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Behavior and Downward Rigidity of Wages**

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Institute of Economics  
Academia Sinica  
Taipei 115, TAIWAN  
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**TAIWAN**

# **The Firm as a Community**

## **Explaining Asymmetric Behavior and Downward Rigidity of Wages**

**Chung-cheng Lin\* and C.C. Yang**

*Institute of Economics, Academia Sinica, Nankang, Taipei 115, Taiwan*

*Department of Public Finance, National Cheng-Chi University, Wenshan, Taipei 116, Taiwan.*

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### **Abstract**

This paper models the firm as a community *à la* Akerlof (1980) to account for asymmetric behavior, and in particular, downward rigidity of wages. It is shown that, through social interaction among workers in the firm community, wage cuts can give rise to a large, discontinuous fall in labor productivity (known as “catastrophe”). Furthermore, this large fall in labor productivity will persist or display inertia (known as “hysteresis”) even if the wages are restored to the pre-cut level and beyond. Our catastrophe/hysteresis finding with respect to wage cuts can rationalize the downward rigidity of wage behavior, and is consistent with the interview evidence of *fragile worker morale* emphasized by Bewley (1999) and others in explaining why employers are sensitive to and refrain from cutting worker pay.

*JEL classification:* A13; E24; J31; J41

*Key words:* Wage rigidity; Firm community; Catastrophe; Hysteresis

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\* Corresponding author. Tel.: +886 2 27822791; fax: +886 2 27853946.

*Mailing address:* Institute of Economics, Academia Sinica, Nankang, Taipei 115, Taiwan.

*E-mail address:* cclin@econ.sinica.edu.tw (Chung-cheng Lin).

## 1. Introduction

Why do wages exhibit downward rigidity? Searching for answers to this question can be stretched back at least as far as Keynes's *General Theory*. Although many explanations have been proposed, the state of knowledge seems to remain unsatisfactory.<sup>1</sup>

In a highly praised book, Bewley (1999) made a recent attempt to answer the puzzling question of why wages do not fall during a recession.<sup>2</sup> He conducted a massive number of interviews with more than 300 business people and labor leaders in the northeast of the United States during the early 1990s. After careful assessment in the light of his interview evidence, Bewley concluded that the most important factor inhibiting wage cuts was the psychological factor of morale, which has nothing to do with any conventional economic theory. This morale story of wage rigidity emphasizes that employers are sensitive to and refrain from cutting worker pay on the basis of the belief that doing so would hurt worker morale, and consequently, labor productivity.<sup>3</sup> According to Bewley (1999, p. 54): "In the mind of business leaders, morale has to do with workers' mood and with the willingness to cooperate with company objectives." Workers have so many opportunities to take advantage of their employers if they want to. Good morale will motivate workers to perform well even without coercion and financial incentives. However, morale is fragile and may deteriorate easily. Cutting wages could be an important input that triggers the evaporation of worker morale.

After suggesting a morale theory of wage rigidity, Bewley (1999, p. 436) concluded at the end of his book:

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<sup>1</sup> See Bewley (1999, chapter 20) for a critical review of the existing theories on wage rigidity. Recent panel-data studies suggest that wages are not completely rigid downward. See Akerlof et al. (1996), Kramarz (2001), and Howitt (2002) for assessments of this strand of the literature.

<sup>2</sup> For a summary of the book, see Bewley (1998). Howitt (2002) provided a review of Bewley's book.

<sup>3</sup> Other interview studies with owners and managers of firms, including Kaufman (1984), Blinder and Choi (1990), Agell and Lundborg (1995), and Campbell and Kamlani (1997), all have a similar finding: pay cuts will adversely affect labor effort and productivity.

*“Companies do use financial incentives and try to maximize profits, and workers want as much money as possible. Workers do cheat, and discipline is vital to organizational effectiveness. What is missing is an appropriate theory of the firm as a community, because more than financial incentives and discipline are needed to make companies function well.”*

We believe this concluding passage embodies Bewley’s deep reflection on the received theories of the firm in the light of his own interview findings. In this paper we respond to Bewley’s call by modeling the firm as a community (in addition to those features associated with financial incentives and discipline). Via such a model, we attempt to account formally for the downward rigidity of wages.

If labor productivity were continuous in wage payment, then small changes in the wage would always produce small changes in productivity. In such a world, employers could formulate their wage policy through trial-and-error, since continuous wage adjustments always lead to continuous variations in labor productivity. This “continuous” world, which is the maintained assumption in the existing literature, can hardly match the phenomenon that employers are sensitive to and refrain from cutting worker pay as documented by Bewley and many others. By contrast, labor productivity *is not* continuous with respect to the wage payment in our firm-as-a-community model. This discontinuous world, as we shall show, fits Bewley’s fragile morale story well and can explain why wages are rigid downward. To our knowledge, this is the first paper ever to formally demonstrate that adjusting wages may give rise to discontinuity in labor productivity.<sup>4</sup>

It is important to recognize that the phenomenon of wage rigidity actually consists of two parts: downward rigidity and upward flexibility. Ideally, a model should be able to

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<sup>4</sup> Shafir et al. (1997) have recognized the importance of the discontinuity issue and cited some evidence in support of the plausible discontinuity in work effort from wage cuts. However, they fall short of providing a formal model and their focus is not on wage rigidity either.

explain not only the downward wage rigidity but also the upward wage flexibility.<sup>5</sup> We believe this asymmetric behavior of wages is the most intriguing feature of the whole phenomenon. However, we know only a handful of models in which the asymmetry of wages emerges explicitly.<sup>6</sup> Our firm-as-a-community model is capable of accounting for asymmetric behavior as well as downward rigidity of wages.

The rest of the paper is organized as follows. Section 2 introduces our model. We analyze the model and explore its implications for wage behavior in Sections 3 and 4. Section 5 concludes.

## 2. Model

Consider a firm in which workers may or may not supply effort  $e$ , which takes on the value 1 if effort is supplied and 0 otherwise. If workers do not shirk or shirk but do not get caught, they receive the real wage  $w$ , which is set by employers. If workers shirk and get caught, they receive a lower wage, which is normalized to zero without loss of generality. Workers, whose only source of income comes from employment, are assumed to maximize a utility function:

$$U = m + (1 - e) - \lambda R, \tag{1}$$

where  $m$  is real wage income,  $-R$  denotes reputation loss in the firm community, and

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<sup>5</sup> For evidence on the asymmetric behavior of wages, see Holzer and Montgomery (1993), Campbell and Kamlani (1997), Bewley (1999, chapters 10-12), and the references cited in Howitt (2002).

<sup>6</sup> Exceptions include: Holmstrom (1983) who developed a two-period implicit contract model in which wages are rigid downward because workers are insured against downside fluctuations, but wages have to be flexible upward to retain workers who may quit; and Lindbeck and Snower (1988) who considered an insider-outsider model in which wages will remain unchanged as demand falls but will increase as demand rises. These exceptions are interesting. However, it seems difficult for them to explain why employers are sensitive to cutting worker pay and why downward wage rigidity has to do with worker morale.

$\lambda$  represents a subjective sensitivity indicator with respect to such loss of reputation. The setting of the utility function above indicates that individuals care not only about their income and leisure, but also about their reputation within the firm. As Akerlof (1980, p. 753) put it colorfully: ‘persons want to be “rich and famous”.’

