RECIPROCITY AND WAGE DETERMINATION IN ECONOMIC RECESSION

By

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Abstract

The concept of downward wage rigidity has been an important tenant of labor economics for decades. Reciprocity theory suggests that people reward kind actions and punish unkind actions, which leads to the conclusion that workers respond to low wages with low effort, and to high wages with high effort. This belief has traditionally discouraged employers from lowering workers' wages; however, in the current economic recession, some firms have been rejecting downward wage rigidity and lowering employee pay in lieu of layoffs. In this paper I modify a wage-setting game to account for economic downturn and analyze the results using reciprocity theory. I find that although low wage is normally met with low effort, when the economy is suffering enough, low wage can be met with high effort, dismantling the former belief that low wages are always met with low effort. The model introduced here shows that a severe recession causes downward wage rigidity to disappear, explaining the actions of firms that choose to decrease wages to stay afloat in tough economic times. By considering possible economic downturn, this paper builds upon previous models to form a more complete model that accounts for both reciprocity and the economic climate and the effect they have on wage determination.

1. Introduction

The majority of current economic literature supports the notion of *downward wage rigidity*, the resistance of firms to lower workers' wages when the market-clearing pay level declines. Empirical support for this rigidity cites the effect of wages on effort as the biggest reason for firms' reluctance to lower employee pay (Campbell and Kamlani, 1997). In the recession of the early 1990s, many business leaders cited lower employee morale, reduced productivity, and long-run hiring and retention difficulties as reasons for favoring layoffs over pay cuts (Bewley, 1998). Akerlof (1982) proposed a sociological model that considered the interaction between workers and their employers as a "gift exchange," where the 'gift' from the firm to the worker is compensation in excess of what the worker could be earning elsewhere and the 'gift' from the worker to the firm is effort in excess of the minimum standard. Akerlof and Yellen (1990) propose the fair wage-effort hypothesis, which suggests that firms refrain from lowering wages because of the positive relationship between wage and effort that arises due to motives of fairness. Fehr et al. (1993) provided experimental support for this hypothesis using an one-sided auction in which buyers selected the price, or 'wage,' after which sellers responded with quality, or 'effort.' The fair wage-hypothesis was further examined in Dufwenberg and Kirchsteiger (2000), which verified the expected result using a model based on reciprocal motivation. These papers, along with many others, support the idea that firms forced to cut costs are more likely to lay off workers than reduce employee pay because of the positive relationship between wages and workers' effort.

Recently, however, there have been reports of downward wage mobility during the recession of the late 2000s. Despite the economic literature citing the link between employee

effort and wages, some firms are beginning to favor pay cuts over lay offs. Conventionally, firms look to cut costs everywhere except worker salaries when times get tough, but a February 2009 Watson Wyatt Worldwide survey of 245 companies cited that 7% had reduced employee pay and another 4% planned to do so (Hancock). As some firms begin to do this, others take note and may follow suit. Some experts expect more firms to begin to cut wages throughout 2009 (Hancock). This trend is not unique to the United States, either; the British Chambers of Commerce recently revealed that 12% of 400 British firms surveyed plan to cut worker pay in 2009, while another 58% are anticipating wage freezes (Seager). Other firms point out that it can take a long time to rehire quality employees after lay offs due to cyclical recession, and that given the current economic climate, many employees understand that a reduction in wages is better than no job at all (Sixel). Despite these emerging trends, there is still no wage deflation in overall national figures; it appears that downward wage rigidity still applies, but as the recession continues, more firms may cut wages in an attempt to retain employees in the hopes that the economy will turn around soon.

The instances above raise the question as to whether there are specific situations in which downward wage rigidity no longer applies. The papers cited above all point to the social forces affecting workers that create a strong link between wages and effort; however, social preferences are generally very sensitive to perceived motivation and reasons for certain actions. Therefore one would assume that a firm's *reasons* for lowering wages would have an impact on the workers' perception of the firm's action and consequently their effort levels in response. Indeed, one study found that a 5% decrease in wages was considered unfair by 77% of telephone survey respondents if the business was doing well and only 32% if the business was losing money (Kahneman et al., 1986). Similarly, Charness (2004) found that causal attribution did affect a

worker's effort response to a decrease in wages, as those who were aware that a low wage was involuntary were more likely to help the firm by exerting higher effort. Outside of the laboratory, it can be difficult to discern how voluntary or involuntary a decrease in wages might be. Nevertheless, it follows that if the economy is bad enough and the firm is suffering enough, workers may view a decrease in pay as involuntary on the part of the firm.

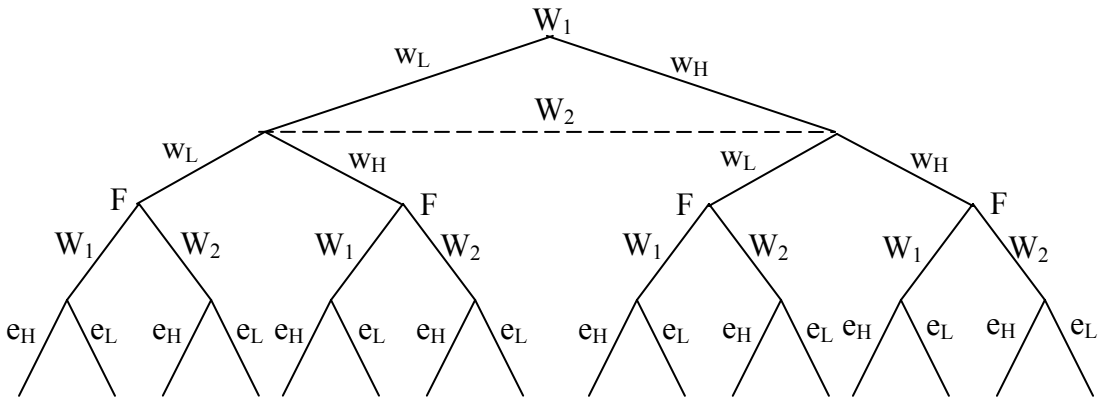
Dufwenberg and Kirchsteiger (2000) analyze a wage-setting game based on the reciprocity theory developed in Dufwenberg and Kirchsteiger (1998). In their analysis, they consider a game where two potential employees simultaneously demand either high or low wage. A firm then decides which worker to hire, and finally the hired worker chooses either high or low effort. The purpose of the game is to analyze the competition between the two workers, and ultimately Dufwenberg and Kirchsteiger (2000) conclude that wage undercutting is not an effective strategy for a potential worker since firms expect low effort from a worker hired at high wage, "even in tight labour markets." This model does not, however, allow for the effect of economic recession on the workers and firm; it is assumed that a worker vying for a position with a firm can always find a low wage-low effort job elsewhere if not hired. Obviously, this assumption will not always hold in difficult economic times with high unemployment when not everyone seeking employment can find a job. A better model would account for this and other effects of economic downturn.

