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ABSTRACT

Efficiency Wages Revisited: The Internal Reference Perspective*

The missing wage rigidity in general equilibrium models of efficiency wages is an artifact of the external wage reference perspective conventionally adopted by the literature. Efficiency wage models based on an internal wage reference perspective are capable of generating strong wage rigidity. We propose a structural model of efficiency wages that is broadly consistent with the reported evidence on fairness in labour relations and rent-sharing. Our model provides a robust explanation for wage rigidity and procyclical effort. It also rationalizes reciprocal behaviour by workers and the observation that firm productivity is a significant predictor of wage setting.

JEL Classification: E24, E32 and J50
Keywords: efficiency wages, reciprocity, rent-sharing and wage rigidity

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1 Introduction

Why don't firms lower wages in the face of depressed labor demand conditions? This question has been at the heart of macroeconomic debates since Keynes [1936]. Yet, as Hall [2003] recently argued *"...a compelling model [that generates a fall in labor demand without a counterfactual fall in productivity] has eluded theorists to date"*.

This paper critically assesses Hall's observation through the lens of efficiency wage theory. We show that the efficiency wage hypothesis by itself implies neither wage rigidity nor a lack thereof. Wage rigidity rather depends on the interpretation of the *reference wage level* to which workers compare their salary when deciding on work effort. As long as this reference wage stays relatively constant, firms avoid large wage reductions following negative labor demand shifts because the thus realized cost savings would be more than offset by the resulting decrease in labor productivity.

Conventional formulations such as Shapiro and Stiglitz' [1984] shirking model, Salop's [1979] labor turnover model, but also Akerlof's [1982] partial gift exchange model interpret the reference wage as *external* to the firm, based on the assumption that workers appraise their wage in light of the remuneration they could obtain if they were not under contract with their current employer.[1] As Danthine and Donaldson [1990] originally point out in a real business cycle context, these models fail to generate wage rigidity in general equilibrium. In Section 2 of the paper, we restate this result more generically using a popular reduced-form effort function proposed by Akerlof. We also demonstrate, however, that if the reference wage is made dependent on firm-*internal* measures of earnings per unit of labor – i.e. if what workers care for is the division of the rent with capital owners – the same efficiency wage model is capable of delivering strong wage rigidity in general equilibrium.

The intuition behind the difference in results is simple. In the external perspective, the wage reference of workers is positively related to outside earnings opportunities such as the average wage (the wage paid by other firms), the employment level (the probability of getting reemployed) and possibly other aggregates such as unemployment benefits (the compensation if not reemployed). In general equilibrium, these variables are sensitive to aggregate shocks. For example, when firms reduce employment in response to a labor demand shift, there is a general equilibrium fall of the wage reference. This makes it optimal for individual firms to lower their wages, a fact that 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. Put graphically, the firm's wage setting curve in

[1] See Yellen [1984] or Katz [1986] for surveys.

general equilibrium implies a steep positive relationship between employment and wages. By contrast, in the internal reference case and under the assumption that the marginal productivity of labor is decreasing, 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 along the effort dimension 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.

The strikingly different implications of the external vs. the internal reference perspectives lead us to scrutinize the empirical support in favor of either view. Section 3 of the paper considers three kinds of evidence: (i) micro-based econometric estimations; (ii) field studies; and (iii) laboratory experiments. Two main messages emerge. First, firm performance appears as a significant predictor of wages even in the long run and after controlling for skill, working conditions, local labor market attributes and union presence. This suggests that rent-sharing is a pervasive feature of firm-worker relations, which is inconsistent with a competitive model of the labor market but also with a purely external perspective on efficiency wages. In both of these situations, individuals with the same ability should eventually receive equal pay for identical jobs independently of firm performance.

Second, field studies as well as laboratory experiments support Akerlof's partial gift exchange view of efficiency wages as an empirically plausible explanation for rent-sharing, but with the added qualifier that workers' effort decision is based on firm-internal performance measures rather than firm-external earning opportunities as originally proposed by Akerlof. Workers feel entitled to a certain part of the value created by the firm and are willing to reciprocate a salary above their entitlement with higher effort. Rent-sharing therefore occurs not because of explicit bargaining power (by trade unions, for instance) but because workers enjoy an *indirect* form of bargaining power because firms are aware of their propensity to reciprocate.

The surveyed evidence raises important questions. Why should workers be willing to reciprocate even though firms by assumption cannot directly punish workers for non-reciprocal behavior (effort is non observable)? And if workers indeed have reciprocal preferences, does an efficiency wage model built on this explicit assumption generate wage rigidity? To answer these questions, Sections 4 and 5 develop and test a structural model of partial gift exchange. Building on Rabin's [1993] introduction of fairness considerations

into game theory, 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 with a gift of effort. These gift elements are defined in terms of material utility and net profits, respectively. The reference point at the light of which workers evaluate the firm's wage offer is a weighted average of the firm's output per worker (the maximum gift of the firm) and the worker's reservation wage (the minimum gift).

In our formulation only workers are prone to reciprocate (in Rabin's setup both types of players derive utility from reciprocal behavior). Their optimal behavior results in a condition for effort that is similar but not identical to Akerlof's reduced-form effort function. Firms, modeled as monopolistic competitors, only care about net profits but they must take the worker's effort condition into account when maximizing profits because effort cannot be contracted directly. Hence, workers enjoy an indirect form of bargaining power, which results in rent-sharing behavior by the firm. This demonstrates that reciprocity can have important economic consequences even if one of the players (the firm) only cares about material payoffs. Our model allows for continuous decision choices and takes into account general equilibrium effects (Rabin's model only offers two choices and is analyzed in partial equilibrium). As such, it can be easily integrated into a modern general equilibrium macroeconomic framework.

Our model has several important implications. First, it can be used to quantify the benefits of reciprocal behavior. We show that as the weight of the reciprocal component of utility increases, equilibrium wages, effort and output increase. Up to a certain point, this makes both workers (in terms of utility of consumption net of disutility of effort) and firms (in terms of net profits) better off, thus providing a potential explanation for workers' propensity to reciprocate even though the firm cannot directly control effort.

Second, our model implies a wage setting curve that links wages to the firm's earnings per unit of labor, which is similar to the reduced-form model with internal wage references of Section 2. Contrary to the reduced-form model, however, the structural nature of this wage setting curve implies that all of the parameters have a clear economic interpretation and can be calibrated using long-run averages or microeconomic estimates.

Third, our structural model generates strong wage rigidity and amplified general equilibrium responses of real quantities to technology shocks (given flexible prices) and demand shocks (given fixed prices). The mechanism behind this result is the same as in the reduced-form model with internal wage references: when firms decrease employment, earnings per worker increase, leading to a raise in the worker's reference wage. Firms therefore find it suboptimal to lower wages and they react to shocks mostly through

changes in employment.

Fourth, effort in our model is procyclical in the sense that it is negatively linked to the markup of marginal cost over prices. Whenever the markup falls (as we observe in demand-driven expansions), firms' earnings per worker fall. This decreases the workers' reference wage. Firms take advantage of this fall in the reservation wage in part by eliciting an increase in effort and in part by lowering their wage offer. Our model thus proposes an alternative explanation to Burnside and Eichenbaum's [1996] labor hoarding story for the procyclicality of effort. By contrast, the reduced form model of Section 2 implies that equilibrium effort is constant for both the external and the internal reference cases. A countercyclical wage response to demand shocks is consistent with a number of econometric studies using structural vector autoregressions.

