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The Macroeconomic Consequences of Reciprocity in Labor Relations*

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Abstract

We develop and analyze a structural model of efficiency wages founded on reciprocity. Workers are assumed to face an explicit trade-off between the disutility of providing effort and the psychological benefit of reciprocating the gift of a wage offer above some reference level. The model provides a rationale for rent sharing—a feature that is very much present in the data but absent from previous formulations of the efficiency wage hypothesis. This firm-internal perspective on efficiency wages has potentially important macroeconomic consequences: rent-sharing considerations promote wage rigidity, internal amplification and differential responses to technology and demand shocks.

Keywords: Reciprocity; rent sharing; efficiency wages; wage rigidity

JEL classification: *E*24; *E*32; *J*50

I. Introduction

Reciprocity is a pervasive feature of labor relations. Workers care about fairness and are willing to reward a generous wage offer by their employer with a commensurate level of effort, even though providing effort in itself is costly and yields no immediate pecuniary benefits. Firms, in turn, understand workers' propensity to reciprocate and take into account the effects of compensation on effort and productivity when setting wages. These are the provocative lessons of a vast literature ranging from surveys by Kahneman,

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Knetsch and Thaler (1986) or Bewley (1999) to laboratory experiments by Fehr and Falk (1999) or Fehr and Gächter (2002), to name just a few.[1]

Is this message relevant and helpful for macroeconomics? Specifically, is a model economy featuring an explicit role for reciprocity in labor relations an interesting alternative representation of reality as opposed to more standard neoclassical perspectives or to traditional efficiency wage constructs? And if so, does such an alternative model help resolve some of the outstanding macroeconomic puzzles? This paper is an attempt at answering these two questions and thereby assessing the macroeconomic relevance of reciprocity in labor relations.[2]

We build a stylized efficiency wage model founded on reciprocity and derive its general equilibrium implications. Our model is founded on Rabin's (1993) introduction of fairness into game theory. Effort cannot be contracted on directly. Workers, however, are assumed to face a trade-off between the disutility of providing effort and the psychological benefit of reciprocating the gift of a wage offer above some reference level. The gift of the firm is defined in terms of the standard component of workers' utility; and the gift of the worker in terms of the net profits of the firm. Firms, modeled as monopolistic competitors, only care about net profits but, by understanding the benefit to be derived from a cooperative workplace, they take workers' propensity to supply effort into account.

As always in an efficiency wage context, a firm's wage offer is evaluated by workers on a relative basis, by comparison with a certain wage reference. Quite naturally, the wage reference emerging from reciprocity considerations depends not only on the worker's outside option—a traditional external reference—but also (and this is new) on the firm's profitability, an internal reference that may be associated with the notion of rent sharing. What our analysis uncovers is that the effective weight placed on the firm's ability to pay turns out to be crucial for the equilibrium properties of a reciprocity-based efficiency wage story. We take this result as a call for additional empirical evidence on the relative importance of the two dimensions of the wage reference.

The emphasis on rent sharing accords well with the message of the experimental and survey studies cited in our first paragraph. These studies indeed emphasize that both workers and firms view rent sharing as an important determinant of the supply of effort: the better (worse) the firm is doing, the more (less) the worker expects to be paid in exchange for a given level of effort. A rent-sharing view also rationalizes the results of panel data estimations, which consistently find various measures of firm performance

[1] The Appendix to this present paper, available at http://www.er.uqam.ca/nobel/r16374, proposes a more extensive review of this evidence.

[2] In his Nobel address, Akerlof (2007) develops a more general reflection on a related theme.

to be significant and quantitatively important predictors of wages, even in the long run and after controlling for skill, working conditions, local labor market attributes and union presence.[3]

We trace the effect of different macroeconomic shocks on the equilibrium of our economy. The main lesson is that reciprocity-induced rent-sharing concerns substantially alter the equilibrium reactions of the economy to the macro shocks we study.

First, the larger the importance of rent-sharing considerations in the wage reference, the more equilibrium adjustments to shocks are in terms of employment and the less in terms of wages. If rent sharing is given sufficient weight, the relative variability of employment and wages conforms to observations, with most of the adjustments taking place in quantities, thus providing one resolution to the so-called wage–employment puzzle. Simultaneously, wages are almost acyclical, also in conformity with the data but in contrast to prominent resolutions of the wage employment puzzle, such as the indivisible labor model; see Hansen (1985). Standard efficiency wage models have typically failed on both fronts. The intuition for this result is straightforward. An external wage reference depends positively on outside earnings opportunities. In general equilibrium, these are sensitive to aggregate shocks. For example, when firms reduce employment in response to a downward shift in labor demand, the general equilibrium fall of the wage reference makes it optimal for individual firms to lower their wages. This leads to a further decrease in the reference wage which makes it possible for firms to propose an even lower wage without severe consequences on effort. By contrast, since a reduction in the firm's payroll following a fall in labor demand *increases* earnings per unit of labor, it raises the internal component of the wage reference. Optimizing with respect to effort therefore results in firms operating along a negatively sloped wage-setting curve if rent-sharing considerations are strong enough. In addition, shocks to productivity not only shift the labor demand curve (as is the case in the external reference case) but also the wage-setting curve. This shift neutralizes (part of) the wage fluctuation and implies that aggregate shocks potentially have a strong effect on employment while leaving real wages and labor productivity largely unchanged.

Beyond this natural resolution of an outstanding puzzle, introducing a rent-sharing component in the reference wage may provide a solution to another puzzle: the differential response of the economy to permanent and temporary shocks. A number of studies using structural vector autoregressions—e.g. Gali (1999), Christiano, Eichenbaum and Vigfusson (2004) and Francis and Ramey (2005)—find that the response of

[3] See Blanchflower, Oswald and Garrett (1990) and Abowd, Creecy and Kramarz (2002). See the Appendix for details.

employment to a permanent shock is initially smaller than (or even inverse to) the reaction to a temporary shock. Independently, Blanchard (1989), Gamber and Joutz (1997) and Fleischman (1999) all report, based on various identification schemes, that conditional on temporary shocks, real wages are acyclical (or even slightly countercyclical) while they are procyclical conditional on permanent shocks. Such responses follow naturally from reciprocity. In response to technology shocks, wages and labor productivity are relatively flexible. This is because both elements of the wage reference, the workers' outside option and firm profitability, are directly affected by the shock. In response to demand shocks, however, wages and labor productivity react much less or even become countercyclical. The reason is the same as before: as firms cut employment, the marginal return to labor and thus output per worker increase, thus preventing the wage reference from falling.