In this paper, I modify the game from Dufwenberg and Kirchsteiger (2000), to include parameters that measure the health of the economy. By modifying the hiring options of the firm and adjusting workers' payoffs to not being hired based on the health of the economy, we can more completely understand a wage-setting game that accounts for social forces that may affect workers' effort choices in economic downturn. Using the parameters α and β as measures of the

health of the economy, we can pinpoint the economic conditions that would result in such outcomes as high effort at low wage, given certain values of Y_W, the worker's sensitivity to reciprocity. After analyzing individual subgames, we can consider a three stage game where a worker chooses whether to demand high or low wage, the firm chooses whether or not to hire him, and the worker finally chooses high or low effort. We can then see how a severe recession would change the kindness perceptions of workers and subsequently their effort levels in response to low wages. By accounting for the effects of economic recession, we can better understand the social forces that impact the interactions between workers and employers and in particular, what is happening in global labor markets as a result of the current recession.

2. The model

To adjust the game from Dufwenberg and Kirchsteiger (2000), we must insert parameters into the game to account for economic downturn. The wage-setting game tree used in Dufwenberg and Kirchsteiger (2000) is as follows:



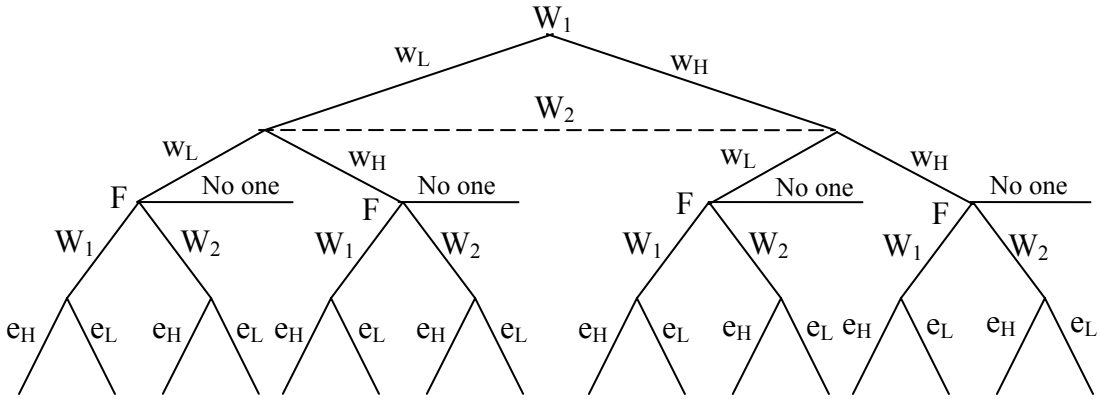
As seen above, two workers, W_1 and W_2, simultaneously make wage demands of either low wage, w_L, or high wage, w_H. The firm, F, then decides to hire either W_1 or W_2. Once the firm has chosen to hire a worker, that worker then chooses his effort level, either high effort, e_H, or low effort, e_L. The payoffs to each player in the game above depend on the effort level of the worker and the wage paid to the worker. Say that the firm hires worker A at a wage w_A and that worker A chooses effort level e_A. The worker incurs a cost to this effort, called c_A. Then the payoff to the hired worker will be $w_A - c_A$, and the payoff to the firm will be $e_A - w_A$. Dufwenberg and Kirchsteiger assume that the worker who is not hired can find another low-wage, low-effort job, so his payoff will be $w_L - c_L$. Therefore you can fill in the payoffs to each outcome of the extensive game above.

In order to account for economic downturn, we must first include an option for the firm to choose to hire neither worker, as that is obviously an option for employers, especially during economics downturn. We also insert two parameters, α and β, to represent the effects of economic downturn on workers and employers, respectively. In Dufwenberg and Kirchsteiger (2000), it is assumed that "it is always possible for a rejected applicant to find a low wage-low effort job somewhere else. Hence, receiving a low wage for a high effort is worse than the outside option" (1074). However, in times of economic downturn, the availability of an outside option becomes questionable. As the demand for labor decreases and the supply of labor increases, it is less and less likely that an applicant to any given job is able to find another job elsewhere. We use the parameter α to represent the payoff to a potential worker's outside option. In Dufwenberg and Kirchsteiger (2000), according to the above assumption, $\alpha = w_L - c_L$ = low wage – cost of low effort. If α were higher than $w_L - c_L$, the worker would choose the outside option rather than the job considered in this game; thus, we do not consider values of α greater

than $w_L - c_L$ in this paper. When the economy weakens, however, a potential employee's outside options tend to become worse. Their options may include lower-paying jobs, jobs with greater risk or poorer working conditions, or no job at all. As this occurs, α decreases and can become negative. Therefore the smaller α, the worse the economy.

Economic recessions do not only affect the payoffs to workers, but firms as well. Due to increased opportunity costs, firms are less profitable in economic downturns; they are less able to capitalize on the effort of their employees. This could be due to inflation, taxes, increased fixed costs, etc. One could capture increasing costs facing the firm in this model by subtracting the parameter β from the firm's payoff at all end nodes. Instead, for the sake of simplicity, we will account for a declining economy by setting the firm's payoff to hiring neither worker at β. In Dufwenberg and Kirchsteiger (2000), if we were to add an outside option for the firm to hire neither worker, the payoff to the firm would be 0. Therefore, in this paper, $\beta \geq 0$, and as the economy worsens, β increases (β represents increasing costs to the firm, etc). Therefore the greater β, the worse the economy.

