Co-worker Altruism and Unemployment[*]

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Abstract

It is well-known that social relationships and altruism among workers foster cooperation in the workplace, and thus may have beneficial effects for firms. Yet, it is unclear how and to what extent co-worker altruism impacts labor market outcomes. In this paper, we find that, while co-worker altruism may be harmless in good times, it may distort the functioning of labor markets during bad times. Specifically, co-worker altruism may potentially lead to wage rigidity and involuntary unemployment in economic downturns. These results seem to be consistent with recent empirical findings.

KEYWORDS: Non-paternalistic altruism, wage rigidity, involuntary unemployment

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1 Introduction

There is ample evidence that social relationships in the workplace are crucial for understanding managerial practices, workers' job satisfaction and employees well-being.[1] In fact, recent field evidence indicates that financial incentives alone have a limited role in explaining what goes on inside profit-maximizing firms (Rotemberg, 2006). In particular, it has been found that worker-to-worker altruism fosters cooperation among workers, suggesting that it may be beneficial for firms to promote positive co-worker relationships.[2] Intuitively, workers may work harder when the satisfaction of the co-workers improves. However, aside from these implications within organizations, it is unclear how and to what extent worker-to-worker altruism shapes labor market outcomes.

Perhaps surprising, we find that worker-to-worker altruism could indeed distort labor market outcomes. Specifically, co-worker altruism could lead to wage rigidity and involuntary unemployment in an otherwise frictionless labor market. Thus, while incentivizing co-worker altruism may be beneficial in economic expansions, it could have detrimental effects in recessions. These results are consistent with empirical findings. Based on interviews with union leaders, job recruiters, and unemployment counselors on the early 1990s recession in the United States, Bewley (1999) found that firms prefer layoffs over pay cuts during a recession to prevent damaging workers' morale (e.g., common happiness), which is understood as a byproduct of workers' social relationships.

To examine the effects of co-worker altruism on labor market outcomes, we consider a labor market in which a representative profit-maximizing firm chooses how many workers to hire and their compensation scheme. We make the following simplifying assumptions. First, to isolate the effect of altruism, we omit performance-pay issues, and instead assume a standard contract that involves a fixed wage rate and a non-binding amount of hours. Second, we model co-worker altruism in a *non-paternalistic* way (see, e.g., Ray, 1987; Bergstrom, 1999; Bramoullé, 2001; Pearce, 1983). Thus, workers' utility functions depend positively on the final welfare of co-workers, and their individual well-being is interdependent. Finally, workers have preferences over consumption, leisure, and the *time spent at the workplace*, where the latter depends on the average level of the co-workers' well-being. Hired workers elect how much labor to supply and how many units of the final good to consume, taking the wage rate as given.

[1] See, e.g., Riordan and Griffeth (1995); Hodson (1997); Ducharme and Martin (2000); Morrison (2004); Wagner and Harter (2006); Krueger and Schkade (2008).

[2] Practitioners have already recognized this fact: according to Berman et al. (2002), more than 85% of managers in the United States actively promote friendship in the workplace by offering social events for employees; see Cohen and Prusak (2002) for a related discussion.

We first examine the game played among workers.[3] When wages are high or low enough, workers' well-being and labor supply are uniquely determined. However, for mid-wage levels, co-worker altruism could lead to multiple levels of workers' well-being, each being associated with a different labor supply decision. For instance, if workers' realized well-being is low, some workers will quit, and those who are employed will supply fewer hours. Consequently, a small pay cut can trigger a low labor supply outcome.

Finally, we study how firms respond to productivity shocks of varying intensity. When productivity is high, as in an economic expansion, the firm raises the wage and hires all available workforce. However, for moderate levels of productivity, the manager abstains from implementing a pay cut, as this may trigger a low morale outcome in the worker game. Instead, the firm insulates employees from adverse market conditions, giving rise to *wage rigidity*. If the economic downturn is more severe, as in a recession, then it is too costly for the firm to shield its workforce completely. The firm finds it optimal to adjust employment while keeping the wage unchanged and, therefore, *involuntary unemployment* emerges.

Our paper relates to the literature on non-paternalistic preferences. There, individuals derive happiness directly from the extent to which others are enjoying themselves, and not from how they are doing so (Ray and Vohra, 2020). This type of utility interdependence has been used to capture altruism in a variety of settings (see, e.g., Dur and Sol, 2010; Genicot, 2016; Galperti and Strulovici, 2017; Bourlès et al., 2017). Contrary to this paper, this literature typically focuses on settings in which altruism induces *unique* levels of well-being among individuals.[4] To the best of our knowledge, this may be the first paper that examines how non-paternalistic co-worker altruism can impact labor markets.

There is an extensive literature that introduces behavioral concerns in organizations. These papers study incomplete contracts in which workers' effort (i.e., labor quality) is unobservable; see, e.g., Kőszegi (2014) for a survey. Of course, behavioral concerns can manifest in many ways, for example, as reciprocity and fairness between the firm and the worker; see Sobel (2005) and references therein.[5] Importantly, this would lead to a very different type of preference interdependence, compared to the one we study in this paper.

Finally, the worker-to-worker altruism literature focuses on the conditions under which altruism would emerge in equilibrium and how this may affect cooperative behavior among workers; see Rotemberg (2006). The question of how co-worker altruism can distort labor

[3]Technically, this is a strategic interaction with *payoff-based externalities* (Ray and Vohra, 2020), in which the worker's utility depends on her own action, and the utilities of other workers (others' actions enter a worker's utility only via the utilities they generate for other players).

[4]See our recent work, Vásquez and Weretka (2020), for an exception.

[5]Fang and Moscarini (2005) study the role of worker confidence in the determination of wages. They consider a fixed pool of workers and find important implications for wage dispersion. By contrast, our focus is on the effects of co-worker altruism on both wage stickiness and involuntary unemployment.

market outcomes in recessions has gone unanswered.

The rest of the paper is organized as follows. In §2, we develop a model that allows us to examine the effects of co-worker altruism on unemployment and wages. In §3, we explore the worker game, and in §4 we study the firm's problem. Finally, we demonstrate robustness of the main result in §5, and then conclude in §6. All omitted proofs are in the Appendix.

2 Interdependent Preferences in the Workplace

The Model. We consider a representative firm (or manager) that faces a continuum of heterogeneous *potential workers* indexed by $i \in [0,1]$. Potential worker i has *reservation utility* $r_i \in \mathbb{R}$.[6] The firm chooses a set of workers $I \subseteq [0,1]$, with mass $\mu(I) \in [0,1]$, and a compensation scheme that specifies a uniform *wage rate* $w \geq 0$.[7] Reservation utilities are distributed according to a cumulative distribution function $F(\cdot)$ with respect to μ. We assume that $F(\cdot)$ is strictly increasing with no atoms and has full support.

Given wage w, each employed worker $i \in I$ elects an *individual labor* supply $\ell_i \geq 0$. The firm then uses total labor $L \equiv \int_I \ell_i d\mu \geq 0$ to produce a consumption good using a technology $Ay(L)$ obeying $y' > 0 > y''$ for $L > 0$, $y(0) = 0$, and $\lim_{L\to 0} y'(L) = \infty$ and $\lim_{L\to\infty} y'(L) = 0$. As usual, the parameter $A > 0$ is understood as the firm's *productivity*. The firm maximizes profits $Ay(L) - wL$, anticipating the labor choices of employed workers.

The available *labor force* μ^S is the mass of potential workers who are willing to work at the prevailing wage rate. The *employment rate* $\mu^D \equiv \mu(I)$ is the mass of employed workers and is bounded by the available labor force, namely, $\mu^D \leq \mu^S$. Naturally, the difference $\mu^S - \mu^D \geq 0$ represents the *level of involuntary unemployment*.

We offer predictions regarding wage, employment, and labor supply for any productivity level A. We say that *wages are rigid* if there exists a range of productivity values such that the equilibrium wage is constant. Further, *there is involuntary unemployment* if $\mu^S - \mu^D > 0$.

The worker game. Each hired worker $i \in I$ chooses how to allocate her endowed time of $T > 1$ hours between labor ℓ_i and *leisure* $T - \ell_i$ to finally consume $c_i \equiv w\ell_i$ units of the final good. The standard labor supply model supposes that workers derive utility from consumption and leisure (Lucas and Rapping, 1969), and so their choices of labor affect their utilities insofar as they crowd out leisure. However, there is ample evidence of social relationships in the workplace (e.g., Bewley, 1999; Rotemberg, 2006). In this paper,

[6] The reservation utilities r_i may reflect foregone leisure (Lucas and Rapping, 1969), potential gains from job search (Diamond, 1981; Pissarides, 1985), or foregone household production (Hansen and Wright, 1998).

[7] Formally, we endow the set $[0,1]$ with a Borel $\sigma-$algebra $\mathcal{I}$ and a measure μ. The firm selects sets $I \in \mathcal{I}$.

workers also care about the quality of their work environment, which is a byproduct of the work climate, social relationships with colleagues, etc. Surely, a positive work environment is highly likely to boosts workers' morale through the enjoyment derived from working. Specifically, we consider the following *utility function*:

$$U_i(c_i, \ell_i, \upsilon) \equiv \alpha \ln(c_i) + \beta \ln(T - \ell_i) + \gamma(\upsilon) \ln(\ell_i), \tag{1}$$

where $\alpha, \beta > 0$. The first two terms in (1) capture the usual trade-off between consumption and leisure, whereas the last one reflects the enjoyment level derived at the workplace. In particular, the level of enjoyment at the workplace is proportional to $\gamma(\upsilon) \in \mathbb{R}$ and depends on the workers' *morale* $\upsilon \equiv \int_I u_i d\mu/\mu(I) \in \mathbb{R}$, namely, the *average realized utility of others*. The variable $u_i \in \mathbb{R}$ is worker i's *realized utility* in the workplace. We next discipline $\gamma(\cdot)$.

Assumption 1. *The function* $\gamma : \mathbb{R} \to (\underline{\gamma}, \bar{\gamma})$ *is differentiable, bounded with* $\underline{\gamma} < 0 < \bar{\gamma}$*, and strictly increasing with vanishing marginal effects* $\lim_{\upsilon\to\infty} \gamma'(\upsilon) = \lim_{\upsilon\to-\infty} \gamma'(\upsilon) = 0$*. Also,*

a) the lowest enjoyment $\underline{\gamma} > -\alpha + \beta/(T-1)$*; and*

b) the marginal enjoyment $\gamma'(\cdot)$ *obeys* $\gamma'(\upsilon) > 1/\ln(T\alpha/(\alpha+\beta))$ *for some* $\upsilon \in \mathbb{R}$.

