Review of Economic Dynamics **3,** 166–193 (2000)
doi:10.1006/redy.1999.0075, available online at http://www.idealibrary.com on IDEAL®

Gift Exchange and the Business Cycle: The Fair Wage Strikes Back[1]

Fabrice Collard

Cepremap, 142 rue du chevaleret, 75013 Paris, France
E-mail: fabrice.collard@cepremap.cnrs.fr

and

David de la Croix

National Fund for Scientific and IRES, Université catholique de Louvain, Place Montesquieu 3, B-1348 Louvain-la-Neuve, Belgium
E-mail: delacroix@ires.ucl.ac.be

Received June 16, 1997; accepted December 22, 1998

We extend the benchmark real business cycle model amending technology for fair wage considerations. Effort depends on current, alternative, and past wages. Past wages are treated as the worker's past wages (personal norm) or as the past wages of the society (social norm). This last model reproduces the high variability of employment, the low variability of wages, and the low wage–employment correlation without requiring a second source of impulsions. Wages and employment dynamics are adequately captured when norms adjust slowly to the environment. Fair wages are thus useful to solve the business cycle puzzle when we allow for intertemporal wage comparisons. *Journal of Economic Literature* Classification Number: E24

Key Words: efficiency wage, effort, time-nonseparability, RBC, wage sluggishness, business cycle puzzle.

INTRODUCTION

One major challenge of macroeconomics is to propose rigorous and convincing explanations of why real wages may be rigid and why employment fluctuates largely in response to shocks. Indeed, inspection of the

[1] We are grateful to two anonymous referees, H. Dellas, J. Duran, M. Eichenbaum, P. Y. Hénin, P. Malgrange, and F. Portier for helpful comments on a previous version. The financial support of the program PAI P4/01 of the Belgian Federal government is gratefully acknowledged.

1094-2025/00 $35.00

U.S. business cycle characteristics of the labor market aggregates shows that the volatility of labor input is high and greater than the volatility of wages. Moreover, the correlation between wages and output is moderate (see Cooley and Prescott (1995)). The standard real business cycle (RBC) model (see, e.g., King *et al*. (1988)) fails to fit these facts. Solving this ‘‘business cycle puzzle’’ has become one of the most challenging tasks for the RBC research program.[2]

Assuming that productivity and workers’ effort are affected by the wage paid by the firm, efficiency wage theories have been judged to be very promising given the goal of understanding labor market characteristics (see, e.g., Blanchard and Fischer, 1989, p. 463). Danthine and Donaldson (1995) list four kinds of efficiency wages: (a) those that discourage shirking by raising the opportunity cost of being fired (shirking model), (b) those that reduce quits (turnover cost model), (c) those that improve the applicant pool (screening model), and (d) those that improve efforts by improving morale with a fair wage (gift exchange model). These theories were first developed in static models, explaining the existence of involuntary unemployment in terms of the optimal response of firms to workers’ behavior. For instance, in the gift exchange model of Akerlof (1982), the effort of an individual worker depends on a comparison between the current wage and a norm which includes the salaries perceived by other workers, the level of unemployment and unemployment benefits, and the actual wage of the individual in previous periods.[3] The optimal response of the firm to this behavior is to offer a wage above the market-clearing level in return for which workers would provide a higher level of effort. This view of labor relationships is supported by a large number of research studies both in applied economics and experimental psychology.[4]

Several papers pursuing the efficiency wage route embed shirking or gift exchange motives in the framework of stochastic dynamic general equilib-

[2] See for instance the contributions of Christiano and Eichenbaum (1992) and Fève and Langot (1994).

[3] Notice that this last element has been omitted in the various subsequent analyses because the majority of them are performed in static frameworks.

[4] A representative study in this category which precedes the theoretical formulation of the efficiency wage models is the one of Adams and Rosenbaum (1962). The agents in this experiment were male college students who were hired on a part-time basis to conduct interviews at a given salary per hour. After completing an extensive questionnaire, agents in the control group were informed that they were suitably qualified for the job. In the experimental group, agents were told that their questionnaires revealed them to be under qualified, but that they would be hired and paid the preestablished rate nevertheless. This manipulation led agents in the experimental group to feel they were overpaid compared to the agents in the control group. The results revealed that the agents in the experimental group conducted more interviews per hour than those in the control group, thereby lending support to the theory.

rium models.[5] The hopes generated by the efficiency wage theories were then strongly dashed by these studies.

In a gift exchange setup, Danthine and Donaldson (1990) conclude that ‘‘The most striking implication to emerge from these data is the inability of our gift exchange example to account for the business cycle puzzle. This result is important because it demonstrates that in efficiency wage models involuntary unemployment . . . is not synonymous with wage sluggishness. . . . most of the adjustment to productivity shocks is in terms of wages. There is almost no adjustment in terms of quantities.’’ A similar disappointment with regard to efficiency wage theories can be found in models of the shirking category as in Uhlig and Xu (1995) and Gomme (1996). Uhlig and Xu (1995) find that, in order to reproduce an adequate level of employment variability, they need to assume implausibly large movements in the technological shock. The reason is that effort moves countercyclically, because the wage norm depends negatively on unemployment. Gomme (1996) also finds that wages are too volatile and too procyclical compared to the data.

Our approach extends the gift exchange model of Danthine and Donaldson (1990) allowing for the reference wage to include past wages of the individual or of others.[6] Indeed, the conclusion that efficiency wage considerations based on the gift exchange paradigm are not sufficient to resolve the business cycle puzzle (Danthine and Donaldson, 1995) seems too hasty because the aforementioned studies have never used the original idea of Akerlof (1982) that the wage norm depends also on past wages. It is fair to recognize that this time-nonseparability in the disutility of effort cannot have been analyzed in the initial static studies of gift exchange models, but it seems feasible and desirable to use it in the more sophisticated dynamic models of the RBC type. This position is reinforced by the group of empirical studies which stress the importance of intertemporal wage comparisons for effort and job satisfaction.

For instance, examining the benchmarks used in the evaluation of payments, Goodman (1974) found that a large proportion of respondents to his survey used their own payment in the past as a comparison standard. Another interesting study was carried out by Lord and Hohenfeld (1979). They compared the performance of baseball players who were paid less one season than they were the season before. Using their own salaries during the previous year as a basis for comparison, they were expected to

[5] To our knowledge, the two other types of efficiency wage models have not been analyzed within stochastic dynamic general equilibrium models.

[6] Although it would have been possible to incorporate a past wage dependency within the shirking framework, this would have led us to assume either an overlapping generations structure as in Danthine and Donaldson (1995) or the inability of workers to save as in Gomme (1996).

have felt underpaid. As the theory predicts, these players lowered their performance. A more recent microeconometric study of Wadhwani and Wall (1991) uses a panel on U.K. manufacturing enterprises to estimate their production function (including the effort function). They allow the wage norm to depend on past wages and show that there is some evidence in favor of this dependence. Additional inferences on the role of past wages on effort can be drawn by analyzing job satisfaction studies. Using a panel data on British employees, Clark (1996) provides evidence that job satisfaction is strongly positively correlated with the change in the worker's payment between the two waves of the panel.

Very recently the survey undertaken by Bewley (1997) brings interesting insights to model wage behavior. He interviewed business people, labor leaders, and unemployment counselors in the United States to understand why wages almost never declined. The key result is that firms dislike pay cuts because they hurt morale. Good morale promotes high productivity, less turnover, and a good company reputation that helps recruiting. Pay cuts hurt morale because of discomfort from reduced living standards and because of an insult effect—workers associate pay increases with approbation and reward. A key point of the survey is that morale depends on the level of wages, but most importantly on wage changes.

Applying the terminology of Becker (1996) to our problem, the inclusion of past wages in the norm can be achieved in two distinct ways: (a) The personal norm includes the relevant past wages perceived by the individual. (b) The social norm incorporates the influence of past actions by peers and others. This distinction is crucial for the type of dynamics which will emerge from the model. In the personal norm case, the firm recognizes the impact of the current wage on the future effort levels of its workers. In the social norm case, the firm has no control on the ‘‘social capital’’ of its workers since it is mainly determined by the situations of peers and relevant others. In the majority of the empirical studies mentioned, the authors have the social norm case implicitly in mind. However, in a fully specified dynamic model with rational expectations, the alternative of the personal norm case could also be of interest. In that case, the problem of the firm should be analyzed as a truly dynamic problem.

