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Wage Rigidity and Macroeconomic Performance

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WAGE RIGIDITY AND MACROECONOMIC PERFORMANCE

1 Introduction

In this paper, a "rock-bottom" open economy macroeconomic model is used for the discussion of the role of structural rigidities, expectations, and shocks in the determination of the price level and its variability. The second section is an informal discussion of some theoretical issues having to do with price flexibility. The third section presents the model. The fourth draws conclusions from it.

2 Issues

2.1 Prices and shocks

It is useful to distinguish between relative prices and the price level (or absolute, or money prices). From microeconomic theory comes the neutrality proposition that all demand and supply decisions are homogeneous of degree zero in prices. Consequently, economic decisions depend on relative prices only. Neutrality in this sense will be assumed throughout. In the macroeconomic tradition, the focus will be on the price level, although all the real action will (implicitly) flow from distortions in relative prices. In the highly aggregated model presented below, the only relative price is the real wage rate.

The economy is subject to a wide variety of shocks. These can be conveniently categorized in two ways: (i) real versus nominal, and (ii) permanent versus transitory. A nominal shock is defined as one for which equilibrium can be restored by an equiproportionate change in all money prices. In the language of Sargent (1979, p. 43), a nominal shock is one for which the economy "dichotomizes". A real shock is everything else. It is clear that this definition of a nominal shock restricts the possibilities considerably. To make it more precise, however, requires a complete model, since dichotomy is a model-wide property. For example, in a standard textbook IS-LM model a change in the nominal money stock is a nominal shock since an equiproportional change in the price level will restore equilibrium. If that model is modified to include total financial wealth (say, money plus government bonds) in the money demand function, the appropriate nominal shock is an equiproportionate increase in both components of financial wealth.

Permanent versus transitory is a self-explanatory distinction. The importance here is that the appropriate reaction to a shock that is

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expected to be permanent is different from the response to one that is expected to be reversed. Therefore, expectations effects hinge on whether the shocks are permanent or transitory.

There is another important distinction to be made: a level shock versus a growth rate shock. The different effects of these are due to expectational effects and to potentially very different dynamic adjustments. The former are well-known, and the latter are too complicated to be usefully analyzed in the rock-bottom model. Only level shocks will be considered in the formal analysis.

2.2 Rigidities

Again, there is a useful classification that can be made: institutional rigidities and expectational rigidities. In the former, prices do not move because they are locked in by binding contracts, costs of adjustment, and so forth. This is true even though agents realize that a different price (i.e., the absence of institutional rigidities) would improve their welfare. It will be argued that this is not necessarily the same as saying that there are unexhausted gains from trade. An expectational rigidity arises if agents at the time feel that the price is right, while later it can be seen that they had been in error and the price was wrong. This may arise because of incomplete information or irrational expectations.[1]

This distinction is important at the policy level. Consider the policy of monetary validation. Given existing institutional rigidities an optimal short-run response to a shock may be to increase the money supply. This policy, however, will ultimately induce an expectation of future validation. If, for whatever reason, the validation policy is abandoned agents may not believe it. The next shock will have especially large effects since there will be both types of rigidity at work. Clearly, a policy of establishing "credibility" will clear up the expectational rigidity, but will do nothing for the institutional rigidity.

The final point of this section has to do with the genesis and optimality of institutional rigidities. It may be argued that the existence of such rigidities is a prima facie case for market failure. If so, there is fertile ground for government intervention because such arrangements are commonplace. Indeed, they are so commonplace that one is

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1. Clearly, the classification is not rigorous. For example, agents may be misinformed (about the nature of the shock, for example) because there exists no institution to disseminate the required information. On the other hand, long-term fixed wage contracts may be optimal (despite the fact that they fix the nominal wage) because workers and firms have heterogeneous information (about, say, the marginal value product of labour. See, for example, Grossman, et al. (1983)). Nevertheless, it serves well at the level of macroeconomic analysis.

forced to question whether they really are due to market failure. A key research program at the microeconomic level is identifying and explaining "rigidities" as optimal responses to uncertainty, asymmetric information, moral hazard, transactions costs, and the like. Although beyond the scope of this paper and of the model presented below, it is worthwhile considering a simple example.

