. 1980. Aggregate Dynamics and Staggered Contacts. *Journal of Political Economy* 88:1–23.

Comment Stephen J. Turnovsky

Joshua Aizenman has written a very elegant paper. It is primarily about the impact of shocks on a small open economy. This is a topic which encompasses an extensive literature. Aizenman's analysis enhances this literature by embodying two features:

(1) The determination of wages through multiperiod contracts
(2) The characterization of the output market by monopolistic competition

The introduction of overlapping wage contracts is an extension of Fischer-Taylor type models and is fairly familiar. The introduction of monopolistic competition into international macroeconomics is much less well known, and here the author applies some of his previous work; see Aizenman (forthcoming).

I shall focus my remarks on the following aspects: (1) the structure of the model, (2) some observations on the implications of the model and comparisons with some standards, and (3) some comments on exchange rate misalignment.

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Review of Model

The model consists of three markets: the goods market, the labor market, and the money market. The first and third of these are straightforward. Demand and output are specified by Cobb-Douglas type functions, which have well-known advantages of analytical convenience. The specification of the demand for money to depend upon only real output is also a great simplification, and I shall comment further on this aspect below.

The key sector of the model is the labor market, where two situations are considered. The first is a benchmark economy in which prices and wages are perfectly flexible. This yields a long-run full employment equilibrium in which long-run purchasing power parity holds. Specifically, the long-run equilibrium real exchange rate equals the ratio of the productivity of labor to the degree of substitutability between domestic and foreign goods.

By contrast, most of the analysis deals with an economy in which wages are preset for a number of periods. The wage rule is set such that the labor market is expected to clear at each period. This leads to the pricing equation (5), in which the price of the k^{th} producer is determined as a markup on (1) the domestic price of foreign goods, (2) the general price level, and (3) the wage rate. This equation, together with the relationship between the average price level and the prices set by individual producers at different stages of the contract cycle, is the source of the dynamics in the model.

The model also distinguishes between the short run and the intermediate run. A key assumption is that wage contracts are negotiated at each period for n periods ahead, with a fraction $1/n$ of the producers signing a contract at each point of time. Thus at time t, say, we observe a vector of wages and prices:

$$w_t = (w_{t,0}, \ldots, w_{t,n-1})$$
$$p_t = (p_{t,0}, \ldots, p_{t,n-1})$$

where

$w_{t,i}$ = wage paid at time t by a producer who signed his wage contract i periods ago,

$p_{t,i}$ = price set at time t by a producer who signed his wage contract i periods ago.

Aizenman then solves for $p_{t,n-k}$, $w_{t,n-k}$ as a function of the shocks over the life of the contract, under the assumption that expectations are rational. In the short run the average price $\bar{p}_t$ is given and all wages but the current are taken as preset. Over the intermediate run, new wage contracts are signed and the average price level $\bar{p}_t$ changes as more firms reset their prices.

With this setup, Aizenman analyzes the effects of both monetary and real shocks on a number of key macroeconomic variables, including (1) the nominal exchange rate, (2) the price level, (3) the real exchange rate, and (4) output. He then considers how these responses change with the degree of substitutability between domestic and foreign goods, as well as analyzing the time profile of the adjustment over the intermediate run. Since the source of the lags is the contracts which last just n periods, all the dynamics take just n periods to complete.

Some Implications of the Model

I now comment on some of the implications of the model and compare them to more standard models in the literature. The benchmark I shall use is a typical stochastic IS-LM model, in which the supply side is represented either by a Lucas supply function (possibly justified in terms of a Gray (1976) type one-period contract) or by means of a Phillips curve giving rise to sluggish prices.

First, consider the shocks themselves. Aizenman shows how a positive monetary disturbance raises the domestic price level and causes a depreciation of both the nominal and real exchange rate. A positive productivity disturbance is shown to increase output and reduce the price level and causes a real depreciation of the exchange rate. The nominal exchange rate may either depreciate or appreciate, depending on whether the parameter $\alpha\zeta \lesseqgtr 1$. Virtually the identical qualitative responses can be shown to occur, for example, in the stochastic short-run model of Turnovsky (1983). That model also predicts an indeterminacy of the nominal exchange rate to supply shocks, and when one normalizes the two models for certain aspects of their specification (such as deflating the money supply by the CPI in the Turnovsky model), the conditions for the response of the exchange rate are almost the same. Finally, as Aizenman himself notes, the conditions for the overshooting of the exchange rate to monetary shocks is the same as in the Dornbusch model with flexible output. So overall, the qualitative responses of the economy to the two classes of disturbances are not too different from what more conventional macro models would predict.

Aizenman studies in some detail the effects of an increase in the degree of substitutability between domestic and foreign goods. He shows how this raises the responsiveness of output to the monetary shock but lowers the responsiveness of both the real and the nominal exchange rate, as well as the price level. Comparing this to the Turnovsky model, I now find some differences. A higher degree of substitutability has an analogous effect on output, as well as on the nominal and real exchange rates. But it now raises, not lowers, the response of the price level to a monetary shock.