Workers are heterogeneous in the sense that  $\lambda$  is idiosyncratic and varies across individuals. For convenience, we let  $\lambda$  be uniformly distributed with support on  $[0, 1]$ . Given  $-R$ , the higher the value of  $\lambda$ , the higher will be the reputation loss for a worker. It is assumed that, due to some exogenous reasons (asymmetric information, non-verifiable problems, etc.), the firm does not pay differential wages on the basis of  $\lambda$ .<sup>7</sup>

Our model will reduce to a simple shirking model if  $R \equiv 0$ . Since the  $R$  term in (1) plays a key role in this paper, we discuss the modeling of the  $R$  term in detail.

### *Modeling reputation loss*

In a seminal paper, Akerlof (1980) put forth the idea that there exists a code of behavior (a social custom or social norm) in the community. A person who disobeys the code will be punished by a non-pecuniary loss of reputation in the community. Following this idea, it is assumed that there exists a social norm with regard to people’s work performance in the firm. Elster (1989a, p. 101) mentioned: “the workplace is a hotbed for norm-guided action” and “one often finds informal norms among the workers that regulate their work effort.” Fehr and Gächter (2000, p. 168) emphasized: “most social relations in neighborhoods, families and workplaces are not governed by explicit

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<sup>7</sup> One may think of the workers in our model in terms of a particular rank or class in the firm (a group of workers who receive more or less the same wage payment). Strand (1987) and Albrecht and Vroman (1998) extended the celebrated Shapiro and Stiglitz (1984) shirking model to include adverse selection as well as moral hazard.

agreements but by social norms.” The norm or code here is that *workers should not shirk*. The prevalence of this work norm seems to be the daily experience of most people in modern times. The focus of this paper is not on why such a norm is established in the first place, but rather on its consequences.

In the presence of the no-shirking norm, we assume the following information structure within a firm: employers will not identify a shirking worker unless he or she gets caught; however, shirkers are known among their worker colleagues. This particular assumption that agents (workers) are well informed but that the principal (employer) is not does not seem unrealistic, and it is actually the starting point of the large literature on implementation under complete information.<sup>8</sup>

A worker who shirks evidently represents a violation of the prescribed code of behavior and hence may be sanctioned by group disapproval, by peer pressure, and in the extreme, by ostracism. Following Akerlof (1980), we summarize these resulting informal social sanctions against the shirker by his or her loss of reputation in the firm. To be specific, we have:

$$R = R(x) \text{ if the worker shirks; } R = 0 \text{ otherwise,}$$

where  $x$  denotes the proportion of shirking workers in the firm. It is assumed:

*Assumption 1.* The function  $R(x)$  is twice continuously differentiable with  $R'(x) < 0$  for all  $x$ .

For the no-shirking norm to be social, people in the firm must share and sustain it. The dependence of  $R$  on  $x$  is to capture some social property of the no-shirking norm. Under our “complete information” assumption, the extant proportion of shirking workers

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<sup>8</sup> See Palfrey (2002) for a survey of the literature. One may assume that even workers are not well informed so that anyone who shirks will not be identified unless he or she gets caught. This “incomplete information” assumption complicates the algebra a little, but our results remain qualitatively the same.

in the firm is known among workers. The assumption  $R'(x) < 0$  indicates that the higher the proportion of shirkers in the firm, the smaller will be the loss of reputation for a shirker as a result of his or her violation of the no-shirking code. This setup 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 extent of the violation becomes more prevalent.

To facilitate our analysis, we also impose the following assumption:

*Assumption 2.*  $R''(x) = 0$  for all  $x$ , and  $R(x) \rightarrow 0$  as  $x \rightarrow 1$ .

The first part of this assumption approximates the reputation loss function in a first-order sense. This is a simplification. As to the second part, it seems plausible. When nobody obeys the code prescribed by the norm, nobody can legitimately impose social sanctions against violators, and as a result, the norm will de facto disappear. As will be seen, the resulting equilibria under Assumption 2 are consistent with the equilibria envisioned by Akerlof (1980).

A simple function that satisfies both Assumptions 1 and 2 is

$$R(x) = 1 - x. \tag{2}$$

For concreteness and simplicity, we will give  $R(x)$  this explicit functional form from now on.

Through the no-shirking norm and the reputation loss specification, we essentially model the firm as a community and let workers interact socially in the firm community. This social interaction will be the key that drives the main results of this paper.



### 3. Preliminary analysis

According to our setup in the previous section, the expected utility of a type  $\lambda$  worker who is not shirking is

$$V^N = w, \quad (3)$$

while for a shirker, the expected utility is

$$V^S = 1 + (1 - q)w - \lambda(1 - x), \quad (4)$$

where  $R(x) = 1 - x$  has been imposed and  $q > 0$  denotes the exogenous probability of shirking detection.<sup>9</sup> From (4), we see that a worker who chooses to shirk will face the risk of losing wage payment ( $w = 0$ ) and a sure loss in reputation (the last term).

From (3)-(4), a type  $\lambda$  worker will choose not to shirk if  $V^N \geq V^S$ ; that is,

$$w \geq 1 + (1 - q)w - \lambda(1 - x). \quad (5)$$

This decision rule prescribes how, given the shirking detection probability  $q$  and the wage payment  $w$ , a type  $\lambda$  worker will make a shirking-or-not choice for each possible proportion of shirking workers  $x$  in the firm community.

Solving from (5) yields the marginal type of workers,  $\hat{\lambda}$ , who are merely indifferent between shirking and non-shirking:

$$\hat{\lambda} = \frac{1 - qw}{1 - x}; \quad (6)$$

$$\hat{\lambda}_w = \frac{\partial \hat{\lambda}}{\partial w} = -\frac{q}{1 - x} < 0; \quad (6a)$$

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<sup>9</sup> Since our parsimonious model is not designed to address the monitoring issue, the probability  $q$  is assumed to be at the margin of its effectiveness and fixed throughout this paper. For a discussion on the possible relationship between shirking detection and wage payments, see Dickens et al. (1989).

$$\hat{\lambda}_x = \frac{\partial \hat{\lambda}}{\partial x} = \frac{1 - qw}{(1 - x)^2} > 0; \quad (6b)$$

$$\hat{\lambda}_{xx} = \frac{\partial^2 \hat{\lambda}}{\partial x^2} = \frac{2(1 - qw)}{(1 - x)^3} > 0. \quad (6c)$$

Workers with  $\lambda \leq \hat{\lambda}$  will shirk, while those with  $\lambda > \hat{\lambda}$  will not shirk. In (6), it is implicitly assumed that  $1 > qw$ ; otherwise, no workers will ever shirk.

The outcome  $\hat{\lambda}_w < 0$  is standard in the shirking literature. It indicates that the higher the wage, the smaller will be the number of shirkers. The outcome  $\hat{\lambda}_x > 0$  captures the “snowballing” effect: the higher the extant proportion of shirkers, the larger will be the number of workers who will choose to shirk. When the shirking behavior is more prevalent, the no-shirking norm will become less effective against shirkers, and consequently, the more intensified shirking will become.