Finally, the reciprocity model has interesting implications for the cyclical behavior of effort. Because the impact of a given level of effort is larger in times of high labor productivity, effort has the tendency to comove with labor productivity. But the cyclicity of effort also depends on how the firm's optimal gift to the worker is affected by the shocks. If workers are sufficiently risk averse, firms set wages such that their gift moves inversely with changes in the worker's wage reference. The overall effect of these two forces on the cyclicity of effort very much depends on the relative importance of the internal vs. the external components of the wage reference and on the nature of the shock hitting the economy.[4]

The rent-sharing feature of a reciprocity-based model stands in contrast with the traditional fair wage literature. In a seminal paper that is in many ways a precursor of the present inquiry, Akerlof (1982) proposed to model effort supply via a reduced-form function featuring the firm's wage offer placed in relation to a wage reference defined in terms of the expected earning opportunities outside the firm. Akerlof's reduced-form effort function can be viewed as a particular case of the structural supply of effort in our model under the extreme, yet counterfactual, assumption that workers do not care at all about the firm's ability to pay. In this purely external case, firms set optimal wages *independently* of their financial situation and the macroeconomic consequences of their behavior (including highly flexible equilibrium wages) are indistinguishable from those obtained in more conventional formulations of efficiency wages such as Shapiro and Stiglitz's (1984) shirking model or Salop's (1979) labor turnover theory.[5]

[4] By contrast, the Appendix shows that if workers' preferences are linear in consumption, firms set wages such that their gift to the worker comoves with changes in the worker's wage reference.

[5] Gomme (1999) analyzes a dynamic stochastic general equilibrium model featuring the shirking efficiency wage formulation of Shapiro and Stiglitz.

A small number of studies departing from Akerlof's original fair wage model are also worth mentioning. Akerlof and Yellen (1990) assume that the worker's reference wage depends in part on peer wages in the same firm in order to explain unemployment and wage dispersion. Collard and de la Croix (2000) and Danthine and Kurmann (2004) introduce past compensation in their definition of the wage reference which otherwise follows Akerlof (1982). They show that doing so may lead to significant real wage rigidity and amplified propagation of exogenous shocks. These studies, however, give no role to rent sharing and the differential response to shocks that it entails, nor do they offer an explicit derivation of their effort function from a utility-maximizing framework.

The rest of the paper is organized as follows. In Section II we outline our reciprocity-based efficiency wage model. Section III details the macroeconomic implications of the model. Section IV concludes.

II. A Reciprocity-based Model of Efficiency Wages

In line with all of efficiency wage theory, the central assumption of our model is that effort is an input to production but firms cannot directly observe the workers' provision of effort. Hence, work effort cannot be paid its marginal product. Firms understand, however, that while workers dislike effort *per se*, they may derive satisfaction from reciprocating a generous wage offer with a commensurate effort level even in the absence of monitoring or other material incentives. We discuss the implications of this assumption in a simple monopolistic competition model that is a close cousin of the New Keynesian model which has become the workhorse of modern macroeconomics.[6]

The Consumer's Problem and the Supply of Effort

Our formulation of the supply of effort is inspired by the more recent literature on reciprocity and its formalization by Rabin (1993). We proceed in four steps.

Step 1: What Provides Satisfaction? As in Rabin (1993), we assume that workers' preferences take the form

$$U = u(c, e) + \lambda s(w, e).$$

The first component in this equation, $u(c, e)$, is standard: it states that utility is derived from consumption, c, while effort, e, provides direct

[6] As in the majority of New Keynesian models, the number of firms and thus the degree of competition is fixed. This is justified by the short-run business cycle preoccupations of these models.

disutility ($u_c > 0$, $u_{cc} \leq 0$ and $u_e < 0$, $u_{ee} < 0$). The second component, $s(w, e)$, admits that in a work environment characterized by reciprocal behavior, providing effort also gives rise to psychological satisfaction.[7] The parameter λ determines the relative importance of reciprocity considerations. In order to focus our analysis on the supply of effort, we abstract from the utility of leisure and assume instead that workers inelastically supply one unit of labor.

Step 2: Modeling the Utility Derived from Reciprocity. The central idea behind reciprocity is that individuals are willing to spend considerable resources to reward (punish) fair (unfair) behavior by others (the firm in our case) even though no direct material gain derives from such action. Rabin formalizes this idea by defining $s(w, e)$ as the product of the respective "gifts" of the worker and the firm

$$s(w, e) = d(e, \cdot)g(w, \cdot).$$

The term $d(e, \cdot)$ represents the gift of the worker towards the firm. It takes the form of a level of effort beyond some reference effort level and is measured in terms of its impact on output per worker. Likewise, the term $g(w, \cdot)$ represents the gift of the firm. It takes the form of a wage above some reference level and is measured in terms of its impact on workers' utility. When workers perceive a wage offer as generous (i.e., $g(w, \cdot) > 0$), their utility may increase if they reciprocate with a gift of higher effort (i.e., $d(e, \cdot) > 0$).

With this definition of preferences, workers face a trade-off between the direct disutility of providing effort and the satisfaction derived from reciprocating kind behavior by the firm. Under reasonable assumptions, this trade-off results in a positive effort level. Precisely, optimal effort is such that the marginal disutility of providing effort equals the marginal "psychological" benefit of reciprocating the gift of the firm with a gift of effort:[8]

$$-u_e = \lambda d_e g(w, \cdot). \tag{1}$$

We label this equation the "Effort Condition" (EC). It spells out the amount of effort a worker is willing to supply in response to a certain wage offer.

[7] This form of satisfaction is not, evidently, available to unemployed workers. Even in the presence of perfect unemployment insurance contracts equalizing the material utility of employed and unemployed workers, one could explain in this model that individuals would prefer having a job rather than being unemployed.
[8] As one of a continuum, the typical worker in this model does not take into account the impact of his own effort on the firm's output and on the gift of the firm.

Step 3: Measuring the Gift of the Worker. To make $d(e, \cdot)$ and $g(w, \cdot)$ explicit, we need to specify the functional forms for utility and profits. We assume that the utility from consumption and effort takes the form $u(c, e) = \log c - e^{\theta}$ with $\theta > 1$;[9] and the typical firm's production function takes the form

$$y = f(e, n) = A(en)^{\alpha}, \tag{2}$$

with $0 < \alpha < 1$.[10]

Given these specifications and continuing in the spirit of Rabin, we define the gift of the worker as

$$d(e, \cdot) = An^{\alpha-1}\left[e^{\alpha} - e_r^{\alpha}\right], \tag{3}$$

where $An^{\alpha-1}e^{\alpha}$ is output per worker if effort is e. Thus the worker's gift is the difference between realized output per worker, on the one hand, and output per worker under a reference effort level e_r, on the other. We think of e_r as a weighted average of a maximum and a minimum effort level, but as the EC (1) makes clear, the only dimension of $d(e, \cdot)$ that matters is the impact of the worker's effort on the measured gift, that is, d_e. Provided the components of e_r do not depend on the effort decision itself, its definition is of no consequence for $d(e, \cdot)$.

