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DEMAND DISTURBANCES AND AGGREGATE FLUCTUATIONS: THE IMPLICATIONS OF NEAR RATIONALITY*

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Business cycle research has fallen into one of two camps: the Keynesian tradition, where demand disturbances give rise to aggregate fluctuations as a result of money illusion; and the new classical school, where informational misperceptions in a fully rational framework yield short-run (and sometimes autocorrelated) deviations away from equilibrium income. Both approaches seem to raise difficulties. The Keynesian explanation rests on *ad hoc* and irrational behaviour, its hallmark being, according to its critics, the failure of agents to execute perceived, mutually advantageous trades. While the classical models escape this criticism, they are still at a preliminary and inconclusive stage in explaining the cycle. Thus, an explanation of why demand disturbances generate aggregate fluctuations remains high on the macroeconomic agenda.

A number of recent papers have examined an intermediate class of macroeconomic models where agents' behaviour falls between the full optimisation of the classical paradigm and the outright irrationality of the Keynesian model. Akerlof and Yellen (1985*a*) defined behaviour as 'near rational' if, in response to some exogenous shock of size ϵ, the agent's loss of welfare resulting from a chosen action, relative to the welfare level that could individually be achieved by full maximisation, was second order in ϵ. They showed how, with a monopolistically competitive goods market and all firms paying an efficiency wage, adherence to a near rational rule of thumb by a fraction of the firms could generate first order non-neutrality of money. They thus demonstrated that near rationality can have dramatically different implications for the short run response of the economy to demand shocks than does full rationality. In related work, Mankiw (1985) has shown that if a monopolist sets price inertially because of a 'menu cost' associated with price changes, even if these menu costs are small the social losses from such behaviour need not be. Most recently, Blanchard (1985) has examined the consequences of near rational behaviour in a general equilibrium model with monopolistic competition in both labour and goods markets. Taken together, these papers provide models in which monetary non-neutrality can be consistent with behaviour which is, to first order, rational. However, these results are limited to static models with monopolistic competition, and they shed little light on whether models with

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near rationality can explain co-movements of macroeconomic variables such as those observed in actual economies.[1]

This paper examines the macroeconomic consequences of near-rational behaviour in a competitive framework. In addition, a simple model with a fully rational and a near rational sector is presented which, for plausible parameter values, generates movements of wages, output and employment consistent with conventional Okun's Law ratios and with the recent research on average and marginal compensation by Schor (1985) and Bils (1985). These results are obtained by considering first a static and then a dynamic model with competitive labour and output markets. Using the static model, we show that policies that incur only second order losses in profits can nonetheless generate first order changes in output and employment. This result confirms a conjecture advanced by Akerlof and Yellen that neither efficiency wages nor monopolistic competition was essential for near rationality to have an important role. In an Appendix, we examine in turn the properties of the model under the alternative labour-market arrangements of nominal contracting and efficiency-wage-payment schedules.

To examine near rationality in a dynamic context, we propose a criterion termed 'stochastic near rationality' according to which a policy is near rational if, when followed, it can be expected to impose only a second order average loss over time. Using a dynamic version of the static framework with competitive output markets, we study numerically the macroeconomic properties of this model when some firms maximise and some are stochastically near rational. These calculations demonstrate that simple models with near rationality can generate co-movements of aggregate variables consistent with those observed in reality. In addition, even though the marginal wage is perfectly flexible and labour markets clear, we show that, in our model, demand management policies are effective and have a natural role to play in short run macroeconomic stabilisation.

I. NEAR RATIONALITY IN A STATIC MODEL

In a fully classical economy, changes in the level of demand do not alter the level of output. Rather, prices change to accommodate the demand shift, while quantities, determined in the labour market, remain unchanged. This section shows how, in a competitive framework, such a conclusion need not be robust against small deviations from rationality. Rather, if some fraction of firms pursue a policy such as expanding hiring and production when demand rises – a strategy which we will demonstrate to be near rational, in Akerlof and Yellen's (1985*a*) sense – demand disturbances can indeed give rise to aggregate fluctuations.

[1] In microeconomic contexts, the effects of small departures from rationality have been studied in the recent game theory-industrial organisation literature (see, e.g. Radner, 1980). Akerlof and Yellen (1985*b*) give a wide range of other microeconomic examples where privately almost costless actions lead to large social costs or benefits. In related work, Haltiwanger and Waldman (1985) address some microeconomic examples where, with both 'sophisticated' and 'naive' agents in the population, the interest is on whether one group or the other (or neither) exerts a 'disproportionate' influence in the equilibrium. Their focus is, however, different from these other papers, and also from that to be presented below, in that they do not restrict their naive agents to be nearly sophisticated, or near rational.

We examine an economy with two types of firms: those that maximise fully, given the set of prices they face, and those that adjust their level of production in the short run to changes in demand. The markets for labour and output operate competitively, labour supply depending on the real wage and demand for output depending on its price. Each maximising firm takes the real wage as given and hires by a marginal product rule. Each near rational firm, however, alters its hiring level with the perceived level of demand, while still paying the going real wage.