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

$$\hat{\lambda} = x. \quad (7)$$

Given a proportion of shirkers  $x$ , there is a corresponding proportion of workers  $\hat{\lambda}$  who will choose to shirk according to (6). However, the resulting  $\hat{\lambda}$  may not be consistent with the given  $x$ . Equation (7) simply imposes the consistent condition. It is clear that, except for corner solutions, an equilibrium  $x$  must satisfy (6) and (7) simultaneously.

#### 4. On asymmetric behavior and downward rigidity of wages

We are ready to explain the asymmetric behavior and downward rigidity of wages. Our explanation proceeds with reference to several figures that serve as illustrations. We depict the status quo first.

##### *Status quo*

Consider Fig. 1. The locus  $XX(w = w_0)$  stands for the functional relationship between  $\hat{\lambda}$  and  $x$  as expressed in (6) when the status quo wage equals  $w_0$ . Due to (6b) and (6c), the slope of  $XX$  is positive and increasing. Note that  $\hat{\lambda} \rightarrow \infty$  as  $x \rightarrow 1$ . This property is due to Assumption 2.

In Fig. 1, the locus  $YY$  traces the relationship between  $\hat{\lambda}$  and  $x$  as expressed in (7). It is obvious that the slope of  $YY$  equals 1.

(Insert Fig. 1 about here)

Given any  $x$ , the actual proportion 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 proportion of workers who would like to shirk is higher than the extant proportion of shirkers. As a result, the actual proportion of shirking workers will be increasing. When  $\hat{\lambda} < x$ , the opposite occurs. The arrows in Fig. 1 summarize the movement of  $x$ .<sup>10</sup>

There are three equilibria in Fig. 1, i.e. the points  $x_0$ ,  $x_1$  and  $x_2$ . However, as the arrows indicate, only  $x_0$  and  $x_2$  are stable equilibria. These two equilibria correspond to two different levels of the no-shirking norm. Note that while the level of shirking is mild at  $x_0$ , all workers shirk at  $x_2$  as the norm unravels. This result is

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<sup>10</sup> A simple dynamics for the movement shown in Fig. 1 is:  $\dot{x} = \kappa(\hat{\lambda} - x)$ , where  $\kappa$  is a positive scalar.

consistent with that envisioned by Akerlof himself (1980, p. 751):

*“[T]here are two 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, we focus on the more interesting case where there is a low shirking equilibrium in the firm community initially. To explain the fragile worker morale with respect to wage cuts, it seems natural to start from a low shirking equilibrium at the status quo.

#### *Adjusting wages*

Now let us consider what will happen if employers adjust the wage payment. According to (6a), the status quo locus  $XX(w = w_0)$  will shift downward if employers raise the wage but it will shift upward if employers cut the wage. Since the status quo equilibrium is at point  $x_0$ , it is not difficult to see from Fig. 1 that raising wages continuously will shift the locus  $XX$  downward continuously, resulting in a continuous decrease in the *equilibrium* proportion of shirking workers. The result for wage cuts will be very different, as we discuss below.

As we have noted, cutting wages will shift the locus  $XX$  upward. Consider the locus  $XX(w = \underline{w} < w_0)$  in Fig. 2. The unique feature of this locus is that it is tangential to the locus  $YY$  at the point  $y$ . When the wage payment is adjusted downward from  $w_0$  on, cutting wages continuously will shift the locus  $XX$  upward continuously, resulting in a continuous increase in the equilibrium proportion of shirking workers. However, this continuous change in equilibrium will not last when the wage

cut reaches  $\underline{w}$ . At  $w = \underline{w}$ , except for  $\hat{\lambda} = x$  at point  $y$ ,  $\hat{\lambda} > x$  for all  $x$  for the locus  $XX(w = \underline{w} < w_0)$ . That is, at  $w = \underline{w}$ , the proportion of workers who will choose to shirk (i.e.  $\hat{\lambda}$ ) is always higher than the corresponding proportion of shirkers (i.e.  $x$ ). This triggers a bandwagon effect to increase the actual proportion of shirkers from point  $y$ . The increase will not stop until the actual proportion of shirkers has reached  $x_2$ , i.e. all workers shirk at the new equilibrium.

(Insert Fig. 2 about here)

The wage,  $\underline{w}$ , associated with the locus  $XX(w = \underline{w} < w_0)$  in Fig. 2 represents a threshold wage level. As soon as the wage cut reaches  $\underline{w}$ , there will be a “catastrophe” or a discontinuous jump *in equilibrium* from  $y$  to  $x_2$ , generating a disastrous rise in the equilibrium proportion of shirkers as a result of a tiny cut in wages.<sup>11</sup>

As wage cuts reach the threshold level, the “size” of the group of shirkers will furnish a critical-mass effect so that the enforcement of the no-shirking norm dramatically loses its bite. The result is that non-shirkers will move en masse to become shirkers. This is the reason for a sudden, disastrous fall in productivity at the wage  $\underline{w}$ . 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.

The above disastrous rise in shirking is an irreversible result or a “hysteresis” in the following sense. Suppose that employers find the disastrous rise in shirking as a result of their wage cut and try to avoid this terrible result by restoring the wage to the pre-cut level. What will happen? Using Fig. 3, the restoration of the wage will shift downward the  $XX$  locus from  $XX(w < \underline{w})$  back to  $XX(w = w_0)$ . However, the

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<sup>11</sup> Catastrophe theory is a mathematical theory that studies how a continuous variation in parameters can cause discontinuous effects in the large. The discontinuous effects or jumps are known as “catastrophes.” For an introduction to catastrophe theory and its applications in economics, see Rosser (2000).

equilibrium proportion of shirking workers will not return to the pre-cut equilibrium  $x_0$ . Instead, since the new status quo equilibrium is at  $x_2$ , it is clear from Fig. 3 that the equilibrium after the restoration of the wage will remain at  $x_2$ . In other words, all of the workers will still choose to shirk in equilibrium even if the wage has been adjusted back to the pre-cut level  $w_0$ .

(Insert Fig. 3 about here)

Within our model setup, we see that  $\hat{\lambda} \rightarrow \infty$  as  $x \rightarrow 1$ . This implies that the equilibrium  $x_2$ , where all workers shirk, is a “sink” in the sense that the firm will be stuck there once it is reached and no wage policy can reverse this disastrous outcome. This result may be extreme, but it nevertheless captures the idea that restoring the effectiveness of social norms is likely to be prohibitively costly once no one believes in the values underlying the norms.

The key to our hysteresis lies in there being two stable equilibria,  $x_0$  and  $x_2$ , associated with the same locus  $XX(w = w_0)$ . Which equilibrium will be realized depends critically on whether the status quo proportion of shirkers is lower or higher than the  $x_1$  shown in Fig. 3. Intuitively speaking, the bite or effectiveness of the social norm against shirking hinges on the proportion of shirking workers at the status quo. If shirking is widespread and rampant in the firm community, the no-shirking norm will be too weak to generate any real reputation loss that will be inflicted on workers who shirk. By contrast, if shirking is mild or moderate, the no-shirking norm will furnish a substantial reputation loss that will be inflicted on workers who shirk. This explains why, depending on whether the status quo portion of shirkers is lower or higher than the  $x_1$  shown in Fig. 3, the same wage payment  $w_0$  can lead to very different proportions of shirking workers in equilibrium.

