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Reciprocity and Downward Wage Rigidity

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Abstract: The employment relationship is to a large extent characterized by incomplete contracts, in which workers have a considerable degree of discretion over the choice of their work effort. This discretion at work kicks in the potential importance of "gift exchange" or reciprocity between workers and employers in their employment relationship. Built on the seminal work of Akerlof (1980), this paper adopts a social norm approach to model reciprocity in labor markets and theoretically derives two versions of downward wage rigidity. The first version explains why employers may adopt a high wage policy far above the competitive level. This version is not a novel finding in the existing literature and is mainly served as a benchmark for later comparison in the current paper. Our main contribution lies in the second version in which not only may employers adopt a high wage policy far above the competitive level, but one can also account for the asymmetric behavior of wages and explain why employers are hesitant about wage cuts in the presence of negative shocks. We argue that this second and stronger version of downward wage rigidity has moved the efficiency wage theory a step forward.

JEL Classification: J41, A13, E24, C91

Key Words: Reciprocity, Downward Wage Rigidity, Social Norm, Efficiency Wage

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I. Introduction

Many people repay those who have been kind to them with gifts and behave in a reciprocal manner. This reciprocal behavior is different from altruism, which is a form of unconditional kindness. It is also different from responses in repeated interactions since reciprocal actions may be costly without there being any expectation of present or future tangible payoffs.

Akerlof (1982, 1984) noticed that reciprocal behavior might have important economic consequences when he observed the phenomenon of "gift exchange" between the worker and the firm. On the workers' side, the "gift" given is that they may be willing to do more than necessary to keep their jobs while, on the firms' side, the "gift" given is that they may be willing to pay wages in excess of the amount necessary to retain their workers. This "gift exchange" between the worker and the firm can give rise to a positive wage-effort relationship, which is the heart of the efficiency wage theory.[1] The possibility of "gift exchange" between the worker and the firm, Akerlof emphasized, is contrary to the prediction of the neoclassical model that firms will never pay more than the market-clearing wage. Because markets with gift-exchange need not clear, Akerlof argued that the presence of gift-exchange or reciprocity might explain the persistence of involuntary unemployment.

In the real world, people's kind or unkind behavior may arise from repeated interactions or may be simply due to unconditional altruism. It is thus difficult to discern with certainty the existence of reciprocity in real world interactions. This difficulty forces economists to search for clean experimental evidence. Recently, Professor Fehr and his coauthors conducted a series of tightly controlled laboratory experiments to study reciprocal behavior in labor markets. Among their many findings, two are most relevant to the current paper.[2] First, the extent to which the workers' "gift" is given is strongly increasing in the "gift" given by employers (Fehr and Gachter,

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1 See Akerlof and Yellen (1986) and Katz (1986) for two introductions to the efficiency wage theory.

2 Fehr and Gachter (1998, 2000) review these experimental studies.

1997; Fehr et al., 1997). Second, the presence of reciprocity gives rise to downward wage rigidity in the sense that employers adopt a high wage policy far above the competitive level and are reluctant to accept workers' underbidding of the prevailing wage (Fehr et al., 1993; Fehr et al., 1998; Fehr and Falk, 1999). These two experimental findings nicely corroborate the gift-exchange efficiency wage hypothesis put forth by Akerlof (1982, 1984).

In the first part of this paper, we adopt a social norm approach to model reciprocity in labor markets and develop a basic model that is consistent with the environment in laboratory experiments to theoretically derive Professor Fehr and his coauthors' two experimental findings above. Several recent papers, including Rabin (1993), Fehr and Schmidt (1999), Bolton and Ockenfels (2000), Dufwenberg and Kirchsteiger (1998, 2000), and Falk and Fischbacher (2000), have also developed models that are capable of explaining or deriving a positive wage-effort relationship on the basis of reciprocal behavior.[3] Thus the prediction of our basic model is not novel. Our novelty lies in the second part of the paper: we extend the basic model to derive a stronger version of downward wage rigidity, which is well documented empirically but cannot be explained by the standard efficiency wage theory.

In many laboratory experiments on reciprocity, the subjects who behave reciprocally and the subjects who exhibit selfish behavior and do not reciprocate are typically found to co-exist (Fehr and Gachter, 1998, 2000). According to Fehr and Schmidt's (2001) assessment, the heterogeneity of agents between reciprocal and selfish types is more important than their possible heterogeneity within reciprocity. Fehr and Fischbacher (2002) provide evidence indicating that the existence of reciprocal agents may lead to a world very different from the one that is exclusively populated by self-interested people. Whether or not a worker is of a reciprocal or a

[3] It should be noted that these papers often intend to explain more than the gift-exchange efficiency wage hypothesis. See Fehr and Schmidt (2001) for a critical survey of this literature.

selfish type is determined endogenously in our basic model and the co-existence of reciprocal and selfish types typically shows up in equilibrium.

The co-existence of reciprocal and selfish types raises an interesting question: how differently would people behave if they knew there were different fractions of reciprocal or selfish types in the society? In the second part of this paper, we extend the basic model to address this social interaction among workers. It turns out that the extension gives rise to a stronger version of downward wage rigidity, in the sense that not only is there a positive wage-effort relationship so that employers may adopt a high wage policy far above the competitive level, but one can also account for the asymmetric behavior of wages and explain why employers are hesitant about wage cuts in the presence of negative shocks. We argue that this strong version of downward wage rigidity has moved the efficiency wage theory a step forward.

The remainder of this paper consists of the following sections. Section II introduces the basic model. Section III extends the basic model to explicitly recognize the co-existence of reciprocal and selfish types of behavior. Section IV concludes.

II. Basic Model

A key feature common to the laboratory experiments conducted by Professor Fehr and his coauthors is that wages paid by firms and effort supplied by workers are determined sequentially: wage payments are specified and committed in advance of effort supplied. This sequence is designed to capture the essence of incomplete labor contracts: workers have a considerable degree of discretion over the execution of the contract after the contract has been signed.[4] As long as (i) effort brings about disutility to workers, and (ii) effort above the minimum level is not

[4] In the case of complete contracts where work effort is exogenously given, Fehr and Falk (1999) showed experimentally that employers will take full advantage of the low wage offers made by workers so that contract wages are close to the competitive level. This finding is intuitive. When work effort is exogenously given, there will no role for reciprocity and there will be no incentive problem either. Recognizing this, a profit-maximizing firm obviously has no reason to offer wages in excess of the competitive level.

enforceable by firms, it is standard to predict under this sequential setting that workers will choose to supply the minimum effort regardless of wage payments. Fehr and Gachter (1997) and Fehr et al. (1997) conducted experiments to test this prediction. They demonstrated that the standard prediction fails dramatically: workers will react reciprocally and the average effort put forward by workers will vary positively with the wage levels offered by firms.[5] In this section, we present a basic model to theoretically derive this reciprocity-elicit-effort result.

A. Model

Consider a one-period employment contract in which a firm specifies and commits to the wage payment in advance of work effort supplied.[6] After accepting the contract, workers in the workplace can choose to supply either high effort (which takes on value 1) or low effort (which takes on value 0).[7] For ease of exposition, supplying low effort may be understood as shirking (non-cooperation) while supplying high effort as non-shirking (cooperation). Workers, whose only source of income comes from employment, are assumed to maximize a utility function:

$$U = w + (1 - e) - C \tag{1}$$

where w is non-negative wage income, e is effort supplied, and C is the psychological cost associated with the choice of e: $C = 0$ if $e = 1$ but $C \geq 0$ if $e = 0$. The C term in (1) plays a key role in this paper. Our modeling strategy is to link it with the adherence to or violation of social norms. In what follows we discuss the modeling of the C term in detail.

According to Fehr and Gachter (2000, p. 166), a social norm is: "1) a behavioral regularity; that is 2) based on a socially shared belief of how one ought to behave; which triggers 3) the

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[5] Fehr and Gachter (1997) and Fehr et al. (1997) also perform experiments to show that if firms have the opportunity to respond reciprocally by rewarding or punishing workers after they observe the workers' effort choice, then the power of reciprocity will be reinforced.

[6] Similar to Fehr and Gachter (1997) and Fehr et al. (1997), the one-shot setting here is designed to rule out complications arising from repeated interactions.

[7] The binary setup here follows Shapiro and Stiglitz (1984) and many others.

enforcement of the prescribed behavior by informal social sanctions." They also emphasized (p. 168): "most social relations in neighborhoods, families and work places are not governed by explicit agreements but by social norms."

In a seminal paper, Akerlof (1980) put forth the idea that there exist a variety of codes of behavior (social customs or social norms) in a society. A person who disobeys these codes will be punished by informal social sanctions such as guilt and shame. Booth (1985), Naylor (1989) and Lindbeck et al. (1999), among others, have elaborated on the argument further. Following this strand of the literature, we assume the existence of the gift-exchange or reciprocity norm (a code of behavior) in the society. This norm, shared commonly among people within the society, prescribes that *individuals should behave reciprocally and be kind to those who have been kind to them*. This norm equally applies to work behavior in the workplace. Casual evidence and daily experience indicate that many societies do have this reciprocity norm.[8] The focus of this paper is not on why such a norm is established in the first place, but rather on its implications if such a norm does in fact exist.[9]

Norms such as individuals being obliged to behave reciprocally are hardly suitable for embodiment in law. Without the enforcement of the state, it seems clear that there must exist informal social sanctions to enforce these norms so as to ensure their survival. According to Posner and Rasmusen (1999), there are various sanctions that enforce norms, including guilt and shame.[10] Both guilt and shame could be applicable to norm violators in the real world. This may not be true in laboratory experiments, however. In order to rule out group-pressure effects, no worker was informed of the effort choice of fellow workers in the experiments conducted by

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[8] The famous Aesop's fables "The Lion and the Mouse" and "The Dove and the Ant" express the key idea of reciprocity: "one good turn deserves another." See Offer (1997) for an account of the significance of reciprocity in many domains (including the workplace) during the course of modern economic growth.

