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Fairness as a source of hysteresis in employment and relative wages*

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Abstract

This paper analyses the influence of norms of fairness on wage formation. Fairness is defined by 'real-wage' and 'relative-wage' norms that relate wage offers to workers' own current wage and to the wages of other groups of workers, and, to avoid shirking, firms pay fair wages. The wage norms change endogenously, and the result is hysteresis with respect to both employment and the distribution of wages. An extension of the model that allows 'induced overeducation' may help explain trends in wage inequality.

JEL classification: E12, E24, J31, J41

Key words: Wage norms, fairness, hysteresis, overeducation, wage inequality, unemployment

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1 Introduction

As suggested by Solow (1990), Akerlof and Yellen (1990) and the burgeoning literature on reciprocity, workers may reciprocate unfair treatment by reducing their productivity. Experimental work as well as survey evidence support this expectation of reciprocity (e.g. Fehr and Gächter (2000), Bewley (1998)). Fair wages, in other words, can be profit maximizing.

The influence of fairness on wages and unemployment has been formalized by Akerlof and Yellen (1990) who show that norms of fairness concerning relative wages may be a source of unemployment. They define the fair wage for any group of workers as a time-invariant function of two arguments: the wages obtained by other groups of workers and the state of the labour market. Two presumptions underlying their formalization seem questionable, however.

It may be misleading, first, to define fairness purely in terms of wage levels. There is no doubt that the wage rates of other groups constitute an important reference point and that *relative-wage norms* play a significant role in most evaluations of fairness. But the wages of other groups may not be the only reference point. A substantial amount of evidence suggests that "the main carriers of decision utility are events, not states; in particular, utility is assigned to gains or losses relative to a reference point which is often status quo" (Kahneman (1994, p. 22)).[1] Thus, people often consider it unfair to reduce the wage of an existing employee when labour market conditions change; by contrast, it is deemed acceptable to reduce the wage for a replacement worker if the current employee leaves (Kahneman, Knetsch and Thaler (1986)).[2] These findings suggest that in evaluating the fairness of a wage offer, workers may focus on *changes* in their wage as well as on relativities vis-a-vis other groups. I shall use the term *real-wage norms* to describe norms concerning the wage offer relative to the worker's own

[1] In a similar vein, Rabin (1998, p. 20; italics in original) concludes that "in attempting to capture behavioral findings with models of social preferences, it is important to note that people seem to implicitly (but pervasively) consider equitable sharing over *changes* in total endowments, not total endowments themselves. ... [A]ny attempt to capture behavioral norms of fairness and distributional justice with formal models of social preferences must confront the 'piecemeal' nature of these norms".

[2] Respondants typically find reductions in *nominal* wages unfair, even in recessions; an equivalent fall in real wages brought about by a combination of price inflation and small nominal nominal wage increases, on the other hand, is not seen as unfair (Kahneman, Knetsch and Thaler (1986)). The effects of 'money illusion' of this kind are explored by Shafir et al. (1997) and Akerlof et al. (1996). I shall abstract from money illusion in this paper in order to focus more clearly on the implications of endogenous changes in aspirations.

current wage, and I shall assume that fairness is determined by a combination of real-wage and relative-wage norms. The inclusion of both relative-wage and real-wage norms is analogous to Easterlin's (2001) analysis of the influence of both relative income and changes in income on income aspirations and reported happiness. The coexistence of multiple reference points (relative- and real-wage norms, in this case) is defended more generally by Shafir et al. (1997) who argue that "instead of evaluating options in terms of a single representation, people entertain multiple representations contemporaneously. In such cases, the response is often a mixture of the assessments induced by the different representations, as weighted by their relative salience" (p. 346)).[3]

Secondly, and more importantly, Akerlof and Yellen's definition of fair wages as a time-invariant function of outcomes is suspect. It does not seem plausible to assume, for instance, that the actual wage can remain permanently above the fair wage without any effects on the norms of fairness. Yet, the formulation used by Akerlof and Yellen implies that the equilibrium wage for high-skill workers will exceed their fair wage permanently. It would seem more reasonable to assume that norms of fairness change endogenously and, to be more specific, that notions of fairness have a large conventional element.

The conventional aspect of fairness is implicit in many discussions of these issues. Keynes (1930), for instance, expressed his sympathy with the view that "there is a large arbitrary element in the relative rates of remuneration, and the factors of production get what they do, not because in any strict sense they precisely earn it, but because past events have led to these rates being customary and usual" (quoted from Keynes 1981, p. 7). Marshall (1887) noted that fairness must be defined "with reference to the methods of industry, the habits of life and the character of the people" (p.212). Fairness, he argues, requires that a worker

> ought to be paid for his work at the usual rate for his trade and neighbourhood; so that he may live in that way to which he and his neighbours in his rank of life *have been accustomed*. (p. 213; italics added)

Similar views have been advocated more recently by Solow (1990), while Hicks (1975) has pointed out that it can be difficult to achieve a general consensus on what is fair and what is not. No system of wages, Hicks argues, "when it is called into question, will ever be found to be fair". Hence "the system of wages should be well established, so that it has the sanction of custom. It then becomes what is expected; and (admittedly on a low

[3]Extensions of the argument in the present paper could include profitability norms as an additional influence on fairness (e.g. Palley (1994)).

level of fairness) what is expected is fair" Hicks (1975, p. 65).[4] The prevailing real-wage norms and relative-wage norms, according to this argument, reflect actual real wage increases and actual relative wage patterns in the past. If, for instance, actual increases in the real wage have been running at 3 percent a year for a long time, this rate of increase will be reflected in the real-wage norm, and anything less than an expected 3 percent increase will be considered unfair, assuming that conditions in the labour market are unchanged.[5] If actual real wage growth drops permanently to 2 percent, however, aspirations will gradually adjust.

The gradual adjustment of notions of fairness to fit actual outcomes is supported, more generally, by psychological studies of adaptation. Thus, according to Kahneman, Knetsch and Thaler (1986, p. 730-1)[6]

> the reference transaction provides a basis for fairness judgments because it is normal, not because it is just. Psychological studies of adaptation suggest that any stable state of affairs tends to become accepted eventually, at least in the sense that alternatives to it no longer readily come to mind. Terms of exchange that are initially seen as unfair may in time acquire the status of reference transaction. Thus, the gap between the behaviour that people consider fair and the behavior that they expect in the market-place tends to be rather small.

The model in this paper represents an attempt to capture these ideas. It is assumed that firms will make wage offers that are 'fair' where fairness is defined in relation to 'real-wage' and 'relative-wage' norms. These wage norms change over time, and the fairness of a wage offer is determined largely by whether it matches what has been achieved in the past. Several conclusions emerge:

- The conventional aspect of the wage norms implies hysteresis with respect to both employment and the distribution of wages.

[4] Models that include some aspects of this argument have been presented by, among others, Paldam (1989) and Skott (1991,1999).

[5] The fairness doctrine, in Marshall's (1887) words, "is modified by the admission that changes in circumstances may require changes in wages in one direction or another" (p. 213).

[6] A related argument is developed by Sugden (1986) who suggests that conventions that evolve spontaneously acquire moral status. See also Bowles (1998) for a broader survey of endogenous preferences and Hargreaves-Heap and Varoufakis (2002) for recent experimental evidence on the evolution of perceptions of fairness.

- In specifications with adaptive expectations, systematic aggregate demand policy can influence long-run employment and, depending on functional forms, policy makers may or may not face a stable Phillips-curve trade-off.
- Changes in productivity growth may affect long-run employment.
- Changes in aggregate employment influence wage inequality and, in some specifications, an increase in unemployment will raise inequality.
- Autonomous shocks to norms can be a powerful influence on both employment and wage inequality. In specifications that allow a mismatch between workers and jobs, the shocks may lead to a decline in both the wage and the employment of low-skill workers. These specifications also imply that the effects on relative wages of changes in the relative supply of high-skill workers become ambiguous.

The rest of this paper is in five sections. The formal model of wage formation is presented in section 2. Section 3 considers the implications of the model for inflation and aggregate employment. Scenarios with rational and adaptive expectations are analysed, and the dynamic properties of the economy are examined using a simple policy rule to describe demand policy. Sections 4 and 5 focus on wage inequality. In section 4 workers have jobs that match their skills. Section 5 extends the model by allowing for a mismatch between the skill requirement of a job and the skills of a worker. A concluding section discusses some limitations of the analysis.

2 A formal model

2.1 Wage norms

Using a simple shirking setup, it is assumed that workers produce high effort ($e = 1$) if they are treated fairly but low effort ($e = 0$) if firms treat them unfairly. Experimental evidence shows that losses, relative to the reference point, have a much larger effect on utility than gains (see e.g. Kahneman, Knetsch and Thaler (1991)), and the shirking specification can be seen as an extreme version of workers' response to this form of 'loss aversion'. Any shortfall of the wage below the fair wage is regarded as highly injurious and leads to the complete withdrawal of effort; wages in excess of the fair wage, on the other hand, have minor effects on utility and bring forth no increase in effort.[7]

[7]It should be noted, perhaps, that shirking need not be given a narrow individualistic interpretation. Shirking can represent a collective response in the form of strikes, for instance, or organized 'work-to

I shall assume that there are two types of jobs, high-skill and low-skill. Adopting a continuous-time framework, the wage rates w_H and w_L for these jobs are state variables and wage determination concerns the determination of the rates of growth of wages at each moment. In accordance with the discussion in section 1, it is assumed that the pattern of fair wage increases is determined by two sets of norms, a relative-wage norm and a real-wage norm. These norms are shared by all workers. This latter assumption is neither innocuous nor entirely plausible, and I shall return to this issue in the conclusion. More 'realistic' specifications, however, would complicate the analytics. Furthermore, it is not clear precisely how norms differ across groups and, by including additional parameters, more complex specifications increase the dangers of ad hoc'ery. At this stage it seems preferable, therefore, to focus on a benchmark case with shared norms.

