Is Increased Price Flexibility Stabilizing?

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This paper uses John Taylor's model of overlapping contracts to show that increased wage and price flexibility can easily be destabilizing because of the Mundell effect. While lower prices increase output, the expectation of falling prices decreases output. Simulations based on realistic parameter values suggest that increases in price flexibility might well increase the cyclical variability of output in the United States.

Most economists would answer the question posed in our title affirmatively. It is certainly true that if prices were completely inflexible, markets could never equilibrate to changing conditions. And given a disturbance in nominal aggregate demand, "more flexible" prices imply that more of the disturbance is absorbed as a change in the price level, leaving less to appear as a cyclical movement in production. Considerations along these lines have led to a widespread belief that an excessively high degree of wage and price inflexibility is responsible for cyclical fluctuations in employment and output.

This paradigmatic belief—that the magnitude of the business cycle depends largely on the degree of institutional wage rigidity—is institutionalized by the pedagogical style of many macroeconomics courses. At some point a "classical" aggregate supply curve generated by complete price flexibility and atomistic markets, is counterposed to a "Keynesian" aggregate demand-aggregate supply model, where the short-run aggregate supply curve is infinitely price elastic because nominal wages are assumed fixed. The teacher then demonstrates that in the classical model a monetary (or any other nominal) shock has no real effects on output because the aggregate price level adjusts to clear all markets, and, in the Keynesian model, a monetary shock has real effects because quantities adjust. The message carried away is that the crucial market failure generating business cycles is the existence of sticky nominal wages: if only the labor market were fully competitive and flexible, then business cycles would be much smaller. This view suggests the desirability of any possible policy measures which increase wage and price flexibility.

This message is too simple. We believe, as we argued in our forthcoming paper, that the sign of the macroeconomic consequences of increased aggregate price flexibility is not a settled issue. We think that the question "is increased price flexibility stabilizing?" is—or should be—kept open, and there is a real chance that aggregate price flexibility would be destabilizing at the margin given the present structure of the American economy.

The view that price level flexibility can be destabilizing has been expressed many times. Irving Fisher (1923, 1925) saw the business cycle as "largely a 'dance of the dollar' ": expected deflation led to high anticipated real interest rates, little investment, and low output. If the money supply were manipulated to stabilize the price level—said Fisher—much of the business cycle would disappear, for

> what concerns business is not whether prices are high or low but whether they are rising or falling. Thus rising prices stimulate business because the prices a

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> producer can get outrun his expenses for interest rent, salaries, and wages, while falling prices depress trade ...[W]e find that this one element, *rapidity of price movement*, during the period 1914–1922 seems to account, almost completely, for the ups and downs of business. [1923, p. 1027].

Keynes argued in his chapter 19 that it was preferable in a gathering recession to increase real balances by printing money rather than by helping along the decline in prices, because

> it would be much better that wages should be rigidly fixed and deemed incapable of material changes, than that depression should be accompanied by a gradual downward tendency of money-wages, a further moderate wage reduction being expected to signalize each increase of, say, one percent in the amount of unemployment. For example, the effect of an expectation that wages are going to sag by, say, two percent in the coming year will be roughly equivalent to the effect of a rise of two percent in the amount of interest payable for the same period. [p. 265]

And, according to Lars Jonung (1981), the Swedish Central Bank's attempt to adopt a price-stability rule for the conduct of monetary policy greatly insulated Sweden from the Great Depression.

More recently, James Tobin (1975) has stressed the potential role of destabilizing deflation in creating a situation in which there is "protracted unemployment which the natural adjustments of a market economy remedy very slowly if at all" (p. 200). He argues that "even with stable monetary and fiscal policy, combined with price and wage flexibility, the adjustment mechanisms of the economy may be too weak to eliminate persistent unemployment" (p. 200), because the destabilizing price change effect on aggregate demand may well swamp the stabilizing price level effect.

In our forthcoming paper, we noted that the increasing degree of nominal rigidity in the U.S. economy over the past century had coincided with a dramatic decrease in the cyclical volatility of economic activity. This observation tends to bely explanations of cyclical fluctuations based on nominal rigidities. We presented models with backward-looking expectations, in which marginal increases in aggregate price flexibility were destabilizing, in the sense that they increased the steady-state variance of output in response to independent stochastic shocks. We conjectured that the same property—destabilizing price flexibility—would hold true in at least some models with fully rational expectations.[1]

This paper presents such a model. We take John Taylor's 1979 and 1980 macroeconomic model with staggered labor contracts and modify it so that (a) it produces persistent fluctuations of output in response to macroeconomic demand shocks, and (b) it allows anticipated changes in the price level to affect the level of real aggregate demand through effects on real interest rates or the distribution of wealth. Solving the model numerically, we find that for a wide range of parameter values, an increase in the responsiveness of wages to excess demand or supply in the labor market leads to an increase in cyclical variability as measured by the steady-state variance of output.