We note at the outset that this rule of thumb differs from the inertial behaviour (with regard to quantities or prices) found in some of the earlier work we cited above. Our justification for such a rule is the simple one that this policy, adjusting employment to take all the labour supplied at the going wage, is both plausible and easy to implement. On a deeper level, it could thus qualify as salient according to Simon's notion of procedural rationality in a satisficing context. Recently, Nelson and Winter (1982) have suggested that firms typically adhere to fixed, simple procedural rules in the short run, even in the face of external disturbances, with evolutionary forces then determining the pattern of observed behaviour. In this light, a critical aspect of the rule of thumb we consider is that, in addition to being easy to follow, it is also almost costless.

The intuition behind our results can be seen by considering an upward shift in the level of demand. The near rational firms increase hiring to accommodate the increased demand, thereby raising the real wage, and, as a result, the level of employment at the maximising firms falls. This partially offsets the increased labour demand, so that the new equilibrium has greater employment, higher output and a shift in the allocation of production towards the near rational firms. Moreover, this new equilibrium is consistent with the price of output remaining unchanged, though the real wage is of course increased.

The properties displayed by the economy heuristically described above depend essentially on two factors: (i) the extent to which aggregate employment adjusts in the face of a demand shift; and (ii) the degree of misallocation of labour, relative to a first best where marginal products are equated in all uses, that is induced by the different responses of the two types of firms. The first effect would naturally lead to countercyclical productivity, other things being equal, given the concavity of firms' technologies. For the model to display broad consistency with Okun's Law, then, the second effect has to predominate.

The Basic Model

Let the maximising firms be denoted by the subscript m, and let the non-maximisers be denoted by the subscript n. For expository convenience, we will assume there is only one firm of each type in the economy. Both firms are price takers in the same product market: this market clears in both the short and the long run. They each hire labour, L_m and L_n respectively, and produce output according to the production functions $F_m(.)$ and $F_n(.)$. We let Y denote the level of real aggregate demand,[1] so that goods market equilibrium requires

$$F_m(L_m) + F_n(L_n) = Y. \tag{1}$$

Labour supply is given by

$$L^S = \phi(w/P), \tag{2}$$

and the maximising firm hires according to

$$F'_m(L_m) = w/P. \tag{3}$$

In the long run, the near-rational firm also hires according to a marginal product rule and this, together with market clearance

$$L = L^S = L_m + L_n, \tag{4}$$

completes the description of long-run equilibrium.

In the short run, however, the non-maximising firm adjusts hiring in response to changes in the level of demand, taking up whatever slack is left given the disturbance to Y and the equilibrium response of the maximiser. Thus, we retain market clearing, even in the short run, with aggregate employment variation reflecting the labour supply elasticity given the shift in the real wage. Moreover, it is readily seen that this strategy of responding to demand shifts is a near rational one. Let $\bar{L}_n$ be the hiring level of the firm if it maximises and let $\tilde{L}_n$ be the hiring level resulting from the rule of thumb, with corresponding expressions for profits in these two cases, $\bar{\Pi}_n = PF_n(\bar{L}_n) - w\bar{L}_n$ from maximising and $\tilde{\Pi}_n = PF_n(\tilde{L}_n) - w\tilde{L}_n$ from the rule of thumb. Then, expanding $F_n(\tilde{L}_n)$ around $\bar{L}_n$ and collecting terms, the individual gain to maximisation, relative to the rule of thumb, is

$$\bar{\Pi}_n - \tilde{\Pi}_n = -\tfrac{1}{2}(\tilde{L}_n - \bar{L}_n)^2 PF''_n(\hat{L}_n) \tag{5}$$

where $\hat{L}_n$ lies between $\tilde{L}_n$ and $\bar{L}_n$. With the employment change being first order in the demand disturbance, the near rationality of the policy follows.

Intuitively, the reason for this is clear. Given the specified rule of thumb, the firm hires labour at the wrong level, relative to marginal productivity considerations at the wage it is paying. Were it to optimise, it believes the wage it would pay would remain the same, but it would now select an employment level to equate the wage and labour's marginal product. The change in revenue consequent upon adherence to the simple rule of thumb is almost exactly offset by the change in costs, and hence the loss of profits is second-order small.

The Response to Demand Disturbances

In order to analyse the response to shifts in demand, it is convenient to express the model in terms of deviations around the long run equilibrium. Let L^*_m, L^*_n, etc. denote these long-run values, and let $y = \ln(Y/Y^*)$, $l_i = (L_i - L^*_i)/L^*_i$ for

[1] We do not specify the demand side of the economy in detail for clarity of exposition. Clearly, a simple quantity theory, with real demand being proportional to real balances, would be the most straightforward way to model the origin of the demand disturbances. Our focus is rather on the response of the system, given that shocks to demand occur.

$i = m$, n and $l = (L - L^*)/L^*$. A second-order Taylor expansion of (1) then yields

$$y = kl - \tfrac{1}{2} a_n r_n l_n^2 - \tfrac{1}{2} a_m r_m l_m^2 - \tfrac{1}{2} k^2 l^2 \tag{6}$$

where $k = (w^*/P) L^*/Y^*$, $r_i = (w^*/P) L_i^*/Y^*$ and $a_i = -L_i^* F_i''(L_i^*)/F_i'(L_i^*)$. Similarly, letting the deviation in real wages be given by $\omega = \ln [(w/P)/(w^*/P)]$, the labour demand of the maximiser is, to second order,

$$l_m = -\omega/a_m - b\omega^2, \tag{7}$$

where $$b = \frac{1}{2}\left[\frac{F_m'''(L_m^*)\,(w^*/P)^2}{L_m^* F_m''(L_m^*)^3} + \frac{1}{a_m}\right].$$

The labour supply equation gives, in deviation form,

$$l = \eta\omega \tag{8}$$

where η is the supply elasticity of labour evaluated at the long-run equilibrium. (Although one could here include a second-order term, only the leading term turns out to be relevant, so we make the simplification at this stage.) The market clearing condition can be rewritten exactly as

$$l = s_m l_m + s_n l_n \tag{9}$$

where s_m and s_n are the employment shares of each firm in long-run equilibrium. Finally, since labour markets are competitive, wages are equal across firms in the short run, both facing the same deviation, ω.