Thus you can see that the game in Dufwenberg and Kirchsteiger (2000) can be modeled as a special case of the game described above where $\alpha = w_L - c_L$, and $\beta = 0$. The new game tree, with an additional option for the firm to hire neither worker, is seen below:



As before, the two workers, W_1 and W_2, simultaneously make wage demands of either low wage, w_L, or high wage, w_H. The firm, F, then decides to hire either W_1 or W_2 *or* to hire neither worker, as is often the case during economic downturn. If the firm chooses to hire a worker, as above, that worker then chooses his effort level, either high effort, e_H, or low effort, e_L. Again, if the firm hires worker A, he earns a wage w_A and that worker chooses effort level e_A. The worker incurs a cost to this effort, called c_A. Then the payoff to the hired worker will be $w_A - c_A$, and the payoff to the firm will be $e_A - w_A$. Now that we have included parameters to account for economic downturn, the worker that is not hired receives a payoff of α, which in our analysis will have a maximum value of $w_L - c_L$, as was the case in Dufwenberg and Kirchsteiger (2000). As the economy worsens, α will fall below $w_L - c_L$ and eventually become more and more negative. If the firm chooses to hire neither worker, both workers will receive a payoff of α, and the firm will receive a payoff of β. The parameter β will have a minimum value of 0, as in the special case based off of Dufwenberg and Kirchsteiger (2000), and will increase as the economy worsens, representing the increasing incentive for the firm to hire neither worker due to increased costs, inflation, taxes, etc. You can now fill in the payoffs to each end node above according to these parameters.

3. Analysis

Typically, games with reciprocal motivation cannot be analyzed via backward induction and analysis of subgames. In this game, however, the firm is a purely selfish player with no reciprocal motivation, so we are able to analyze the larger game by first considering smaller

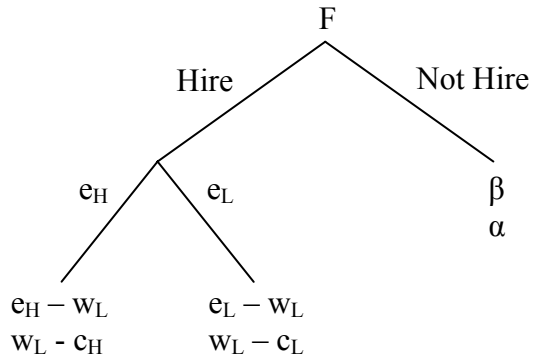
subgames. We first consider smaller two stage subgames to assist in our analysis of the larger three stage game. To further simplify the analysis, we also choose arbitrary values for each payoff parameter other than α and β:

w_L	w_H	c_L	c_H	e_L	e_H
4	6	2	3	7	9

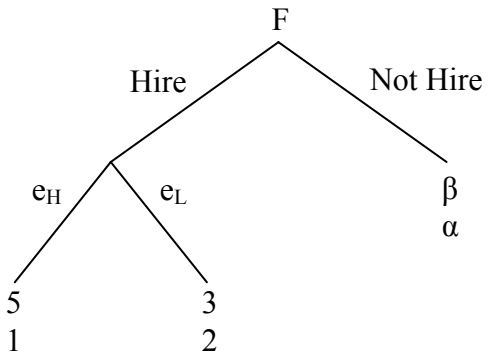
We can now complete analysis of the following games for the above specified values. Note that the analysis can be completed using any values for these parameters.

Two Stage Low Wage Subgame

We begin by looking at a specific subgame in which a firm chooses to hire or not hire a worker at low wage, and then the worker chooses high effort or low effort:



Here, we notice that for the special case that parallels the game in Dufwenberg and Kirchsteiger (2000), $\alpha = w_L - c_L = 4 - 2 = 2$ and $\beta = 0$. Allowing for other values of α and β, we insert the parameter values given above to the other subgame payoffs:



Note that the maximum value of α, based on the case paralleling Dufwenberg and Kirchsteiger (2000), is $w_L - c_L = 4 - 2 = 2$, and the possible payoffs to the worker when the firm chooses hire are 1 and 2. Thus if $\alpha < 1$, the worker is always better off being hired than not being hired, so the firm is always kind to hire the worker. However, if $1 < \alpha < 2$, the kindness of the firm is not as obvious. Thus, we analyze these two situations separately.

Observation 1(a): For $\alpha < 1$, the worker chooses high effort if $Y_W > 1/(1 - \alpha)$.

First consider the situation where $\alpha < 1$. Then the firm is kind for hiring the worker regardless of whether the worker chooses high or low effort. We can calculate the worker's belief about the firm's kindness from choosing hire. Let p'' be the probability that the worker chooses e_H.

$$[p'' + 2(1 - p'')] - [\tfrac{1}{2}(p'' + 2(1 - p'') + \alpha)] = p'' + 2(1 - p'') - \tfrac{1}{2} p'' - (1 - p'') - \tfrac{1}{2} \alpha$$

$$= \tfrac{1}{2} p'' + (1 - p'') - \tfrac{1}{2} \alpha$$

Once the firm chooses to hire the worker, you can see from the tree above that the firm will receive a payoff of 5 if the worker chooses e_H and 3 if the worker chooses e_L. Therefore, the equitable payoff to the firm from the worker is $(5 + 3)/2 = 4$. Then the worker's kindness to the

firm from choosing e_H is +1 and the worker's kindness to the firm from choosing e_L is –1. Next, we can find the worker's payoffs to high effort and low effort levels using reciprocity theory:

W's payoff to e_H:

$$1 + Y_W(1)(½\ p'' + (1 - p'') - ½\ \alpha) = 1 + Y_W(1 - ½\ p'' - 1/2\ \alpha)$$

W's payoff to e_L:

$$2 + Y_W(-1)(½\ p'' + (1 - p'') - ½\ \alpha) = 2 - Y_W(1 - ½\ p'' - 1/2\ \alpha)$$

Now, if the worker chooses high effort, then $p'' = 1$ since beliefs are always correct in equilibrium. For the worker to choose high effort, then the payoff to e_H must be greater than the payoff to e_L, given $p'' = 1$.

$$1 + Y_W(1 - ½ - 1/2\ \alpha) > 2 - Y_W(1 - ½ - 1/2\ \alpha)$$

$$Y_W(1 - \alpha) > 1$$

$$Y_W > 1/(1 - \alpha)$$

Thus the worker must have a sensitivity to reciprocity greater than $1/(1 - \alpha)$ to choose high effort for $\alpha < 1$. Recall that as the economy worsens, α declines. As α becomes more and more negative, $1/(1 - \alpha)$ becomes smaller and smaller, meaning that you have to be less and less sensitive to reciprocity to choose high effort as the economy worsens. In this sense, α represents "job desperation".

Observation 1(b): For $\alpha < 1$, the worker chooses low effort if $Y_W < 1/(2 - \alpha)$.

