The Macroeconomic Consequences of Reciprocity in Labor Relations*

Jean-Pierre Danthine†
Université de Lausanne, FAME
and CEPR

André Kurmann‡
Université du Québec à Montréal
and CIRPÉE

July 2005

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 important macroeconomic consequences: rent-sharing considerations promote wage rigidity, internal amplification and asymmetric responses to technology and demand shocks.

JEL classification: E24; E32; J50

Keywords: Reciprocity; Rent-sharing; Efficiency wages; Wage rigidity

---

*We thank Steve Ambler, David Andolfatto, Paul Beaudry, Samuel Danthine, Ernst Fehr, Bruce Shearer and Etienne Wasmer for helpful suggestions. Earlier versions of this paper have been presented at the CIRPÉE research days, the Lausanne macro workshop, McMasters University, Johns Hopkins University, the University of Stockholm, the Federal Reserve Bank of Kansas City, Paris I, IIES, the University of Zürich, the Canadian Economic Association 2004 meeting, and the 2005 meeting of the Société Canadienne des Sciences Économiques. We thank the participants for their comments. Financial support from the SSHRC, FQRSC and the Swiss National Science Foundation under contract 101312-103856 is gratefully acknowledged.

† *Contact address:* Jean-Pierre Danthine, Ecole des Hautes Etudes Commerciales, Université de Lausanne, 33 Route de Chavannes, CH-1007 Lausanne, Switzerland. *Email:* Jean-Pierre.Danthine@unil.ch.

‡ *Contact address:* André Kurmann, Université du Québec à Montréal, Department of Economics, P.O. Box 8888 Downtown Station, Montréal (QC) H3C 3P8, Canada. *Email:* kurmann.andre@uqam.ca.

1 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 by itself is costly and yields no immediate pecuniary benefits. Firms, in turn, understand the worker's propensity to reciprocate and take into account the effects of compensation on effort and productivity when setting wages. These are the lessons of a vast body of empirical evidence ranging from surveys by Kahneman, Knetsch and Thaler (1987) or Bewley (1999) to laboratory experiments by Fehr and Falk (1999) or Fehr and Gächter (2002), to name just a few.

In this paper, we build a general equilibrium efficiency wage model founded on reciprocity. Our model is inspired by Rabin's (1993) introduction of fairness in game theory. Workers 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 workers in terms of the net profits of the firm. Firms, modeled as monopolistic competitors, only care for net profits but, understanding the benefit to be derived from a cooperative workplace, they take workers' propensity to supply effort into account (as effort cannot be contracted on directly).

Quite naturally, the wage reference in light of which a worker gauges a given wage offer and decides on his effort level is a weighted average of his outside option, on the one hand, and the firm's profitability, on the other. As a result, the wage that elicits the optimal level of effort depends on expected earnings outside the firm (notably the employment and unemployment rates, the wage paid by competitors and the level of unemployment compensation) and the firm's ability to pay (captured by output per worker).

The wage setting behavior of the firms in our economy 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. Our model also rationalizes the results of panel data estimations, which consistently find various measures of firm performance 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.[1]

[1]Blanchflower et al. (1990), Abowd et al. (2002). Section 2 reviews this evidence.

We trace the impact of different macroeconomic shocks on the equilibrium of our economy. The results reveal that our reciprocity-based perspective on rent-sharing has the potential to resolve some of the outstanding puzzles in the theory of economic fluctuations. First, the rent-sharing component in the reference wage is shown to contribute an important element of asymmetry in the way the economy reacts to different types of shocks. In response to technology shocks (given flexible prices), 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 (given fixed prices), however, wages and labor productivity react much less or even become countercyclical. The reason is that, as firms cut employment, the marginal return to labor and thus output per worker increases, thus preventing the wage reference from falling. This result accords well with a number of econometric studies using structural vector autoregressions. For example, Blanchard (1989), Gamber and Joutz (1997) and Fleischman (1999) all report that, conditional on demand shocks, real wages are acyclical or even slightly countercyclical.

Our results also show that the larger the weight of rent sharing in the wage reference, the more adjustments to shocks are in terms of employment and the less in terms of wages. At the opposite, if the reference is purely external, wages are highly procyclical and substantially more variable than employment. Hence, our revisiting of the gift-exchange paradigm naturally and structurally gets at one of the most vexing issue in dynamic labor market models: the wage-employment puzzle. The intuition is straightforward. In the external perspective, the wage reference depends positively on outside earnings opportunities. In general equilibrium, these variables 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 and thus makes it possible for firms to propose an even lower wage without severe consequences on effort. By contrast, in the internal reference case, a reduction in the firm's payroll due to a labor demand shift *increases* earnings per unit of labor and thus the wage reference. Optimizing with respect to effort therefore results in firms operating along a negatively sloped wage setting curve. Furthermore, 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 productivity largely unchanged.

Finally, our model has interesting implications for the cyclical behavior of effort. With a reference wage depending on both rent-sharing and outside option, effort is procyclical in response to a technology shock and acyclical in response to a demand shock. There are two forces behind this result. First, workers find it worthwhile to supply extra effort in times where productivity is high. Second, it is optimal for firms to increase their wage more than proportionally in response to increases in productivity or in workers' outside option. The asymmetry in the cyclical behavior of labor productivity then translates into an asymmetry in the cyclical response of effort.

The rent-sharing implication of our model stands in contrast with the traditional fair wage literature. Originally proposed by Akerlof (1982) under the name of partial gift exchange, this literature has almost uniformly modeled effort supply as a reduced-form function that depends on the wage rate relative to 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 for 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' (1984) shirking model or Salop's (1979) labor turnover theory.

A small number of studies departing from Akerlof's original fair wage model are 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 the definition of the reference wage. They show that doing so may lead to significant real wage rigidity and amplified propagation of exogenous shocks. None of these studies consider rent-sharing, however, 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. Section 2 reviews the empirical evidence on reciprocity in labor relations and rent-sharing. Section 3 presents our reciprocity-based efficiency wage model. Section 4 discusses the macroeconomic implications of the model in response to exogenous supply and demand shocks. Section 5 compares our wage setting curve with the wage behavior arising from a search and matching context before concluding.

2 Empirical evidence on reciprocity and rent sharing

One of the most important findings in experimental economics is that many individuals are willing to spend considerable resources to reward (punish) fair (unfair) behavior by others even though no direct material gain derives from such action. One experiment close to our efficiency wage model is conducted by Fehr and Falk (1999).[2] Individuals are either assigned the role of a worker or a firm manager. The results show that if effort cannot be contracted in advance, the average wage chosen by the firm is considerably higher than the reservation wage of the worker, even though competitive bidding should push the equilibrium remuneration down to the worker's reservation wage. Workers in the experiment often try to underbid in order to obtain a job, but managers consistently refuse. This choice turns out to be rational because hired workers on average reciprocate the favor of a high wage with high effort (even though providing effort is costly), thus increasing the firm's profit relative to a low-wage / low-effort policy.

The hypothesis that reciprocity is an important element in labor relations also receives strong support from field studies such as Levine (1993), Campbell and Kamlani (1997) and Bewley (1999) who survey U.S. company managers and labor leaders about wage policy.[3] Most respondents in these studies report favoring layoffs over wage cuts during downturns because the negative effect of wage cuts on work morale, and thus on productivity, would outweigh the associated cost savings.

Interestingly, managers in Bewley's survey generally dismiss the shirking theory of efficiency wages. Rather than promoting a high effort level, the threat of punishment if caught shirking (in the form of firing or of a wage penalty) creates a negative workplace atmosphere that is counterproductive. Bewley concludes from his inquiry that Akerlof's (1982) partial gift exchange hypothesis of efficiency wages is the explanation for wage rigidity that is most consistent with empirical evidence. This view also receives strong support from an experiment by Fehr and Gächter (2002). Their setup is similar to the one of Fehr and Falk discussed above, but with the addition that firm managers can make workers pay a fine if the latter are caught shirking (which occurs with a fixed probability). Except for very low wage offers, workers in this setting provide much lower effort than in the original experiment where no verification of shirking is allowed.

The notion of reciprocity in labor relations is not operational until the relevant references considered by workers when deciding on effort are identified. In a famous study, Kahneman, Knetsch and Thaler (1986) shed light on this issue by interviewing a ran-

[2]Other experiments that simulate similar worker-employer relationships are Fehr, Kirchsteiger and Riedl [1993] or Gächter and Falk [2002]. See Fehr and Gächter [2000] for a general survey.