The model is now solved to determine employment and wage deviations in terms of the deviation in demand. We use (7), (8) and (9) to express l, l_m and l_n in terms of ω, and substitute into (6) to write y as a fourth-order polynomial in ω. Since ω is monotonic in y local to $y = 0$, this function can be inverted around $y = 0$ to approximate the wage deviation by a second-order Taylor series in y; some work establishes this relation to be

$$\omega = (k\eta)^{-1} y + (f/\eta)\, y^2, \tag{10}$$

where $$f = (k^3\eta^2)^{-1}\,[r_n(\tfrac{1}{2}a_n \lambda^2 - s_m b) + r_m(\tfrac{1}{2}/a_m + s_n b)] + \tfrac{1}{2}k^{-1},$$

$$\lambda = \frac{\eta}{s_n} + \frac{s_m}{s_n a_m}.$$

Thus, real-wage fluctuations are first order. Not surprisingly, these short run fluctuations will be larger the smaller is the labour supply elasticity. Using (8), we then find that

$$l = k^{-1} y + f y^2 \tag{11}$$

with this overall change being made up of the changes at the two firms

$$l_m = -(ka_m\eta)^{-1} y - (b/k^2\eta^2 + f/a_m\eta)\, y^2 \tag{12}$$

$$l_n = (\lambda/k\eta)\, y + (s_m b/k^2\eta^2 s_n + \lambda f/\eta)\, y^2. \tag{13}$$

These changes are first order in the short run, so the near rationality of the rule of thumb follows: they are, however, of opposite sign. Overall,

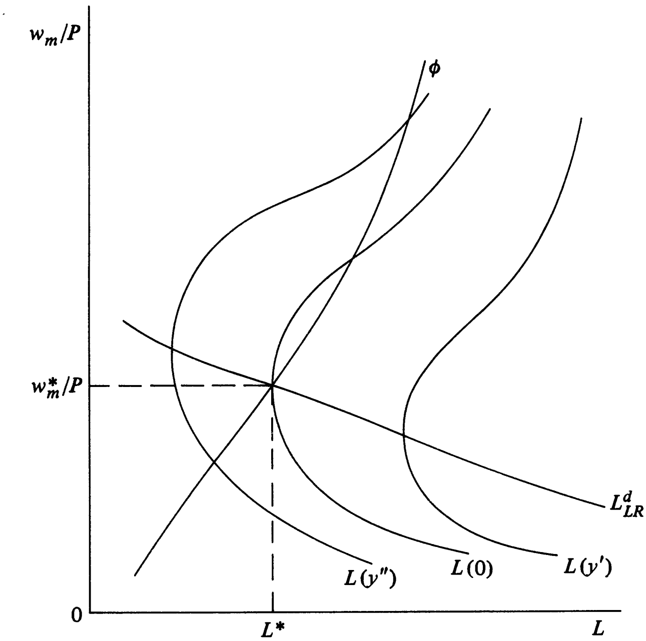

Fig. 1. Demand disturbances and the maximiser's demand for labour. y' represents a positive demand shock, y'' represents a negative demand shock.

$dl_m/dl = -(a_m \eta)^{-1}$ to first order, so that with a_m typically positive but less than unity[1] and η small, we have dl_m/dl large and negative for reasonable parameter values.

Three properties of this solution merit comment. First, from (11) the elasticity of employment with respect to demand is approximately

$$\frac{dl}{dy} = k^{-1} + 2fy. \tag{14}$$

The two terms in this derivative reflect the two effects mentioned at the outset. The leading term comes from the output change consequent upon the change in total employment; the second term reflects the fact that, as (12) and (13) record, there is a different response by each of the two firms, leading to an inefficient short run allocation of labour. Clearly, as y approaches zero, the derivative becomes $k^{-1} = Y^*/(w^*/P)L^*$, the ratio of the average to the marginal product of labour. The Okun's Law ratio is less than one, and a classical type of result obtains. For larger values of y, the effect of inefficient labour allocation can increase this ratio, at least for sizable negative demand shocks when labour can be reallocated very inefficiently and the goods market still clears. Note, however, that this Okun's Law effect is of second order in this static model.

Second, there is a possibility that large, positive demand shocks cannot be accommodated by the near rational firm, depending on the labour supply

[1] For example, if $F_m(L_m) = AL_m^b$ where A and b are positive constants, then $a_m = 1 - b$.

elasticity. Fig. 1 shows the labour market equilibrium in the long and short run.[1] The long-run aggregate labour supply and demand are given by ϕ and L^d_{LR}, respectively. The slopes of the short run labour demand curves depend on whether the demand shift is positive or negative. For a positive shift, the maximising firm will contract production, responding to the higher wage it faces as the near rational firm increases hiring, and conversely for a negative shift. Thus the short run demand curve slopes down when the maximiser expands hiring and up when it contracts, and the locus of points with minimum total employment – when marginal products are equated at the two firms – is the long-run demand curve. Evidently, marginal products and labour supply might be such that an increase in product demand would shift the labour demand curve sufficiently far out that the labour market would not clear. This would necessarily occur with perfectly inelastic labour supply: in this case, no positive real demand shock could be met. In general, whether labour supply can expand enough to meet short run demand will be determined by the relevant slopes.