Gray (1976) considers the issue of contract indexation in a standard one-output macroeconomic model. She analyzes the comparative static responses to nominal and real shocks (the nominal money stock and the marginal productivity of labour, respectively). In the absence of contracts, the appropriate response to a negative (say) monetary shock is an equiproportionate change in all prices, leaving all real variables unaffected. The response to a negative real shock is a reduction in the real wage rate.

If workers and firms are bound by a contract specifying a nominal wage rate, the correct response to a nominal shock is impossible in the short run. If the contract is indexed, so that real wages are fixed, this is not so: the appropriate response occurs automatically. The opposite is true in the case of a real shock. That is, a fixed real wage makes adjustment to a real shock impossible. Gray finds that the optimal degree of indexation (defined as that which minimizes the mean squared deviation between actual output and output in the absence of any contracts) lies between full indexation (which is optimal in the absence of real shocks) and the degree of indexation appropriate to an economy without nominal shocks. Where it lies depends on the relative contributions of the two shocks to overall economic variability.[2]

Suppose the economy has found such an optimum, and that we have a model of such an economy. A simulation experiment that considered only a nominal shock would conclude that the economy is under-indexed (i.e., that the nominal wage is insufficiently flexible), whereas one looking at a real shock would conclude the opposite. In fact, institutions (i.e., markets) must deal with a range of shocks and so it will not be optimal to have them "tuned" to a specific type of shock.

A real issue arises if the mix of shocks changes. In the example above, this implies that the degree of indexation should change. Institutions change only slowly, however, and the change can be sufficiently costly that it is not worthwhile if the change in the mix is only a temporary aberration. Viewed in this light, the policy of validation (of large oil price changes, for example) is an attempt to re-establish the historical mix of shocks (by matching an unusually large real shock by a similar nominal shock).

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2. In a more disaggregated model, some real shocks would be industry specific. Therefore, the optimal degree of indexation would vary from industry to industry.

3 A Simple Analytic Model

This section uses a "rock-bottom" open economy macro model to further examine some of the issues raised above. It is assumed there is one output, two assets (money and bonds), trade implying purchasing power parity and uncovered interest parity, and rational expectations. While none of these is particularily realistic, the model provides a reasonable starting point for a theoretical discussion.

The equations defining the model are:

$$q_t = a(p_t - E(p_t|I_{t-1})) + \bar{q}_t; \; a > 0 \tag{1}$$

$$m_t - p_t = -\ell_1 r_t + \ell_2 q_t; \; \ell_1, \ell_2 > 0 \tag{2}$$

$$p_t = p_t^* + e_t \tag{3}$$

$$r_t = r_t^* - (e_t - E(e_{t-1}|I_t)) \tag{4}$$

$$m_t = cm_{t-1} + u_t \tag{5}$$

$$\bar{q}_t = b\bar{q}_{t-1} + v_t. \tag{6}$$

All variables (except r and r*, the domestic and world interest rates) are in logarithms. The notation $E(x_t|I_s)$ denotes the rational expectation of the variable x_t conditional on the period s information set. The information set I_s is assumed to include all past values of the variables, the stochastic processes generating the shocks, plus the current exchange rate e_t (defined as the price of foreign exchange).[3] It does not include the current realizations of the shocks (u_t, v_t). The The exogenous driving variables are the nominal money stock m_t, and "trend" output $\bar{q}_t$. For convenience, these are assumed to be AR(1), (with $0 < b$, $c < 1$) with innovations (u and v) that are white noise with variances σ_u^2 and σ_v^2, and they are assumed to be independent of one another.[4]

Real output q_t is assumed to depend on the difference between the actual output price p_t and its expectation as of one period earlier. Behind this is a labour market with one-period contracts which set nominal wages w_t. The <u>ex post</u> real wage is $w_t - p_t$, while the contractual wage is $w_t - E(p_t|I_{t-1})$. A larger than expected price reduces the real wage and therefore increases output. This, then, is the "institutional rigidity", and its total effect is summarized by the parameter "a". If

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3. The interest rate is also observed, presumably, but is assumed to yield no information beyond that found in e_t.