[3]See Bewley (2002) for a summary.

domly selected sample of individuals on their perception of fairness of alternative firm actions in different profit situations. They report that a substantial proportion of individuals consider the principle of dual entitlement to be an important standard of fairness: workers are entitled to a reference salary, while firms are entitled to a reference profit. Accordingly, a wage reduction is more likely to be judged unfair if it results in a gain for the firm than if it permits averting a loss.[4]

The importance of rent-sharing considerations in the management of effort is largely confirmed in an experiment by Fehr, Gächter and Kirchsteiger (1997). Firms in this experiment are assigned different levels of profitability and make (costly) wage offers to workers. Workers are then given the choice in a randomly determined order to accept wage offers. Once workers accept an offer, they observe the profitability of their firm and decide on the level of (costly) effort they want to provide. The results are striking: workers consistently offer high effort in return for a high wage. Firms, in turn, seem to understand the negative (suboptimal) effect of inadequate rent sharing on effort and offer wages that are increasing in the level of profitability assigned; i.e. they pay pure job rents.

By construction, these studies on rent sharing focus on very specific references and may therefore miss other elements considered by workers in their evaluation of fairness. In particular, employees may pay attention to outside references such as wages paid for similar jobs at other firms or local unemployment rates. The aforementioned survey studies (Levine (1993), Campbell and Kamlani (1997) and Bewley (1999)) suggest that this is not the case: workers' morale rather depends on firm-internal references such as established pay traditions, the firm's ability to pay, the difference between current and past wages, and the compensation of peer workers in the same firm. Importantly, according to the surveyed managers, even in cases of high unemployment, substantial reductions in pay are possible only in situations of great financial distress when wage reductions are the only way to prevent the firm from going bankrupt or laying off a large fraction of its workforce. Bewley (2002, page 7) goes even further and argues that *"...employees usually have little notion of a fair or market value for their services and quickly come to believe that they are entitled to their existing pay, no matter how high it may be....workers do not use pay rates at other firms as reference wages, for they know too little about them. Exceptions to this statement may occur when workers are*

[4] The idea of dual entitlement is closely related to Adam's (1963) theory of equity and Blau -Homan (1955, 1961) theory of social exchange. Both theories hypothesize that the rewards of an exchange (here between firms and workers) should be proportional to the perceived value of the different parties' inputs. Numerous studies in psychology and sociology have attempted to test these theories and report overall strongly supportive results. See Akerlof and Yellen (1990) for a review of this evidence.

represented by an active union that keeps them informed about what other firms pay."[5] Furthermore, most managers in Bewley's survey responded that they do not take into consideration underbidding by job applicants, thus closing off an indirect channel through which external references could possibly affect average firm pay.

We do not wish to argue here that references external to the firm are completely irrelevant to the worker's effort decision. In fact, Bewley's conclusion simply suggests that workers often have only incomplete information on their earnings potential outside the firm. But it is clear that the firm's ability to pay and established rent-sharing traditions are non-negligible references in workers' perception of fairness. While incomplete information (e.g., about the firm's revenues) may be relevant here as well, this conclusion should be robust provided some learning about the relevant variable is taking place.

Additional evidence in favor of rent-sharing in general comes from a rich set of microeconometric studies on the sources of wage dispersion. Starting with Slichter (1950), a long line of studies – from Dickens and Katz (1987), Krueger and Summers (1988) for the U.S.; Blanchflower, Oswald and Garrett (1990), Nickell and Wadhwani (1990), Holmlund and Zetterberg (1991) or Hildreth and Oswald (1997) for European labor markets; and Christofides and Oswald (1992) or Abowd and Lemieux (1993) for Canada – document that wages for apparently identical jobs differ significantly across industries, and that these differences are remarkably robust over time and across countries. Based on the evidence, they argue that these wage differentials cannot be attributed entirely to differences in skill or working conditions. Rather, differences in compensation depend to a substantial part on the firm's ability to pay, even in sectors where unions do not play an important role.[6]

Murphy and Topel (1987) challenge the rent-sharing view and argue instead that

[5] Bewley's observation that unions act as an information source accords with studies by Agell and Lundborg [1995, 1999] and Agell and Bennmarker [2004] who survey managers of Swedish companies about wage determination. In line with Bewley, many of their respondents indicate that wage claims are affected by profits and the firm's ability to pay. However, and in contrast to the responses of U.S. companies, Swedish managers gave larger support to the view that firm-external information such as unemployment and wages at other firms also matter for wage determination. Agell and Bennmarker try to assess whether this difference can be explained by the greater importance of labor unions in Sweden compared to the U.S. They find a significant positive correlation between union density and the appreciation of the external reference perspective, thus lending further support to the view that incomplete information is part of the explanation for why workers focus on internal rather than external wage references.

[6] As a rough measure of how much industry profits matter for wage dispersion, Blanchflower, Oswald and Sanfey (1996) report a Lester's range of approximately 25% of the mean wage. Lester's range is defined as four standard deviations of the firm performance variable (i.e. profits) times the elasticity of wages with respect to the firm performance variable.

high-wage individuals get sorted into high-performance firms because of *unobserved* abilities. The recent availability of large firm-worker matched panel data makes it possible to assess the relevance of rent-sharing versus the sorting argument. Abowd and Kramarz (2000) thus decompose wage data for France and Washington State, respectively, into observed worker characteristics plus unobserved worker and unobserved firm effects. Their estimates show that the two effects are about equally important in explaining wage disparity. Abowd, Creecy and Kramarz (2002) further report that the correlation between the two effects is slightly negative, a result that appears to contradict the sorting argument. Finally, Abowd, Kramarz, Margolis and Troske (2001) find that the unobserved firm effect is strongly and positively correlated with different firm productivity measures.[7]

While complementary explanations for rent sharing cannot be ruled out, the reciprocity view of labor relations features prominently among the potential organizing principles for the reported evidence. In particular it proposes (i) that reciprocal behavior by individuals is central to the firm's management of work effort; and (ii) that the firm's ability to pay is an important factor in workers' perception of a given wage offer (and thus of their effort decision). The model we now develop rationalizes this perspective.

3 A reciprocity-based model of efficiency wages

In line with efficiency wage theory, we assume that effort per unit of labor is an input to production but firms cannot directly observe the worker's provision of effort. Hence, in contrast with work hours, 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. If workers are fairly treated and work morale is high, workers will voluntarily provide effort even in the absence of monitoring or other material incentives.

[7] The latter finding is confirmed by Arai (2003) who uses firm-worker matched data from Sweden. Arai's estimates of the wage-profit relation are sizable and stable across unionized vs. non-unionized workers, blue-collar vs. white-collar workers, and for manufacturing and non-manufacturing sectors. Interestingly, Arai also introduces controls for worker supervision but finds no significant change in the wage-profit relation, thus providing further evidence against the shirking hypothesis.

3.1 The supply of effort

Akerlof (1982) in his seminal paper, and several studies thereafter, summarized the fair wage hypothesis of efficiency wages via a simple effort function of the form

$$e = e(w, w^r), \tag{1}$$

where effort, e, is an increasing function of the wage offer, w, and a decreasing function of some reference wage, w^r, viewed as "fair" by the worker. While broadly in line with this general perspective, the model we outline presently seeks explicit foundations for the functional form linking effort with the wage offer and the wage reference; for the measure of distance between wage offer and wage reference; and, above all, for the definition of the latter. This objective is justified by the observation, emphasized in what follows, that the ability of the efficiency wage perspective to generate significant rigidity and endogenous propagation to shocks is very much dependent on the definition of the wage reference.

Our model is inspired by the more recent literature on reciprocity and its formalization by Rabin (1993). It leads to an optimal condition for effort supply (equation (4)) that could equally well be taken as a reduced form expression for effort, i.e., as an alternative to the representation (1). Our development proceeds 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, $u(c, e)$, is standard: it states that utility is derived from consumption, c, while effort, e, provides direct disutility ($u_c > 0$, $u_{cc} \leq 0$ and $u_e < 0$, $u_{ee} < 0$). The second component, $s(w, e)$, admits that psychological satisfaction can also arise from providing effort in a work environment characterized by reciprocal behavior. 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 formalized 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]

$$-u_e = \lambda d_e g(w,\cdot). \tag{2}$$

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.

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 $u(c,e) = c - e^{\theta}$ with $\theta > 2$; and the production function takes the form $f(en) = A(en)^{\alpha}$ with $0 < \alpha < 1$.