[9] The establishment of the reciprocity norm may be explained in terms of the evolutionary process; see Guth and Yarri (1992) and Guth (1995).

[10] For details, see Posner and Rasmusen (1999).

Professor Fehr and his coauthors. Thus external sanctions such as shame will have no chance of occurring in laboratory experiments because shame results only if others know of the violation of the reciprocity norm. To be consistent with the information condition in laboratory experiments, we focus in the basic model on an internal sanction: guilt. Guilt is incurred as a result of the process of socialization such as through education and upbringing and, therefore, it may occur even if the violator will never be caught or known for sure. We summarize the resulting guilt imposed upon a violator of the reciprocity norm by the psychological cost that he or she incurs. This psychological cost is represented by the *C* term in (1). To be specific, it is specified as:

$$C = \lambda c(w);\ c(w=0) = 0,\ c'(w) = dc/dw > 0 \qquad (2)$$

where λ is an idiosyncratic sensitivity indicator which may capture the degree of personal belief in the reciprocity norm, and *c*(.) denotes a common psychological cost function which is increasing in the wage payment. We explain more about our setup (2) in what follows.

Workers in the workplace are heterogeneous in the sense that λ is idiosyncratic and varies across workers. The distribution of λ is assumed uniform with support on [0, 1].[11] Given *c*(.), the higher the value of λ, the higher will be the psychological cost incurred. It is also assumed that, due to asymmetric information, the firm cannot identify the hidden characteristic λ associated with a particular worker. Consequently, the firm cannot reject workers having a lower λ when recruiting employees, and cannot pay differential wages on the basis of λ either.[12]

In the field of psychology, there is the so-called "equity theory."[13] It basically says that, in interpersonal or social exchange, the perceived value of "inputs" will tend to equal the perceived value of "outcomes" in the subjective sense. Empirical studies are on balance strongly

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[11] This is a convenient rather than a critical assumption.

[12] The possibility of screening is ruled out here since it is not the focus of this paper. The scalar parameter λ may only be a proxy for the multi-dimensional characteristics of workers and there may exist heterogeneity among workers even after the screening in recruiting.

[13] See Adams (1963). It is worth mentioning that a version similar to the equity theory appears as the "social exchange theory" in the field of sociology; see Akerlof and Yellen (1990) for the detail.

supportive of this theory according to Akerlof and Yellen (1990). On the basis of this theory, it is arguable that, the higher the wages that the firm pays, the heavier will be the guilt sanction that will be imposed upon workers who choose to supply low effort. This is true because the "outcome" (the enjoyment of one unit of leisure due to supplying low effort) remains unchanged, but the "input" (the wage payment) has become higher. To restore a balance between the perceived value of the "input" and of the "outcome," shirking workers will likely "adjust" their guilt *upward*. Put simply, the impact of the firm's paying higher wages may be thought of as "crowding in" a shirking worker's guilt arising from the violation of the reciprocity norm. The extent of the "crowding in" effect will become larger as the firm raises the wage payment. This leads to the setup $c'(w) > 0$ in (2).

This completes the description of our basic model.

B. Analysis

According to our setup, the utility of a type λ worker equals

$U^1 = w$ if $e = 1$ (supplying high effort or non-shirking); (3a)

$U^0 = w + 1 - \lambda c(w)$ if $e = 0$ (supplying low effort or shirking). (3b)

It is obvious from (3) that workers will always choose to shirk if there is no psychological cost involved (i.e. $c(w) \equiv 0$).

With $c(w) \geq 0$, a type λ worker will choose to supply high effort if $U^1 \geq U^0$; that is, if the following inequality holds:[14]

$\lambda c(w) \geq 1$. (4)

From (4), the marginal type of workers ($\hat{\lambda}$) who are merely indifferent between supplying high and low effort is given by:

[14] Because wage payments are specified and committed in advance of efforts supplied, the same *w* terms appear in both (3a) and (3b) and hence they are cancelled out in (4).

$$\hat{\lambda} = \frac{1}{c(w)} \tag{5}$$

with

$$\hat{\lambda}_w = \frac{d\hat{\lambda}}{dw} = -\frac{c'(w)}{c^2} < 0. \tag{5a}$$

Workers with $\lambda \geq \hat{\lambda}$ will choose to supply high effort, while those with $\lambda < \hat{\lambda}$ will choose to supply low effort. Note that $\hat{\lambda} > 1$ if $c(w) < 1$. In words, all workers will choose to shirk if the psychological cost involved is smaller than 1. From (1), we see that supplying high effort will lose the enjoyment of leisure whose value equals 1. This is the reason why no worker will choose to supply high effort in our setup if $c(w) < 1$.

When $c(w) > 1$, $\hat{\lambda} < 1$ and hence some workers will choose to shirk while others do not. Because of (5a), the firm's paying higher wages will elicit larger fractions of workers to supply high effort. The reasoning behind this result is intuitive. Higher wages offered by the firm crowd in psychological costs inflicted on workers who choose to supply low effort. This "crowding in" effect results in a reduction in the fraction of shirking workers and, hence, a higher average effort or productivity. We have therefore derived the result that workers will react reciprocally and that the average effort put forward by workers will vary positively with the wage levels offered by firms.

In anticipation of a positive wage-effort relationship, the firm's paying a higher wage will then involve a benefit as well as a cost. The tradeoff between the benefit and the cost at the margin leads to a profit-maximizing efficiency wage. Since this efficiency wage is profit-maximizing, it can therefore explain why employers may adopt a high wage policy far above the competitive level, and also why they are reluctant to accept workers' underbidding of the

prevailing wage in the presence of high unemployment as hypothesized by Akerlof (1982, 1984) and found experimentally in Fehr et al. (1993), Fehr et al. (1998), and Fehr and Falk (1999).[15]

To sum up, we state:

Proposition 1. *Even though wage payments are specified and committed in advance of workers' effort supplied, social disapproval associated with the violation of the reciprocity norm will elicit high effort from workers as long as the firm adopts a high wage policy. This reciprocity-elicit-effort result leads to a positive wage-effort relationship, which in turn explains why employers may adopt a high wage policy far above the competitive level, and also why they are reluctant to accept workers' underbidding of the prevailing wage in the presence of high unemployment.*

After the labor contract has been signed and the wage payment has been specified and committed, it is clear that the greater the costly effort put forward by workers, the higher will be the firm's profit and the lower the workers' payoff. If workers have other-regarding preferences with an aversion to inequality as in Fehr and Schmidt (1999) or Bolton and Ockenfels (2000), then they will respond to high wage payments with high effort levels simply to avoid an unequal consequence in the distribution of the trade surplus between the firm and the worker. In view of the workers' response, a profit-maximizing firm will have an incentive to pay wages above the competitive level.

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[15] These papers confirmed this result in the experimental environments of the so-called "one-sided oral auction" or "double auction." These auction environments represent competitive bidding processes, in which there are many firms and many workers competing against each other, and either firms or workers or both are free to submit and accept wage bids. As demonstrated in Fehr et al. (1998), however, the persistent force that shapes wage rigidity is reciprocity rather than competition. It is worth noting that the possibility of "gift exchange" between the worker and the firm could explain dual labor markets endogenously according to Akerlof (1982, p. 544):
Primary markets are those in which the gift component of labor input and wages is sizeable, and therefore wages are not market-clearing. Secondary labor markets are those in which wages are market-clearing.

The high wage-high effort outcome can also be explained if individuals have the desire to repay kind intentions with kind actions and unkind intentions with unkind actions (Rabin, 1993; Dufwenberg and Kirchsteiger, 1998 and 2000), or have synthesized preferences that merge an aversion to inequality aversion with kind/unkind intentions (Falk and Fischbacher, 2000).

Our approach here is somewhat different, in that it regards reciprocity as a consequence of social approval or disapproval.[16] On the basis of the seminal work of Akerlof (1980), we assume the existence of the "reciprocity norm" in the society and allow for the imposition of informal social sanctions on those who violate the reciprocity norm. In our model, high wage payments will induce workers' reciprocal behavior in the form of high effort simply because they "crowd in" the shirking workers' guilt arising from the violation of the reciprocity norm when supplying low effort.

Anyway, the version of downward wage rigidity stated in Proposition 1 is not a novel finding in the existing literature and is mainly served as a benchmark for later comparison in the current paper. We now turn to deriving the second version of downward wage rigidity.

III. Extended Model

The co-existence of the subjects who behave reciprocally and the subjects who exhibit selfish behavior and do not reciprocate is typically displayed in our basic model. From (5), we see that: (i) $\hat{\lambda} \to 0$ only if $c(w) \to \infty$, and (ii) $\hat{\lambda} < 1$ if $c(w) > 1$. Thus, $0 < \hat{\lambda} < 1$ holds as long as $1 < c(w) < \infty$.