The aim of this paper is thus to evaluate whether incorporating past wage comparisons in gift exchange models can help to solve the business cycle puzzle related to the labor market and hence promote a new direction for research. The evaluation of the performance of the model is carried out using standard real business cycle techniques, including the comparisons between the properties of the data generated by a stylized calibrated model and those from the real world. The moments on which the comparison will bear are essentially the volatility and the correlation of hours and wages with respect to output. We also examine the ability of the model to mimic the dynamic pattern of wages and hours. An important characteristic of this research is that it provides a very simple extension of Danthine and Donaldson (1990) that allows effort to depend on past wages.

Allowing effort to depend on past wages introduces a source of wage sluggishness that the standard gift exchange model cannot account for. Further, we may expect that this assumption helps to reproduce the high variability of employment, the low variability of wages, and the low wage–employment correlation without requiring a second source of impulsions as in standard business cycle models (see, e.g., Christiano and Eichenbaum (1992)).

The structure of the paper is as follows. The model is described in the first section. The second section presents the performance of the model in terms of moment matching and the implications in terms of wage and employment dynamics. Section 3 proposes and evaluates an extension of the model in which norms adjust slowly. The last section concludes.

1. THE MODEL

We broaden the benchmark RBC framework, amending the technology for fair wages considerations, and develop a model on the lines proposed by Danthine and Donaldson (1990). In their gift exchange model, effort is an increasing function of current wage (w_t), and decreases with the current alternative wage (w_t^a) which serves as a benchmark for the workers to evaluate their salary. Going back to the original idea of Akerlof (1982) and relying on the aforementioned empirical studies, we amend this effort function for past wage considerations. Efficiency of labor will be a function of current and past wage. We treat the past wage in two ways. First, it is viewed as the past wage of the society, bearing upon the social capital of workers. We call this case the social norm case. Second, it is the own past wage of the worker, and we call it a personal norm. We first present the behavior of an household concerning its consumption–saving decision before considering the behavior of firms.

1.1. *The Household*

The economy is populated by many identical infinitely lived agents, uniformly distributed on $[0, 1]$. Each household has to define consumption–saving plans such that it maximizes its discounted expected utility, subject to its intertemporal budget constraint

$$\max_{c_{j,t}e_{j,t},\,k_{j,t+1}} E_0 \sum_{t=0}^{\infty} \beta^t \Bigg[\log c_{j,t} - d_{j,t} \times \left(e_{j,t} - \phi - \gamma \log\left(\frac{w_t}{w_t^a} \right) - \psi \log\left(\frac{w_t}{w_t^s} \right) \right)^2 \Bigg]$$

$$\text{s.t.} \quad \begin{cases} c_{j,t} + k_{j,t+1} \leq (1 + r_t - \delta) k_{j,t} + w_t(1 - u_t) \\ c_{j,t} \geq 0,\ e_{j,t} \geq 0,\ k_{j,t} \geq 0. \end{cases}$$

The index j identifies a variable as pertaining to individual j. Unsubscripted variables represent economy-wide levels. The variables c and e denote consumption and effort while ϕ, γ, and ψ are positive parameters. d is a dummy variable which takes the value 1 when the worker is employed and zero otherwise. The household can either consume or save, through investment. k denotes physical capital, while $0 < \delta < 1$ is the constant depreciation rate. $0 < \beta < 1$ is the psychological discount factor. The household offers its work in the labor market at the real wage w_t but has to pay $u_t w_t$ for unemployment insurance.[7] u_t denotes the unemployment rate. It must be clear that since the representative household is price taker, r_t and w_t are taken as given.

Our model differs from the standard RBC model at several points.[8] One of the most striking points is that labor does not enter in the utility function. This implies that the main mechanism at work in the model will not be the standard intertemporal labor substitution effect usually driving RBC models. In fact, in this class of models the household supplies inelastically one unit of time, and only a fraction of time will be employed by the firm. We call l_t this fraction of time. Unemployment is thus expressed in terms of hours.

Effort enters the utility function only when the household works, namely, when the dummy variable $d_{j,t}$ equals one. One important point is that the utility drawn from the job itself (job satisfaction) is separable from the utility drawn from consumption so that effort is independent of wealth. We thus first solve for effort and then derive the optimal consumption−savings plan of the household. Notice that the so-called effort function is the consequence of maximizing the utility with respect to $e_{j,t}$. In this model,

[7] The explicit treatment of the unemployment insurance is provided in Appendix B.

[8] For additional discussion, see the surveys of Danthine and Donaldson (1993) and Langot (1993).

the determination of effort relies on two effects. On the one hand, households will raise their effort with increases in the ratio of their current wage to an outside alternative wage, w_t^a. On the other hand, effort increases when the current wage is higher than a norm that includes past wages

$$w_t^s = w_{t-1}.$$

We extend this specification in Section 3 to allow for habit persistence. The parameters γ and ψ determine the sensitivity of effort to wage comparisons with the alternative wage and with past wages, respectively. Finally ϕ is the amount of effort an individual is willing to provide if he or she does not receive a raise in his wage this period and is not better off than the average person.

The rationality of using the above functional form for the utility function can be found in Bewley (1997) who concludes that the theory of Akerlof (1982) is correct in emphasizing morale, and errs only if importance is attached to wage levels rather than to changes in them.[9] Further, this specification appears parsimonious and nests the utility function of Danthine and Donaldson (1990) (indeed we retrieve their case when $\psi = 0$). Moreover, since the model will be solved using log-linearization there is no potential major gain in using more complicated modelling, such as threshold functions.

Another important feature of this model is that the real wage is not Walrasian, rather it is determined by the firm depending on the level of effort the household supplies. Thus, there will be periods in which households will be unemployed. This is captured by the dummy variable $d_{j,t}$. Since all agents are assumed to be identical ex ante the unemployed will be drawn randomly, leading to an unemployment rate

$$u_t = 1 - l_t.$$

If there were no insurance, unemployment would introduce an ex post heterogeneity that would affect the optimal consumption−saving plans in the next periods. Stated in another way, unemployed households have a lower income than employed ones, so that they reduce their level of saving. The computation of the entire sequence of decisions for an individual would then imply that we have to know its entire history in the labor

[9] A possible extension of our effort function could be to distinguish between real and nominal wage comparisons. Indeed, Bewley (1997) finds that "the standard of living effect of pay cuts gives rise to real rigidity, for it is real wages that affect well-being. The insult effect might be able to cause purely nominal rigidity, for workers could feel insulted by a nominal pay cut, even if consumer prices were falling."

market. To avoid this kind of complexity, we assume, as in Danthine and Donaldson (1990), that unemployment insurance contracts are offered without transaction costs. Since households are risk averse, they will choose to be fully insured, so that they will preserve their wealth whether they are employed or not.

The set of first-order necessary conditions with regard to $c_{j,t}$, $e_{j,t}$ and $k_{j,t+1}$ is

$$\frac{1}{c_{j,t}} = x_{j,t} \tag{1}$$

$$e_{j,t} = \phi + \gamma \log\left(\frac{w_t}{w_t^a}\right) + \psi \log\left(\frac{w_t}{w_{t-1}}\right) \tag{2}$$

$$1 = \beta E_t\left[\frac{x_{j,t+1}}{x_{j,t}}(1 + r_{t+1} - \delta)\right] \tag{3}$$

where $x_{j,t}$ is the multiplier associated to the intertemporal budget constraint. We also impose the following transversality condition

$$\lim_{\ell \to \infty} E_t\left[\beta^{t+\ell} x_{j,t+\ell} k_{j,t+1+\ell}\right] = 0$$

Equation (1) gives the Frischian demand for consumption. Equation (2) defines the effort function that firms will take into account in their plans. The relation (3) describes the standard consumption−saving arbitrage. Finally the transversality condition excludes any Ponzi games.