4. These stochastic assumptions could be modified at the expense of algebraic complexity.

a = 0, there are either no contracts or the contracts are made contingent in such a way as to wipe out price level effects. In principle, "a" will hinge on the exogenous processes and the costs of changing wages. These issues cannot be addressed in the present model but see, for example, Gray (1978).

Equation (2) describes asset market equilibrium and features a standard LM curve. Equation (3) defines purchasing power parity and in what follows the foreign price p_t^* is normalized to zero. Equation (4) is the uncovered interest parity condition, and the foreign interest rate r_t^* is also normalized to zero.[5]

Using standard techniques (see, for example, Barro (1976)) one can write the rational expectations solution for p_t in terms of six "state variables" (m_{t-2}, u_{t-1}, u_t, $\bar{q}_{t-2}$, v_{t-1}, v_t)

$$p_t = k_1 m_{t-2} + k_2 u_{t-1} + k_3 u_t + k_4 \bar{q}_{t-2} + k_5 v_{t-1} + k_6 v_t \tag{7}$$

where $k_1 = c^2/B_c$

$$k_2 = c/B_c - (1-\theta)\, a\, \ell_1 \ell_2 S$$

$$k_3 = (1+\ell_1)/AB_c - (1-\theta)\,\ell_1 S$$

$$k_4 = -\, b^2/B_b$$

$$k_5 = -\, b/B_b - \theta\, \ell_2^2\, aS$$

$$k_6 = -\,\ell_2(1+\ell_1)/AB_b - \theta \ell_1 \ell_2 S$$

$$A \equiv 1 + \ell_1 + \ell_2 a$$

$$B_b = 1 + \ell_1(1-b)$$

$$B_c = 1 + \ell_1(1-c)$$

$$S = (1+\ell_1)(c-b)/AB_b B_c$$

and where θ is the fraction of the total variance in p accounted for by the monetary shock u.

A brief general description of the solution is in order. Except for those of m_{t-2} and $\bar{q}_{t-2}$, the coefficients are composed of two parts: one containing θ (or $1-\theta$) and one not. The former is due to the assumption

5. It is possible to build foreign price and interest rate shocks into the model, but the computational cost would be enormous. With one exception, mentioned below, there is little gain to offset this cost.

that agents do not observe the current shocks. They can, however, estimate them using the observation of e_t. This observation is weighted by the variances of the underlying shocks (i.e., by θ) to estimate the contribution of each of those shocks. Of course, in any realization this weighting may be incorrect, but on average it is accurate. Since all the expectations enter the model as one-period differences (i.e., $E(p_t|I_{t-1})$ and $E(e_{t+1}|I_t)$), the duration of the shock is important in terms of its effect on the variable of interest. Duration is determined by the parameters b and c. If, for example, c = 0, then the money shocks are transitory, and will have no effect at all on future variables. If c = 1, then the shock is permanent. If both shocks are equally durable (b = c) then the effect on the future is identical, and there is no need to disentangle them.[6] Therefore, if all the variance is due to the monetary shock (θ=1), the solution becomes[7]

$$p_t=(c^2m_{t-2}+cu_{t-1}+(1+\ell_1)u_t/A)/B_c.$$

This is referred to as the "full information" solution since there is no doubt about the origin of the shock. An analogous situation with respect to the real shock occurs if $\theta = 0$. If c = b, the full information solution appears even though agents do not know the origin of the shock. In this case, the economy acts as if there was full information. The coefficients on m_{t-2} and $\bar{q}_{t-2}$ have only full information parts because they are always in the relevant information sets. In general, however, the effect of the incomplete information part of the solution is to decrease (in absolute value) the coefficient on the more permanent shock. Finally, note that in k_3 and k_6 the incomplete information part of the of the solution is always less in absolute value than the full information part. Therefore, the money shock coefficients are positive and the real shock coefficients are negative.