The paper is organized as follows: Section I describes our modifications of the Taylor model and shows that increasing the flexibility of prices may well be destabilizing in our modified model. Section II verifies the robustness of this result by examining modifications of the time structure of contracts. We are able to verify that the volatility of output ultimately declines as the wage-price process approaches perfect Walras-like flexibility. But this limiting result is very misleading as a guide to marginal changes in price flexibility that start from current levels. Sec-

[1] Bennett McCallum (1983) presents a model in which price flexibility is never destabilizing. Our conjecture has also been challenged by Robert Driskill and Steven Sheffrin (1986). For reasons discussed below, we believe that their model does not provide a satisfactory framework for examining the issue of destabilizing price flexibility.

tion III considers supply shocks and shows that our conclusion that price flexibility can be destabilizing holds for situations in which there are a mixture of supply and demand shocks. Section IV generalizes the analysis by allowing aggregate demand to depend on both Tobin's q and the rate of deflation as well as the real interest rate. The former generalization tends to increase the stabilizing character of price flexibility while the latter reduces it. Section V concludes the paper by discussing some empirical observations supporting our analysis and discussing directions for future research.

I. Wage Rigidity and Output Volatility

Taylor (1979 for the intuitive, simplified version; 1980 for the full model and extensions) set forth the following simple macroeconomic model to illustrate how the asynchronization of nominal price-setting decisions can have important aggregate effects:

(1) $y_t = m_t - p_t + v_t$ aggregate demand

(2) $m_t = hp_t$ money supply rule

(3) $p_t = .5(w_t + w_{t-1})$

definition of price level

(4) $w_t = .5w_{t-1} + .5E_{t-1}w_{t+1} + g(.5E_{t-1}y_t + .5E_{t-1}y_{t+1}) + e_t$

wage-setting equation

where e_t and v_t are stochastic shocks.

Equations (1) through (3) are completely standard. Equation (1) says that with variables in logarithms, output y_t is equal to money balances $m_t - p_t$ plus a white-noise velocity shock v_t. Equation (2) asserts that the monetary authority partially accommodates increases in the price level by increasing the nominal money supply in the proportion h. Equation (3) defines the aggregate price level. Taylor supposes that workers negotiate two-period fixed nominal wage contracts. The aggregate price level in period t is simply the average of the two different contracts in force at that moment—the contract which begins in period $t-1$ and the contract which begins in period t. Each contract covers half of the labor force, and w_t is defined as the (log of the) wage paid in periods t and $t+1$ to those workers whose contract is negotiated at the end of $t-1$.

Equation (4) contains the heart of the model. The contract wage w_t is set as the average of the contract wages w_{t-1} and the expected contract wage w_{t+1}—the average of the wages of those contracts which overlap the periods covered by the contract which pays w_t—adjusted for excess demand or supply in the labor market through the terms containing $E_{t-1}y_t$ and $E_{t-1}y_{t+1}$. The "E_{t-1}" appears because the contract is negotiated before the realization of period t's shocks. The parameter g represents the degree of wage flexibility: the higher is g, the greater is the response of wages to anticipated demand conditions.

Recent research, George Akerlof and Janet Yellen (1985), N. Gregory Mankiw (1985), and Olivier Blanchard (1985), suggests that contracts of the type envisioned by Taylor can be justified on microeconomic grounds. The private loss from such arrangements is second-order, relative to the social consequence which is first-order. In the presence of small transactions costs, firms and workers may therefore enter into such contracts. Alternatively, following the arguments advanced in Stanley Fischer (1984), the analytical use of a contracting model of this type may be justified on empirical grounds: contracts similar to those envisioned by Taylor do predominate in American labor markets, even if economists cannot fully rationalize their existence.

Taylor's model provides a clean and forceful implementation of the fundamental insight that the asynchronization of price changing decisions can have significant consequences for the business cycle. But for the purpose of examining the effects of varying degrees of price flexibility, Taylor's particular implementation of this idea is deficient in two major respects: first, the specific models advanced by Taylor (1979, 1980) produce the wrong kind of output persistence; second, the specific model possesses no channel through which price flexibility could be stabilizing.

As Taylor demonstrates, equations (1) through (4) can be solved to produce a moving average representation for output as a function of the shocks e_t and v_t:

$$(5)\quad y_t = .5\beta e_t - .5\beta \times \left\{ \sum_1^{\infty} \left((D)^{i-1} + (D)^i \right) e_{t-i} \right\} + v_t,$$

where D is some complex function of structural parameters and $\beta = 1 - h$. An aggregate demand shock—the velocity shock v_t—generates no persistent fluctuations. The only source of persistent fluctuations is the e_t shock in equation (4).

The business cycle described by Taylor in equation (5) is, therefore, a cost-push business cycle. Cyclical output fluctuations are driven by the e_t supply-side shock to the nominal wage level, not by the v_t shock to demand. As Taylor's model stands, it has relatively little to tell us about the persistent output fluctuations in response to demand-side shocks that Keynesian economists, at least, think lie at the heart of the business cycle.[2] If a version of Taylor's (1979) model is to generate persistent output fluctuations as a result of demand shocks, the demand shocks must be serially correlated.

For our purposes, there must also be an additional modification: as Taylor's model stands, there is no channel through which price flexibility could possibly be destabilizing. Given v_t and the monetary policy reaction function, output moves inversely with the price level. In order to model how deflation might exert downward pressure on output, we must complicate the determinants of aggregate demand. We do this by relaxing Taylor's assumption that the demand for money is interest inelastic.