Algebraically, it is assumed that the fair wage increases are given by

$$\hat{w}_i^f = \alpha_i \left[R_i(n_i, n_j, \dot{n}_i^e, \dot{n}_j^e, t) - \log \frac{w_i}{w_j} \right] + \left[S_i(n, \dot{n}^e, \frac{w_i}{p}, \pi^e, t) - \log \frac{w_i}{p} \right] \tag{1}$$

where subscripts i and j $(i = H, L,\ j = H, L, i \neq j)$ indicate high and low skill; carets and dots denote growth rates and time derivatives (e.g., $\hat{w}_i = \frac{dw_i}{dt}/w, \dot{n} = dn/dt$), and superscripts f and e indicate fair and expected values of a variable. The expressions in the square brackets on the right hand side of (1) correspond to the relative-wage and real-wage norm, respectively.

For $i = H$ (and analogously for $i = L$) the relative-wage norm, R_H, depends positively on the level and expected change of the employment rate for high-skill workers (n_H and $\dot{n}_H^e$) and inversely on the level and expected change of the employment rate for low-skill workers $(n_L, \dot{n}_L^e)$. These employment indicators in conjunction with the conventional elements (as represented by the time variable t) define the relative-wage norm.[8] For tractability reasons, a simple linear specification of R_i will be used

$$R_i = k_i(t) + m_i(n_i - n_j) + s_i \left(\dot{n}_i^e - \dot{n}_j^e \right) \tag{2}$$

This additive form includes a time-dependent constant term $k_i(t)$ but the slope coefficients m_i and s_i are taken to be time-invariant. Since, by assumption, all workers

rule' campaigns. Fairness norms influence union members, too, and wage demands in unionized labour markets may be driven by the norms of fairness that prevail among the members. From this perspective, the model describes a wage-setting monopoly union in a right-to-manage framework. The differences vis-a-vis standard models of this kind concern the specification of union-preferences and an emphasis on endogenous changes these preferences.

[8] The introduction of 'overeducation' in section 5 implies that the indicators of employment conditions for high-skill workers will be redefined in this section.

share the same norms, we have $R_i \equiv -R_j$ and the parameters must satisfy the following conditions:

$$m_H = m_L = m, \qquad s_H = s_L = s, \qquad k_H(t) = -k_L(t) = k(t) \tag{3}$$

Shared wage norms also imply that there are no pressures for the relative wage to change when $\log w_H/w_L = R_H$. Thus, using (1), the real-wage norm must satisfy $S_H - \log w_H/p \equiv S_L - \log w_L/p$. This condition is met by the linear specification

$$S_i = a(t) + bn + c\dot{n}^e + \log \frac{w_i}{p} + \pi^e \tag{4}$$

The slope coefficients b and c are time-invariant, and the conventional aspects are captured by the time-dependent constant $a(t)$. The inflation term π^e means that 'money illusion' is excluded (cf. footnote 2). It should be noted, however, that the fair wage increase is nominal. The nominal wage increase is adjusted for expected inflation, but it is assumed that the individual employer will not be held responsible for unanticipated changes in the general price level. Shortfalls of actual real wage growth below expectations therefore do not lead to shirking.

The parameters α_i describe the weights of the two norms. For $\alpha_i \rightarrow 0$ only the real-wage norm matters; $\alpha_i \rightarrow \infty$ implies that wage determination is driven by the relative-wage norm. The salience of relative wages (and hence the weight α_i) depends on the 'visibility' of the workers who receive the other wage. It seems natural to suppose that this visibility will be related to both the proportion of workers in the other group and the wage rate of these workers. Thus, the share of the other group's wages in total wage income provides a simple and intuitive measure of visibility, and I shall assume that the weights α_H and α_L are given by

$$\alpha_H = (1-\eta)\,\rho \tag{5}$$

$$\alpha_L = \eta\rho \tag{6}$$

where η is the share of high-skill wages in total wage income ($\eta = \frac{w_H N_H}{w_H N_H + w_L N_L}$) and $\rho > 0$. This specification, in addition to being plausible, simplifies the analysis below.

The shirking assumption implies that actual wage increases will be equal to fair increases, that is, $\hat{w}_H = \hat{w}_H^f$ and $\hat{w}_L = \hat{w}_L^f$, and using equations (1)-(6) we get the following wage equations

$$\hat{w}_H - \hat{w}_L = \rho \left[k(t) + m(n_H - n_L) + s(\dot{n}_H^e - \dot{n}_L^e) - \log \frac{w_H}{w_L} \right] \tag{7}$$

$$\begin{aligned} \hat{w} &= \eta \hat{w}_H + (1-\eta)\hat{w}_L \\ &= a(t) + bn + c\dot{n}^e + \pi^e \end{aligned} \tag{8}$$

The parameters a, b, c, k, m and s reflect the prevailing norms of fairness. The conventional aspect of the norms - the influence of past realizations on the norms - is represented by the time-dependence of a and k, and, in accordance with the discussion in section 1, I shall assume that this time-dependence can be captured by a simple adaptive specification:

$$\dot{a} = \mu_a \left[\hat{w} - (a(t) + bn + c\dot{n} + \pi)\right] \tag{9}$$
$$\dot{k} = \mu_k[\log \frac{w_H}{w_L} - (k(t) + m(n_H - n_L) + s(\dot{n}_H - \dot{n}_L))] \tag{10}$$

The adjustment of the real-wage norm is proportional to the difference between the actual rate of growth of wages and the current norm, where the norm is evaluated at the realized inflation rate and change in employment (equation (9)). Analogously, the adjustment of the norm for relative wages is proportional to the difference between the actual relative wage and the current norm, with the current norm evaluated at the realized changes in employment (equation (10)).[9] Note, however, that the real-wage norm concerns a variable (the change in wages) that can change freely at each moment and that adjustments to the real-wage norm only take place if there are unanticipated inflation or employment shocks. Thus, substituting equation (8) into (9) yields

$$\dot{a} = \mu_a \left[(\pi^e - \pi) + c(\dot{n}^e - \dot{n})\right] \tag{11}$$

The relative wage w_H/w_L, on the other hand, is a state variable, and if past shocks have produced a discrepancy between actual relative wages and the relative-wage norm, then this discrepancy cannot be eliminated instantaneously.[10]

The adjustment parameters μ_a and μ_k in (9)-(10) are important. There is nothing surprising or unusual in the assumption that changes in the relative wage are related to the labour market conditions faced by different groups of workers, as in equation (7), or that (expected) real wage increases depend on employment as in equation (8).[11]

[9]The adaptive specification is similar to Easterlin's (2001) verbal analysis of adjustments in aspirations and to Akerlof's (1980) assumption of proportionality between the change in the strength of a norm and the difference between the number of people who obey the norm and the number of people who support the norm.

[10]There is a straightforward reason for this asymmetry between the two norms. In an economy with technical progress and rising real wages, conventions concerning the *level* of real wages cannot survive. Conventions, however, may be formed with respect to the *level* of relative wages and the *growth* in real wages.

[11]Note that for $c = 0$ and constant parameters a and b, the specification in (8) yields a standard, expectations-augmented Phillips curve. The empirical evidence for the US suggests that $b \approx 1$ (Blanchard and Katz (1997)).

Thus, without endogenous changes in k and a, the equations could be reinterpreted to fit other structural explanations. The distinctiveness of a norm-based theory, in this sense, derives from the conventional nature of the norms.

Fast adjustments in k - a high value of μ_k - implies that changes in labour market conditions have short-lived effects on the growth rate of relative wages and, therefore, small long-run effects on the relative wage: a change in $n_H - n_L$, for instance, has an immediate impact on the relative wage norm but since actual relative wages move sluggishly, fast adjustments in the wage norm imply that equality between actual relative wages and the norm will be re-established before the actual relative wage has moved very far. Analogously, a high value of μ_a implies that the effects of a change in employment on the fair rate of growth in real wages is short-lived: increased employment, for instance, leads to a shortfall of the actual growth in wages below the real-wage norm (evaluated at the increased employment rate) but downward adjustments of the real-wage norm dampen the inflationary consequences.

2.2 Employment and pricing

If firms maximize profits and if inputs can be adjusted flexibly, the specification of the production function determines how labour inputs depend on total employment n. Assuming that there are constant returns to scale, that there are no non-labour inputs, and that productivity growth is Hicks-neutral, we have[12]

$$Y = AF(N_H, N_L) \tag{12}$$

$$\hat{A} = q \tag{13}$$

where q is the rate of technical progress and N_H and N_L are the number of high- and low-skill jobs. Cost minimization implies that the proportion of high-skill jobs in total employment is a function of the relative wage,

$$\frac{N_H}{n} = f(\frac{w_H}{w_L}); f' \leq 0 \tag{14}$$

For a profit maximizing firm, finally, price is set as a markup on marginal cost. Assuming that the markup is constant (corresponding to a constant elasticity of the

[12] The production function could be interpreted as a reduced-form expression with other inputs chosen optimally. Hicks-neutrality with respect to the different types of labour is consistent with technical progress being purely labour augmenting (i.e. Harrod neutral), as assumed in most growth models.

perceived demand curve), the rate of price inflation is determined by wage inflation and productivity growth,

$$\pi = \hat{w} - q \tag{15}$$

3 Implications for employment and inflation

3.1 Perfect foresight and rational expectations

Consider first the implications of assuming that price and employment expectations are being met; that is, let

$$\pi = \pi^e, \dot{n} = \dot{n}^e \tag{16}$$

Equation (11) implies that the parameter a will remain constant, and from (8) and (15)-(16) it follows that

$$\dot{n} = \frac{q - a - bn}{c} \tag{17}$$

Equation (17) implies that the employment rate will converge towards a long-run stationary solution

$$n \to n^* = \frac{q - a}{b} \tag{18}$$

Thus, under perfect foresight the model resembles standard theories of a structurally determined 'natural rate of unemployment', with a natural rate that is asymptotically constant.