Formulation (3) has the property that, because the gift is measured in units of output, a larger effort level could actually result in a decreased gift in the face of an adverse technology shock. There is some plausibility in this: a worker may understand that, in bad times when productivity is low, an extra display of zeal will not be valued by the firm as much as in good times when productivity is high. The alternative specification where this effect is absent and the gift of the worker is measured directly in terms of effort, as in

$$d(e, \cdot) = (e - e_r), \tag{4}$$

is equally plausible, however. It has the advantage of making the model simpler and more transparent because, coupled with the log utility assumption, it delivers constant effort in equilibrium. Our strategy therefore consists in exploring the two versions of the model starting with the simpler one—the "constant effort model" of definition (4)—for which the underlying mechanics can be made fully explicit and then developing numerically the more general "variable effort" version of definition (3).

[9] In the Appendix we explore the implications of assuming utility is linear in consumption. It turns out that $u(c) = \log c$ is one necessary ingredient for a simple, transparent, version of our economy with constant effort.

[10] Our results rely, in a fundamental way, on the hypothesis of decreasing returns to labor as would obtain with a standard constant returns to scale production function with capital and labor. We abstract from capital in order to keep our analysis more transparent.

Step 4: Measuring the Gift of the Firm. The gift of the firm is similarly measured as the difference between the utility from consumption under the actual wage offer and the utility that would obtain under a reference wage. Contrary to the definition of the worker's gift, the definition of the reference wage in the gift of the firm is of importance. Abstracting from savings, and taking account of an income "tax" rate $(1-\tau)$ (see later), the utility from the actual wage offer w equals $\log(\tau w)$. The reference utility level, in turn, is defined as the weighted average (with weights φ and $(1-\varphi)$, respectively) of the utility associated with the maximum wage $w_{\max}$ and the minimum wage $w_{\min}$ that the firm could possibly pay. The firm cannot pay more than y/n or it would go bankrupt. In fact, if the wage reference is equal to y/n, no effort will be forthcoming because it is impossible for the firm to pay more. Our logarithmic formulation for utility thus leads us to set $w_{\max}=(y/n)^{\nu}$ with $\nu<1$, and the associated utility level becomes $\log[\tau(y/n)^{\nu}]$. The lower end of possible wage offers is given by the fact that a worker always has the option to refuse an offer and "quit". In this case, his expected remuneration can be measured by $\tau\bar{w}^{\bar{n}}b^{1-\bar{n}}$, with $\bar{w}$ denoting the expected wage if hired by another firm, $\bar{n}$ the probability of re-employment and b the consumption level if unemployed (to be specified later).[11] With these assumptions, the gift of the firm towards the worker takes the form

$$g(w,\cdot)=\log(\tau w)-\{\varphi\log[\tau(y/n)^{\nu}]+(1-\varphi)\log[\tau\bar{w}^{\bar{n}}b^{1-\bar{n}}]\}, \qquad (5)$$

and the EC in (1) becomes

$$Qe^{\theta-\alpha}=\left\{\begin{array}{ll} g(w,\cdot) & \text{if } d(e,\cdot)=(e-e_r) \\ An^{\alpha-1}g(w,\cdot) & \text{if } d(e,\cdot)=An^{\alpha-1}\left[e^{\alpha}-e_r^{\alpha}\right] \end{array}\right\}, \qquad (6)$$

with $Q=\theta/\lambda\alpha$, and $g(w,\cdot)$ defined by (5).

Equation (5) integrates two very different perspectives on what makes workers willing to supply effort. Consider first the case $\varphi=0$. In this perspective, the wage reference is purely external—it depends only on the worker's outside option—and the EC subsumes various versions of the efficiency wage hypothesis. In his original paper, Akerlof (1982) motivated it as a result of a gift exchange postulating that the wage reference would correspond to what the worker could earn outside his current employment relationship. But the same condition could also be viewed as the reduced-form consequence of the shirking model of Shapiro and Stiglitz (1984)

[11] For our logarithmic formulation of preferences for consumption, the geometric average implies that the utility associated with the minimum wage equals the expected value of working at another firm and remaining non-employed $\bar{n}\log(\bar{w})+(1-\bar{n})\log(b)$. It thus permits a natural comparison with the Akerlof gift exchange model which makes the same modeling choice—see below.

or of the turnover model of Salop (1979). In both cases a real wage in excess of some external reference is what induces the worker to provide effort, because being fired, respectively quitting, is thus made costly to him/her.

The opposite situation is $\varphi = 1$. Here, rent sharing within the firm—i.e., between workers and firm owners—is at the center of attention, while conditions of remuneration outside of the firm are irrelevant.[12] In this firm-*internal* reference view, workers appraise the salary offer in light of the firm's output per employee, y/n. The closer the actual w is to y/n, the more favorable to the worker is the sharing of the rent and the more generous the typical worker is with his effort;[13] conversely, the farther away from the maximal wage offer the actual compensation is, the larger the rent appropriated by firm owners and the lower the forthcoming level of effort (*ceteris paribus*).

The Firm's Problem and the Demand for Labor

Firms cannot directly observe effort. They understand, however, that workers reciprocate according to (6). The typical firm's manager thus makes the first move in the form of a wage offer that is the result of his estimating how the offer will be perceived by the worker and how the worker will react to the gift of the firm thus manifested.[14] Firms are monopolistic competitors selling differentiated products. The representative firm's problem can be written as

$$\max_{w,n} \psi f(en) - wn, \tag{7}$$

subject to the effort condition (6). The parameter ψ is the inverse of the optimal markup (i.e., the real marginal cost) that the typical firm applies as a result of its monopolistic position in the product market; see Blanchard and Kyotaki (1987) for details. This parameter depends in

[12] Danthine and Kurmann (2006) describe the impact of such an alternative wage reference in the context of Akerlof's reduced-form effort function.

[13] It is easy to see that, for this extreme case to make sense, the firm must be able to pay more than what is viewed as the wage reference or else its gift will never be positive and effort and output will always be zero. This explains the restriction $\nu < 1$.