Akerlof and Yellen [1990] also adopt an internal reference perspective when they examine the implications of a model where workers with different skills compare their wage to the wage of co-workers in the same firm when deciding on effort. They find that such a model has the potential to explain the intra-industry wage differentials observed in the data. Other formulations of efficiency wage have been proposed to remedy the failure of existing external reference models to deliver wage rigidity. Collard and De la Croix [2000] and an earlier study by the present authors (Danthine and Kurmann [2004]) extend Akerlof's original reduced-form effort function to include the workers past wage in the reference wage. Their simulations show that as long as this intertemporal wage link plays an important role, the model is capable of generating strong wage rigidity. All three of these studies are based on a reduced-form effort function that is loosely motivated by the partial gift exchange hypothesis.

2 Internal vs. external wage references: theory

In this section, we use a simple reduced-form model of efficiency wages, inspired by Akerlof [1982], to contrast the implications of the internal vs. external definitions of the reference wage in the theory of efficiency wages.

2.1 Illustrating the qualitative difference

Consider an economy with identical workers and identical firms. Firms use effective labor en to produce the output y as per

$$y = f(en),$$

with $f' > 0$, $f'' < 0$. A key assumption throughout is that work effort e cannot be observed directly. Despite effort being costly to them (in terms of utility), workers are assumed to volunteer effort according to

$$e = -a_0 + a_1 \left(\frac{w}{w_r} \right)^{\gamma}, \; 0 < \gamma < 1. \tag{1}$$

In this relation, identified as the Effort Condition (EC), w denotes the workers' real wage per unit of labor while w_r stands for the reference wage in light of which workers evaluate their compensation. The larger the premium of w over w_r, the more the representative worker is willing to provide effort. This EC subsumes various alternative versions of the efficiency wage story. In his original paper, Akerlof [1982] motivated it as the result of reciprocity: the exchange between workers and firms of a gift of effort against a gift of a remuneration over and above some reference to be defined. 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.

What should the reference wage w_r be? In the shirking and the turnover stories, but also in the gift exchange view proposed by Akerlof, the perspective is decidedly *external*.[2] That is, workers compare their salary to the compensation they could expect to receive were they not employed with their current firm (because they are under the threat of being fired in the shirking model, or they may be tempted to quit in the turnover model). Then, w_r depends on the wage workers would obtain if rehired by another (identical) firm, $\bar{w}$, on the probability of reemployment after leaving the firm, which we identify as the aggregate level of employment $\bar{n}$ (with full employment being normalized at 1), and on the level of unemployment benefits the worker obtains if he is not re-hired, which we will denote as $w_{\min}$. One expects the following partial derivatives: $e_{\bar{w}} < 0$, $e_{\bar{n}} < 0$, and $e_{w_{\min}} < 0$.

But there is an alternative approach, at least in the gift exchange perspective, one that places the issue of *rent sharing* between firms and workers at the center of attention. In this *internal* reference view, workers appreciate their salary offer in light of the firm's output per employee, y/n, and of their reservation wage $w_{\min}$. The former represents

[2]The external perspective is closely related to Keynes' [1936] relative wage theory. Indeed, Keynes [1936, page 14] notes in his explanation of involuntary unemployment that *"...individuals who consent to a reduction in money wages relatively to others will suffer a relative wage reduction in real wages, which is sufficient justification for them to resist it. On the other hand, it would be impracticable to resist every reduction of real wages due to changes in the purchasing power of money, which affects all workers alike."*

the maximum wage at which the entire rent is attributed to the worker, the latter the minimum one below which the worker would rather stay home (and possibly collect unemployment compensations). The closer the actual w is to the most generous wage offer, the more workers are ready to volunteer effort: $e_{y/n} < 0$; conversely a wage offer close to the worker's reservation wage, at which most of the rent goes to the firm, elicit a lower effort level: $e_{w_{\min}} < 0$. We summarize the two perspectives by

$$w_r = w_r(\bar{w}, \bar{n}, w_{\min}, y/n). \tag{2}$$

In the external reference view we have $w_{y/n} = 0$, while in the internal reference perspective, outside opportunities (except for the determinants of the reservation wage) do not enter the definition of the reference wage and thus $w_{\bar{w}} = 0$, $w_{\bar{n}} = 0$.

Equations (1) and (2) are part of firms' information set. That is, firms understand what makes workers volunteer effort. As a consequence they optimize with respect to both labor n and the salary w.[3] The representative firm's cost minimization program is

$$\begin{aligned} & \min_{n,w} wn \\ \text{s.t. } y &\leq f(en) \\ e &= -a_0 + a_1 \left(\frac{w}{w_r}\right)^{\gamma}. \end{aligned} \tag{3}$$

It yields the first-order conditions

$$w = \psi \left(f_n + f_e \frac{\partial e}{\partial n}\right) \tag{4}$$

$$n = \psi f_e \frac{\partial e}{\partial w}, \tag{5}$$

where the Lagrangian multiplier for the first constraint ψ represents the real marginal cost, or, in the case of a non-competitive product market, the inverse of the firm's markup of price over marginal.[4] We can rewrite $f_e = f_n n/e$ and express condition (4) as

$$w = \psi f_n (1 + \varepsilon_{e,n}), \tag{6}$$

where $\varepsilon_{e,n} = \partial e/\partial n * n/e$ is the elasticity of effort with respect to the firm's labor input. It is also useful to combine the two first-order conditions to obtain (after some

[3] This statement only applies if total labor supply at the optimal wage is in excess of total labor demand, a condition that will prevail throughout.

[4] In perfect competition, marginal cost must equal the price level and hence $\psi = 1$. In the comparative statics exercises of Section 5, we explicitly refer to a monopolistic product market where firms charge prices above marginal cost, i.e. $\psi < 1$.

rearrangement)

$$\varepsilon_{e,w} - \varepsilon_{e,n} = 1, \tag{7}$$

where $\varepsilon_{e,w} = \partial e/\partial w * w/e > 0$ is the elasticity of workers' effort with respect to the wage.

Equation (6) determines the labor demand. In the external reference case, $\partial e/\partial n = 0$ since $e_{y/n} = 0$ and firms consider $\bar{w}$ and $\bar{n}$ as exogenous. The employment decision is then standard, stating that the marginal product of labor (multiplied by the real marginal cost) should be equated to the wage rate. In the internal reference perspective, however, $\partial e/\partial n > 0$. In that case, the marginal condition is to equate the wage rate to the marginal product of labor (modified by the real marginal cost) augmented by the elasticity of effort to employment. This leads to the following proposition

Proposition 1 *The internal wage reference view of efficiency wages leads to overemployment in the sense that, ceteris paribus and in particular for a given wage, firms hire more labor than if the considered reference compensation level is external.*

The intuition behind this proposition is straightforward: firms understand that hiring more labor reduces output per worker and thus the workers' wage reference. A larger workforce therefore reduces the wage needed to elicit a given level of effort.[5]

We refer to equation (7) as the Modified Solow Condition (MSC). For the external reference case, the MSC reduces 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, a fact underlining the ubiquity of the external reference perspective in the literature. For the internal reference case, however, the traditional Solow condition no longer holds. This is because a marginal wage increase has an additional effect on effort coming from the fact that the induced decrease in employment has itself a negative impact on effort. Thus, ceteris paribus, the

[5]This mechanism is similar to the one at work in Stole and Zwiebel's (1996) model of intrafirm bargaining. In their model, 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. Contrary to Stole and Zwiebel's model, however, the internal reference efficiency wage hypothesis 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. We thank Etienne Wasmer for pointing out this similarity.

last wage increase warranted in the external reference case would not pay for itself in the internal reference context. Hence, our second proposition

Proposition 2 *Ceteris paribus, firms set lower wages if the wage reference is internal than if it is external.*

Note that this proposition 2 depends on the property that the elasticity of effort with respect to wage is decreasing, a property that is easily established. Care must be exercised in making use of Proposition 2 because the ceteris paribus condition will not typically hold. It is the case indeed that the definition of w_r affects the value of $\varepsilon_{e,w}$ and $\varepsilon_{e,n}$.