Given these specifications and continuing in the spirit of Rabin, we now propose a measure of the gift of the worker. It is the difference between realized output per worker, on the one hand, and output per worker under a reference effort level, on the other. The latter is a weighted average (with weight μ and $(1-\mu)$, respectively) of output per worker under the maximum possible effort level, $e_{\max}$, and output per worker in the case of minimum possible effort, $e_{\min}$, on the other. Given our specification of utility, we naturally derive $e_{\min} = \arg\max_e (c - e^{\theta}) \Longrightarrow e_{\min} = 0$ and $e_{\max} = \arg\min_e (c - e^{\theta}) \Longrightarrow e_{\max} = c^{1/\theta}$. Since $An^{\alpha-1}e^{\alpha}$ represents output per worker if effort is e, the gift of the worker to the firm writes

$$\begin{aligned} d(e,\cdot) &= An^{\alpha-1}e^{\alpha} - \{\mu[An^{\alpha-1}c^{\alpha/\theta}] + (1-\mu)[0]\} \\ &= An^{\alpha-1}[e^{\alpha} - \mu c^{\alpha/\theta}]. \end{aligned}$$

Equation (2) makes clear that 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. Rabin's formulation has the property that, because the gift is measured in units of output, a larger effort level could

[8]The typical worker in this model is assumed to be one of a continuum who does not take into account the impact of his own individual effort on the firm's output and on the gift of the firm.

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. In the robustness section, however, we test an alternative specification where this effect is absent and the gift of the worker is measured directly in terms of effort, as in $d(e, \cdot) = G(e - \mu c^{1/\theta})$.

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 follow under a reference wage, the latter being a weighted average (with weight φ and $(1-\varphi)$, respectively) of the maximum and the minimum possible wage, $w_{\max}$ and $w_{\min}$. With linear-in-consumption preferences, utility payoffs are measured in wage units. The firm cannot pay more than y/n or it would go bankrupt. We assume that $w_{\max} = (y/n)^{\nu}, \nu < 1$. The parameter $\nu < 1$ is introduced for two reasons. One is practical: while it could technically pay a maximum wage of y/n, if $\nu = 1$, it will be impossible for the firm to extend a positive gift, and thus elicit a positive effort level, in the extreme case where $\varphi = 1$. Yet, it will turn out to be very convenient to convey intuition for our results by analyzing the extreme cases where $\varphi = 0$ or 1. Furthermore, a maximum wage lower than y/n is representative of more general formulations where the production process requires the use of factors of production other than labor, or in the presence of fixed costs.[9]

A worker always has the option to refuse a wage offer and "quit". In this case, his expected remuneration can be measured by $\bar{w}^{\bar{n}} b^{(1-\bar{n})}$, with $\bar{w}$ denoting the wage if hired by another firm, $\bar{n}$ the probability of reemployment and b the level of unemployment benefits which is relevant if the worker is not re-hired. Since we consider a continuum of identical firms, $\bar{w}$ and $\bar{n}$ also represent the aggregate level of wages and employment, respectively (with full employment being normalized to 1). To avoid an asymmetric impact of variations in the parameter ν, the outside option is raised to the same power as y/n in the maximum wage, that is, we assume the minimum acceptable wage to the worker is $\left[\bar{w}^{\bar{n}} b^{(1-\bar{n})}\right]^{\nu}$. This could be representative of a situation where there are costs to job search. We emphasize that while the ν parameter is useful to analyze the case where $\varphi = 1$, none of our results will ultimately depend on the specific value taken by ν (Section 4.3 makes this point). If the wage is lower, the worker is better off quitting

[9] It turns out to be important to introduce some curvature in the phrasing of the problem and thus represent a maximum wage lower than y/n via an exponent ν lower than 1, rather than by deducting a fixed proportion per worker from y/n. This is because in the latter case both the labor demand and the wage setting curves are linear in y/n and therefore no well defined interior equilibrium exists.

(not accepting the wage offer). With these assumptions, the gift of the firm towards the worker takes the form:[10]

$$g(w,\cdot) = w - \left\{\varphi\left(\frac{y}{n}\right)^{\nu} + (1-\varphi)[\bar{w}^{\bar{n}}b^{(1-\bar{n})}]^{\nu}\right\}, \tag{3}$$

while the EC can be expressed as

$$Qe^{\theta} = \frac{y}{n}\left[w - \left\{\varphi\left(\frac{y}{n}\right)^{\nu} + (1-\varphi)[\bar{w}^{\bar{n}}b^{(1-\bar{n})}]^{\nu}\right\}\right] \tag{4}$$

with $Q = \theta/\lambda\alpha$.

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

The opposite situation is $\varphi = 1$. Here what matters is not the conditions of remuneration outside the firm. The sharing of the rent within the firm, between workers and firm owners, is at the center of attention – a perspective that is very much related to the idea of reciprocity and the notion of equitable payoffs. In this firm-*internal* reference view, workers view 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 of his effort; 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).

3.2 Firm's optimal policy

As discussed above, firms cannot directly observe effort. They understand, however, that workers reciprocate according to the EC in (4). The firm's manager thus makes the first

[10] Our analysis is static and therefore it cannot address the issue of incomplete information and learning touched upon in the previous section. Modeling information frictions in a fully dynamic context is an obvious natural extension to the present paper. See the concluding section.

move in the form of a wage offer which is the result of his estimating (according to (4)) how the offer will be perceived by the worker and how the worker will react to the gift of the firm thus manifested.[11] Specifically, firms solve

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

subject to the effort condition in (4). The term ψ represents the inverse of the markup (i.e. the real marginal cost) that firms apply in monopolistic competition; and $f(\cdot)$ is the production function.[12] The ensuing first order conditions are

$$w = \psi\left(f_n + f_e \frac{\partial e}{\partial n}\right) \tag{5}$$

$$n = \psi f_e \frac{\partial e}{\partial w}. \tag{6}$$

Given the log-linear nature of the production function, we can rewrite $f_e = f_n n/e$ and express condition (5) as

$$w = \psi f_n(1 + \varepsilon_{e,n}), \tag{7}$$

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.[13]

[11] Note that the behavior of the firm is entirely rational. Contrary to Rabin's, our formulation of the problem is thus asymmetrical with a rational firm optimizing in a context where workers display reciprocal behavior. Our approach thus demonstrates that reciprocity may have important economic consequences even if one of the players (the firm) only cares about material payoffs. Note as well that, as opposed to Rabin's, our model allows for continuous decision choices and takes into account general equilibrium effects.

[12] 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. $\psi < 1$.

[13] 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 negociation. An increase in labor therefore reduces the negociated 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.

Similarly, we can combine conditions (5) and (6) to obtain

$$\varepsilon_{e,w} - \varepsilon_{e,n} = 1. \tag{8}$$

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 current 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 paribus, the last wage increase warranted in a standard efficiency wage context would not pay for itself here.[14]

3.3 Equilibrium

With homogenous firms and workers, equilibrium implies that wages and employment are the same for everyone; i.e. $w = \bar{w}$ and $n = \bar{n}$. In order to conveniently summarize our main equilibrium equations, we first combine (7) with the MSC (8) to obtain, after rearranging (see the appendix for details), an explicit expression for the labor demand:

$$w = \frac{(\theta - 1)}{(\theta - \alpha)} \alpha \psi \frac{y}{n} + \frac{(1 - \alpha)\theta}{(\theta - \alpha)} \nu \varphi \left(\frac{y}{n}\right)^{\nu}. \tag{9}$$

We can likewise combine the effort function (4) with the MSC (8) to eliminate the effort variable and obtain

$$w = \bar{\theta} \varphi \left(\frac{y}{n}\right)^{\nu} + \tilde{\theta}(1 - \varphi) \left(w^n b^{(1-n)}\right)^{\nu}, \tag{10}$$

where $\bar{\theta} = (\theta - 1 - \nu)/(\theta - 2) > 1$ and $\tilde{\theta} = (\theta - 1)/(\theta - 2) > 1$, and we have made the substitution $w = \bar{w}$ and $n = \bar{n}$ descriptive of equilibrium. Equation (10) is the aggregate wage setting curve. It replaces the labor supply equation of standard Walrasian models and stipulates that the equilibrium wage, designed to elicit optimal effort, is increasing in the firms' productivity, y/n, and the workers expected outside earning option, $w^n b^{(1-n)}$.

[14] 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.

This property is intuitive: an increase in the wage reference, ceteris paribus, forces firms to increase their own wage offer. It is an important driver in the comparative statics results that follow.[15] Finally, taking this wage setting equation into account, equilibrium effort is described by

$$Qe^{\theta} = \frac{y}{n}\left[(\bar{\theta}-1)\varphi\left(\frac{y}{n}\right)^{\nu} + (\tilde{\theta}-1)(1-\varphi)\left(w^{n}b^{(1-n)}\right)^{\nu}\right]. \tag{11}$$

In equilibrium, $y = c$ (no investment). The equilibrium values of w, n, e, y are implied by the solution to the system formed by the labor demand curve (9), the wage setting curve (10), the optimal effort equation (11), and the production function. The difference between the resulting employment level and the total amount of labor supplied determines the level of unemployment.