The co-existence of reciprocal and selfish types of behavior raises an interesting question that has not been addressed so far. This is the question of how differently people might behave if they knew there were different fractions of reciprocal or selfish types in the workplace. In this

[16] Fehr and Falk (forthcoming) discussed how reciprocal and social approval incentives, respectively, might interact with material incentives. They did not integrate reciprocity and social approval into a unified framework.

section, we extend the basic model to a world in which social interactions among workers explicitly recognize the co-existence of the fractions of reciprocal or selfish types in the workplace. Since the aim of this section is not to explain reciprocal findings in laboratory experiments as in the basic model, social sanctions imposed on a norm violator are extended to include shame as well as guilt.[17]

A. Model

Let x denote the fraction of workers who choose to shirk and hence who do not reciprocate. The variable x also denotes the probability that a worker will shirk and, hence, represents the shirking propensity of workers. The extant shirking propensity of workers is assumed to be common knowledge among workers, though any worker who shirks will not be identified unless they get caught. This assumption may not be as strong as it appears, as long as aggregate output is observable and can be used to infer aggregate input.[18]

Suppose that the psychological cost (including guilt and shame) imposed on a type λ worker if he or she chooses to shirk is as follows:

$$C = \lambda C(w, x);\ \partial C / \partial w > 0,\ \partial C / \partial x < 0 \qquad (2\text{-}1)$$

This setup extends the psychological cost term in (2) to explicitly take into account the co-existence of reciprocal and selfish types in the workplace. The reason for the sign of $\partial C / \partial w$ is the same as that in the basic model. As to the sign of $\partial C / \partial x$, it is in line with the emphasis in the social norm literature that the bite or effectiveness of social norms against their violators will become less intense if the violation becomes more prevalent.[19]

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[17] It is standard in experimental labor markets for one worker to be matched with one employer. Thus, so far, social interactions in the workplace as we address them here are not the focus of laboratory experiments.

[18] For the "cash posters" case cited in Akerlof (1982), output was easily observable since workers kept records of their own outputs.

[19] See Akerlof (1980), Booth (1985), Naylor 1989), and Lindbeck et al. (1999), among others. Because of the incorporation of the x term in (2-1), this extended model in the technical sense resembles models of social interactions or networks in which aggregate/average behavior enters the individual's utility function. See Manski

For simplicity and concreteness, we focus on a special form of (2-1):

$$C = \lambda c(w)(1-x);\ c(w=0)=0,\ c'(w)>0. \tag{2-2}$$

This special form captures the essence of the general setup (2-1) in that the psychological cost inflicted on workers who violate the reciprocity norm depends not only on their own view of the code of behavior (i.e. λ) but also positively on the wage payment (i.e. *w*) and negatively on the fraction of workers who choose to shirk (i.e. *x*). Our main findings will hold qualitatively even if *C* depends on *x* nonlinearly as in (2-1). We briefly discuss the nonlinear case in the Appendix.

B. Analysis

Under the extended model, the utility of a type λ worker equals

$$U^1 = w \quad \text{if } e=1 \text{ (non-shirking);} \tag{3-1a}$$

$$U^0 = w+1-\lambda c(w)(1-x) \quad \text{if } e=0 \text{ (shirking).} \tag{3-1b}$$

Employing (3-1a) and (3-1b), the marginal type of workers ($\hat{\lambda}$) who are merely indifferent between supplying high and low effort is given by:

$$\hat{\lambda} = \frac{1}{c(w)(1-x)} \tag{5-1}$$

with

$$\hat{\lambda}_w = \frac{\partial \hat{\lambda}}{\partial w} = -\frac{c'(w)}{c^2(1-x)} < 0; \tag{5-1a}$$

$$\hat{\lambda}_x = \frac{\partial \hat{\lambda}}{\partial x} = \frac{1}{c(1-x)^2} > 0; \tag{5-1b}$$

$$\hat{\lambda}_{xx} = \frac{\partial^2 \hat{\lambda}}{\partial x^2} = \frac{2}{c(1-x)^3} > 0. \tag{5-1c}$$

For each possible *x*, workers with $\lambda \geq \hat{\lambda}$ will choose to supply high effort, while those with $\lambda < \hat{\lambda}$ will choose to supply low effort.

(2000) and Shy (2001) for relevant references.

The sign of $\hat{\lambda}_w$ in (5-1a) is the same as before, except that it is derived under a given *x*. The outcome $\hat{\lambda}_x > 0$ in (5-1b) captures the "snowballing" effect: the higher the fraction of shirking workers at the *status quo*, the higher will be the fraction of workers who choose to supply low rather than high effort. When the shirking behavior is more prevalent, the reciprocity norm will become less effective against shirkers and, consequently, the more prevalent that shirking is, the greater the extent that shirking will be intensified. Note that $\hat{\lambda}_{xx} > 0$ in (5-1c), that is, the snowballing effect will be accelerating as the fraction of shirking workers becomes larger.

Since λ is assumed uniformly distributed with support on [0,1], by the definition of $\hat{\lambda}$, we also have:

$$\hat{\lambda} = x \tag{6}$$

Given a fraction of shirking workers, there is a corresponding fraction of workers who will choose to shirk. However, the resulting $\hat{\lambda}$ may not be consistent with the given *x*. Equation (6) simply imposes the consistency condition. It is clear that, except for corner solutions, an equilibrium *x* must satisfy (5-1) and (6) simultaneously. In the remainder of this subsection, we illustrate equilibria and associated properties resulting from our model with the help of several figures.

Consider Figure 1. The locus $XX(w = w_0)$ in the figure stands for the functional relationship between $\hat{\lambda}$ and *x* as expressed in (5-1) when the firm's offered wage equals w_0. The slope of XX is positive because of $\hat{\lambda}_x > 0$ in (5-1b). Note that the slope of XX is increasing with respect to *x*. This shape of the graph is due to $\hat{\lambda}_{xx} > 0$ in (5-1c). Note also that, according to (5-1), $\hat{\lambda} = 1/c(w_0)$ at $x = 0$ while $\hat{\lambda} \to \infty$ as $x \to 1$. This explains why in Figure 1 $XX(w = w_0) = 1/c(w_0)$ at $x = 0$ and $XX(w = w_0) \to \infty$ as $x \to 1$.

In Figure 1, the locus YY traces the relationship between $\hat{\lambda}$ and *x* as expressed in (6). It is obvious that the slope of YY equals 1.

(Insert Figure 1 About Here)

Given any x, the fraction of shirking workers will be increasing if $\hat{\lambda} > x$ but it will be decreasing if $\hat{\lambda} < x$. The reasoning behind this result is intuitive. When $\hat{\lambda} > x$, the fraction of workers who will choose to shirk is higher than the given fraction of workers who shirk. As a result, the actual fraction of shirking workers will be increasing. When $\hat{\lambda} < x$, the opposite occurs. The arrows in Figure 1 summarize the movement of x.[20]

There are three equilibria in Figure 1; that is, points x_0, x_1 and x_2. However, as the arrows indicate, only x_0 and x_2 are stable equilibria. Note that, while the level of shirking is mild at x_0, all workers shirk at x_2. This kind of multiple equilibria is clearly envisioned by Akerlof himself (1980, p. 751):

[T]here are two stable equilibria. In one of these equilibria the custom is obeyed, and the values underlying the custom are widely subscribed to by members of the community. In the other equilibrium the custom has disappeared, no one believes in the values underlying it, and it is not obeyed.

Although there are two possible stable equilibria, it seems "normal" for the workplace to have a low shirking equilibrium at the beginning. From Figure 1, we also see that as long as the fraction of shirking workers is mild or moderate at the wage w_0, the equilibrium must initially be at the low equilibrium x_0.

Now suppose that the initial equilibrium associated with the wage payment w_0 is at x_0 as shown in Figure 1. Consider what will happen if the firm varies its wage payments. According to (5-1a), the locus $XX(w = w_0)$ will shift downward (upward) if the firm raises (cuts) its wages. With the equilibrium at x_0 initially, it is not difficult to see from Figure 1 that raising wages

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[20] A simple dynamics that captures the movement shown in Figure 1 is:
$\dot{x} = \alpha(\hat{\lambda} - x)$
where α is a positive scalar.

continuously will shift the locus XX downward continuously, resulting in a continuous decrease in the *equilibrium* fraction of shirking workers.

The result for wage cuts is very different, however. Consider the locus $XX(w = w_1 < w_0)$ in Figure 2. The salient feature of this locus is that it is tangential to the locus *YY* at point *y*. When the wage payment is adjusted downward from w_0 on, we see from Figure 2 that cutting wages continuously will shift the locus *XX* upward continuously until the wage cut reaches w_1. At $w = w_1$, except for $\hat{\lambda} = x$ at point *y*, $\hat{\lambda} > x$ for all *x* for the locus $XX(w = w_1 < w_0)$. That is, at $w = w_1$, the fraction of workers who choose to shirk (i.e. $\hat{\lambda}$) is almost always larger than the corresponding fraction of shirking workers (i.e. *x*). This triggers a bandwagon effect such that workers move en masse to become shirkers. The movement will not stop until the actual fraction of shirking workers has reached x_2; that is, all workers shirk at the new equilibrium.