### *Effort/productivity function*

Given the status quo wage  $w_0$ , one can derive the effort/productivity function facing employers. Equating (6) with (7) yields:

$$x^* = \frac{1 - qw}{1 - x^*}, \quad (8)$$

where  $x^*$  denotes the (interior) equilibrium proportion of shirking workers. Since in our model a worker's effort takes on the value 1 if effort is supplied and 0 otherwise, the average amount of equilibrium effort supplied by the workers equals  $1 - x^*$ . This amount of equilibrium effort also represents the average productivity of the firm.

Using (8), we have:

$$\frac{\partial(1 - x^*)}{\partial w} = \frac{q}{1 - 2x^*} > 0. \quad (9)$$

It can be shown that the denominator  $1 - 2x^* > 0$  must be true at  $x^*$  if  $x^*$  is a stable equilibrium.<sup>12</sup> This result enables us to assign a positive sign to (9) as long as  $x^* > 0$ .<sup>13</sup> Thus (9) gives rise to a positive wage-effort relationship, which is the heart of the efficiency wage hypothesis. It can be shown that the sign of  $\partial^2(1 - x^*)/\partial w^2$  is negative.

On the basis of the above analysis, one can draw the effort/productivity function corresponding to Fig. 1-3 as shown in Fig. 4. When the wage is adjusted upward from the status quo wage  $w_0$ , the effort/productivity will rise continuously at a decreasing rate. By contrast, when the wage is adjusted downward from the status quo wage  $w_0$ , the effort/productivity will decline continuously at an increasing rate until  $\underline{w}$  is reached. At the threshold wage  $\underline{w}$ , it will fall discontinuously all the way to zero and remain there even if the wage is restored to the status quo wage  $w_0$  and beyond.<sup>14</sup>

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<sup>12</sup> Using the simple dynamics specified in Footnote 10, the stability requires:  $\partial\dot{x}/\partial x = \kappa(\hat{\lambda}_x - 1) < 0$ . From equation (6), (6b) and (7),  $(\hat{\lambda}_x - 1) < 0$  implies  $1 - 2x^* > 0$ .

<sup>13</sup> The equilibrium effort may be unresponsive to a wage raise at  $x = 0$ .

<sup>14</sup> (8) is a quadratic equation in  $x^*$  and hence has two distinct roots in general. It will give rise to the

(Insert Fig. 4 about here)

It is interesting to observe from Fig. 4 that the equilibrium effort/productivity is either at high levels (represented by the curve  $y_1$ ) or at low levels (the zero equilibrium effort/productivity), and there is no middle ground. This no-middle-ground result can be seen directly from Fig. 1 to Fig. 3: except for  $x = 1$ , any proportion of shirkers that is located at point  $y$  and beyond will never be realized as a stable equilibrium. These unstable equilibria are represented by the dotted line in Fig. 4. For example, at the status quo wage  $w_0$ , there are three equilibrium proportions of shirking workers,  $x_0$ ,  $x_1$  and  $x_2$  (see Fig. 1). These three equilibria correspond to the three equilibria in relation to effort/productivity shown in Fig. 4, that is,  $1 - x_0$ ,  $1 - x_1$  and  $1 - x_2$ .

To sum up our finding, we state:

**Result 1.** *The positive wage-effort relationship holds in our firm community. However, work effort in response to wage adjustments behaves asymmetrically. Starting from a low-shirking equilibrium, while average effort is continuous in wage raises, it is not continuous in wage cuts -- a continuous cut in wages can give rise to a large, discontinuous fall in effort, and furthermore, this large fall in effort will persist even if the wages are restored to the pre-cut level and beyond. Because of the large, discontinuous fall in average effort and its persistence, the effort function facing employers becomes de facto a correspondence with two parts: one is associated with high efforts while the other is associated with low efforts, and there is no middle ground in between.*

#### *Efficiency wage*

To discern the value added of Result 1 to the extant literature, it is best to compare it with the efficiency wage hypothesis, which is a leading candidate explanation as to why

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unique root  $x^* = 1/2$  when the locus  $XX$  is tangential to the locus  $YY$  (the point  $y$  in Fig. 2).



labor markets do not clear in the presence of high involuntary unemployment.<sup>15</sup>

The central tenet of the efficiency wage hypothesis is that workers' productivity increases along with the wage offered, and consequently, there is a benefit as well as a cost involved in the payment of higher wages by employers. The tradeoff between the benefit and the cost at the margin leads to a profit-maximizing efficiency wage, and this, in turn, explains why employers may find it unprofitable to cut wages even in the presence of high unemployment.

According to this argument, the equilibrium wage may be far above the market-clearing wage and so it can explain the persistence of involuntary unemployment. However, the equilibrium wage will likely exhibit high flexibility in the presence of shocks since it represents the profit-maximization wage.<sup>16</sup>

Let  $e(w) \equiv 1 - x^*(w)$ , that is, the effort function facing employers. Employers are assumed to choose a wage to maximize the following profit function:

$$\pi = se(w) - [(1 - x^*) + x^*(1 - q)]w = se(w) - [1 - q + e(w)q]w \quad (10)$$

where  $s$  is an idiosyncratic shift factor denoting shocks in either technology or the relative price of the firm's product (with  $s = s_0$  at the status quo).<sup>17</sup> In (10), both non-shirkers (i.e.  $1 - x^*$ ) and shirkers who do not get caught (i.e.  $x^*(1 - q)$ ) will receive the wage  $w$ .

The first-order condition from maximizing (10) yields:

$$\frac{\partial \pi}{\partial w} = (s - qw)e'(w) - [1 - q + e(w)q] = 0. \quad (11)$$

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<sup>15</sup> See Blanchard and Fischer (1989, chapter 9) and Romer (1996, chapter 10).

<sup>16</sup> It is known that the profit-maximizing efficiency wage derived from the Solow condition is a real wage rigidity and independent of any idiosyncratic shock (Blanchard and Fischer, 1989, Section 9.4). This result may be too strong to be true, and moreover, it cannot explain the asymmetric behavior of wages.

<sup>17</sup> Since shocks are idiosyncratic, there is no distinction between real and money wage. The purpose of this setup is to abstract from the question of whether wage rigidity is real or nominal, which is not our focus in this paper. An appendix that explores nominal wage rigidity from the viewpoints of money illusion (Shafir et al., 1997) and intentions (Fehr and Schmidt, 2003) is available from the authors upon request.

The comparative statics on the basis of (11) leads to:

$$\frac{dw}{ds} = -\frac{e'}{(s-qw)e''-2qe'} > 0, \quad (12)$$

where we have made use of the sign of (9) and the second-order condition  $(s-qw)e''-2qe' < 0$ . If, as is typically assumed, the effort function were continuous without exhibiting catastrophe/hysteresis, the profit-maximization wage would be highly flexible according to (12). Employers would raise wages in the presence of positive shocks ( $s > s_0$ ) and cut wages in the presence of negative shocks ( $s < s_0$ ). Neither asymmetric behavior nor downward rigidity of wages would be expected.