Before closing this section, let us add a few comments on equation (11). This condition describes the result, at equilibrium, of firms' "effort management policy". Since $\bar{\theta} > 1$ and $\tilde{\theta} > 1$, firms set wages such that effort increases with both labor productivity y/n and the outside option $w^{n}b^{(1-n)}$. The positive influence of the y/n term outside the square brackets is the result of our modeling choice discussed in section 3.1 (step 3): workers volunteer effort more willingly in situations where firms are highly productive because the same gift of effort yields a larger output increment and is thus more highly valued by firms in such circumstances. The positive coefficient on the two components of the wage reference (inside the brackets) is more surprising. One could have expected that, when firms are confronted with a tougher competition, in the sense that the wage reference is higher, they would find it optimal to increase their own wage offer (as stipulated by the wage setting curve) but also to accept a decrease in workers' effort level (since the latter is apparently more costly to obtain).

This cannot be the case in our setup. Equation (4) makes clear that effort is positive only if w is larger than the wage reference. This requires that both θ's in (10) are indeed larger than 1, which delivers the property in question by (11). Thus, a high wage reference, in general, and a high y/n, in particular, signal a good time to elicit (and to volunteer) effort and effort co-moves with these variables over the cycle.

To get a feel for this result, consider Figure 1 depicting the effort condition (4) for the case of a purely external reference.[16] The EC is a concave function in the $e - w$ space. An increase in the wage reference corresponds to a rightward translation of this

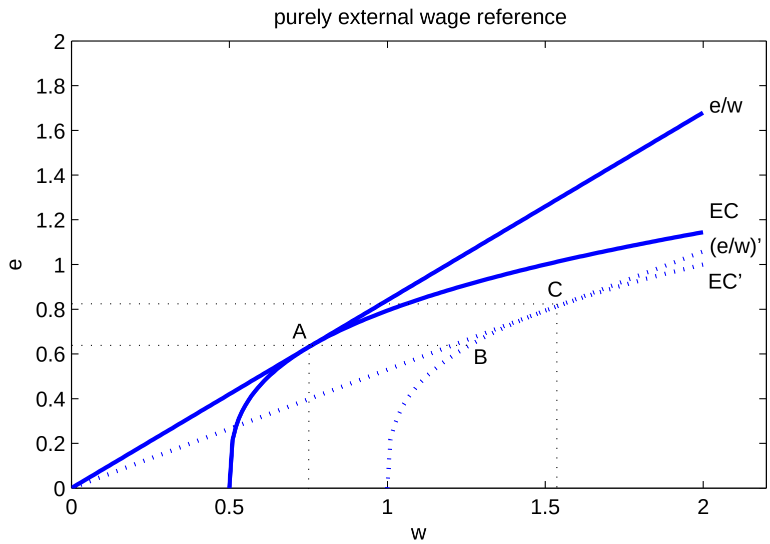
[15]The similarity between this wage setting equation and the one obtained in a search and matching context will be taken up in our concluding comments.

[16]For clarity we abstract from the y/n term outside the square bracket in (11). The argument made for one extreme case would hold in the other extreme case as well although the shape of the EC curve would not be identical and the MSC rather than the SC would have to be invoked.

concave curve with unchanged slope $\partial e/\partial w$ for any given e level. Concavity then implies that tangency with a ray from the origin of slope e/w must occur at a higher e level (point C rather than B). Thus, for the SC to obtain, the firm must increase its wage offer in order to elicit this higher effort level. While we cannot claim that this result would prevail for any change in our functional forms, it is more robust than the initial intuition would suggest. Indeed, given that the EC curve is a concave function of the premium of the wage over the reference wage, a property that itself follows from the highly plausible assumption that the marginal disutility of effort is increasing ($u_{ee} < 0$), a negative or zero correlation between effort and the wage reference would obtain only if changes in the wage reference were to significantly modify the *shape* of the EC curve (with a rightward shift being associated with an increase in the curvature).

To summarize, whatever its definition, an increase in the wage reference robustly leads firms to increase their wage offer. This implies that optimal effort adjusts to a level such that the marginal wage change elicits a smaller effort response (e/w lower implies $\partial e/\partial w$ lower by the SC). In the absence of major changes in the shape of the EC, concavity means that the new effort level is higher. If, in addition, the increase in the wage reference comes from a rise in y/n, the impact of a given gift of effort by workers is larger and they will be more prone to reciprocate. In substance, these two elements mean that, contrary to intuition, effort is *not* more costly to obtain when the wage reference is higher.

Figure 1: Illustrating the optimal effort condition



4 Wages, employment and effort in the cycle

We now analyze the properties of our reciprocity-based efficiency wage model. The main focus is on how rent-sharing considerations affect the general equilibrium responses of wages, employment and effort to exogenous shocks. We perform two sets of comparative statics exercises; the first involves a technology shock given flexible prices; and the second deals with a demand shock given fixed prices.[17]

4.1 Comparative statics

The comparative statics analysis is performed with respect to a benchmark equilibrium whose calibration is summarized in Table 1.

Table 1: Benchmark calibration

Parameter	n	α	ψ	ρ	φ	θ	v	A
Value	0.95	0.66	0.9	0.5	0.5	3	0.75	1

We target a realistic level for equilibrium unemployment of 5%, resulting in an employment level $n = 0.95$. This pins down the value of one parameter, in our case λ, in terms of the values of the other parameters and n (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 equilibrium markup $1/\psi$ of 11%), and $\rho = 0.5$ (a replacement ratio of unemployment benefits to equilibrium wages of 50%). The resulting level of unemployment benefits b is then kept constant when computing the comparative statics (in line with the observation that b usually depends on a weighted average of past wages).

As to the calibration of φ, recall that $\varphi = 0$ corresponds to the situation (privileged by traditional efficiency wage models) where workers have a purely external vision of the reference wage. The case of $\varphi = 1$, by contrast, is the one where outside earning opportunities do not matter and only internal rent-sharing considerations are relevant. The evidence reviewed in Section 2 supports the view that both these perspectives are important; we therefore select $\varphi = 0.5$ as our benchmark. Since one of our main tasks

[17]Our ultimate objective is to incorporate a model such as the one developed in Section 3 into a full-blown dynamic stochastic general equilibrium framework. We refrain from doing so at this stage because this requires making and justifying a number of additional, non-trivial, modeling choices. The super-imposed structure would obscure the underlying mechanics of our model and make it harder to convey the intuition behind our results. We have checked, nevertheless, that all of our conclusions hold up in a small loglinear New Keynesian framework (the details of this model, and the results, are available from the authors upon request).

will be to assess how the model properties depend on φ, we will also analyze extensively the two extreme cases, $\varphi = 0$ and $\varphi = 1$.

Finally, in the absence of clear guidance on the parameters θ and ν, we select $\theta = 3$ (recall that our model requires $\theta > 2$ for the equilibrium to be well-defined) and $\nu = 0.75$ for our benchmark and perform extensive robustness tests. Our benchmark calibration implies an equilibrium labor income share $wn/y = 0.58$ which is close to the average labor income share observed in the U.S. over the post-World-War-II period.

Table 2a displays the general equilibrium responses of the model to a 1% *decrease* in technology A, given flexible prices. Under this hypothesis, 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.

Table 2a: Response of endogenous variables to a 1% technology shock

Value of φ	y	n	w	e	ψ	y/n
0	-2.10	-0.79	-1.32	-0.88	0	-1.32
0.5	-2.27	-1.15	-1.10	-0.78	0	-1.14
1	-2.97	-2.97	0	0	0	0

Table 2b reports the responses following a *negative* 1% shock in demand y under the assumption that prices are completely fixed. This scenario mimicks a Keynesian situation where the equilibrium is fully demand-determined and firms have to adjust their production to exactly match the reduction in demand.

Table 2b: Response of endogenous variables to a 1% demand shock

Value of φ	y	n	w	e	ψ	y/n
0	-1	-0.95	-1.59	-0.55	-1.54	-0.05
0.5	-1	-1.46	-0.31	-0.04	-0.86	0.47
1	-1	-2.19	0.91	0.71	-0.30	1.21

Consider first the comparative statics for our benchmark calibration $\varphi = 0.5$ (second row of each table). The 1% decrease in A in Table 2a results in a strong decrease in output (-2.27%) as the direct effect of the fall in productivity is amplified by a decrease in both employment (-1.15%) and effort (-0.78%). The real wage decreases by 1.1% and the decline in labor productivity y/n is commensurate (-1.14%).