The modified model exhibits a kind of Mundell effect. The interest rate that determines demand for goods is a real interest rate; the interest rate that clears the money market is a nominal interest rate. Inflation or deflation drive a wedge between the two and shift the short-run solution of the *IS-LM* system, which determines output. While a lower price level is expansionary, the expectation of falling prices is contractionary, creating the possibility of instability. This seems the easiest but not the only way to model the host of possible channels—redistributions, bankruptcies, liquidity failures, real interest rate changes, and so forth—through which deflation might depress output.

We assume output as determined by the *IS* curve depends on the short-run real interest rate and a serially correlated demand shift term s_t:

$$(6)\quad y_t = -A\{i_t - [E_t p_{t+1} - p_t]\} + s_t$$

$$(7)\quad s_t = \mu s_{t-1} + z_t,$$

where z_t is independent and identically distributed. The money-demand function is standard, with velocity depending on the nominal interest rate:

$$(8)\quad m_t = p_t + y_t - v_t$$

$$(9)\quad v_t = G i_t.$$

Paralleling Driskill and Sheffrin, the money authority follows an interest rate rule which is designed to remove m_t as an independent

[2]What economic interpretation can be given to a positive e_t shock? It is an exogenous increase in the wage rate attached to the particular contract that begins in period t. It may be thought of as representing an exogenous outburst of union militancy. These episodes of successful bargaining lead to inflation, to a higher price level. Because the monetary authority does not fully accomodate this cost-push shock, this price level increase is gradually rolled back by a prolonged period of subnormal output. The business cycle described by Taylor is, therefore, a cost-push business cycle.

Driskill and Sheffrin show that in such a model where the business cycle is driven by supply shocks, then price flexibility must be stabilizing at the margin. This creates an interesting tradeoff: we show that under some circumstances, price flexibility is destabilizing at the margin in response to demand shocks. The degree of price flexibility that minimizes the variance of output will thus depend on the relative magnitudes and the correlations of demand and supply shocks. We discuss this further below.

variable from (8) and (9):

$$(10) \qquad m_t = \beta i_t.$$

Deleting the "cost-push" wage shock from the wage equation, but otherwise using the price level definition and the wage-setting equation from the original two-period contract version of the Taylor model described above yields

$$(11) \quad p_t = .5(w_t + w_{t-1})$$

$$(12) \quad w_t = .5(w_{t-1} + E_{t-1}(w_{t+1})) + .5g(E_{t-1}y_t + E_{t-1}y_{t+1}).$$

This model (6)–(12) is numerically solved for a range of parameter values. Although there are five free parameters—g, β, G, A, and μ—the behavior of output and prices has only four independent dimensions of variation. The parameters G and β affect the movement of Y_t and p_t only through their sum since substituting (10) and (9) into (8) leads to

$$(13) \qquad y_t + p_t = (\beta + G)i_t,$$

and substituting (13) into (6) leads to

$$(14) \quad y_t = [A\{[E_t p_{t+1} - p_t] - B(p_t)\} + s_t] / (1 + AB),$$

where $B = (\beta + G)^{-1}$. Equation (14) reveals that the price level affects, directly and indirectly, output through two channels: there is a "destabilizing" expected price change effect and a "stabilizing" price level effect.

With this model, we pose the following question: given that the model falls short of some ideal contingent-claims Walrasian economy in many ways, does additional aggregate price flexibility—an increase in the responsiveness of wages to anticipated excess supply and demand, an increase in the coefficient g—stabilize the economy? We calculate the steady-state variance of output in response to a unit variance white-noise process for z_t, and determine whether additional price flexibility increases or decreases the steady-state variance of output for the economically relevant part of the range of parameter values.

In our initial set of numerical solutions,[3] we let A—the semielasticity of output with respect to the real interest rate—vary between 1 and 3. Assuming an average nominal interest rate of 8 percent, the .17 interest elasticity of real spending estimated by Benjamin Friedman (1978) is equivalent to an A of two. The inverse of the sum of the interest semielasticities of money demand and money supply, B, takes on three values: from .2, for an accommodating monetary policy (or a banking sector which elastically supplies real balances) and a sizable responsiveness of money demand to interest rates, to .6, representing relatively unaccommodating money supply and money demand behavior. To place these values in perspective, note that with a nominal interest rate assumed to average 8 percent and Steven Goldfeld's (1976) estimate of $-.20$ for the interest elasticity of money demand, completely interest inelastic money supply implies B equals .42; if the money supply has an interest elasticity of $+.20$, then B equals .21.

A good way to evaluate the plausibility of our parameter estimates for A and B is to calculate their implications for the simple Keynesian multiplier.[4] Holding all present

[3] The model is solved numerically for the steady-state variance of output by the following procedure: first, we calculate the impulse response functions for output and prices in response to a single z_t shock. To determine a unique solution, the transversaility condition that the effects of the shock eventually damp out is imposed. The model thus becomes a two-point boundary value problem which can be solved numerically along the lines of the Fair-Taylor (1983) algorithm. That is, we assume a path of expectations for prices and output after the shock, solve the model forward conditional on this path, check for convergence, update, and iterate. Second, once the impulse response function has been solved, the steady-state variance of output in response to a univariate white-noise process for z_t is easy to determine: it is simply the squared sum of the individual output responses to a unit z_t shock.