By Assumption 1, first as morale υ rises the worker's enjoyment $\gamma(\upsilon)$ rises too. Second, when workers' morale is low and negative, the enjoyment at the workplace is also negative, capturing the psychological phenomenon of *emotional contagion* among co-workers (e.g., Hatfield et al., 2014).[8] Relatedly, workers are not too sensitive to changes in co-workers welfare when this one is already high or low enough, capturing small contagion effects. However, this reverses for mid morale υ levels: part *b*) states that contagion effects can, in turn, be non-trivial. Third, to avoid a corner solution, part *a*) posits that the enjoyment at the workplace is not too low to incentivize effort at the workplace. Finally, γ is bounded to ensure that the worker's problem is well-behaved. The logistic, S-shaped, function depicted in the left panel of Figure 1 satisfies these assumptions.

Example 1 (Parametrization). We use the following parameters and functional forms to illustrate our analysis. We set $T = 24$; $\alpha = \beta = 1$; $\gamma(\upsilon) = 1/(1 + e^{-4\upsilon}) - 1/2$; $r_i \sim \mathcal{N}(0, 1)$; and $y(L) = \sqrt{L}$. Thus, $\bar{\gamma} = -\underline{\gamma} = 1/2$, and also $\underline{\gamma} = -1/2 > -\alpha + \beta/(T-1) = -0.96$. Finally, $\gamma'(0) = 4 > 1/\ln(T\alpha/(\alpha+\beta)) = 0.4$. Altogether, Assumption 1 is satisfied. ♢

Solution concept. Our equilibrium notion for the worker game is inspired by recent developments in the literature on non-paternalistic altruism (see, e.g., Ray and Vohra, 2020;

[8] Vásquez and Weretka (2020) give a psychological foundation for this type of interdependent preferences.

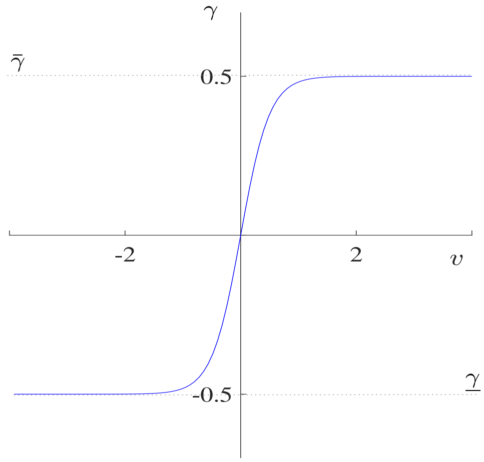

Figure 1: **The enjoyment function** $\gamma(\upsilon)$**.** The figure plots $\gamma(\upsilon) = 1/(1 + e^{-4\upsilon}) - 1/2$, which satisfies Assumption 1, given $\alpha = \beta = 1$ and $T = 24$.

Vásquez and Weretka, 2020). First and crucially, we endow workers with *consistent beliefs* about workers' morale υ. Intuitively, this means that, for any labor profile $(\ell_i)_{i \in I}$, morale υ is correctly forecasted by workers. Hence, an equilibrium in the worker game is effectively a Nash equilibrium given consistent beliefs. Next, we observe that all employed workers make the same decisions at the margin; thus, in equilibrium, all hired workers end up with the same realized utility level and choose the same labor intensity, say, ℓ. So workers' morale υ coincides with a worker's own realized utility, and ℓ represents the *average individual labor supply*. Consequently, an equilibrium in the worker game can be summarized by an *outcome* (υ, ℓ). Finally, since workers in a continuum have a negligible impact on aggregate variables, we further restrict workers' beliefs so that each operates under the premise that her behavior alone does not alter the realized utility of others.

Definition 1. Given workers I and a wage rate w, an outcome (υ, ℓ) is *implementable* iff:

i) *Optimality:* Labor supply is ℓ solves $\max_{\ell' \geq 0} U_i(w\ell', \ell', \upsilon)$;

ii) *Consistent Beliefs:* Morale υ obeys $U_i(w\ell, \ell, \upsilon) = \upsilon$; and

iii) *Individual rationality:* $\upsilon \geq r_i$ for all employed workers $i \in I$.

Definition 1 states that an outcome (υ, ℓ) is implementable by the firm, if (υ, ℓ) is an equilibrium outcome of the worker game (conditions *i*) and *ii*)) and, in addition, all employed workers get at least their reservation utility (condition *iii*)). Appendix B provides a game-theoretic foundation for the use of Definition 1 to analyze the worker game.

We solve the model using backward induction. There, the firm correctly anticipates the equilibrium responses of employed workers. If the firm's choices induce multiple implementable outcomes, the firm operates assuming its best-case scenario as in the traditional mechanism design literature. Namely, we examine *firm-preferred equilibrium.*

Remark 1 (On Selection Rules). In the traditional mechanism design literature, the designer chooses the game and the equilibrium, and so optimizes assuming that the *best* equilibrium outcome will hold. By contrast, in the recent literature on robust mechanism design, the designer chooses the game but not the equilibrium. The designer may want to elect a game that performs well for all equilibrium outcomes. This concern leads to an adversarial rule, in which the designer conjectures that the *worst* outcome will be realized; see Bergemann and Morris (2019) for a survey. While our leading case considers the former criterion, this is purely expositional. In §5 we verify our results for *general* selection rules; in particular, the "worst-case scenario" selection rule.

Remark 2 (Utility Function). It is well-known that, in the basic static labor supply model, an increase in wages has ambiguous effects on labor supply decisions, unless strong assumptions are made (see, e.g., Keane, 2011). In particular, if the substitution effect is stronger than the income effect, an increase in wages reduces a worker's labor supply. Because our goal is to examine the effects of co-worker altruism on labor choices and, ultimately, on wages an unemployment, this led us to consider a utility function in which these income and substitution effects cancel one another. Indeed, section §3.2 shows that, given utility function (1), workers' labor supply choices are positively affected by wages only via its effect on the average welfare of others. In general, as long as assumption are placed on the utility function so that a worker's labor supply is increasing in wage w for a fixed morale level υ, our qualitative results should hold.

3 Equilibrium Analysis

3.1 Standard Preferences

As a benchmark, we first consider the non-altruistic case, or $\gamma \equiv 0$. This is the standard labor supply model with Cobb-Douglas preferences. First, suppose that the firm chooses wage w and hires a set of workers I. By Definition 1-i), the individual labor supply ℓ maximizes workers' utility. The first-order condition yields an *inelastic* average labor supply $\ell = T\alpha/(\alpha+\beta)$. Next, by Definition 1-ii), workers' morale obeys $\upsilon = U_i(w\ell, \ell, \upsilon) \equiv V(w)$. That is, workers' morale is determined by the workers' indirect utility function,

$$V(w) = \alpha \ln\left(w\frac{T\alpha}{\alpha+\beta}\right) + \beta \ln\left(\frac{T\beta}{\alpha+\beta}\right).$$

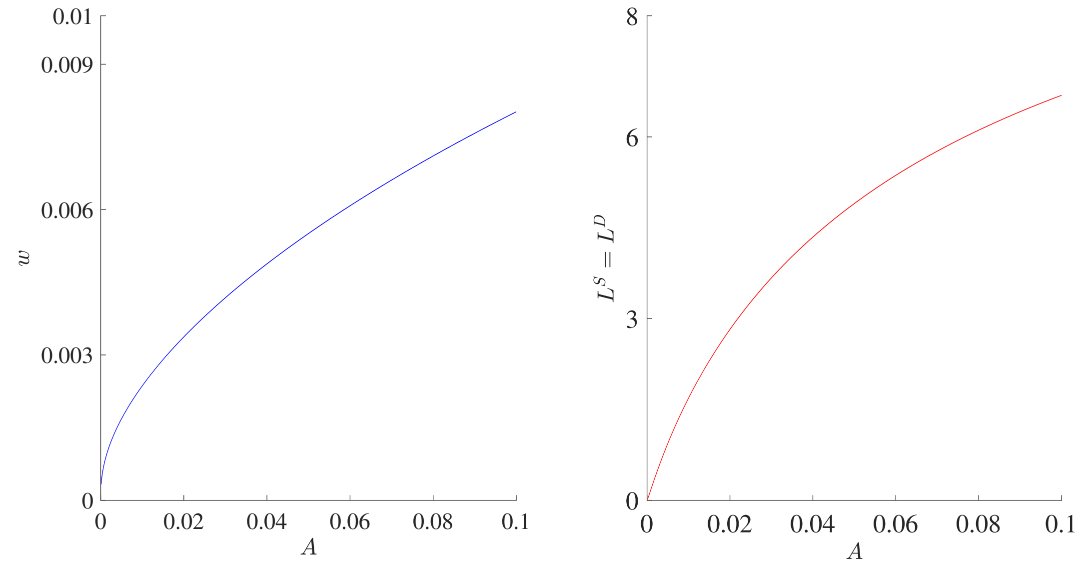

Figure 2: **Benchmark Case with Standard Preferences.** When workers are neutral toward each other, the equilibrium wage rate $w^*(A)$ and labor $L^S(w^*(A))$ are both increasing in the productivity level A. There is neither wage rigidity nor involuntary unemployment.

The available labor force $\mu^S = F(V(w))$ is strictly increasing in w, since $V'(w) > 0$.

Turning to the firm's problem, notice that the firm finds it optimal to hire every available worker, and so $\mu^D = \mu^S$. Otherwise, the firm could raise its profits with a pay cut and then offset its effect by hiring more workers, so that output remains unchanged. Now, the equilibrium wage w^* solves a standard monopsony problem with an upward-sloping and continuous *labor supply function* $L^S(w) \equiv T\alpha/(\alpha+\beta)F(V(w))$. Thus, for any productivity A, wage w^* maximizes monopsony profits $Ay(L^S(w)) - wL^S(w)$. By standard results, the optimal wage rate w^* is strictly increasing in productivity A, as an increase in A raises the marginal productivity of labor. Likewise, both labor supply $L^S(w^*(A))$ and employment rate $\mu^D = \mu^S$ are strictly increasing in productivity A, as seen in Figure 2.

All told, *there is no wage rigidity or involuntary unemployment when workers' are unaffected by the welfare of others.* Wages covary with productivity, and workers are respectively hired or voluntarily quit when their utility outweighs or falls behind their reservation utility.