Turning to the demand shock in Table 2b, output adjusts, by construction, to the new level of demand (it falls by exactly 1%). Since effort barely reacts (-0.04%), the concavity of the production function implies that firms achieve the required drop in effective labor, en, through a more than proportionate decrease in employment (-1.46%). Wages, in turn, react only modestly (-0.31%) while labor productivity increases by 0.47%. Finally, note that as effective labor, en, adjusts to its new cost-minimizing level, real marginal cost, ψ, also decreases from its optimal (flexible price) level (-0.86%).[18]

The first striking aspect of these results is how they differ across the two shocks. While both shocks lead to a situation of depressed economic activity, the fall in employment per unit of output is almost three times as large in response to the demand shock than in response to the technology shock ($\Delta n/\Delta y = 1.46$ in Table 2b versus $\Delta n/\Delta y = 0.51$ in Table 2a). Conversely, the relative wage change is smaller in the demand shock case ($\Delta w/\Delta y = 0.31$ in Table 2b versus $\Delta w/\Delta y = 0.49$ in Table 2a). Finally, labor productivity responds in opposite directions ($\Delta(y/n) = .47\%$ in Table 2b versus $\Delta(y/n) = -1.14\%$ in Table 2a).

This asymmetry is entirely due to the rent sharing element in the wage reference and the fact that labor productivity reacts in 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 and e.[19]

The asymmetry in the 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), Francis and Ramey (2003) and Christiano, Eichenbaum and Vigfusson (2003) find that the response of employment to a technology shock is initially smaller than (or even inverse to) the reaction to a demand shock. Independently, Blanchard (1989), Gamber and Joutz (1997) and Fleischman (1999) all report, based on various identification schemes, that conditional on demand shocks, real wages are acyclical (or even slightly countercyclical) while they are procyclical conditional on technology shocks.

The second interesting dimension of our results is the influence of the parameter φ. Reading Tables 2a and 2b from top to bottom, one sees that, whatever the source of the shock, a stronger emphasis on the internal reference perspective systematically

[18] As is standard in the New Keynesian literature, our fixed price demand shock is sufficiently small for profits of the monopolistically competitive firms to remain positive.

[19] One could suspect that the asymmetry of results is due to the fact 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 asymmetry 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. This outcome is confirmed in the small loglinear New Keynesian extension mentioned in footnote 17.

increases the effect on employment and decreases the effect on wages. In fact, for $\varphi = 0$, the wage reaction to both types of shocks is larger than the employment reaction. 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. By contrast, for $\varphi = 1$, wages become completely acyclical in response to a technology shock and even countercyclical in response to a demand shock. Reciprocity-based rent-sharing thus appears as a potentially important source of real wage rigidity.

Finally, the results in Tables 2a and 2b demonstrate that the two perspectives bear sharply different implications for the behavior of effort. Whatever the type of shock, the case of $\varphi = 0$ induces a pro-cyclical reaction of effort. In contrast, for $\varphi = 1$, effort does not respond to a technology shock while a demand shock induces a strongly counter-cyclical effort response (provoked by the increase in y/n). For the plausible benchmark of $\varphi = 0.5$, effort is procyclical in response to the technology shock and acyclical in response to the demand shock. In this case, our model thus offers a competing explanation to Burnside and Eichenbaum's (1996) labor hoarding story for the pro-cyclicity of effort. A pro-cyclical effort endows the model economy with an internal amplification mechanism and results in a more plausible series for Solow residuals as a measure of technology shocks. The intuition for these results is developed in details in the next subsection.

4.2 Generating intuition: a further look at the extremes

In order to understand the mechanics behind these results, it is useful to probe further the two extreme cases, $\varphi = 0$ and $\varphi = 1$. Table 3 regroups the relevant equilibrium equations in simplified form.[20]

Table 3: Equilibrium equations for extreme values of φ

	$\varphi = 0$	$\varphi = 1$
WS	$w = \tilde{\theta}\left(w^n b^{(1-n)}\right)^{\nu}$	$w = \bar{\theta}\left(\frac{y}{n}\right)^{\nu}$
LD	$w = \frac{(\theta-1)}{(\theta-\alpha)}\alpha\psi\frac{y}{n}$	$w = \frac{(\theta-1)}{(\theta-\alpha)-(1-\alpha)\frac{\nu\theta}{\bar{\theta}}}\alpha\psi\frac{y}{n}$
EC	$Qe^{\theta} = \frac{y}{n}\frac{\tilde{\theta}-1}{\tilde{\theta}}w$	$Qe^{\theta} = \frac{y}{n}\frac{\bar{\theta}-1}{\bar{\theta}}w$

Note that the wage setting curve (WS) is the only dimension that clearly set the two cases apart. But for slightly different slope coefficients, the labor demand (LD) and effort conditions (EC) have the same form.

[20]The formulas for the ECs were derived using the wage setting curve to substitute for $\left[w^n b^{(1-n)}\right]^{\nu}$ and $\frac{y}{n}{}^{\nu}$, respectively.

4.2.1 Purely External reference

Consider first the wage setting curve in the purely external wage reference ($\varphi = 0$): $w = \tilde{\theta}[w^n b^{(1-n)}]^\nu$. Taking unemployment benefits b as given, there is a direct relationship between w and n that does not involve other variables. *Both* technology and demand shocks therefore result in shifts of the labor demand curve moving the equilibrium *along* the wage setting curve. This is why the relative responses of w and n in the $\varphi = 0$ case are perfectly symmetrical and largely independent from the source of the shock. We can use the elasticity of w with respect to n as a good measure of wage rigidity. With $\nu = 1$ and $b = \rho w$, this elasticity equals[21]

$$\frac{\partial w}{\partial n}\frac{n}{w} = \frac{n}{(1-n)}(\log w - \log b) = -\frac{n}{(1-n)}\log \rho > 0.$$

For unemployment rates between 5% and 10% and replacement ratios vary between 0.35 and 0.65, we obtain the matrix of elasticities reported in Table 4.

Table 4: Wage employment elasticity when $\varphi = 0$

	$\rho = 0.35$	$\rho = 0.65$
$n = 0.9$	9.45	3.88
$n = 0.95$	19.95	8.19

Even in the "most favorable" scenario ($n = 0.9$ and $\rho = 0.65$), labor demand shifts wages almost four times as much as employment. The intuition for the absence of wage rigidity in this case 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, decreases 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.

A fuller understanding of our comparative statics results is forthcoming if one traces the effect of the two shocks on the equilibrium equations of Table 3. Let us consider first the effects of a negative technology shock for $\varphi = 0$. (The analysis for the case of $\varphi = 1$ is performed in the next subsection.)

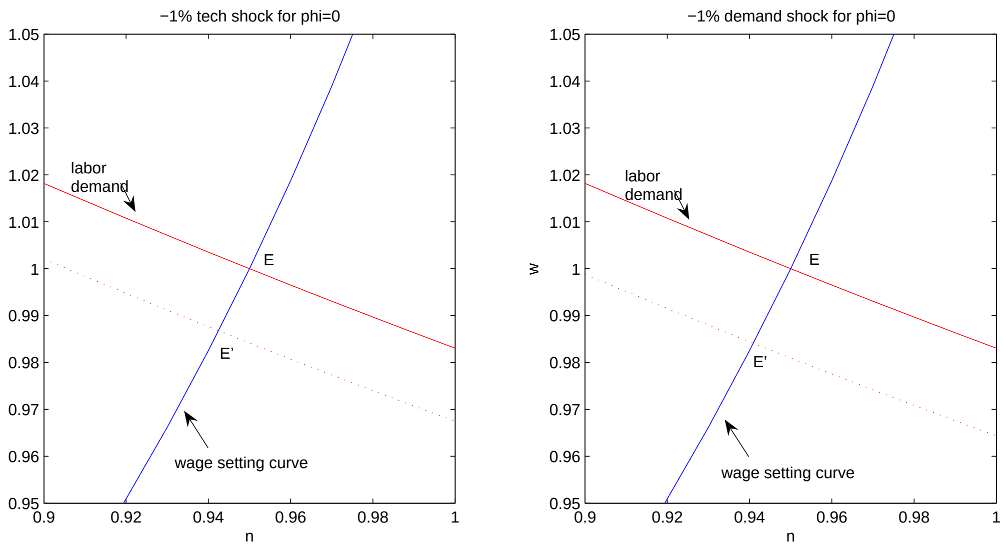
Assuming for the moment that e remains at its equilibrium level, the firm needs to decrease both n and w for the LD and the WS to hold after a negative technology

[21] The second equality is obtained by setting unemployment benefits at their equilibrium value $b = \rho w$. This elasticity measure and the values in Table 4 should therefore be considered as approximations around the benchmark equilibrium.

shock. This is because the WS stipulates a positive relationship between w and n, and a counterfactual increase in the two variables, and with it a further drop in y/n (by the concavity of the production function), would violate the LD condition.[22] Turning to effort, the EC implies that workers decrease e because both y/n and the wage reference are lower. This in turn amplifies the negative effect of the drop in A on y, n and w.

