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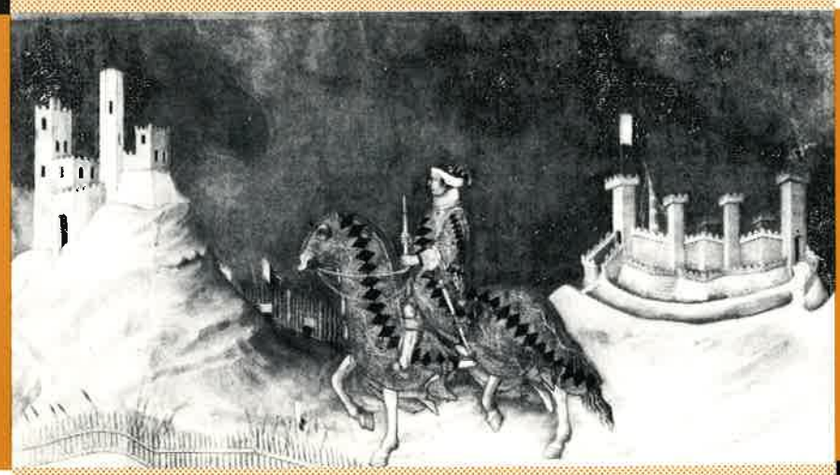
INFLATION EXPECTATIONS, PRICE FLEXIBILITY, AND OUTPUT VARIABILITY IN MACRO MODELS



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by

GIANCARLO MARINI and PASQUALE SCARAMOZZINO

ABSTRACT

This paper demonstrates that inflation expectations may be destabilizing even in models with both rational expectations and flexible prices. The proposition that increased wage (price) flexibility may exacerbate employment and output fluctuations is also analytically confirmed in a variety of macroeconomic models with nominal inertia. A notable exception is a monopolistic competition framework with synchronized contracts where aggregate demand variability, and thus employment fluctuations, increase with the duration of contracts. However, active demand management is shown to be always a superior stabilizing tool than increased nominal price flexibility.

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1. Introduction

Wage and price deflations are not always capable of restoring a market clearing equilibrium, starting from a situation of underemployment. The Pigou effect associated with falling prices may well be outweighed by the contraction in investment generated by deflation expectations. This, in a nutshell, is the essence of Keynes' (1936, chap. 19) scepticism towards the self-equilibrating forces of the market should nominal prices be flexible downwards.

In the present paper we explore the issue of whether the existence of nominal wage and/or price rigidities can lead to a destabilization of the levels of activity and employment. The channel through which destabilization might occur is represented by expectations of the future price level. Following a demand shock, the movement in the aggregate price level acts as an automatic stabilizer due to a real balance effect. Current expectations of future inflation, however, may play a destabilizing role *via* changes in the *ex ante* real rate of interest, if expected inflation moves procyclically. Whether expected inflation exacerbates output and employment fluctuations depends on the mechanism whereby expectations are formed, on the characteristics of the shocks from which the economy is affected, and on the precise nature of the rigidities in the labour and product markets.

An alternative perspective had been taken up by Fisher (1923, 1925, 1933) who focusses on the disruption to financial markets and institutions occurring whilst a deflation is taking place. The starting point of Fisher's analysis was the observed positive correlation between (a distributed lag of) price changes and an indicator of trade volume. The

argument for a deflation-based theory of business cycles relies on debt liquidation and distress selling when borrowers are over-exposed. The resulting fall in prices reduces net profits, with the initial fall in output and employment being further aggravated by the ensuing pessimism and loss of confidence. Mundell (1963) shows that anticipated inflation can have real effects in a Meltzer-type framework where wealth can be held in the form of either money or shares[1]. As stressed by Sheffrin (1989), Irving Fisher's theory of the business cycle is based on movements of the *ex post* real interest rate and their consequences on indebted investors in the economy.

In the present paper the emphasis is on the *ex ante* real interest rate and on imperfections in the labour and product markets. As a consequence of the existence of imperfections in the economy, an increased response of wages and prices to labour and product market imbalances might in principle have perverse effects due to second-best considerations. A countercyclical demand management policy can however be more effective in dampening output fluctuations than a policy aimed at reducing rigidities in the labour market.

An elegant formalization of the problem is presented by Tobin (1975, 1980) in a dynamic context where agents form expectations adaptively. This issue has been forcefully reproposed in modern macroeconomics by DeLong and Summers (1986b) in a Taylor-type staggered wage model with rational expectations, modified to incorporate expected inflation and persistent aggregate demand shocks. In the presence of supply shocks, as shown by Driskill and Sheffrin (1986), Taylor's (1986) stabilizing results would in fact be replicated. A possible conclusion would appear to be that the source of instability associated with inflation expectations can still be

present in models with rational expectations and price inertia. On the other hand, such a destabilizing outcome does not seem to be possible in new classical models. However, a destabilizing expected inflation effect is also present in models à-la Lucas (1973) and Sargent-Wallace (1975) with both rational expectations and flexible prices.

We investigate the problem of whether increased wage and price flexibility may be destabilizing in a variety of models. Our emphasis on alternative supply specifications reflects the consideration, clearly expressed by e.g. Blanchard and Fischer (1989), that the main source of controversy in current macroeconomics lies in how to characterize the supply side of the economy. We present a battery of analytical results broadly supporting the predictions derived by DeLong and Summers on the basis of numerical simulations. The notable exception is constituted by a variant of the monopolistic competition model originally proposed by Ball (1987). Increased wage flexibility is, in this model, even more desirable when inflation expectations are duly taken into account. The puzzle is however only apparent, since, in spite of the alleged similarity of Ball's framework with Fischer's (1977) overlapping wage model, monopolistic competition allows a crucial role for aggregate demand in affecting employment. Hence, when inflation expectations are present, firms operating in longer contracting regimes are exposed to an additional channel of variability.

The scheme of this paper is as follows. Tobin's analysis is presented in Section 2. Section 3 confirms the prediction of DeLong and Summers that increased price flexibility may only occur when expected inflation is appropriately modelled. It is shown that, even in the presence of autoregressive demand shocks, increased wage flexibility is stabilizing in

both Taylor's and Fischer's models. Section 4 establishes that also new classical models are subject to the channel of instability associated with expected inflation. Section 5 presents our proposed versions of a price staggering and an overlapping wage contract model respectively. Analytical results confirm the view that increased flexibility may indeed be destabilizing.