From equation (1), output is given as

$$\begin{aligned} q_t &= a((1+\ell_1)/AB_c-(1-\theta)\ell_1 S)u_t \\ &+ (((1+\ell_1)(1+\ell_1-\ell_1 b)-\ell_1\ell_2 ab)/AB_b \\ &- a\theta\ell_1\ell_2 S)\ v_t + b\bar{q}_{t-1}. \end{aligned} \tag{8}$$

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6. The choice of b = c is not a general property of this class of models, but there will exist some relationship between b and c that makes the equilibrium appear "as if" it were a full information equilibrium.

7. The coefficients on $\bar{q}_{t-2}$, v_{t-1} and v_t do not vanish, but are difficult to interpret since the shocks themselves never occur if θ = 1.

Monetary policy affects output (even if it is observed, i.e., if $(1-\theta)\ell_1 S=0$) because of the presence of contracts (see, e.g., Fischer (1977) and Taylor (1980)). Indeed, although equation (5) specifies an exogenous monetary process, it could specify a policy rule and this rule could be used to offset real shocks to the extent that they were unanticipated by those who signed contracts in the previous period.

4 Issues

4.1 Price flexibility

There are two often-used measures of price flexibility. The first is its variance. The second is the split of nominal output changes between price and quantity. As is clear from equation (7), the variance of prices depends on all the parameters of the model, and notably on the duration (b,c) and mix (θ) of the shocks. In view of the stochastic assumptions embodied in (5) and (6), the variance of the (log of the) price level is [8]

$$\mathrm{Var}(p) = (k_2^2+k_3^2)\sigma^2 u+(k_5^2+k_6^2)\sigma_v^2. \tag{9}$$

Expressions such as $\partial \mathrm{Var}(p)/\partial\sigma_u^2$ are easily calculated, but difficult to sign. For example, a change in the variance of the monetary shock has an obvious direct effect of reducing price variance, but it also has an indirect effect by changing θ (this assumes agents realize that the relative variance of the two shocks has changed). These effects need not operate in the same direction.

Of more immediate interest is the effect on price variability of a change in the institutional rigidity, summarized by the parameter "a". The relevant expression is

$$\frac{\partial \mathrm{Var}(p)}{\partial a} = \sigma_u^2 [-2k_2(1+\ell_1)\ell_1\ell_2 S(1-\theta)/A - 2k_3^2\ell_2/A] + \sigma_v^2 [-2k_5(1+\ell_1)\ell_2^2 S\theta/A - 2k_6^2\ell_2/A]. \tag{10}$$

The terms having k_2 and k_5 work directly through the aggregate supply relation and depend on agents being unable to observe, at period t-1, the shocks u_{t-1} and v_{t-1}. Assume there is no confusion (i.e., S = 0). This leaves the effect of contemporaneous shocks, working through the asset market. In this case, $\partial \mathrm{Var}(p)/\partial a< 0$. The result that an increase in the rigidity reduces price variance (what one might expect) follows

8. The terms corresponding to m_{t-2} and $\bar{q}_{t-2}$ have been omitted. This does not effect the calculations made below. A more "realistic" model would have to make assumptions about the covariance structure of the shocks.

because a higher value of "a" increases the size of the income change (for any shock), and through the money demand function (represented by ℓ_2) this does some of the "work" that would otherwise have to be done by the price level.[9]