Next, consider the situation where the worker chooses low effort. Then $p'' = 0$ since beliefs are always correct in equilibrium, and the worker's payoff to low effort must be greater

than his payoff to high effort.

$$1 + Y_W(1 - 1/2\ \alpha) < 2 - Y_W(1 - 1/2\ \alpha)$$

$$Y_W(2 - \alpha) < 1$$

$$Y_W < 1/(2 - \alpha)$$

Thus the worker must have a coefficient of reciprocity sensitivity less than $1/(2 - \alpha)$ to choose low effort when $\alpha < 1$. Thus, as α decreases, Y_W must be lower and lower for the worker to choose low effort. As the economy worsens, a worker must be less and less sensitive to reciprocity to choose low effort.

Observation 1(c): For $\alpha < 1$ and $1/(1 - \alpha) < Y_W < 1/(2 - \alpha)$, the worker chooses high effort with probability $2 - \alpha - 1/Y_W$ and low effort with probability $\alpha + 1/Y_W - 1$.

Now we must consider the situation where $1/(1 - \alpha) < Y_W < 1/(2 - \alpha)$. Here the worker will mix strategies so that he is indifferent between choosing high and low effort. Say the worker chooses high effort with probability p and low effort with probability $1 - p$. Then set the worker's payoff to e_H equal to his payoff to e_L and solve for p.

$$\text{W's payoff to } e_H = \text{W's payoff to } e_L$$

$$1 + Y_W(1/2p + (1 - p) - 1/2\ \alpha) = 2 - Y_W(1/2p + (1 - p) - 1/2\ \alpha)$$

$$p(Y_W - 2\ Y_W) = 1 - 2Y_W + Y_W\ \alpha$$

$$p = 2 - \alpha - 1/Y_W$$

For $1/(1 - \alpha) < Y_W < 1/(2 - \alpha)$, the worker will choose high effort with probability $2 - \alpha - 1/Y_W$ and low effort with probability $\alpha + 1/Y_W - 1$.

Observation 2: For $1 \leq \alpha \leq 2$, the worker chooses high effort with probability $2 - \alpha - 1/Y_W$ and low effort with probability $\alpha + 1/Y_W - 1$.

Next, we analyze the situation where $1 \leq \alpha \leq 2$. Using reciprocity theory, we find that there is no pure strategy sequential reciprocity equilibrium. To prove this, assume that the worker will end up choosing high effort. Then the worker's payoff is 1, which is less than α, so the firm was unkind in hiring the worker. Thus the worker would want to punish the firm's unkindness by deviating and choosing low effort, which results in a contradiction. Similarly, if the worker chooses low effort, his payoff is 2, which is greater than α. Thus, the firm was kind to hire the worker, and the worker would want to reciprocate by choosing high effort. This contradiction shows that a pure strategy equilibrium is not sustainable for $1 \leq \alpha \leq 2$. Instead, we must find the mixed equilibrium.

Assume that the worker will choose high effort with probability p and low effort with probability $1 - p$. Therefore the worker's expected payoff is $p(1) + (1 - p)(2) = p + 2 - 2p = 2 - p$. If $\alpha > 2 - p$, then it is unkind for the firm to choose hire, and the worker will always choose low effort.

Consider the worker's utility from high and low effort. According to the theory of sequential reciprocity of Dufwenberg and Kirchsteiger (2004), the worker's utility to choosing high effort will be equal to his payoff plus his sensitivity to reciprocity, Y_W, times his reciprocity payoff. Thus

$$\text{W's payoff to } e_H = 1 + Y_W(1)[(2 - p) - \tfrac{1}{2}(2 - p + \alpha)]$$

and

$$\text{W's payoff to } e_L = 2 + Y_W(-1)[(2 - p) - \tfrac{1}{2}(2 - p + \alpha)].$$

To find the mixed equilibrium, we must find p such that the worker's payoff to e_H equals his payoff to e_L and solve for p. We find that the equilibrium occurs where $p = 2 - \alpha - 1/Y_W$. Therefore, when $1 \leq \alpha \leq 2$, the worker will choose high effort with probability $2 - \alpha - 1/Y_W$.

Now we can analyze the decisions of the firm based on the observations above about the worker's decisions. We assume that the firm is a purely selfish player, so the firm will make its decisions based only on what it expects the worker to do, and not on kindness perceptions, which simplifies our analysis. Thus the firm's decision depends on the parameters α, β, and Y_W.

Observation 3:

(a) If $\beta < 3$, the firm always hires the worker.

(b) If $\beta > 5$, the firm will never hire the worker.

If the worker chooses low effort, the firm receives a payoff of 3. If the worker chooses high effort, the firm receives 5. Thus, if $\beta < 3$, the firm will always hire the worker, regardless of the effort level the firm expects the worker to choose. Conversely, if $\beta > 5$, the firm will never choose to hire the worker. Recall that the higher the value of β, the worse the economy, since β represents increasing costs to the firm.

Observation 3(c): If $3 < \beta < 5$ and $\alpha > 2$, the firm will never hire the worker.

If $3 < \beta < 5$ and $\alpha > 2$, the worker will always choose low effort, resulting in a payoff of 3 to the firm, so the firm will never choose to hire the worker.

Observation 3(d): If $3 < \beta < 5$ and $1 < \alpha < 2$, the firm will hire the worker if $Y_W > 2/(7 - 2\alpha - \beta)$.

For $1 < \alpha < 2$, as shown in observation 2, the worker will choose high effort with probability $p = 2 - \alpha - 1/ Y_W$. Then we calculate the payoff to the firm from that mix, and compare it to the value of β. If the payoff from the mix is greater than β, then the firm will choose hire.

$$5(2 - \alpha - 1/ Y_W) + 3(1 - (2 - \alpha - 1/ Y_W)) > \beta$$

$$10 - 5\alpha - 5/ Y_W - 3 + 3\alpha + 3/ Y_W > \beta$$

$$7 - 2\alpha - 2/ Y_W > \beta$$

$$7 - 2\alpha - \beta > 2/ Y_W$$

$$Y_W > 2/(7 - 2\alpha - \beta)$$

Thus if $Y_W > 2/(7 - 2\alpha - \beta)$, the firm will choose hire; else, the firm will choose to not hire the worker.

Observation 3(e): If $3 < \beta < 5$ and $\alpha < 1$:

(1) the firm will hire the worker if $Y_W > 1/(1 - \alpha)$.

(2) the firm will not hire the worker if $Y_W < 1/(2 - \alpha)$.