Now consider our derived effort function. A distinct feature associated with the effort function in Fig. 4 is that there is an “edge” wage,  $\underline{w}$ , beyond which wage cuts will give rise to catastrophes in labor productivity.<sup>18</sup> From (11), we obtain:

$$\underline{s} = q\underline{w} + \frac{1-q(1-e(\underline{w}))}{e'(\underline{w})}, \quad (13)$$

where  $\underline{s}$  is the critical shock corresponding to the “edge” wage  $\underline{w}$ . Note that the profit-maximization wage  $w^*$  will equal the edge wage  $\underline{w}$  for all  $s \leq \underline{s}$ . This “rigidity” result opens a possible route to explain the downward rigidity of wages. In particular, if  $s_0 \leq \underline{s}$  holds, then  $w^* = \underline{w}$  for all  $s \leq s_0$ , 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).

Despite being interesting and potentially in the right direction, the above result falls short of “establishing” the downward rigidity of wages. Specifically, the critical

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<sup>18</sup> Strictly speaking, the “edge” wage should be  $\underline{w} - \varepsilon$ , where  $\varepsilon$  is a very small, positive number. For ease of exposition, we simply ignore  $\varepsilon$ .

condition  $s_0 \leq \underline{s}$  may or may not hold for a high fraction of firms at the status quo.<sup>19</sup>

### *Uncertainty*

So far, no uncertainty is involved regarding the “edge” beyond which wage cuts will give rise to catastrophes in labor productivity. However, it seems more realistic to assume that employers do not know *ex ante* the exact location where the “edge” occurs. This possibility opens a different route to explain the downward rigidity of wages in our model.

Suppose from the viewpoint of employers that a *distribution* rather than a singleton characterizes the “edge.” From this “edge” distribution, employers will subjectively face a positive probability of catastrophe occurrence, denoted by  $\theta(w; w_0)$ , if they cut worker pay from the status quo wage  $w_0$  to  $w$ . The probability  $\theta$  is presumably increasing in wage cut, that is,  $\partial\theta/\partial w < 0$  for  $w \leq w_0$ .<sup>20</sup>

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<sup>19</sup> Assuming that  $s_0 = 1$  and using (8)-(9) and (13),  $1 \leq \underline{s}$  if and only if:

$$\eta(\underline{w}) \leq \frac{1 - 2qx^*(\underline{w})}{1 - qx^*(\underline{w})}, \quad (\#)$$

in which  $\eta \equiv -x^*R'(x^*)/R(x^*) = x^*/(1-x^*)$ . The stability requires that  $1 - 2x^* > 0$  at  $x^*$ , and hence, we have  $0 < \eta < 1$ . Workers who are caught shirking are dismissed in shirking models; see, for example, Shapiro and Stiglitz (1984). In line with this literature, the term  $qx^*$  in our model represents the proportion of workers who get dismissed. Available data indicate that the average monthly dismissal rate is around 0.3 per 100 employees (Bewley, 1999, p. 130). Now suppose that all firms are identical, except for  $\eta$ . Since little is known about  $\eta$  empirically, it does not seem unreasonable to assume *a priori* that  $\eta$  is uniformly distributed over (0, 1). Then, from (#), the fraction of the firms with  $w^* = \underline{w}$  at the status quo would equal 8/9 if  $qx^* = 1/10$ . This fraction would still reach 3/4 even if the value of  $qx^*$  is as high as 1/5.

<sup>20</sup> One may not rule out the possibility that  $\partial\theta/\partial w = 0$  at  $w = w_0$ . However, this possibility is a measure zero as compared to the set of other possibilities that  $\partial\theta/\partial w < 0$  at  $w = w_0$ . Moreover,

Now consider a low-shirking equilibrium with the profit-maximization wage  $w^* = w_0$  at the status quo ( $s = s_0$ ). When there is the uncertainty as described above, employers will face different profit functions, depending on whether they raise or cut wages. If they raise wages, employers will maximize the profit function  $\pi(\cdot)$  defined by (10) and follow the comparative statics of wages prescribed by (12). By contrast, if they cut wages, employers will maximize a different profit function:

$$\Pi = (1 - \theta(w; w_0)) \cdot \pi + \theta(w; w_0) \cdot 0, \quad (14)$$

in which  $\pi = 0$  if catastrophes occur.<sup>21</sup> This profit function differs from  $\pi(\cdot)$  simply because cutting wages may give rise to catastrophes in labor productivity. If there were no possibility of catastrophes so that  $\theta(w; w_0) = 0$ , then  $\Pi = \pi$  would hold.

The first-order condition from maximizing (14) yields:

$$(1 - \theta) \cdot \frac{\partial \pi}{\partial w} - \pi \cdot \frac{\partial \theta}{\partial w} = 0. \quad (15)$$

Since  $\partial \theta / \partial w < 0$  for  $w \leq w_0$  by our assumption, the profit-maximization wage  $w^{**}(s)$  derived from (15) will be higher than the profit-maximization wage  $w^*(s)$  derived from (11) for any  $s \leq s_0$ . In particular, we have  $w^{**}(s_0) > w^*(s_0) = w_0$ .

It can be checked that the comparative statics on the basis of (15) leads to  $dw/ds > 0$  as well. This result together with  $w^{**}(s_0) > w_0$  implies that there exists  $s_1 < s_0$  with  $w^{**}(s_1) = w_0$ . Since  $w^{**}(s) \geq w_0$  for all  $s$  with  $s_1 \leq s \leq s_0$ , we obtain the

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suppose that a set of distributions rather than a unique distribution characterizes the “edge.” Then, as implied by the famous Ellsberg (1961) paradox, a decision maker will tend to behave cautiously in the face of the imprecise knowledge of the odds. In terms of our model, this means that employers will tend to pick a higher value of  $\theta(w; w_0)$  in their calculation of catastrophes.

<sup>21</sup> This assumption will be true in our setup if the firm has the option of closedown.

result that employers will cut their worker pay from the status quo wage  $w_0$  if and only if negative shocks are large enough so as to satisfy  $s < s_1$ .

The solid, zigzag line in Fig. 5 depicts the optimal wage policy against shocks when starting from a low-shirking equilibrium with  $w^*(s_0) = w_0$ . It is clear from the figure that the wage  $w_0$  will remain optimal in the presence of negative shocks if and only if the extent of the shocks does not exceed  $s_0 - s_1$ . It is also clear from the figure that employers will raise wages in the presence of positive shocks.

(Insert Fig. 5 about here)

To sum up our finding, we state:

**Result 2.** *Starting from a low-shirking equilibrium and facing uncertainty with regard to the exact location of the “edge” where catastrophes occur, employers will raise wages in the presence of positive shocks, but they will cut wages in the presence of negative shocks if and only if the shocks are sufficiently adverse.*

Caution and hesitation regarding wage cuts vividly show up in Bewley’s (1999, chapter 11) massive interviews of employers. All employers in the interviews thought that pay cuts would cause problems and their main argument was that employee reactions would cost them more than the pay cuts would save. Bewley (p. 430) summarized his survey findings by writing: “Resistance to pay reduction comes primarily from employers, not from workers or their representatives, though it is anticipation of negative employee reactions that makes employers oppose pay cutting.” Our model clearly fits this description. Bewley (pp. 214-5) observed that pay cuts, if they did occur, were brought about mainly when firms had financial problems or had trouble competing. These may

well correspond to the situation where shocks are sufficiently adverse.<sup>22</sup>

Finally, we would like to refer to two main testable hypotheses that might potentially falsify the theory of our paper. One is from the viewpoint of workers. The testable hypothesis is that the workers' effort function is discontinuous rather than continuous with respect to wage cuts (see Fig. 4). The other testable hypothesis is from the perspective of employers. It is that the employers' wage payment decision exhibits asymmetric behavior. That is, the employers will raise wages in the presence of positive shocks, but they will cut wages in the presence of negative shocks only if the shocks are sufficiently adverse (see Fig. 5). Some evidence in support of both hypotheses does exist.<sup>23</sup>

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<sup>22</sup> In our model, workers are concerned with their *absolute* wage payment. An interesting extension is to take into consideration the scenario where workers are concerned with their wage *relative* to the wages received by other people doing similar work in other firms. However, this extension raises the difficult issue of how relative wages are determined, whether the firm would react differently to an economy-wide shock than to a firm-specific shock, whether the stigma should depend on relative wages as well as the fraction of others that shirk, and so on. We should admit that our model is not complete in this regard, and it would be better to write another paper in which the relative-wage considerations are integrated into the analysis from the beginning.