A monopolistic competition model where reducing contract length is stabilizing even when inflation expectations are considered is presented in Section 6. The results are evaluated and critically compared with the previous findings. Section 7 readdresses the issue of active demand management in versions of Fischer's and Ball's models. Our choice is motivated by the availability of analytical solutions. We are able to show that active policy dominates increased wage flexibility as a stabilization tool, reaffirming thus the Keynesian prediction. Some available empirical evidence is interpreted in Section 8. The limits and scope for future empirical work are briefly discussed.

A summary of the results is presented in the concluding Section 9.

2. The dynamic stability of equilibrium under adaptive expectations

The issue of whether a market economy might ever be unable to remedy to a protracted disequilibrium in the goods market, which had sparked off a hot theoretical controversy between Keynes and Pigou[2], has been addressed by Tobin (1975) in an explicitly dynamic framework (see also Tobin (1980)). The potential source of instability is identified with a price change effect upon aggregate demand, *via* changes in the *ex ante* real rate of

interest.

Effective demand, e, depends positively on real output, y, negatively on the price level, p (due to both a Keynes effect on real balances and a Pigou effect on wealth), and positively on expected inflation[3]:

$$e=e(y,p,\pi^e) \tag{1}$$

where $0<e_y<1$. The supply side of the economy is characterized by adjustment of output to effective demand (equation (2)), by an expectations-augmented Phillips curve (equation (3)), and by an adaptive rule for expectations formation (equation (4))[4]:

$$\dot{y} = a_y(e-y) \tag{2}$$

$$\pi = a_p(y-y^*) + \pi^e \tag{3}$$

$$\dot{\pi}^e = a_{\pi^e}(\pi-\pi^e) \tag{4}$$

Equations (2)-(4) describe a dynamical system in the variables (y,p,π^e). Necessary condition for local stability is

$$\underset{(-)}{p^*e_p} + \underset{(+)(+)}{a_{\pi^e}\cdot e_{\pi^e}} < 0 \tag{5}$$

where p^* is the equilibrium value of prices. It is easily seen that, for a given expectations formation parameter a_{π^e}, condition (4) is not satisfied if the stabilizing role of e_p is small relative to the 'speculative' effect of inflation expectations upon aggregate demand as measured by e_{π^e}.

An intuitive account for this result can be as follows. When output is lower than its full employment level, current prices increase by less than expected, thereby stimulating aggregate demand through a real balance effect. By contrast, a negative inflationary surprise implies a downward revision of current expectations of future inflation, due to the adaptive rule for expectations formation. This will increase the expected *ex ante* real interest rate and depress aggregate demand. The latter effect may well outweigh the former, thus violating condition (4).

The assumption of adaptive expectations is crucial in driving the results. It implies that, in the presence of an inflationary surprise, expectations are always revised *in the same direction* as the shock. On the other hand, if agents are entirely backward-looking as implied by the rule they only gradually adjust their inflation expectations to a permanent shock to the level of activity. Hence, they will be systematically surprised by the realized inflation level in each period.

3. Price inertia and output variability

It has been shown that when *both* inflation *and* serially correlated demand shocks are present a destabilization outcome might ensue (see e.g. DeLong and Summers (1986b)). In order to isolate the role played by the expected inflation effect, we now analyse models in which such an effect is *absent*. We consider Taylor's (1979, 1980) and Fischer's (1977) models modified to allow for autoregressive demand shocks. We are able to show that serial correlation of the shocks *per se* is unable to generate a destabilizing outcome. The expected inflation effect is thus necessary for

the variability of output to increase as wages and prices become more flexible.

We now look at Taylor's model with staggered wage setting, modified to incorporate persistent effects of the shocks. Aggregate demand is given by (all variables are in logs)

$$m_t - p_t = y_t - v_t \tag{6}$$

where m_t are nominal balances, p_t the price level, y_t real output (or, equivalently, a measure of the real output gap), and v_t an aggregate velocity shock, which for simplicity is the only source of uncertainty considered. The following stationary AR(1) process is postulated for v_t:

$$v_t = \rho v_{t-1} + z_t \tag{7}$$

where z_t is a white noise with variance σ_z^2. Nominal wages are uniformly staggered, and are set according to the rule

$$w_t = \frac{1}{2}\,(w_{t-1} + E_{t-1}w_{t+1}) + \frac{1}{2}\,g\,(E_{t-1}y_t + E_{t-1}y_{t+1}) \tag{8}$$

The parameter g measures the sensitivity of wages to imbalances in the goods (and hence labour) markets. Prices are a constant mark-up on wages:

$$p_t = \frac{1}{2}\,(w_t + w_{t-1}) \tag{9}$$

Finally, the monetary authorities adjust nominal balances to the price level:

(10) $$m_t = \mu\, p_t$$

The degree of policy accommodation is expressed by μ. By substituting the money rule (10) into (6), the aggregate demand is given by

(11) $$y_t = -\nu\, p_t + v_t \qquad \nu \equiv 1-\mu$$

By replacing equation (9) for aggregate prices into (11) one obtains

(12) $$y_t = -\frac{\nu}{2}\,(w_t + w_{t-1}) + v_t$$

Taking expectations of (12) by making use of (7), replacing into (8) and rearranging one has

(13) $$w_t = \theta\,(w_{t-1} + E_{t-1}w_{t+1}) + \frac{\alpha\rho(1+\rho)}{1+\nu\alpha}\,v_{t-1}$$

where $\alpha \equiv g/2$ and

$$\theta \equiv \frac{1}{2}\,\frac{1-\alpha\nu}{1+\alpha\nu}$$

The minimal state solution of (13) has the form

(14) $$w_t = \pi_1\, w_{t-1} + \pi_2\, v_{t-1}$$

where π_1, π_2 are undetermined coefficients. By taking expectations of (14), replacing into (13) and equating coefficients one obtains

(15a) $$\pi_1 = \frac{1}{2\,\theta}\,(1 - \sqrt{1-4\theta^2}\,)$$

(15b) $$\pi_2 = \frac{\alpha\rho(1+\rho)}{[1-\theta(\pi_1+\rho)]\,(1+\alpha\nu)}$$

where the solution (15a) for π_1 is the stable root. By taking variances of both sides of (14) using equation (7) and by stationarity one has

(16) $$\sigma_w^2 = \frac{1}{(1-\pi_1^2)(1-\rho^2)}\left(\pi_2^2 + \frac{2\pi_1\pi_2^2\rho}{1-\pi_1\rho}\right)\sigma_z^2$$

Finally, by using (12) the variance of output is found to be

(17) $$\sigma_y^2 = \frac{\nu^2}{4}\,(1+\pi_1)^2\,\sigma_w^2$$

$$+\frac{1}{1-\rho^2}\left[\frac{\nu(1+\pi_1)\pi_2\rho}{1-\pi_1\rho}\,(\nu\pi_2-\rho) + \nu\pi_2\left(\frac{\nu\pi_2}{4}+\rho\right) + 1\right]\sigma_z^2$$

From the simulation results reported in Table 1 it clearly emerges that increased wage flexibility, as measured by g, is likely to be stabilizing in the sense of implying a lower ratio of the steady state variance of output relative to the variance of the demand innovation, z_t. This property holds true for a variety of values of the degree of monetary accommodation and of serial correlation of the demand shocks. Only as the autocorrelation parameter becomes very large *and* the degree of monetary accommodation remains very low would increased flexibility be destabilizing at the margin.