This simple benchmark shares many predictions with real business cycle models (e.g., Lucas and Rapping, 1969) as well as labor-search models (Diamond, 1981; Pissarides, 1985). These models, with their focus on the supply side, have difficulties reproducing some of the empirical patterns observed over the business cycle. For instance, these theories predict that low productivity must be accompanied by a significant drop in the real wage rate; yet, in practice, salaries vary very little during business cycles.[9] Job departures are also not accounted

[9] Although search models are capable of explaining, respectively, more and less volatility in employment and wages than the real business cycle framework can do, they can account for only a small fraction of the

for by these theories. Reductions in salaries should trigger a surge in workers voluntary quitting less attractive jobs. However, quitting for unemployment sharply falls, as does the chance of finding another job, during a recession (Bewley, 1999, p. 398). Finally, supply-side theories assume that agents choose unemployment to take advantage of their more attractive alternatives. Yet, the broad psychological literature shows that job loss is often a traumatic experience (Argyle, 2013; Clark et al., 2001), and it is one of the main events that have a long-lasting adverse impact on life satisfaction (Lucas et al., 2004; Kahneman and Krueger, 2006).[10] These arguments highlight the involuntary nature of unemployment.

3.2 The Effects of Co-Worker Altruism

We now consider the case in which workers' preferences are interdependent. As in §3.1, given average morale υ and wage w, the average individual labor ℓ maximizes utility U_i in (1). The first-order condition yields the *optimal individual labor supply function*:

$$\ell(\upsilon) = T\left(\frac{\alpha + \gamma(\upsilon)}{\alpha + \beta + \gamma(\upsilon)}\right). \tag{2}$$

The optimal labor supply $\ell(\cdot)$ is strictly increasing and bounded, since $\ell(\upsilon)$ is bounded by Assumption 1. The workers' indirect utility function $V(w, \upsilon) \equiv \max_{\ell'} U_i(w\ell', \ell', \upsilon)$ now depends also on the conjectured morale level υ. Moreover,

Lemma 1. *For any wage $w > 0$, the indirect utility function $V(w, \cdot)$ is differentiable, strictly increasing, additively separable in (w, υ), and uniformly bounded.*

Next, by Definition 1-ii), in equilibrium workers' morale υ must be consistent — namely, it must solve $\upsilon = V(w, \upsilon)$. The next lemma characterizes the fixed-point correspondence $\Upsilon(w) \equiv \{\upsilon \in \mathbb{R} : V(w, \upsilon) = \upsilon\}$, which determines workers' consistent morale levels, given w.

Lemma 2.

(a) For any wage $w > 0$, $\Upsilon(w)$ is non-empty and contains a smallest and a largest element, both are strictly increasing in w.

(b) There exist wages $w_2 > w_1 > 0$ such that for all $w \in (0, w_1) \cup (w_2, \infty)$, the fixed-point correspondence $\Upsilon(w)$ is single-valued.

(c) There exists a non-empty interval $[w_3, w_4]$ wherein $\Upsilon(w)$ contains multiple fixed-points.

unemployment volatility observed in the data; see Shimer (2005).

[10]These findings are in line with the observations of the advisers to the unemployed during a recession, as "their clients are desperate for work and miserable being jobless" (Bewley, 1999, p. 400).

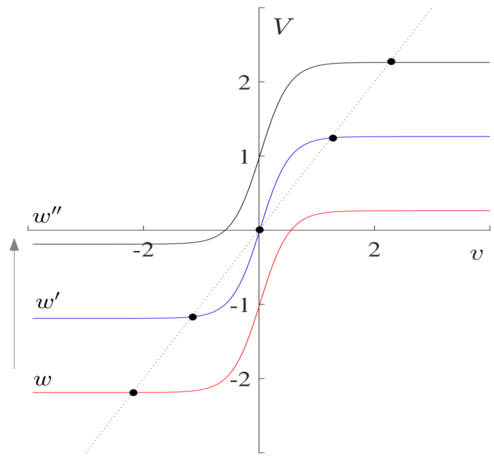

Figure 3: **Indirect Utility Function and Belief Consistency.** The figure fixes the wage at three different levels, $w < w' < w''$, and depicts the indirect utility function V with altruistic worker-preferences. For a fixed wage, the function V is strictly increasing in v and bounded. Also, an increase in wage shifts the indirect utility function V up without affecting its slope (parallel shift). In equilibrium, workers' morale v is a fixed point of V by consistency of workers' beliefs. For wage w and w'', there is a unique consistent morale level. However, for mid wage w', the function V has multiple fixed points.

Figure 3 illustrates these findings, using Example 1. The indirect utility function parallely shifts up when wage w rises; thus, for either low enough or high enough wages, consistency of beliefs uniquely pins down the workers' morale. However, when wages are in a mid range, there are naturally multiple consistent morale levels.

We now turn to characterize the supply of labor at the individual and aggregate levels. First, contrary to §3.1, when workers care about the welfare of their colleagues, wages affect labor supply through a novel channel: the individual labor supply (2) depends on workers' morale, which in turn depends on the wage rate via the indirect utility function $V(w, \cdot)$. In particular, workers work harder (or supply more labor), provided that their workplace enjoyment is positive ($\gamma(v) \geq 0$ for consistent morale v). Also, they now respond to wages because of a multiplier effect caused by workers' morale, not the monetary incentives directly.

The aggregate labor supply reflects both the intensive and extensive margin, and is given by $\ell(v)F(v)$ for consistent morale v (i.e., for $v \in \Upsilon(w)$). Notice that, for either low enough or high enough wages, the individual and aggregate labor supplies both slope up in the (w, ℓ)-space, because workers' (consistent) morale level is unique and increasing in wage w (Lemma 2). Nonetheless, for mid wages, the labor characterization is more subtle because of the emergence of multiple consistent morale levels. Technically, the individual and aggregate labor supplies take multiple values for intermediate wages; the supply of labor is a *correspondence* at the individual and aggregate level, as depicted in Figure 4. However,

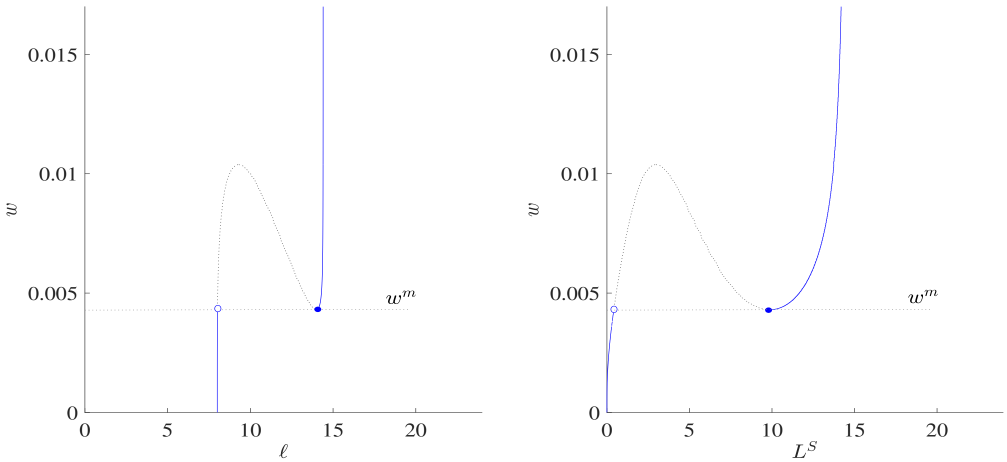

Figure 4: **The Individual and Aggregate Labor Supply.** The left and right panel depict the individual and aggregate labor supply, respectively. When workers care about their co-workers' welfare, the individual ℓ and aggregate labor supplies L^S are increasing and right-continuous functions. In both panels, when wage w equals w^m, the labor supply functions jump right as wage w^m induces multiple consistent morale levels.

when the focus is on firm-preferred equilibrium (i.e., the firm optimizes assuming its best-case scenario), the relevant labor supply is an increasing and right-continuous function (see Appendix A.5 for a proof). Moreover, as seen in Figure 4, when wage rate w falls slightly below a wage threshold, the individual labor supply and available labor force drastically fall, because workers' morale υ discontinuously falls as well. Thus, a small downward wage adjustment may have sizable effects on the labor market. In general, it enough to focus on the lowest wage that yields multiple consistent morale levels, which we henceforth refer it as *morale wage* w^m.[11]

4 The Firm's Responses to Productivity Shocks

Consider the firm's problem. It is apparent that the firm's problem can be reduced to:

$$\max_{\substack{w\in[0,\infty) \\ L\in[0,L^S(w)]}} \; Ay(L) - wL,$$

where the labor supply function $L^S(w)$ is reflected by the right panel of Figure 4. We now examine the implications for labor market outcomes. We show that wage rigidity and involuntary unemployment emerge for mid levels of productivity under mild assumptions.

[11]Appendix A.3 shows that $w^m \in (0,\infty)$ and that $\Upsilon(w^m)$ contains multiple fixed-points.

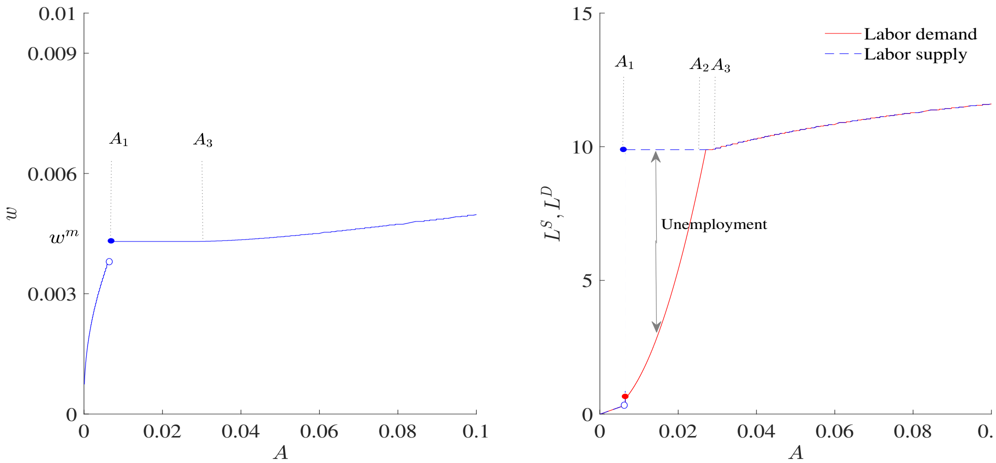

Figure 5: **Implications on Wages and Unemployment.** LEFT: In an economic expansion, $A > A_3$, wages vary continuously and there is neither wage rigidity nor involuntary unemployment. However, in mild and severe recessions, $A \in (A_1, A_3]$, the firm keeps the wage fixed at w^m, giving rise to wage rigidity. RIGHT: In expansions and mild recessions, the firm hires all available workers and there is no involuntary unemployment. However, in severe recessions $A \in (A_1, A_2)$, the firm fires workers giving rise to involuntary unemployment.