1.2. *The Firm*

There are a large number of identical firms on the continuum [0; 1]. We thus assume that there exists a representative firm that produces a homogeneous good that can either be consumed or accumulated. Its technology is described by the production function

$$y_t = a_t k_t^{\alpha} (l_t e_t)^{1-\alpha}$$

where k_t denotes the firm's capital stock, l_t the level of employment, and e_t the effort level. The technological shock a_t is assumed to be a stationary exogenous $AR(1)$ process

$$\log(a_t) = \rho \log(a_{t-1}) + \varepsilon_t \tag{4}$$

with $|\rho| < 1$. ε_t is a Gaussian white noise with $E(\varepsilon_t) = 0$ and $E(\varepsilon_t^2) = \sigma^2$.

In Becker's (1996) terminology, the inclusion of past wages in the wage norm can be achieved either as a personal norm, hence including the past wage perceived by the individual, or as a social norm incorporating the influence of past actions by peers and others. The personal norm case differs from the social one in that past wages are not treated as an externality. The firm adopts a dynamic wage setting behavior: it recognizes that increasing wages today will affect the level of effort of its workers tomorrow. We then have to consider the two different cases in turn depending on the status of the past wages in the effort function.[10] The social norm case is presented in the main text whereas the reader is referred to Appendix A for a full statement of the personal norm case.

In the social norm case the firm has no control over the "social capital" of its workers. This implies that future wage decisions are taken as exogenous by employers. The wage setting behavior of the firm—and thus the whole behavior of the firm—is then static. The firm seeks to maximize its profit

$$\max_{k_t, w_t, l_t} y_t - w_t l_t - r_t k_t \qquad \text{s.t. } e_t = \phi + \gamma \log\left(\frac{w_t}{w_t^a}\right) + \psi \log\left(\frac{w_t}{w_t^s}\right).$$

The first-order necessary conditions with respect to l_t, w_t and k_t are then given by

$$(1-\alpha)\frac{y_t}{l_t} = w_t \tag{5}$$

$$(1-\alpha)\frac{y_t}{e_t}\left(\frac{\gamma + \psi}{w_t}\right) = l_t \tag{6}$$

$$\alpha\frac{y_t}{k_t} = r_t. \tag{7}$$

Equation (5) determines the optimal employment decision of the firm. Since it maximizes its profit, it hires workers until the marginal product of labor equals the real wage. This leads to the traditional labor demand, but for the fact that the real wage is not settled as to clear markets. Equation (6) corresponds to the wage setting behavior of the firm. It states that the firm will increase wages until the marginal cost implied equals the marginal

[10] Of course, one might consider a more general framework which is a combination of the two cases, in which part of the wage norm is social and part is personal.

return in terms of effort. Combining (5) and (6) we find

$$e_t = \gamma + \psi \tag{8}$$

which corresponds to the so-called Solow's (1979) condition

$$\frac{\partial e(.)}{\partial w_t} \frac{w_t}{e(.)} = 1.$$

According to (8), the firm chooses the real wage in such a way that effort is constant over the business cycle.

Finally, Eq. (7) furnishes the physical capital demand of the firm.

1.3. *The Equilibrium*

Since all agents are homogeneous, the general equilibrium can be described in terms of the first-order conditions of the representative individual at the aggregate level. At equilibrium we have the market clearing conditions and definitions,

$$k_t = \int_0^1 k_{j,t}\,\mathrm{d}j \qquad \text{and} \qquad c_t = \int_0^1 c_{j,t}\,\mathrm{d}j.$$

We further have to specify the form of the alternative wage. We will consider that it is given by the arithmetic[11] average of current wage and unemployment compensation, set to zero in the model

$$w_t^a = l_t w_t.$$

Gathering together the equations which are common to the two models (see Appendix A for the personal norm case), we get a set of equations, denoted by $\mathscr{E}$,

$$e_t = \phi + \gamma \log\left(\frac{w_t}{w_t^a}\right) + \psi \log\left(\frac{w_t}{w_{t-1}}\right) \tag{9}$$

$$w_t = (1-\alpha)\frac{y_t}{l_t} \tag{10}$$

[11] This is a difference with Danthine and Donaldson (1990) since they use a geometric average with a nonzero unemployment benefit. Our assumption, being simpler, implies that hours would not fluctuate at all if $\psi = 0$.

$$1 = \beta \mathrm{E}_t \left[\frac{c_t}{c_{t+1}} \left(\alpha \frac{y_{t+1}}{k_{t+1}} + 1 - \delta \right) \right] \tag{11}$$

$$y_t = a_t k_t^{\alpha} (e_t l_t)^{1-\alpha} \tag{12}$$

$$k_{t+1} = y_t - c_t + (1 - \delta) k_t \tag{13}$$

$$w_t^a = l_t w_t \tag{14}$$

in which (13) is the goods market clearing condition.

DEFINITION 1. The decentralized equilibrium of the economy in the social norm case is a set of policy rules for $\{c_t, y_t, e_t, l_t, k_{t+1}, w_t;\ t \geq 0\}$ such that $\mathscr{E}$ holds and

$$e_t = \gamma + \psi. \tag{15}$$

DEFINITION 2. The decentralized equilibrium of the economy in the personal norm case (see Appendix A) is a set of policy rules for $\{c_t, y_t, e_t, l_t, k_{t+1}, w_t, z_t;\ t \geq 0\}$ such that $\mathscr{E}$ holds and

$$s_t w_{t-1} = -(1 - \alpha) \frac{y_t}{e_t} \frac{\psi}{z_{t-1}} \tag{16}$$

$$s_t = \gamma \frac{l_t}{e_t} - l_t + \beta E_t \left[\frac{c_t}{c_{t+1}} s_{t+1} z_t \right] \tag{17}$$

$$w_t = z_{t-1} w_{t-1}. \tag{18}$$

2. THE MODEL AND THE LABOR MARKET PUZZLE

In order to evaluate the interest of our two models with respect to the labor market stylized facts, we adopt the standard RBC methodology. The preceding systems are log-linearized around the deterministic steady state. The system of linear difference equations is then solved using the method proposed by Farmer (1993).

2.1. *Calibration*

The structural parameters are taken from Danthine and Donaldson (1990). This gives $\alpha = 0.36$, $\beta = 0.99$, $\delta = 0.025$, $\rho = 0.95$, $\sigma = 0.009$, and $\gamma = 0.9$. Considering the parameters of the effort function, the constant term ϕ is always set so as to obtain an unemployment rate at steady state

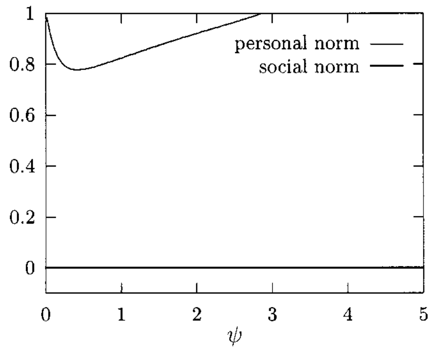

FIG. 1. Correlation between output and effort.

of 10%. This implies approximately $\phi = 0.8$ in the personal norm case and $\phi = 0.8 + \psi$ in the social norm case.

Since we do not have any useful information to determine a reasonable value for the sensitivity of effort to past wages, ψ, we first compute various labor market moments for different values of ψ. The moments are computed using the frequency-domain technique advocated by Uhlig (1995). The theoretical moments are obtained after a prefiltering by Hodrick and Prescott's (1980) method with $\lambda = 1600$. In the personal norm case, the parameter ψ is allowed to vary between 0 and 2.86. Indeed, if ψ is above 2.86, the steady state loses its stability in the saddle-point sense.[12] In the social norm case, ψ is allowed to vary between 0 and 5. Notice that when $\psi = 0$, the two models are actually identical. They are also identical to the model of Danthine and Donaldson (1990) up to the definition of the alternative wage.