The stabilizing outcome becomes even more likely if the information

set of wage setters is allowed to coincide with that of the investors (as for instance in Ambler and Phaneuf (1989)). Equation (8) is replaced by

$$(8') \qquad w_t = \frac{1}{2}\,(w_{t-1} + E_t w_{t+1}) + \frac{1}{2}\,g\,(y_t + E_t y_{t+1})$$

The guess solution for wages now takes the form

$$(18) \qquad w_t = \pi_1\, w_{t-1} + \pi_2\, v_t$$

Solving as before, the undetermined coefficients are

$$(19a) \qquad \pi_1 = \frac{1}{2\,\theta}\,(1 - \sqrt{1-4\theta^2}\,)$$

$$(19b) \qquad \pi_2 = \frac{\alpha(1+\rho)}{[1-\theta(\pi_1+\rho)](1+\alpha\nu)}$$

and

$$(20) \qquad \sigma_y^2 = \frac{1}{2(1-\pi_1)(1-\pi_1\rho)(1-\rho^2)}\,\{\,\nu^2\pi_2^2(1+\rho)$$

$$- 2\nu\pi_2(1-\pi_1)(1+\rho) + 2(1-\pi_1)(1-\pi_1\rho)\,\}\,\sigma_z^2$$

The simulations presented in Table 2 for σ_z^2 normalized to unity show that the steady state variance of output is uniformly lower than when wage setters condition their settlements upon information available at t-1 only (as in Table 1). Increased wage flexibility is now *always* stabilizing, for the parameter values considered.

The prediction that increases in wage flexibility are indeed stabilizing when the expected inflation effect is assumed away can be easily demonstrated in a simple variant of Fischer's (1977) overlapping contracts framework.

The basic structure of the model is as follows. Assuming that nominal wages are predetermined for either one or two periods in order to maintain the expected real wage constant, output supply can be expressed as

$$(21) \qquad y_t = \alpha k\,(p_t - E_{t-1}p_t) + (1-\alpha)\,k\,(p_t - E_{t-2}p_t) \qquad 0 < \alpha < 1$$

Our proposed measure of wage flexibility is thus α, that is the proportion of shorter contracts in the economy. Aggregate demand is simply modelled by inverting a quantity theory equation:

$$(22) \qquad y_t = \gamma\,(m_t - p_t) + \varepsilon_t$$

Solving the model with the standard method of undetermined coefficients it can be easily shown that

$$(23) \qquad \frac{\partial\sigma_y^2}{\partial\alpha} = -\,\frac{2k\rho(1-\alpha)}{[k(1-\alpha)+\gamma]^3} < 0$$

Hence, increases in wage flexibility reduce the asymptotic variance of output when inflation expectations are not explicitly considered.

It might be worth noting that, unlike in Taylor's model, the asymptotic variance of output would be totally unaffected by changes in wage flexibility in case of purely white noise shocks. The reason for this is that there is no genuine forward looking component in Fischer's

contracting structure. In other words, a white noise random disturbance would always be expected to be zero irrespective of the duration of the contracts.

4. Expected inflation in flexible price models

The expected inflation effect is the true key for a possible destabilizing influence of increased wage and price flexibility. As noted by Keynes, a fall in wages following excess supply of labour would not necessarily contribute to a reduction in unemployment. Aggregate demand, while boosted by the Pigou effect, might well fall in the end *via* the adverse effects of expectations of future deflation on investment. Such a possibility is unquestionable in presence of static and/or extrapolative expectations and, as demonstrated by Tobin, is present also when there is a partial adjustment mechanism, or expectations are adaptive.

The contributions of DeLong and Summers (1986b, 1988) have recast the issue in modern macroeconomics, showing that the hypothesis of rational expectations does not in itself deny such a potential source of instability. However, there would appear to be no room for possible destabilizing inflation expectations in new classical models (McCallum (1983), DeLong and Summers (1988)). Yet, this channel of potential instability is present even in rational expectations new classical models. In fact, the stabilizing result derived by McCallum (1983) critically hinges on the purely white noise nature of aggregate demand disturbances, as shown below. Similarly, Flemming's (1987) instability results for certain ranges of parameter values, obtained in a rational expectations

model with sticky prices but perfectly flexible wages and employment, depend on assuming random walk aggregate demand shocks.

The framework chosen is the textbook new classical model of the Sargent-Wallace (1975) variety, where output supply depends only on price surprises

$$y_t = k\,(p_t - E_{t-1}p_t) \tag{24}$$

and the demand side of the economy is specified according to the simple rational expectations augmented IS-LM schedules

$$y_t = -\,\delta\,(r_t - E_t p_{t+1} + p_t) + \varepsilon'_t \tag{25}$$

$$m_t - p_t = \chi_1\, y_t - \chi_2\, r_t \tag{26}$$

Combining equations (25) and (26) one obtains

$$y_t = \gamma\,(m_t - p_t) + \beta\,(E_t p_{t+1} - p_t) + \varepsilon_t \tag{27}$$

where $\beta \equiv \delta/(\delta\chi_1+\chi_2)$, $\gamma \equiv \delta\chi_2/(\delta\chi_1+\chi_2)$, and $\varepsilon_t \equiv [\chi_2/(\delta\chi_1+\chi_2)]\varepsilon'_t$. Solving the model, one obtains the following expression for output:

$$y_t = \Xi \cdot u_t \tag{28}$$

where

$$\Xi \equiv \frac{k(\beta+\gamma)}{[\beta(1-\rho)+\gamma](k+\beta+\gamma)}$$

whence one obtains

$$(29) \qquad \frac{\partial \sigma_y^2}{\partial \beta} = \frac{2k^2(\beta+\gamma)}{[\beta(1-\rho)+\gamma]^3(k+\beta+\gamma)^2} \{k\gamma\rho-(\beta+\gamma)^2(1-\rho)\} \sigma_u^2$$

The asymptotic variance of output is thus an increasing function of the interest rate sensitivity of aggregate demand, expressed by β, if the demand disturbances are highly serially correlated (i.e. ρ is close to unity). A destabilizing result would instead ensue for ρ close to zero.