Now relax the assumption of perfect foresight. Prices are determined by a constant markup on unit wage costs, and if agents know the current rate of wage inflation and the rate of technical progress, it follows from (16) that under rational expectations price inflation will still be fully anticipated,

$$\pi^e = \pi \tag{19}$$

Shocks to aggregate demand, however, will produce unanticipated changes in real output.

Let $X = PY$ denote aggregate nominal demand and assume that $x = \log X$ follows a stochastic process

$$x = v + \varepsilon \tag{20}$$

where $v(t)$ is a systematic and known component and where $\varepsilon(t)$ follows a Wiener process. Assuming that the growth rate of the labour force is known, it is shown in Appendix 1 that employment follows a Gaussian process defined by

$$n(t) = \varepsilon(t) + \int \left(\frac{q - a(t_0) - c\mu_a \varepsilon(t_0)}{c} + \mu_a \varepsilon(t) - \frac{b}{c} n(t) \right) dt \tag{21}$$

The expected value and variance of $n(t)$, given information available at time t_0, are given by ordinary differential equations, and (see Appendix 1)

$$En(t) \rightarrow \frac{q - a(t_0)}{b} \quad \text{for } t \rightarrow \infty \tag{22}$$

$$\frac{V(n(t))}{t} \rightarrow \left(\mu_a \frac{c}{b}\right)^2 \quad \text{for } t \rightarrow \infty \tag{23}$$

The intuition behind (22)-(23) is straightforward. The expected value of the innovations ε is zero and the trajectory of the expected value of n corresponds to that under perfect foresight (compare (22) and (18)). Unanticipated shocks produce deviations of the actual from the expected change in employment. If the real-wage norm depends on expected changes in employment ($c > 0$) and if the norm contains a conventional element ($\mu_a > 0$), these deviations lead to adjustments in the real-wage norm, and a change in a, in turn, leaves a permanent mark on employment (as indicated by the dependence of $E(n(t))$ on the value of $a(t_0)$). Employment, in other words, is subject to hysteresis, and the importance of the parameters μ_a and c for the generation of hysteresis is reflected in the expression for the asymptotic variance (equation (23)).

The long-run effects of shocks to parameters and exogenous variables can be derived using (22)-(23). The rise in unemployment in the 1970s, first, was preceded by a drop in the growth rates of labour productivity and real wages. In the US the trend increase in real wages fell from about 3 percent a year in 1945-1970 to zero in 1970-1995. In the model, this shift can be captured by a permanent drop in q. This drop in real-wage growth reduces employment. The magnitude of the reduction depends on the slope coefficients in the 'Phillips curve' (8). With $b = 1$ and $c = 0$ (cf. footnote 11), the observed slowdown of 3 percentage points causes the steady state solution for the employment rate to decline by 3 percentage points.

A second shock relates to the real-wage norms. Associated in part with the escalation of the war in South East Asia and the anti-war movement, a social and political radicalization from the late 1960s may have spilled over into greater worker aggressiveness in the labour market, that is, there may have been an autonomous rise in the real-wage norm.[13] A rise of this kind, an upward shift in the real-wage norm corresponding to an increase in $a(t_0)$ in equation (22), reduces employment.

[13] Newell and Symons (1987) include a dummy variable for 1969-76 in their wage equations to account for "the world-wide increased militancy over this period" (p. 581). Grubb (1986, p. 69) also suggests that "changes in union 'militancy' were involved in the 'wage explosion' " and includes strike variables and dummies in his wage equations to capture these changes.

3.2 Adaptive expectations

Under rational expectations the systematic components of aggregate nominal demand had no real effects in this model. Suppose, however, that expectations are formed adaptively. Specifically, let

$$\dot{\pi}^e = \nu(\pi - \pi^e) \tag{24}$$

$$\dot{n}^e = \dot{n}^e_H = \dot{n}^e_L = 0 \tag{25}$$

and, for simplicity, leave out the stochastic shocks. If policy makers were to manipulate aggregate demand so as to maintain actual employment at the level $\bar{n}$ then, substituting (8), (15) and (25) into (11), we would get

$$\dot{a} = \mu_a [q - a - b\bar{n}] \tag{26}$$

This first-order differential equation has a globally stable solution

$$\bar{a} = q - b\bar{n} \tag{27}$$

At $a = \bar{a}$ we have $\dot{a} = 0$ and hence, using (11) and (25), $\pi = \pi^e$. Furthermore, inflation is stable when $\pi = \pi^e$ (substitute (8) and (25) into (15), differentiate and use (24)). Thus, the endogenous adjustment in wage norms implies that the 'natural rate' (or $NAIRU$) converges to the actual rate of unemployment.

The inflationary costs of raising the rate of employment depends on the adjustment speeds. To see this, note that - from (11), (24) and (25) - we have $\Delta a = -\frac{\mu_a}{\nu}\Delta\pi^e - \mu_a c\Delta n$. Furthermore, if the economy was at a $NAIRU$ before the policy intervention, then $\Delta\pi^e = \Delta\pi$ and, using (27), $\Delta a = -b\Delta n$. It follows that $\Delta\pi = \frac{(b-\mu_a c)\nu}{\mu_a}\Delta n$. Thus, we get a non-vertical long-run Phillips curve with a slope of $\frac{(b-\mu_a c)\nu}{\mu_a}$. The position of the Phillips curve, however, depends on the (conventionally determined) initial value of a.[14]

The exogenous determination of employment at some rate $\bar{n}$ is a poor representation of actual policy formation. Suppose instead, in line with simple Taylor rules for monetary policy, that policy makers have a target rate of inflation, $\bar{\pi}$, and that they respond to deviations of actual inflation from this target by changing the level of aggregate demand.

[14] Inflation is decreasing in the rate of employment if $b < \mu_a c$. This paradoxical result arises if static employment expectations (equation (25)) are combined with strong effects of changes in employment on the real-wage norm. This combination seems implausible, and I shall assume that $b > \mu_a c$.

Specifically, let[15]

$$\dot{n} = \lambda(\bar{\pi} - \pi) \tag{28}$$

Retaining the assumption of adaptive expectations, we now get a two-dimensional dynamic system in (n, π^e). This system has a globally stable equilibrium given by (see Appendix 2)

$$n^* = \frac{q + \frac{\mu_a}{\nu}\bar{\pi} - c_1}{b - \mu_a c} \tag{29}$$

$$\pi^{e*} = \bar{\pi} \tag{30}$$

The inflation rate is uniquely determined by the target rate of inflation. The employment rate, on the other hand, depends on a constant of integration, c_1, and an autonomous shift in real-wage norms is associated with a change in this constant. Thus, as in the case of rational expectations, increased militancy or a decline in productivity growth produces a fall in employment.

The dynamic response to a decline in productivity growth is illustrated in figure 1 (the same pattern of response is obtained following an autonomous increase in the real-wage norm). The figure uses $b = 1, c = 0, \lambda = 0.2, \nu = 0.5, \bar{\pi} = 0.03$ and an initial steady-state employment rate of 0.9. Two cases are shown, one with fast and one with slow adjustment of the real-wage norm, the latter showing noticeable similarities with the stylized pattern of unemployment and inflation in the US and most OECD countries after the slowdown around 1970.