Figure 1 compares the correlation between effort and output for the two models. Considering first the social norm case, since the Solow condition is verified, the real wage will adjust so that effort is constant over the business cycle. This implies that, in fact of a positive productivity shock, wages have to increase in order to compensate for the potential drop in effort linked to the reduction in unemployment. In the personal norm case, Fig. 1 shows that effort is procyclical. In that case, in the face of a positive productivity shock, it is optimal for firms to increase wages in order to increase effort. In fact, the rise in wages does more than compensate for the effect of unemployment on effort. This contrasts

[12] When $\psi = 2.86$ the steady state is nonhyperbolic and a flip bifurcation occurs.

sharply with the conclusion of Uhlig and Xu (1995) that effort movements predicted by efficiency wage theories are countercyclical. This is true only when the effort function is static.

The procyclicity of effort in the personal norm case may explain the procyclical measurement error of the Solow residual documented by Hall (1990) and Rotemberg and Summers (1990). A similar explanation might be obtained in a model with labor hoarding, e.g., in Burnside *et al.* (1993). In the labor hoarding case, effort is an adjustment variable that lets firms vary their labor input when the level of employment is chosen before the occurrence of shocks. Thus, one period after the shock, effort returns to its steady state level. In our case, effort could optimally remain out of the steady state for more than one period.

Figure 2 presents the labor market moments for both the personal and social norm cases. Notice first that the volatility exhibited by the personal norm case is higher than the one generated by the social norm case. This can be understood in view of the previous discussion. In the personal norm case, effort is procyclical which requires larger movements in the real wage. Thus, the real wage displays a higher volatility. Since the real wage is more volatile, so is labor.

Notice that we have calibrated the standard deviation of the productivity shock using the usual value to facilitate the comparison with other RBC models. The above results suggest, however, that the personal norm model would be consistent with a lower standard deviation of the productivity shock. This contrasts again with the conclusion of Uhlig and Xu (1995) that efficiency wage models require implausibly large movements in the technology parameters.

Further, Fig. 2 shows that as ψ increases the relative volatility of hours increases whilst the relative volatility of wages decreases. Moreover, the correlation between hours and output is an increasing function of ψ, whereas the correlation between wages and output decreases as ψ rises.

This can be easily understood in the social norm case if we rewrite the effort function in equilibrium as

$$\log\left(\frac{y_t}{l_t}\right) = 1 - \frac{\phi}{\gamma + \psi} + \frac{\gamma}{\gamma + \psi}\log(y_t) + \left(1 - \frac{\gamma}{\gamma + \psi}\right)\log\left(\frac{y_{t-1}}{l_{t-1}}\right). \tag{19}$$

As long as $\psi = 0$, the volatility of productivity is given by that of output. But as soon as ψ increases, the presence of past wages leads to a smoothing behavior of wage dynamics. This implies that the relative variability of productivity decreases with ψ. This can be interpreted as a

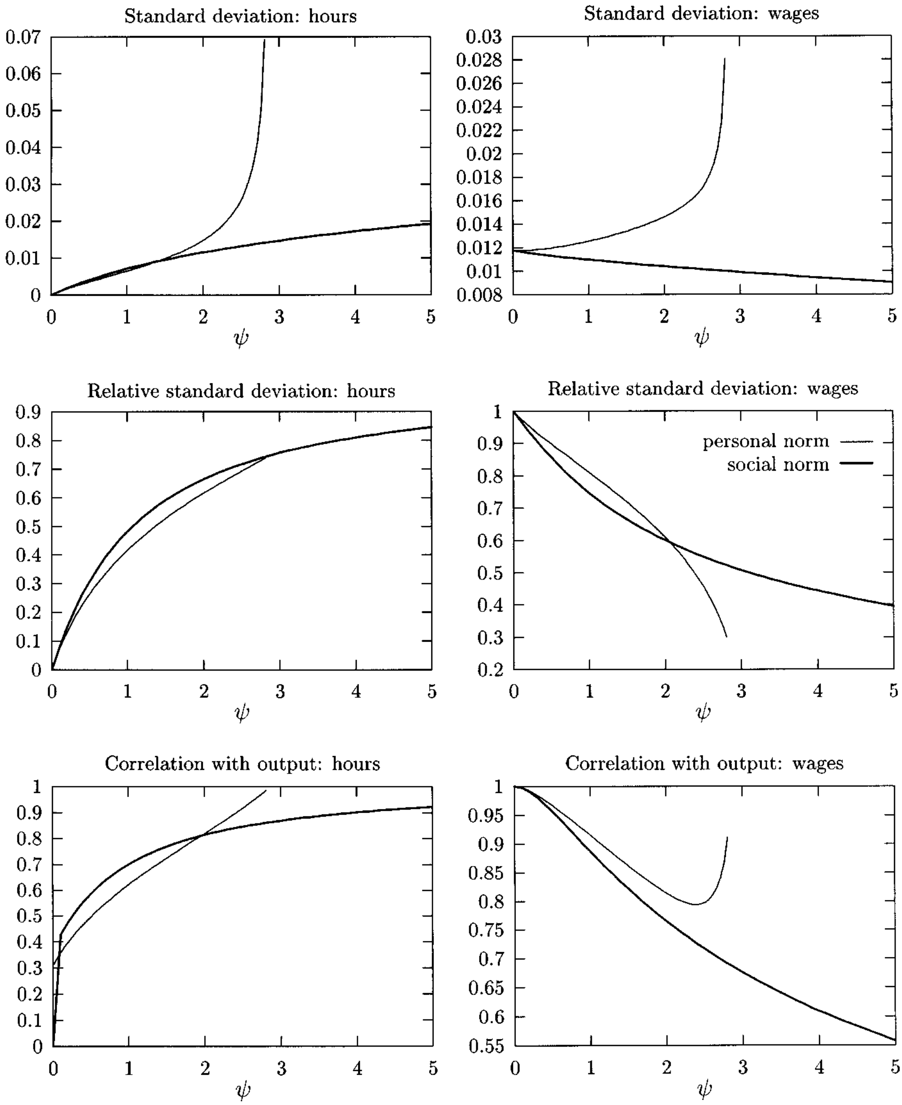

FIG. 2. Labor market moments.

dissociation between productivity and output as ψ increases because the weight of past wages—i.e., productivity—increases with ψ. This dissociation can also explain the behavior of the correlation with output since, as soon as $\psi \neq 0$, output and productivity are dissociated, so that their correlation is lowered.

The same reasoning can be applied to the labor demand, which can be rewritten in the social norm case as

$$\log(l_t) = \frac{\phi}{\gamma + \psi} - 1 + \frac{\psi}{\gamma + \psi}\left[\log(y_t) - \log(y_{t-1}) + \log(l_{t-1})\right]. \quad (20)$$

This implies that when ψ increases, the volatility of labor increases relative to that of output. The same happens as we consider the correlation between hours and output. This can be explained by the same dissociation phenomenon implied by the increase in ψ. As ψ raises, the weight of past wages increases so that hours determination does not rely only on current wages, which are, in the standard RBC model, highly correlated to output, but also on past wages. As a consequence, the correlation between hours and output is lowered.

As it can be seen from Fig. 2, this does not remain true in the personal norm case, because effort is procyclical. This means that as soon as firms take into account past wages, they behave in such a way that changes in effort will break the dissociation.

In order to go beyond these qualitative considerations we choose a value for ψ in the two cases. We have chosen to calibrate ψ so as to reproduce exactly the correlation between hours and output. The evaluation of the models will thus be based on the three remaining moments of interest which are the relative standard deviations of hours and wages, and the correlation between wages and output. The values of ψ which are compatible with an output–hours correlation of 0.86 are, respectively, 2.21 for the personal norm case and 2.8 for the social norm case. Interpreting an iso-effort curve as a wage curve linking wages to unemployment at constant effort level, we can relate the slope of this curve to estimates of the unemployment elasticity of real wages growth. In our setting this elasticity is given by

$$\frac{-\gamma}{\psi}\left(\frac{u_t}{1 - u_t}\right)$$

which is close to $-\frac{1}{10\psi}$ for our calibration. This implies that ψ should be greater than 1 to be in accordance with the evidence gathered in Blanchflower and Oswald (1994).