Hence, price stickiness is neither a necessary nor a sufficient condition for destabilizing inflation expectations. When demand disturbances are a white noise (ρ=0), the innovation in the shock is purely transitory and expected inflation moves countercyclically. When the shock follows a random walk (ρ=1), by contrast, the current shock is fully reflected in the expectation of the future price level. However, the current price only partially incorporates the shock. Expected inflation will thus move in the same direction as the shock.

A similar result can be obtained in the "island" model presented by Lucas (1973), modified to incorporate autoregressive demand shocks and the expected inflation effect. Output supply and demand in each market, indexed by "z", are modelled, respectively, as follows:

$$(30) \qquad y_t(z) = k\,[p_t(z) - E_z p_t]$$

$$(31) \qquad y_t(z) = \gamma\,[m_t(z) - E_z p_t] + \beta\,[E_z p_{t+1}] + \nu_t(z) + \varepsilon_t$$

where E_z denotes the mathematical expectation conditional on the available

information set, which in addition to all past values of endogenous and exogenous variables contains also the observation of the prevailing equilibrium price in the market. Money balances are constant, say $m_t(z)=m$, and $\nu_t(z)$, the local random shock, is assumed to be white noise.

Solving the model, one obtains the economy-wide equilibrium output as

$$(32) \qquad y_t = (1-\theta) \frac{k[\gamma+\beta\theta\rho+\beta(1-\rho)]}{[k(1-\theta)+(\beta+\gamma)\theta][\beta(1-\rho)+\gamma]} u_t$$

where $\theta \equiv \sigma_u^2/(\sigma_y^2+\sigma_u^2)$. It can immediately be seen that the expected inflation effect is always stabilizing when the demand shock is close to a white noise, while it can be destabilizing in case of a random walk disturbance, provided that $k>\gamma$.

The economic intuition is similar to the previous case. When there is a low degree of serial correlation in the shock, expected inflation always moved countercyclically, while for a high degree of persistence expected inflation may move procyclically. The crucial requirement is that the elasticity of output supply with respect to the "terms of trade" or price ratio is greater than the elasticity of aggregate demand with respect to real money balances. In such a case, the response of actual prices to current innovations will be dampened, while the future price level is expected to react fully to such a shock. Hence, expected inflation moves procyclically and destabilizes output.

We have thus reinforced the proposition advanced by DeLong and Summers (1986b). No chronic inertia is required in order to have destabilizing inflation expectations. The crucial factor seems to be the degree of persistence in demand shocks. When persistence is high, destabilizing

inflation expectations are likely to be present even in new classical models.

5. Nominal inertia, autoregressive demand shocks and inflation expectations

In the present Section we analyse some specifications of the supply side of the economy in which prices and wages exhibit nominal inertia. When demand shocks are autoregressive and the expected inflation effect on aggregate demand is present, increased flexibility is likely to be destabilizing under the different specifications considered.

The first model we consider presents price staggering à-la Blanchard (1983). The steady state variance of output might increase as prices become more responsive to product market imbalances, depending on parameter values. The size of the information set of price setters turns out to be crucial. We then explore the properties of a variant of Fischer's (1977) overlapping wage contracting set-up. We derive exact results which provide analytical support to some of DeLong and Summers' (1986b) results.

5.1. Staggered price setting

The framework we consider follows Blanchard (1983) and Blanchard and Fischer (1989, chap. 8) in assuming that prices are set in a staggered fashion. Staggering is uniform over time with prices remaining constant for two periods. The price equation is given by

$$p_t = \frac{1}{2}\,(p_{t-1} + E_{t-1}p_{t+1}) + \frac{1}{2}\,g\,(E_{t-1}y_t + E_{t-1}y_{t+1}) \tag{33}$$

In order to focus on the expected inflation effect, we assume away the real balance effect. Aggregate demand is thus given by

$$y_t = \delta\,(E_t p_{t+1} - p_t) + v_t \tag{34}$$

where v_t is a stationary AR(1) shock:

$$v_t = \rho v_{t-1} + z_t \tag{35}$$

and $z_t \sim WN(0,\sigma_z^2)$. From (33) it immediately follows that $E_t p_{t+1} = p_{t+1}$ (since the price level is predetermined). Taking expectations of y_t and y_{t+1} using (34) and (35), substituting into (33) and rearranging one obtains

$$p_t = \frac{1}{2}\,(p_{t-1} + E_{t-1}p_{t+1}) + \frac{1}{2}\,g\delta\,(E_{t-1}p_{t+2} + E_{t-1}p_t) + \frac{1}{2}\,g\rho(1+\rho)\,v_{t-1} \tag{36}$$

The minimal state solution is postulated to be

$$p_t = \pi_0 p_{t-1} + \pi_1 v_{t-1} \tag{37}$$

Taking expectations using (35), substituting into (36) and equating coefficients with (37) one obtains

(38a) $$\pi_0 = \frac{-(1+g\delta)+\sqrt{1+6g\delta+g^2\delta^2}}{2g\delta}$$

(38b) $$\pi_1 = \frac{g\rho(1+\rho)}{2-\pi_0-\rho-g\delta[\pi_0(\pi_0+\rho)+\rho^2-1]}$$

The solution chosen for π_0 is the unique one meeting the stability requirements. Finally, the steady state variance of output is seen to be

(39) $$\sigma_y^2 = \frac{1}{1-\rho^2}\left[\delta^2\pi_1^2\frac{1-\pi_0}{1+\pi_0} + (\delta\pi_1+1)^2\right]\sigma_z^2$$

The simulations in Table 3 are carried out for parameter values comparable to DeLong and Summers' (1986b). The variance of the demand innovation, σ_z^2, has been normalized to unity. Increased price flexibility is *always destabilizing* at the margin. DeLong and Summers' results are thus strongly confirmed.