[14] Note that the firm itself does not display reciprocity. Contrary to Rabin's, our formulation of the problem is thus asymmetrical with the firm optimizing in a standard fashion in a context where workers do display reciprocal behavior. Note as well that, as opposed to Rabin's, our model allows for continuous decision choices and takes into account general equilibrium effects.

particular on the elasticity of substitution across the differentiated goods offered by competing firms.[15]

Aggregation and Equilibrium

We assume a [0–1] continuum of *ex-ante* identical firms and similarly a [0–1] continuum of identical families. Each family consists of a [0–1] continuum of individuals with preferences over consumption and effort. Each family owns a perfectly diversified portfolio of claims to firms' dividends and redistributes income to its members, some of whom are working while others are unemployed. The motivation for the family construct is the usual one: preserving *ex-post* worker homogeneity in a world of unemployment.

With homogeneous firms and workers, optimal wages and employment are identical and, in equilibrium, $w = \bar{w}$ and $\int_0^1 n d\gamma = n = \bar{n}$ where γ indexes the continuum of firms. The latter substitutes for the labor market-clearing condition: the labor market is typically in disequilibrium with unemployment (or non-employment) equal to $(1 - n)$. In the absence of savings and investment, the entire period output is consumed, that is, aggregate consumption equals $y = \int_0^1 y d\gamma$. On the income side, total income y is also a measure of family income received in the forms of the wages of its member workers and dividends. It is redistributed within each family as per $y = \tau[wn + b(1 - n)]$. This determines the "tax" level $(1 - \tau)$ as a function of the targeted consumption of the unemployed. We will calibrate b such that, in the benchmark case, it is a plausible proportion ρ of the equilibrium wage: $b = \rho w$.

We close the model by introducing a very stylized monetary sector consisting of a monetary authority fixing the nominal money supply M, and a reduced-form money demand equation $y = M/P$, where P is the aggregate price level (normalized at 1). The sole objective of this monetary sector is to examine the model's responses to an aggregate demand shock in the form of an exogenous change to M when prices are fixed.

The flexible price equilibrium for w, n, e, y is determined by the solution to the system formed by the production function (2), the optimal effort equation (6), the labor demand curve to be derived shortly as the outcome of firms optimizing over employment (equation (15)) and the wage-setting curve that is the result of firms optimizing over wage and effort (equation (13)) together with the labor and goods market-clearing conditions.

[15] In perfect competition, marginal cost must equal the price level and hence $\psi = 1$. In the comparative statics exercises below, we explicitly refer to a monopolistic product market where firms charge prices above marginal cost, i.e., $\psi < 1$. In Dixit and Stiglitz's (1977) monopolistically competitive framework, the equilibrium value of ψ equals $(\mu - 1)/\mu$, where $\mu > 1$ is the elasticity of substitution between differentiated goods.

Optimal Firm Decisions

The first-order conditions to problem (7) are

$$w = \psi \left(f_n + f_e \frac{\partial e}{\partial n} \right) \tag{8}$$

$$n = \psi f_e \frac{\partial e}{\partial w}. \tag{9}$$

We can rewrite $f_e = f_n n/e$ and express condition (8) as

$$w = \psi f_n (1 + \varepsilon_{e,n}), \tag{10}$$

where $\varepsilon_{e,n} \equiv \partial e/\partial n * n/e$ is the elasticity of effort with respect to the firm's labor input. This equation determines the labor demand. Since $\varepsilon_{e,n} > 0$, the marginal condition requires equating the wage rate to the marginal product of labor (modified by the real marginal cost) augmented by the elasticity of effort to employment; i.e., firms understand that hiring more labor reduces output per worker and thus the workers' wage reference. For a given wage, taking the derived effort function into account thus leads to a form of overemployment in the sense that firms hire more labor than in a standard set-up.[16]

Similarly, we can combine conditions (8) and (9) to obtain

$$\varepsilon_{e,w} - \varepsilon_{e,n} = 1, \tag{11}$$

where $\varepsilon_{e,w} \equiv \partial e/\partial w * w/e$ is the elasticity of workers' effort with respect to the wage. We refer to this equation as the Modified Solow Condition (MSC). If $\varepsilon_{e,n} = 0$, the MSC would reduce to Solow's (1979) original condition, $\varepsilon_{e,w} = 1$: the wage rate is optimal if, at the margin, a 1% increase in wage implies a 1% increase in effort. The marginal wage increase then exactly pays for itself in terms of increased output. This condition is omnipresent in existing efficiency wage models. In our set-up, however, the traditional Solow condition no longer holds. This is because a marginal wage increase has an additional (negative) effect on effort coming from the induced decrease in employment and the consequent rise in y/n. Thus, *ceteris*

[16] This result mirrors Stole and Zwiebel (1996) who develop a model of intrafirm bargaining where workers are assumed to enjoy a fixed amount of bargaining power and labor productivity is taken to be the firm's threat point in the wage negotiation. An increase in labor therefore reduces the negotiated wage, a fact that leads firms to hire more labor. We thank Etienne Wasmer for pointing out this similarity. Contrary to Stole and Zwiebel, however, our model does not impose that workers have explicit bargaining power. Rather, workers have indirect bargaining power in the sense that firms internalize the effort consequence of a low salary. Furthermore, Stole and Zwiebel's equilibrium is one where unemployment is absent and the wage equals the one obtained in a Walrasian labor market without bargaining.

paribus, the last wage increase warranted in a standard efficiency wage context would not pay for itself here.[17]

Using the implicit function theorem, we can derive explicit expressions for $\varepsilon_{e,w}$ and $\varepsilon_{e,n}$ (see the Appendix). The resulting MSC in (11) can then be combined with the EC in (6) to eliminate the effort variable. After rearranging, we obtain the firm's optimal wage-setting curve:

$$\log w = \frac{1-\varphi\nu}{\theta-1} + \varphi \log[(y/n)^{\nu}] + (1-\varphi)\log[\bar{w}^{\bar{n}} b^{1-\bar{n}}]. \qquad (12)$$

Before closing the model, let us observe that the identical wage condition $w=\bar{w}$ and the labor market-clearing condition $n=\bar{n}$ permit rewriting the wage-setting curve as:

$$\log w = \frac{g^* + \varphi\nu \log[y/n] + (1-\varphi)(1-n)\log b}{1-(1-\varphi)n}. \qquad (13)$$

This equation replaces the traditional labor supply equation of standard Walrasian models. It stipulates that the wage set to elicit optimal effort is increasing in both the firms' productivity, y/n and the compensation b of the non-employed. The effect of aggregate employment n is ambiguous, however. On the one hand, a higher n *ceteris paribus* implies a lower labor productivity y/n and thus a lower optimal wage. On the other hand, a higher n implies higher outside earning options, $(w)^n b^{(1-n)}$ and thus exerts upward pressure on the optimal wage. Which of these two effects prevails in equilibrium depends on the weight φ determining the relative importance of the two components in the reference wage used by the typical worker. The value of φ therefore plays a crucial role as will be clear in the comparative static results of the next section.