Theorem 1 (Wage Rigidity and Unemployment). *There are reservation utilities $\bar{r} > \underline{r} > 0$ and a critical level $\bar{\epsilon} \in (0,1)$, such that for any distribution $F(\cdot)$ for which the mass of potential workers with reservation utility in $[\underline{r}, \bar{r}]$ is above $\bar{\epsilon}$, namely, $F(\bar{r}) - F(\underline{r}) \geq \bar{\epsilon}$, wage rigidity and involuntary unemployment emerge in equilibrium for mid productivity levels A.*

The intuition behind Theorem 1 is best understood by examining Figure 5 (the formal proof is delegated to Appendix A.4). Figure 5 depicts productivity thresholds $A_3 > A_2 > A_1$ such that, in equilibrium: (1) wages are rigid and there is involuntary unemployment when $A \in (A_1, A_2)$ and; (2) wages are rigid and there is no involuntary unemployment when $A \in [A_2, A_3]$. To see this, let us first classify productivity shocks according to their intensity level and then explain how these ones shape the equilibrium wage and unemployment level.

Expansions. When the firm's productivity is high, or $A > A_3$, the firm finds it optimal to hire all available workers based on the same logic given in §3.1. Thus, the firm behaves as a monopsony facing an upward-sloping and continuous labor supply function $L^S(w)$. By our previous analysis in §3.1, both the wage and employment rates are strictly increasing in productivity A. Hence, the wage smoothly falls to morale wage w^m as productivity falls to A_3. Likewise, the firm gradually adjusts employment downward as the economy decelerates.

Mild Recessions. When the economy starts to slow down or when the firm's productivity $A \in [A_2, A_3]$, it is never optimal to choose wage $w > w^m$, as $w = w^m$ is optimal for productivity $A = A_3$. Thus, the firm restricts wages to $w \leq w^m$. However, wages $w < w^m$ trigger a low morale outcome, leading to a sizable drop in labor supply. Thus, a profit-maximizing firm chooses to *insulate* its employees from these adverse productivity shocks, meaning that for all productivity $A \in [A_2, A_3]$, the optimal wage equals w^m and employment satisfies $\mu^D = \mu^S$. Thus, there is wage rigidity but no involuntary unemployment.

Severe Recessions. In an economic recession, or when productivity $A \in (A_1, A_2)$, the firm still faces the event of having workers with low morale should it decide to lower their wages. As productivity A falls from A_2 to A_1, the firm no longer finds it optimal to keep the firm's employment level full. In particular, the firm chooses to fire some of its employees (see Figure 5, right panel). Thus, the employment level is strictly less than the available labor force, $\mu^D < \mu^S$, and *involuntary unemployment emerges.* As seen in Figure 5, *there is also wage rigidity* as the firm keeps the wage at w^m to prevent from hurting the workers' morale.

Contrary to the implicit insurance literature (Baily, 1974; Azariadis, 1975), the firm here is not motivated by the potential long-term benefits of providing income insurance to its workers. Instead, what happens during severe recessions is that the firm's market power vanishes due to "morale concerns." As seen in Figure 5, the firm behaves as a competitive firm that takes the wage w^m as given and chooses labor to maximize profits. In mild recessions, the firm hires all available workers (binding case), whereas in severe recessions it hires strictly fewer workers than those available (non-binding case). This economic mechanism also yields different implications compared to efficiency wage models (Shapiro and Stiglitz, 1984), because in those models involuntary unemployment emerge for all productivity levels.

Depressions. For productivity $A \leq A_1$, it becomes too costly for the firm to keep workers' morale high by fixing the wage at w^m. As productivity falls from A_1, the firm chooses to discontinuously lower wages. The employment and labor supply drop significantly.

5 Robustness

A. Stability. So far we have considered a firm that chooses wages and demands labor, assuming *all* equilibria (in the worker game) are equally plausible. However, some equilibrium outcomes may be more plausible than others. After a small perturbation, would a natural tatonnement process lead the firm to consider another equilibrium?

The social psychology literature allows us to motivate a natural tatonnement process for beliefs. According to this literature, emotional contagion is a process that is "...relatively *automatic, unintentional, uncontrollable*, and largely inaccessible to conversant awareness..."

(Hatfield et al., 2014). This process induces individuals to quickly synchronize their own emotions with those of others, and thus *converge* emotionally (Iacoboni, 2009; Hatfield et al., 1993; Singer et al., 2004). So motivated, we posit that workers initially start with some beliefs about a morale level, and then they adjust their beliefs accordingly after observing the workers' morale at the workplace.

Precisely, we consider the following tatonnement process:

$$\dot{\upsilon}_t = \eta(V(w, \upsilon_t) - \upsilon_t), \tag{3}$$

where $\eta \in (0, 1)$ determines the speed of adjustment. Given wage w, consistent morale υ^* is *stable* if it is asymptotically stable for the adjustment process (3), in other words, every dynamic converges to the equilibrium υ^*. By standard arguments, for almost all wage rates w, the largest and smallest consistent morale levels are stable. Also, even if for some wages w the largest consistent morale level is unstable, it can be arbitrarily approximated to a stable one; Appendix A.5 provides a formal proof. Thus, the firm's optimal behavior is unaffected by this stability criterion. Hence, our implications regarding wage rigidity and unemployment remain unchanged, even if the focus is on stable equilibria.

B. Equilibrium Selection Rules. Another premise of our framework is that the firm optimizes with respect to its *best* implementable outcome. Next, we show that our results do not depend on this specific equilibrium selection, but rather on the fact that the *labor supply function is discontinuous for any selection rule*.

To gain some intuition, consider the polar case in which the firm optimizes assuming the "worst-case" scenario. This case resembles a cautious or *pessimistic* firm that assumes that the lowest labor supply will prevail. Figure 6 depicts the aggregate labor supply faced by a pessimistic firm. For the range of wages with multiple implementable outcomes, the one with the lowest aggregate labor supply is relevant. Compared to our leading case, the aggregate labor supply $L^S(w)$ is discontinuous at a higher morale wage w^m. Intuitively, a cautious firm is more reluctant to cut wages to prevent a low morale outcome, giving rise to rigidities at higher wage levels. Thus, wage rigidity and involuntary unemployment also emerge for mid productivity levels — as seen in Figure 6. Thus, our qualitative results extend to this case.

In general, our results extend to any piecewise continuous *selection rule*. Appendix A.6 shows that $L^S(w)$ is necessarily discontinuous and, therefore, our qualitative predictions hold for arbitrary selection rules.

C. Sympathy for the unemployed. We can extend our model to include settings in which workers' morale is harmed by both wage decreases and layoffs. This would require an

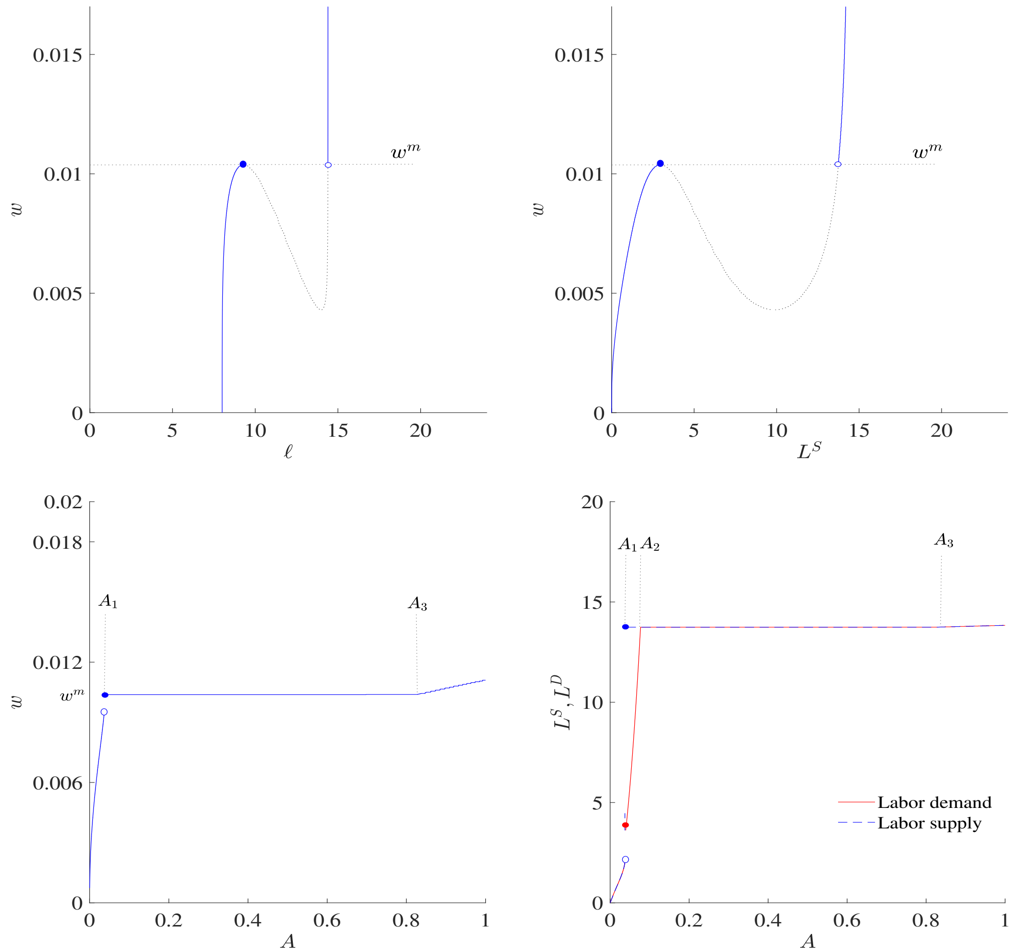

Figure 6: **Implications on Wages and Unemployment with Pessimistic Firm Beliefs.** TOP: The labor supply functions are increasing and left-continuous, and they jump right when wage w equals the morale wage w^m, which is now the highest wage that yields multiple equilibria. BOTTOM: Wage rigidity and involuntary unemployment emerge for mid levels of productivity.

alternative determination of morale υ in Definition 1-ii), so that workers' morale reflects the reservation utility of non-hired workers I^c:

$$\upsilon = U_i(w\ell, \ell, \upsilon) + \zeta \int_{I^c} r_i d\mu / \mu(I^c),$$

where the relative weight $\zeta \in [0, 1]$. In this case, workers' morale is the average utility at the workplace plus the average reservation utility of non-hired workers. Thus, layoffs have a direct impact on workers' morale. By standard continuity arguments, wage rigidity and involuntary unemployment would still emerge for mid productivity levels, provided that workers are affected more by their co-workers' welfare (i.e., they hold for low enough ζ).