These results however critically depend on the price setters' information set. If prices are conditional on the observation of *current* shocks, equation (33) is replaced by

(33') $$p_t = \frac{1}{2}(p_{t-1} + E_t p_{t+1}) + \frac{1}{2} g (y_t + E_t y_{t+1})$$

Prices are now given by

(40) $$p_t = \pi_0 p_{t-1} + \pi_1 v_{t-1} + \pi_2 z_t$$

where

(41a) $$\pi_0 = \frac{-(1+\alpha)+\sqrt{1+6\alpha+\alpha^2}}{2\alpha}$$

(41b) $$\pi_1 = \frac{g\rho(1+\rho)}{2+\alpha-\pi_0-\rho-\alpha(\pi_0^2+\pi_0\rho+\rho^2)}$$

(41c) $$\pi_2 = \frac{(1+\alpha)\pi_1+g(1-\rho)}{(2+\alpha)-(1-\alpha)\pi_0}$$

and where $\alpha \equiv g\delta$. The steady state variance of output is equal to

(42) $$\sigma_y^2 = [A^2D + B^2E + C^2 + 2ABF]\,\sigma_z^2$$

where

$$A \equiv \delta\pi_0\,(\pi_0-1)$$

$$B \equiv \delta\pi_1\,(\pi_0+\rho-1) + \rho$$

$$C \equiv \delta\,(\pi_0\pi_2+\pi_1-\pi_2) + 1$$

$$D \equiv \frac{1}{1-\pi_0^2}\left[\frac{\pi_1^2}{1-\rho^2} + \pi_2^2 + \frac{2\pi_0\pi_1}{1-\pi_0\rho}\left(\frac{\pi_1\rho}{1-\rho^2} + \pi_2\right)\right]$$

$$E \equiv \frac{1}{1-\rho^2}$$

$$F \equiv \frac{1}{1-\pi_0\rho}\left(\frac{\pi_1\rho}{1-\rho^2} + \pi_2\right)$$

From Table 4 one can see that, when price expectations are conditional

on the *current* information set, increased flexibility is almost always *stabilizing* at the margin[5] despite the absence of a (stabilizing) real balance effect. Therefore, the set of events upon which inflation expectations are formed turns out to be crucial.

5.2. Overlapping contracts

Analytical results showing the ambiguity of decreases in wage flexibility can be obtained in our simple version of Fischer's (1977) model modified to incorporate inflation expectations[6].

The basic model now consists of the following equations

$$y_t = \alpha k(p_t - E_{t-1}p_t) + (1-\alpha)k(p_t - E_{t-2}p_t) \qquad 0<\alpha<1 \tag{43}$$

$$y_t = \gamma(m-p_t) + \beta(E_t p_{t+1} - p_t) + \varepsilon_t \tag{44}$$

$$\varepsilon_t = \rho\varepsilon_{t-1} + u_t \qquad 0<\rho<1 \tag{45}$$

where y_t is real output, p_t output price, m nominal money balances (assumed constant for simplicity), and ε_t a real demand shock.

The coefficient α in the aggregate supply (43) is the proportion of one-period contracts in the economy, and measures the degree of flexibility of wages and prices. Equation (44) is aggregate demand, and equation (45) is the stationary AR(1) stochastic process followed by the aggregate demand disturbance.

Solving the model one obtains (see Marini and Scaramozzino (1990)):

$$\frac{\partial\sigma_y^2}{\partial\alpha} = \Theta\cdot\{k(1-\alpha)\beta[\beta(1-\rho)+\gamma] + (\beta+\gamma)^2\beta - k(k+\beta+\gamma)^2(1-\alpha)(\beta+\gamma)^2\rho\}\,\sigma_u^2 \tag{46}$$

where

$$\Theta \equiv \frac{2}{(k+\beta+\gamma)^2[k(1-\alpha)+\beta+\gamma]^3[\beta(1-\rho)+\gamma]^2}$$

It is clear that whether or not increases in price flexibility are stabilizing crucially depends on the degree of persistence of aggregate demand shocks. They are destabilizing for a low value of the autocorrelation parameter and conversely, confirming thus the simulations of DeLong and Summers (1986b). It is apparent that in case of white noise shocks the explicit inclusion of the expected inflation would lead to the irrelevance of contract length for output variability, since agents would always expect the shock to be zero irrespective of the date in which they are due to sign contracts.

6. Inflation expectations and contract length in a monopolistic competition model

Our analysis has so far provided analytical support for the prediction that increases in wage/price flexibility may be destabilizing due to the expected inflation effect, in modified versions of the contracting models proposed by Fischer and Taylor. It has also been shown that destabilizing inflation expectations are possible even in new classical models.

These results are, however, not general and can be reversed in a class of "neo-Keynesian" models based on monopolistic competition. As originally demonstrated by Ball (1987), increased wage flexibility, in the form of reduced contract length, is likely to be stabilizing. Ball's result is obtained in a Blanchard and Kiyotaki (1987) -type model, where the demand for labour of monopolistically competitive firms depends negatively on the real wage and positively on real money balances. The crucial condition for stabilizing increases in wage flexibility is that the real balance effect outweighs the real wage effect on labour demand.

We now investigate the robustness of this finding when inflation expectations are explicitly included in the aggregate demand schedule as in DeLong and Summers (1986b):

$$(47) \qquad y_t = \alpha\,(m_t - p_t) + \beta\,(E_t p_{t+1} - p_t) + \eta_t$$

Nominal money follows the random process

$$(48) \qquad m_t = m_{t-1} + \xi_t$$

where η_t, ξ_t are white noise disturbances.

The supply side of the economy is modelled in a standard fashion. A constant return to scale technology is available to all firms (indexed by "i"), which are uniformly distributed over the interval [0,1]:

$$(49) \qquad y_{it} = \ell_{it}$$

The share of each firm's demand is

$$(50) \qquad y_{it} - y_t = -\gamma\,(p_{it} - p_t) \qquad \gamma > 1$$

From the first-order condition for employment we can derive labour demand as

$$(51) \qquad \ell_{it} = \alpha\,(m_t - p_t) + \beta\,(E_t p_{t+1} - p_t) - \gamma\,(w_{it} - p_t) + \eta_t$$

Labour supply is assumed to be inelastic and is normalized to zero for simplicity, so that the market clearing level of employment is $\ell^*_{it} = 0$.