The same sequence of effects applies for the fixed price demand shock and this explains that the two types of shocks have similar effects (on n and w) in the external reference case. For a given e, the firm decreases n to meet the required drop in y. The lower employment level triggers a fall in the wage reference and thus w, e and y/n all decrease as implied by the WS, LD and EC curves. In addition, the EC and the WS imply that the drop in w is relatively larger than the drop in y/n. As a result, real marginal cost ψ also falls (by the LD). These adjustments are illustrated in Figure 2.

Figure 2: Comparative statics when $\varphi = 0$



Note: Calibration as described in the text, in particular $A = 1; \alpha = .66; \psi = .9; n = .95; \nu = .75; \rho = .5$

4.2.2 Purely internal reference

Turning to the purely internal reference case ($\varphi = 1$) case, first observe that the wage setting curve (combined with the production function), $w = \bar{\theta}(Ae^{\alpha}n^{\alpha-1})^{\nu}$, is fundamen-

[22]This later point also explains why firms decrease n by a relatively small amount (compared to w) so as not to completely neutralize or even reverse the negative effect of A on y/n.

tally different from the corresponding equation in the external case. For a given level of technology A and effort e, the elasticity of w with respect to n becomes (again setting $\nu = 1$)

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

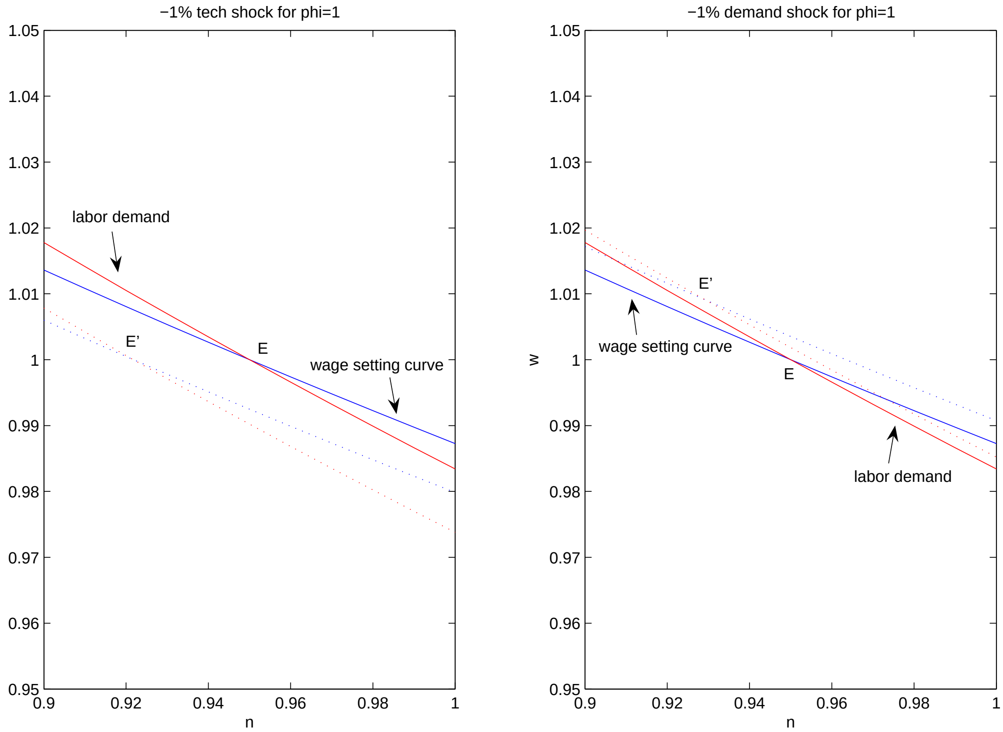
Everything else constant, firms thus accompany higher employment with *lower* instead of higher wages. The central mechanism behind this result is diminishing marginal returns of labor ($0 < \alpha < 1$). A decrease in employment ceteris paribus leads to an increase in output per worker y/n. As a result,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

Another 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 and/or general equilibrium effects on e 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 shocks.

To understand the impact of a negative technology shock in this case, it suffices to observe that the LD and WS curves form a system in w and y/n that is independent of A. Technology shock therefore leave w, y/n and e unchanged as we found in Table 2b.

By contrast, exogenous changes in demand under fixed prices affect the firm's real marginal costs ψ. This additional margin shifts the LD but does not directly affect the WS. Hence, w, y/n and e may all adjust in response to a demand shock. Assuming as before that e initially remains at its equilibrium level, the drop in demand requires the firm to decrease n, thus resulting in an increase in y/n. This increase in y/n leads the firm to raise w. The increase in w, in turn, has the effect that workers step up their effort level e (by the EC), thus amplifying the fall in n and the increase in y/n and w (the WS shifts up). These adjustments are illustrated in Figure 3 where one sees that the negative technology shock (left-hand panel) shifts *down* both LD and WS. On the contrary, in the negative demand shock case, the general equilibrium increase in e shifts *upward* both the WS and the LD – a reaction that is very different from the purely external case where the LD shifts down along the stable WS. Note that this asymmetric move in n and w would occur even if the LD were to shift down after the demand shock (which would be the case if the increase in effort were smaller and was outweighed by the decrease in real marginal cost).

Figure 3: Comparative statics when $\varphi = 1$



Note: Calibration as described in the text, in particular $A = 1; \alpha = .66; \psi = .9; n = .95; \nu = .75; \rho = .5$

4.3 Robustness

We assess the robustness of our benchmark model along two dimensions. First, we report how the comparative statics change for different calibrations of ν and θ, the two parameters for which we have little a priori evidence. Second, we consider an alternative definition of the worker's gift $d(e, \cdot)$.

4.3.1 Robustness to alternative calibrations of ν and θ

Tables 5a and 5b display the changes in y, n, w and e following a -1% technology shock and a -1% demand shock when $\nu = 0.5$ and $\nu = 0.9$, respectively. All other parameters are left at their benchmark calibration values. The following observations are worth making. First, a higher value of ν does not alter the reaction to a technology shock when $\varphi = 1$, that is, in the internal reference case. In the case of a demand shock, the reaction of all three endogenous variables, employment, wage and effort is amplified when $\nu = .9$. By contrast, the performance of the model with an entirely external reference deteriorates with both shocks being met by a larger wage adjustment and a smaller employment reaction. The intuition here is that the higher value of ν makes the outside wage reference even more responsive to general equilibrium effects. The consequence is that the performance of the model where both perspectives are present (and $\varphi = .5$) deteriorates somewhat quantitatively. Our previous message, however, remains unchanged: the more rent-sharing matters in firms' wage policy, the more wage rigidity, internal amplification, and asymmetric responses to technology and demand shocks the model implies.

Table 5a: Robustness to different ν for -1% technology shock

	$\nu = 0.5$				$\nu = 0.9$			
Value of φ	y	n	w	e	y	n	w	e
0	-2.38	-1.48	-0.91	-0.61	-1.95	-0.39	-1.56	-1.04
.5	-2.58	-1.95	-0.62	-0.44	-2.03	-0.56	-1.46	-1.00
1	-2.97	-2.97	0	0	-2.97	-2.97	0	0

Table 5b: Robustness to different ν for -1% demand shock

	$\nu = 0.5$				$\nu = 0.9$			
Value of φ	y	n	w	e	y	n	w	e
0	-1.00	-1.34	-0.82	-0.16	-1.00	-0.59	-2.31	-0.91
.5	-1.00	-1.63	-0.13	0.14	-1.00	-1.26	-0.52	-0.24
1	-1.00	-1.99	0.50	0.50	-1.00	-2.35	1.24	0.87

Tables 6a and 6b display the same information for alternative values of the parameter θ: $\theta = 2.5$ and $\theta = 0.5$ (recall that $\theta > 2$ for the model to have a positive equilibrium). A larger θ increases the workers aversion to effort. The effort function thus becomes more concave in its arguments, i.e. changes in w, y/n or $w^n b^{1-n}$ have a relatively smaller effect on the supply of effort. Here as well there is no impact of this parameter change in the case of a technology shock when $\varphi = 1$. In the case of a demand shock, all three endogenous variables, n, w, e react less when θ increases. The changes are in the same direction under a technology shock when $\varphi = 0$: an increase in θ decreases the reaction of n, w and e. By contrast, a demand shock causes a *larger* decrease in both n and w (but not e). These contrasted results imply that the comparative statics is little affected by variations in θ when both perspectives are present ($\varphi = .5$).