[4] But note that in the equations simulated, the multiplier has already been solved out.

TABLE 1—STEADY-STATE VARIANCE OF OUTPUT IN RESPONSE TO DEMAND SHOCKS

		$g=$ 0	.1	.2	.4	.6	.8	1.0
$B=.2$								
$\mu=.5$	$A=1$	93	95[a]	99[a]	110[a]	120[a]	128[a]	134[a]
	2	68	72[a]	78[a]	90[a]	100[a]	106[a]	109[a]
	3	52	56[a]	63[a]	74[a]	82[a]	86[a]	88[a]
$\mu=.75$	$A=1$	159	163[a]	179[a]	213[a]	242[a]	267[a]	286[a]
	2	117	126[a]	148[a]	178[a]	194[a]	201[a]	202[a]
	3	89	101[a]	124[a]	157[a]	164	163	160
$B=.4$								
$\mu=.5$	$A=1$	68	69[a]	71[a]	76[a]	81[a]	83[a]	83[a]
	2	41	42[a]	44[a]	49[a]	53[a]	56[a]	56
	3	28	22[a]	22[a]	25[a]	27[a]	28[a]	27
$\mu=.75$	$A=1$	117	116[a]	118[a]	129[a]	140[a]	149[a]	153[a]
	2	71	70[a]	74[a]	85[a]	94	88	79
	3	47	36[a]	37[a]	42[a]	46	45	41
$B=.6$								
$\mu=.5$	$A=1$	52	53[a]	53[a]	56[a]	59[a]	61[a]	62[a]
	2	28	28[a]	29[a]	31[a]	33[a]	34[a]	34[a]
	3	17	17[a]	18[a]	19[a]	21[a]	22[a]	22
$\mu=.75$	$A=1$	89	87	85[a]	88[a]	93[a]	97[a]	99[a]
	2	47	46	45[a]	49[a]	54[a]	56[a]	56[a]
	3	29	28[a]	28[a]	31[a]	34	33	31

[a]Price flexibility is destabilizing at the margin.

and future expected prices constant, the simple comparative-statics multiplier obtained from equations (6)–(10), assuming a marginal propensity to spend of .67 is given by

		$B=.2$	$B=.6$
$M=$	$A=1$	2.5	2.2
	$A=2$	2.1	1.5
	$A=3$	1.9	1.5

An increase in autonomous spending of 1 percent of *GNP* leads in the comparative statics to an increase in nominal demand of M percent. These values span most estimates of this spending multiplier.

We allow g, the responsiveness of wages to excess demand or supply in the labor market, to vary between 0 and 1. Thinking of a period as one year, a value of .1 for g implies that a 1 percent reduction in output reduces the wages by .05 percent in the first year and by .1 percent after two years. In the language of Arthur Okun (1978), it implies a sacrifice ratio of 20 slightly greater than his upper-bound estimate. A value of 1 for g implies a sacrifice ratio of 2, which is somewhat below Jeffrey Sachs' (1985) optimistic reading of recent experience.

The basic numerical solutions are presented in Table 1. The degree of price flexibility increases within each row reading across. And it can be clearly seen that increasing price flexibility typically increases —not decreases—the steady-state variance of output.

Price flexibility is destabilizing at the margin in almost all cases. Only as the disturbance to the *IS* equation approaches a random walk is price flexibility ever helpful in reducing the variance of output, and then only over a relatively narrow range as the parameters move from a situation with no price flexibility to one with some price flexibility. Starting from the position of no price response to output fluctuations at all, a small amount of price flexibility can effectively damp the far-future effects of a current shock, thus reducing steady-state output variance. But very soon the margin of diminishing returns is reached because the far-future output fluctuations have already been damped, there are only small marginal returns as price flexibility is increased, and increased price flexibility disturbs the real interest rate in the present.

The pattern of responses shown in Table 1 is typical of the many calculations which we performed. In general, increases in B, A, and μ all tend to slightly increase the region over which price flexibility is stabilizing. The steeper the *LM* curve or the flatter the *IS* curve, the smaller is the scope for destabilizing price flexibility. And the more persistent are shocks, the more likely are the advantages of moving the price level quickly towards its equilibrium level to counteract the disadvantages of having a volatile rate of change of the price level.

It is interesting to note that price flexibility increases the variance of output not by increasing the persistence of shocks, but by front-loading their effects. As Figure 1 shows, the combination of price flexibility and the real interest rate effect together concentrate the output effects of a persistent nominal demand shocks in the present and near future, close in time to the moment when the shock occurs. If, in response to a monetary contraction, the price level is expected to decline substantially, then (a) real balances will be back to normal in the following period, so the effects of the contraction will not persist, and (b) the contractionary effects of high nominal interest rates will be reinforced by the extra increase in the real interest rate created by the anticipated price decline. Output is subject to shorter—and sharper in a variance metric—swings if prices are more flexible. In our forthcoming paper, we show that serial correlation in output has in fact increased over time as prices have become more and output less volatile. The serial correlation in annual deviations of output from trend has risen from approximately .4 before World War I to approximately .8 today. A common pattern—increased serial correlation and decreased volatility with more rigid prices—is present both in history and in the model. Perhaps this mechanism has something to do with the changing character of American business cycles.