D. Concave Enjoyment Function. Finally, Assumption 1 states that $\gamma(\cdot)$ has vanishing marginal effects for for both large and low values of υ. In Appendix C, we simulate the model to capture a situation in which workers' marginal altruistic concerns are monotone decreasing: $\gamma'' < 0 \leq \gamma'$. This, e.g., would resemble a setting in which, at the margin, workers greatly care about others' welfare when this one is low but not much when it is high. The numerical results confirm the existence of wage rigidity and involuntary unemployment for mid productivity levels. Whether in reality γ is "concave" or "S-shaped" is, thus, an empirical question. Altogether, this reflects that, as long as the contagion effects in the worker game lead to multiple consistent morale levels, the labor supply functions at the individual and aggregate level will have natural discontinuities that may prevent smooth adjustments in the labor market.

6 Concluding Remarks

In this paper, we show that, when workers are affected by the welfare of others, the firm's responses to adverse productivity shocks involve rigid wages and involuntary transitions to unemployment. This novel finding is robust to different model variations, and in line with the empirical patterns and transmission mechanisms explained by practitioners (Bewley, 1999). It highlights that, while social relationships may be harmless in good times, they may distort the functioning of labor markets in bad times. Thus, promoting co-worker altruism may have unintended effects on the overall economy, especially during times of economic hardship.

A Omitted Proofs

A.1 The Indirect Utility Function V: Proof of Lemma 1

First, consider the workers' optimization problem. As argued in §3.2, for any $\upsilon \in \mathbb{R}$, the optimal individual labor supply solves the first-order condition (2). The optimal individual labor supply $\ell(\cdot)$ is strictly increasing $\ell' > 0$, as $\gamma' > 0$. Also, by Assumption 1-a), ℓ is uniformly bounded from below, $\ell(\cdot) > T\left(\frac{\alpha+\underline{\gamma}}{\alpha+\beta+\underline{\gamma}}\right) > 1$, and from above, $\ell(\cdot) < T\left(\frac{\alpha+\bar{\gamma}}{\alpha+\beta+\bar{\gamma}}\right)$. Thus, the value function $V(w,\upsilon) = U_i(w\ell(\upsilon), \ell(\upsilon), \upsilon)$ is differentiable in υ and, by the Envelope Theorem, its derivative $\partial V(w,\upsilon)/\partial\upsilon$ obeys:

$$\frac{\partial V(w,\upsilon)}{\partial \upsilon} = \frac{\partial U_i(w\ell,\ell,\upsilon)}{\partial \upsilon} = \gamma'(\upsilon)\ln(\ell(\upsilon)). \tag{4}$$

Hence, $V(w,\cdot)$ is strictly increasing, as $\gamma' > 0$ and $\ln(\ell(\upsilon)) > 0$.

Next, we show that $V(w,\cdot)$ is additively separable. Plugging (2) into the utility function (1), we see that there exists functions $V_1(w)$ and $V_2(\gamma(\upsilon))$ such that,

$$V(w,\upsilon) = V_1(w) + V_2(\gamma(\upsilon)).$$

In particular, $V_1(w) \equiv \alpha \ln(w)$ which is strictly increasing, continuous, and its inverse is well-defined. On the other hand, $V_2(\gamma(\upsilon))$ is given by:

$$V_2(\gamma(\upsilon)) \equiv (\alpha+\beta+\gamma(\upsilon))\ln T + (\alpha+\gamma(\upsilon))\ln(\alpha+\gamma(\upsilon)) - (\alpha+\beta+\gamma(\upsilon))\ln(\alpha+\beta+\gamma(\upsilon)),$$

which is strictly increasing, continuous, and uniformly bounded from below and above by $\underline{V} \equiv V_2(\underline{\gamma})$ and $\overline{V} \equiv V_2(\bar{\gamma})$, respectively. Thus, the value function $V(w,\upsilon)$ is also uniformly bounded from below and above by $V_1(w) + \underline{V}$ and $V_1(w) + \overline{V}$, respectively. $\square$

A.2 The Fixed-Point Correspondence: Proof of Lemma 2

Proof (*a*)**.** We want to show that, for any wage $w > 0$, $\Upsilon(w)$ is non-empty and contains a smallest and a largest element, namely, $\underline{\upsilon}(w)$ and $\bar{\upsilon}(w)$, respectively. Moreover, both elements $\underline{\upsilon}(w), \bar{\upsilon}(w) \in \Upsilon(w)$ are strictly increasing in w. We prove this in two steps.

Step 1: Existence. Fix $w > 0$ and restrict the domain of $V(w,\cdot)$ to the interval $[V_1(w) + \underline{V}, V_1(w) + \overline{V}]$. Clearly, the restricted value function is monotone and maps into itself, by Lemma 1. Thus, by Tarski's Fixed Point Theorem, the restricted function has a fixed point and so does the unrestricted value function, namely, $\Upsilon(w) \neq \emptyset$. Also, since $[V_1(w) + \underline{V}, V_1(w) + \overline{V}]$ is a complete lattice, $\Upsilon(w)$ is also complete lattice, by Tarski's Theorem, and so both the greatest lower bound and least upper bound belong to $\Upsilon(w)$.

Step 2: Monotonicity. By Step 1, $\underline{\upsilon}(w) = \inf\{\upsilon : V(w,\upsilon) \leq \upsilon\}$. Now consider $w' < w$. Because $V(w,\upsilon)$ is strictly increasing in w, we have $V(w', \underline{\upsilon}(w)) < \underline{\upsilon}(w)$. In other words, $\underline{\upsilon}(w) \in \{\upsilon : V(w',\upsilon) \leq \upsilon\}$, and thus $\underline{\upsilon}(w') < \underline{\upsilon}(w)$. It follows that $\underline{\upsilon}(\cdot)$ is strictly increasing. The proof for the monotonicity of the largest element $\bar{\upsilon}(w)$ is analogous. $\square$

Proof (*b*)**.** First, because $\lim_{\upsilon \to -\infty} \gamma'(\upsilon) = 0$, there exist υ_1 such that,

$$\frac{\partial V(w,\upsilon)}{\partial \upsilon} = \gamma'(\upsilon)\ln(\ell(\upsilon)) < 1.$$

for all $\upsilon \in (-\infty, \upsilon_1)$. Next, define $w_1 > 0$ so that $V_1(w_1) \equiv \upsilon_1 - \overline{V}$. Thus, $V_1(w_1) + \overline{V} = \upsilon_1$, and so for all wages $w \in (0, w_1)$, we have $V_1(w) + \overline{V} < \upsilon_1$, since $V_1(w)$ is strictly increasing.

This implies that for all $w \in (0, w_1)$, the fixed-point correspondence

$$\Upsilon(w) \subset [V_1(w) + \underline{V}, V_1(w) + \overline{V}] \subset (-\infty, \upsilon_1).$$

Therefore, for all $w \in (0, w_1)$, the function $V(w, \upsilon) - \upsilon$ is strictly decreasing for all $\upsilon \in [V_1(w) + \underline{V}, V_1(w) + \overline{V}]$, and thus it vanishes only once. In other words, $\Upsilon(w)$ must have a unique fixed-point. The argument for the upper interval (w_2, ∞) is analogous. $\square$

Proof (c)**.** First, by Assumption 1-b), there exists $\upsilon^\dagger$ so that $\gamma'(\upsilon^\dagger) \ln(\ell(\upsilon^\dagger)) > 1$. This implies that at $\upsilon = \upsilon^\dagger$ the slope of value function is strictly greater than one,

$$\frac{\partial V(w, \upsilon^\dagger)}{\partial \upsilon} = \gamma'(\upsilon^\dagger) \ln(\ell(\upsilon^\dagger)) > 1.$$

Thus, by continuity, there exists $\varepsilon > 0$ such that $\gamma'(\upsilon) \ln(\ell(\upsilon)) > 1$ for all $\upsilon \in [\upsilon^\dagger - \varepsilon, \upsilon^\dagger + \varepsilon]$. Next, for each υ, define $W(\upsilon)$ as the wage that makes υ a fixed-point, or $V_1(W(\upsilon)) \equiv \upsilon - V_2(\gamma(\upsilon))$. Now, let $w_3 \equiv W(\upsilon^\dagger - \varepsilon)$ and $w_4 \equiv W(\upsilon^\dagger + \varepsilon)$. By construction, any $\upsilon \in [\upsilon^\dagger - \varepsilon, \upsilon^\dagger + \varepsilon]$ solves $V(W(\upsilon), \upsilon) = \upsilon$ and $\partial V(W(\upsilon), \upsilon)/\partial \upsilon > 1$. Hence, $V(W(\upsilon), \upsilon + \Delta) > \upsilon + \Delta$ for small enough $\Delta > 0$. But since $V(W(\upsilon), \cdot)$ is uniformly bounded, by Lemma 1, we have that $V(W(\upsilon), \upsilon_h) < \upsilon_h$ for high enough υ_h. Thus, by continuity of $V(W(\upsilon), \cdot)$, there exists $\bar{\upsilon} \in (\upsilon + \Delta, \upsilon_h)$ with $V(W(\upsilon), \bar{\upsilon}) = \bar{\upsilon}$. Altogether, $\underline{\upsilon}(w) < \bar{\upsilon}(w)$ for all $w \in [w_3, w_4]$.$\square$

A.3 The Morale Wage w^m

Let the *morale wage* be the lowest wage that yields multiple consistent morale levels, namely, $w^m \equiv \inf\{w > 0 : \underline{\upsilon}(w) < \bar{\upsilon}(w)\}$. The next lemma proves that morale wage is well-defined.

Lemma A.3.1. *The morale wage $w^m \in (0, \infty)$ and entails $\underline{\upsilon}(w^m) < \bar{\upsilon}(w^m)$.*

Proof: First, by Lemma 2-(b), $w^m > 0$. Also, by Lemma 2-(c), the set $\{w > 0 : \underline{\upsilon}(w) < \bar{\upsilon}(w)\} \neq \emptyset$ and so $w^m < \infty$. Next, we show that $\underline{\upsilon}(w^m) < \bar{\upsilon}(w^m)$.