Table 6a: Robustness to different θ for -1% technology shock

	$\theta = 2.5$				$\theta = 5$			
Value of φ	y	n	w	e	y	n	w	e
0	-2.38	-0.90	-1.45	-1.20	-1.71	-0.64	-1.07	-0.43
.5	-2.51	-1.23	-1.26	-1.05	-1.92	-1.00	-0.89	-0.39
1	-2.97	-2.97	0	0	-2.97	-2.97	0	0

Table 6b: Robustness to different θ for -1% demand shock

	$\theta = 2.5$				$\theta = 5$			
Value of φ	y	n	w	e	y	n	w	e
0	-1.00	-0.87	-1.45	-0.64	-1.00	-1.15	-1.90	-0.35
.5	-1.00	-1.43	-0.40	-0.07	-1.00	-1.49	-0.21	-0.01
1	-1.00	-2.65	1.26	1.18	-1.00	-1.76	0.58	0.27

4.3.2 Robustness to alternative definition of the worker's gift

The second robustness check we perform concerns an alternative definition of the worker's gift to the firm, $d(e, \cdot)$. In section 3.1, we defined this gift as $d(e, \cdot) = An^{\alpha-1}[e^{\alpha} - \mu c^{\alpha/\theta}]$. The presence of the $An^{\alpha-1}$ term implies that the worker realizes that supplying effort is less valuable to the firm in low productivity situations and vice versa in high productivity states. As we noted, this modeling choice is part of the explanation for the procyclicity of effort in our model.

Yet, it seems also possible that the worker does not internalize the productivity situation of the firm when measuring his gift of effort. If this is the case, it may be more appropriate to define the worker's gift to the firm directly in terms of effort as in

$$d(e, \cdot) = G(e - \mu c^{1/\theta}).$$

For simplicity and for lack of indication otherwise, we assume here that G_e is a constant normalized to 1. Leaving the gift of the firm towards the worker unchanged, the effort function thus becomes

$$Qe^{\theta} = e\left[w - \left\{\varphi\left(\frac{y}{n}\right)^{\nu} + (1-\varphi)[\bar{w}^{\bar{n}}b^{(1-\bar{n})}]^{\nu}\right\}\right],$$

with $Q = \theta/\lambda$. As can be seen immediately, the y/n term in front of the gift of the firm towards the worker on the left-hand-side of this equation is replaced by e. Hence, the firm's productive situation (i.e. $An^{\alpha-1}$) no longer affects the worker's evaluation of the gift to the firm. At the same time, the fact that effort now enters linearly on the left-hand side makes the supply of effort less concave. Everything else constant, movements in the gift of the firm therefore have a larger effect on effort than before.

The change in the effort function hardly affects the rest of the model. The wage setting curve in (10) remains exactly the same, while the labor demand takes on a slightly different form and becomes

$$w = \alpha\psi\frac{y}{n} + (1-\alpha)v\varphi\left(\frac{y}{n}\right)^{\nu}.$$

Tables 7a and 7b report the comparative statics with respect to a technology shock for this alternative definition of the effort function (all parameters are kept at their benchmark calibration values).

Table 7a: Changes in endogenous variables following a 1% technology shock

(Alternative definition of the gift of the worker - Various φ)

Value of φ	y	n	w	e	ψ	y/n
0	-1.84	-0.69	-1.16	-0.58	0	-1.16
.5	-2.03	-1.02	-1.00	-0.55	0	-1.03
1	-2.97	-2.97	0	0	0	0

Table 7b: Changes in endogenous variables following a 1% demand shock

(Alternative definition of the gift of the worker - Various φ)

Value of φ	y	n	w	e	ψ	y/n
0	-1	-0.82	-1.37	-0.69	-1.18	-0.18
.5	-1	-1.20	-0.39	-0.30	-0.65	0.20
1	-1	-1.79	0.60	0.30	-0.20	0.81

In the case of a technology shock, the absence of the labor productivity effect on the gift of effort outweighs the amplifying effect of the smaller curvature of the EC on the supply of effort. Effort therefore becomes less procyclical (unless, of course, $\varphi = 1$ in which case effort remains constant). This in turn reduces the internal amplification mechanism and implies a smaller fall in output and labor productivity. As a result, both wages and employment decrease by a smaller amount.

For the negative demand shock case, the relative forces are inverted: the amplifying effect of the smaller curvature in the EC outweighs the absence of the labor productivity effect on the gift of effort and effort becomes more procyclical. Employment therefore needs to fall by less to meet the lower demand, and wages also become less procyclical.

Overall, these differences are quantitatively small and they do not alter the qualitative message of our model: rent-sharing considerations promote wage rigidity, internal amplification and asymmetric responses to technology and demand shocks.

5 Conclusion

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 setup 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 workers' outside earning opportunities but also on their own profitability. The resulting form of rent sharing generates strong wage rigidity, significant asymmetries in reaction to demand and supply shocks, and pro-cyclical effort.

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). From this perspective, our model stands as a complementary explanation for the pervasive micro-econometric evidence that the firm's ability to pay is an important determinant of wages. The implications of our view on rent-sharing for cyclical macroeconomics are new, however. We show, in particular, that, together with the assumption of diminishing marginal returns to labor, rent-sharing arising from reciprocity has the potential to answer some of the outstanding puzzles in the theory of economic fluctuations.

The lessons of our exercise may extend well beyond the specifics of our model. Consider the burgeoning literature on search and matching in the labor market, for example. Rent-sharing in this 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.[23]

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 is the crucial difference between our setting, which delivers rigidity, and the search and matching framework, which does not. Part of the answer is the absence of diminishing marginal returns to labor in the search and matching models. Firms in those models are small and can only hire one worker. Changes in technology therefore translate one-to-one into changes in

[23]See, for example, equation 1.20 in Pissarides (2000)

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 analysis 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. Combining a thus-enriched search and matching framework with the efficiency 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 setup is a second natural extension of our research. This undertaking will 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 often workers 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.

[24] A recent study by Cahuc, Marque and Wasmer (2004) is a first step in this direction. These authors combine Stole and Zwiebel's (1996) intra-firm 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.

References

[1] Abowd, John M., and Francis Kramarz, "Inter-industry and Firm-size Wage Differentials: New Evidence from Linked Employer-Employee Data," Cornell University working paper (2000).

[2] Abowd, John M., Francis Kramarz, David N. Margolis, and Kenneth R. Troske, "The Relative Importance of Employer and Employee Effects on Compensation: A Comparison of France and the United States," *Journal of the Japanese and International Economies*, XV (2001), 419-436.

[3] Abowd, John M., Robert Creecy, and Francis Kramarz, "Computing Person and Firm Effects Using Linked Longitudinal Employer-Employee Data," Cornell University working paper (2002).

[4] Abowd, John M., and Thomas Lemieux, "The Effects of Product Market Competition on Collective Bargaining Agreements: The Case of Foreign Competition in Canada," *Quarterly Journal of Economics*, CVIII (1993), 983-1014.

[5] Adams, J. Stacy, "Toward an Understanding of Inequity," *Journal of Abnormal and Social Psychology*, LXVII (1963), 422-436.

[6] Agell, Jonas, and Helge Bennmarker, "Endogenous Wage Rigidity," Stockholm University working paper (2004).

[7] Agell, Jonas, and Per Lundborg, "Theories of Pay and Unemployment: Survey Evidence from Swedish Manufacturing Firms." *Scandinavian Journal of Economics*, XCI (1995), 295-307.

[8] Agell, Jonas, and Per Lundborg, "Survey Evidence on Wage Rigidity and Unemployment," *Scandinavian Journal of Economics*, CV (1999), 15-29.

[9] Akerlof, George A., "Labor Contracts as Partial Gift Exchange," *Quarterly Journal of Economics*, XCVII (1982), 543-569.

[10] Akerlof, George A. and Janet L. Yellen, "The Fair Wage-Effort Hypothesis and Unemployment," *Quarterly Journal of Economics*, CV (1990), 255-283.