Although this model is too simple and stylized for the conclusions reached from

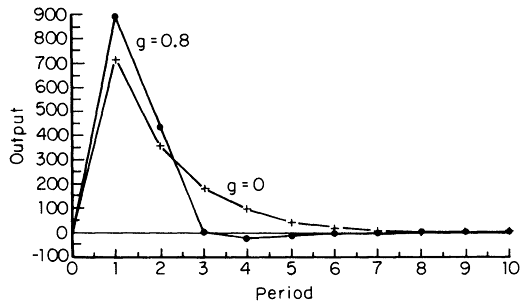

FIGURE 1. IMPULSE RESPONSE TO DEMAND SHOCK ($A = 2$, $B = .2$, $\mu = .5$)

analysis of it to be easily applied, the conclusions do seem striking. Taking Taylor's (1979) model, and modifying it so that it (*i*) allows for the influence of real interest rates on aggregate demand, and (*ii*) generates persistent output fluctuations in response to demand-side shocks, we found that this model exhibits destabilizing price flexibility as stressed by Fisher, Keynes, and Tobin for a wide range of plausible parameter values.

II. Alternative Contract Structures

A. *Changing Contract Length*

In addition to changing g as a way of modeling increases or decreases in wage and price flexibility, there is another possible type of change in price flexibility that can be analyzed with this model. It is possible to change the number and the length of the overlapping contracts. Taylor (1980) describes how to generalize his wage-setting equation from the case of two-period to the case of many-period contracts.

The previous section has shown that price flexibility is almost always destabilizing for the case of two-period contracts, but how does the variance of output change as the number of periods a given contract lasts increases from two to three to four?

Table 2 shows that, at least for the parameters chosen, increasing the length of contracts in the model frequently decreases the steady-state variance of output. We present only results for $B = .4$. With $B = .2$, increas-

TABLE 2—STEADY-STATE VARIANCE FOR INCREASING CONTRACT LENGTH
($A=2$; $B=.4$)

		$g=$						
	Contract Length	0	.1	.2	.4	.6	.8	1.0
$\mu=.5$	2 periods	41	42[a]	44[a]	49[a]	53[a]	56[a]	57[a]
	3 periods	41	42[a]	43[a]	45[a]	47[a]	49[a]	49[a]
	4 periods	41	42	42[a]	43[a]	44[a]	45[a]	45[a]
$\mu=.75$	2 periods	71	70[a]	74[a]	85[a]	94	88	79
	3 periods	71	70[a]	72[a]	77[a]	79	78	75
	4 periods	71	70[a]	71[a]	73[a]	76	75	72

[a]Denotes that price flexibility is destabilizing at the margin.

ing contract length reduces the variance of output for all our chosen values of μ and A. As the contract length increases, the aggregate price level does not adjust as quickly to nominal shocks. And this sluggish response of the price level slightly reduces the magnitude of real interest rate fluctuations enough to reduce the variance of output in many cases.

This result casts some doubt upon the validity of arguments by those who, like Lester Thurow (1979), argue that the United States should attempt to explicitly encourage the development of "corporatist" institutions to explicitly conduct centralized wage bargaining. More generally, it calls into question standard Keynesian arguments suggesting that long-term contracts help to explain the cyclical variability of output. In the model we are working with, shortened contracts, frequent reopeners, and so forth do not necessarily stabilize output.

B. *Approaching the Limit of Perfect Markets*

There is yet another dimension of changing flexibility available which we can use to further explore the properties of this simple model: it is possible to change the "length" of the period itself, to reduce the amount of "time" taken up by each count of the index t. Instead of thinking of the model as comprising one-year periods and two-year labor contracts, we can examine the performance of the model with six-month periods and one-year contracts, or with three-month periods, and so forth. How do the effects of price flexibility change as we change the length of the period in the model?

In order to effectively halve the length of the amount of time covered by a single period in the model, the following steps are necessary: first, we set the parameter μ_{new} equal to $\sqrt{\mu_{old}}$. For the demand shock to decay in the same amount of time in the transformed model, it must decay in twice the number of periods. Second, we adjust the variance of the initial shock z_t so that the steady-state variance of the shift term s_t in the *IS* curve is the same as it was before.

Keeping the parameter g the same in the transformed and the untransformed model implies that the transformation to a period that covers half as much time involves a doubling of the responsiveness of the price level to output deviations.

This way of increasing price flexibility has a strong advantage over the other two possible ways—decreasing the contract length and increasing the value of the parameter g. It is not possible by varying the contract length or increasing g to create a sequence of economies which smoothly converges to the Walrasian limit. There is a tremendous difference between one- and two-period contracts, and continuously increasing g eventually leads to economically meaningless behavior on the part of the model as small expected price changes lead to enormous output jumps in the present. Shortening the amount of time covered by a single period allows for continuous movement to the Walrasian ideal, where nominal demand shocks have no real effects at all.