Inserting the optimal wage (12) into the definition of the firm's gift in (5) reveals that the firm finds it optimal to keep its gift to the worker constant at $g^* = (1-\varphi\nu)/(\theta-1)$. The EC thus becomes

$$Qe^{\theta-\alpha} = \left\{ \begin{array}{ll} g^* & \text{if } d(e,\cdot) = (e-e_r) \\ An^{\alpha-1}g^* & \text{if } d(e,\cdot) = An^{\alpha-1}[e^{\alpha}-e_r^{\alpha}] \end{array} \right\}. \qquad (14)$$

In the simpler version of our model with $d(e,\cdot) = (e-e_r)$ the constancy of the optimal gift implies that workers keep effort constant. In the richer version, effort varies with y/n because workers are willing to provide a higher gift in the form of effort in times of high productivity. In the Appendix, we

[17] Layard, Nickell and Jackman (1991) is a rare reference discussing efficiency wage models where the Solow condition fails to hold. They mention the case of a more complex production function and another one that combines wage bargaining with efficiency wage considerations. These authors also briefly mention the possibility that the workers' goodwill could be influenced by the firm's ability to pay. They do not explore the implications of that hypothesis, however.

also explore a situation where workers' utility of consumption function is not logarithmic and where, as a consequence, the optimal gift of the firm is not constant.

Finally, using these observations together with the explicit expression for $\varepsilon_{e,n}$, the labor demand can be rewritten as

$$\log n = \log\left(\frac{\psi\alpha}{\mu}\right) + \log(y/w), \tag{15}$$

where

$$\mu \equiv \left\{\begin{array}{ll} 1-\varphi(1-\alpha)\nu & \text{in the constant effort model} \\ (1-\alpha)g^* + 1 - \varphi(1-\alpha)\nu & \text{in the variable effort model} \end{array}\right\}.$$

III. The Macroeconomic Consequences of Reciprocity

We analyze the macroeconomic consequences of our model by computing the general equilibrium responses of output, employment and wages to two types of exogenous shocks. The first shock involves a change in technology A given flexible prices, akin to a productivity shock in a real business cycle model. Under this scenario, the equilibrium is supply-determined, aggregate demand absorbs the supply of output forthcoming at the equilibrium levels of effort and employment, and the markup remains unchanged. The second shock is a change in the money supply M with prices being (temporarily) kept fixed at their benchmark (flexible price equilibrium) level. This scenario mimics a Keynesian situation where the equilibrium is fully demand-determined as firms are assumed to satisfy the demand at the given prices. Total output is thus determined by $M = y$ and the real marginal cost ψ changes as firms' profits drop below the level that would obtain if prices were flexible; that is, firms effectively determine their cost minimizing employment and wage levels for the given level of output. For both shocks, we keep the consumption level of the non-employed b fixed at its original benchmark equilibrium level.

The Constant Effort Model

We start by examining the properties of the model with constant effort, that is, with the gift of the worker described by equation (4) and under the log utility hypothesis. The constancy of effort allows us to carry out the comparative statics analytically.

In order to understand the effect of rent sharing, it is useful to consider first the extreme cases $\varphi = 0$ and $\varphi = 1$. When $\varphi = 0$, the worker's wage reference is purely external and rent sharing is absent. In this case, the wage-setting curve (13) reduces to

$$\log w = \frac{1}{(\theta - 1)(1 - n)} + \log b. \tag{16}$$

Taking b as given, there is a direct relationship between w and n that does not involve other variables. *Both* technology and monetary shocks therefore result in shifts of the labor demand curve moving the equilibrium *along* the wage-setting curve. Hence, despite the very different nature of these two shocks, the relative responses of w and n in the $\varphi = 0$ case are very much similar.

To obtain a sense of the magnitude of this response, we compute the elasticity of w with respect to n, which can be considered as a measure of wage rigidity:

$$\frac{\partial w}{\partial n}\frac{n}{w} = \frac{n}{(1-n)}(\log w - \log b) = -\frac{n}{(1-n)}\log \rho,$$

where the second equality is obtained by setting the consumption level of the non-employed to its equilibrium value $b = \rho w$. This elasticity measure should therefore be considered as an approximation around equilibrium. The value of this elasticity depends on the calibration of n and ρ. If $(1-n)$ is interpreted as the unemployment rate, then n is calibrated between 0.9 and 0.95 (an unemployment rate between 5% and 10%). If, however, we interpret $(1-n)$ as the fraction of non-employed workers (unemployed and people not participating in the labor market), then n is around 0.7. Setting the replacement ratio ρ between 0.35 and 0.5, we obtain the matrix of possible elasticities shown in Table 1.

Even in the "most favorable" scenario ($n = 0.7$ and $\rho = 0.5$), changes in labor demand shift wages more than one and a half times as much as employment. The intuition for this absence of wage rigidity is straightforward. The only reason for firms to hold their wages constant is if all other firms keep theirs constant. But even if they were to do so, the decrease in employment that follows a negative shock, in and of itself, would decrease the wage reference. The result is that firms find it optimal to decrease their own wage and, as they are all in the same situation, nothing prevents both the wage and the wage reference from adjusting flexibly. These adjustments are illustrated in Figure 1. In both cases, the labor demand shifts along a

Table 1. *Wage employment elasticity when* $\varphi = 0$

	$\rho = 0.35$	$\rho = 0.5$
$n = 0.7$	2.45	1.62
$n = 0.95$	19.95	8.19

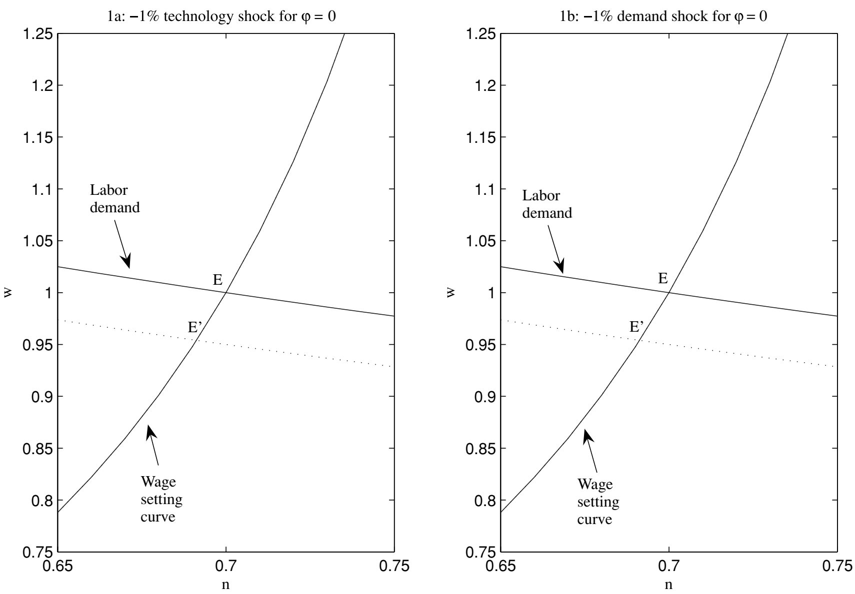

Fig. 1. Comparative statics when $\varphi = 0$.
Note: Calibration as described in the text, in particular $A = 1$; $\alpha = 0.66$; $\psi = 0.9$; $n = 0.95$; $\nu = 0.75$; $\rho = 0.5$.

steep wage-setting curve; in one case this is because a change in A affects labor productivity y/n for a given level of n; and, in the other, because a change in M at fixed prices affects the firm's real marginal cost ψ.