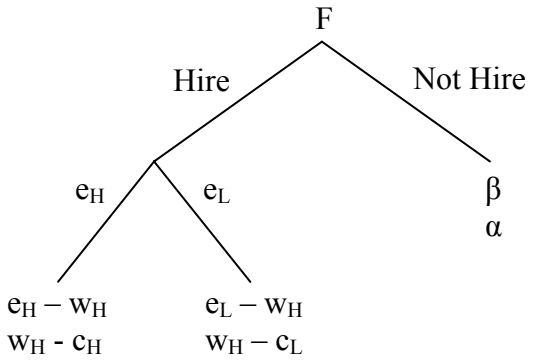
(3) if $1/(1 - \alpha) < Y_W < 1/(2 - \alpha)$, the firm will hire the worker if $Y_W > 2/(7 - 2\alpha - \beta)$.

If $\alpha < 1$, the worker will choose high effort if $Y_W > 1/(1 - \alpha)$ and low effort if $Y_W < 1/(2 - \alpha)$, as shown in Observation 1 above. Assume the firm knows the worker's value of Y_W. Then the firm chooses hire if $Y_W > 1/(1 - \alpha)$, and chooses do not hire if $Y_W < 1/(2 - \alpha)$.

For intermediate values where $1/(1 - \alpha) < Y_W < 1/(2 - \alpha)$, the worker chooses high effort with probability $p = 2 - \alpha - 1/ Y_W$. Then, as in Observation 3(d) above, we calculate the payoff to the firm from that mix, and compare it to the value of β. Thus if $Y_W > 2/(7 - 2\alpha - \beta)$, the firm will choose hire; else, the firm will choose to not hire the worker.

Two Stage High Wage Subgame

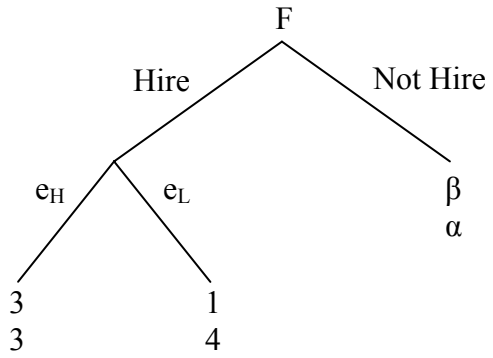
We continue our analysis by looking at a specific subgame in which a firm chooses to hire or not hire a worker at high wage, and then the worker chooses high effort or low effort:



Again, we notice that for the special case that represents the game in Dufwenberg and Kirchsteiger (2000), $\alpha = w_L - c_L = 4 - 2 = 2$ and $\beta = 0$. Recall that the values for each parameter are chosen as follows:

w_L	w_H	c_L	c_H	e_L	e_H
4	6	2	3	7	9

We then apply these parameters to the subgame payoffs:



Again, for the special case presented in Dufwenberg and Kirchsteiger (2000), $\alpha = w_L - c_L = 4 - 2 = 2$, so in this game, $\alpha \leq 2$. Since the lowest payoff the worker can receive from being hired is 3, the firm is *always* kind to the worker by choosing hire. Once the firm chooses to hire the worker, the firm will receive a payoff of 3 if the worker chooses e_H and a payoff of 1 if the worker choose e_L. Then the equitable payoff to the firm from the worker is $(3 + 1)/2 = 2$. Thus the worker's kindness to the firm of choosing e_H is +1 and the worker's kindness to the firm of choosing e_L is –1. Now we can calculate the worker's payoffs to high and low effort and find the values of Y_W that will result in each outcome.

Consider the worker's utility from high and low effort:

$$\text{W's payoff to } e_H = 3 + Y_W(1)[(4 - p) - \tfrac{1}{2}(4 - p + \alpha)]$$

and

$$\text{W's payoff to } e_L = 4 + Y_W(-1)[(4 - p) - \tfrac{1}{2}(4 - p + \alpha)].$$

Next we must calculate the worker's belief about the firm's kindness from choosing hire:

$$[3p'' + 4(1 - p'')] - [\tfrac{1}{2}(3p'' + 4(1 - p'') + \alpha)] = 3p'' + 4(1 - p'') - 2 + \tfrac{1}{2} p'' - \tfrac{1}{2} \alpha$$

$$= 2 - \tfrac{1}{2} p'' - \tfrac{1}{2} \alpha$$

Next, find the worker's payoffs to high effort and low effort levels using reciprocity theory:

W's payoff to e_H:

$$3 + Y_W(1)(2 - \tfrac{1}{2} p'' - \tfrac{1}{2} \alpha) = 3 + Y_W(2 - \tfrac{1}{2} p'' - 1/2\ \alpha)$$

W's payoff to e_L:

$$4 + Y_W(-1)(2 - \tfrac{1}{2} p'' - \tfrac{1}{2} \alpha) = 4 - Y_W(2 - \tfrac{1}{2} p'' - 1/2\ \alpha)$$

Observation 1(a): The worker will choose high effort if $Y_W > 1/(3 - \alpha)$.

If the worker chooses high effort, then $p'' = 1$ since beliefs are always correct in equilibrium. For the worker to choose high effort, then the payoff to e_H must be greater than the payoff to e_L, given $p'' = 1$.

$$3 + Y_W(2 - \tfrac{1}{2} - 1/2\ \alpha) > 4 - Y_W(2 - \tfrac{1}{2} - 1/2\ \alpha)$$

$$Y_W(3 - \alpha) > 1$$

$$Y_W > 1/(3 - \alpha)$$

Thus the worker must have a sensitivity to reciprocity greater than $1/(3 - \alpha)$ to choose high effort. Recall that as the economy worsens, α declines from its maximum value of 2. Therefore $1/(3 - \alpha)$ is between 0 and 1. As α becomes more and more negative, $1/(3 - \alpha)$ becomes smaller and smaller, meaning that you have to be less and less sensitive to reciprocity to choose high effort as the economy worsens. Also, recall that in the low wage subgame, Y_W needed to be greater than $1/(1 - \alpha)$ to choose high effort, which is a higher threshold than $1/(3 - \alpha)$; thus in the low wage subgame, workers must be more sensitive to reciprocity to choose high effort than in the high wage subgame.

Observation 1(b): The worker will choose low effort if $Y_W < 1/(4 - \alpha)$.

Next, consider the situation where the worker chooses low effort. Then p'' = 0 since beliefs are always correct in equilibrium, and the worker's payoff to low effort must be greater than his payoff to high effort.

$$3 + Y_W(2 - 1/2\ \alpha) < 4 - Y_W(2 - 1/2\ \alpha)$$

$$Y_W(4 - \alpha) < 1$$

$$Y_W < 1/(4 - \alpha)$$

Thus the worker must have a coefficient of reciprocity sensitivity less than $1/(4 - \alpha)$ to choose low effort when $\alpha < 1$. Thus, as α decreases, Y_W must be lower and lower for the worker to choose low effort. As the economy worsens, a worker must be less and less sensitive to reciprocity to choose low effort.