TABLE 3—STEADY-STATE VARIANCE APPROACHING THE WALRASIAN LIMIT ($A = 2$; $B = .4$)

	Period Length						
$g =$	1	1/2	1/4	1/8	1/16	1/32	...1/∞
0	33	33	33	33	33	33	...33
.1	33	34	34	32	25	18	...0
.2	34	35	36	33	24	16	...0
.4	36	39	41	35	24	15	...0
.6	37	43	42	36	26	15	...0
.8	38	45	43	37	27	16	...0
1.0	39	48	44	38	29	16	...0

As Table 3 illustrates, convergence toward the Walrasian limit does happen eventually: for periods of 1/8 the original or shorter, the steady-state variance of output drops relatively quickly (although by only 10–20 percent, by much less than 50 percent, with each iteration) as the period is shortened further.[5] But before the value of 1/8, convergence toward the limit is not, or is at most only slightly, visible. The effect of a shortened period in causing more rapid price changes—and thus more of an incentive to postpone or accelerate spending by one period—approximately balances the stabilizing effects of more rapid price flexibility. In the limit, increased price flexibility is indeed stabilizing. But one must already be very close to that Walrasian limit before its properties become a good guide to the behavior of the model.

III. Supply Shocks

Although increased price flexibility clearly often is destabilizing at the margin in response to demand shocks in our models, increased price flexibility is—as Driskill and Sheffrin have proved—stabilizing at the margin in response to supply-side shocks to the level of wages. This raises an interesting question: if there is a mixed distribution of shocks, how heavily does the mix have to be tilted towards supply shocks before there ceases to be a region where increased price flexibility is destabilizing at the margin? If we change our wage-determination equation to add a supply shock:

$$W_t = .5(W_{t-1} + E_{t-1}W_{t+1}) + x(.5E_{t-1}(Y_t + Y_{t+1})) + N_t, \quad (15)$$

how large does σ_N^2 have to be relative to σ_z^2 for the region where price flexibility is destabilizing at the margin to disappear?

In our model the answer turns out to be somewhat surprising. As price flexibility increases, the variance of output generated by a serially uncorrelated supply shock quickly declines and approaches an asymptote for the reasonable parameter values used here, as Table 4 reports.

There is thus a region where (i) further increases in price flexibility do little to reduce output variance generated by supply-side shocks, and (ii) further increases still add to the variance generated by demand shocks. Therefore the distribution of shocks must be heavily weighted toward the supply side for the region where price flexibility is destabilizing to disappear.

Table 5 reports some sample output variances for different distributions of independent shocks. The variance of N_t, the supply shock, is taken to be one; the variance of the demand shock, z_t, is taken to be B.

The intuition behind this result is rather simple. Driskill and Sheffrin show that the output response of a real interest rate-enhanced Taylor-like model to a supply shock is an ARMA(11) process. As the degree of price flexibility increases, the autoregressive term becomes smaller and smaller because the economy moves to eliminate effects that are not due to this period's and last period's surprise shock. In the limit, state variables become simple one-period moving averages of shocks.

Now the autoregressive parameter turns out typically to be already quite small for relatively low g. It is not uncommon for an autoregressive parameter of .3 to be associ-

[5] Results are presented for $B = .4$. Results for $B = .2$ show even slower convergence toward the Walrasian limit.

TABLE 4—STEADY-STATE VARIANCE IN RESPONSE TO SUPPLY SHOCKS

	$A=$	$g=$ 0	.1	.2	.4	.6	.8	Asymptote
$B=.2$	1	∞	30	28	27	27	26	26
	2	∞	85	80	78	76	76	75
	3	∞	142	136	132	130	130	130
$B=.4$	1	∞	37	33	31	29	28	27
	2	∞	84	76	71	68	66	65
	3	∞	123	112	105	102	100	99

TABLE 5—STEADY-STATE VARIANCE IN RESPONSE TO MIXED SHOCKS ($A=2$; $\mu=.5$)

	Ratio of Supply to Demand Shock Variance	$g=$ 0	.1	.2	.4	.6	.8	1.0
$B=.2$	1	∞	157[a]	158[a]	168[a]	177[a]	181[a]	183[a]
	2	∞	121	119[a]	123[a]	127[a]	130[a]	131[a]
	5	∞	99	96	95[a]	96[a]	97[a]	97[a]
	10	∞	92	88	86[a]	86[a]	87[a]	87
$B=.4$	1	∞	126	120	120[a]	121[a]	122[a]	122[a]
	2	∞	105	98	95	96[a]	97[a]	97[a]
	5	∞	92	85	81	79	79[a]	79
	10	∞	88	80	76	74	74	72

[a] Denotes that price flexibility is destabilizing on the margin.

ated with a g of similar magnitude. The contribution of the "out-period" terms of an ARMA(1,1) to the total variance of the process is approximately the square of the autoregressive parameter times the contribution of the first two "in-period" terms, in which shocks enter the moving average portion of the process. Therefore, even with a g of only 0.3, the variance caused by supply shocks is already only some 9 percent above its asymptotic value. There is no room for further increases in price flexibility to produce significant declines in supply-shock-driven output variability.