[15] Policy makers control $\dot{v}$, the growth of aggregate nominal demand. The growth rate of aggregate demand is $\dot{v}^* = \bar{\pi} + q$ when inflation is at its target and employment is constant. Thus, let

$$\dot{v} = \bar{\lambda}(\bar{\pi} - \pi) + \dot{v}^* = \bar{\lambda}(\bar{\pi} - \pi) + \bar{\pi} + q$$

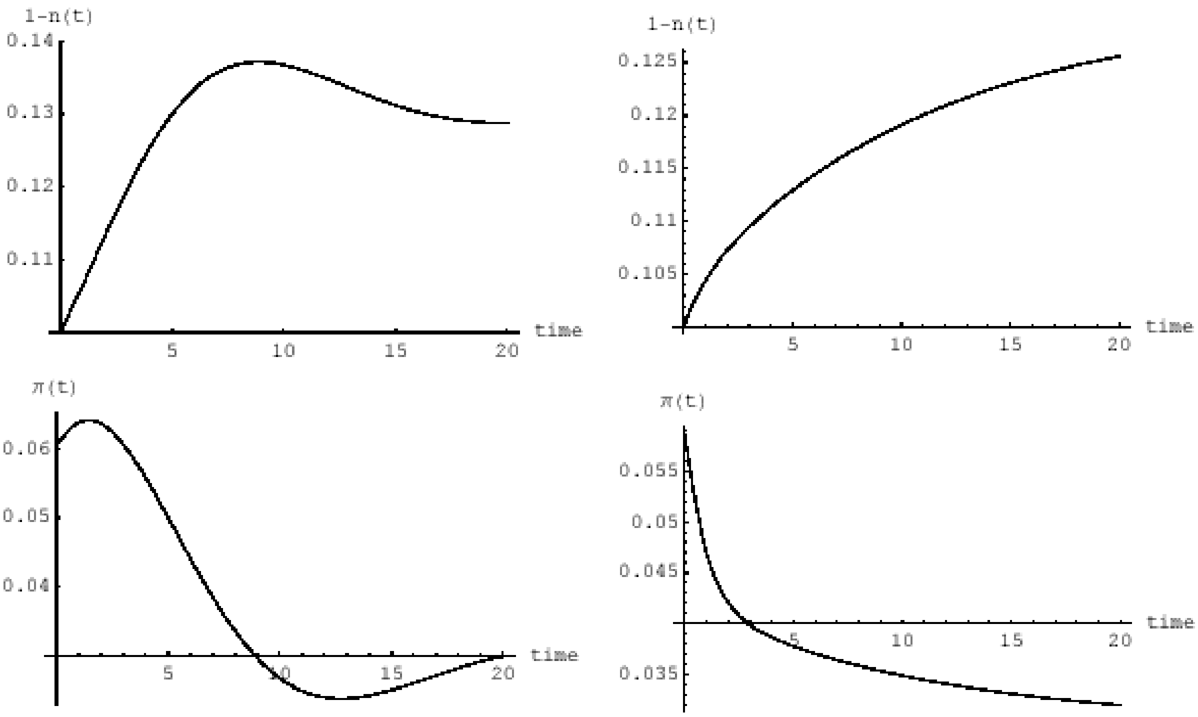
Since

$$\dot{n} = \dot{v} - \hat{w} = \dot{v} - \pi - q$$

we now get (28) with $\lambda = 1 + \bar{\lambda}$.

Figure 1: Dynamic effects on unemployment and inflation
of a 3 percentage point drop in productivity growth

$\mu_a = 0.1$ $\mu_a = 1$



Unlike the case of rational expectations, systematic expansionary policy also affect employment when expectations are adaptive. Demand policy is represented by the choice of an inflation target and, using (29) and footnote 14, we have $\partial n^* / \partial \bar{\pi} > 0$. As in the case of changes in productivity growth, the dynamic response depends on the adjustment speed μ_a; high adjustment speeds give monotonic convergence, low adjustment speeds lead to damped oscillations.

3.3 A shifting Phillips curve

Consider the case with adaptive expectations and the policy rule (28), and assume that the economy has reached a steady state at time t_0. A shock is then introduced. The value of the inflation target in the policy rule, for instance, may start to shift. Let π_0 be the value of $\bar{\pi}$ associated with the initial steady state and assume that, from time t_1

onwards, the target is at a new constant value, $\bar{\pi}_1$. Algebraically,

$$\bar{\pi} = \begin{array}{l} \bar{\pi}_0 \text{ for } t < t_0 \\ \bar{\pi}(t) \text{ for } t_0 < t < t_1 \\ \bar{\pi}_1 \text{ for } t < t_1 \end{array} \tag{31}$$

The steady-state results in section 3.2 hold for all time-paths of $\bar{\pi}$ in the interval from t_0 to t_1. There is a fixed proportionality between the effects of unanticipated inflation on $\dot{a}$ and $\dot{\pi}^e$; that is, using (11) and (24), $\partial\dot{a}/\partial(\pi - \pi^e) = -(\mu_a/\nu)d\dot{\pi}^e/d(\pi - \pi^e)$. This proportionality implies that it is possible to derive the long-run effects of a change in the inflation target without knowing the precise movements of the target for the turbulent period between t_0 and t_1. But the proportional specification of the adjustments represents a special case, and non-proportional specifications may complicate the comparative statics in an interesting way.

Consider for example the implications of replacing the linear specification of the adjustment in inflationary expectations with a cubic version:

$$\dot{\pi}^e = \nu(\pi - \pi^e)^3 \tag{32}$$

This cubic specification implies that small inflation surprises will have a disproportionate influence on the real-wage norm and large surprises a disproportionate effect on inflationary expectations. As a result, employment can be raised without any inflationary costs. This possibility is demonstrated formally in Appendix 3 in which a sharp negative shock to employment is followed by a slow expansion. The initial negative shock to employment pushes actual inflation far below expected inflation, and this quickly reduces inflationary expectations but has only minor effects on the real-wage norm. The ensuing period of mildly expansionary policy has a disproportionate effect on the real-wage norm, and, as inflationary expectations slowly return to their old equilibrium level, the real-wage norm falls below its previous equilibrium level.

The possibility of permanent non-inflationary increases in employment (and, analogously, the risk of permanent reductions in employment without reductions in inflation) does not depend on a cubic specification. Any difference in the functional form of equations (11) and (32) that breaks the proportional effects of unanticipated inflation on $\dot{a}$ and $\dot{\pi}^e$ has this consequence. At a theoretical level, this result shows that, even under adaptive expectations and in the absence of autonomous shocks to norms, the long-run Phillips curve may be shifting over time. With non-proportional adjustment functions there is neither a stable trade-off nor a structurally determined natural rate. Clever policy (or good luck) may increase employment without inflationary cost; bad policy (or bad luck) may cause employment to go up permanently. The policy significance of these results clearly should not be exaggerated. In the absence of reliable knowledge about the functional forms it is not very helpful to be told that 'good policy' could reduce unemployment. The theoretical point - the absence of a stable long-run Phillips curve or a stable $NAIRU$ - still remains, however.

4 Wage inequality

Let the total labour force be normalized at unity and let γ denote the proportion of high-skill workers. Then, using (14), the employment rates for high- and low-skill workers are given by

$$n_H = \frac{N_H}{H} = \frac{1}{\gamma}\frac{N_H}{n}n = \frac{1}{\gamma}f(\frac{w_H}{w_L})n \tag{33}$$

$$n_L = \frac{N_L}{L} = \frac{n-N_H}{1-\gamma} = \frac{n}{1-\gamma}\left(1-f(\frac{w_H}{w_L})\right) \tag{34}$$

The analysis in section 3 has determined the movements in employment and, given the time path of n, the dynamics for relative wages follow from (7), (10), (33) and (34). As in section 3, different cases may arise depending on how expectations are formed. Setting the parameter s in equation (7) equal to zero, however, expectations play no role for the movements in relative wages, given the time path of n, and I shall focus on this special case.

Substituting the time path $n(t)$, $s = 0$ and the expressions (33)-(34) for n_H and n_L into (7) and (10), we get a two-dimensional (non-autonomous) system of differential equations for $\log\frac{w_H}{w_L}$ and k,

$$\hat{w}_H - \hat{w}_L = \rho\left[k(t) + mn(\frac{f(\frac{w_H}{w_L})}{\gamma} - \frac{1-f(\frac{w_H}{w_L})}{1-\gamma}) - \log\frac{w_H}{w_L}\right] \tag{35}$$

$$\dot{k} = -\frac{\mu_k}{\rho}(\hat{w}_H - \hat{w}_L) \tag{36}$$

Since the change in k is proportional to the change in $\log w_H/w_L$, there is only one, rather than two equilibrium conditions. Using $f' < 0$, this equilibrium condition implies that

$$\frac{w_H}{w_L} = \phi(n,k); \qquad \phi_1 \gtreqless 0 \text{ if } \frac{f(w_H)}{\gamma} \gtreqless \frac{1-f(\frac{w_H}{w_L})}{1-\gamma}, \quad \phi_2 > 0 \tag{37}$$

and, given an employment rate n, the system will converge to a point in the equilibrium set described by (37). To see this, integrate equation (36) to get

$$k(t) = -\frac{\mu_k}{\rho} \log \frac{w_H(t)}{w_L(t)} + c_2 \tag{38}$$

where c_2 is determined by the initial conditions. Substituting the time path (38) into equation (35), we obtain a one-dimensional, globally stable differential equation for $\log \frac{w_H}{w_L}$. Note, however, that the solution for w_H/w_L depends on c_2, that is, on the initial value of the relative-wage norm k.

Empirically, the employment rate for high-skill workers almost invariably exceeds that for low-skill workers (that is, $\frac{f(w_H)}{\gamma} > \frac{1-f(\frac{w_H}{w_L})}{1-\gamma}$) and it follows, using (37)-(38), that the relative wage is increasing in n. Thus, a fall in employment - associated, for instance, with a decline in q or an increase in a_0 - will lead to a decline in wage inequality. The magnitude of the decline depends on the production function (via the f-function), but the adjustment speeds ρ and μ_k also play a role. Equation (36) implies that $\Delta \log \frac{w_H}{w_L} = -\frac{\rho}{\mu_k}\Delta k$. It follows - using (37) - that changes in employment have strong repercussions for wage inequality when the ratio of adjustment parameters $\frac{\rho}{\mu_k}$ is large. Conversely, a small value of this ratio implies that k bears the brunt of the adjustment.