In equilibrium, both the EC and the MSC need to hold. Combining the two equations and assuming that the effort level implied by the MSC is unique, we can substitute out effort to obtain an equilibrium equation for the wage. This expression is the "wage setting curve", which replaces the labor supply equation of standard Walrasian models. Together with the labor demand condition (6), the wage setting curve determines the labor market equilibrium. The difference between the equilibrium employment thus determined and the amount of labor supplied at the equilibrium wage identifies the level of unemployment.

2.2 Implications for wage adjustments

To be more concrete, let us assume the log-linear technology $y = A(en)^{\alpha}$ and follow Akerlof in defining the external reference wage as

$$w_r = \bar{w}^{\bar{n}} b^{1-\bar{n}}.$$

A stands for the level of the technology while b is the level of unemployment benefits, which we interpret as the individual's reservation wage. According to this formulation, the reference wage is the geometric average of $\bar{w}$ and b with the employment rate $\bar{n}$ and the unemployment rate $1 - \bar{n}$ naturally corresponding to the probabilities of earning either remuneration.

In the same spirit, we define the internal reference as

$$w_r = \left(\frac{y}{n}\right)^{\nu} b^{1-\nu},$$

where ν is some arbitrary constant between 0 and 1. The minimum compensation level is identified as the worker's reservation wage and assumed equal to unemployment benefits b. If the offered wage was lower, the worker would decline the offer.[6]

[6] Alternatively, we could have assumed the existence of a mandated minimum wage. As long as this minimum is constant, however, the conclusions reached below remain unchanged.

In the case of the external reference, the labor demand and the Solow condition (SC) take the form

$$w = \psi\alpha\frac{y}{n} \tag{8}$$

$$1 = \varepsilon_{e,w} = \frac{\gamma a_1}{e}\left(\frac{w}{w_r}\right)^{\gamma}. \tag{9}$$

Combining the EC with this expression for the SC, the model implies that the optimal wage (from the perspective of the employer) is a constant markup over the reference wage w_r

$$\frac{w}{w_r} = \left(\frac{a_0}{a_1(1-\gamma)}\right)^{\frac{1}{\gamma}}. \tag{10}$$

It follows that

$$e = \frac{\gamma a_0}{(1-\gamma)}. \tag{11}$$

In the case of the internal reference, the optimal labor and wage decisions are more complex because the firm takes account of the consequences of changes in n on the wage reference and thus on effort, i.e., the general form of conditions (6) and (7) apply. They become

$$w = \psi\alpha\frac{y}{n}\left[1 + \frac{\nu[1-\gamma(1-\nu)](1-\alpha)a_1\gamma\left(\frac{w}{w_r}\right)^{\gamma}}{a_0\gamma[1-\nu(1-\alpha)]}\right] \tag{12}$$

$$e = -\frac{a_0\alpha\nu\gamma}{1+\alpha\nu\gamma} + \frac{a_1\gamma\left[1-\nu(1-\alpha)\right]}{1+\alpha\nu\gamma}\left(\frac{w}{w_r}\right)^{\gamma}. \tag{13}$$

Combining the MSC and the EC we obtain the wage setting curve

$$\frac{w}{w_r} = \left(\frac{a_0}{a_1(1-\gamma(1-\nu))}\right)^{\frac{1}{\gamma}}, \tag{14}$$

from which one derives

$$e = \frac{\gamma a_0(1-\nu)}{1-\gamma(1-\nu)}. \tag{15}$$

The formal similarity between the two perspectives is evident. In both cases, it is optimal to set the wage at a constant premium over the reference wage and this implies that optimal effort is *constant* in the sense of being unrelated to the equilibrium level of

endogenous variables. Note that the internal reference implies a lower equilibrium effort level than the one implied in the external reference case.

Moreover, in the external as well as the internal reference, as long as w_r belongs to the "ceteris paribus" – i.e. in a partial equilibrium context – the efficiency wage model generates strong wage rigidity. This is the argument made by Yellen [1984] among others. The crucial difference arises once attention is paid to the fact that in general equilibrium, the reference wage w_r is itself an endogenous variable and it may be strongly affected by external shocks. This is indeed the case in the external (but not the internal) perspective in which 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 all of them are in the same situation, nothing prevents both the wage offers and the wage reference from adjusting flexibly. Thus once imbedded in a general equilibrium model, the external reference efficiency wage model fails to generate sluggish wage movements, a point made early on by Danthine and Donaldson [1990] in a real business cycle context.

Pursuing this reasoning more formally, let us observe that with homogenous firms and workers, equilibrium implies $\bar{w} = w$ and $\bar{n} = n$. Hence, the wage setting curve (10) becomes

$$n = 1 - \frac{\log\left(\frac{a_0}{a_1(1-\gamma)}\right)}{\gamma(\log w - \log b)}. \tag{16}$$

The elasticity of w with respect to n along this wage setting curve is

$$\frac{\partial w}{\partial n}\frac{n}{w} = \frac{n}{1-n}(\log w - \log b) = \frac{-n}{1-n}\log\rho > 0. \tag{17}$$

The second equality is obtained under the plausible assumption that unemployment benefits in equilibrium are a fraction of the salary; i.e. $b = \rho w$ with $0 < \rho < 1$ being defined as the replacement ratio. This substitution permits expressing the elasticity independently from the parameters of the effort function (a_0, a_1, γ), or from other structural parameters (α, ψ, A).

By contrast, there is no difference in the internal reference case between the wage setting curve for the firm and the corresponding general equilibrium relation as the wage reference is a function of firm-internal measures and not of economy-wide aggregates. We use the solution for optimal effort and the fact that $y/n = Ae^{\alpha}n^{\alpha-1}$ to write the internal reference wage setting curve as

$$w = \frac{C^{\frac{1}{\gamma}}A^{\nu}b^{1-\nu}}{n^{(1-\alpha)\nu}}, \tag{18}$$

where $C \equiv \left[\frac{1}{a_1}\left(\frac{a_0\gamma(1-\nu)}{1-\gamma(1-\nu)}\right)^{1+\alpha\nu\gamma}\right]^{1/\gamma}$. The elasticity of w with respect to n along the wage setting curve is

$$\frac{\partial w}{\partial n}\frac{n}{w} = \nu(\alpha - 1). \tag{19}$$

Figure Ia plots the external reference wage setting curve together with the labor demand (8) for the case $n = 0.95, \rho = 0.5$.[7] The depicted wage setting curve is very steep implying that wages are highly sensitive to shifts in labor demand. The shape of the wage setting curve is robust to alternative calibrations of the various parameters. Figure Ib depicts the internal reference wage setting curve (18) together with the equation for labor demand (12). This wage setting curve implies a negative relationship between w and n that is fundamentally different from the one obtained in the external case: the higher is employment, the lower is output per worker y/n (since the optimal effort is always constant). This in turn results in a lower reference wage. Everything else constant, firms therefore accompany higher employment with lower wages.

Since $0 < \alpha < 1$, the internal reference elasticity (19) is negative and its size depends on the weight placed by workers on the two components of the reference wage. The more ambitious their rent-sharing objective (the larger ν), the larger the fall in wages consecutive to a given increase in employment. The fall in wages is typically small since α is commonly set around 0.6 to 0.7 and $0 \leq \nu \leq 1$. Moreover, changes in employment brought about by labor demand shifts may also shift the wage setting curve. In particular, if labor demand increases because of a positive productivity shock to A, the wage setting curve shifts up and thus neutralizes (some of the) negative impact on wages. Section 5 provides a complete quantitative assessment of these different effects and confirms that the internal reference perspective generates strong wage rigidity.