We conclude that the introduction of supply shocks into our simple model is unlikely to remove our central result: that there is a significant and reasonable region of parameters for which price flexibility is destabilizing. Even if shocks on the supply side play a quantitatively significant role in cyclical output fluctuations, additional price flexibility may well do relatively little to damp their effects and may amplify the output fluctuations induced by demand shocks.[6]

IV. Alternative Determinants of Aggregate Demand

The previous sections have all assumed that what matters for the determination of aggregate demand is the short-term real in-

[6] Taylor (1980) concludes that the phenomenon of destabilizing price flexibility is not of empirical significance. He relies on the relatively primitive model developed in our forthcoming article with inertial expectations in the price equation, that lacks any attempt at explicit microfoundations, and generates output movements in response to demand shocks that have negative serial correlation. Taylor finds that for the primitive model with supply and demand shocks, there are regions where price flexibility is stabilizing and regions where price flexibility is destabilizing, but that empirically reasonable parameter values are likely to be contained in the stabilizing region. We find it hard to judge what parameter values are reasonable in such a stylized model.

TABLE 6—STEADY-STATE VARIANCE FOR A Q THEORY OF AGGREGATE DEMAND ($\mu = .5$; $\delta = .20$)

		$g =$					
	$A =$	.1	.2	.4	.6	.8	1.0
$B = .2$	1	78.0[a]	79.0[a]	79.6[a]	80.4[a]	78.4	75.1
	2	52.0[a]	53.6[a]	55.8[a]	54.3	54.1	50.8
	3	37.3[a]	39.1[a]	39.8[a]	40.8	40.4	37.2
$B = .4$	1	53.0	52.9[a]	53.1[a]	53.4[a]	52.5	50.1
	2	27.9[a]	28.4[a]	29.1[a]	28.9	28.8	27.4
	3	17.1[a]	17.6[a]	18.2[a]	18.1	17.9	16.1
$B = .6$	1	39.4	39.1	39.0	39.2[a]	38.7	37.5
	2	17.6[a]	17.8[a]	18.0[a]	18.1	18.0	17.6
	3	9.7[a]	10.0[a]	10.2[a]	10.2	10.1	9.9

[a] Denotes that price flexibility is destabilizing at the margin.

terest rate, the one-period interest rate r_t. But there is an important and convincing line of thought which argues that the relevant interest rate for the purpose of determining investment is a long-term interest rate. Suppose that the level of aggregate demand is determined by the level of investment, which is in turn determined by Tobin's q. How does this shift in the mechanism that determines aggregate demand change the results of the previous sections?

Blanchard and Sachs (1982) consider a model with quantity-constrained demands, fully optimizing agents, and durable capital that is costly to adjust. They conclude that the Mundell effect is not strong enough to be destabilizing. In their model, price flexibility amplifies fluctuations in the short-term real interest rate. But because price flexibility leads to the faster damping of disturbances, long-term rates are less erratic and output is less variable.

A critical issue here is the length of time which constitutes the "long run," the horizon with which Tobin's q is calculated. In the spirit of the previous models in this paper, we replace r_t in (8) with its closest analogue in a q-theoretic framework, $q_t - 1$:

$$(16) \qquad (1 + AB) y_t = A(q_t - 1) + s_t.$$

Arbitrage implies that q_t evolves according to

$$(17) \qquad q_t = (1 - K - r_t) q_{t+1} + (F_k)_t,$$

where $(F_k)_t$ is the return paid on a unit of capital in place in period t, K is the sum of the risk premium on equity and rate of depreciation, and r_t is the real short-term interest rate. Clearly the larger is K, the closer is q_t to $1 - r_t$. If K is "high enough" in some sense, price flexibility will be destabilizing even in this q-theoretic framework. The process determining q_t will place very high weight on the more volatile real return fluctuations in the present and less weight on the more stable real returns in the far future. The interesting question is whether K is likely to be high enough to render price flexibility destabilizing in actual economies.

Since World War II, the real return on equities in the United States has averaged some nine or so percentage points higher per year than the return on Treasury bills. One component of K is therefore this risk premium. It is reasonable to assume that capital depreciates at 10 percent per year. We therefore assume that $K = 20$ in the calculations reported below, although our results are somewhat sensitive on this assumption.[7]

The model used for the simulations reported in Table 6 is our basic model with two-period contracts, only with the IS aggregate demand equation (6) replaced by (16), and with the arbitrage equation (17) included with a value of .20 for K. Profits $(F_k)_t$ are assumed constant; allowing for

[7] If K is lower, then the destabilizing effect of price flexibility is reduced. With $K = 16$, destabilizing effects are severely damped. And if K is lowered to 10, then price flexibility is never destabilizing for the parameter values considered.

procyclical profits introduces an accelerator into the model without changing its qualitative behavior. Results are presented for $\mu = 5$. Price flexibility is more destabilizing for lower values, and less destabilizing for higher values of μ.

Price flexibility is still destabilizing over a range, although not over as large a range as the basic model. Moving to a theory of aggregate demand based on the long-term rather than on the short-term interest rate weakens but does not eliminate the plausibility of destabilizing price flexibility. With higher values of B, the traditional conclusion that price flexibility is stabilizing is restored.

As Robert Hall (1977) emphasizes, there are strong reasons to expect investment to depend on short as well as long real rates. Timing is a critical aspect of many investment decisions. For many types of capital goods, adjustment costs are not important. And so the financial variable that should enter into the determinant of aggregate demand should be neither r_t nor q_{t-1}, but instead some weighted average.