(Insert Figure 2 About Here)

In the extended model, workers' behavior depends on how many of them are behaving reciprocally and how many are behaving selfishly. Given any wage payment, there is a corresponding minimum fraction of shirking workers such that all workers will choose to shirk once the extant fraction of shirking workers surpasses the minimum fraction. This minimum fraction equals x_1 in Figure 1 when the wage payment is at w_0. By shifting the locus *XX* upward, wage cuts will lower this minimum fraction and, at the same time, increase the equilibrium fraction of shirking workers. At the threshold wage w_1, the equilibrium fraction of shirking workers will meet the minimum fraction. This explains why in Figure 2 there is a discontinuous jump in the *equilibrium* fraction of shirking workers from *y* to x_2 as a result of a trivial cut in wages. Water will freeze or melt as a gradual change in temperature reaches some critical level. An analogous event occurs in the human world of our model. Workers will endure wage cuts and

adhere to the reciprocity norm only up to some limit. Beyond that limit, a dramatic loss of effectiveness of the reciprocity norm will result.[21]

The above disastrous rise in shirking is irreversible. Suppose that the firm finds out about the disastrous rise in shirking and tries to avoid this terrible result by restoring the wage payment to the pre-cut level w_0. What will happen? Using Figure 2, the restoration of the wage payment will shift the *XX* locus downward from $XX(w = w_1 < w_0)$ back to $XX(w = w_0)$. However, the equilibrium fraction of shirking workers will not return to the pre-cut level x_0. Instead, since the new *status quo* equilibrium associated with the wage payment w_1 is at x_2, it is clear from Figure 2 that the equilibrium after the restoration of the wage payment will remain at x_2. In other words, all workers will still choose to shirk in equilibrium even if the wage has been restored to the pre-cut level. Furthermore, because at any wage *w*, $\hat{\lambda} \to \infty$ and hence $XX(w) \to \infty$ as $x \to 1$ (see (5-1)), it is evident that the stable equilibrium x_2 is a "sink" in the sense that the society will be stuck there once it is reached and no wage policy can change this disastrous outcome.[22]

C. Effort/Productivity Function

Given that the initial equilibrium associated with the wage payment w_0 is at x_0 as shown in Figure 1, varying wage payments will result in different equilibria. These equilibria in turn determine the effort/productivity function facing the firm. We derive the effort/productivity function in this subsection.

Equating (5-1) with (6) yields:

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[21] Catastrophe theory is a mathematical theory that studies how a continuous variation in parameters can give rise to discontinuous effects or jumps in the large. These discontinuous effects or jumps are known as "catastrophes." From our analysis, we see that our model displays some features of "catastrophes" in the sense that there are large, discontinuous changes in the equilibrium fraction of shirking workers as the wage varies continuously. For an introduction to catastrophe theory and its application in economics, see Rosser (2000).

[22] The "sink" result can be reversed if *C* depends on *x* nonlinearly as in (2-1). However, the irreversibility still holds in the nonlinear case, in the sense that the equilibrium fraction of shirking workers will remain much higher and not return to the pre-cut level even if the wage payment has been restored. To return to a low shirking equilibrium again, the wage payment may need to be extraordinarily high. See the Appendix for the detail.

$$x^* = \frac{1}{c(w)(1-x^*)} \tag{7}$$

where x^* denotes the equilibrium fraction of shirking workers if $0 < x^* < 1$ (i.e. if x^* is not a corner solution). On the basis of (7), the solution x^* is given by:

$$x^* = \frac{1}{2}[1 \pm \sqrt{1-4/c(w)}] \tag{8}$$

In terms of Figure 1, $x^* = \frac{1}{2}[1-\sqrt{1-4/c(w)}]$ is associated with the stable equilibrium x_0 while $x^* = \frac{1}{2}[1+\sqrt{1-4/c(w)}]$ is associated with the unstable equilibrium x_1.

When $1-4/c(w)=0$, there will be a unique solution $x^* = 1/2$ according to (8). This unique solution corresponds to point *y* in Figure 2. Thus the threshold wage w_1 in Figure 2 is equal to $c^{-1}(4)$, where $c^{-1}(.)$ denotes the inverse function of *c*(.). All workers will choose to shirk in equilibrium as soon as wage payments reach the threshold level (i.e. $w \le w_1$). To prevent all workers from shirking, wage payments offered by the firm must exceed $c^{-1}(4)$.

Since in our model a worker's effort takes on value 1 if high effort is supplied and 0 if low effort is supplied, the average amount of equilibrium effort supplied by the workers equals $1-x^*$. This amount of equilibrium effort also represents the average productivity in the workplace. From (7), we have:

$$\frac{dx^*}{dw} = -\frac{c'(w)}{c^2(w)(1-2x^*)} \tag{9}$$

It can be shown that the stability condition for an interior x^* imposes the restriction: $x^* < 1/2$.[23] This restriction can also be seen directly by noting that point *y* in Figure 2 corresponds to the unique solution $x^* = 1/2$, and hence any *interior* equilibrium with $x^* \ge 1/2$ will never be

---

[23] Using the simple dynamics specified in Footnote 20, the stability condition requires that (by using (5-1) and (5-1b)):

$$\frac{\partial \dot{x}}{\partial x} = \alpha(\hat{\lambda}_x - 1) = \alpha\hat{\lambda}[\frac{1-c(w)(1-x^*)^2}{1-x^*}] < 0.$$

This inequality implies that $1-c(w)(1-x^*)^2 < 0$. Using (5-1) and (6), we then have the restriction: $x^* < 1/2$.

realized as a stable equilibrium. With the restriction $x^* < 1/2$, the sign of (9) is negative. Thus, in a way similar to the basic model, higher wage payments will elicit reciprocity in the form of higher average effort from workers in equilibrium.

On the basis of the above analysis, one can draw the effort/productivity function corresponding to Figures 1-2 as shown in Figure 3. When the wage is adjusted upward from the wage w_0, the average effort/productivity will rise continuously according to the sign of (9). This yields a positive wage-effort relationship. On the other hand, when the wage is adjusted downward from the wage w_0, the average effort/productivity will decline continuously until it reaches w_1. At the threshold wage w_1, the average effort/productivity falls discontinuously all the way to the zero level and will remain at the zero level regardless of future wage payments.

(Insert Figure 3 About Here)

The dotted line of the effort/productivity function shown in Figure 3 represents the set of unstable equilibria. For example, at the wage w_0, there are three equilibrium fractions of shirking workers, x_0, x_1 and x_2, in Figure 1. These three equilibria correspond to the three equilibria in the average effort/productivity shown in Figure 3, that is, $1-x_0$, $1-x_1$ and $1-x_2$. Since x_1 in Figure 1 is an unstable equilibrium, $1-x_1$ in Figure 3 is an unstable equilibrium too.

Since $c(w) \to \infty$ as $w \to \infty$, we see from (8) that the stable x^* approaches 0 while the unstable x^* approaches 1 as $w \to \infty$. This explains why in Figure 3, as the wage payment goes to infinity, the real line approaches 1 asymptotically while the dotted line approaches zero asymptotically. It is also interesting to note from Figure 3 that when $w > c^{-1}(4)$, the same wage payment can result in a stable equilibrium effort/productivity that is either at some high level (say, $1-x_0$) or at the zero level (say, $1-x_2$) and there is no middle ground in between.

D. Discussion

Compared to the basic model, what are the differences that the extended model has made? To answer this question, we first draw the effort/productivity function facing the firm in the basic model. Based on (5) and (5-a), we know that: (i) $\hat{\lambda} > 1$ if $w < c^{-1}(1)$, that is, all workers choose to shirk and do not reciprocate if wage payments are lower than $c^{-1}(1)$, and (ii) the equilibrium effort/productivity is increasing continuously with respect to the wage payment once $w \geq c^{-1}(1)$. This leads to the graph shown in Figure 4.

(Insert Figure 4 About Here)

By comparing Figures 3 and 4, we think there are two key differences:

(a) Continuity versus discontinuity. In the basic model, agents live in a world in which continuous wage adjustments always lead to continuous variations in labor productivity. In the extended model, by contrast, agents live in a world in which, while continuous wage raises lead to continuous increases in labor productivity, continuous wage cuts can result in a large, discontinuous fall in labor productivity as workers move en masse to become shirkers.

(b) Reversibility versus irreversibility. In the basic model, any fall in labor productivity can be recovered simply by restoring wage payments to the previous level. In the extended model, by contrast, all workers choose to shirk and do not reciprocate once the wage cut reaches the threshold level $c^{-1}(4)$. Furthermore, this result is irreversible.[24]

Both the basic and the extended model are capable of deriving theoretically the central tenet of the efficiency wage hypothesis: a positive wage-effort relationship. Because of the positive wage-effort relationship, there is a benefit as well as a cost associated with the paying of a higher wage by employers and the tradeoff between the benefit and the cost at the margin leads to a profit-maximizing efficiency wage. This efficiency wage is profit-maximizing and, therefore, can explain why employers may adopt a high wage policy far above the competitive level and

[24] See the Appendix for the qualification of this irreversible result.

why they are reluctant to accept workers' underbidding of the prevailing wage when high unemployment persists.

According to this standard efficiency wage argument, equilibrium wages may be far above the market-clearing wage but they may also exhibit high flexibility in the sense that employers are likely to adjust the wages they offer as soon as shocks come. To explain a stronger version of downward wage rigidity in the sense that employers are hesitant to cut their wage payments in the presence of negative shocks, the extended model may be of help.