<sup>23</sup> See footnotes 4 and 5. From equation (8), we see that: (i) when the wage rises above  $1/q$ , the only equilibrium is one in which no one shirks, and (ii) a large, discontinuous fall in labor productivity will occur if the wage falls below  $3/4q$  (substituting  $x^* = 1/2$  in (8)). Thus, there should be more wage flexibility in high-paying jobs (wage payments that are above  $1/q$ ) than low-paying jobs (wage payments that are near  $3/4q$ ). This is also a testable hypothesis implied by our model. Note that  $1/q - 3/4q = 1/4q$ . Thus, the lower the  $q$ , the more room there will be for wage cuts without the occurrence of a "catastrophe." The shirking detection technology (represented by the parameter  $q$  in our model) may differ across firms, industries, or countries. Another testable hypothesis implied by our model is that a high-shirking detection (a higher  $q$ ) should be associated with less wage flexibility than a low-shirking detection (a lower  $q$ ).

## **5. Conclusion**

“Actions are shaped jointly by norms and self-interest” (Elster, 1989b, p. 151). This statement seems compelling. Akerlof (1980) emphasized that the non-pecuniary enforcement of norms may dominate or depress pecuniary self-interest so as to ensure the survival of the norms. In this paper we model the firm as a community, detecting that the non-pecuniary enforcement of norms may lose its bite dramatically as the amount of pecuniary rewards is reduced. To prevent the dramatic loss of effectiveness of the bite of the norms and the resulting catastrophe/hysteresis in productivity from occurring, employers need to maintain pecuniary rewards and hence do not cut their worker pay as much as they could. This explains why wages are rigid downward.

Our model in this paper is admittedly rudimentary. We do not claim that the factors we omit are irrelevant or unimportant for wage adjustments. Still, it is hoped that our firm-as-a-community model may have contributed to a better understanding of asymmetric behavior, and in particular, downward rigidity of wages.

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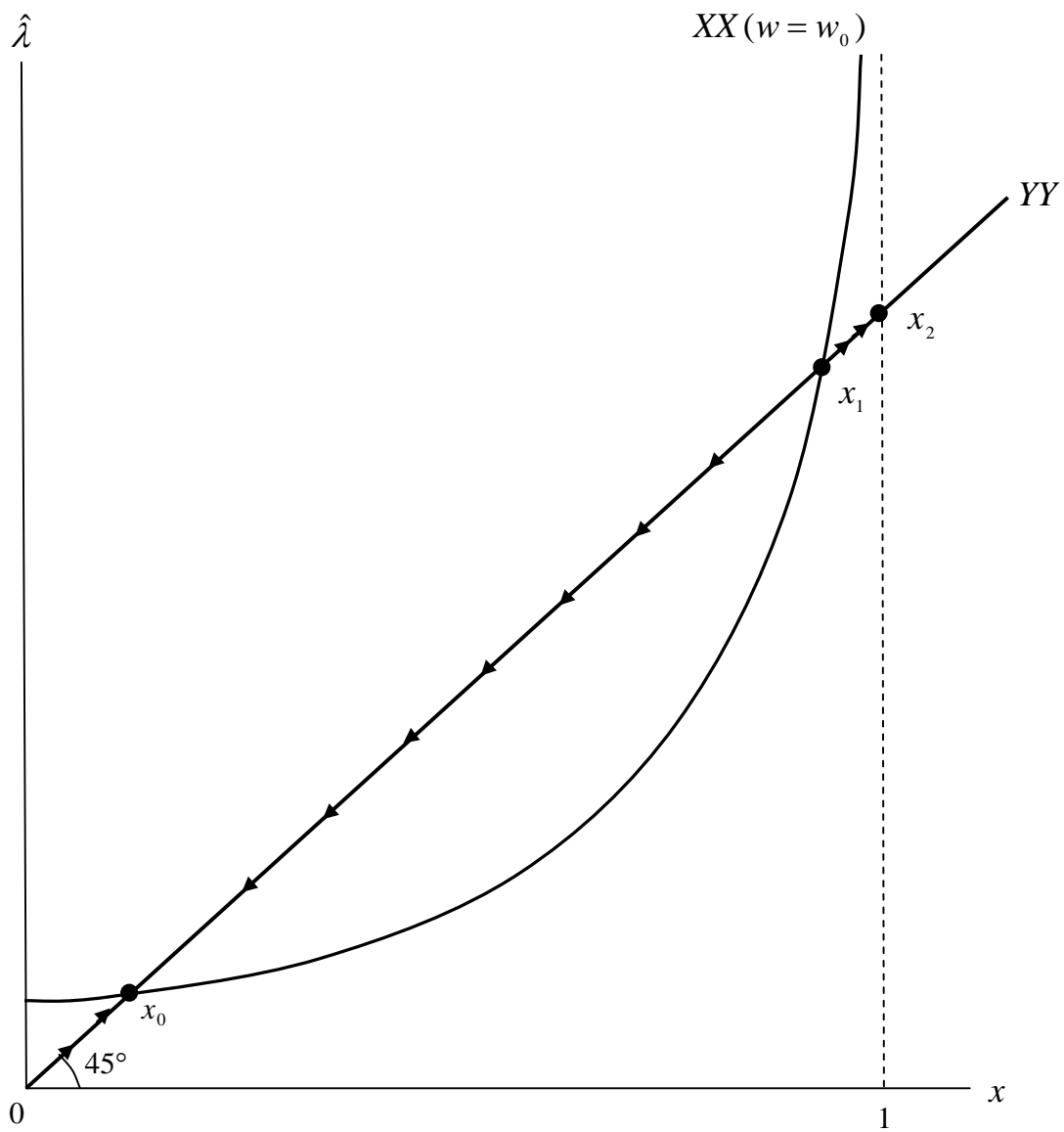