2.2. *The Labor Market Puzzle*

In the personal norm case, a first glance at the impulse response functions presented in Fig. 3 indicates that fair wage considerations induce a propagation mechanism that strongly magnifies the effect of productivity

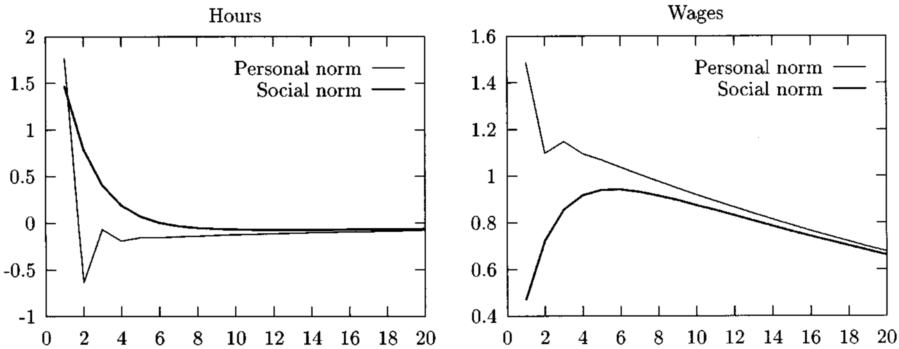

FIG. 3. Impulse responses to a 1% positive productivity shock.

shocks on activity. Wages respond instantaneously in a stronger way than in the social norm case, as optimal effort is strongly procyclical. Moreover, impulse response functions display oscillations. In the social norm case, wages respond slowly to the productivity shock and reach a peak after 6 quarters. Indeed, the presence of a social norm acts as a smoothing mechanism so that wages adjust slowly to the new situation. This slow movement in wages implies a large rise in hours during the first 3 quarters. These characteristics make the model useful to reproduce the stylized fact of large movements in hours and slow movements in wages.

We present in Table I the main stylized facts of the U.S. economy as reported in Cooley and Prescott (1995)[13] (and Gomes *et al.* (1997) for unemployment data) together with the properties of various RBC models.

[13] The data on wages come from the average real hourly earnings from the Establishment Survey.

TABLE I
Basic Statistics

	U.S. data		Hansen (1985)		Danthine–Donaldson (1990)		Danthine–Donaldson (1995)		Personal norm ($\psi = 2.21$)		Social norm ($\psi = 2.8$)	
	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)
c	0.74	0.83	0.29	0.87	0.58	0.80	0.19	0.69	0.18	0.60	0.26	0.79
i	4.79	0.91	3.24	0.99	6.46	0.86	3.45	0.99	3.61	0.99	3.33	0.99
l	0.92	0.86	0.77	0.98	0.16	1.00	0.72	0.98	0.65	0.86	0.74	0.86
w	0.44	0.68	0.28	0.87	0.83	1.00	0.35	0.91	0.55	0.80	0.52	0.69
u	7.68	−0.87	—	—	—	—	—	—	6.02	−0.86	6.66	−0.86

Note. (a): standard deviations relative to output. (b): contemporaneous correlations with output.

We take Hansen's (1985) model with indivisible labor as benchmark. The advantage of this model compared to earlier work is to generate more volatility in hours. We next present the results of two models due to Danthine and Donaldson. The first one, an efficiency wage model of the gift exchange type, is similar to our model when $\psi = 0$, up to the definition of the alternative wage. As was stressed in the Introduction, it performs poorly with respect to the labor market stylized facts, showing that efficiency wages are not synonymous with wage sluggishness. The second model of Danthine and Donaldson (1995) is one of the most appealing non-Walrasian models so far. It is based on labor contracts with two types of labor (young and old) and optimal minimum wage and unemployment benefits. In their survey, Danthine and Donaldson (1993) argue that this model can be viewed as providing a resolution to the wage-employment variability puzzle. We argue however that our social norm model performs even better, in particular concerning the correlation between wages and output.

Let us now discuss the main contribution of our models compared to the previous studies.[14] First, like all the models presented in Table I ours mimics the ranking of relative volatilities of consumption, investment, hours, and wages (except Danthine and Donaldson (1990)). All variables are procyclical.

Second, the social norm case displays a relative volatility of hours as high as Hansen's (1985) model without the need for the indivisibility assumption (implying an infinitely elastic labor supply). This is mainly due to the social norm assumption, as explained previously in the impulse response functions analysis. Moreover, the relative volatility of wages is well reproduced by both models. It is worth noting that if Hansen's model improves the reproduction of the relative volatility of hours, it is at the price of a deterioration in the reproduction of that of wages. Here, the social norm assumption allows for large movements in hours without lowering too much the variability of wages.

Third, when we consider the correlation between wages and output, the social norm model is able to reproduce almost exactly this correlation, which is in contrast with all other models. This is due to the dissociation that is introduced by the social norm between the evolution of wages and output. In Hansen's model, as well as in all the other reference models in Table I, wages are determined by the marginal productivity of labor and are therefore highly correlated with output. In the two models we consider, this is no longer true, since current wages also rely on past wages. But this

[14] Notice that since ψ is calibrated in order to match exactly the correlation between hours and output, consequently, our comments will not rely on this moment.

TABLE II
corr(l_t, w_t)

U.S. data[a]	Hansen (1985)[b]	C.−E. (1992)	Personal norm	Social norm
0.19	0.74	0.57	0.38	0.23

Note. C.−E.: Christiano−Eichenbaum.
[a]Taken from Fairise (1995).
[b]Taken from Hairault (1995).

effect is lowered in the personal norm case, as firms try to counter this dissociation using their intertemporal behavior for effort.

Finally, concerning unemployment, our models reproduce very well the correlation with output. Concerning standard deviations, as previously, the social norm case performs better, although unemployment volatility is a bit underestimated. However, it appears that our models outperform search models like the one of Gomes *et al.* (1997) with respect to these criteria.[15]

Let us now consider the implications of the models in terms of the instantaneous correlation between wages and employment. Previous research has shown that existing RBC models systematically overestimate this correlation: around 0.2 in U.S. data. The only way to lower this correlation was to add a second source of stochastic impulsions that affect labor supply. Indeed Christiano and Eichenbaum (1992) show that introducing fiscal shocks making labor supply more volatile can be a way to account for a lower correlation between wages and employment.

Table II shows that the social norm case allows us to mimic closely the slightly positive actual correlation between wages and employment, without requiring the introduction of additional shocks. In this model, the effect of a technological shock on wages is initially lower than in the perfect competition case, thus lowering the positive link between wages and employment. Once again, the personal norm case does worse than the social norm one, but still does better than Hansen (1985) and Christiano and Eichenbaum (1992).

Going back to the comparison between our models and the RBC models with labor hoarding à la Burnside *et al.* (1993), we compute the ratio Λ of the standard deviation of the log of effort to the standard deviation of the log of total effective labor input (el). We obtain a value of $\Lambda = 0.55$ for the personal norm case (and obviously $\Lambda = 0$ in the social norm case) that can be compared to a value between 0.09 and 0.16 in the model of Burnside *et al.* (1993). Hence, effort is more volatile in our model than in a model with labor hoarding.

[15] Our models, unlike the search approach, have nothing to say about unemployment duration and job inflows and outflows.

2.3. *The Dynamics of Wages and Employment*

Let us now turn our attention to the dynamics of wages and employment along the cycle. It is indeed interesting to evaluate the performances of our models in terms of cross-correlograms to see whether the replacement of the intertemporal substitution mechanism (through labor supply) by fair wage considerations allows us to mimic the dynamic pattern of aggregates in the labor market.

Figure 4 presents the cross-correlogram between output and hours on the one hand (left panel) and output and wages on the other hand (right panel). The theoretical moments from our models are compared with their empirical counterpart taken from Cooley and Prescott (1995). Concerning the cross-correlogram between output and hours, our two models show very bad performance. Although the models have been calibrated to match exactly the instantaneous correlation, it is clear that all other correlations are underestimated at all leads and lags. Concerning the cross-correlogram between output and wages, it appears that the personal norm case underestimates the correlation between output and wages at all leads and lags. The social norm case underestimates leading correlations and overestimates lagging correlations although the overall pattern seems to be well reproduced. It is worth noting that the theoretical model predicts that wages are a leading indicator of the cycle which slightly contradicts the data.