One may similarly compute the external reference elasticity (17) for different values of n and ρ.[8] Given that unemployment is between 5% and 10% in most industrialized economies and the replacement ratios vary between 0.35 and 0.65, the external reference

[7] The two graphs of Figure I correspond to the calibration described in detail in Section 5. Note that, in the external reference case, full employment is not attainable: as n approaches 1 (full employment), the firm will want to increase its wage without bound.

[8] This elasticity measure would not be constant over the cycle as n and b/w vary. Rather, it should be considered as an approximation around the steady state value of n (and $b = \rho w$). Section 5 provides a more complete quantitative assessment of this model.

model implies the following measures of wage rigidity

	$\rho = 0.35$	$\rho = 0.65$
$n = 0.9$	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 impact wages almost four times as much as employment.

3 Internal vs. external references: empirical evidence

The strikingly different implications of the internal vs. the external reference perspective naturally lead to two questions. First, is rent-sharing a pervasive feature of the labor market? Second, if so, what is the underlying rationale? To shed light on these issues, we review three types of empirical evidence : (i) micro-based estimations; (ii) laboratory experiments; and (iii) field studies.

3.1 Evidence from micro-based estimations

Dickens and Katz [1987] and Krueger and Summers [1988] 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.

A number of subsequent studies concur with this conclusion in support of rent sharing. Blanchflower, Oswald and Sanfey [1996], among others, use U.S. manufacturing data and find that industry profits per employee have a significant positive long-term effect on hourly earnings. They estimate an elasticity between wages and average industry profits of 0.08, which is substantial given the large variability of profits.[9] Their estimates remain essentially unaffected by controls for unionization, thus confirming that rent-sharing is largely independent of union bargaining power.[10]

[9] As a rough measure of how much industry profits matter for wage dispersion, Blanchflower 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.

[10] Broadly similar results are reported by other studies for alternative measures of compensation and firm performance, over different time periods, and across various industries and countries. Examples are Blanchflower, Oswald and Garrett [1990], Nickell and Wadhwani [1990], Holmlund and Zetterberg

Murphy and Topel [1990] challenge the rent-sharing view and argue instead that 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 contradicts 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, thus corroborating the rent-sharing hypothesis. 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, contrary to the prediction of the shirking hypothesis.[11]

In sum, the available evidence from micro estimates supports the view that rent-sharing is a pervasive feature of firm-worker relations, independently of union presence. This finding is inconsistent with a competitive view of the labor market as well as with a purely external perspective of efficiency wages. In both cases individuals with equal qualification would sooner or later be paid the same wage.

3.2 Evidence from experimental economics

The fact that the correlation between wages and firm performance appears independent from union presence begs the question of what could possibly explain rent-sharing. A large number of laboratory experiments bearing on reciprocity suggest that the major reason why firms are willing to share rents is to preserve or enhance work morale.

The most important finding of the experimental literature on reciprocity 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 context is conducted by Fehr and Falk [1999].[12]

[1991] or Hildreth and Oswald [1997] for European labor markets, and Christofides and Oswald [1992] or Abowd and Lemieux [1993] for Canada.

[11] See for example Alexopoulos [2002] for a shirking model with monetary punishment where firms with lower intensity of supervision pay higher wages and record higher profits per employee.

[12] Other experiments that simulate similar worker-employer relationships are Fehr, Kirchsteiger and

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.

A second experiment by Fehr, Gächter and Kirchsteiger [1996] clearly shows that individuals understand the negative (suboptimal) effect of inadequate rent sharing on effort. In their experiment, firm type individuals are assigned different levels of profitability and make (costly) wage offers to worker types. 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, offer wages that are increasing in the level of profitability assigned. Thus, firms pay pure job rents, in accord with the evidence from micro-estimates discussed above.

3.3 Evidence from field studies

The view that rent-sharing is the result of the firm's concern for workers' perception of what is fair is largely confirmed by field studies. For example, Kahneman, Knetsch and Thaler [1986] interview a randomly selected sample of individuals on their perception of the degree of fairness of alternative firm actions in different profit situations. They find 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.[13]

Firms, in turn, seem to be well aware that work morale is an important determinant of effort and thus productivity. This is documented in more recent field studies such as

Riedl [1998] or Gächter and Falk [2002]. See Fehr and Gächter [2000] for a general survey.

[13]The idea of internal equity and entitlement to a certain remuneration is also at the heart of Adam's [1963] theory of equity and Blau-Homan's [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 literature.

Bewley [1999] who surveys company managers and labor leaders in the Northeastern U.S. about wage determination. Most managers in the survey prefer layoffs over wage cuts even in times of high unemployment because the negative effect of wage cuts on work morale and thus on productivity would outweigh the associated cost savings. When asked more specifically about the determinants of work morale, Bewley's respondents offer that work morale has little to do with outside earnings opportunities but largely depends on firm-internal references such as established pay traditions, the difference between current and past wages, and the compensation of peer workers in the same firm. 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.[14]

The evidence produced by Bewley and other survey studies suggest that the firm's ability to pay is not the only internal measure of comparison that matters for work effort. This is consistent with rent-sharing if workers are uncertain about the productivity of the firm and/or the portion of firm revenue they are "entitled" to receive. In fact, Bewley [2002, page 7] asserts in his summary discussion 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."* A similar issue of incomplete information may also explain why workers do not focus on outside earning opportunities. As Bewley continues "*...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 represented by an active union that keeps them informed about what other firms pay."*[15] Moreover, most of the 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. On these grounds, Bewley rejects the empirical relevance of Keynes' relative wage theory and the external view in general.[16]

[14] A similar picture emerges from surveys on U.S. firms by Levine [1993] and Campbell and Kamlani [1997]. See Bewley [2002] for a summary.

[15] The incomplete information story appears consistent with the above reviewed micro-evidence about wage differentials. As noted, a large part of wage differentials is left unexplained by *observable* worker or firm characteristics. Assuming that workers cannot evaluate *unobservable* firm-worker specific factors at other firms, this observation could explain why pay rates at other companies are not used to evaluate the own personal wage.

[16] Bewley's observation that unions act as an information source accords with studies by Agell and Lundborg [1995, 1999] and Agell and Bennmarker [2003] 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.

One final result coming out of Bewley's study is that managers generally dismiss the shirking theory of efficiency wages as a relevant determinant of wage setting. Rather than eliciting high effort, the threat of punishment (in the form of firing or retaining a fraction of the wage) if caught shirking would foster a negative workplace atmosphere that is counterproductive. Interestingly, the idea that explicit incentives may crowd out the positive effects of reciprocity on work effort is consistent with an experiment by Fehr and Gächter [2002]. Their setup is similar to the one of by Fehr, Gächter and Kirchsteiger discussed above, but with the addition that firm types can make the worker-type pay a fine if the latter is caught shirking (which occurs with a fixed probability). Except for very low levels of profits, worker types in this setting provide much lower effort than in the original experiment where no verification of shirking is allowed.

In sum, Akerlof's [1982] partial gift exchange hypothesis of efficiency wages appears to be the explanation for rent-sharing that is most consistent with the empirical evidence. The qualifier that worker's perception of fairness depends to a large part on firm-internal references must be added, however. Workers feel entitled to a certain part of the firm's value. If they perceive a wage offer as fair, they are willing to reciprocate with high effort. Firms are aware of the workers' sense of entitlement and their propensity to reciprocate. Because effort is difficult to contract, firms incorporate these elements in their wage setting decision. In other words, workers enjoy *indirect* bargaining power through the fact that firms understand the negative impact that an unfair wage offer would have on effort.