Fig. 1. Status quo

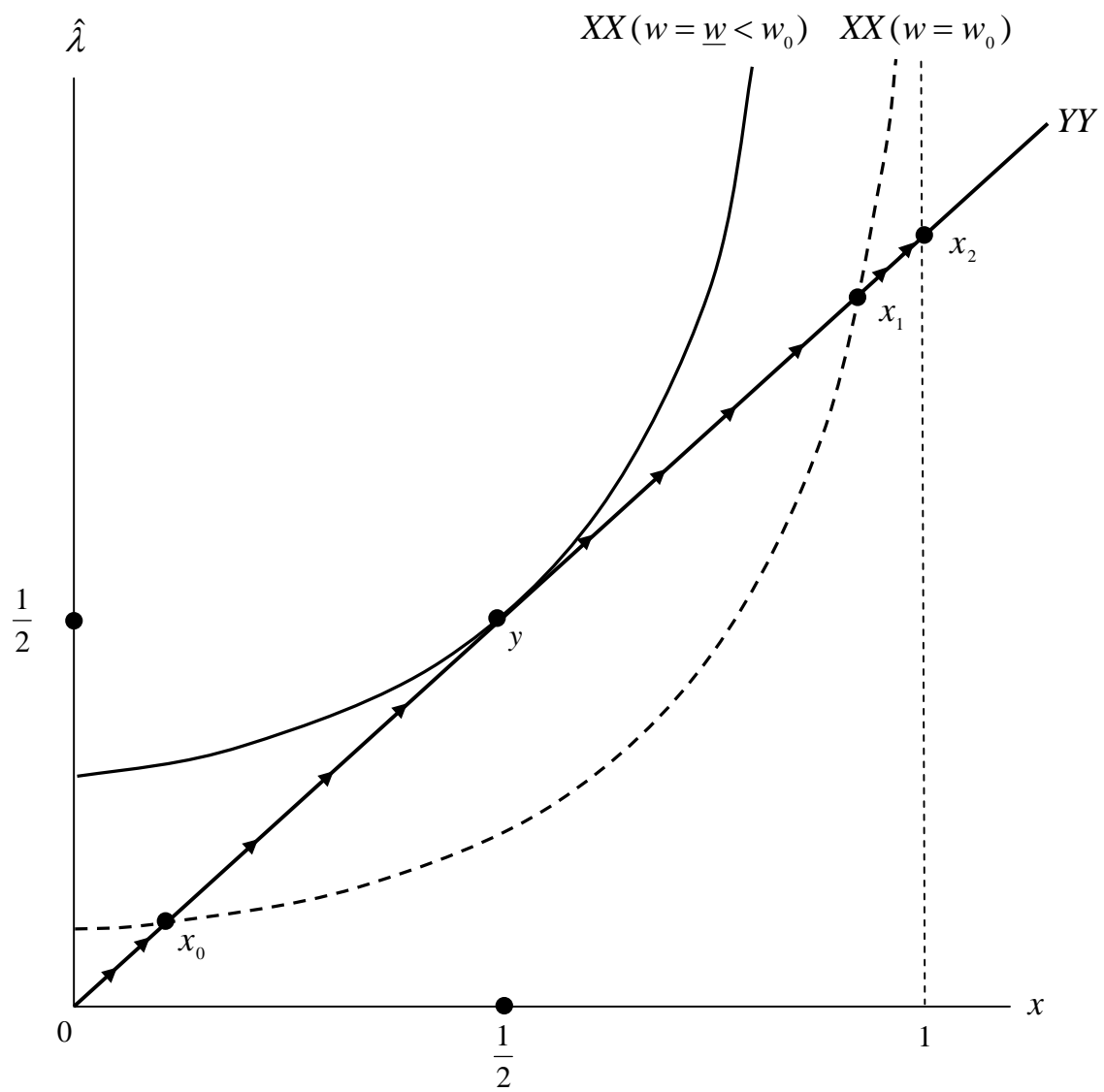


Fig. 2. Catastrophe

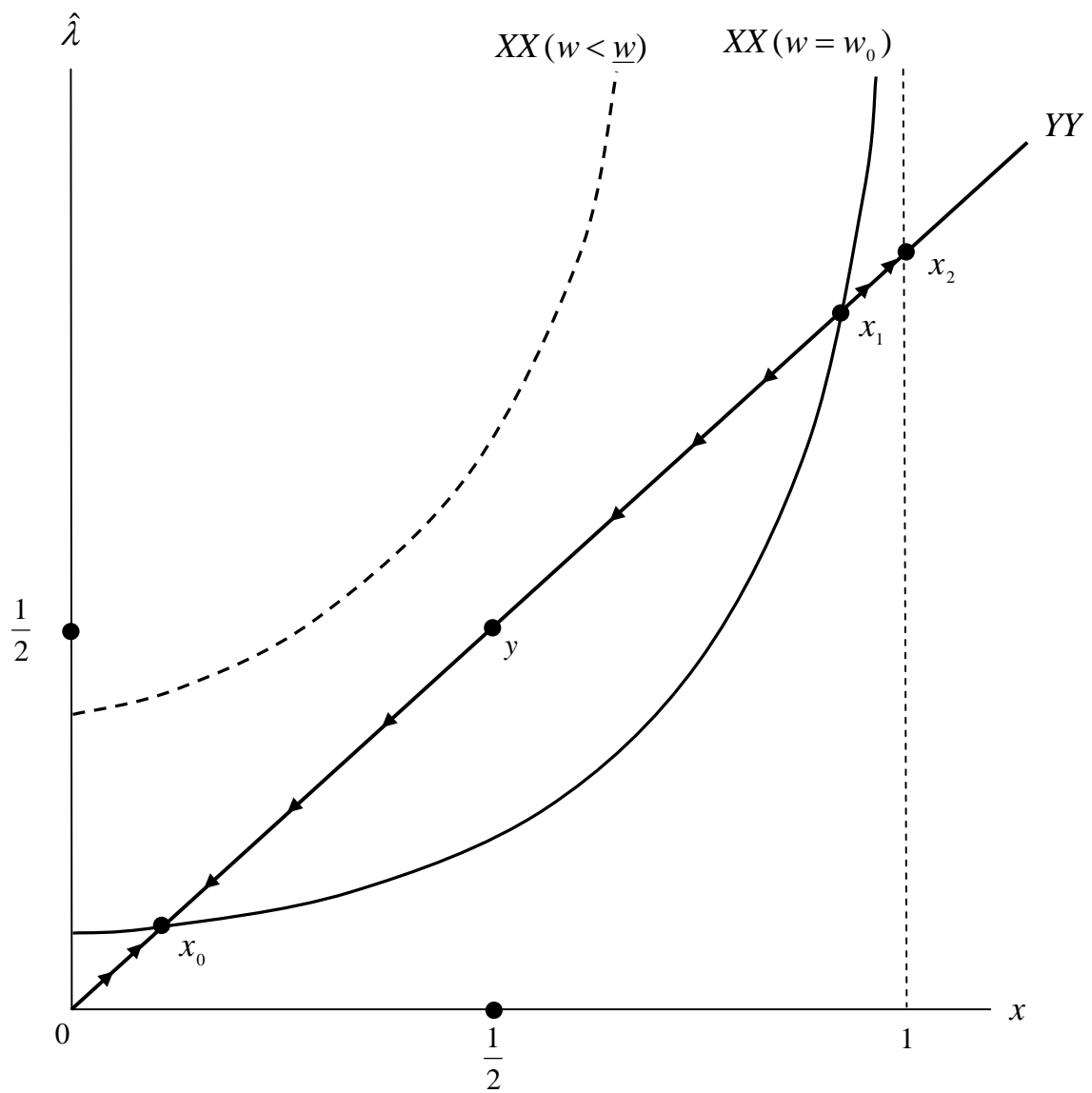


Fig. 3. Hysteresis

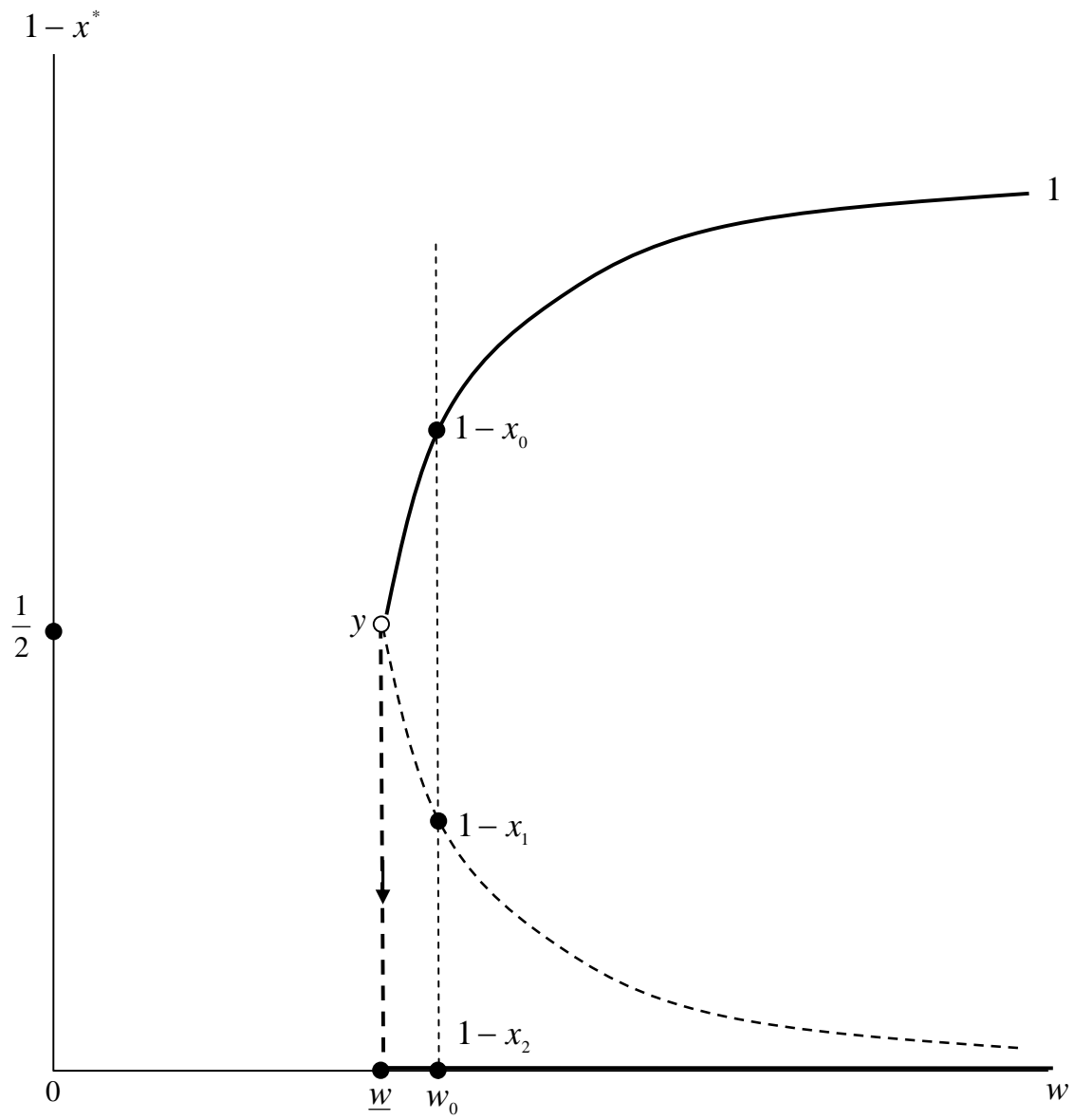