To further enlarge the set of facts against which the model can be confronted, we assess the ability of the model to mimic wage persistence.

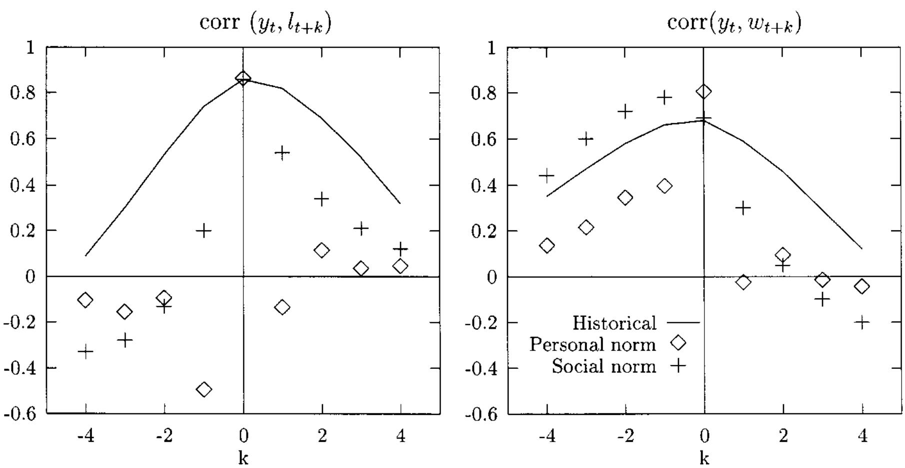

FIG. 4. Cross-correlograms.

We first estimate an ARMA process on HP filtered wages (from Cooley and Prescott (1995)). Data suggest that wages are best represented by an AR(3) process. We then simulate each model 1000 times to obtain artificial series for wages. These series are then filtered and used to estimate the AR(3). Table III reports the sample average of these estimates. Both models perform poorly: the personal norm model underestimates the first-order partial autocorrelation of wages; on the contrary, the social norm model overestimates this moment. Thus persistence implications appear disappointing.

3. HABIT PERSISTENCE

Part of these disappointing results is due to the absence of intertemporal substitution in the labor supply. It is in fact not very surprising that our fair wage models do perform so badly in terms of cross-correlograms because the dynamics implied by our effort function is limited to a one-lag habit formation structure. We now analyze to what extent this problem can be solved assuming more habit persistence in the formation of norms. Taking our inspiration from the literature on consumers' habit formation, we define a habit stock (see Ryder and Heal (1973) and de la Croix (1998)),

$$w_t^s = \mu \sum_{i=1}^{\infty} (1-\mu)^{i-1} w_{t-i}. \tag{21}$$

w_t^s is alternatively the stock of social capital or the stock of personal capital depending on the whole history of wages. μ is related to the mental depreciation rate of the household. When $\mu = 1$ we retrieve our previous specification.

TABLE III
AR(3) Processes for Wages

	θ_1	θ_2	θ_3	R^2
Data	0.9639	−0.0105	−0.1638	0.73
	(0.0967)[a]	(0.1363)	(0.0973)	
Personal norm	0.4810	0.1427[b]	−0.0823[b]	0.32
Social norm	1.2939	−0.4122	−0.0755[b]	0.83

[a] Standard errors in parentheses.
[b] Not significantly different (at 5%) from data estimates.

Household's preferences are now described by

$$\sum_{t=0}^{\infty} \beta^t \left[\log c_{j,t} - d_{j,t} \left(e_{j,t} - \phi - \gamma \log\left(\frac{w_t}{w_t^a} \right) - \psi \log\left(\frac{w_t}{w_t^s} \right) \right)^2 \right].$$

The definition of equilibrium in the social norm case has now to take into account the modified effort function and the new accumulation rule of social capital. The definition of equilibrium in the personal norm case is modified more importantly; Eqs. (16) and (17) are replaced by

$$l_t = \mu s_t + (1-\alpha) \frac{y_t}{e_t} \frac{\gamma + \psi}{w_t} \tag{22}$$

$$s_t = \beta E_t \left[\frac{c_t}{c_{t+1}} \left((1-\mu) s_{t+1} - \psi \frac{1-\alpha}{w_{t+1}^s} \frac{y_{t+1}}{e_{t+1}} \right) \right] \tag{23}$$

in which s_t is now the Lagrangean multiplier associated with the accumulation rule of personal capital (21).

This "enlarged" model has only one additional free parameter, namely μ. We therefore have to calibrate two parameters, ψ and μ, for which we do not have a priori information. We choose to exploit the information contained in the lead and lag structures of the correlograms without imposing to match two particular moments. This corresponds to overidentifying the two parameters.[16] Accordingly we minimize the distance between a series of moments and their empirical counterpart. The retained moments are the relative standard deviations of wages and employment to output and the correlations of wages and employment with output from lag 4 to lead 4. The parameter ϕ is still used to obtain a steady state unemployment rate of 10%. This implies 18 degrees of overidentification. This procedure gives the following result: social case: $\phi = 3.27$, $\psi = 2.46$, $\mu = 0.10$; personal case: $\phi = 1.35$, $\psi = 6.46$, $\mu = 0.11$. Here again the value of ψ is consistent with low unemployment elasticities of the real wage along the wage curve. It is worth noting that the value of μ is nearly the same in the two cases, stemming from a relatively slow adjustment of norms to current wages. As shown in Table V, this speed of adjustment generates a persistence of real wages which is empirically plausible.

Table IV reports the basic properties of our two enlarged models and Fig. 5 displays the two cross-correlograms. We first observe that the reproduction of relative volatilities is still accurate so that the introduction

[16] This can be seen as a simulated method of moments in which we do not make any statistical inference.

TABLE IV
Basic Statistics: Enlarged Model

	U.S. data		Personal norm		Social norm	
	(a)	(b)	(a)	(b)	(a)	(b)
c	0.74	0.83	0.28	0.88	0.32	0.91
i	4.79	0.91	3.21	0.99	3.09	0.99
l	0.92	0.86	0.79	0.99	0.74	0.99
w	0.44	0.68	0.22	0.96	0.27	0.96
u	7.68	−0.87	7.11	−0.99	6.65	−0.99

Note. (a): standard deviations relative to output. (b): contemporaneous correlations with output.

of a slow adjustment of norms does not deteriorate the ability of the model to generate volatile hours and sluggish wages. On the other hand, the improvement in the cross-correlograms is substantial. The time pattern of the correlations is adequately reproduced at all leads and lags. The price to pay for these improvements is a too high contemporaneous correlation of both wages and employment with output. Notice also that the difference between the social norm model and the personal norm model is substantially reduced so that we may no longer conclude that the social norm case clearly dominates.[17]

[17] Moreover, the inspection of the impulse−response functions (not reported here) shows that the propagation mechanism of the personal norm case still magnifies the effect of productivity shocks on activity but no longer implies oscillating impulse response functions.

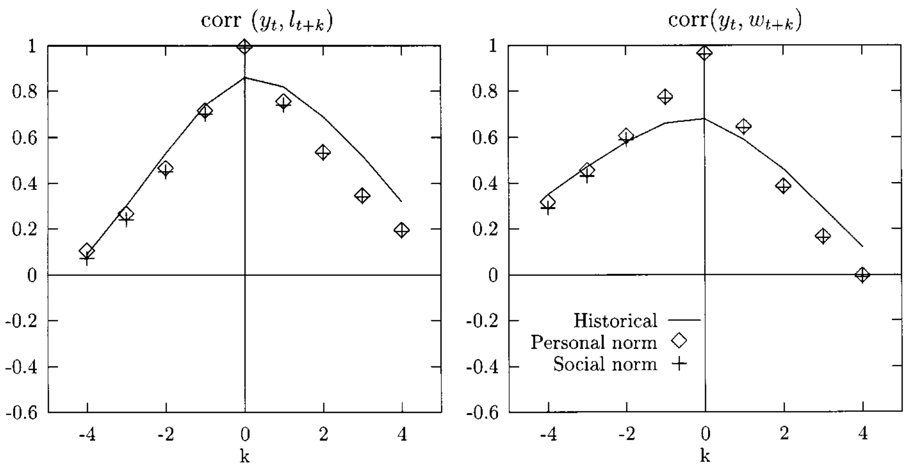

FIG. 5. Cross-correlograms: enlarged model.