By contradiction, assume that $\Upsilon(w^m) = \{\upsilon^m\}$ and define $g(w, \upsilon) \equiv V(w, \upsilon) - \upsilon$. Then $g(w^m, \upsilon) \neq 0$ for all $\upsilon \neq \upsilon^m$. Also, since $\lim_{\upsilon \to -\infty} g(w^m, \upsilon) = \infty$ and $\lim_{\upsilon \to \infty} g(w^m, \upsilon) = -\infty$, the function $g(w^m, \upsilon)$ must be strictly decreasing to ensure a single-crossing, and so

$$\frac{\partial g(w^m, \upsilon^m)}{\partial \upsilon} < 0.$$

But then, by the Implicit Function Theorem, there exist open neighborhoods $\mathcal{V}$ and $\mathcal{W}$ about υ^m and w^m, respectively, and a bijective function $\phi : \mathcal{W} \to \mathcal{V}$ such that $g(w, \phi(w)) = 0$.

Next, consider a minimizing sequence of $\{w_n\}_n \to w^m$ such that $\{w_n\}_n \subset \mathcal{W}$ and $w_n > w^m$, with $\underline{v}(w_n) < \bar{v}(w_n)$ for all n. As previously argued, for any $w_n \in \mathcal{W}$ there is a unique fixed-point $\phi(w_n) \in \mathcal{V}$; therefore, there must exist another one, say, $\hat{\phi}(w_n)$ in the complement $\mathcal{V}^c$. Because $\Upsilon(w_n)$ is bounded and $\mathcal{V}^c$ is closed, we can extract a subsequence $\{w_{n_k}, \hat{\phi}(w_{n_k})\}_k \to \{w^m, \hat{\phi}^m\}$ with $\hat{\phi}^m \in \mathcal{V}^c$. Finally, since $g(w, v)$ is jointly continuous, $g(w^m, \hat{\phi}^m) = 0$, which contradicts that $\Upsilon(w^m)$ is single-valued. $\square$

A.4 Wage Rigidity and Unemployment: Proof of Theorem 1

In a firm-preferred equilibrium, the aggregate labor supply can be written as:

$$L^S(w) = \begin{cases} \ell(\underline{v}(w))F(\underline{v}(w)), & \text{if } 0 \leq w < w^m \\ \ell(\bar{v}(w))F(\bar{v}(w)), & \text{if } w \geq w^m \end{cases} \tag{5}$$

Since $\ell(\cdot)$ and $F(\cdot)$ are strictly increasing, $L^S(w)$ exhibits a discontinuous right jump at wage $w = w^m$. Call $\underline{r} \equiv \underline{v}(w^m)$ and $\bar{r} \equiv \bar{v}(w^m)$ the minimal and maximal realized utility that can arise when the wage is w^m (Lemma A.3.1). Also, let $\epsilon > 0$ so that $F(\underline{r}) \leq \epsilon$ and $F(\bar{r}) \geq 1-\epsilon$. Finally, define $\bar{A} \equiv w^m/y'(\ell(\bar{r}))$.

Proof of Theorem 1. As a first step, we'll show that there exists a productivity range wherein profits are uniformly bounded from above for all wages $w < w^m$. First, since $y(L)$ is strictly concave with $y(0) = 0$, we have that profits $\bar{A}y(\ell(\bar{r})) - \ell(\bar{r})w^m > 0$. Next, since profits are continuous in productivity A, there exists a productivity level $\underline{A} \in (0, \bar{A})$ such that $\underline{A}y(\ell(\bar{r})) - \ell(\bar{r})w^m > 0$. Also, for any wage w below w^m, monotonicity of $\underline{v}(\cdot)$ (Lemma 2-*a*)) implies that $\underline{v}(w) \leq \underline{v}(w^m) = \underline{r}$. Thus, the labor supply is bounded: $L^S(w) \leq \ell(\underline{r})\epsilon$. This implies that, for any wage $w \in (0, w^m)$ and productivity $A \in [\underline{A}, \bar{A}]$ the firm's profit is uniformly bounded from above by $\bar{\pi}(\epsilon) \equiv \bar{A}y(\ell(\underline{r})\epsilon)$.

Next, we show that for any productivity $A \in [\underline{A}, \bar{A}]$, fixing the wage at $w = w^m$ is strictly better than choosing any other wage $w < w^m$. To see this, consider a firm that sets wage $w = w^m$, and optimally chooses the amount of labor $L^D \leq L^S(w^m)$. Observe that for all productivity $A \in [\underline{A}, \bar{A}]$, the maximal profit — namely, $\max_{L^D \leq L^S(w^m)} Ay(L^D) - w^m L^D$ — is uniformly bounded from below by $\underline{\pi}(\epsilon) \equiv \underline{A}y(\ell(\bar{r})(1-\epsilon)) - \ell(\bar{r})(1-\epsilon)w^m$. Also, these bounds $\bar{\pi}(\epsilon)$ and $\underline{\pi}(\epsilon)$ are continuous and obey $\lim_{\epsilon \to 0} \bar{\pi}(\epsilon) = 0$ and $\lim_{\epsilon \to 0} \bar{\pi}(\epsilon) = \underline{A}y(\ell(\bar{r})) - \ell(\bar{r})w^m > 0$. Consequently, there exists $\epsilon^1 > 0$ such that for all $\epsilon \leq \epsilon^1$, we have $\bar{\pi}(\epsilon^1) < \underline{\pi}(\epsilon^1)$. Altogether, for all productivity $A \in [\underline{A}, \bar{A}]$, keeping the wage fixed at $w = w^m$ strictly dominates any choice involving $w < w^m$.

Finally, we conclude by showing that for a range of productivity levels A, fixing $w = w^m$

along with involuntary unemployment are globally optimal for the firm. Let $\epsilon^2 \in (0, \epsilon^1)$ for which $\bar{\bar{A}} \equiv w^m / y'(\ell(\bar{r})(1-\epsilon^2)) \in (\underline{A}, \bar{A})$. (Notice that this value is well defined.) Next, for any distribution $F(\cdot)$ that satisfies $F(\bar{r}) \geq 1-\epsilon^2$, labor supply $L^S(w^m) = \ell(\bar{r})F(\bar{r}) \geq \ell(\bar{r})(1-\epsilon^2)$. The profit maximizing labor demand of a *wage taking* firm facing wage w^m is implicitly determined by the FOC: $Ay'(L^D) = w^m$. So by construction, for all productivity $A \in (\underline{A}, \bar{\bar{A}})$, this choice satisfies $L^D < L^S(w^m)$, and hence it involves involuntary unemployment. Finally, the choice of a wage-taking firm gives strictly higher profit than any other choice $L > L^D$ given w^m. Because such pair (L^D, w^m) is available to the firm, these choices dominate any other alternative involving $L > L^D$ and $w \geq w^m$. Altogether, (L^D, w^m) is globally optimal. To conclude argument define $\bar{\epsilon} = 1 - \epsilon^2$. $\square$

A.5 Stability of Implementable Outcomes

We'll show that the solution to the firm's problem is robust.

Step 1: $\partial g(\bar{v}, w)/\partial v \leq 0$ for $\bar{v} \in \Upsilon(w)$. Indeed, consider the largest morale level $\bar{v}(w)$. By Lemma 2-(c), we must have $\partial g(\bar{v}, w)/\partial v \leq 0$; otherwise, $\bar{v}(w)$ would not be the largest fixed-point, which is a contradiction.

Step 2: for almost all $w > 0$, we have $\partial g(\bar{v}, w)/\partial v < 0$. To see this, recall that for any $w > 0$ the function $g(v, w) \equiv V(w, v) - v$ is separable in (v, w), since $V(w, v)$ is separable by Lemma 1, and also strictly increasing in w as $\partial g(v, w)/\partial w = \partial V(w, v)/\partial w = \alpha/w > 0$. Thus, g is transverse to zero, or $g(\cdot, \cdot) \pitchfork 0$. Consequently, by the Transversality Theorem, $g(\cdot, w) \pitchfork 0$ for almost all $w > 0$ (Milnor, 1997). In other words, for almost all wage $w > 0$ and $\tilde{v} \in \Upsilon(w)$, $\partial g(\tilde{v}, w)/\partial v \neq 0$.

Step 3: for almost all $w > 0$, the largest morale level $\bar{v}$ is stable. By Steps 1–2, we conclude that for almost all wages $w > 0$, the largest morale level $\bar{v}$ satisfies $\partial g(\bar{v}, w)/\partial v < 0$. Thus, for almost all $w > 0$, the tâtonnement (3) asymptotically converges to $\bar{v}$, by standard results.[12]

Next, consider a wage $w^\dagger > 0$ for which $\bar{v}(w^\dagger)$ is unstable according to (3), and take a converging sequence $\{w_n\}_n \downarrow w^\dagger$ such that $\bar{v}_n \equiv \bar{v}(w_n)$ is stable for all n. Such sequence must exist, as the set of wages for which $\bar{v}$ is unstable has zero Lebesgue measure. Also, because $\bar{v}(\cdot)$ is increasing, by Lemma 2-(a), and bounded from below by $\bar{v}(w^\dagger)$, the image sequence $\{\bar{v}_n\}_n$ must converge to some limit $\bar{v}^\dagger$, obeying $\bar{v}^\dagger \geq \bar{v}(w^\dagger)$.

Step 4: $\bar{v}^\dagger = \bar{v}(w^\dagger)$. To see this, notice that *under optimistic beliefs, the largest morale level $\bar{v}(w)$ is right-continuous.* Indeed, by definition, $g(\bar{v}_n, w_n) = 0$ for all n. Thus, $g(\bar{v}^\dagger, w^\dagger) = 0$

[12] The lowest morale level $\underline{v}(w) \in \Upsilon(w)$ is also stable for almost all wages $w > 0$, following the same logic.

because g is jointly continuous. That is, $\bar{\upsilon}^\dagger \in \Upsilon(w^\dagger)$ and so $\bar{\upsilon}^\dagger \leq \bar{\upsilon}(w^\dagger)$. But, $\bar{\upsilon}^\dagger \geq \bar{\upsilon}(w^\dagger)$, and so $\bar{\upsilon}^\dagger = \bar{\upsilon}(w^\dagger)$.