Let $e(w) \equiv 1 - x^*(w)$; that is, the effort function facing the firm. If the effort function is known, one may then assume the following maximization problem for the firm:[25]

$$\max \ \pi = se(w) - w \tag{10}$$

where *s* is a shift factor denoting either demand or technology shocks. The first-order condition from the above maximization problem yields:

$$se'(w) = 1 \tag{11}$$

The comparative statics on the basis of (12) leads to:

$$\frac{dw}{ds} = -\frac{e'}{se''} > 0 \tag{12}$$

where the determination of the sign is based on the sign of (9) and the second-order condition requirement $se''(w) < 0$.

If the effort function facing the firm is that as shown in Figure 4, then, according to (12), the profit-maximizing wage will be highly flexible with few constraints. The firm will raise wages in the presence of positive shocks and cut wages in the presence of negative shocks. By contrast, the profit-maximizing wage will behave quite different in response to shocks if the effort function

[25] Note that the population of workers is normalized to unity and may correspond to any size. It will not change our main point here if we bring in the employment decision of the firm. Solow (1979) showed that the profit-maximizing efficiency wage would be independent of any shocks if and only if the wage enters the production function in a labor-augmenting way. To facilitate the comparison between the basic and the extended model, one may simply assume that the wage here does not enter the production function in a labor-augmenting way.

facing the firm is that as shown in Figure 3. Consider a low fraction of shirking workers at the initial equilibrium. The firm will still raise wages in the presence of positive shocks. However, in face of the possibility that there will be a large, discontinuous fall in labor productivity and that this large fall is irreversible, the firm will more or less restrain itself from cutting wages in the presence of negative shocks.

Employers hesitate to cut wages is caused by the fact that there is an "edge" wage, w_1 associated with the effort function in Figure 3, beyond which wage cuts will give rise to catastrophes in labor productivity. From (11), we obtain:

$$s_1 = \frac{1}{e'(w_1)} \tag{13}$$

where s_1 is the critical shock corresponding to the "edge" wage w_1. Note that the profit-maximization wage w^* will equal the edge wage w_1 for all $s \le s_1$. This "rigidity" result opens a possible route to explain the downward rigidity of wages. In particular, if the status quo shock is s_0 and $s_0 \le s_1$ holds, then $w^* = w_1$ for all $s \le s_0$, that is, employers will not cut wages in the presence of negative shocks and hence wages will be rigid downward. The significance of this result is best understood by comparing it with the standard "flexibility" result as exemplified by (12). There is no possibility for wage rigidity according to (12), whereas this possibility exists according to (13).

Employers in the real world may not know exactly the effort function facing them since they may know neither the distribution of the idiosyncratic parameter λ nor the psychological cost function *c*(.). Indeed, both λ and *c*(.) may be fickle. This ignorance does not matter a great deal for employers in the basic model, however. The reason for this is that employers in the basic model can formulate their wage policy through trial-and-error, since continuous wage adjustments always lead to continuous variations in labor productivity and any fall in labor productivity can be recovered simply by restoring wage payments to the previous level. The feasibility of this trial-and-error wage policy is clearly seen from Figure 4. In such a continuous

world, there would seem no reason to expect the occurrence of wage rigidity in the presence of shocks.

The trial-and-error wage adjustment policy may not, however, be feasible to employers in the extended model. Without knowing the distribution of the idiosyncratic parameter λ and/or the psychological cost function $c(.)$, employers in the extended model may never know how far wage cuts can go without trigger a sudden, large fall in productivity. In view of the possibly disastrous consequences and their irreversibility, employers have to be very cautious and, therefore, will hesitate about wage cuts in the presence of negative shocks. Note that such worries never impose themselves on employers in the case of wage raises in the presence of positive shocks. Taken together, the discontinuity/irreversibility finding in the extended model allows us to explain why wages behave asymmetrically and, in particular, why wages are rigid downward in the presence of negative shocks.[26]

To sum up our finding, we state:

Proposition 2. *The positive wage-effort relationship derived in the basic model remains true in the extended model in which social interactions among workers explicitly recognize the co-existence of reciprocal and selfish types in the workplace. In the basic model, labor effort is continuous in wages and, therefore, any fall in labor effort can be recovered simply by restoring the wage payment to the previous level. Under this continuous and reversible world, it is difficult to explain why wages are rigid downward in the presence of negative shocks. In the extended*

[26] For evidence on the asymmetric behavior of wages, see Holzer and Montgomery (1993), Campbell and Kamilani (1997) and Bewley (1999, chapters 10-12). The whole of Bewley's (1999) book is devoted to explaining why wages don't fall during a recession. Caution and hesitation about wage cuts are vividly shown up in Bewley's (1999, chapter 11) massive interviews of employers. All employers in the Bewley interview thought that pay cuts would cause problems and their main argument was that employee reaction would cost them more than they would save from pay cuts. This main argument put forward by these employers seems more consistent with the discontinuous effort/productivity function in the extended model than the continuous effort/productivity function in the basic model. Indeed, with a continuous effort/productivity function, pay cuts would often be profitable in the presence of negative shocks as captured by the comparative statics of (12).

model, starting from a low-shirking equilibrium, while labor effort is continuous in wage raises, a continuous wage cut will cause a large, discontinuous fall in labor effort and, furthermore, this fall will persist and may even be irreversible. Under such a discontinuous and irreversible world, wages behave asymmetrically and, in particular, wages are likely to be rigid downward in the presence of negative shocks.

IV. Conclusion

Built on the seminal work of Akerlof (1980), this paper adopts a social norm approach to model reciprocity in labor markets. We first consider a basic model in which a positive wage-effort relationship is derived. In anticipation of a positive wage-effort relationship, the firm's paying a higher wage will then involve a benefit as well as a cost. The tradeoff between the benefit and the cost at the margin leads to a profit-maximizing efficiency wage. Since this efficiency wage is profit-maximizing, it can therefore explain why employers may adopt a high wage policy far above the competitive level, and also why they are reluctant to accept workers' underbidding of the prevailing wage in the presence of high unemployment as hypothesized by Akerlof (1982, 1984) and found experimentally in Fehr et al. (1993), Fehr et al. (1998), and Fehr and Falk (1999).

More importantly, we also consider an extended model in which social interactions among workers explicitly recognize the co-existence of reciprocal and selfish types in the workplace. This extension gives rise to a stronger version of downward wage rigidity, in the sense that not only is there a positive wage-effort relationship so that employers may adopt a high wage policy far above the competitive level, but one can also account for the asymmetric behavior of wages and explain why employers are hesitant about wage cuts in the presence of negative shocks. This stronger version of downward wage rigidity has, we believe, moved the efficiency wage theory a step forward. The standard efficiency wage argument can explain why employers may adopt a

high wage policy far above the competitive level and why they are reluctant to accept workers' underbidding of the prevailing wage when high unemployment persists. However, it cannot explain the asymmetric behavior of wages nor why wages are rigid downward in the presence of negative shocks.

Appendix

With the general setup (2-1), the sign associated with $\hat{\lambda}_w$ in (5-1a) and that associated with $\hat{\lambda}_x$ in (5-1b) will remain unchanged. However, the sign associated with $\hat{\lambda}_{xx}$ in (5-1c) may become ambiguous. Consider Figure A1, which may be thought of as a nonlinear extension of Figure 1. There are three equilibria that satisfy (5-1) and (6) simultaneously in Figure A1; that is, points x_0, x_1 and x_2. As the arrows in the figure indicate, however, only x_0 and x_2 are stable equilibria. Let us assume that the initial equilibrium associated with the *status quo* wage w_0 is at x_0.

Now consider Figure A2. The locus $XX(w = w_1 < w_0)$ is tangential to the locus *YY* at point y, while the locus $XX(w = w_1' > w_0)$ is tangential to the locus *YY* at point y'. As can be seen from the figure, when the wage cut reaches w_1, it will trigger a bandwagon effect such that the equilibrium fraction of shirkers will move en masse from y to x_3. This movement gives rise to a substantial increase in the fraction of shirkers, but not all workers choose to shirk at the new equilibrium.

The irreversible result will qualitatively remain true, in the sense that restoring wages to the pre-cut level w_0 will only reduce the equilibrium fraction of shirkers from x_3 to x_2, and not back to the initial equilibrium x_0. In order to return to a low shirking equilibrium again, the wage has to be raised all the way to w_1', a wage payment that may be extraordinarily high.

The corresponding effort/productivity function facing the firm is shown in Figure A3. Apart from the "sink" result being reversible and not all workers shirking at high-shirking equilibria, the graph is similar to that in Figure 3.