The proposed welfare loss function is minimizing squared deviations of actual from frictionless employment

$$(52) \qquad z_{it} = E\,[(\ell_{it} - \ell^*_{it})^2] = E(\ell^2_{it})$$

Following Ball (1987), we evaluate the effect on firm "i" of a switch in the contracting regime of all other firms. Solving the model, it can be shown that the value of the losses in the one and two periods contracting regimes are respectively[7]

$$(53) \qquad z^{(1)}_{it} = \gamma^2\,\sigma^2_\xi + \frac{\gamma^2}{(\alpha+\beta)^2}\,\sigma^2_\eta$$

$$(54) \qquad z^{(2)}_{it} = (\alpha+\beta)^2\,\sigma^2_\xi + \sigma^2_\eta$$

From (53) and (54), the necessary and sufficient condition for negative externalities from longer contracts is

(55) $\gamma < \alpha + \beta$

Hence, the expected inflation effect makes increased wage flexibility more likely to be stabilizing. It is worth pointing out that the result in (55) would still hold unchanged if both contracting regimes were lagged one period or the aggregate demand shock were to follow an autoregressive process (see Marini and Scaramozzino (1989)).

The intuition of our result is straightforward. Inflation expectations are less volatile the shorter the contracting regime. Employment and output fluctuations are thus more likely to increase with contract length in presence of the expected inflation effect[8].

7. Active policy and wage flexibility

We now turn to the role of counter-cyclical policy in models with wage stickiness. For the sake of simplicity, we consider only the monopolistic competition model and the variant of Fischer's overlapping contract framework. The first model is of particular interest, since increases in wage flexibility are likely to be stabilizing. The relevant issue is thus to assess the relative effectiveness of monetary policy vis-à-vis a reduction in contract length.

Let us consider first the monopolistic competition set up outlined in Section 6. The model structure in unchanged with the exception of the monetary rule which takes the form

(48') $m_t = m_{t-1} + \xi_t - \delta_1 \xi_{t-1} - \delta_2 \eta_{t-1}$

The welfare loss functions are now respectively given by

(53') $z_{it}^{(1)} = \frac{\gamma^2}{(\alpha+\beta)^2} \left\{ [\alpha + \beta (1-\delta_1)]^2 \sigma_\xi^2 + (1-\beta\delta_2)^2 \sigma_\eta^2 \right\}$

(54') $z_{it}^{(2)} = [\alpha + \beta (1-\delta_1)]^2 \sigma_\xi^2 + (1-\beta\delta_2)^2 \sigma_\eta^2$

It can immediately be shown that optimal setting of the feedback parameters

$$\delta_1^* = \frac{\alpha+\beta}{\beta}, \qquad \delta_2^* = \frac{1}{\beta}$$

reduces to zero both losses. The first best can thus be achieved regardless of the duration of contracts. Innovations in demand shocks are totally offset in present value terms. The optimal policy is designed to counteract the undesirable impact of shocks on the real wage and aggregate demand. Effectively, the monetary authorities can eliminate the "imperfections" due to the existence of predetermined contracts and replicate the frictionless equilibrium[9].

No reduction of contract length could, of course, match active policy. Structural reforms, if feasible, designed to shorten the duration of contracts and, in general, to promote a greater flexibility in wage/price responses to unforeseen shocks, are clearly an inferior stabilizing tool. In other words, increases in nominal price flexibility, even when stabilizing and enforceable, can never be preferred to optimally designed demand policy. Our results thus confirm Sheffrin's (1989) suggestion that a lagged feedback rule can be very effective in dampening output fluctuations.

A similar policy effectiveness result can be obtained in the Fischer-

type model presented in Section 5.2, where the monetary rule is now given by

$$m_t = m - \psi u_{t-1} \tag{56}$$

Solving the model, one obtains

$$\sigma_y^2 = \left[\frac{k^2}{(k+\beta+\gamma)^2} (\beta\pi + 1)^2 + (1-\alpha)^2 k^2\pi^2 \right] \sigma_u^2 \tag{57}$$

where

$$\pi \equiv \frac{(\beta+\gamma)\rho + \beta\gamma^2(1-\rho)\psi}{\beta(1-\rho) + \gamma} \equiv A_0 + A_1\psi$$

The quadratic function in π in (57) has real roots since $\Delta = -k^2 \cdot (1-\alpha)^2(k+\beta+\gamma)^2 < 0$. Hence, provided $\beta \neq 0$ (i.e. if the expected inflation effect on aggregate demand is present), there exists an optimal feedback parameter ψ^* in the monetary rule (56) which reduces to zero the asymptotic variance of output. This result holds for any value of ρ strictly less than unity, that is irrespective of whether or not increases in wage flexibility are stabilizing.

A very similar result had been obtained by Hahn and Solow (1986) in an OLG framework with capital accumulation. They contrast an economy with flexible wages to another with a fixed wage but in which an active monetary policy is pursued. Agents live for three periods. Accordingly, production, investment, and prices follow a third-order difference equation. It is established that active monetary policy dominates increased wage

flexibility from the point of view of the stability of the system.

In conclusion, the case in favour of counter-cyclical demand management, as opposite to wage or price policies, appears to be very strong.

8. Some empirical evidence

The issue of whether increased wage/price flexibility leads to dampen, or to exacerbate, output variability has been empirically investigated by several authors. Various measures of rigidity of the labour and goods markets have been related to the variability of employment and activity levels over the cycle. The evidence tends to be mixed and inconclusive. A common problem with these studies lies in the difficulty of controlling for the stance of monetary and fiscal policy in the face of economy-wide disturbances. If the authorities actively engage in countercyclical measures, output fluctuations may be lower, for given wage and price flexibility, even if the expected inflation effect exerts a destabilizing influence. Thus, it is crucial to control for the degree of accommodation of both discretionary *and* automatic stabilization policies.

DeLong and Summers (1986a) compare and contrast the behaviour of output and wages/prices in the US economy before and after WW II. They observe that the historical period following the war has been characterised by a greater degree of 'institutionalization' of the economy. The increased role played by the unions and the lengthening of labour contracts have led to a more rigid wage and price setting behaviour relative to the pre-war period. Simultaneously, the more recent period has experienced a greater

persistence of the effects of shocks. DeLong and Summers speculate on these findings to argue that discretionary policies have been ineffective in dampening output fluctuations. Their preferred explanation for the lower cyclical variability which has been experienced recently lies in the reduced scope for destabilizing inflation expectations in the presence of pervasive nominal rigidities.