Observation 1(c): For $1/(4 - \alpha) < Y_W < 1/(3 - \alpha)$, the worker will choose high effort with probability $4 - \alpha - 1/Y_W$ and low effort with probability $\alpha + 1/Y_W - 1$.

Now we consider the situation where $1/(4 - \alpha) < Y_W < 1/(3 - \alpha)$. Here the worker will mix strategies so that he is indifferent between choosing high and low effort. Say the worker chooses high effort with probability p and low effort with probability $1 - p$. Then set $U(e_H) = U(e_L)$ and solve for p.

$$U(e_H) = U(e_L)$$

$$3 + Y_W(2 - \tfrac{1}{2}\ p - 1/2\ \alpha) = 4 - Y_W(2 - \tfrac{1}{2}\ p - 1/2\ \alpha)$$

$$p(Y_W - 2\ Y_W) = 1 - 4Y_W + Y_W\ \alpha$$

$$p = 4 - \alpha - 1/Y_W$$

For $1/(4 - \alpha) < Y_W < 1/(3 - \alpha)$, the worker will choose high effort with probability $4 - \alpha - 1/Y_W$ and low effort with probability $\alpha + 1/Y_W - 1$.

Now we can analyze the decisions of the firm. We assume that the firm is a purely selfish player, so the firm will make its decision based only on what it expects the worker to do. This depends on the parameters α, β, and Y_W.

Observation 2:

(a) If $\beta < 1$, the firm always hires the worker.

(b) If $\beta > 3$, the firm will never hire the worker.

If the worker chooses low effort, the firm receives a payoff of 1. If the worker chooses high effort, the firm receives 3. Thus, if $\beta < 1$, the firm will always hire the worker, regardless of the effort level the firm expects the worker to choose. Conversely, if $\beta > 3$, the firm will never choose to hire the worker.

Observation 2(c): For $1 < \beta < 3$:

(1) the firm will hire the worker if $Y_W > 1/(3 - \alpha)$.

(2) the firm will not hire the worker if $Y_W < 1/(4 - \alpha)$.

(3) if $1/(4 - \alpha) < Y_W < 1/(3 - \alpha)$, the firm will hire the worker if $Y_W > 2/(9 - 2\alpha - \beta)$.

If $1 < \beta < 3$ and $\alpha < 2$, the worker will choose high effort if $Y_W > 1/(3 - \alpha)$ and low effort if $Y_W < 1/(4 - \alpha)$, as shown above. Assume the firm knows the workers value of Y_W. Then the

firm chooses hire if $Y_W > 1/(3 - \alpha)$, and chooses do not hire if $Y_W < 1/(4 - \alpha)$. For intermediate values where $1/(4 - \alpha) < Y_W < 1/(3 - \alpha)$, the worker chooses high effort with probability $p = 4 - \alpha - 1/ Y_W$. Then we calculate the payoff to the firm from that mix, and compare it to the value of β. If the payoff from the mix is greater than β, then the firm will choose hire.

$$3(4 - \alpha - 1/ Y_W) + 1(1 - (4 - \alpha - 1/ Y_W)) > \beta$$

$$12 - 3\alpha - 3/ Y_W - 3 + \alpha + 1/ Y_W > \beta$$

$$9 - 2\alpha - 2/ Y_W > \beta$$

$$9 - 2\alpha - \beta > 2/ Y_W$$

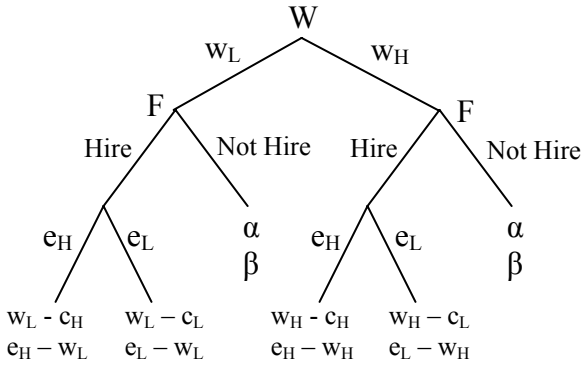
$$Y_W > 2/(9 - 2\alpha - \beta)$$

Thus if $Y_W > 2/(9 - 2\alpha - \beta)$, the firm will choose hire; else, the firm will choose to not hire the worker.

Three Stage Game

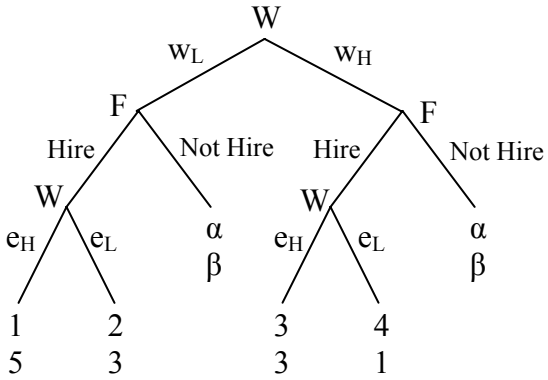
Now that we have analyzed both two stage subgames, we can combine them with a first move where the worker chooses whether to demand high wage or low wage. Again, it is not a general property of games with reciprocal motivation that one can solve subgames and work backwards. However, the game discussed in this paper does have this property. We assume that the firm is a purely selfish player, and thus does not react to kindness implied by preceding or succeeding choices. The firm's behavior can then be solved for individual subgames and will not change based on the addition of another move by the worker. The worker does, however, react to kindness, but in the third stage of the game (where he selects either high or low effort), his

kindness perceptions are defined entirely within that subgame since it is the only point in the tree at which the worker reacts to a move by the firm. Given this property and the selfishness of the firm, we are able to easily analyze what the worker will do at the root of the game using reciprocal motivation. Note that since the worker now moves first instead of the firm, the payoffs listed at each end node have the worker's payoff listed first, with the firm's payoff below.