Autonomous changes in pay norms also affect wage disparity. The ascendancy of free market ideology since the late 1970s has been particularly strong in the US and the UK, the two OECD countries with the most dramatic increase in wage inequality. The manifestations of this ascendancy can be found across a range of areas, including a decline in both the membership and strength of unions, privatization of public services, changes in welfare provisions and unemployment benefits, tax reforms and an increased use of financial incentives. In the present, stylized model the change in ideological climate may be associated with a greater acceptance of market-generated inequalitites, that is, a non-egalitarian shift in the relative-wage norm.[16] Equations (37)-(38) imply that an autonomous increase in the initial value, k_0, of k (or equivalently, an increase in the constant of integration c_2 in (38)) leads to a rise in long-run inequality. The increase

[16] A related argument has been advanced by Atkinson (1998, p. 19) who suggests that

> [t]here are reasons to suppose that there has been a shift from company pay policies to individual negotiation, and for conventional pay norms to break down. This process may acquire a dynamic of its own: As more people are remunerated outside the conventional norms, so adherence to these norms becomes weaker, and the socially acceptable range of remuneration becomes wider.

in wage inequality, however, leads to a fall in the employment of high-skill workers and an increase in low-skill employment.

Changes in the relative supply of high-skill workers, γ, or shifts in the $f(.)$ function, finally, influence the relative wage. In both cases the effects are as one would expect. The relative wage for high-skill workers is decreasing in the supply of high-skill workers while an upward shift in f causes the relative wage of high-skill workers to increase. The shift in f, furthermore, raises the employment rate for high-skill workers and reduces that for low-skill workers.

Table 1 summarizes these comparative results for wage inequality. The rise in unemployment in the 1970s and 1980s reduces wage inequality, and autonomous shifts in relative-wage norms or changes in relative supplies also fail to explain a pattern of increases in both wage inequality and high-skill employment. In this model, shifts in relative demand are needed to account for the observed trends.

Table 1: Effects of changes in n, k_0, γ and $f(.)$ on the steady-state solutions of $w_H/w_L, n_H$ and n_L

	n	k_0	γ	$f(.)$
$\log\left(\frac{w_H}{w_L}\right)^*$	$+$	$+$	$-$	$+$
n_H^*	$+$	$-$	$-$	$+$
n_L^*	$+$	$+$	$+$	$-$

5 Wage inequality and 'induced overeducation'

As an empirical observation, unemployment is largely concentrated among low-skill (and low-paid) groups. This stylized fact is sharpened in this section into an assumption of zero unemployment for high-skill workers. The absence of unemployment among high-skill workers need not imply, however, that all high-skill workers have high-skill jobs. The evidence suggests that many workers are 'overeducated'.[17] A study by Sicherman (1991), for instance, reports that 40 percent of US workers are overeducated and Hersch (1991) finds overeducation figures ranging from 28 to 78 percent for different groups of workers in a sample from Oregon. Similar figures have been found for other countries. Qualifications are not necessarily the same as formal education, of course, and the measurement of overeducation involves many difficulties, both conceptual and em-

[17] Workers are 'overeducated' if their education exceeds the requirements set by the employer; 'credentialism' occurs when a change in the pool of applicants leads employers to raise the skills required for recruitment to an otherwise unchanged job

pirical. Summarizing the evidence, however, Green et al. (1999, p.15) suggest that "overeducation is a widespread phenomenon both in Europe and the United States of America".[18]

In this section I shall assume that any high-skill workers that fail to get high-skill jobs take low-skill jobs instead. Thus, there is 'induced overeducation': a sustained increase in the supply or decrease in the demand for high-skill workers raises the level of overeducation.[19] Theoretically, two conditions are needed to rationalize this assumption of induced overeducation. High-skill workers, first, must prefer low-skill employment to unemployment. As long as wages in low-skill jobs exceed the level of unemployment benefits, this preference can be justified on strictly economic grounds if the probability of moving from a low-skill to a high-skill job is at least as high as the probability of moving from unemployment to a high-skill job. I shall assume that this condition is met: it seems unreasonable, many search models notwithstanding, to suppose that only unemployed workers can engage in job search, and working below one's formal qualification may send a better signal to prospective employers than (prolonged) unemployment. The extensive

[18] Undereducation - workers who report having less education than required to get the job - also exists. Quantitatively, most studies indicate that about 10-20 percent of all workers are undereducated. The existence of undereducation on this scale could reflect unmeasured heterogeneity and the futility of trying to measure qualifications by length of education. Alternatively, however, it could indicate credentialism: although employers may want workers with the 'required education', this level may not be needed to do the job.

[19] High-skill workers who have been laid off may not adjust their job aspirations immediately. Differential labour hoarding, furthermore, causes other short-run complications: temporary changes in demand will affect the number of low-skill jobs disproportionately, and there will be a tendency for overeducation to decrease when high-skill workers in low-skill jobs are laid off as a result of differential labour hoarding. Short-run fluctuations in overeducation therefore say little about the implications of sustained changes in aggregate activity or in the skill composition of the labour force.

Evidence on medium- and long-run changes in overeducation and credentialism is limited since most empirical studies rely on surveys for a particular year. In the UK, the incidence of overeducation increased between the 1970s and 1980s and stabilized since the late 1980s (Green et al (1999)), and Robinson and Manacorda (1997, p. 3) find that between 1984 and 1994 "the increase in the supply of better educated labour has allowed firms to indulge in 'credentialism', employing more highly qualified staff to do jobs which previously were done by less qualified staff". In the US, the evidence is ambiguous. Wolff (2000, p. 27) concludes that between 1950 and 1990 there has been a growing mismatch "between skill requirements of the workplace and the educational attainment of the workforce, with the latter increasing much more rapidly than the former". Daly et al. (2000), on the other hand, find a decline in overeducation between 1976 and 1985. More generally, Hartog's (2000) survey of the literature reports an increasing incidence of overeducation (and decreasing undereducation) since the 1970s in a number of countries.

use of internal job ladders reinforces these benefits of getting a job, even if initially it has to be one for which one is overqualified.

Secondly, firms must prefer high- to low-skill workers when filling low-skill jobs. This ranking may arise in different ways. One simple story runs as follows.[20] Fairness dictates that all workers in low-skill jobs be paid the same wage since attempts to differentiate would lead to worker resentment and shirking. High-skill workers, however, may be (slightly) more productive in these jobs. This assumption is in line with Büchel's (2002) finding that "overeducated workers are generally more productive than others" and that this is why "firms hire overeducated workers in large numbers". For present purposes, the productivity difference can be arbitrarily small. If all workers in low-skill jobs must be paid the same wage, firms will prefer high-skill workers as long as there is any productivity difference. To simplify the analysis I shall focus on the limiting case with the productivity difference going to zero.

The assumptions of zero unemployment among high-skill workers and the employment of some high-skill workers in low-skill jobs are captured algebraically by the following equations:

$$H = \gamma = N_H + N_{HL} \tag{39}$$

$$L = 1 - \gamma = N_{LL} + U_L \tag{40}$$

$$n = N_H + N_{HL} + N_{LL} = N_H + N_L \tag{41}$$

where N_H and N_{HL} are the number of high-skill workers in high- and low-skill jobs; N_{LL} and U_L the number of low-skill workers that are employed (in low-skill jobs) and unemployed; and $N_L = N_{LL} + N_{HL}$ the number of low-skill jobs. As before, n is the employment rate; the total number of workers has been normalized at unity and γ is the proportion of high-skill workers.

The employment of low-skill workers can still be measured by their employment rate. By assumption, however, there is no unemployment among high-skill workers and the obvious indicator of employment conditions for this group now becomes the proportion of high-skill workers that have high-skill jobs. Thus, in this section let

$$n_H = \frac{N_H}{\gamma} = \frac{1}{\gamma} f(\frac{w_H}{w_L}) n \tag{42}$$

$$n_L = \frac{N_{LL}}{1-\gamma} = \frac{n - N_H - N_{HL}}{1-\gamma} = \frac{n-\gamma}{1-\gamma} \tag{43}$$

[20] See Skott (2002) for an alternative approach to the joint determination of wages, employment rates and the degree of overeducation in a shirking model.

The analysis now proceeds as in section 4, but using (42)-(43) instead of (33)-(34). We get the following two-dimensional system,

$$\hat{w}_H - \hat{w}_L = \rho\left[k(t) + m(\frac{1}{\gamma}f(\frac{w_H}{w_L})n - \frac{n-\gamma}{1-\gamma}) - \log\frac{w_H}{w_L}\right] \quad (44)$$

$$\dot{k} = -\frac{\mu_k}{\rho}\left(\hat{w}_H - \hat{w}_L\right) \quad (45)$$

As in section 4, there is one, rather than two equilibrium conditions,

$$\frac{w_H}{w_L} = \chi(n,k); \qquad \chi_1 \lesseqgtr 0 \text{ if } \frac{f(\frac{w_H}{w_L})}{\gamma} \lesseqgtr \frac{1}{1-\gamma}, \quad \chi_2 > 0 \quad (46)$$

The functional form and the sign conditions for the partial with respect to employment are different, however, and these differences affect the comparative statics.

If, as suggested by the evidence reported above, about 30 percent of all workers are overeducated then the conditions for χ_1 to be negative are met and a fall in employment will lead to an increase in wage inequality.[21] Thus, in the presence of induced overeducation, factors which raise the unemployment rate (a decline in productivity growth, for instance) may also contribute to an increase in wage inequality, even though the increase in unemployment will be concentrated among low-skill workers.[22]

As in section 4, autonomous shifts in relative-wage norms may lead to increasing wage disparity. The interesting difference is that, given the specification of induced overeducation in this section, relative employment rates are unaffected by the change in relative wages: some high-skill workers move from high- to low-skill jobs but their employment rate does not change and, if aggregate employment is kept constant, the employment rate for low-skill workers also remains unchanged.