It is not clear, however, whether the line of argument followed by DeLong and Summers adequately controls for discretionary stabilization policies. A possible strategy the authorities may pursue when engaging in counter-cyclical policies might consist in 'smoothing out' over the cycle the effects of shocks, thereby dampening the impact effect but at the same time *increasing* persistence. Hence, it seems one is still allowed to entertain the notion that the lower cyclical variability of employment and activity levels in the period following WW II may well be due to active counter-cyclical policies.

Taylor (1986) carries out a similar analysis for the US for the periods 1891-1914 and 1952-83. The former period has been characterised by larger cyclical fluctuations and more flexible wages and prices than the latter one. By making use of a bivariate VAR system for prices and output, Taylor is able to show that the variance of the shocks to the economy has been lower in the more recent period. Taylor's findings are consistent with the hypothesis that discretionary policies have been less accommodating, and hence more effective in dampening output fluctuations, in the post-war period[10].

Finally, Summers and Wadhwani (1987) perform a cross country comparison for 16 OECD economies. They analyse the relationship between labour cost flexibility and output variability. Their measure of wage

flexibility is based upon an expectations augmented Phillips curve, suitably modified to allow for both nominal and real rigidities. They find no conclusive evidence of a systematic relationship between nominal wage flexibility and cyclical fluctuations of employment and output. Their procedure may however also be open to the criticism previously outlined since it does not explicitly control for the stance of counter-cyclical policy.

9. Conclusions

Inflation expectations may exert a destabilizing role even in models with flexible prices and rational expectations in presence of persistent aggregate demand shocks. Future prices may, in fact, increase more than current prices in response to demand innovations in standard new classical models.

Hence, the source of instability associated to expectations of future price movements, dating back to the work of Keynes, Fisher and more recently Tobin, is not confined to models with price inertia.

The proposition advanced by DeLong and Summers that increases in wage and price flexibility may be overall destabilizing *via* the expected inflation effect is also in general analytically confirmed in a number of popular macromodels such as staggered wage (price) setting and overlapping wage contracts. The notable exception is a monopolistic competition framework with synchronized contracts of the kind presented by Ball (1987). A longer contracts regime would in this case exacerbate aggregate demand fluctuations and hence the variability of employment about the competitive

equilibrium level.

However, increased flexibility, even when stabilizing, appears to be dominated by active demand management. The effectiveness of policy is enhanced by the presence of the expected inflation effect, independently of whether or not it is stabilizing. Removing rigidities in the labour and goods markets would thus appear to be, at best, an inferior substitute for active policy in any case.

Table 1 - Steady state variance of output: Taylor model with AR(1) demand shocks and expectations conditional on information at time t-1

	ρ=0.2				ρ=0.4			
	μ=0.2	0.4	0.6	0.8	μ=0.2	0.4	0.6	0.8
g=0.1	1.0378	1.0385	1.0394	1.0404	1.1590	1.1641	1.1703	1.1783
0.2	1.0355	1.0365	1.0378	1.0394	1.1446	1.1509	1.1590	1.1703
0.3	1.0338	1.0350	1.0365	1.0385	1.1351	1.1419	1.1509	1.1641
0.4	1.0324	1.0338	1.0355	1.0378	1.1281	1.1351	1.1446	1.1590
0.5	1.0313	1.0328	1.0346	1.0371	1.1227	1.1297	1.1394	1.1547
0.6	1.0304	1.0319	1.0338	1.0365	1.1183	1.1253	1.1351	1.1509
0.7	1.0295	1.0311	1.0331	1.0360	1.1146	1.1215	1.1314	1.1476
0.8	1.0288	1.0304	1.0324	1.0355	1.1115	1.1183	1.1281	1.1446
0.9	1.0281	1.0297	1.0319	1.0350	1.1088	1.1155	1.1253	1.1419

	ρ=0.6				ρ=0.8			
	μ=0.2	0.4	0.6	0.8	μ=0.2	0.4	0.6	0.8
g=0.1	1.3999	1.4199	1.4465	1.4854	1.8973	1.9501	2.0352	2.1967
0.2	1.3513	1.3713	1.3999	1.4465	1.8040	1.8365	1.8973	2.0352
0.3	1.3248	1.3434	1.3713	1.4199	1.7733	1.7933	1.8365	1.9501
0.4	1.3077	1.3248	1.3513	1.3999	1.7614	1.7733	1.8040	1.8973
0.5	1.2956	1.3114	1.3364	1.3842	1.7570	1.7634	1.7849	1.8617
0.6	1.2866	1.3012	1.3248	1.3713	1.7560	1.7586	1.7733	1.8365
0.7	1.2796	1.2932	1.3154	1.3605	1.7565*	1.7565	1.7660	1.8179
0.8	1.2740	1.2866	1.3077	1.3513	1.7578*	1.7560	1.7614	1.8040
0.9	1.2693	1.2813	1.3012	1.3434	1.7594*	1.7563*	1.7586	1.7933

* Increased flexibility is destabilizing at the margin.

Table 2 - Steady state variance of output: Taylor model with AR(1) demand shocks and expectations conditional on information at time t

	ρ=0.2				ρ=0.4			
	μ=0.2	0.4	0.6	0.8	μ=0.2	0.4	0.6	0.8
g=0.1	0.9435	0.9622	0.9834	1.0085	0.9878	1.0216	1.0621	1.1133
0.2	0.8843	0.9115	0.9435	0.9834	0.8889	0.9328	0.9878	1.0621
0.3	0.8397	0.8722	0.9115	0.9622	0.8211	0.8699	0.9328	1.0216
0.4	0.8036	0.8397	0.8843	0.9435	0.7695	0.8211	0.8889	0.9878
0.5	0.7733	0.8120	0.8607	0.9268	0.7281	0.7813	0.8524	0.9586
0.6	0.7470	0.7878	0.8397	0.9115	0.6938	0.7478	0.8211	0.9328
0.7	0.7240	0.7664	0.8208	0.8974	0.6644	0.7190	0.7938	0.9098
0.8	0.7034	0.7470	0.8036	0.8843	0.6390	0.6938	0.7695	0.8889
0.9	0.6849	0.7295	0.7878	0.8722	0.6166	0.6714	0.7478	0.8699