The slope of the wage-setting curve and thus the adjustment of w and n depends, of course, on the relative importance of b in the wage reference. Because we keep this variable constant in our comparative statics, the wage adjustment is larger the smaller ρ and the larger n.

For $\varphi = 1$, outside earning opportunities do not matter and the worker cares only for the difference between the wage and the firm's labor productivity y/n. In this case, the wage-setting curve (13) becomes

$$\begin{aligned} \log w &= \frac{1-\nu}{\theta-1} + \nu \log[y/n] \\ &= \frac{1-\nu}{\theta-1} + \nu \log A - (1-\alpha)\nu \log n + \alpha\nu \log e. \end{aligned} \tag{17}$$

This equation is fundamentally different from the wage-setting equation in the previous case. Employment now enters negatively rather than positively and the elasticity of w with respect to n for a given level of technology A

becomes

$$\frac{\partial w}{\partial n}\frac{n}{w} = \nu(\alpha - 1) < 0.$$

Everything else constant, firms thus accompany higher employment with *lower* instead of higher wages. The central mechanism behind this result is diminishing marginal returns of labor ($0 < \alpha < 1$). A decrease in employment, *ceteris paribus*, leads to an increase in output per worker y/n. As a result, the reference wage in the worker's effort condition falls and firms lower wages to elicit optimal effort.

The second significant difference arises because the relationship between w and n is no longer independent of other variables as was the case for $\varphi = 0$. Changes in A alter the productive situation of the firm and thus output per worker y/n. This implies that the wage-setting curve itself, and not only the labor demand curve, shifts in response to technology shocks. Observe in particular that the labor demand in (15) and the wage-setting curve in (17) form a system in w and y/n that is independent of A or y. Technology shocks therefore leave w and y/n unchanged. This striking result arises because the wage-setting curve (17) has the property that the effect of a 1% increase in output on the optimal wage is exactly compensated by the impact of a 1% increase in employment. But the labor demand curve (15) precisely implies that *ceteris paribus* (i.e., at constant wage) a 1% increase in output requires a 1% increase in employment.[18]

By contrast, exogenous changes in M under fixed prices affect the firm's real marginal costs ψ. This additional margin shifts the labor demand but does not directly affect the wage-setting curve. Hence, w and y/n both adjust in response to a demand shock. The drop in demand therefore requires the firm to decrease employment and this implies an increase in y/n forcing the firm to raise w. These adjustments are illustrated in Figure 2 where one sees that the negative technology shock (left-hand panel) shifts *down* both the labor demand and wage-setting curves while only the labor demand curve is affected by a demand shock.

The general case $0 < \varphi < 1$ is simply a weighted average of the two extremes. The more important the internal perspective, the smaller the slope of the wage-setting curve and the more it shifts in response to shocks in A, and conversely when more weight is placed on the external perspective. Consequently, with more weight on the internal component of the wage

[18] Expressed in another way, assume a 1% increase in output and start with the hypothesis that this leaves the wage unchanged. Then the labor demand equation implies that there will be a 1% increase in employment. Now go to the wage-setting equation. It tells us that indeed if both employment and output increase by 1%, then the optimal wage should remain unadjusted.

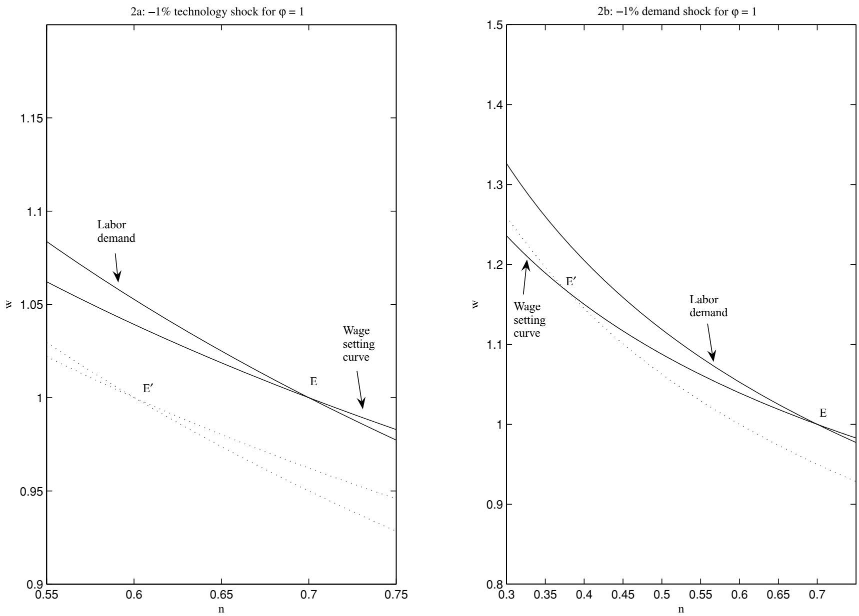

Fig. 2. Comparative statics when $\varphi = 1$
Note: Calibration as described in the text, in particular $A = 1$; $\alpha = 0.66$; $\psi = 0.9$; $n = 0.95$; $\nu = 0.75$; $\rho = 0.5$.

reference, wages are more rigid, hours are more volatile and the response of the economy to technology and demand shocks is more differentiated.

The Variable Effort Model

We now perform the same comparative static exercises for the model variant with variable effort. Here the gift of the worker is given by equation (3) under the maintained hypothesis of log utility. We consider the case of linear utility in the Appendix. The analysis is more involved because the relationship between w and n is now influenced by another variable margin, effort. We therefore need to resort to a numerical exercise to examine the properties of the model. This exercise is not meant as a full-blown quantitative examination of our model but rather as a robustness check of the above results to variable effort.