Induced overeducation also implies that, unlike in section 4, the effects of relative supply on relative wages are ambiguous. An increase in the share of high-skill workers will reduce the proportion of high-skill workers that get high-skill jobs, but those high-skill workers that fail to get a high-skill job will move into low-skill jobs and bump

[21] To see this, note that

$$f(\frac{w_H}{w_L}) = \frac{N_H}{n} = \frac{\gamma - N_{HL}}{n}$$
$$= \frac{\gamma}{n} - \Omega$$

where Ω is the degree of overeducation. Using $\Omega \approx 0.3$, the condition for $\chi_1 < 0$ in (46) will hold for all values of γ, as long as the employment rate exceeds 42 percent.

[22] Explanations along these lines have been suggested by Thurow (1998) and Skott and Auerbach (2000).

low-skill workers into unemployment. Thus, both $n_H = N_H/\gamma$ and $n_L = (n-\gamma)/(1-\gamma)$ will fall and movements in relative wages depend on the difference $n_H - n_L$.[23]

Turning, finally, to changes in relative labour demand, an upward shift in the $f-$function still leads to a rise in the relative wage of high-skill workers. The asymmetry between the ambiguous effects of changes in relative supply and the unambiguous effects of changes in relative demand has a simple explanation. Relative supply refers to the skill-composition of workers; relative demand, on the other hand, concerns the skill-composition of jobs, and, in the presence of overeducation, the effects of changes in the compositions of jobs and workers can be very different.

The comparative results for the case with induced overeducation are summarized in Table 2.

Table 2: Effects of changes in n, k_0, γ and $f(.)$ in a set-up with induced overeducation

	n	k_0	γ	$f(.)$
$\log\left(\frac{w_H}{w_L}\right)^*$	$-$	$+$	$+/-$	$+$

The more precise, dynamic response of the system (44)-(45) to shocks depends on parameter values. Empirical evidence can be used to calibrate some of these parameters in a relatively straightforward manner and to indicate the relevant magnitude of the different variables in an initial steady state. Thus, as in section 3.3, let $b = 1, c = 0, \lambda = 0.2, \nu = 0.5, \pi_0 = \bar{\pi} = 0.03, n_0 = 0.9$. Values associated with high- and low-skill workers are harder to assign since they depend on the delineation of the two categories but Figures 2-3 show some typical simulations of the response to a productivity slowdown or an increase in the relative supply of high-skill workers for different adjustment speeds and production functions (details about the choice of parameter values are in Appendix 4). Note the similarity in Figures 2-3 of the outcomes for the two specifications of the production function: because the fair relative wage remains almost unchanged even if the composition of jobs is kept constant (as in the Leontief case), firms have little incentive to change their input proportions in the Cobb-Douglas case.

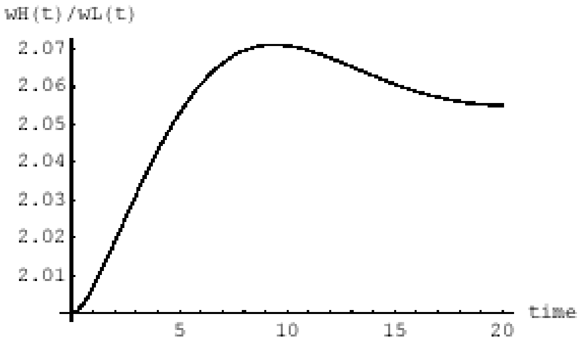
[23] Setting the left-hand-side of (44) equal to zero and using (38), we have

$$d\log\frac{w_H}{w_L}/d\gamma = m\left(\frac{\rho+\mu_k}{\rho} - m\frac{n}{\gamma}f'(\frac{w_H}{w_L})\frac{w_H}{w_L}\right)^{-1}\left[(\frac{1}{1-\gamma} - \frac{1}{\gamma}f(\frac{w_H}{w_L})) - (n-\gamma)(\frac{1}{(1-\gamma)^2} - \frac{1}{\gamma^2}f(\frac{w_H}{w_L}))\right]$$

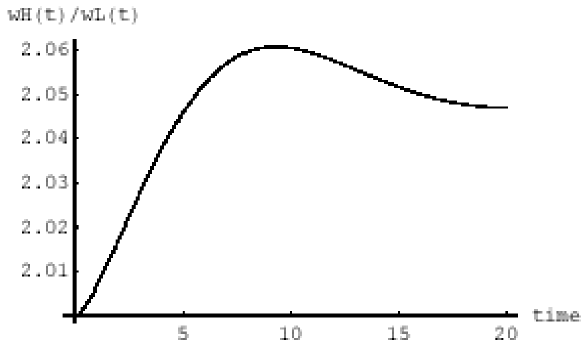
The evidence of overeducation suggests that $\frac{1}{1-\gamma} - \frac{1}{\gamma}f(\frac{w_H}{w_L}) > 0$ (cf. above). It follows that the counterintuitive result - an increase in γ leading to a rise in the relative wage - is obtained if n does not exceed γ by very much.

Figure 2: Dynamic effects on wage inequality of a 3 percentage point drop in productivity growth in a set-up with overeducation

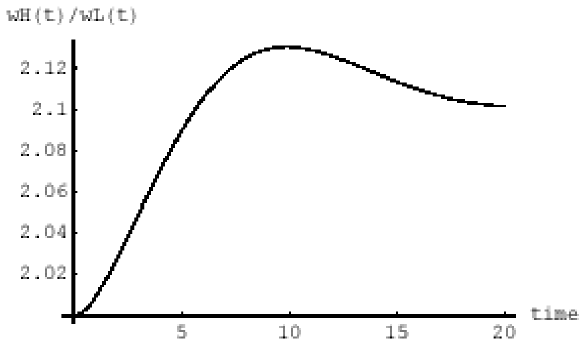
Leontief case; $\mu_a = 0.1, \mu_k = 1$



Cobb-Douglas case; $\mu_a = 0.1, \mu_k = 0.1$



Leontief case; $\mu_a = 0.1, \mu_k = 0.1$



Cobb-Douglas case; $\mu_a = 0.1, \mu_k = 0.1$

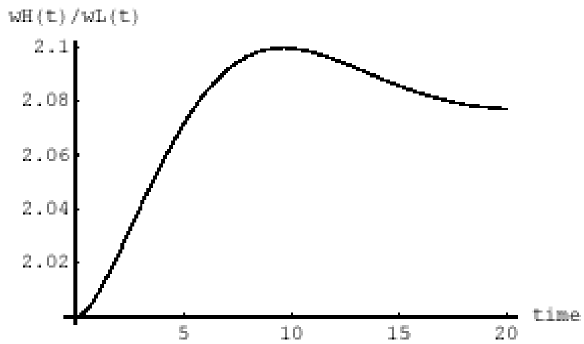
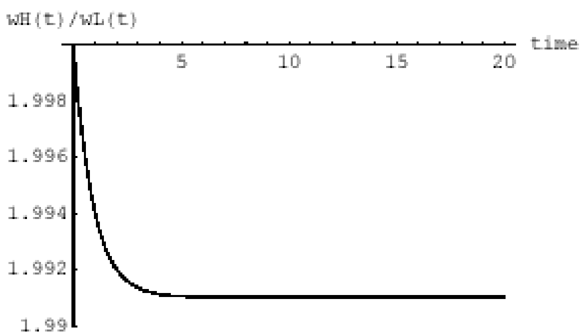
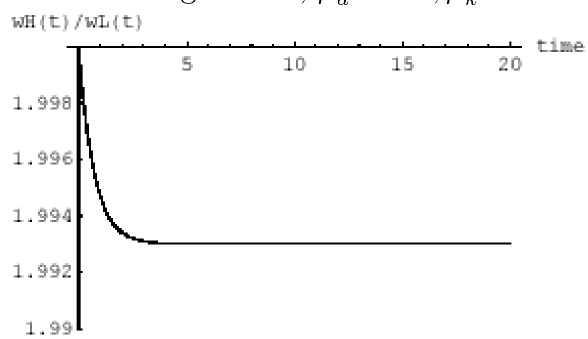


Figure 3: Dynamic effects on wage inequality of an increase in relative labour supply from $\frac{\gamma}{1-\gamma} = 1.5$ to $\frac{\gamma}{1-\gamma} = 2$ in a set-up with overeducation

Leontief case; $\mu_a = 0.1, \mu_k = 0.1$



Cobb-Douglas case; $\mu_a = 0.1, \mu_k = 0.1$



6 Conclusions

This paper has analysed a stylized model of wage formation. The analysis presumes that norms of fairness determine the evolution of wages, that these norms make allowance for the state of the labour market, and that the norms themselves evolve endogenously. A key implication of these assumptions is the absence of a structurally determined natural rate of unemployment or $NAIRU$. Under rational expectations, systematic policy has no real effects but the model exhibits hysteresis: unanticipated demand shocks produce permanent shifts in the equilibrium rate of employment. Adaptive expectations imply that systematic expansionary policies can raise employment permanently without ever-increasing inflation. In light of the large productivity slowdown from around 1970 (and the recent partial recovery in productivity growth), it is noteworthy also that a fall in productivity growth raises unemployment in this model.

An extension of the basic model allows for induced overeducation and a mismatch between jobs and workers. This mismatch fits the empirical evidence and it can be rationalized within the fair-wage framework: it is rational for firms to pay fair wages in order to avoid shirking, it is individually rational for unemployed high-skill workers to accept low-skill jobs, and as long as $w_H > w_L$ there are incentives for workers to invest in skills, even if there is a risk that they will spend part of their working lives in low-skill jobs.