4 A reciprocity-based model of efficiency wages

The strikingly different implications of the internal and external reference perspectives together with the empirical support obtained for the rent-sharing- internal reference view suggest a more formal exploration of the latter construct starting from first principles. This is the objective of the present section where we develop an efficiency wage model that is (i) built on an explicit formulation of reciprocity; and (ii) incorporates a measure of the firm's ability to pay as an important determinant of (perceived) fairness. Our model

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.

can be considered as a structural treatment of Akerlof's partial gift exchange idea. It is very much inspired by the approach proposed by Rabin [1993] whose objective was to develop a game theoretical representation of the experimental evidence on fairness.

Our model offers two noticeable advantages relative to the reduced form model of Section 2. First, our explicit modeling permits giving an economic meaning to all the parameters that matter in the calibration of the model. It also allows us to think in more specific terms about reciprocity and the implications of alternative assumptions for the optimal effort decision of workers. Second, the model of Section 2 implies that effort is constant (for both the internal and the external versions), a property that we anticipate (and later confirm) is probably an artifact of the specific reduced-form effort function proposed by Akerlof. In reality, there are good reasons to believe that effort varies over the business cycle. The model of the present section allows us to explore this point in more details.

4.1 Workers

Workers' preferences are assumed to be of the form

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

where $u(c)$ is the utility derived from consumption, $h(e)$ is the disutility of effort and $s(w, e)$ represents the benefit of reciprocal behavior. The parameter λ determines the relative importance of reciprocity considerations in workers' preferences. To focus our analysis on the supply of effort, we abstract from the disutility of leisure, assuming instead that each worker inelastically supplies one unit of labor.

The reciprocity component of utility $s(w, e)$ is defined as

$$s(w, e) = d(e, w)g(w, e),$$

where $d(e, w)$ represents the gift of the worker towards the employer, and $g(w, e)$ is the gift of the firm towards the worker (as perceived by the worker).

Under reasonable assumptions, the definition of utility implies that workers will supply positive effort because the disutility of effort is compensated by the satisfaction derived from reciprocating kind behavior in a bilateral relation in which individual effort contributes to the payoff of the other party. More precisely, with the assumed separable utility function, optimal effort is such that the marginal disutility of providing effort equals the marginal "psychological" benefit of reciprocating a positive (negative) gift by

the firm with a positive (negative) gift in terms of effort[17]

$$h_e = \lambda d_e g(w, e). \tag{20}$$

We label this equation the "Effort Condition" (EC) because, as in the case of the reduced-form formulation of Section 2, it spells out how much effort a worker is willing to supply in response to a certain wage offer. As was the case before, the EC is part of the information set of the firm. The firm's manager makes the first move in the form of a wage offer which is the result of his estimating (correctly, according to (20)) how the offer will be perceived by the worker and how the worker will react to the "kindness" of the firm thus manifested.

In specifying the gift of the worker and the gift of the firm, we follow Rabin in deriving $d(e, w)$ and $g(w, e)$ from material payoffs. To be specific let us assume the following functional forms

$$\begin{aligned} u(c) &= \frac{1}{\chi} c^{\chi} \\ h(e) &= e^{\theta} \\ y &= A(ne)^{\alpha}. \end{aligned}$$

with $\gamma < 1$, $\theta \geq 2$ and $0 < \alpha \leq 1$.[18]

The worker's gift towards the firm is measured by

$$d(e, w) = \frac{e^{\alpha} - [\mu e_{\max}^{\alpha} + (1 - \mu)0]}{e_{\max}^{\alpha} - 0} = \frac{e^{\alpha}}{e_{\max}^{\alpha}} - \mu,$$

while the gift of the firm towards the worker is measured according to

$$g(w, e) = \frac{w^{\chi} - [\varphi(y/n)^{\chi} + (1 - \varphi)b^{\chi}]}{(y/n)^{\chi} - b^{\chi}}.$$

The idea behind these expressions is as follows. The worker's gift towards the firm is measured in terms of the firm's profit per worker or $y/n - w$.[19] It is a function of the distance between the actual effort provided by the worker and the reference effort level which is the term in square bracket. The denominator provides the metric, which is the

[17] 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; i.e. $g_e = 0$.

[18] For $h_{eee} \geq 0$ (i.e. $\theta \geq 2$ for the function form assumed here) the EC implies a concave relationship between effort and the wage.

[19] The cost term w drops out because it enters separably into the profit function of the firm. Similarly, the $h(e)$ term will drop out of the definition of the worker's gift because it enters separately into the worker's utility.

difference between profit per worker when effort is maximal and when it is minimal. We make the assumption that the minimum level of effort is $e_{\min} = 0$. The maximum effort and the weight μ are set to arbitrary constants whose values do not affect the conclusions of the model.

The firm's gift is likewise a function of the distance, measured in terms of the resulting worker's utility, between the actual wage and the reference wage. Here we simply assume that consumption is proportional to the salary; i.e. $u(c(w) \propto \frac{1}{\chi} w^{\chi}$. As in the internal perspective of Section 2, the reference wage is a weighted average of the maximum possible wage, $w_{\max} = y/n$, and the minimum admissible wage, $w_{\min} = b$ (i.e. the reservation wage). The weight φ is taken as exogenous. However, constraining unemployment benefits to be a constant replacement ratio ρ of wages (i.e. $\rho = b/w$), φ can be linked to other structural parameters that are easily calibrated. In a sense, our definition of the reference wage can be viewed as the outcome of a repeated Nash bargaining with y/n being the firm's threat point and b being the worker's threat point.

Using the above expressions, the effort function (20) becomes

$$e = \left[\frac{w^{\chi} - [\varphi \left(\frac{y}{n}\right)^{\chi} + (1-\varphi) b^{\chi}]}{Q[\left(\frac{y}{n}\right)^{\chi} - b^{\chi}]} \right]^{\frac{1}{\theta - \alpha}} , \tag{21}$$

with $Q \equiv \theta e_{\max}^{\alpha} / \alpha\lambda$. Note that Q is decreasing with λ, the weight of reciprocity considerations in the workers' utility. The larger λ, the higher the amount of effort provided for given values of w, y/n and b.[20]

4.2 Firms

Our homogenous firms understand workers' propensity to reciprocate and internalize the effect of their employment and wage decisions on effort as described by the EC.[21] Cost minimization yields the same labor demand and MSC conditions as in Section 2 repeated here for convenience

$$\begin{aligned} w &= \psi f_n (1 + \varepsilon_{e,n}) \\ 1 &= \varepsilon_{e,w} - \varepsilon_{e,n} \ . \end{aligned}$$

[20] If $\lambda = 0$ (i.e. workers do not care about reciprocity), effort is zero for any combination of w, y/n and b.

[21] We depart from Rabin's setup by not assuming that the other player, the firm, also displays a preference for reciprocity.

Under the effort condition (21), these equations have the following closed-form solutions

$$w = \psi\alpha\frac{y}{n}\frac{(1-\varphi)(\theta-\alpha)b^{\chi}+\varphi(\theta-\alpha-\chi)(y/n)^{\chi}}{(1-\varphi)(\theta-\alpha)b^{\chi}+\alpha\varphi(\theta-\alpha-\chi)(y/n)^{\chi}} \tag{22}$$

$$e = \left[\frac{\gamma w^{\chi}-\varphi\gamma(\frac{y}{n})^{\chi}}{(\theta-\alpha)Q[(\frac{y}{n})^{\chi}-b^{\chi}]}\right]^{\frac{1}{\theta-\alpha}}. \tag{23}$$

Denoting $\hat{\theta}=(\theta-\alpha)/(\theta-\alpha-\chi)>1$, we can combine the MSC (23) and the EC (22) to obtain the following simple wage setting curve

$$w=\left[\varphi\left(\frac{y}{n}\right)^{\chi}+\hat{\theta}(1-\varphi)b^{\chi}\right]^{\frac{1}{\chi}}. \tag{24}$$

This expression stipulates that the wage necessary to elicit optimal effort is increasing in both the firms' productivity y/n and the workers reservation wage b. Thus, the firm's optimization along the effort dimension naturally results in some form of rent-sharing that is not due to the bargaining power of trade unions. Rather workers in the present context enjoy an indirect form of bargaining power because of the sequential nature of our labor market (firms set wages and employment, workers respond with effort) and the fact that firms cannot contract on effort. That rent-sharing is independent of union presence matches well with the empirical evidence discussed in Section 3. Our model also illustrates that reciprocity can have economic consequences even when it is one-sided only, i.e., when only one of the players cares about reciprocity.