Third, we note from (10) that the model predicts a real wage that is first order pro-cyclical. This prediction is consistent with recent empirical evidence, based on disaggregated data or on data from a number of industrial nations, where strong pro-cyclicality has been found (Schor, 1985; Bils, 1985). We return to this point in connection with the properties of our dynamic model in Section II.

In summary, this simple static model illustrates how adherence to a near rational rule of thumb can alter the properties of an otherwise classical model. Aggregate fluctuations can arise from demand disturbances as a result of the interaction of the two types of firm. A negative demand shock induces the non-maximising firm to reduce employment and output. Total labour supply drops with the real wage, and there are temporary labour flows from the non-maximising to the maximising firm. The response to a positive demand shock is symmetric, with the maximising firm reducing employment and the non-maximising firm expanding, except that total employment will change relatively more than for a negative shock. For reasonable parameter values, a moderate decline in demand can result in a decline in output which exceeds the decline in employment. Clearly, for both positive and negative shocks, an activist policy of demand management might serve to stabilise both employment and output.

Finally, note that this simple static model can be extended to account for alternative labour market arrangements, adding greater realism at the cost of some complexity. In an Appendix, we present the general model that allows for differential wages at the two types of firms, and we give two important applications of this general structure. We first detail a model where the near rational firm faces contractual limitations that produce downward nominal wage rigidity; this clearly reduces the magnitude of fluctuations in average compensation. We then study a model where the efficiency wages are paid in the non-maximising sector. This creates a gap between the marginal products in the two firms and, as a result, the short term transfer of labour from one firm

[1] Fig. 1 portrays labour demand curves for the case when $F_n(L) = F_m(L) = L^b$, with $b > 0$. Although different curves obtain for different technologies, the qualitative features remain the same.

to another will now have a first-order effect. The Okun's Law ratio will then be higher, under plausible parameterisations, than in the basic competitive model, and there will be deviations in the maximising firm's wage that exceed the changes in average compensation.

II. THE DYNAMIC FRAMEWORK

In this section we develop a dynamic macroeconomic model with near rationality and we study its implications for the joint properties of wages, employment and output. We define behaviour as *stochastically near rational* if it results in losses, relative to what could individually be achieved by full maximisation, that have an expected value which is second order in the standard deviation of the exogenous shock. Restricting the non-maximising firms to stochastically near-rational policies amounts to disallowance of more than second-order mistakes, on the average, and seems the natural extension of the concept of static near rationality.

There are many sets of operating rules that could qualify as stochastically near rational in the model we employ. One salient policy, which is the one we investigate, is for the non-maximising firm to pay a constant real wage while hiring labour so as to accommodate short-run demand disturbances. Such a strategy has the merit of simplicity – non-maximising firms respond to changes in their perceived demand, holding wages constant – and will be not far from optimal on average, the gains for some realisations balancing the losses for others. However, we will show how such a sensible, if suboptimal, policy can lead to our simple model economy exhibiting a surprising accordance with key macroeconomic empirical regularities.

The model we consider has two types of firms, as did our earlier static framework. Here, however, long-run equilibrium wages are assumed to be higher in the non-maximising firm. This assumption is based on the observation that wages commonly differ across jobs requiring broadly similar skills. Several theoretical explanations of such differentials exist, even when labour is homogeneous, as in our model. The efficiency wage model, in its various forms, provides one explanation since labour productivity depends upon the real wage.[1] Or some jobs may be unionised and others not, with the union workers being both more productive and better paid.[2] While we will not restrict ourselves to any one particular motivation for this long-run differential, it is consistent with the notion of a 'dual labour market' and with the idea that recessions are best characterised, not as an absolute shortage of jobs, but as a shortage of good jobs.

[1] There are many possible motivations for the efficiency wage formulation. If firms have difficulty in monitoring worker performance, payment of an efficiency wage can discourage shirking (e.g. Shapiro and Stiglitz, 1984); if worker heterogeneity is important but not observable ex ante, a higher wage offer may improve the expected quality of new hires enough to offset the wage bill increase (e.g. Weiss, 1980); and, even in the absence of such conditions, higher wages may improve worker morale and loyalty to the firm (e.g. Akerlof, 1982). Yellen (1984) gives a survey of these and other approaches, together with some important qualifications.

[2] See Brown and Medoff (1978) and Freeman and Medoff (1979, 1984).

Our dynamic model remains close to the basic static framework for expository purposes. We introduce the possibility of serial correlation of the demand disturbances, but all other features of a dynamic model are deliberately suppressed. Production is instantaneous, there is no net investment in inventories or capital, and workers supply labour according to $\phi(.)$ without intertemporal substitution considerations. Augmentation of the dynamic structure along these or other lines would add to the analysis, and particularly to the empirical performance of the model, but at the cost of clarity.