For the sake of clarity, we slightly abuse and introduce some notation that is just needed here. The firm's optimization can be written as $(\mathcal{P}) : \sup_{w>0} \Pi(w|\Upsilon)$, where $\Pi(w|\Upsilon) \equiv \sup_{\upsilon \in \Upsilon(w)} \pi(\upsilon, w)$ and

$$\pi(\upsilon, w) \equiv \sup_{L \in [0, \ell(\upsilon)F(\upsilon)]} Ay(L) - wL.$$

Observe that $\pi(\upsilon, w)$ is jointly continuous, by the Maximum Theorem. Moreover, $\pi(\cdot, w)$ is increasing in υ, and so $\Pi(w|\Upsilon) = \pi(\bar{\upsilon}(w), w)$ since $\bar{\upsilon}(w) \in \Upsilon(w)$. Also, since $\bar{\upsilon}(w)$ is right-continuous (Step 4), it follows that $\Pi(w|\Upsilon)$ *is right-continuous* as well.

Analogously, given $w > 0$, call $\Upsilon^*(w)$ the *set of stable morale levels*. Under optimistic and stable beliefs, the firm solves $(\mathcal{P}^*) : \sup_{w>0} \Pi(w|\Upsilon^*)$. We say that w^* *solves* $(\mathcal{P}^*)$ if there exists sequence $(w_n) \to w^*$ such that $\Pi(w_n) \to \sup_{w>0} \Pi(w|\Upsilon^*)$.

Let $\Pi^* \equiv \sup_w \Pi(w|\Upsilon)$ and suppose that $w^* > 0$ solves $(\mathcal{P})$, namely, $\Pi(w^*|\Upsilon) = \Pi^*$.[13]

STEP 5: IF w^* SOLVES $(\mathcal{P})$ THEN IT ALSO SOLVES $(\mathcal{P}^*)$. To see this, first notice that $\sup_{w>0} \Pi(w|\Upsilon^*) \leq \Pi^*$ as $\Upsilon^*(w) \subseteq \Upsilon(w)$. Now, let $\mathcal{W} \equiv \{w : \bar{\upsilon}(w) \in \Upsilon^*(w)\}$ be the (full Lebesgue measure) set of wages w for which $\bar{\upsilon}(w)$ is stable. Next, we separate in cases.

Case 1: $w^* \in \mathcal{W}$. Then $\bar{\upsilon}(w^*) \in \Upsilon^*(w^*)$, and so $\Pi(w^*|\Upsilon^*) = \Pi(w^*|\Upsilon) = \Pi^*$.

Case 2: $w^* \notin \mathcal{W}$. Here, $\bar{\upsilon}(w^*)$ is unstable, and so $\bar{\upsilon}(w^*) > \sup(\Upsilon^*(w))$. Thus, $\pi(\bar{\upsilon}(w^*), w^*) \geq \pi(\upsilon, w^*)$ for all $\upsilon \in \Upsilon^*(w^*)$, as $\pi(\cdot, w^*)$ is increasing. Consequently, $\Pi^* \geq \Pi(w^*|\Upsilon^*)$. Now if $\Pi(w^*|\Upsilon) = \Pi(w^*|\Upsilon^*)$ then w^* solves $(\mathcal{P}^*)$. Otherwise, $\Pi^* > \Pi(w^*|\Upsilon^*)$. In such case, we consider a convergent sequence $\{w_n\} \to w^*$ and extract a monotone decreasing subsequence $\{w_{n_k}\} \downarrow w^*$. WLOG we can pick a subsequence with $w_{n_k} \in \mathcal{W}$ for all k, as $\mathcal{W}$ has full measure. But, as previously argued, $\Pi(\cdot|\Upsilon)$ is right-continuous, and so $\Pi^* = \Pi(w^*|\Upsilon) = \lim_{w_{n_k} \downarrow w^*} \Pi(w_{n_k}|\Upsilon) = \lim_{w_{n_k} \downarrow w^*} \Pi(w_{n_k}|\Upsilon^*)$. That is, w^* solves $\mathcal{P}^*$. $\square$

A.6 General Selection Rules

We now show that for any piecewise continuous selection $w \mapsto \sigma(w) \in \Upsilon(w)$, the induced labor supply $L^S(w) \equiv \ell(\sigma(w))F(\sigma(w))$ is discontinuous. Thus, wage rigidity and involuntary emerge, under mild conditions, by paralleling the logic given in the proof of Theorem 1.

Let $\upsilon_o \equiv \inf \{\upsilon \in \mathbb{R} : \exists \varepsilon > 0 \text{ such that } g(\cdot, w) \text{ is increasing on } (\upsilon, \upsilon + \varepsilon)\}$.

[13] Such wage w^* must exist. First, the labor supply is bounded, $\ell(\cdot)F(\cdot) < \hat{L}$ for some $\hat{L} > 0$. Thus, $\Pi(w|\Upsilon) \leq \bar{\Pi}(w) \equiv \max_{L \in [0,\hat{L}]} Ay(L) - wL$. Second, since $Ay'(0) - w = \infty$, $\bar{\Pi}(w)$ is strictly decreasing and continuous, by standard results. Finally, $\bar{\Pi}(0) > 0 > \bar{\Pi}(\infty) = -\infty$; thus, there exists $\hat{w} \in (0, \infty)$ such that $\bar{\Pi}(w) < 0$ for all $w > \hat{w}$. Altogether, $\sup_{w>0} \Pi(w|\Upsilon) = \max_{w \in [0,\hat{w}]} \Pi(w|\Upsilon)$, as $\Pi(\cdot|\Upsilon)$ is right-continuous.

STEP 1: $\upsilon_o \in (-\infty, \infty)$. Because the value function $V(w, \upsilon)$ is additively separable (Lemma 1), the derivative of $g(\upsilon, w) \equiv V(w, \upsilon) - \upsilon$ in υ is unaffected by w. Also, because $\lim_{\upsilon \to -\infty} \gamma'(\upsilon) = 0$ by assumption, we have that $\lim_{\upsilon \to -\infty} g_\upsilon(\upsilon, w) = -1$, and so $g(\upsilon, w)$ strictly decreasing on the "left tail." Thus, $\upsilon_o > -\infty$. Also, by assumption, there exists υ with $g_\upsilon(\upsilon, w) > 0$; thus, $\upsilon_o < \infty$.

STEP 2: $g(\cdot, w)$ IS STRICTLY DECREASING ON $(-\infty, \upsilon_o)$. Suppose not. Then, there exist $\upsilon_1, \upsilon_2 \in (-\infty, \upsilon_o)$ with $\upsilon_2 > \upsilon_1$ and $g(\upsilon_2, w) \geq g(\upsilon_1, w)$. Because $g(\cdot, w)$ is continuous, there exists $\upsilon^\star \in [\upsilon_2, \upsilon_1]$ such that $g(\upsilon^\star, w) = \max_{\upsilon \in [\upsilon_1, \upsilon_2]} g(\upsilon, w)$. If $\upsilon^\star > \upsilon_1$, then there exists $\upsilon' \in (\upsilon_1, \upsilon^\star)$ such that $g(\cdot, w)$ increases on $(\upsilon', \upsilon^\star)$. But then $\upsilon_o \leq \upsilon'$, which is a contradiction. Alternatively, if $\upsilon^\star = \upsilon_1$, then $g(\upsilon_2, w) = g(\upsilon^\star, w)$, and so there exists $\upsilon'' \in (\upsilon_1, \upsilon_2)$ such that $g(\cdot, w)$ increases on (υ'', υ^2). But then, again, $\upsilon_o \leq \upsilon''$, which is a contradiction

Let $w_o \equiv W(\upsilon_o)$, where $W(\cdot)$ is defined in the proof of Lemma 2-(c). By construction, $g(\upsilon, w)$ is strictly decreasing in υ and strictly increasing in w for all $(\upsilon, w) \in (-\infty, \upsilon_o) \times (0, w_o)$. Thus, $W : (-\infty, \upsilon_o) \mapsto (0, w_o)$ is strictly increasing and differentiable, with derivative $W'(\upsilon) = -g_\upsilon(\upsilon, W(\upsilon))/g_w(\upsilon, W(\upsilon)) > 0$. Finally, $W(\cdot)$ is surjective, and so its inverse $W^{-1}(\cdot)$ is well-defined, namely, $g(W^{-1}(w), w) = 0$ for all $w \in (0, w_o)$.

STEP 3: ANY CONTINUOUS SELECTION $\sigma : (0, \infty) \mapsto \mathbb{R}$ MUST COINCIDE WITH $W^{-1}(\cdot)$ ON $(0, w_o)$. Suppose not, and let $w_\sigma = \inf\{w \in (0, w_o) : W^{-1}(w) \neq \sigma(w)\}$. First, $w_\sigma > 0$, as for low w the correspondence $\Upsilon(w)$ is single-valued (Lemma 2-(b)). Next, consider two cases.

Case 1: $\sigma(w_\sigma) = W^{-1}(w_\sigma)$. Then by definition of w_σ, there exists sequence $\{w_n\}_n \to w_\sigma$ such that $\sigma(w_n) \neq W^{-1}(w_n)$. Since for each w_n the selection $\sigma(w_n) \in \Upsilon(w_n)$, we must have $\sigma(w_n) \geq \upsilon_o$. But then, $\sigma(w_\sigma) = \lim_{n \to \infty} \sigma(w_n) \geq \upsilon_o$. This is a contradiction, since $\sigma(w_\sigma) = W^{-1}(w_\sigma) \in (-\infty, \upsilon_o)$.

Case 2: $\sigma(w_\sigma) \neq W^{-1}(w_\sigma)$. Then, $\sigma(w_\sigma) \geq \upsilon_o$. Next, consider any sequence $\{w_n\} \to w_\sigma$ with $w_n < w_\sigma$. By definition of w_σ, $\sigma(w_n) = W^{-1}(w_n)$ for all n. Thus,

$$\lim_{w_n \to w_\sigma} \sigma(w_n) = \lim_{w_n \to w_\sigma} W^{-1}(w_n) = W^{-1}\left(\lim_{w_n \to w_\sigma}\right) = W^{-1}(w_\sigma) < \upsilon_o \leq \sigma(w_\sigma).$$

Therefore, the selection $\sigma(\cdot)$ is discontinuous at w_σ, which is a contradiction.