4.3 Optimal reciprocity

The labor demand (22) and the wage setting curve (24) together with the effort condition (21) determine the labor market equilibrium and thus the level of aggregate output and consumption ($y=c$) in a flexible price equilibrium context. Formally, this equilibrium is computed by first combining the labor demand and the wage setting curve with the condition that $b=\rho w$. This allows us to express φ as a function of χ, θ, ρ, ψ and α. Next, we use the value of φ together with the EC, the wage setting curve and $b=\rho w$ to compute the equilibrium value for effort. Finally, the production function and the labor demand allow us to pin down the equilibrium values for y and w, respectively, as a function of the the above parameters plus a calibrated value for n. Figure II depicts the resulting labor market. As in the reduced-form case with internal references, the wage-setting curve is downward-sloping.[22]

[22]This graph is computed for the calibration used in Section 5, and under the assumption that effort stays constant at its equilibrium value.

From the labor demand (22) it can be inferred that the relative importance of the reciprocal component of preferences λ has no impact on the equilibrium values of φ and wn/y.[23] The equilibrium values of e, w, and y, however, all increase in λ. Thus a world where reciprocity considerations receive a greater weight is characterized by a higher equilibrium consumption level. Of course it is also a world where the level of effort is higher and effort provides disutility. But, since the marginal utility from consumption is decreasing while the opposite is the case for the marginal disutility from effort, the standard portion of utility $c^{\chi}/\chi - e^{\theta}$ has a well-defined maximum for $\lambda > 0$. This maximum is an equilibrium as long as firms' profits are positive at this point (otherwise, the firm would find it optimal to set wages to zero in which case, effort is zero and production is zero). Figure III depicts the relation between the standard portion of utility ($c^{\chi}/\chi - e^{\theta}$) and net profits over an interval of λ. For the calibration used in Section 5 below, the utility maximizing λ occurs for a value of approximately 9.5. From an evolutionary perspective one may thus argue that reciprocal behavior is stable.[24]

5 Comparative statics

We perform two sets of comparative statics exercises. First, we compute the general equilibrium responses to a productivity shock A, under the equilibrium description provided above, that is, assuming that prices are completely flexible. If prices are flexible the equilibrium is supply-determined with prices adjusting for aggregate demand to absorb the supply of output forthcoming at the equilibrium levels of effort and employment. Second, we consider a change in demand y under the assumption that prices are completely fixed. This is a Keynesian situation, where the equilibrium is entirely demand-determined and firms lower production so as to exactly match the reduction in demand. Effective labor adjusts to the new cost-minimizing level and the markup $1/\psi$ departs from its opti-

[23] In fact, both λ and $e_{\max}$ appear in the model equations only through the constant Q, which enters both the EC and the MSC in the same way. Hence, λ and $e_{\max}$ drop out as a determinants of φ and wn/y.

[24] Of course, one could argue that workers increase their material utility by providing zero effort after having received the wage from the firm. The optimality of such a strategy rests on two assumptions, however: (i) workers do not care about reciprocity ($\lambda = 0$); and (ii) firms can be fooled consistently into believing that workers care about reciprocity even though they don't (otherwise, providing zero effort would lower total utility). The problem with the second assumption is that firm are likely to sooner or later revise their beliefs or go out of business (after all, they are making negative profits). In either case, wages and thus material utility would drop to zero, which makes providing zero effort a suboptimal long-run strategy for the worker.

mal (flexible price) level as the price of effective labor adjusts.[25] To put the different results into perspective, we also report the corresponding comparative statics for the reduced-form models of Section 2.

5.1 Calibration

The comparative statics calculations are performed relative to a benchmark equilibrium. For the reciprocity-based model, this equilibrium is the flexible price equilibrium described above. We calibrate $\chi = -2$, $\theta = 2$, $\lambda = 9.5$, $\rho = 0.5$ (a replacement ratio of 50%), $n = 0.95$ (an unemployment rate of 5%), $\psi = 0.9$ (a markup of 11%), $\alpha = 0.6$, $A = 1$ and $e_{\max} = 1$. The weight φ in the definition of the reference wage resulting from these values is 0.49 and the implied labor income share is $wn/y = 0.58$, which is close to the average labor income share observed in the US over the post-World-War-II period.

For the reduced-form model with external wage references, the equilibrium is computed by first combining the wage setting equation (16) with $b = \rho w$ to solve for a_0 as a function of a_1, γ, ρ and n. Then we use the condition for optimal effort (11), the production function and the labor demand (8) to pin down the equilibrium values for e, y and w, respectively. For the reduced-form model with internal wage references, computing the equilibrium is a bit more involved because the weight of the reference wage ν is exogenous rather than an aggregate variable as in the external reference model ($\bar{n}$). This adds an additional free parameter. We first combine the labor demand (12), the EC in (15), the wage setting equation (18) and $b = \rho w$ to express a_0 as a function of a_1, γ, ρ, α, ψ and ν. As in the external reference case, we then use the EC, the production function and the labor demand to compute the equilibrium values for e, y and w, respectively.

For both the external and the internal reference model, the parameters that are common with the reciprocity-based model are set to the same values: $\rho = 0.5$, $n = 0.95$, $\psi = 0.9$, $\alpha = 0.6$, $A = 1$. The remaining parameters are calibrated as follows: $\gamma = 0.5$ and $a_1 = 1$ for the external reference model; and $\gamma = 0.5$, $a_1 = 1$ and $\nu = 0.20$ for the internal reference model. These values imply an equilibrium labor income share of $wn/y = 0.54$ and $wn/y = 0.586$ for the external and the internal reference models, respectively.

The comparative statics results obtained for the three models and reported below are robust to alternative calibrations of the different parameters. In particular, for the reciprocity-based model, the values chosen for λ, A and $e_{\max}$ do not affect the compara-

[25] As is standard in the New Keynesian literature, we consider demand shocks that are sufficiently small for profits of the monopolistically competitive firms to remain positive.

tive statics in any way. These robustness checks as well as a more detailled description of the comparative statics computations are reported in an appendix that is available on the authors' websites.

5.2 Technology shock with flexible prices

The second row of Table I displays the general equilibrium responses of our reciprocity-based model to a decrease in the productivity variable A by 1%, given flexible prices. The value of b is held constant at its benchmark equilibrium level. This is a neoclassical situation where the equilibrium is fully supply determined and the markup remains constant. Surprisingly, w, y/n as well as e remain unchanged, while employment and output decrease by 2.48% – almost 2.5 times as much as the productivity shock itself. Our reciprocity-based model thus exhibits strong rigidity in real wages and labor productivity while generating substantially amplified responses in real quantities.

The intuition behind this result is the following. Consider the labor demand (22) and the wage setting curve (24). In both equations, the wage depends on the reservation wage value b and labor productivity y/n. The latter is positively related to A. Since we keep b constant after the decrease in A, the only way the firm can satisfy both the labor demand and the wage setting curve is to adjust n in such a way that both y/n and w remain at their original levels. As a result, effort remains unchanged as well.