Fig. 4. Effort / productivity function

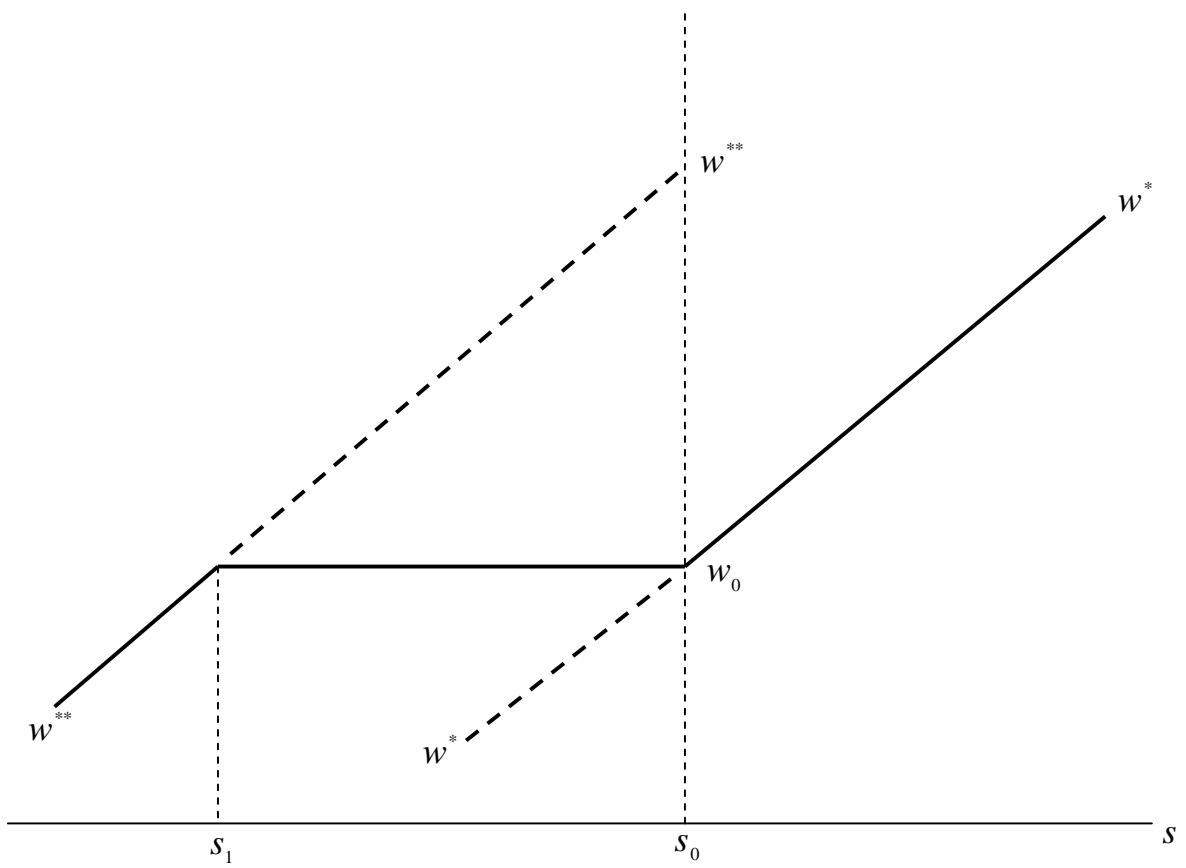


Fig. 5. Optimal wage policy

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