TABLE V
AR(3) Processes for Wages—Enlarged Models

	θ_1	θ_2	θ_3	R^2
Data	0.9639	−0.0105	−0.1638	0.73
	(0.0967)[a]	(0.1363)	(0.0973)	
Personal norm	0.7638	−0.0351[b]	−0.0764[b]	0.51
Social norm	0.7879[b]	−0.0316[b]	−0.0781[b]	0.55

[a] Standard errors in parentheses.
[b] Not significantly different (at 5%) from data estimates.

The persistence properties of the model are reported in Table V. It appears that, contrary to the previous case, both models are able to display a more adequate degree of persistence. Nevertheless, the social norm case seems to outperform the personal norm case, in that each parameter of the AR process is not significantly different from its empirical counterpart. Thus, introducing habit persistence smooths the wage norm profile and accounts for internal wage dynamics.

Finally, note that habit persistence reduces significantly the ratio Λ of the standard deviation of the log of effort to the standard deviation of the log of total effective labor input (el). We now obtain a value of $\Lambda = 0.38$ for the personal norm case showing that the volatility of labor input is no longer essentially due to the one of effort.

4. CONCLUSION

We have extended the benchmark RBC model, amending its technology for fair wage considerations. In this model, effort depends on two effects. On the one hand, households will raise their effort with increases in the ratio of current wage to an alternative wage which represents alternative opportunities in the labor market. On the other hand, effort increases with the ratio of current wage to past wage. The past wage is treated either as the worker's past wage (personal norm case) or as the past wage of society (social norm case).

In both models, the high variability of employment and the low variability of wages are reproduced without requiring additional features such as nominal rigidities, tastes shocks, or indivisible labor. The social norm model is able to reproduce almost exactly the correlation between wages and output, which is in contrast with all other existing models. It also allows us to mimic closely the slightly positive actual correlation between real wages and employment. In the personal norm case, fair wage considerations induce a propagation mechanism that magnifies the effect of productivity shocks on activity and implies a procyclical effort.

A simple extension of the model allowing for a slow adjustment of norms to current situations improves substantially the reproduction of the cross-correlations between wages, employment, and output at different leads and lags and the pattern of wage persistence.

Contrary to the pessimistic conclusion of Danthine and Donaldson (1990) and Uhlig and Xu (1995), our results show that fair wage considerations are useful to solve the business cycle puzzle when we allow for intertemporal wage comparisons.

APPENDIX A: THE PERSONAL NORM CASE

The personal norm case differs from the social norm case in that past wages are not treated as an externality. The firm now adopts a dynamic wage setting behavior: it recognizes that increasing wages today will affect the level of effort of its workers tomorrow. The program of the firm is then transformed. It maximizes the sum of its expected discounted profit flows subject to the evolution of wages

$$\max_{w_t, l_t, k_t} E_0 \sum_{t=0}^{\infty} p_t [y_t - w_t l_t - r_t k_t]$$

$$\text{s.t.} \quad w_t = z_{t-1} w_{t-1}$$

$$e_t = \phi + \gamma \log\left(\frac{w_t}{w_t^a}\right) + \psi \log\left(\frac{w_t}{w_{t-1}}\right),$$

where z_{t-1} denotes the growth factor of the real wage. It is worth noting that following Rotemberg and Woodford (1992), the firm discount factor is given by the stochastic process $\{p_t\}_{t=-\infty}^{\infty}$, which represents a stochastic pricing kernel for contingent claims.[18] Thus a security whose payout in period $t+1$ is the random variable b_{t+1} has a present value of $E_t[p_{t+1} b_{t+1}]/p_t$ in units of the period t good.

By denoting s_t the Lagrange multiplier attached to the law of motion of wages, the first-order conditions are then given by Eqs. (5) and (7) as well

[18] This process is normalized such that $p_0 = 1$.

as by

$$(1-\alpha)\frac{y_t}{e_t}\frac{\psi}{z_{t-1}} + s_t w_{t-1} = 0 \tag{24}$$

$$s_t = (1-\alpha)\frac{y_t}{e_t}\frac{\gamma}{w_t} - l_t + E_t\left[\frac{p_{t+1}}{p_t}s_{t+1}z_t\right] \tag{25}$$

and the additional transversality condition $\lim_{\ell\to\infty}E_t[\frac{p_{t+1+\ell}}{p_{t+\ell}}s_{t+\ell}w_{t+\ell}] = 0$.

The way in which capital decisions are taken is left unaffected by the change in the wage setting behavior. The employment choice still corresponds to the previous rule (social norm), but the policy rule for the real wage is different.

Equation (24) together with (25) allows understanding of the wage setting policy of the firm

$$E_t\left[\frac{p_{t+1}}{p_t}(1-\alpha)\psi\frac{y_{t+1}}{e_{t+1}}\right] = (1-\alpha)(\psi+\gamma)\frac{y_t}{e_t} - w_t l_t. \tag{26}$$

First of all, it appears that the traditional Solow condition does not hold anymore in this setting. Condition (26) can then be interpreted as follows: on the one hand, increasing the real wage in period t implies a rise in productivity net of a higher labor cost (right-hand side). On the other hand, a higher wage in period t leads to a lower effort in period $t+1$, inducing a loss in productivity (left-hand side).

Households and firms have access to a complete set of frictionless security markets. At equilibrium, standard nonarbitrage theory (see, e.g., Lucas (1978)) implies that p_t will be set such that the discounted marginal rate of intertemporal substitution equals asset prices. Otherwise stated, p_t will be proportional to the discounted marginal value of wealth

$$p_t \propto \beta^t\left(\frac{1}{c_t}\right).$$

Gathering and rearranging the different equations, we obtain Definition 2.

APPENDIX B: THE UNEMPLOYMENT INSURANCE SYSTEM

The problem of the representative household j is to maximize its utility over its life-cycle[19]

$$\max E_0\sum_{t=0}^{\infty}\beta^t\mathscr{U}_t,$$

[19] For convenience we omit the subscript identifying a given individual.

where $\mathscr{U}_t = \pi_t U_t^{\ell} + (1 - \pi_t) U_t^u$. π_t denotes the probability of being employed in period t and is given, according to the law of large numbers, by l_t. U_t^n is defined by

$$U_t^n = \begin{cases} \log\left(c_t^{\ell}\right) + G(e_t, w_t, w_{t-1}, w_t^a) & \text{if } n = \ell \\ \log(c_t^u) & \text{if } n = u, \end{cases}$$

where $G(e_t, w_t, w_{t-1}, w_t^a) = \left(e_t - \phi - \gamma \log\left(\frac{w_t}{w_t^a}\right) - \psi \log\left(\frac{w_t}{w_{t-1}}\right)\right)^2$.