The Model

We will detail the model in terms of deviations around the long-run equilibrium, analogously to our solution of the static model. It will suffice for our results to retain only leading terms in the expansions, so we will omit all higher order terms from the outset.

Goods market equilibrium at time t is given by

$$y_t = r_m l_{mt} + r_n l_{nt} \tag{15}$$

while the labour demand at the maximising firm becomes

$$l_{mt} = -a_m^{-1} \omega_{mt}. \tag{16}$$

Labour supply, to first order, is given by

$$l_t = \eta \omega_{mt}, \tag{17}$$

and, as before, the aggregate shift in employment is

$$l_t = s_m l_{mt} + s_n l_{nt}. \tag{18}$$

The wage behaviour of the non-maximising firm follows directly from the rule of thumb specifying payment of a constant real wage, so, for all t,

$$\omega_{nt} = 0. \tag{19}$$

Hence, letting the average wage be $w_t = s_n w_{nt} + s_m w_{mt}$ and letting ω_t be its log deviation, we have

$$\omega_t = \frac{r_m}{k} \omega_{mt}. \tag{20}$$

Finally, the model is completed by the assumption that deviations of aggregate demand follow a stationary moving average process

$$y_t = d(B)\,\epsilon_t \tag{21}$$

where ϵ_t is an independent error term with finite variance and $d(B)$ is a polynomial in the backward lag operator B.

The solution to this linear model in terms of the demand disturbances is straightforward. We first present this solution and then check that the assumed rule of thumb is, according to the concept of stochastic near rationality, a sensible policy. That done, we return to examine the properties of our solution, particularly the implied variances and covariances of output, employment and wages during a sequence of stochastic short-run equilibria.

Analogous to our solution procedure in Section II, we express the demand deviation in terms of the deviation in the maximising firm's wage, using (16)–(18) to solve for l_m and l_n and substituting into (15). This implies

$$\omega_{mt} = cd(B)\,\epsilon_t \tag{22}$$

using (21), where

$$c = \left[\frac{\eta r_n}{s_n} + \frac{(r_n s_m/s_n - r_m)}{a_m}\right]^{-1}.$$

Consequently, the deviation of total employment is found from (17) to be

$$l_t = c\eta d(B)\,\epsilon_t, \tag{23}$$

it being made up of deviations at the two firms

$$l_{mt} = -(c/a_m)\,d(B)\,\epsilon_t \tag{24}$$

$$l_{nt} = c(\eta/s_n + s_m/s_n a_m)\,d(B)\,\epsilon_t. \tag{25}$$

Finally, the behaviour of average compensation is given by

$$\omega_t = (cr_m/k)\,d(B)\,\epsilon_t. \tag{26}$$

It is readily established that the proposed rule of thumb is in fact stochastically near rational, either if the non-maximising firm pays a constant real wage or, more generally, if $\omega_{nt} = \omega_{mt}$. In the former case, our previous results apply directly. In the latter, we let tildes denote variables evaluated under the rule of thumb and overbars denote evaluation if the firm were to maximise, so that $\tilde{\Pi}_{nt}$ represents profits at t under the rule of thumb and $\bar{\Pi}_{nt}$ represents profits that the non-maximising firm would realise were it to hire optimally. Then, expanding $F(\tilde{L}_{nt})$ around $\bar{L}_{nt}$ and retaining terms to second order, use of (22) and some rearrangement yields

$$(\tilde{\Pi}_{nt} - \bar{\Pi}_{nt})/\bar{w}_{nt}\bar{L}_{nt} = -cd(B)\,\epsilon_t + \mathrm{O}(\sigma_\epsilon^2). \tag{27}$$

Thus $\mathrm{E}(\tilde{\Pi}_{nt} - \bar{\Pi}_{nt}) = \mathrm{O}$ and the proposed rule of thumb is stochastically near rational.

We now turn to examine the properties of the solution to this model. We are interested in the behaviour of output, employment and wages implied by our solution. In principle, one can calculate variances and covariances of these magnitudes directly from our solution (22)–(26). However, these moments depend non-linearly on the underlying parameters of technology and labour supply and are difficult to interpret directly. Consequently, we have computed the moments of these variables numerically using specific parameter values. For these calculations, we assume that the non-maximising firm has a production function $F_n(L_n) = L_n^\alpha$, that $\alpha = 0{\cdot}5$, that $k = 0{\cdot}67$, and that one half of the labour force is employed in the non-maximising firm, so that $s_n = 0{\cdot}5$. We compute the moment ratios for three plausible values for the elasticity of labour supply, 0·15, 0·20 and 0·25, and we allow for a range of values for w_n^*/w_m^*, the ratio of long run wages at the two firms. The results are presented in Table 1.

The second column of Table 1 presents the ratio of the standard deviation of output fluctuations to the standard deviation of employment changes: this is the Okun's Law ratio for this economy. For the parameter values specified, the ratio ranges from 1·22 to 3·87. It is smaller as the elasticity of labour supply is larger and as the long-run equilibrium wage gap between the two firms is smaller. This has an intuitive interpretation. In this model, output can be reduced in two ways: by workers deciding not to work at the wage offered, or by workers shifting from the non-maximising to the maximising firm and thereby becoming less productive. Thus, employment will be less sensitive to demand and output disturbances when it is less responsive to changes in the wage and when the gap in worker productivities between the two firms is larger.