[11] Arai, Mahmood, "Wages, Profits and Capital Intensity: Evidence from Matched Worker-Firm Data," *Journal of Labor Economics*, XXI (2003), 593-618.

[12] Bewley, Truman F., *Why Wages Don't Fall During a Recession* (Cambridge: Harvard University Press, 1999).

[13] Bewley, Truman F., "Fairness, Reciprocity, and Wage Rigidity," Cowles Foundation Discussion Paper No. 1383 (2002).

[14] Blanchard, Olivier J., "A Traditional Interpretation of Macroeconomic Fluctuations," *American Economic Review*, LXXIX (1989), 1146-1164.

[15] Blanchflower, David G, Andrew J. Oswald, and Mario D. Garrett, "Insider Power in Wage Determination," *Economica*, LVII (1990), 363-370.

[16] Blanchflower, David G, Andrew J. Oswald, and Peter Sanfey, "Wages, Profits and Rent-Sharing," *Quarterly Journal of Economics*, CXI (1996), 227-251.

[17] Blau, Peter M., *The Dynamics of Bureaucracy: A Study of Interpersonal Realtions in Two Government Agencies* (Chicago: Chicago University Press, 1955).

[18] Burnside, Craig, and Martin Eichenbaum, "Factor Hoarding and the Propagation of Business Cycle Shocks," *American Economic Review*, LXXXVI (1996), 1154-1174.

[19] Cahuc, Pierre, Francois Marque, and Etienne Wasmer, "A Theory of Wages and Labour Demand with Intra-Firm Bargaining and Matching Frictions," CEPR Discussion paper no. 4605 (2004).

[20] Campbell, Carl, and Kunal Kamlani, "The Reasons for Wage Rigidity: Evidence from Survey of Firms," *Quarterly Journal of Economics*, CXII (1997), 759-789.

[21] Christiano, Lawrence, Martin Eichenbaum and Robert Vigfusson, "The Response of Hours to a Technology Shock: Evidence Based on Direct Measures of Technology", Working paper, Northwestern University (2003)

[22] Christofides, Louis N., and Andrew J. Oswald, "Real Wage Determination and Rent-Sharing in Collective Bargaining Agreements." *Quarterly Journal of Economics*, CVII (1992), 985-1002.

[23] Collard, Fabrice, and David De la Croix, "Gift Exchange and the Business Cycle: The Fair Wage Strikes Back," *Review of Economic Dynamics*, III (2000), 166-193.

[24] Danthine, Jean-Pierre, and John B. Donaldson, "Efficiency Wages and the Real Business Cycles", *European Economic Review*, XXXIV (1990), 1275-1301.

[25] Danthine, Jean-Pierre, and André Kurmann, "Fair Wages in a New Keynesian Model of the Business Cycle," *Review of Economic Dynamics*, VII (2004), 107-142.

[26] Diamond, Peter A., "Mobility Costs, Frictional Unemployment, and Efficiency," *Journal of Political Economy*, 1981, 89, 798812.

[27] Dickens, William T. and Lawrence Katz, "Inter-Industry Wage Differences and Industry Characteristics," in Kevin Land and Jonathan S. Leonard, eds., *Unemployment and the Structure of the Labor Market* (Oxford: Basil Blackwell, 1987).

[28] Fehr, Ernst, and Armin Falk, "Wage Rigidity in a Competitive Incomplete Contract Market," *Journal of Political Economy*, CVII (1999), 106-134.

[29] Fehr, Ernst, and Simon Gächter, "Fairness and Retaliation: The Economics of Reciprocity," *Journal of Economic Perspectives*, XIV (2000), 159-181.

[30] ________, and ________, "Do Incentive Contracts Undermine Voluntary Cooperation?" Institute for Empirical Research in Economics working paper No. 34 (2002).

[31] Fehr, Ernst, Simon Gächter, and Georg Kirchsteiger, "Reciprocity as a Contract Enforcement Device," *Econometrica*, LXV (1997), 833-860.

[32] Fehr, Ernst, Georg Kirchsteiger, and Arno Riedl, "Does Fairness Prevent Market Clearing? An Experimental Investigation," *Quarterly Journal of Economics*, CVIII (1993), 437-460.

[33] Fleischman, Charles A., "The Causes of Business Cycles and the Cyclicality of Real Wages," Board of Governors of the Federal Reserve System working paper (1999).

[34] Francis, Neville and Valerie Ramey (2003). "Is the technology driven business cycle dead? Shocks and aggregate fluctuations revisited", *Journal of Monetary Economics*, forthcoming.

[35] Gächter, Simon, and Armin Falk, "Reputation and Reciprocity: Consequences for the Labour Relation," *Scandiavian Journal of Economics*, CIV (2002), 1-26.

[36] Gali, J., "Technology, Employment, and the Business Cycle: Do Technology Shocks Explain Aggregate Fluctuations?," *American Economic Review*, 89, 1, (1999), 249-271,

[37] Gamber, Edward N., and Frederick L. Joutz, "Real Wages over the Business Cycle," *Eastern Economic Journal*, XXIII (1997), 277-291.

[38] Hall, Robert E., "Modern Theory of Unemployment Fluctuations: Empirics and Policy Applications," *American Economic Review Papers and Proceedings*, XCIII (2003), 145-150.

[39] Hildreth, Andrew K. G., and Andrew J. Oswald, "Rent-Sharing and Wages: Evidence from Company and Establishment Panels," *Journal of Labor Economics*, XV (1997), 318-337.

[40] Holmlund, Bertil, and Johnny Zetterberg, "Insider Effects on Wage Determination: Evidence from 5 Countries," *European Economic Review*, XXXV (1991), 35-78.

[41] Homans, George C., *Social Behavior: Its Elementary Forms* (New York: Harcourt Brace Jovanovich, 1961).

[42] Kahneman, Daniel, Jack L. Knetsch, and Richard Thaler, "Fairness as a Constraint of Profit Seeking: Entitlemnets in the Market," *American Economic Review*, LXXVI (1986), 728-241.

[43] Krueger, Alan B, and Lawrence H. Summers, "Efficiency Wages and the Inter-Industry Wage Structure," *Econometrica*, LVI (1988), 259-293.

[44] Layard, R., S. Nickell, and R. Jackman, *Unemployment: Macroeconomic Performance and the Labour Market*, Oxford: Oxford University press (1991).

[45] Levine, David I., "Fairness, Markets, and Ability to Pay: Evidence from Compensation Executives," *American Economic Review*, CXXXIII (1993), 1241-1259.

[46] Lindbeck, Assar, and Dennis J. Snower, *The Insider-Outsider Theory of Employment and Unemployment*, Cambridge: Mass.: MIT Press, (1988)

[47] Mortensen, Dale, and Christopher Pissarides (1994): "Job Creation and Job Destruction in the Theory of Unemployment," *Review of Economic Studies*, 61, 397415.

[48] Murphy, Kevin M., and Robert Topel, "Unemployment, Risk and Earnings: Testing for Equalizing Wage Differences in the Labor Market," in Kevin Land and Jonathan S. Leonard, eds., *Unemployment and the Structure of the Labor Market* (Oxford: Basil Blackwell, 1987).

[49] Nickell, Stephen J., and Sushil Wadwhani, "Insider Forces and Wage Determination," *Economic Journal*, C (1990), 496-509.

[50] Pissarides, (2000): Equilibrium Unemployment Theory. MIT Press, Cambridge, MA, second edn.

[51] Rabin, Matthew, "Incorporating Fairness into Game Theory and Economics," *American Economic Review*, LXXXIII (1993), 1281-1302.

[52] Salop, Stephen C., "A Model of the Natural Rate of Unemployment," *American Economic Review*, LXIX (1979), 117-125.

[53] Shapiro, Carl, and Joseph E. Stiglitz, "Equilibrium Unemployment as a Worker Discipline Device," *American Economic Review*, LXXIV (1984), 433-444.

[54] Shimer, Robert, "The Cyclical Behavior of Equilibrium Unemployment and Vacancies," *American Economic Review*, CXXXXV (2005),25-49."

[55] Slichter, Sumner, "Notes on the Structure of Wages," *Review of Economics and Statistics*, XXXII (1950), 80-91.

[56] Solow, Robert M., "Another Possible Source of Wage Rigidity", *Journal of Macroeconomics*, I (1979), 79-82.

[57] Stole, Lars A., and Jeffrey Zwiebel, "Organizational Design and Technology Choice under Intrafirm Bargaining," *American Economic Review*, LXXXVI (1996), 195-222.