The reason is straightforward. In either economy, as the degree of substitutability α increases, the real exchange rate becomes less flexible. More of the adjustment in the real sector in response to a monetary shock must be borne by output and less by the real exchange rate. But in the Turnovsky model, supply is determined by a Lucas supply function, or in other words, by price surprises. Output is therefore proportional to short-run price movements. Hence any increase in the responsiveness of output must be reflected by an increase in the responsiveness of the price level.

I now turn to the dynamic adjustment. The key feature of the dynamics is that the responses of prices and output to either a monetary or a supply shock accelerate over the n periods of the adjustment, which is determined by the contract length. This is in marked contrast to a conventional sluggish price model such as Dornbusch (1976), in which these responses decelerate over time and take an infinite time to complete. As a further contrast, the Lucas-Gray one-period contract model yields no persistence from such shocks; the adjustment is completed within just one period.

The reason for the dynamics in the Aizenman model stems from the relationship relating the average price at time t to the prices set by the individual producers at that time, namely, $\bar{p}_t = \frac{1}{n} [p_{t,0} + p_{t,1} + \ldots + p_{t,t-n}]$. Over time, an increasing number of firms will renegotiate their contracts. Since their wages rise, they increase their prices by a greater amount than do those producers whose wages are preset by preexisting contracts. The more firms that go through the renegotiating cycle, the larger the increase in the average price level, although this process comes to an abrupt halt after time n, when all firms have renegotiated.

The dynamic time paths illustrated in figures 6.3 and 6.4 of Aizenman's paper are strong predictions of the model, and one may quite naturally ask whether these are likely to be the kind of dynamics one observes in response to a monetary disturbance. While one might doubt that this is the case, it is intriguing to note that the dynamic time path for the average price $\bar{p}_t$ illustrated in figure 6.3 is identical to that encountered in simple models which analyze the effects of "announced" monetary disturbances. More specifically, consider the dynamics of the Cagan model as described in Sargent and Wallace's (1973) well-known paper. As their analysis showed, a monetary expansion announced at time 0, say, to take effect at time $T > 0$, will lead to an adjustment path in the price level identical to that of figure 6.3. There is an initial jump increase in the price level, with steady acceleration until time T, when the announced monetary expansion takes place and the adjustment is completed. The acceleration reflects the fact that during the adjustment phase, the economy is following an unstable dynamic time path. There is a parallel here, since the contract which presets wages over a number of periods serves very much as an announcement.

Aizenman's model is of course based on several simplifying assumptions, and I would like to briefly comment on two. The first is the assumption that the supply of labor is inelastic. If one were to drop this assumption and assume instead that the supply of labor depends upon the expected real wage rate, we would immediately introduce two real wage rates into the model. While producers would evaluate the real wage in terms of the price of their good, workers would base their decisions on the real wage defined in terms of the consumer price index. In the standard Gray-type contract models, this distinction complicates the contract somewhat, and it must surely do so here as well.

Secondly, the demand for money is assumed to be interest inelastic. If instead the demand for money were to depend upon the interest rate, forward-looking behavior would be introduced into price setting. As it stands, the price equation (12) is entirely backward looking.

Misalignment of Exchange Rates

The model presented is a descriptive one. It tells us how the economy responds to the two types of disturbances introduced in the paper. But it is well known from previous work on stochastic macroeconomics that the impact of shocks depends critically upon the policy regimes in operation. In particular, it will depend upon (1) monetary–exchange market policy and (2) labor market–wage indexation policy. This is touched upon briefly in the paper, but it would seem to merit further discussion.

Long-run optimal real exchange rate equilibrium is defined by the flexible price model through the relation $\bar{s} \equiv \bar{e} + \bar{p}^* - \bar{p} = q/\alpha$, where $\bar{\ }$ denotes steady-state levels. One can then view the deviation of the current real exchange rate s from s, $(s - \bar{s})$ as a measure of real exchange rate misalignment. An important question to address is how wage indexation and monetary rules, based on responding to the misalignment $s - \bar{s}$ and the shocks this embodies, can be designed to achieve some specified optimality objective. This is a natural extension of previous work by Aizenman and Frenkel (1985) and Turnovsky (1987). These studies emphasize the tradeoffs and interdependence between labor market and monetary policies under different sets of information structures. The existence of multiperiod wage contracts raises the question of the optimal degrees of indexation of different wages at different points in the contract cycle. Aizenman's paper could be extended to examine this issue.

References

Aizenman, J. Forthcoming. Monopolistic competition, relative prices, and output adjustment in the open economy. *American Economic Review*.

Aizenman, J., and J. A. Frenkel. 1985. Optimal wage indexation, foreign exchange market intervention, and monetary policy. *American Economic Review* 75:402–23.

Dornbusch, R. 1976. Expectations and exchange rate dynamics. *Journal of Political Economy* 84:1161–76.

Gray, J. A. 1976. Wage indexation: A macroeconomic approach. *Journal of Monetary Economics* 2:221–35.

Sargent, T. J., and N. Wallace. 1973. The stability of models of money and growth with perfect foresight. *Econometrica* 41:1043–48.

Turnovsky, S. J. 1983. Wage indexation and exchange market intervention in a small open economy. *Canadian Journal of Economics* 16:574–92.

———. 1987. Optimal monetary policy and wage indexation under alternative disturbances and information structures. *Journal of Money, Credit, and Banking* 19:157–80.