(Insert Figures A1, A2 ands A3 About Here)

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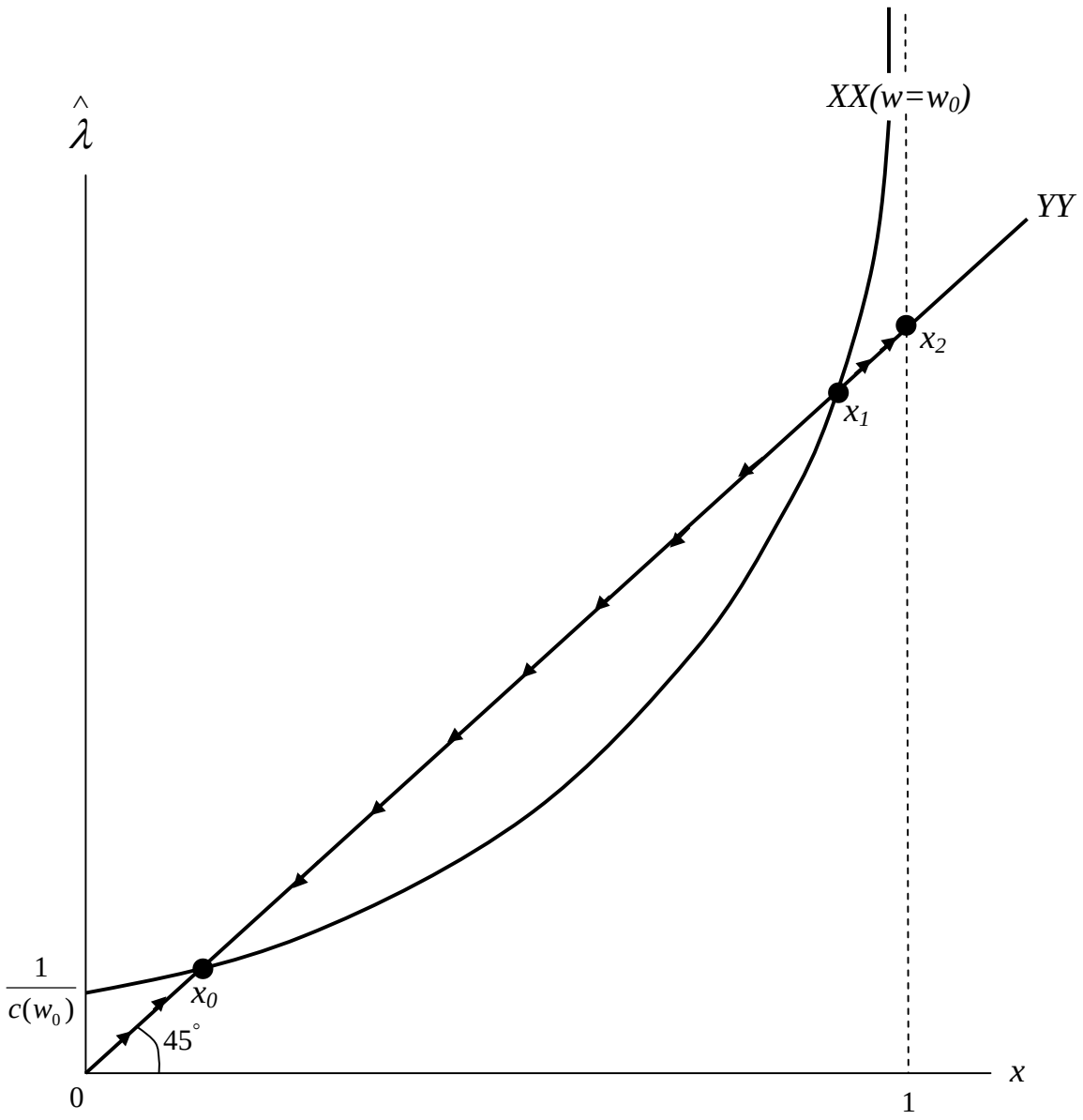