The true coefficients of hypothetical regressions of average and marginal wages on output are presented in the final two columns of Table 1. The results accord with Bils' recent findings on two counts. First, the elasticity of average wage movements with respect to output is in the same range as that estimated by Bils. When the average wage level is about 20% higher in the non-maximising firm, for example, an intermediate value for the elasticity of labour supply yields an average wage movement of 1·70 for a unit change in output; Bils' empirical conclusion is that a fall in the unemployment rate of one percentage point is associated with an increase in the average real wage of between 1·5 and 2·0 (1985, pp. 683–4). Second, the behaviour of the wages of those workers who change employment over the cycle is much more strongly procyclical. For the parameter values just considered, our model yields an elasticity of the marginal wage with respect to income of 3·73.[1]

One open question that arises from these numerical results is the extent to which Okun's Law is an inter-sectoral phenomenon. Although evidence has been cited of procyclical productivity in most sectors (e.g. Bernanke and Powell, 1986; Fay and Medoff, 1985), several recent papers highlight the role of inter-sectoral shifts over the cycle (e.g. Lilien, 1982; Abraham and Katz, 1986). These two effects can be complementary, of course, but we are at present unaware of any precise attempts to assess their relative importance. Such empirical study will ultimately determine the quantitative importance of this near rational model of Okun's Law and the cycle.

Finally, we note that, since output is determined by aggregate demand in the short run, there may be a role for demand management by the government in this type of economy. Indeed, if the shock ϵ_t were observable to the government and if entirely effective demand management instruments were available, then these instruments could be used to stabilise output and employment completely. If, as is more likely, the shocks to demand were only partially observable or the demand management instruments could only be used with a lag or were

[1] A referee has pointed out to us that, under the efficiency wage interpretation, changes in the maximiser's wage may alter the cost of job loss, the sorting effect of differential wages, or worker morale at the near rational firm. Consequently, even with payment of a constant efficiency wage in the short run, there may be an indirect effect on productivity through this changed relative wage. The general effect of this will be to lower the Okun's Law ratio for any particular set of parameters relative to the figures in Table 1, though its quantitative importance remains an open issue. What is clear, however, is that our qualitative conclusions are robust to this mitigating factor; in a more explicit efficiency wage, dual labour-market model, there must always remain an inter-sectoral productivity gap, even if it is squeezed in booms, so there will be upgrading of labour over the cycle. For one model of this issue, see Jones (1985).

Table I

Properties of the Dynamic Near-Rational Economy

	w_n^*/w_m^*	SD(y)/SD(l)	$\frac{\text{cov}(\omega, y)}{\text{var}(y)}$	$\frac{\text{cov}(\omega_m, y)}{\text{var}(y)}$
$\eta = 0·15$	1·2	1·54	1·96	4·32
	1·4	2·27	1·22	2·94
	1·6	2·89	0·88	2·31
	1·8	3·41	0·70	1·95
	2·0	3·87	0·57	1·72
$\eta = 0·20$	1·2	1·34	1·70	3·73
	1·4	1·90	1·10	2·63
	1·6	2·37	0·81	2·11
	1·8	2·78	0·64	1·80
	2·0	3·13	0·53	1·60
$\eta = 0·25$	1·2	1·22	1·49	3·28
	1·4	1·68	0·96	2·39
	1·6	2·06	0·75	1·94
	1·8	2·39	0·60	1·67
	2·0	2·68	0·50	1·49

Parameter values: $\alpha = 0·5$, $k = 0·67$, $s_n = 0·5$.

only partially effective, then countercyclical policies could dampen but not eliminate the influence of these exogenous shocks.

Whether such policies would be welfare enhancing is beyond the scope of formal treatment in this paper, although we conjecture that, while any gains would be of second order in our static model (essentially because that model has no externalities), the benefits of policy could be first order in the dynamic setting with long-run intersectoral wage differentials. The welfare properties of these efficiency wage type models are an important topic for further study.

III. CONCLUSION

This paper has shown how, contrary to some views, many Harberger triangles can indeed make an Okun gap. It has illustrated how adherence to a near-rational rule of thumb can dramatically alter the properties of short-run macroeconomic equilibria, with otherwise classical models exhibiting aggregate fluctuations in response to demand disturbances. Most significantly, the framework we analysed naturally gave rise to patterns of co-variation among wages in the flexible wage sector, average compensation, employment and output which squared up well with the empirical facts. This suggests that near-rational theories of the cycle merit further quantitative investigation.

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References

Abraham, K. and Katz, L. F. (1986). 'Cyclical unemployment: sectoral shifts or aggregate disturbances?' *Journal of Policital Economy*, vol. 94, pp. 507–22.

Akerlof, G. A. (1982). 'Labor contracts as partial gift exchange.' *Quarterly Journal of Economics*, vol. 97, pp. 543–69.

—— and Yellen, J. L. (1985*a*). 'A near-rational model of the business cycle, with wage and price inertia.' *Quarterly Journal of Economics*, vol. 100, pp. 823–38.

—— —— (1985*b*). 'Can small deviations from rationality make significant differences to economic equilibria?' *American Economic Review*, vol. 75, pp. 708–20.

Bernanke, B. and Powell, J. (1986). 'The cyclical behavior of industrial labor markets: a comparison of pre-war and post-war eras.' In *The American Business Cycle: Continuity and Change* (ed. R. J. Gordon). Chicago: University of Chicago Press.