The second row of Table II shows the response to a 1% decrease in A for the reduced-form model with internal references. The similarity to the comparative statics of the reciprocity-based model above is striking. The firm again finds it optimal to react to the increase in total factor productivity with an increase in employment and output while leaving all other variables (wage, markup, labor productivity) constant. Here the constancy of effort is a necessary consequence of the firm's optimal behavior.

In comparison, the reduced-form model with external wage references is incapable of generating substantial wage rigidity. As the second row of Table III shows, firms react to the decrease in A by lowering both employment and wages so that the labor demand condition (8) holds again. In equilibrium, however, employment drops by only 0.08% while wages fall by 0.97%. Effort remains at its constant optimal value. As a result, production decreases by hardly more than the shock itself (-1.04%) and labor productivity drops substantially (-0.97%). The small labor response is due to the fact that in equilibrium, the reference wage declines with the decrease in both w and n. Hence, firms can afford to decrease their wage substantially since it must remain a fixed proportion of the reference wage by condition (16).

5.3 Demand shock with fixed prices

The second set of comparative statics relates to a negative 1% shock in demand y, under the assumption that prices are completely fixed. As before we keep unemployment benefits constant at the original equilibrium level.

The third row of Table I shows the responses of the reciprocity-based model. Firms reduce employment by 1.59%, leading to an increase in labor productivity and thus the reference wage. Firms meet part of this increase in the reference wage with a wage increase of 0.10% but also react with a decrease in their gift to workers, thus accepting a decrease in the level of effort (-0.08%). As in the previous exercise, the reciprocity-based model is characterized by a high degree of wage rigidity and large reactions in employment and output.

The model has some interesting additional implications. First, effort comoves with output, which is explained by the fact that in equilibrium, effort is negatively related to the markup $1/\psi$. Given that the markup is countercyclical over the cycle in the case of demand-led expansions, our reciprocity-based model thus offers an alternative to Burnside and Eichenbaum's [1996] labor hoarding story for why effort is procyclical.

A second interesting implication is that the real wage is mildly countercyclical with respect to the demand shock. This result is consistent with a number of recent econometric studies using structural vector autoregressions to investigate the cyclicality of macroeconomic aggregates to supply and demand shocks. Based on different identification schemes, Blanchard [1989], Gamber and Joutz [1997] and Fleischman [1999] all report a small negative correlation between real wages and cyclical indicators conditional on demand shocks.

The third row of Table II reports the analogous results for the reduced-form internal reference model. Here as well, the decrease in labor induced by the 1% decrease in demand increases labor productivity y/n. This means that the reference wage increases. Contrary to the the reciprocity-based model, however, the optimal effort level is constant. Firms thus increase their wage (by 0.13%) to elicit the optimal effort. The response of real wages in response to demand shocks is countercylical as well. Effort, however, remains constant by definition, which explains why the reactions of employment, labor productivity and the markup are slightly larger than in the reciprocity-based model.

In comparison, the third row of Table III shows the response of the external reference model to the same 1% decrease in demand given fixed prices. Since wages are set such that effort is constant, the drop in effective labor required to match the new demand must come from a decrease in labor. As in the case of a technology shock, the ensuing decrease in aggregate employment implies that the reference wage decreases. This in

turn means that firms decrease wages to prevent a (suboptimal) decrease in the supply of effort. But this decrease in firms' wages pushes the reference wage further down. It is thus unsurprising that the wage change necessary to induce the required increase in employment is very large: w decreases by more than 15% for a decrease in n of only 1.66%. This large variation in the wage is accompanied by an equally large increase in the markup $1/\psi$.

In sum, the external reference view is unable to generate sluggish wage dynamics in general equilibrium. For reasonable calibrations, the reference wage strongly co-moves with employment and aggregate shocks, thus forcing firms to adjust their wages substantially. By contrast, the reference wage is much more stable in the internal case and actually moves inversely with employment. This is true both for the reduced-form model and our structural reciprocity-based model. Hence, wages are sluggish and negatively related to employment. This provides a quantitative confirmation of our discussion in Section 2: the efficiency wage hypothesis by itself implies neither wage rigidity nor lack thereof. Wage rigidity rather depends on the interpretation of the *reference wage level* to which workers compare their salary when deciding on work effort.

6 Conclusion

In this paper, we show that the missing wage rigidity in general equilibrium models with efficiency wages is an artifact of the external wage reference perspective conventionally adopted by the literature. Efficiency wage models based on an internal wage reference perspective are capable of generating strong wage rigidity and provide a satisfactory answer to Hall's call for a model that generates a fall in labor demand without a counterfactual fall in productivity. Intuitively, this result arises because workers in the internal perspective consider firm productivity as an important benchmark for their effort decision. Given that productivity decreases with employment, the reference wage and thus the optimal wage decrease when the firm expands its labor force.

The question whether the efficiency wage hypothesis is consistent with the acyclical behavior of real wages over the business cycle therefore boils down to whether the internal reference perspective is a relevant description of how workers and firms do behave. Based on empirical evidence obtained with a variety of different methods, we conclude that rent sharing is indeed a pervasive feature of modern labor relations.

One of the main reasons for the importance of internal references appears to be workers' propensity to reciprocate a fair treatment by the firm, notably in terms of wages, with above normal effort. We accordingly propose a structural model of efficiency wages

that is broadly consistent with the reported evidence on fairness in labor relations. Our model provides a robust explanation for wage rigidity, procyclical effort and countercyclical wages in response to demand shocks. It also implies an optimal wage setting equation that rationalizes the observation that firm productivity is a significant predictor of wage setting by firms.

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Table I

Comparative statics for reciprocity-based model

Calibration of benchmark equilibrium

n	A	α	ρ	ψ	χ	θ	φ	wn/y
0.95	1	0.6	0.5	0.9	-2	2	0.49	0.58

Change in variables to shock (in % from benchmark equilibrium)

	y	n	w	e	ψ	wn/y	y/n
- 1% technology shock (flexible prices)	-2.48%	-2.48%	0.00%	0.00%	0.00%	0%	0.00%
- 1% demand shock (fixed prices)	-1.00%	-1.59%	0.10%	-0.08%	-0.43%	-0.49%	0.60%

Table II

Comparative statics for reduced-form model with internal references

Calibration of benchmark equilibrium

n	A	α	ρ	ψ	γ	ν	wn/y
0.95	1	0.6	0.5	0.9	0.5	0.20	0.59

Change in variables to shock (in % from benchmark equilibrium)

	y	n	w	e	ψ	wn/y	y/n
- 1% technology shock (flexible prices)	-2.48%	-2.48%	0.00%	0.00%	0.00%	0%	0.00%
- 1% demand shock (fixed prices)	-1.00%	-1.66%	0.13%	0.00%	-0.53%	-0.53%	0.67%

Table III

Comparative statics for reduced-form model with external references

Calibration of benchmark equilibrium

n	A	α	ρ	ψ	γ	wn/y
0.95	1	0.6	0.5	0.9	0.5	0.54

Change in variables (in % from benchmark equilibrium)

	y	n	w	e	ψ	wn/y	y/n
- 1% technology shock (flexible prices)	-1.04%	-0.08%	-0.97%	0.00%	0.00%	0%	-0.97%
- 1% demand shock (fixed prices)	-1.00%	-1.66%	-15.32%	0.00%	-15.90%	-15.90%	0.67%