There are several other reasons to think that the weight placed on r_t should be relatively high. Much cyclically sensitive capital formation is nondurable, or not very durable. Moreover, there may be effects which are well-correlated with the short-term interest rate which are not in representative decision-maker models. Agents may be limited in their spending by liquidity constraints. And sharp declines in the price level that were unanticipated at the moment many contracts specifying financial liability were written can have large effects on aggregate demand through the distributions of wealth. Putting a high weight on r_t would lead us back towards the results in earlier sections.

Destabilizing price flexibility is not removed as a possibility by the move from using short-term to using long-term interest rates in the determination of aggregate demand. Our initial conclusion that models derived from Taylor (1979, 1980) can exhibit destabilizing price flexibility for a wide range of plausible parameter values has turned out to be quite robust. If Taylor's models can serve as a reasonable base from which to reason about the behavior of the economy, the results of this paper show that there is every reason to take Keynes seriously when he challenges the view that increased price flexibility would reduce the seriousness of business cycles.

V. Conclusions

Our results suggest that standard Keynesian models wage and price rigidity have the implication that increases in price flexibility starting from degrees of flexibility like those observed in economies such as the United States may well increase the cyclical variability of output. This conclusion holds even allowing for forward-looking behavior in wage-setting and in financial markets. This observation makes it unlikely that the extra degree of nominal rigidity of the type associated with union contracts, for example, can plausibly be blamed for cyclical fluctuations in output. Even if increased nominal rigidity is not stabilizing, it is unlikely to be significantly destabilizing. As we have emphasized in our forthcoming paper, these observations are consistent with the broad sweep of American macroeconomic history. The increasingly non-Walrasian character of the economy and the associated reductions in wage and price flexibility have coincided with improvements in macroeconomic performance.

The mainline American Keynesian view that the major difference between economies that are well-approximated by classical models and economies that are well-approximated by Keynesian models lies in the fact that the first set of economies have more aggregate price flexibility is particularly odd in view of the origins of Keynesian economics in the experience of the Great Depression. Between 1929 and 1932, the U.S. price level declined by 9 percent a year. In 1932, U.S. real *GNP* was two-thirds of what it had been three years earlier. It is difficult to believe that the problems of the U.S. economy during the Great Contraction were due to the fact that prices did not adjust quickly enough to absorb the nominal shock which came either from inappropriate monetary policy or from pessimistic animal spirits. It seems implausible to assert that if only the price level had declined by 20 instead of 9 percent per year, that the U.S. economy would have had a high level of output in 1932. Rather more plausible is the belief that if the price level had fallen at 20 percent per year, the contraction would have been even more serious as very high real interest rates would have drastically reduced the level of economic activity.

Events surrounding the trough of the Great Depression lend some support to our position, although a convincing analysis must wait for the future. During the decline of 1929–33, the view that price declines were a cause—as well as a consequence—of depressed output gathered force. President Roosevelt was greeted on his inauguration by demands for a rollback of deflation, demands which found expression in the National Industrial Recovery Act. According to Ellis Hawley, American business leaders believed that "excessive competition," by depressing wages and product prices without writing down fixed debt-related costs, "had destroyed profitable operation, undermined business confidence, and reduced the rate of investment" (1966, p. 27). According to W. Arthur Lewis, the NIRA was intended to "promote recovery... by raising prices, and thus dissipating the gloom of business men... and by raising wages" (1949, p. 107).

The NIRA was signed in June 1933, a few months after the trough in both output and prices. Over the period of its operation, it certainly raised prices. Output also recovered somewhat, and clearly the recovery was not triggered by any further decline in nominal interest rates or by fiscal policy (as E. Cary Brown, 1956, has convincingly demonstrated). In Lewis' judgment, the initial "psychological effect [of the NIRA] was good; business men took heart from the prospect of rising prices" (p. 107). Nevertheless the possible stimulative effects of the NIRA operating through price expectations remain speculative. Rolling back deflation was only one of the policies embedded in the NIRA. The NIRA's encouragement of cartelization may have had contractionary macroeconomic effects of its own.

International evidence corroborates our skepticism about the causal role of substantial nominal rigidities in explaining business cycles. In much of Latin America, high rates of inflation are endemic. Perhaps because of the increased wage and price flexibility that accompanies rapid inflation, real interest rates are much more variable than in the United States and so too is real output. Despite a high degree of price flexibility, monetary and fiscal policies have potent effects on the level of economic activity.

As Franklin Fisher (1984) emphasizes, economics does not possess a fully satisfactory theory of price adjustment. There does not yet exist a convincing demonstration that a decentralized economy will rapidly converge to its Walrasian equilibrium after being shocked. The stability of an economy without institutional impediments to price flexibility in the face of demand shocks is an assumption, not a conclusion of economic analysis. The performance of actual economies suggests that it may not be a particularly good one.

While calling into question the common conclusion that more nominal rigidities mean more variability in output and employment, our results support arguments suggesting the importance of the existence of nominal rigidities in explaining cyclical fluctuations. A problem for "menu" arguments explaining business cycles is that the rigidities explained seem small relative to the length and depth of the fluctuations that must be explained. Our analysis suggests that because of the effects of expected price changes, even small amounts of nominal rigidity can be substantially destabilizing.

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