STEP 4: THERE IS NO CONTINUOUS SELECTION $\sigma(w)$ ON $(0, \infty)$. By contradiction, suppose $\sigma(\cdot)$ is continuous. Then, by the previous step, $\sigma(\cdot)$ must coincide with $W^{-1}(\cdot)$ on $(0, w_o)$. Also, there exists $\varepsilon > 0$ such that $g(\upsilon, w_o)$ is increasing for all $\upsilon \in (\upsilon_o, \upsilon_o + \varepsilon)$. Thus, because $g(\cdot, \upsilon)$ is strictly increasing, $g(w, \upsilon) > 0 = g(w_o, \upsilon_o)$ for all $w > w_o$ and $\upsilon \in (\upsilon_o, \upsilon_o + \varepsilon)$. This implies that for all $w > w_o$, any selection $\sigma(w) \geq \upsilon_o + \varepsilon$. Finally, consider sequences

$\{w_n'\} \uparrow w_o$ and $\{w_n''\} \downarrow w_o$. Then,

$$\lim_{w_n' \uparrow w_o} \sigma(w_n) = \sigma(w_o) = v_o < v_o + \varepsilon \leq \lim_{w_n'' \downarrow w_o} \sigma(w_n).$$

Therefore, $\sigma(\cdot)$ is discontinuous at w_o, which is a contradiction. □

B A Game-Theoretic Foundation

In this section, we develop a conceptual principal-agent framework with many agents who have interdependent preferences among each other. Specifically, the principal chooses a simultaneous move game with complete information, wherein players *care* about the realized utility of others (Ray and Vohra, 2020; Vásquez and Weretka, 2020).

A *game* Γ consists of a set of agents I and a strategy set for each agent S_i, with $\mathcal{S} \equiv \times_{i\in I} S_i$ and generic element $s = (s_i)_{i\in I}$. We assume that agents' realized utilities depend upon not only the strategy profile being played, but also the realized utilities of others. Formally, a *utility function* of agent i is a map $U_i : \mathcal{S} \times \mathbb{R}^I \to \mathbb{R}$, defined over available strategy profiles $s \in \mathcal{S}$ and realized agents' payoffs $u \in \mathbb{R}^I$. Thus, for any profile s, an interdependent *utility system* $\mathcal{U} \equiv (U_i)_{i\in I}$ maps the agents' payoffs into itself: $\mathcal{U}(s,\cdot) : \mathbb{R}^I \to \mathbb{R}^I$. Altogether, a game is described by $\Gamma \equiv \langle I, \mathcal{S}, \mathcal{U}\rangle$. The set of games available to the principal is $\mathcal{G}$.

A key challenge when analyzing this class of games is that, because of the feedback effects among agents' final or *realized utilities* $u \equiv (u_i)_{i\in I}$, for some strategy profile s there may be multiple solutions to the utility system $\mathcal{U}(s,u) = u$. If so, the utility system fails to induce uniquely a normal-form game, and standard solution concepts, such as the Nash equilibrium, are inapplicable.[14] We bypass this issue by endowing agents with *consistent beliefs* about the others' realized utilities. This allows agents to assess unilateral deviations, which is a key step toward the determination of the strategies that arise in equilibrium.

Individual beliefs about the realized utilities of others are *consistent at s* if they can be justified by a solution to the system $\mathcal{U}(s,u) = u$. Precisely, fix a utility system $\mathcal{U}$ and strategy profile s. The set of unilateral deviations for agent i given s is $\mathcal{S}_{i|s} \equiv \{s' \in \mathcal{S} : s'_{-i} = s_{-i}\}$ and the union of such deviation sets is $\mathcal{S}_s \equiv \bigcup_{i\in I} \mathcal{S}_{i|s}$. Next, the *set of reduced-form payoffs* is $\mathcal{U}_s \equiv \{u \in \mathbb{R}^{I\times\mathcal{S}_s} : u(s') = \mathcal{U}(s', u(s')), \forall s' \in \mathcal{S}_s\}$ with generic element $u(s) \equiv (u_i(s))_{i\in I}$, $s \in \mathcal{S}_s$. In words, for any potential deviation s', consistency of beliefs demands that players' realized utilities $u(s')$ solve the utility system $\mathcal{U}(s', u(s')) = u(s')$.

[14] For example, in a two-agent game there are, respectively, infinite and none reduced-form payoffs when $U_i(s, u_{-i}) = u_{-i}$ and $U_i(s, u_{-i}) = u_{-i} + 1$ for both agents.

Definition 2. A strategy profile s is an *equilibrium given consistent beliefs* $u(\cdot) \in \mathcal{U}_s$ if for each player $i \in I$, $u_i(s) \geq u_i((s_i', s_{-i}))$ for all $s_i' \in S_i$.

Because a strategy profile may be associated with multiple realized utilities u, we focus on the game's outcomes. Given Γ, an *outcome* is a tuple $o \equiv (s, u(s)) \in \mathcal{S} \times \mathbb{R}^I$. We call the *set of feasible outcomes* $\mathcal{O}_\Gamma$ and assume that agents have heterogeneous *reservation utilities* $r_i \in \mathbb{R}$, $i \in I$. A feasible outcome $o \equiv (s, u(s)) \in \mathcal{O}_\Gamma$ is *implementable with beliefs* $u \in \mathcal{U}_s$ if the profile s is an equilibrium given beliefs u and individual rationality holds, i.e., $u_i(s) \geq r_i$ for all i. In other words, an outcome is implementable when the strategy chosen by each agent is optimal, given consistent beliefs, and all agents have incentives to participate.

Now let us turn to the principal's incentives. In general, the principal may care about not only agents' actions, but also their well-being. Thus, we define her payoff function $\pi(\cdot)$ over the set of feasible outcomes $\mathcal{O}_\Gamma$. As in a sub-game Perfect Equilibrium, the principal forecasts the equilibrium response to variations in the environment, which translates into the principal restricting her attention to the *set of implementable outcomes* $\mathcal{O}^*_\Gamma$. Next, we endowed the principal with an equilibrium *selection rule* $\sigma : \Gamma \mapsto \mathcal{S} \times \mathbb{R}^I$, where $\sigma(\Gamma) \in \mathcal{O}^*_\Gamma$ for all $\Gamma \in \mathcal{G}$. Altogether, the principal solves:

$$\sup_{\Gamma \in \mathcal{G}} \pi(\sigma(\Gamma)).$$

For instance, if the principal cares about the best-case scenario, as in the traditional mechanism design literature, then $\pi(\sigma(\Gamma)) \equiv \sup_{o \in \mathcal{O}^*_\Gamma} \pi(o)$. Conversely, if the principal cares about the worst-case scenario, $\pi(\sigma(\Gamma)) \equiv \inf_{o \in \mathcal{O}^*_\Gamma} \pi(o)$, as in the robust design literature.

Finally, we can further restrict the agents' beliefs in settings in which there is a large population (or continuum) of agents, wherein each agent "cares" about the average realized welfare of the population. Because individual agents in a continuum have negligible impact on aggregate variables, we restrict the agents' beliefs and thus refine the implementable outcome set. For beliefs $u \in \mathcal{U}_s$, agents are *negligible* if for any agent i and deviation $s' = (s_i', s_{-i})$ their beliefs u obey $u_{-i}(s') = u_{-i}(s)$. Thus, each agent operates under the premise that her behavior alone does not alter the realized welfare of others. This framework justifies the use of Definition 1 in the worker subgame. Indeed, it easily follows that,

Claim B.0.1. *Given a set of workers I and a wage rate w, a symmetric outcome (υ, ℓ) is implementable among negligible workers if and only if (υ, ℓ) satisfies Definition 1.*

Proof: Step 1: Sufficiency. Suppose the outcome (υ, ℓ) is implementable among negligible workers. Since beliefs at the equilibrium strategy are consistent, they satisfy $U_i(w\ell, \ell, \upsilon) =$

υ for all $i \in I$, or condition ii). Next, since we consider negligible workers, their beliefs regarding utilities of others are fixed, implying that morale is fixed at υ for all off equilibrium deviations ℓ'. Given such beliefs, the equilibrium condition in Definition 1 implies the optimality condition i). Finally iii) is implied by the individual rationality condition.

STEP 2: NECESSITY. Assume (υ, ℓ) satisfy conditions i)–iii). Fix a worker i, and consider an arbitrary unilateral deviation $\ell_i \in (0, T)$ from $\ell_j = \ell$ for all $j \neq i$. Notice that the wage is fixed, and the choice of ℓ_i affects utilities of others only indirectly through worker i's utility. However, since worker i is negligible in a continuum, we have that others' utilities are unchanged and workers' morale is thus fixed at υ. Given this constant beliefs for all off equilibrium deviation, worker i's utility after deviating is $U_i(w\ell, \ell, \upsilon)$, which is maximized when $\ell_i = \ell$, by condition i). This logic holds for all workers, and thus the best response condition in Definition 1 is met. Finally, iii) obviously implies individual rationality. $\square$

C Concave Enjoyment Function γ

We use the following parametrization: we set $T = 24$; $y(L) = \sqrt{L}$; and $\alpha = \beta = 1$. Then, we consider $r_i \sim \mathcal{N}(1, 1)$. Finally, $\gamma : (-1, \infty) \to \mathbb{R}$, with $\gamma(\upsilon) = \frac{\upsilon}{2(1+\upsilon)}$. Notice that γ rises with diminishing returns $\gamma' \geq 0 > \gamma''$.

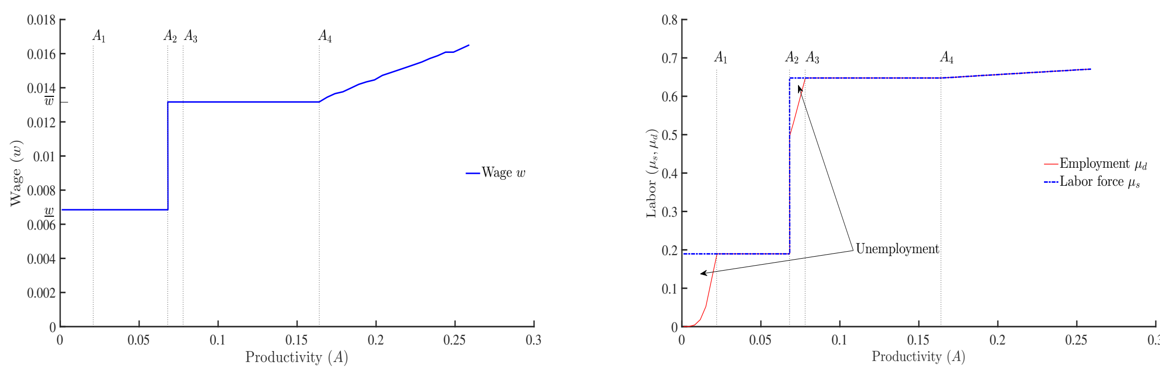

Figure 7: Wage rigidity and involuntary unemployment both emerge for mid productivity levels when the enjoyment function is concave.

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