Figure I
Labor market equilibrium for reduced-form models

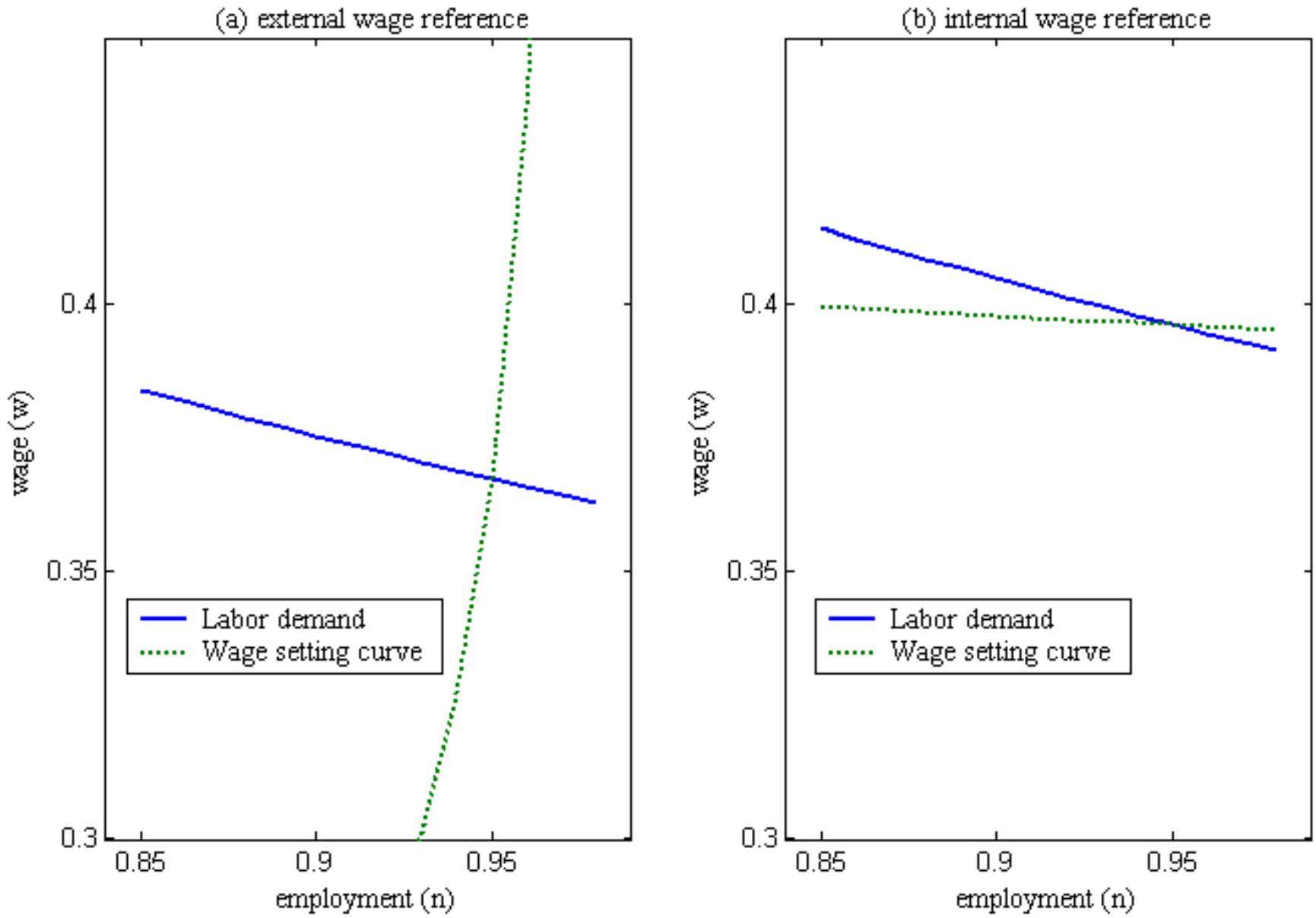

Figure II
Labor market equilibrium for reciprocity-based model

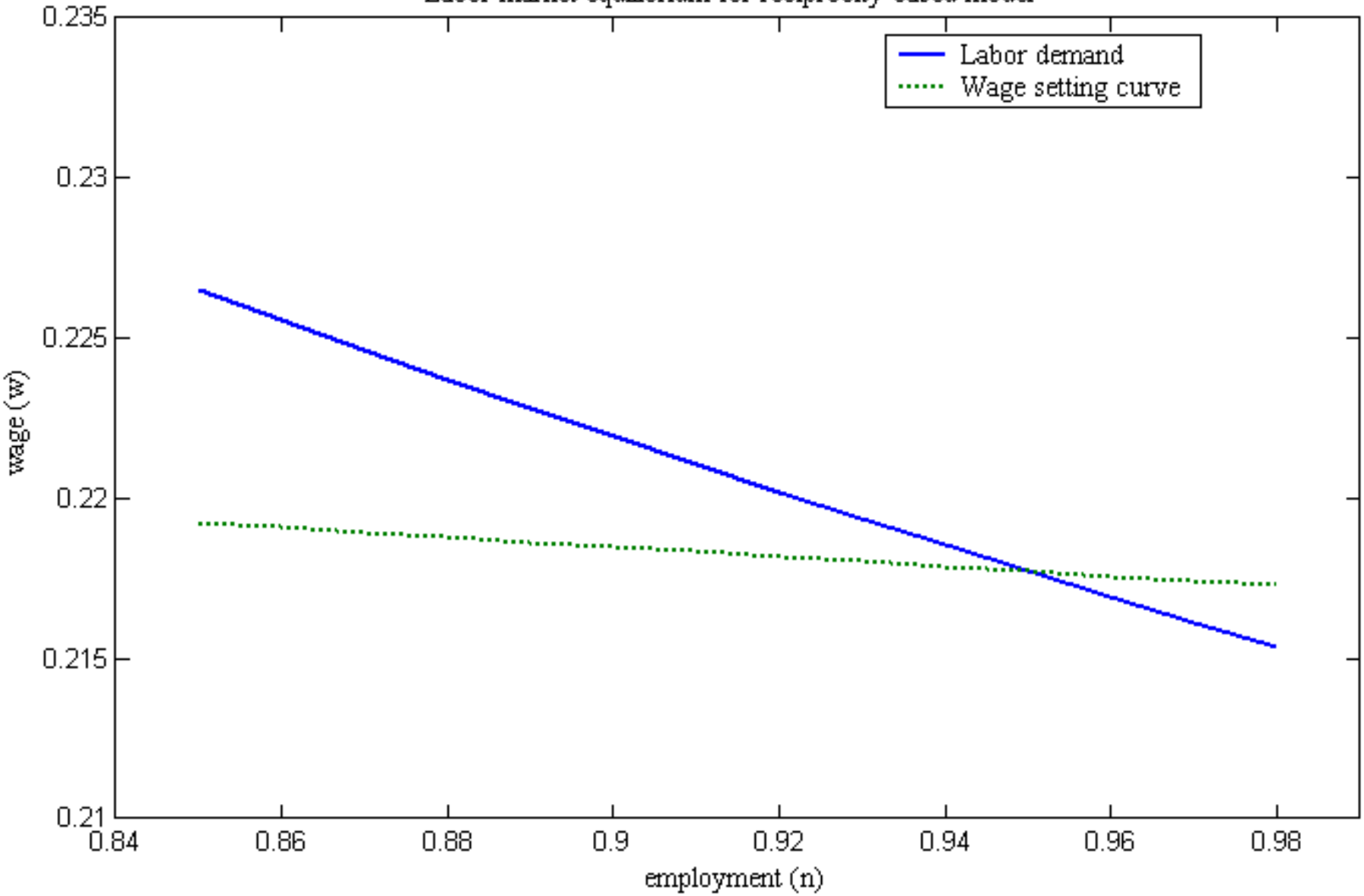

Figure III
Optimal reciprocity