Bils, M. J. (1985). 'Real wages over the business cycle: evidence from panel data.' *Journal of Political Economy*, vol. 93, pp. 666–89.

Blanchard, O. J. (1985). 'Monopolistic competition, small menu costs and real effects of nominal money.' Massachusetts Institute of Technology. (Mimeographed.)

Brown, C. and Medoff, J. L. (1978). 'Trade unions in the production process.' *Journal of Political Economy*, vol. 86, pp. 355–78.

Fay, J. A. and Medoff, J. L. (1985). 'Labor and output over the business cycle: some direct evidence.' *American Economic Review*, vol. 75, pp. 638–55.

Freeman, R. B. and Medoff, J. L. (1979). 'The two faces of unionism.' *The Public Interest*, vol. 57, pp. 69–93.

—— —— (1984). *What Do Unions Do?* New York: Basic Books.

Haltiwanger, J. and Waldman, M. (1985). 'Rational expectations and the limits of rationality: an analysis of heterogeneity.' *American Economic Review*, vol. 75, pp. 326–40.

Jones, S. R. G. (1985). 'Dual labour markets, productivity and unemployment.' University of British Columbia, Discussion Paper No. 85–22.

Lilien, D. (1982). 'Sectoral shifts and cyclical unemployment.' *Journal of Political Economy*, vol. 9, pp. 777–93.

Mankiw, N. G. (1985). 'Small menu costs and large business cycles: a macroeconomic model of monopoly.' *Quarterly Journal of Economics*, vol. 95, pp. 529–37.

Nelson, R. R. and Winter, S. G. (1982). *An Evolutionary Theory of Economic Change*. Cambridge, Mass.: Harvard University Press.

Radner, R. (1980). 'Collusive behavior in noncooperative epsilon-equilibria of oligopolies with long but finite lives.' *Journal of Economic Theory*, vol. 22, pp. 136–54.

Schor, J. B. (1985). 'Changes in the cyclical pattern of real wages: evidence from nine countries, 1955–1980.' Economic Journal, vol. 95, pp. 452–68.

Shapiro, C. and Stiglitz, J. E. (1984). 'Equilibrium unemployment as a worker discipline device.' *American Economic Review*, vol. 74, pp. 433–44.

Solow, R. M. (1979). 'Another possible source of wage stickiness.' *Journal of Macroeconomics*, vol. 1, pp. 79–82.

Weiss, A. (1980). 'Job queues and layoffs in labor markets with flexible wages.' *Journal of Political Economy*, vol. 88, pp. 526–38.

Yellen, J. L. (1984). 'Efficiency wage models of unemployment.' *American Economic Review*, vol. 74, pp. 200–5.

Appendix

In this Appendix, we present the general static model which underlies the competitive analysis of Section I, and we show how two other particular cases within this framework yield new implications for the behaviour of wages, output and employment.

The General Model

In deviations form, the general model is as follows:

$$y = r_n\, l_n + r_m\, l_m - \tfrac{1}{2} a_n\, r_n\, l_n^2 - \tfrac{1}{2} a_m\, r_m\, l_m^2 - \tfrac{1}{2}(r_n\, l_n + r_m\, l_m)^2, \qquad \text{(A 1)}$$

$$l_m = -a_m^{-1}\omega_m - b\omega_m^2, \qquad \text{(A 2)}$$

$$l = \eta\omega_m, \qquad \text{(A 3)}$$

$$l = s_m l_m + s_n l_n, \tag{A 4}$$

$$\omega = \frac{r_n}{k}\omega_n + \frac{r_m}{k}\omega_m. \tag{A 5}$$

(A 1) is the goods market clearing condition, to second order, allowing for differential wage movements at the two firms. (A 2) is the maximiser's labour demand, as in the competitive case, while (A 3) is the approximate labour supply equation. Note that, when movements in the wage can be different at the two firms, it must be the case that labour supply responds to the minimum offer, with rationing of any higher paid openings. Also, since it can never be optimal for the maximising firm to pay more for its labour than does the near rational one, the relevant wage for labour supply is w_m. (A 4) is the exact clearing conditions for the labour market, as in Section I, while (A 5) records the behaviour of average compensation. The model is then completed by specification of the non-maximiser's labour demand, according to the near rational rule of thumb.

Downward Wage Rigidity

Suppose that the model is altered so that the non-maximising firm faces a contract which prohibits nominal wage reductions: increases, say in the form of bonus payments, are allowed, however. We assume that the maximising firm is free to alter its wage in either direction. With this change, the short run model is completed by

$$\omega_n = \begin{cases} \omega_m & \text{if } y \geq 0, \\ 0 & \text{if } y < 0. \end{cases} \tag{A 6}$$

It is easy to check that the competitive solution for l, l_n, l_m and ω_n still obtains, but the behaviour of average compensation is now

$$\omega = \begin{cases} \omega_m & \text{if } y \geq 0, \\ s_m \omega_m & \text{if } y < 0, \end{cases} \tag{A 7}$$

where, in turn, ω_m is given by the expression (10) in the text. Not surprisingly, in the event of a negative shock to demand, the assumed contractual structure prevents the average real wage from dropping as much as the 'marginal' real wage ω_m. However, the average real wage rises in response to an increase in demand from long run equilibrium level, exactly as in the competitive case in Section I.