	ρ=0.6				ρ=0.8			
	μ=0.2	0.4	0.6	0.8	μ=0.2	0.4	0.6	0.8
g=0.1	1.0824	1.1462	1.2283	1.3438	1.2198	1.3440	1.5233	1.8265
0.2	0.9157	0.9865	1.0824	1.2283	0.9421	1.0529	1.2198	1.5233
0.3	0.8144	0.8863	0.9865	1.1462	0.7986	0.8988	1.0529	1.3440
0.4	0.7432	0.8144	0.9157	1.0824	0.7066	0.7986	0.9421	1.2198
0.5	0.6891	0.7591	0.8600	1.0303	0.6409	0.7265	0.8612	1.1266
0.6	0.6461	0.7145	0.8144	0.9865	0.5909	0.6713	0.7986	1.0529
0.7	0.6106	0.6775	0.7761	0.9488	0.5512	0.6272	0.7483	0.9927
0.8	0.5807	0.6461	0.7432	0.9157	0.5186	0.5909	0.7066	0.9421
0.9	0.5550	0.6189	0.7145	0.8863	0.4913	0.5604	0.6713	0.8988

Table 3 - Steady state variance of output: price staggering with expectations conditional on information at time t-1

	ρ=0.2			ρ=0.4		
	δ=1	2	3	δ=1	2	3
g=0.1	1.0505	1.0886	1.1194	1.1588	1.2810	1.3815
0.2	1.0886	1.1453	1.1873	1.2810	1.4673	1.6089
0.3	1.1194	1.1873	1.2350	1.3815	1.6089	1.7730
0.4	1.1453	1.2207	1.2714	1.4673	1.7232	1.9008
0.5	1.1677	1.2481	1.3006	1.5423	1.8189	2.0046
0.6	1.1873	1.2714	1.3248	1.6089	1.9008	2.0914
0.7	1.2049	1.2915	1.3452	1.6688	1.9722	2.1654
0.8	1.2207	1.3092	1.3628	1.7232	2.0352	2.2296
0.9	1.2350	1.3248	1.3781	1.7730	2.0914	2.2858
1.0	1.2481	1.3387	1.3916	1.8189	2.1420	2.3355

	ρ=0.6			ρ=0.8		
	δ=1	2	3	δ=1	2	3
g=0.1	1.4261	1.7765	2.0776	2.4905	3.9560	5.3320
0.2	1.7765	2.3425	2.7937	3.9560	6.6090	8.8886
0.3	2.0776	2.7937	3.3349	5.3320	8.8886	11.7451
0.4	2.3425	3.1689	3.7672	6.6090	10.8576	14.0920
0.5	2.5794	3.4890	4.1243	7.7918	12.5764	16.0613
0.6	2.7937	3.7672	4.4260	8.8886	14.0920	17.7420
0.7	2.9892	4.0122	4.6854	9.9079	15.4406	19.1966
0.8	3.1689	4.2302	4.9114	10.8576	16.6500	20.4700
0.9	3.3349	4.4260	5.1105	11.7451	17.7420	21.5956
1.0	3.4890	4.6030	5.2875	12.5764	18.7338	22.5988

Table 4 - Steady state variance of output: price staggering with expectations conditional on information at time t

	ρ=0.2			ρ=0.4		
	δ=1	2	3	δ=1	2	3
g=0.1	1.0458	0.9972	0.9333	1.2712	1.2290	1.1513
0.2	0.9972	0.8664	0.7397	1.2290	1.0638	0.8929
0.3	0.9333	0.7397	0.5816	1.1513	0.8929	0.6780
0.4	0.8664	0.6298	0.4605	1.0638	0.7435	0.5149
0.5	0.8012	0.5375	0.3681	0.9763	0.6184	0.3927
0.6	0.7397	0.4605	0.2972	0.8929	0.5149	0.3010
0.7	0.6825	0.3962	0.2422	0.8151	0.4296	0.2316
0.8	0.6298	0.3424	0.1989	0.7435	0.3592	0.1786
0.9	0.5816	0.2972	0.1645	0.6780	0.3010	0.1379
1.0	0.5375	0.2590	0.1369	0.6184	0.2526	0.1064

	ρ=0.6			ρ=0.8		
	δ=1	2	3	δ=1	2	3
g=0.1	1.8892	1.8696	1.7789	4.5045	4.7513	4.6410
0.2	1.8796	1.6501	1.3845	4.7513*	4.4047	3.8294
0.3	1.7789	1.3845	1.0415	4.6410	3.8294	3.0076
0.4	1.6501	1.1466	0.7788	4.4047	3.2661	2.3396
0.5	1.5155	0.9455	0.5823	4.1227	2.7670	1.8195
0.6	1.3845	0.7788	0.4356	3.8294	2.3396	1.4181
0.7	1.2610	0.6415	0.3256	3.5412	1.9782	1.1080
0.8	1.1466	0.5286	0.2427	3.2661	1.6740	0.8670
0.9	1.0415	0.4356	0.1800	3.0076	1.4181	0.6789
1.0	0.9455	0.3588	0.1324	2.7670	1.2027	0.5311

* Increased flexibility is destabilizing at the margin.

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Notes

[1]Theories of depressions based on similar arguments have been proposed again recently by Bernanke (1983), Bernanke and Gertler (1989), and Calomiris and Hubbard (1989) amongst others. This research programme relates macroeconomic fluctuations to agency costs in firms and credit institutions.

[2]See Keynes (1936, chap. 19) and Pigou (1943, 1947).

[3]The expansionary effect of expected inflation is assumed to outweigh the capital losses incurred by holders of money balances.

[4]Tobin contrasts this model (which he defines as the Walras-Keynes-Phillips adjustment system) to a Marshallian model, in which *prices* - rather than quantities - respond to an excess of demand over output, and where the level of activity reacts to deviations from full employment *via* changes in factor prices. The Marshallian system is shown to be always dynamically stable.

[5]Only in one of the reported cases increased flexibility has been found to be destabilizing at the margin.

[6]See Marini and Scaramozzino (1990) for a detailed description of the model.

[7]Expressions (51) and (52) are obtained as the losses to firm "i" in the second period of a two-period contract, when all other firms are in one- or two-period contracts respectively.

[8]A similar model of monopolistic competition, which can be seen as implying DeLong and Summers' (1986b) and King's (1988) models as special cases, has recently been proposed by Cantor (1989) (for an extensive discussion, see Sheffrin (1989)). Cantor finds that the effects of increased wage and price flexibility on output variability are *not* invariant with respect to uniform shifts in contracting regimes. The chosen measure of wage flexibility is the proportion of firms in short contracts. Cantor's model predicts a hump-shaped response of the price level to shocks. The resulting inflation pattern seems however to be counterfactual, as shown by Sheffrin (1989).

[9]See Marini and Scaramozzino (1989) for a more detailed explanation.

[10]These results are confirmed in Taylor (1988).

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