Consider now the split of nominal income between price and quantity ($y_t = q_t + p_t$). Since in the long run (given a constant growth rate of real output) changes in the growth rate of inflation reflect only changes in the inflation rate, the short-run split is often interpreted as the effect of rigidities that prevent shocks from being passed through directly to prices. In the present context, the appropriate measure of the split is the mean of p_t conditional on a unit change in y_t (these are to be understood as being deviations), which is

$$F = \frac{Cov(py)}{Var(y)}. \tag{11}$$

Note that this is the population regression coefficient (i.e., the "true" coefficient, abstracting from econometric problems) from p = Fy, and is

$$F = \frac{k_3^2\ (1+a)\ \sigma_u^2 + (k_6^2\ (1+a) + k_6)\ \sigma_v^2}{k_3^2\ (1+a)^2\ \ \sigma_u^2 + (k_6(1+a)+1)^2\ \ \sigma_v^2}. \tag{12}$$

In discussing (12), a few points are in order. First, F does not describe the effect of a nominal shock on p and q assuming y is moved exogenously. Rather, it depends on the average effect of both shocks, and indeed on all the parameters of the model. A regression of p on y will therefore be difficult to interpret as indicating the short-run effect of a monetary policy that reduces nominal income by one unit.

Second, to illustrate further the problem of interpreting F, consider what the split would be conditional on $y_t = 1$ and $v_t = 0$ (i.e., only a monetary shock). Then

$$y_t = p_t + q_t = (k_3 + ak_3)u_t = 1$$

implies that

$$u_t = (k_3 + ak_3)^{-1},$$

$$p_t = k_3(k_3 + ak_3)^{-1}, \text{ and}$$

$$q_t = ak_3(k_3 + ak_3)^{-1}.$$

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9. A more complete model would consider the interactions between "a" (which arises, for example, from contracting behaviour) and the shocks themselves. This will, in general, add further ambiguity to the results.

In this case, a = 0 implies $p_t = 1$ and $q_t = 0$, the conventionally predicted split of a monetary shock in the absence of rigidities. The observed split will differ from this because, in fact, other shocks are present. This is an example of the well-known "Lucas criticism" (Lucas (1975)).

Finally, it is of interest nevertheless to ask how F would change with respect to the rigidity. Conventional reasoning suggests that the absence of rigidities should imply that (nominal, at least) shocks would be reflected only in price movements. This is not true because both monetary and real shocks change q and p such that they do not offset (i.e., in fact q is not exogenous). Therefore Cov(py) $\neq 1$ even if a = 0.

Unfortunately, the general expression for $\partial F / \partial a$ is extremely complicated. A reduction in "a" has offsetting effects. First, as noted above, it increases k_3 and k_6. Second it has a direct effect in reducing both Cov(py) and Var(y). In general, there is no clear, or even monotonic relationship between F and "a". The conclusion is that the split coefficient must be interpreted with great care.

4.2 Policy credibility

Interpret (5) as a monetary policy rule. Disregarding its optimality properties, assume the monetary authority knows u_t and communicates it to private agents. There are two polar cases. First, agents disregard the information completely and rely on their observation of e_t to form expectations of u_t and v_t. This yields the model described in Section 2. The other possibility is that agents accept the announcement of u_t as the truth. In a model with only two shocks, this is equivalent to full information.[10] In this sort of model there is a presumption that the full information solution is optimal. Although the model has no welfare index by which to gauge optimality, it is assumed that fully informed agents will make the best use of information available, and that more information leads to better decisions.

Are aggregate statistics, such as overall price variance and the split, useful indicators of the welfare improvement? The effect of credibility on the size of k_3 and k_6 depends on the sign of S. As was explained in Section 2, the effect of S is to reduce (in absolute magnitude) the size of the coefficient on the more permanent shock, and to increase the other. Therefore, if the more permanent shock is also the small variance shock, then the full information variance of p will be smaller than the incomplete information variance. Of course, the effect

10. Were there more than two shocks, of course, knowledge of u_t would not be equivalent to full information. In terms of an ad hoc welfare index (the mean squared deviation from full information output, for example) it need not necessarily be the case that welfare improves if one shock (out of three, say) becomes known.

on F is more complicated still. Otherwise put, the effect of credibility on observed price flexibility (interpeted as variance or as the split) depends on the parameters of the model.

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