And, using the above arbitrary parameters, the payoffs to the end nodes are as follows:

w_L	w_H	c_L	c_H	e_L	e_H
4	6	2	3	7	9



We now need to do new reciprocity calculations from the root of the game to analyze this three stage game. Note that we would be able to do calculations similar to those above for each two stage subgame to find the values of Y_W for which the worker would choose to demand either

high or low wage. These calculations are extremely involved and complicated, so to simplify our analysis we will focus on the most interesting situation, where Y_W is high, i.e. the worker is very sensitive to reciprocity. This case corresponds to the high Y_W case presented in Dufwenberg and Kirchsteiger (2000) in which they find the high wage equilibrium outcome. In this three stage game, the utility to the worker is based on the worker's beliefs about what the firm believes the worker is going to do (beliefs about beliefs). First consider the situation where $\alpha < 1$. For $\alpha < 1$, the firm is considered kind for hiring the worker at either wage w_L or w_H, since the lowest payoff the worker can receive from being hired is 1. Since we are considering the situation where Y_W is high, the worker will reciprocate the firm's kindness by choosing e_H. The firm's decision of whether to choose Hire or Not Hire will depend on the value of β. We can now analyze what happens at the root of the game.

Observation 1(a): For $\alpha < 1$ and $\beta < 1$, there is one pure strategy equilibrium, $\{w_L, \text{Hire}, e_H\}$.

First, we know that the worker will choose e_H at each of the the third decision nodes since the firm is kind to hire for $\alpha < 1$. Then, since $\beta < 1$, the firm will always choose Hire since the firm will receive a payoff of 3 if the worker demands w_H and 5 if the worker demands w_L, since he knows the worker is very sensitive to reciprocity and will exert high effort. Then we can analyze what happens at the root by assuming an equilibrium and arguing to a contradiction. Assume that $\{w_H, \text{Hire}, e_H\}$ is a pure strategy equilibrium. The firm is being kind to the worker by choosing hire, but at the root the worker is not being kind to the firm, since he is giving the firm a payoff of 3 instead of 5 by demanding high wage. The worker would want to reciprocate the firm's kindness, and would thus want to deviate and demand w_L instead. Therefore $\{w_H,$

Hire, e_H} is not an equilibrium. Now, assume that {w_L, Hire, e_H} is an equilibrium. The firm is being kind to the worker by choosing Hire, and the worker is being kind to the firm at the root by demanding low wage. Thus there is no incentive for either player to deviate, so {w_L, Hire, e_H} is a pure strategy equilibrium for $\alpha < 1$, $\beta < 1$.[1]

Observation 1(b): For $\alpha < 1$, $1 < \beta < 3$, there is one pure strategy equilibrium, {w_L, Hire, e_H}.

Next, consider the case where $1 < \beta < 3$. As before, the firm is kind to hire at either wage, so the worker, who has a very high Y_W, will reciprocate by choosing e_H at either wage. We assume that the firm knows this about the worker, so he knows that he will receive a payoff of 5 for hiring the worker at low wage and 3 for hiring the worker at high wage. Since $1 < \beta < 3$, the firm will choose to hire the worker at either wage. Thus we have the same analysis as above, and we can see that the only pure strategy equilibrium is {w_L, Hire, e_H}.

Observation 1(c): For $a < 1$, $3 < \beta < 5$, there are two pure strategy equilibria, {w_L, Hire, e_H} and {w_H, Not Hire, e_H}.

Now consider $3 < \beta < 5$. At low wage, the firm will receive a payoff of 5 for hiring the worker, since he knows that the worker has a high value of Y_W and will choose e_H. Thus the firm will choose Hire if the worker demands w_L. If the worker demands w_H, however, the worker would only receive a payoff of 3 from choosing Hire. Since $\beta > 3$, the firm will choose Not Hire

[1] Note that there is of course a point at which the value of Y_W is not high enough to support {w_L, Hire, e_H} as an equilibrium, since the worker will not be *so* sensitive to reciprocity as to take a decrease in his own pay in order to be kind to the firm. At this point there will be a mixed strategy equilibrium, rather than a pure strategy equilibrium. For the analysis above, we focus only on the case where Y_W is very high.

at high wage. We can now check for equilibrium. Assume $\{w_L, \text{Hire}, e_H\}$ is an equilibrium, as before. Since $\alpha < 1$, the firm is kind to the worker by choosing Hire, and the worker is kind to the firm by demanding low wage.[2] Thus the worker would not want to deviate from demanding low wage, so $\{w_L, \text{Hire}, e_H\}$ is an equilibrium. Next, assume that $\{w_H, \text{Hire}, e_H\}$ is an equilibrium. The firm chooses Not Hire, so the firm is unkind to the worker by giving the worker a payoff of $\alpha < 1$, when he would have received a payoff of 3 had the firm chose Hire. At the root, however, the worker is also unkind to the firm by demanding a high wage rather than a low wage. Thus the worker is reciprocating the firm's unkindness, so he has no incentive to deviate. Therefore $\{w_L, \text{Hire}, e_H\}$ is also a pure strategy equilibrium to the game.[3]

Observation 1(d): For $\alpha < 1$, $\beta > 5$, there are two pure strategy equilibria, $\{w_L, \text{Not Hire}, e_H\}$ and $\{w_H, \text{Not Hire}, e_H\}$.

Next consider the case where $\beta > 5$. Recall that an increase in β corresponds to deteriorating economic conditions. For $\beta > 5$, the economy is so bad that the firm will choose Not Hire at either wage, since β is higher than the maximum payoff the firm could receive by choosing Hire. Assume that the strategy profile $\{w_L, \text{Not Hire}, e_H\}$ is an equilibrium.[4] The firm is unkind to the worker by choosing Not Hire; however, the worker knows that the firm will choose Not Hire for either wage and will therefore receive a payoff of β regardless of what the

[2] The firm receives a payoff of 5 when the worker demands low wage and reciprocates with high effort, and only receives a payoff of β, where $3 < \beta < 5$, if the worker demands high wage, since the firm will choose Not Hire. Thus the worker is kind to the firm by demanding low wage.

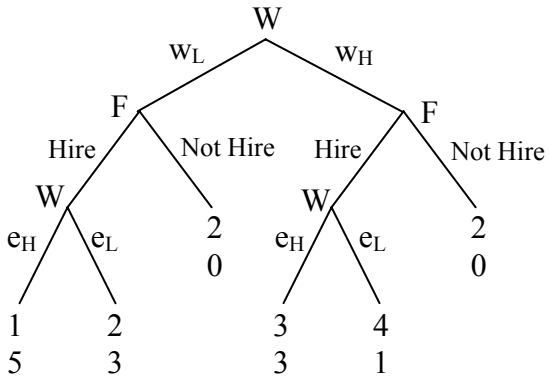
[3] Note that there is also a mixed strategy equilibrium. We could solve for this equilibrium using the guidelines set forth in this paper, but for the sake of simplicity I will focus only on the pure strategy equilibria above.