The presence of induced overeducation implies that changes in aggregate activity will have a disproportionately large impact on the rate of unemployment among low-skill workers and that a decline in economic activity therefore may put downward pressure on the relative wage rate for low-skill jobs. Thus, expansionary demand policy may have derived benefits in the form of reduced inequality. Furthermore, the reduction in overeducation itself represents an improvement in the utilization of the existing skills of the workforce, that is, a reduction in hidden unemployment of a kind that is ignored in models with perfect matching of jobs and workers.

The presence of induced overeducation also implies that autonomous shifts in relative-wage norms may lead to changes in relative wages with little or no effect on the relative employment of high- and low-skill workers. A reduction in wage inequality, however, affects the composition of jobs and thereby reduces hidden unemployment in the form of overeducation. From a dynamic perspective reduced inequality exerts a negative influence on the private incentives for education. Since the presence of overeducation entails a negative externality this incentive effect may be socially beneficial but other externalities of imperfections clearly may reverse this conclusion.[24]

[24]More importantly, perhaps, the argument applies to the productive benefits of high skills, in a narrow sense, rather than to the broader value - to individuals and society - of having an educated and knowledgeable population.

On the empirical side, an increase in unemployment and changes in the ideological climate may, according to this model, have contributed to rising inequality with respect to both wages and employment from the 1970s to the 1990s. But, needless to say, although changes in wage norms, endogenous as well as autonomous, may have played a role in the movements of wages and employment, other complementary influences undoubtedly have been at work too. The analysis in this paper, moreover, has obvious limitations arising from the highly stylized modelling of wage norms. It was assumed, for instance, that notions of fairness are shared by all workers. If fairness norms adjust towards realized outcomes, the notions of fairness will clearly coincide in a steady state. Outside the steady state, however, the notion of fair relative wages may be group-specific. The fair wage ratio as seen from the perspective of workers in low-skill jobs may deviate from the perception of those in high-skill jobs. It seems likely, in particular, that the adjustment of fair wages towards actual wages will be asymmetric: while it is easy to convince oneself of the fairness of a pay rise, it may be difficult and take much longer to accept the fairness of a reduction in pay. This kind of asymmetry implies that, outside a steady state, there will be a tendency for (most groups of) workers to feel that their relative wage is unduly low. Furthermore, shocks to relative wages may have little impact on the demand for wage increases from those workers that have benefitted from the shocks while the wage demands of those that have been hit negatively escalate. Asymmetric adjustment speeds, consequently, may have repercussions for average wage and price inflation, and average wage inflation will not be a simple function of aggregate variables as in equation (8).

The specification of the real-wage norm could also be generalized, particularly in the case with overeducation. The present specification uses the overall rate of unemployment to indicate the average tightness of the labour market. In the presence of overeducation, however, the labour market may get tighter if the proportion of high-skill workers in low-skill jobs declines, even if aggregate employment is unchanged. Thus, arguably, the real-wage norm should depend on n_H and n_L separately as well as on the wage ratio w_H/w_L.[25]

I have chosen to leave these complications and extensions for future work. The main conclusions (including the absence of a structurally determined $NAIRU$ and the poten-

[25] For low-skill workers the outside option is unemployment benefits, and benefits can be indexed to low-skill wages so that the ratio of wages to benefits is kept constant. The analogous simplification is not possible for high-skill jobs. The fallback wage for high-skill workers is w_L and, unlike the ratio of low-skill wages to benefits, the wage ratio w_H/w_L is determined endogenously and thus cannot be assumed constant.

tial importance for wage inequality of both changes in aggregate activity and autonomous shifts in norms of fairness) are, I believe, quite robust with respect to extensions of this kind, and, although conceptually straightforward, the extensions are analytically messy. A simple specification makes for greater transparency and, given the current state of knowledge, one should perhaps also be wary of introducing complex specifications with many degrees of freedom and a large number of unknown parameters.

Even the simple specification in this paper has a number of new parameters and degrees of freedom, and models of a structurally determined $NAIRU$ may seem theoretically tighter and more satisfying. But perhaps there is a need to broaden the perspective and include new parameters. Even strong supporters of the $NAIRU$ framework concede that the applicability of $NAIRU$-theory may be limited. Thus, Gordon (1997, p. 28) concludes that

> Within the postwar experience of the United States, the modest fluctuations in the NAIRU seem plausible in magnitude and timing. When applied to Europe or to the United States in the Great Depression, however, fluctuations in the NAIRU seem too large to be plausible and seem mainly to mimic movements in the actual unemployment rate.

It is hard to know what to make of this conclusion. There are no hints in the standard theory to suggest that its range of applicability be delimited in this way. From a Popperian perspective, and in the absence of good reasons for the limited applicability, Gordon's reading of the evidence must imply that the theory should be rejected.

7 Appendix

7.1 Appendix 1: Movements in employment under rational expectations

We have $PY = \beta wn$ where β is equal to the product of the markup factor and the size of the labour force, and, using a logarithmic approximation,

$$x = v + \varepsilon = \log \beta + \log w + (n - 1) \tag{A1}$$

Under rational expectations, the expected rate of change in x is given by $\dot{x}^e = \dot{v} = \hat{\beta}^e + \hat{w}_a^e + \dot{n}^e$ where

$$\hat{w}_a = \hat{w} + \frac{(w_H - w_L)\, N_H}{w_H N_H + w_L N_L} \theta (\hat{w}_H - \hat{w}_L) \tag{A2}$$

and where $\theta = \frac{f'(w_H/w_L)}{f(w_H/w_L)} (w_H/w_L)$ is the elasticity of the share of high-skill jobs in total employment with respect to the relative wage (cf. section 2.2).[26] The markup, the growth rate of labour force and the growth in wages are assumed known. Thus, we have $\hat{\beta}^e = \hat{\beta}, \hat{w}_a^e = \hat{w}_a$ and

$$\dot{v} = \hat{\beta} + \hat{w}_a + \dot{n}^e \tag{A3}$$

Integrating (A3), we get

$$v = \log \beta + \log w + \int \dot{n}^e dt \tag{A4}$$

Substituting (A4) into (A1) and re-arranging, we get

$$\varepsilon = n - \int \dot{n}^e dt \tag{A5}$$

Using (11), (19) and (A5) we now have

$$a(t) - a(t_0) = -\mu_a c\, (\varepsilon(t) - \varepsilon(t_0)) \tag{A6}$$

[26] It is the growth of average wages $\hat{w}_a$ rather than average growth of wages $\hat{w}$ that matters here. The two growth rates differ in that the growth of the average wage includes the effects of compositional changes in the labour force,

$$\begin{aligned} \hat{w}_a &= \frac{d \log w}{dt} = \frac{d \log \frac{N_H w_H + N_L w_L}{n}}{dt} \\ &= \eta \left(\hat{w}_H + \frac{\widehat{N_H}}{n} \right) + (1 - \eta) \left(\hat{w}_L + \frac{\widehat{N_L}}{n} \right) \\ &= \hat{w} + \eta \frac{\widehat{N_H}}{n} + (1 - \eta) \frac{\widehat{N_L}}{n} \end{aligned}$$

and equations (8), (15) and (19) imply that

$$\dot{n}^e = \frac{q - a(t) - bn}{c} \tag{A7}$$

Hence, using (A5)-(A7),

$$n(t) = \varepsilon(t) + \int \left(\frac{q - a(t_0) - c\mu_a \varepsilon(t_0)}{c} + \mu_a \varepsilon(t) - \frac{b}{c} n(t) \right) dt \tag{A8}$$

Now, consider the two-dimensional, linear system of stochastic differential equations

$$\begin{pmatrix} dn \\ d\varepsilon \end{pmatrix} = \begin{pmatrix} \frac{q - a(t_0) - c\mu_a \varepsilon(t_0)}{c} \\ 0 \end{pmatrix} dt + \begin{pmatrix} -\frac{b}{c} & \mu_a \\ 0 & 0 \end{pmatrix} \begin{pmatrix} n \\ \varepsilon \end{pmatrix} dt + \begin{pmatrix} 1 \\ 1 \end{pmatrix} d\varepsilon \tag{A9}$$

The solution $(n(t), \varepsilon(t))$ is a Gaussian process (see e.g. Arnold (1974, Theorem 8.2.10). The mean values $(m_1, m_2) = (E(n(t), E(\varepsilon(t))$ and the covariance matrix

$$K = \begin{pmatrix} V(n(t)) & Cov(n(t), \varepsilon(t)) \\ Cov(n(t), \varepsilon(t)) & V(\varepsilon(t)) \end{pmatrix} = \begin{pmatrix} \sigma_n^2 & c_{n\varepsilon} \\ c_{n\varepsilon} & \sigma_\varepsilon^2 \end{pmatrix} \tag{A10}$$

are given by the solutions to the deterministic differential equations (Arnold (1974, Theorem 8.2.6))

$$\dot{m} = \begin{pmatrix} \frac{q - a(t_0) - c\mu_a \varepsilon_0}{c} \\ 0 \end{pmatrix} + \begin{pmatrix} -\frac{b}{c} & \mu_a \\ 0 & 0 \end{pmatrix} m; \quad m(t_0) = \begin{pmatrix} n(t_0) \\ \varepsilon(t_0) \end{pmatrix} \tag{A11}$$

$$\dot{K} = \begin{pmatrix} -\frac{b}{c} & \mu_a \\ 0 & 0 \end{pmatrix} K + K \begin{pmatrix} -\frac{b}{c} & 0 \\ \mu_a & 0 \end{pmatrix} + \begin{pmatrix} 1 \\ 1 \end{pmatrix} (1,1); \quad K(t_0) = \begin{pmatrix} 0 & 0 \\ 0 & 0 \end{pmatrix} \tag{A12}$$