Efficiency wages

Suppose that the non-maximising firm has an efficiency-wage-production function and that, in the long run, this efficiency wage exceeds the wage paid by the maximising firm. One interpretation of this structure is that of primary and secondary labour markets, with the more desirable jobs being offered by the primary, efficiency wage firm (see Jones, 1985). An implication of efficiency wage payments is that the real wage will be held constant at a point where the elasticity of effort with respect to this wage is unitary (e.g. Solow, 1979). In the long run, the firm will pay such a wage and hire labour up to the point where its marginal product equals this wage. In the short run, however, we assume the firm alters hiring to accommodate changes in demand, keeping its real wage constant. This is readily shown to be near rational since, paying a constant efficiency wage, the only error made by the firm in its choice of labour input: for the usual reasons, this results in only a second order loss of profits.

The short run model is given by (A 1)–(A 5) and, an implication of the rule of thumb,

$$\omega_n = 0. \tag{A 8}$$

Note that (A 1) remains valid even when output depends on wage payments, via the labour efficiency effect, precisely because of (A 8). Solving the model as in the text, we find that, to second order,

$$l = gy + hy^2 \tag{A 9}$$

where
$$g = \eta[r_m \rho\eta/s_m + r_m(\rho-1)/a_m]^{-1},$$

$$h = \frac{g^3}{\eta^2}[r_n(\tfrac{1}{2}a_n \lambda^2 - s_m b/s_n) + r_m(\tfrac{1}{2}/a_m + b)] + \tfrac{1}{2}g$$

and
$$\rho = w_n^*/w_m^*.$$

This overall employment deviation is made up of the changes at the two firms:

$$l_m = -(g/a_m \eta)\, y - (bg^2/\eta^2 + h/a_m \eta)\, y^2, \tag{A 10}$$

and
$$l_n = (\lambda g/\eta)\, y + (\lambda h/\eta + bs_m g^2/\eta^2 s_n)\, y^2. \tag{A 11}$$

Finally, the market clearing real wage is, to second order,

$$\omega_m = (g/\eta)\, y + (h/\eta)\, y^2. \tag{A 12}$$

For $\rho = 1$, the case of no wage differential in long run equilibrium, these expressions reduce to those of Section I.

Although these expressions are rather complicated, some general observations nevertheless can be made concerning the short run equilibrium described by (A 9)–(A 12). First (A 10) and (A 11) imply that, for small positive shifts in y, there will be a decrease in employment at the maximising firm and an increase in employment at the non-maximising firm. Furthermore, (A 12) indicates that the market clearing wage will rise for positive y. Thus a positive demand shock is met by expansion of the non-maximising firm and contraction of the maximising firm; the market clearing wage rises, and, since $g > 0$, more workers enter the labour force. The response to a negative demand shock is the opposite: to first order, the non-maximising firm contracts and the maximising firm expands, the market clearing wage drops, and employment declines.

Second, the first-order response of employment to a demand shock is likely to be less than in the model of Section I. Formally, for plausible parameter values, the coefficient g in (A 9) will be considerably less than the corresponding coefficient, k^{-1} in (11) in the text. Letting $(dl/dy)_{\text{ew}}$ and $(dl/dy)_{\text{comp}}$ denote the

Okun's Law ratios for the efficiency wage and competitive labour market models, respectively, we have

$$\frac{(dl/dy)_{\text{ew}}}{(dl/dy)_{\text{comp}}} = \frac{\rho-(\rho-1)\,s_m}{\rho+(\rho-1)\,s_m/a_m\,\eta}. \tag{A 13}$$

Since $\rho > 1$ by assumption, $a_m > 0$, $\eta > 0$, and $s_m > 0$, a sufficient condition for (A 13), to be less than one is that employment in the primary sector be less than employment in the secondary sector. As an example, if $\rho = 2$, $s_m = s_n = \frac{1}{2}$, $\eta = 0{\cdot}2$ and $a_m = \frac{1}{3}$,[1] then the ratio in (A 13) is 0·16 and the Okun's Law ratio is much greater in the efficiency wage case. The reason for this is clear: since the workers in the two firms have different marginal products, a shift of a worker from the non-maximising to the maximising firm will reduce total output without altering total employmemt. Thus, even with perfectly inelastic labour supply, shifts in employment between the two sectors result in first order changes in aggregate output.

Finally, deviations in average labour compensation will typically be smaller than deviations in the market clearing wage ω_m. Using (A 5) and (A 12), to first order,

$$d\omega/d\omega_m = k[r_n\,\lambda - r_m(a_m^{-1}-1)]. \tag{A 14}$$

The term in brackets in (A 14) will partially cancel and will typically be less than one; since $k < 1$, the fluctuations in the average wage will be less than the fluctuations in the 'marginal wage' ω_m.

In summary, the equilibria of this model are broadly similar to those of the competitive labour market example of Section I; they are also, therefore, similar to our preceding example of labour contracts. However, total employment fluctuations will be smaller for small demand disturbances than in the other examples. Also, average wage shifts will not be as large as if there were competitive labour markets and no efficiency wage payments. Since there are two different wages and employment decreases in the efficiency wage (primary) firm under a negative demand shock, a decline in demand induces increased involuntary underemployment.

[1] If $F_n(L_n) = (eL_n)^{\frac{2}{3}}$, where e is effort, then $a_n = \frac{1}{3}$, for example.