Figure 1. Equilibria

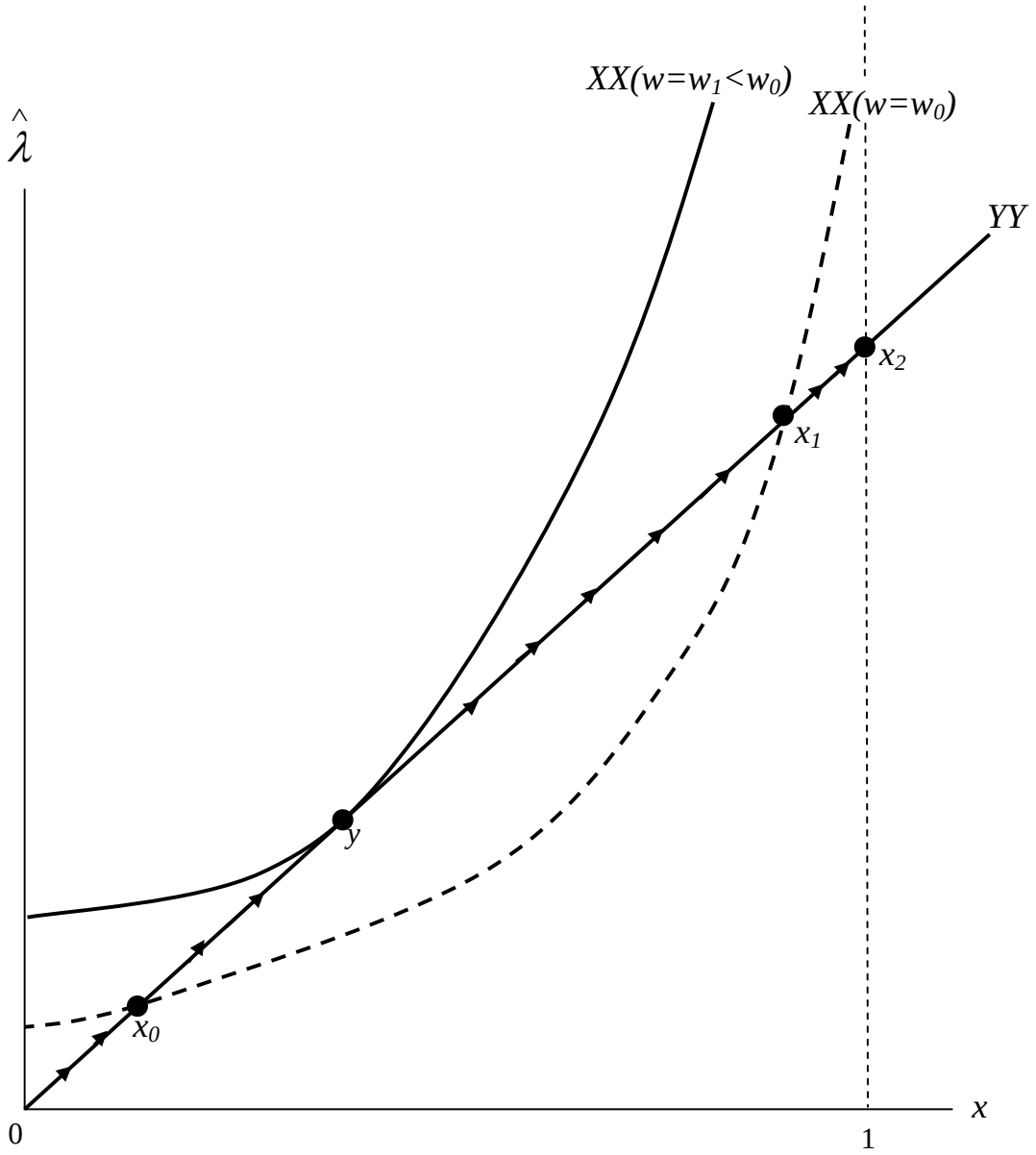

Figure 2. Changes in equilibrium

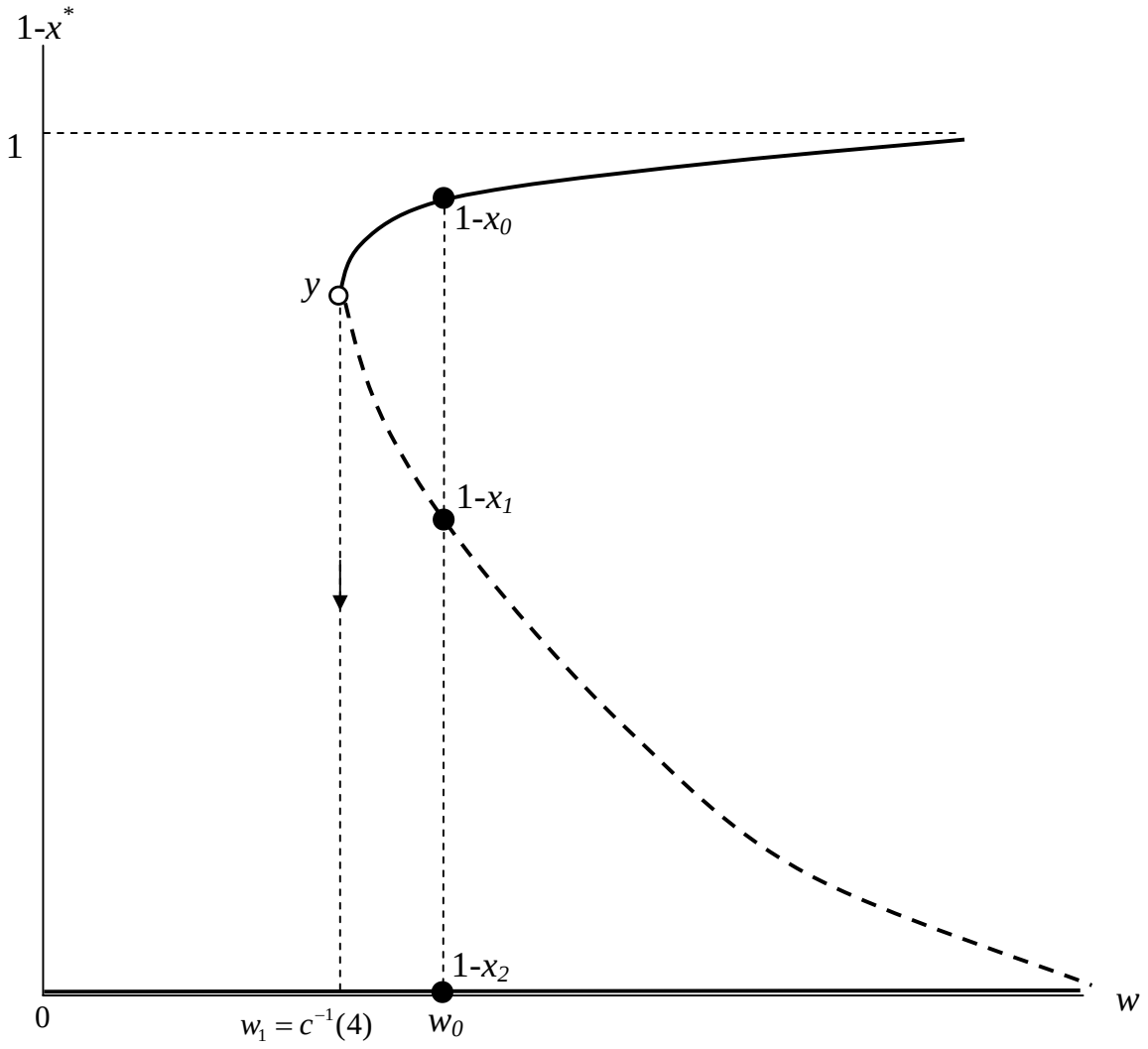

Figure 3. Effort/productivity function

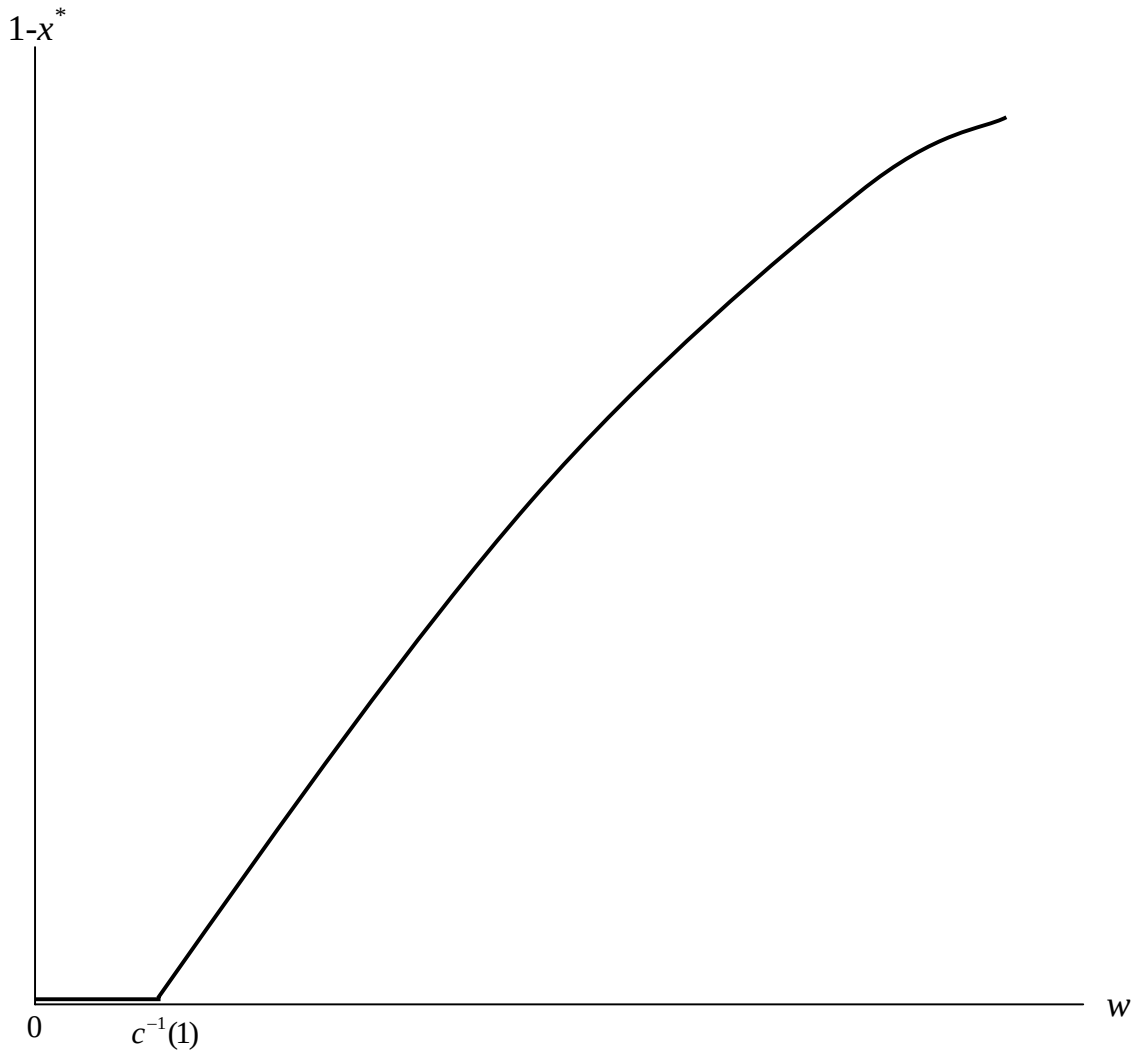

Figure 4. Effort/productivity function in basic model

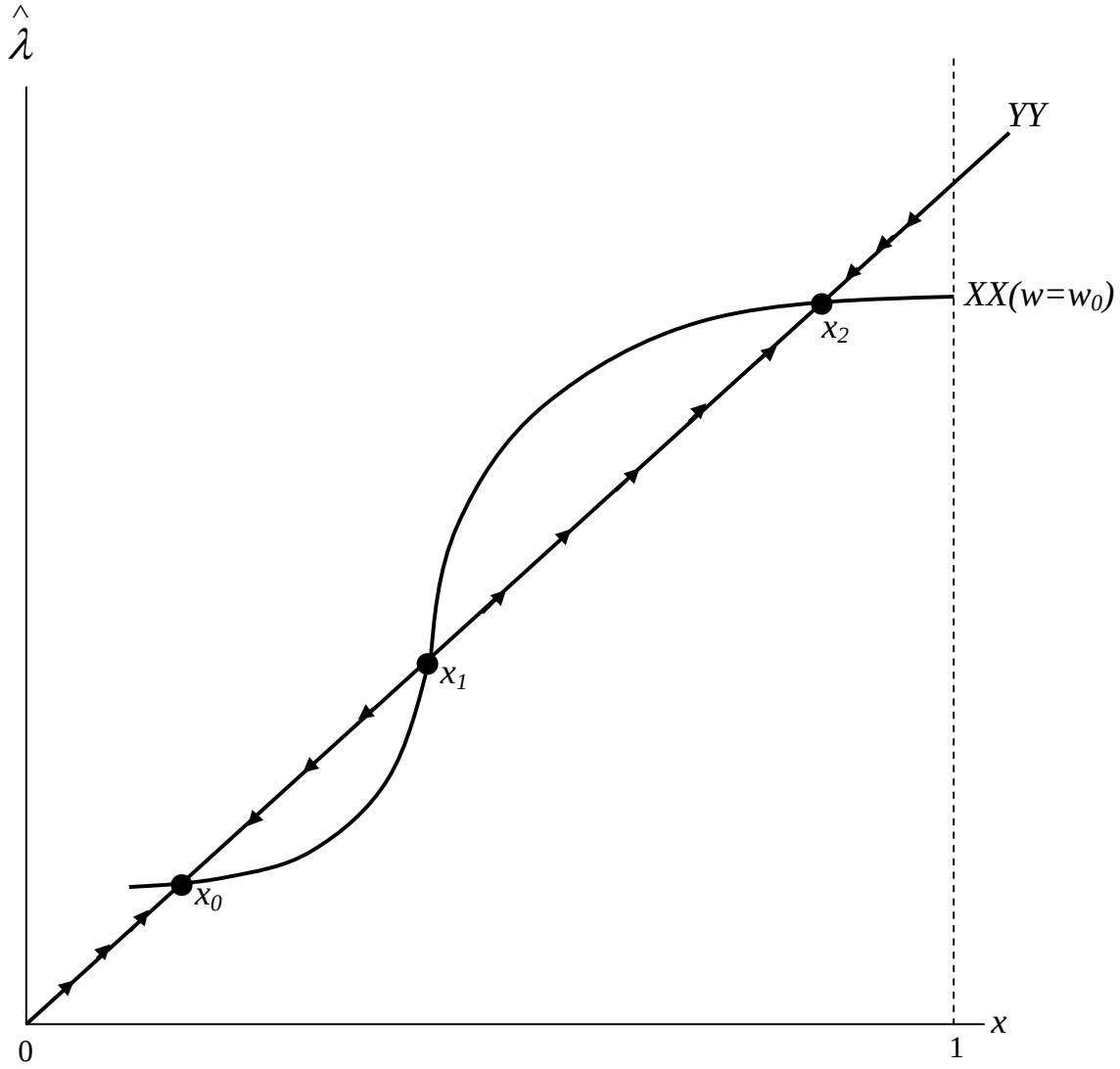

Figure A1. Equilibria

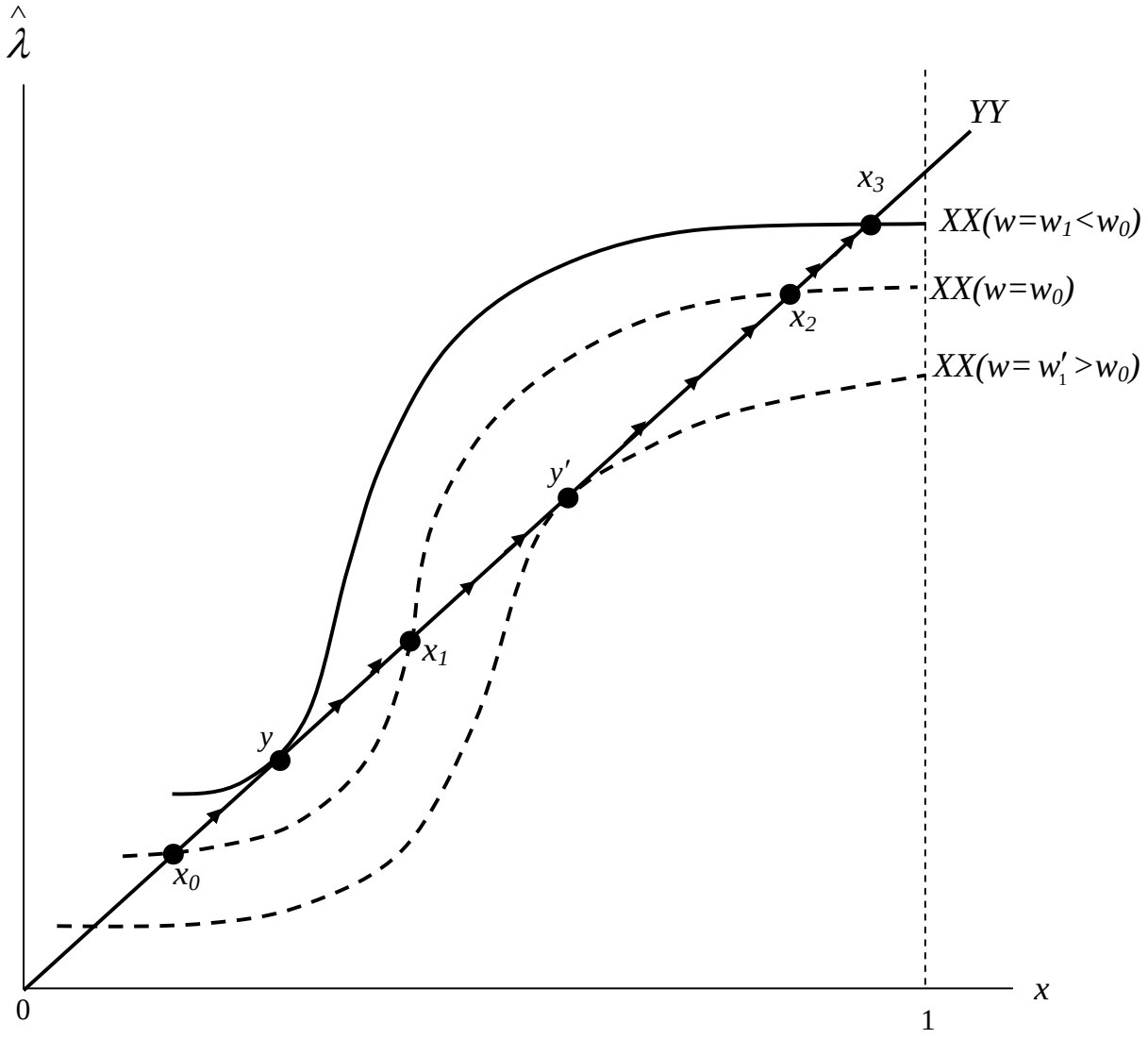

Figure A2. Changes in equilibria

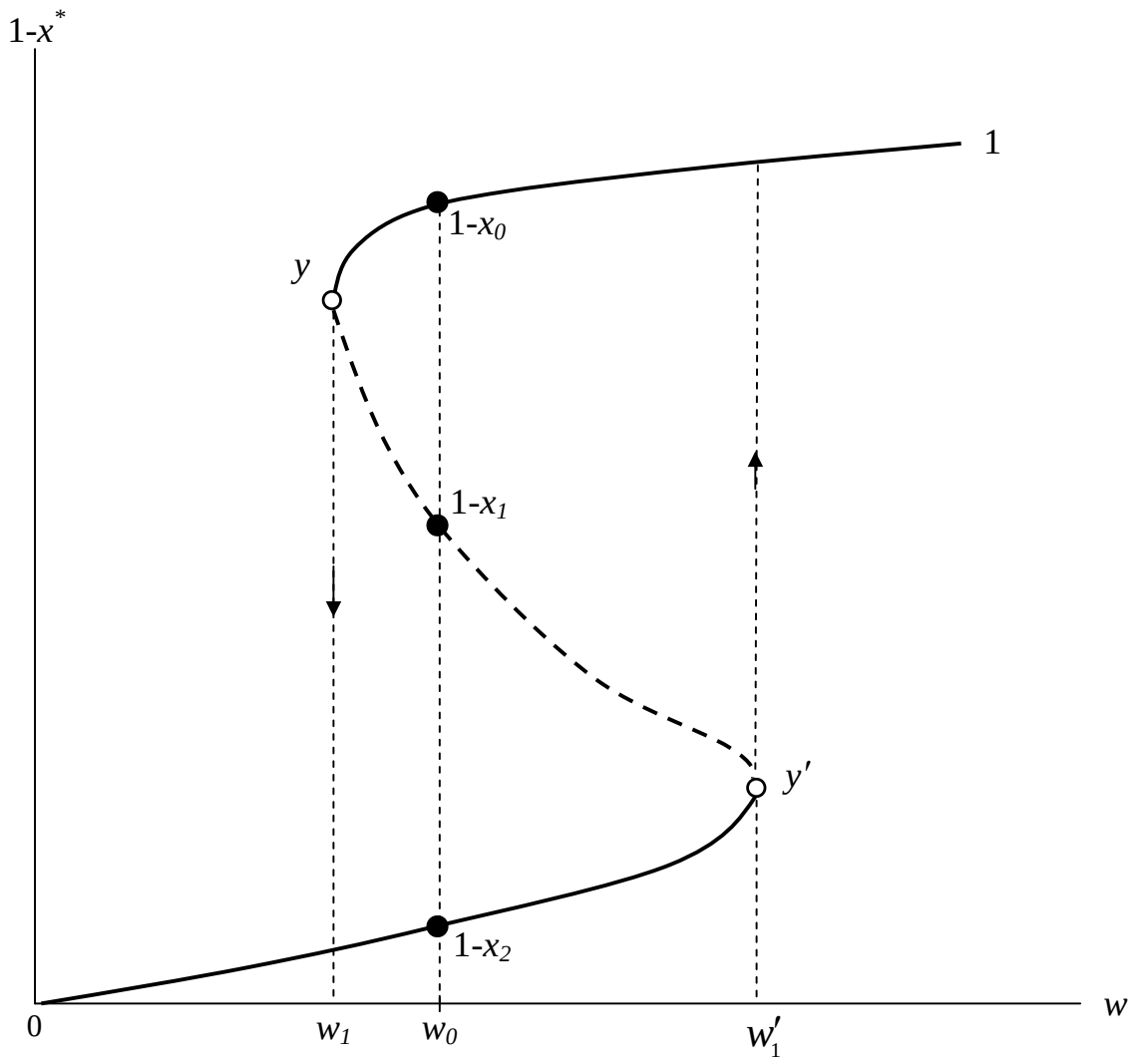

Figure A3. Effort/productivity function

Number	Author(s)	Title	Date
06-A015	Chung-cheng Lin C.C. Yang	Reciprocity and Downward Wage Rigidity	12/06
06-A014	Chung-cheng Lin C.C. Yang	The Firm as a Community Explaining Asymmetric Behavior and Downward Rigidity of Wages	12/06
06-A013	林忠正 黃璀娟	補習是一種社會風俗	11/06
06-A012	Pei-Chou Lin Deng-Shing Huang	Technological Regimes and Firm Survival: Evidence across Sectors and over Time	11/06
06-A011	Deng-Shing Huang Yo-Yi Huang Cheng-Te Lee	Technology Advantage and Trade : Home Market Effects Revisited	10/06
06-A010	Chung-Ming Kuan	Artifcial Neural Networks	09/06
06-A009	Wei-Ming Lee Chung-Ming Kuan	Testing Over-Identifying Restrictions without Consistent Estimation of the Asymptotic Covariance Matrix	09/06
06-A008	Chung-Ming Kuan. Yu-Wei Hsieh	Improved HAC Covariance Matrix Estimation Based on Forecast Errors	09/06
06-A007	Yu-Chin Hsu Chung-Ming Kuan	Change-Point Estimation of Nonstationary *I(d)* Processes	09/06
06-A006	Yuko Kinishita Chia-Hui Lu	On the Role of Absorptive Capacity: FDI Matters to Growth	08/06
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