Writing out these equations,

$$\dot{m}_1 = \frac{q - a(t_0) - c\mu_a \varepsilon(t_0)}{c} - \frac{b}{c} m_1 + \mu_a m_2 \tag{A13}$$

$$\dot{m}_2 = 0 \tag{A14}$$

$$\dot{\sigma}_n^2 = 1 + 2\mu_a c_{n\varepsilon} - 2\frac{b}{c}\sigma_n^2 \tag{A15}$$

$$\dot{c}_{n\varepsilon} = 1 + \mu_a \sigma_\varepsilon^2 - \frac{b}{c} c_{n\varepsilon} \tag{A16}$$

$$\dot{\sigma}_\varepsilon^2 = 1 \tag{A17}$$

The solutions are given by

$$
\begin{aligned}
m_1(t) &= \frac{q-a(t_0)}{b} + (n_0 - \frac{q-a(t_0)}{b})\exp(-\frac{b}{c}t) && \text{(A18)}\\
m_2(t) &= 0 && \text{(A19)}\\
\sigma_n^2 &= \frac{c}{b}\left[1 + \mu_a\frac{c}{b} - \left(\mu_a\frac{c}{b}\right)^2 - \frac{1}{2}\mu_a^2\frac{c}{b}\right] + \left(\mu_a\frac{c}{b}\right)^2 t \\
&\quad + D_1\exp(-2\frac{b}{c}t) + D_2\exp(-\frac{b}{c}t) && \text{(A20)}\\
c_{n\varepsilon} &= \frac{c}{b}\left[1 - \mu_a\frac{c}{b}\right] + \mu_a\frac{c}{b}t + D_2\exp(-\frac{b}{c}t) && \text{(A21)}\\
\sigma_\varepsilon^2 &= t && \text{(A22)}
\end{aligned}
$$

where the arbitrary constants D_1 and D_2 are determined so that $\sigma_n^2(t_0) = c_{n\varepsilon}(t_0) = 0$.

7.2 Appendix 2: A simple policy rule

Substituting (8), (15) and (25) into (11), (24) and (28), we get:

$$
\begin{aligned}
\dot{a} &= \mu_a(q - a - bn - c\dot{n}) && \text{(A23)}\\
\dot{\pi}^e &= \nu(a + bn - q) && \text{(A24)}\\
\dot{n} &= \lambda(\bar{\pi} + q - a - bn - \pi^e) && \text{(A25)}
\end{aligned}
$$

Furthermore, using (A23)-(A25), we have

$$
\dot{a} = -\frac{\mu_a}{\nu}\dot{\pi}^e - \mu_a c\dot{n} \tag{A26}
$$

and hence

$$
a(t) = -\frac{\mu_a}{\nu}\pi^e(t) - \mu_a c n(t) + c_1 \tag{A27}
$$

where c_1, an arbitrary constant of integration, is determined by the initial conditions. Substituting (A27) into (A24)-(A25), we get

$$
\begin{aligned}
\dot{\pi}^e &= \nu\left[-\frac{\mu_a}{\nu}\pi^e + c_1 + (b - \mu_a c)n - q\right] && \text{(A28)}\\
\dot{n} &= \lambda\left[\bar{\pi} + q + (\frac{\mu_a}{\nu} - 1)\pi^e - c_1 - (b - \mu_a c)n\right] && \text{(A29)}
\end{aligned}
$$

The Jacobian of this system is given by

$$
J(\pi^e, n) = \begin{pmatrix} -\mu_a & \nu b \\ \lambda(\frac{\mu_a}{\nu} - 1) & -\lambda b \end{pmatrix} \tag{A30}
$$

with

$$TR = -\mu_a - \lambda b < 0 \tag{A31}$$

$$DET = \lambda \nu b > 0 \tag{A32}$$

Hence, the system has a globally stable equilibrium given by

$$n^* = \frac{q + \frac{\mu_a}{\nu}\bar{\pi} - c_1}{b - \mu_a c} \tag{A33}$$

$$\pi^{e*} = \bar{\pi} \tag{A34}$$

7.3 Appendix 3: Non-inflationary expansion

Integrating (11) and (39), and using (27), we now get,

$$\Delta\pi^e = \nu \int (\pi - \pi^e)^3 dt \tag{A35}$$

$$\Delta n = \frac{\mu_a}{b - \mu_a c} \int (\pi - \pi^e) dt \tag{A36}$$

Assume that a steady state with $\pi = \bar{\pi}_0$ and $n = n_0$ has been reached at t_0 and consider a policy that yields the following path for employment,

$$n(t) = \begin{matrix} \frac{q - a(t) - \kappa\delta}{b} \text{ for } t_0 < t < t_0 + \theta \\ \frac{q - a(t) + \delta}{b} \text{ for } t_0 + \theta < t < t_0 + 1 = t_1 \\ \frac{q - a(t)}{b} \text{ for } t_1 < t \end{matrix} \tag{A37}$$

This policy implies (use (8), (15) and (25)) that

$$\pi - \pi^e = \begin{matrix} -\kappa\delta \text{ for } t_0 < t < t_0 + \theta \\ \delta \text{ for } t_0 + \theta < t < t_0 + 1 = t_1 \\ 0 \text{ for } t_1 < t \end{matrix} \tag{A38}$$

and, using (A35) and (A36), we get

$$\Delta n = \frac{\mu_a}{b - \mu_a c}((1 - \theta)\delta - \theta\kappa\delta) \tag{A39}$$

$$\Delta\pi = \Delta\pi^e = \nu\left((1 - \theta)\delta^3 - \theta\kappa^3\delta^3\right) \tag{A40}$$

$$\pi^e(t) = \pi(t) = \pi_1 = \pi_0 + \Delta\pi \text{ for } t > t_1 \tag{A41}$$

$$n(t) = n_1 = n_0 + \Delta n \text{ for } t > t_1 \tag{A42}$$

Thus, a new steady state has been attained at the end of the turbulence at time t_1. It is readily seen, moreover, that if $\theta = 1/(1+\kappa^3)$, inflation is unchanged ($\Delta\pi = 0$) while the change in employment is given by $\Delta n = \frac{\mu_a}{b-\mu_a c}\frac{\kappa\delta}{1+\kappa^3}(\kappa^2 - 1)$. Thus, for $\kappa > 1$, the period of turbulence has succeeded in raising the equilibrium solution for employment without any inflationary costs.

7.4 Appendix 4: Benchmark values

Any attempt to approximate a continuum of skills using two internally homogeneous skill categories must be imperfect and, to a large extent, arbitrary. Interesting delineations, however, should not have one skill-category dominating in terms of either the composition of workers or jobs. I therefore set γ equal to 0.6; if 30 percent of all employed workers are overeducated and the aggregate employment rate is 0.9, this delineation implies that the proportion of high-skill jobs will be 0.33, the employment rate for low-skill workers 0.75 and the employment rate for high-skill workers in high skill jobs 0.55. With this delineation, an initial wage ratio of about 2 seems plausible. (The wage ratio w_H/w_L is the ratio of wages in high-skill jobs to wages in low-skill jobs. Since some high-skill workers work in low-skill jobs, the ratio of the average wage for high-skill workers to the low-skill wage will be lower; if 30 percent of the employed workers are overeducated this latter ratio is equal to 1.55 when $w_H/w_L = 2$). Setting the parameter m in the expression for the relative-wage norm equal to one, the associated steady state value for k is $\log 2 + 0.2$, or approximately 0.9. These benchmark values for parameters and the initial steady state are summarized in Table 3.

Table 3: Benchmark values

b	γ	m	q	$\bar{\pi}$	a_0	k_0	n_0	n_{H0}	n_{L0}	$\left(\frac{w_H}{w_L}\right)_0$	π_0
1	0.6	1	0.03	0.03	0.87	$\log 2 + 0.2$	0.9	0.55	0.75	2	0.03

With a Leontief specification of the production function, we have

$$Y = A\min\{N_H, \beta N_L\} \tag{A43}$$

$$\frac{N_H}{n} = f(\frac{w_H}{w_L}) = \frac{\beta}{1+\beta} \tag{A44}$$

and, since N_H/n is equal to 0.33/0.9 in the initial steady state, we get

$$\beta = \frac{0.33}{0.57} \approx 0.58 \tag{A45}$$

In the Cobb-Douglas case,

$$\begin{aligned} Y &= AN_H^{\alpha}N_L^{1-\alpha} && \text{(A46)} \\ \frac{N_H}{n} &= f(\frac{w_H}{w_L}) = \frac{1}{1+\frac{w_H}{w_L}\frac{1-\alpha}{\alpha}} && \text{(A47)} \end{aligned}$$

and (using the initial values of the relative wage and the employment pattern)

$$\alpha = \frac{66}{123} \approx 0.54 \quad \text{(A48)}$$

The only remaining parameters are the adjustment speeds $\lambda, \nu, \rho, \mu_a, \mu_k$. The simulations illustrated in Figures 2-3 use $\lambda = 0.2, \nu = 0.5, \rho = 1$ and different values of μ_a and μ_k.

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