The numerical exercise is performed with respect to the calibration of parameters summarized in Table 2. We target an equilibrium ratio of employment to population of 70% and an income share of employment $s \equiv wn/y = 0.66$. Both values are close to the corresponding averages for the U.S. economy. Together with the calibration of the other

Table 2. *Calibration of parameters*

Parameter	n	α	ψ	ρ	φ	s	ν	A
Value	0.70	0.66	0.9	0.5	0.5	0.66	0.75	1

parameters, s pins down the value of θ, and n pins down the value of λ (see the Appendix for details). On grounds of plausibility or following previous studies, we set $A = 1$ (a pure normalization without any material consequence), $\alpha = 0.66$, $\psi = 0.9$ (i.e., an average markup $1/\psi$ of 11%), and a ratio of consumption of working individuals to non-working individuals $\rho = 0.5$. As before, the implied consumption level on non-working individuals b is kept constant when computing the comparative statics.

For the parameter ν, we select a benchmark value of 0.75, implying an equilibrium ratio of $(y/n)^{\nu}$ to (y/n) equal to 0.66. This choice is arbitrary as ν has no clear microeconomic interpretation. However, we have performed extensive robustness checks with respect to this parameter. They are summarized in the Appendix to this paper. Finally, the aggregate budget constraint in equilibrium implies $\tau = 1.25$; i.e., workers receive a subsidy from the family. This subsidy is financed out of dividends from firm ownership.

In what follows, we report comparative statics for different values of φ—the key parameter of our model—ranging from cases where the external wage reference perspective is predominant (φ close to 0) to others where the internal reference view takes increasing importance (φ close to 1).

Table 3a displays the general equilibrium responses of the model to a 1% *decrease* in technology A, given flexible prices. Table 3b reports the responses following a *negative* 1% shock in demand y under the assumption that prices are completely fixed.

The first interesting dimension of our results is the influence of the parameter φ. Looking at the impact of a technology shock, we observe that as the weight placed on rent-sharing considerations increases, the fall in productivity translates increasingly into a fall in employment and output and less so into a fall in wages.[19]

In the case of a demand shock, similar observations can be made: the fall in demand impacts less on wages when more weight is placed on the internal reference. Even more striking, wages turn countercyclical: they increase with a fall in demand for φ somewhere between 0.5 and 0.75.

[19] As we discussed in the analysis of the model variant with constant effort, when $\varphi = 1$ wages do not move in response to a technology shock and the entire adjustment occurs through employment and output.

Table 3a. *Response (in percent) of endogenous variables to a 1% technology shock*

Value of φ	y	n	w	e	ψ	y/n
0.1	−1.48	−0.61	−0.88	−0.12	0	−0.88
0.25	−1.53	−0.69	−0.85	−0.12	0	−0.85
0.5	−1.66	−0.89	−0.78	−0.11	0	−0.78
0.75	−1.94	−1.34	−0.61	−0.09	0	−0.61
0.9	−2.34	−1.98	−0.37	−0.05	0	−0.37

Table 3b. *Response (in percent) of endogenous variables to a 1% demand shock*

Value of φ	y	n	w	e	ψ	y/n
0.1	−1	−1.58	−1.68	0.08	−2.26	0.59
0.25	−1	−1.58	−0.96	0.08	−1.53	0.59
0.5	−1	−1.58	−0.25	0.08	−0.83	0.59
0.75	−1	−1.58	0.17	0.08	−0.42	0.59
0.9	−1	−1.58	0.34	0.08	−0.24	0.59

Average product increases with a fall in demand but to an extent that is not affected by the definition of the wage reference. Similarly, the fall in employment is substantial but independent of φ.

These results largely confirm those obtained analytically for the constant effort variant of our model. It thus appears that reciprocity in labor relations might be an important element in the simultaneous solution of two outstanding labor market puzzles. Indeed, for φ sufficiently high and under plausible combinations of demand and supply shocks, our reciprocity-based efficiency wage model delivers wage rigidity in combination with large employment reactions—thus resolving the wage employment puzzle—as well as acyclical wages—in accord with the Dunlop (1938) and Tarshis (1938) observation.[20]

The second striking feature of the comparative statics is the differential impact of demand vs. supply shocks. When the internal and the external perspectives receive equal weight ($\varphi = 0.5$), the fall in employment per unit of output is three times as large in response to the demand shock than in response to the technology shock ($\Delta n/\Delta y = 1.58$ in Table 3b vs. $\Delta n/\Delta y = 0.53$ in Table 3a). Conversely, the relative wage change is almost twice smaller in the demand shock case ($\Delta w/\Delta y = 0.25$ in Table 3b vs. $\Delta w/\Delta y = 0.47$ in Table 3a).

[20] On the other hand, an efficiency wage model with only an external reference perspective ($\varphi = 0.1$) does not generate significant wage rigidity. This confirms and generalizes the conclusion of Danthine and Donaldson (1990) that once imbedded in general equilibrium, traditional efficiency wage models with a purely external reference vision cannot resolve the wage–employment puzzle.

This difference in response is largely due to the rent-sharing element in the wage reference and the fact that labor productivity reacts in the opposite direction under the two shocks. In the face of a supply shock, y/n falls in equilibrium and so does unambiguously the wage reference (since workers' outside option also falls). In the case of a demand shock, y/n increases, thus dampening the fall of the wage reference and the resulting decrease in w.[21]

The differential responses of n and w when rent sharing matters accords well with the predictions of a number of studies using structural vector autoregressions. Thus, Gali (1999), Christiano *et al.* (2004) and Francis and Ramey (2005) find that the response of employment to a permanent shock is initially smaller than (or even inverse to) the reaction to a temporary shock. Independently, Blanchard (1989), Gamber and Joutz (1997) and Fleischman (1999) all report, based on various identification schemes, that conditional on temporary shocks, real wages are acyclical (or even slightly countercyclical) while they are procyclical conditional on permanent shocks.

Finally, the results in Tables 3a and 3b demonstrate that the two shocks bear sharply different implications for the behavior of effort. In the technology shock case, effort is procyclical but responds less for larger values of φ. For the demand shock case, by contrast, effort is mildly countercyclical (a result of the increase in y/n).

In the Appendix we test the robustness of our main results to alternative specifications of the model. In particular we examine the impact of different values of the parameter ν and different degrees of curvature for the utility function. Our principal qualitative results are unaffected by these parameter changes. The main impact of moving away from a log utility function appears on the cyclicality of effort.