[4] Recall that a strategy profile must include what each player would do at every node, even if that node is never reached. Thus, even though the firm chooses Not Hire, the strategy profile must include what the worker would do *if* the firm chose Hire, which would be to choose e_H.

worker does. Thus the worker cannot be unkind to the firm to reciprocate his choice of Not Hire, so the worker is indifferent between wL and wH. Both $\{w_L$, Not Hire, $e_H\}$ and $\{w_H$, Not Hire, $e_H\}$ are pure strategy equilibrium in this case.[5]

The above analysis considers $\alpha < 1$. We could also solve the three stage game for $1 < \alpha < 2$. For these values of α, the firm is still always kind to the worker by choosing Hire at w_H, but at w_L the worker chooses e_H with a probability $p = 2 - \alpha - 1/Y_W$. Since Y_W is very high, $p \approx 2 - \alpha$. Here there would be no pure strategy equilibria to the game, but one could solve for the mixed strategy equilibria. Recall that a decrease in α represents a decline in the economy, and that according to the parallel game in Dufwenberg and Kirchsteiger (2000), the maximum value of α for the parameters used in this paper is 2. Since we are mostly interested in the effects of a very poor economy, we will not analyze the situation where $1 < \alpha < 2$ here.

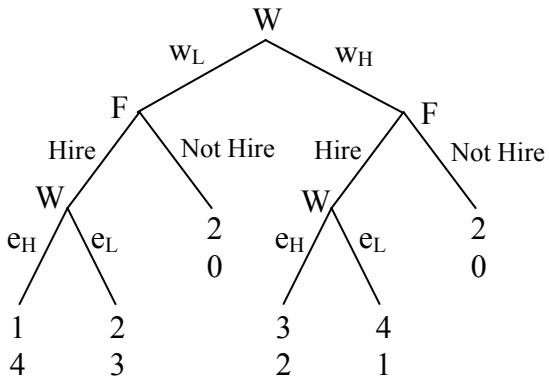
Finally, let's consider the above game for the special conditions paralleling the game in Dufwenberg and Kirchsteiger (2000). As explained when the model was introduced, the parameters that would result in a special case resembling their game are $\alpha = w_L - c_L = 2$ and $\beta = 0$. Then the game is as follows:



[5] Again, one could solve for the mixed strategy equilibrium for this case as well, though we do not do it here.

Notice that the firm is kind to hire the worker at high wage, since the payoffs 3 or 4 are both higher than $\alpha = 2$. Again, assuming high Y_W, the worker will reciprocate with e_H. On the other hand, the firm is unkind to hire the worker at w_L, since $\alpha = 2$ is at least as big as the worker's payoff from being hired. Thus the worker will reciprocate by choosing e_L. Since the firm is purely selfish, he will choose Hire at either wage since the resulting possible payoffs are all greater than $\beta = 0$. At the root, the worker sees that the firm is unkind to him by choosing Hire at w_L, and the worker wants to reciprocate that unkindness by being unkind to the firm. With the parameters above, however, the firm receives a payoff of 3 from either outcome, so the worker is indifferent between w_L and w_H. However, a small change in the parameters from $e_H = 9$ to $e_H = 8$ yields a more insightful result[6]:

w_L	w_H	c_L	c_H	e_L	e_H
4	6	2	3	7	8



Now you can see that the firm receives a payoff of 3 to $\{w_L, \text{Hire}, e_L\}$ and a payoff of 2 to $\{w_H, \text{Hire}, e_H\}$. Now the worker can reciprocate the firm's unkindness to choosing Hire at w_L by deviating at the root and choosing w_H. Thus, the parameters paralleling Dufwenberg and

[6] The parameters used in this paper required adjustment to show the desired result because the values assigned to the parameters are for didactic purposes only and thus are very close. The values that would correspond to these parameters in a more realistic situation would not be so similar and thus we would not encounter this ambiguity problem.

Kirchsteiger (2000) yield the result that the pure strategy equilibrium is $\{w_H, \text{Hire}, e_H\}$ and that w_H is met with e_H and w_L is met with e_L, as concluded in their paper. We can now compare these to our results above accounting for variations in α and β to see the effect of economic downturn on their results.

3. Conclusion

Much of economic literature focuses on the concept of downward wage rigidity and its practical implications on labor markets. Dufwenberg and Kirchsteiger (2000) model this concept through a wage setting game, demonstrating the relationship between wage and worker effort and showing that firms are reluctant to lower wages because lower wages are met with low effort. It is apparent, however, that this is not always the case in the real world, especially given the current economic recession. It seems that the condition of the economy has a profound impact on downward wage rigidity, but previously was not included in game theoretic analyses of wage setting games.

By adjusting the game in Dufwenberg and Kirchsteiger (2000), I was able to account for economic downturn using the parameters α and β, representing decreasing outside options to workers and increasing costs to firms, respectively. Depending on the values of α, β, and Y_W, the worker's sensitivity to reciprocity, I demonstrated that there are specific conditions where low wage would be met with high effort. In addition, when assuming high sensitivity to reciprocity, we saw that in a three stage wage-setting game, it is a pure strategy equilibrium for the worker to demand low wage, the firm to hire the worker, and the worker to subsequently put forth high

effort. Based on the analysis of the two stage subgames above, we see that high sensitivity to reciprocity is analogous to very low α, since as the economy becomes worse and worse (α decreases), a worker must be less and less sensitive to reciprocity to see the outcome above. Therefore, I have demonstrated that if α is low enough (an economic recession is severe enough), downward wage rigidity disappears, and workers respond to even a low wage with high effort.

Dufwenberg and Kirchsteiger (2000) showed that high wage is met with high effort and that low wage is met with low effort, and thus firms will choose to hire an applicant demanding high wage over an applicant demanding low wage. Here, we have seen that an economic recession can eliminate downward wage rigidity, and low wage can be met with high effort. Based on that conclusion, it is easy to see that a firm, given the necessary economic conditions, would choose to hire a low wage worker over a high wage worker.

As a recession becomes deep enough, the traditional relationship between wage and a worker's effort disappears. Knowing this, some firms may choose to lower employee pay to cut costs during a recession rather than lay off workers. Accounting for economic recession in the wage-setting model above explains this result, and also explains why we will see a reappearance of downward wage rigidity when the economy pulls out of the recession. We now have a more complete model for analyzing wage-effort interactions in any economic climate.

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