We assume that an insurance system allows households to buy an asset g_t at a price τ_t which insures them against unemployment. Then the intertemporal budget constraint of a given household is

$$\begin{aligned} c_t^{\ell} + \tau_t g_t + k_{t+1}^{\ell} &\leq (1 + r_t - \delta) k_t + w_t l_t \qquad \text{if } n = \ell \\ c_t^u + \tau_t g_t + k_{t+1}^u &\leq (1 + r_t - \delta) k_t + g_t \qquad \text{if } n = u. \end{aligned}$$

Knowing that in period t a household has a probability l_t of being employed, the Bellman equation associated to that problem is given by

$$\mathscr{V}(\Delta_t) = l_t \mathscr{V}^{\ell}\left(\Delta_t^{\ell}\right) + (1 - l_t) \mathscr{V}^u(\Delta_t^u) = \max \mathscr{L}_t$$

in which $\Delta_t^n = \{k_t^n, w_{t-1}, a_t\}$ and $\mathscr{L}_t$ denotes the Lagrangean

$$\begin{aligned} \mathscr{L}_t = l_t &\Big\{ \log\left(c_t^{\ell}\right) + G(e_t, w_t, w_{t-1}, w_t^a) \\ &\quad + \beta E_t \left[l_{t+1} \mathscr{V}^{\ell}\left(\Delta_{t+1}^{\ell}\right) + (1 - l_{t+1}) \mathscr{V}^u(\Delta_{t+1}^u) \right] \Big\} \\ &+ (1 - l_t) \Big\{ \log(c_t^u) + \beta E_t \left[l_{t+1} \mathscr{V}^l\left(\Delta_{t+1}^{\ell}\right) + (1 - l_{t+1}) \mathscr{V}^u(\Delta_{t+1}^u) \right] \Big\} \\ &+ l_t x_t^{\ell} \left\{ (1 + r_t - \delta) k_t + w_t l_t - c_t^{\ell} - \tau_t g_t - k_{t+1} \right\} \\ &+ (1 - l_t) x_t^u \{ (1 + r_t - \delta) k_t + g_t - c_t^u - \tau_t g_t - k_{t+1} \}. \end{aligned}$$

The first-order necessary conditions with respect to c_t^{ℓ}, c_t^u, e_t, τ_t, k_{t+1}^{ℓ}, and k_{t+1}^u are

$$\frac{1}{c_t^{\ell}} = x_t^{\ell} \tag{27}$$

$$\frac{1}{c_t^u} = x_t^u \tag{28}$$

$$G_e(e_t, w_t, w_{t-1}, w_t^a) = 0 \tag{29}$$

$$\tau_t l_t x_t^{\ell} = (1 - \tau_t)(1 - l_t) x_t^u \tag{30}$$

$$l_t x_t^{\ell} = \beta E_t \left[l_{t+1} (1 + r_{t+1} - \delta) x_{t+1}^{\ell} \right] \tag{31}$$

$$(1 - l_t) x_t^u = \beta E_t \left[(1 - l_{t+1})(1 + r_{t+1} - \delta) x_{t+1}^u \right]. \tag{32}$$

The profit of the insurance company is given by

$$\tau_t g_t - (1 - l_t) g_t.$$

The maximization of the profit leads the company to charge $\tau_t = 1 - l_t$. Then from (30), we get

$$x_t^{\ell} = x_t^u = x_t \ \forall t.$$

Thus, (27) and (28) imply that the level of consumption is the same for an employed and an unemployed household. Taking these results into account, we find that a given household always chooses to be fully insured $g_t = w_t l_t$.

REFERENCES

Adams, J., and Rosenbaum, W. (1962). "The Relationship of Worker Productivity to Cognitive Dissonance about Wage Inequalities," *Journal of Applied Psychology* **46**, 161–164.

Akerlof, G. (1982). "Labor Contracts as Partial Gift Exchange," *Quarterly Journal of Economics* **97**, 543–569.

Becker, G. (1996). *Accounting for Tastes*, Cambridge, MA: Harvard Univ. Press.

Bewley, T. (1997). "Why Not Cut Pay?" Working Paper, Cowles Foundation.

Blanchard, O., and Fischer, S. (1989). *Lectures on Macroeconomics,* Cambridge, MA: MIT Press.

Blanchflower, D., and Oswald, A. (1994). *The Wage Curve*, Cambridge, MA: MIT Press.

Burnside, C., Eichenbaum, M., and Rebelo, S. (1993). "Labor Hoarding and the Business Cycle," *Journal of Political Economy* **101**, 245–273.

Christiano, L., and Eichenbaum, M. (1992). "Current Real Business Cycle Theories and Aggregate Labor-Market Fluctuations," *American Economic Review* **82**, 430–450.

Clark, A. (1996). "Are Wages Habit Forming? Evidence from Micro-Data," Working Paper, OCDE.

Cooley, T., and Prescott, E. (1995). "Economic Growth and Business Cycles," In *Frontiers of Business Cycle Research* (T. Cooley, Ed.). Princeton, NJ: Princeton Univ. Press.

Danthine, J.-P., and Donaldson, J. (1990). "Efficiency Wages and the Business Cycle Puzzle," *European Economic Review* **34**, 1275–1301.

Danthine, J.-P., and Donaldson, J. (1993). "Methodological and Empirical Issues in Real Business Cycle Theory," *European Economic Review* **37**, 1–35.

Danthine, J.-P., and Donaldson, J. (1995). "Non-walrasian economies," In *Frontiers of Business Cycle Research* (T. Cooley, Ed.). Princeton, NJ: Princeton University Press.

de la Croix, D. (1998). "Growth and the Relativity of Satisfaction," *Mathematical Social Sciences*, forthcoming.

Fairise, X. (1995). "Nominal Wage Contracts and the Short-Run Dynamics of Real Wages," In *Advances in Business Cycle Research* (P.-Y. Hénin, Ed.). Berlin/New York: Springer-Verlag.

Farmer, R. (1993). *The Macroeconomics of Self-Fulfilling Prophecies*, Cambridge, MA: MIT Press.

Fève, P., and Langot, F. (1994). "The RBC Model Through Statistical Inference: An Application with French Data," *Journal of Applied Econometrics* **9**, S11–S35.

Gomes, J., Greenwood, J., and Rebelo, S. (1997). "Equilibrium Unemployment," University of Rochester.

Gomme, P. (1996). "Shirking, Unemployment and Aggregate Fluctuations," Simon Fraser Univ.

Goodman, P. (1974). "An Examination of Referents Used in the Evaluation of Pay," *Organizational Behavior and Human Performance* **12**, 170–195.

Hairault, J.-O. (1995). "Presentation and Evaluation of the Real Business Cycle Approach," In *Advances in Business Cycle Research* (P.-Y. Hénin, Ed.). Berlin/New York: Springer-Verlag.

Hall, R. (1990). "Invariance Properties of the Solow Residual," In *Growth, Productivity and Unemployment. Essays to Celebrate Bob Solow's Birthday* (P. Diamond, Ed.), pp. 71–112. Cambridge, MA: MIT Press.

Hansen, G. (1985). "Indivisible Labor and the Business Cycle," *Journal of Monetary Economics* **16**, 309–327.

Hodrick, R., and Prescott, E. (1980). "Post-War U.S. Business Cycles: An Empirical Investigation," mimeo.

King, R., Plosser, N., and Rebelo, S. (1988). "Production, Growth and Business Cycles, I," *Journal of Monetary Economics* **21**, 196–232.

Langot, F. (1993). "La Dynamique de l'Emploi et du Chômage dans les Modèles d'Équilibre Général: Fondements Théoriques et Évaluations Empiriques," Thèse de Doctorat, Université de Paris I.

Lord, R., and Hohenfeld, J. (1979). "Longitudinal Field Assessment of Equity Effects on the Performance of Major League Baseball Players," *Journal of Applied Psychology* **64**, 19–26.

Lucas, R. (1978). "Asset Prices in an Exchange Economy," *Econometrica* **46**, 1429–1445.

Rotemberg, J., and Summers, L. (1990). "Inflexible Prices and Procyclical Productivity," *Quarterly Journal of Economics* **105**, 851–874.

Rotemberg, J., and Woodford, M. (1992). "Oligopolistic Pricing and the Effects of Aggregate Demand on Economic Activity," *Journal of Political Economy* **100**(6), 1153–1207.

Ryder, H., and Heal, G. (1973). "Optimal Growth with Inter-Temporally Dependent Preferences," *Review of Economic Studies* **40**, 1–31.

Solow, R. (1979). "Another Possible Source of Wage Stickiness," *Journal of Macroeconomics* **1**, 79–82.

Uhlig, H. (1995). "A Toolkit for Analyzing Nonlinear Dynamic Stochastic Models Easily," Working Paper, FRB of Minneapolis.

Uhlig, H., and Xu, Y. (1995). "Effort and the Cycle: Cyclical Implications of Efficiency Wages," Working Paper, CentER (Tilburg).

Wadhwani, S., and Wall, M. (1991). "A Direct Test of the Efficiency Wage Model Using UK Micro-Data," *Oxford Economic Papers* **43**, 529–548.