IV. Conclusion: The Carrot or the Stick?

In this paper, we have developed an explicit model of reciprocity in labor relations suitable for inclusion in a macroeconomic general equilibrium setting. In line with the evidence from experimental economics and field studies, our set-up naturally features the firm's ability to pay as one of the main determinants of effort. Taking workers' behavior into account, firms find it optimal to set wages at a level that depends not only on

[21] One could suspect that the difference of results is due to the fact that the comparative statics for the technology shock are computed under flexible prices while the comparative statics for the demand shock are computed under completely fixed prices. This is not the case, however. In fact, the difference in results would be even more extreme if we imposed price fixity in the technology shock case: employment would decrease by a smaller amount or even increase (depending on the degree of accommodation of monetary policy). The fall in labor productivity and wages would be made even larger as a result.

workers' outside earning opportunities but also on their own profitability. The inclusion of rent-sharing considerations tends to make wages rigid and acyclical and generate heterogeneous responses to demand and supply shocks, thus providing a possible solution to some outstanding puzzles in the theory of economic fluctuations.

Our world is one where the management of workers' effort by firm managers is at the center of attention as it is in all of the efficiency wage literature. The debate to date can be cast in terms of a carrot vs. stick alternative. The dominant "shirking" view, as in Shapiro and Stiglitz (1984), argues in favor of the stick: firms' optimal effort management policy consists in setting a wage above worker's reservation wage and using the threat of firing if found shirking to elicit effort. Recent experimental studies tend to dismiss this claim and rather support Akerlof's "carrot perspective": the optimal management of effort consists in offering a fair (above marginal product) wage as workers will then reciprocate this gift by providing more than minimal effort in exchange. From a macroeconomic perspective the carrot vs. stick debate has been of minor importance so far as the two views appear to generate the same aggregate predictions.

This is not the case with the reciprocity view we develop here. It clearly sides with the carrot perspective but, using new insights from the experimental literature, it adapts the notion of what is considered a fair wage. In our reading, one lesson of this literature is that a wage well above a worker's outside option may still be judged unfair and thus fail to elicit high effort if the sharing of the rent within the firm is disproportionately in favor of firm owners. This view implies that some measure of firm profitability should be part of the wage reference. The exercise we have performed shows that whether this is the case or not, and to what extent, may be decisive in determining the import of the reciprocity–gift exchange approach for macroeconomics. In particular it has significant implications for wage rigidity, shock amplification, and the responses to demand and supply shocks as well as the cyclical behavior of effort.

Our measure of profitability (inspired by Rabin) is specific; other indicators may be more appropriate depending on the information context of workers and the type of relations prevailing within the firm. Moreover, all firms should not necessarily be expected to behave identically. For better or for worse, the stick approach to effort management would probably prevail in some contexts. We nevertheless believe that our stylized model uncovers a robust and fundamental message for aggregate macroeconomics. Profitability measures, whatever they are, will be affected asymmetrically by different economic shocks. To the extent that they play a role in workers' perception of what is fair, the effort management strategy of managers has significant consequences for labor markets which may be crucial to help understand some important macroeconomic observations.

Our reciprocity-based efficiency wage model is not the first theory justifying a sharing of the rent between workers and firm owners. Notable are the insider–outsider model of Lindbeck and Snower (1988) and the search and matching models of Diamond (1981) and Mortensen and Pissarides (1994). Rent sharing in the latter context arises because a firm–worker match creates a surplus that the parties split according to some set bargaining rule. Labor productivity enters the definition of the threat point of the firm while the outside option represents the threat point of the worker. The resulting equation for wages bears a striking resemblance to the wage-setting equation of our model.[22]

Yet, recent papers by Hall (2003) and Shimer (2005) conclude that search and matching models largely fail to generate quantitatively important responses to plausible exogenous technology shocks and that wages remain much too volatile. Given the similarity in the determinants of wage setting, it is interesting to ask what the crucial difference is between our setting, which delivers rigidity, and the search and matching framework, which does not. Part of the answer is the absence of intrafirm diminishing marginal returns to labor in the search and matching models. Firms in those models are either small and can only hire one worker or they do not internalize the effect that large employment and thus wages has on labor productivity; see e.g. Merz (1995) or Andolfatto (1996). Changes in technology therefore translate one-to-one into changes in labor productivity, a fact that implies a strong response of wages and small responses of employment and output to such shocks. By contrast, firms in our model optimally choose employment, and thus labor productivity (given that marginal returns to labor are diminishing). Moreover, the management of workers' effort in a context of reciprocity leads firms to neutralize most of the effect of the technology shock on labor productivity by suitably adjusting employment, thus avoiding suboptimal swings in wages. Effort management, in conjunction with diminishing marginal returns to labor, therefore generates substantially amplified responses in employment and output while changes in wages remain comparatively small.

This discussion suggests that an interesting extension of our work would consist in modifying the search and matching set-up to allow for large (multi-worker) firms with diminishing marginal returns to labor.[23] Combining a thus enriched search and matching framework with the efficiency

[22] See, for example, Pissarides (2000, eq. 1.20).

[23] A recent study by Cahuc, Marque and Wasmer (2004) is a first step in this direction. These authors combine Stole and Zwiebel's (1996) intrafirm bargaining model with search and matching frictions and analyze how large firms with diminishing marginal productivity of labor internalize the effect of their employment decision on labor productivity and thus on the outcome of the wage bargaining. Their research is, however, exclusively focused on the steady-state implications of this construct in the presence of different types of labor.

wage considerations of this paper would bridge the gap between alternative departures from the Walrasian labor supply paradigm and may provide important new insights on the labor market.[24]

Inserting our reciprocity-based efficiency wage model into a dynamic general equilibrium set-up is a natural extension of our research. This undertaking would require thinking more carefully about another dimension of the wage reference. Indeed, we have made workers perfectly aware of the firm's productivity and of their outside option. The survey studies of Bewley (1999) and others, however, emphasize that workers often have only limited information on these components of the wage reference. The dynamic generalization of the present model will have to take a stance on these informational frictions. It is plausible to assume that workers learn only gradually about supply and demand shocks that affect productivity as well as their outside option. Such a learning process may explain why workers often take their own past wage as a reference, a feature that, in and of itself, would introduce persistence in the reactions to external shocks. Fleshing out such a construct and working out its implications is the subject of our current research.

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[24] Papers by Hall (2005) and more recently Brügemann and Moscarini (2007) illustrate that the wage-setting mechanism in search models is crucial for its business cycle implications. Among other things, Brügemann and Moscarini (2007) show that Shapiro and Stiglitz's (1984) shirking mechanism for wage determination implies a quasi-rent for the worker that remains completely fixed over the business cycle. The thus created rigidity does not come close, however, to generate the observed volatility of employment and vacancies. It would be interesting to examine to what extent our efficiency wage construct is capable of improving on this result.

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