

Motivation Under Monopsony: The Effects of Labor Market Power on Incentives Within the Firm

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Abstract

How does imperfect labor market competition affect workers' behavior within the firm? I develop a model of career concerns under infrequent outside offers and dynamic wage renegotiation. In equilibrium, wages respond asymmetrically to performance: unexpectedly strong performance causes small wage gains, but unexpectedly poor performance triggers large wage cuts or separation. As a result, workers target acceptable rather than exceptional performance, and choose inefficiently safe projects when they have discretion over risk. These distortions affect different types of workers: workers who are "secure" in their jobs, in that their employers are far from credibly threatening renegotiation, exert too little effort but take nearly efficient risks; workers who are "insecure" exert high effort but inefficiently avoid risk. The mechanism links imperfect competition to empirical observations of concave wage-performance profiles, performance-targeting, and managerial conservatism.

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1. Introduction

There is now substantial evidence that labor markets are imperfectly competitive: workers face a limited set of employers; search frictions impede mobility; and outside offers arrive infrequently.¹ As in any market, imperfect competition can cause misallocation and distort prices (wages) and quantities (employment). A distinguishing feature of the employment relationship, however, is that it typically leaves workers with substantial discretion (Simon 1951; Hart and Moore 1990): whether to exert effort; whether to take risks; and which projects to prioritize. Yet the effects of labor market power on behavior *within the firm* remain a “neglected topic” (Langella and Manning 2021, p. 2935).² How does labor market power shape workers’ behavior on the job?

I study this question in a setting with three features common to many employment relationships. First, contracts are incomplete: many aspects of the worker’s behavior and performance are non-contractible, perhaps because they are too complex to specify *ex ante* or too difficult to verify *ex post* (Williamson 1981; Gibbons 1998). Workers are therefore disciplined partly by career concerns (Holmström 1982/1999). Second, the labor market is imperfectly competitive: outside offers arrive only occasionally, as in the frictional search literature (Jovanovic 1979; Burdett and Mortensen 1998). Third, wages are renegotiated when either party has a credible threat to terminate employment; otherwise, the current wage remains in place (Malcomson 1999; Postel-Vinay and Robin 2002).

I show that these features have a distinctive joint implication for wage dynamics: workers receive *small* wage increases after performing unexpectedly well, but *large* wage reductions after performing unexpectedly poorly. This asymmetry has two behavioral consequences. First, it affects the *level* of output by generating *dynamic performance-targeting*: workers exert effort to avoid falling below “acceptable” performance, but have muted incentives to exceed it. Second, it affects the *variance* of output by generating *conservatism*: because workers bear more downside risk than upside gain, even risk-neutral workers at risk-neutral firms behave as if risk-averse. I argue that this mechanism provides a natural explanation for evidence from three settings: (1) the labor literature on concave wage responses to performance; (2) the organizational literature on performance targeting; and (3) the innovation literature on managerial conservatism. Labor market power thus shapes behavior *within the firm*, beyond its well-known effects on wages and employment, and a simple model of labor market power explains several patterns previously documented in empirical work, as well as generating novel predictions for the effect of competition on internal labor markets.

To see the intuition, consider a worker of uncertain ability whose wage equals her current expected output, which is also her expected output in future periods. Suppose the worker’s current output is informative about future output (in the sense of the monotone likelihood ratio property). As a result, strong current performance increases expected future output, and so, in a competitive labor market, outside employers bid the wage up; poor performance lowers expected future output, so the incumbent employer can credibly threaten termination to bargain the wage down. In standard career-concerns models (Fama 1980; Holmström 1982/1999), these forces are symmetric: wages adjust one-for-one to both positive and negative revisions of expected future output.

Under imperfect competition, this symmetry breaks down. To fix ideas, consider the limiting case in which the worker expects no outside offers. Imperfect competition preserves the employer’s ability to bargain wages *down*: if poor performance lowers expected future output, the firm still has

¹For recent reviews, see Manning (2021); Kline (2025); Caldwell et al. (2026a).

²Similarly, Caldwell et al. (2026a) write that “further research is needed to clarify the relationship between labor discipline and monopsony both theoretically and empirically” (p. 48). Hoffman and Stanton (2025) state that “few models... explicitly analyze how labor market competition influences... equilibrium incentive contracts” (p. 763).

a credible threat to terminate employment. But imperfect competition weakens the worker’s ability to bargain wages *up*: without a credible outside offer, strong performance may not translate into a higher wage. In models where wage renegotiation requires a credible threat (*e.g.*, Postel-Vinay and Robin 2002), the worker captures none of the surplus gain. If she *can* renegotiate, her wage rises only in proportion to her bargaining share. As a result, the worker’s wage falls one-for-one with declines in expected output but rises less than one-for-one with increases.

I formalize this intuition in a model of career concerns under imperfect competition. A worker of initially unknown ability chooses an action, which, together with her ability, determines the drift of output. After observing output, the firm and the worker may renegotiate wages, if either has a credible threat to terminate employment. In a competitive labor market, the worker’s continuation value is linear in expected output. Under imperfect competition, this relationship is concave: poor performance reduces the worker’s continuation value more than good performance raises it. I first show this result assuming wages are flexibly renegotiated in response to credible threats; I then extend it to allow for rent-sharing, downward wage rigidity, wage posting, and endogenous search.

This result rationalizes evidence that poor performance is often punished more than good performance is rewarded, from line employees (Trevor et al. 1997) to security analysts (Hong et al. 2000), fund managers (Chevalier and Ellison 1999; Ibert et al. 2018), and executives (Leone et al. 2006; Jenter and Lewellen 2021). Existing accounts impose this asymmetry exogenously, *e.g.*, by allowing termination but not raises (Hirshleifer and Thakor 1992; Zwiebel 1995), which raises the question of why firms can motivate workers “only through the use or threat of dismissal” (Aghion and Jackson 2016, p. 2). I show that labor market power generates such an asymmetry endogenously.

This asymmetric response of wages shapes workers’ behavior within the firm. Suppose first that the worker can exert costly effort to affect expected output. When she is *insecure* in her job, in that her employer is close to credibly threatening termination, effort is strongly incentivized: better performance forestalls wage cuts and reduces the probability of separation. When she is *secure*, with the employer far from the termination threshold, incentives are weaker: strong performance is only partially capitalized into higher wages. Workers therefore exert effort to avoid falling below an acceptable threshold, but have muted incentives to push performance far above it.

I refer to this pattern as *performance targeting*. A long literature in organizational economics documents performance targeting in large organizations.³ Existing accounts emphasize explicit performance thresholds or discrete bonus schemes (Oyer 1998; Jensen 2003; Neal and Schanzenbach 2010; Kuhn and Yu 2025). These accounts are incomplete: most jobs do not involve discrete targets or indeed any explicit incentive pay (Lemieux et al. 2009; Gittleman and Pierce 2013). Performance targeting arises naturally under imperfect competition, even without explicit incentive pay.

Now suppose the worker determines the *variance* of output by choosing safer or riskier projects. Under perfect competition, wages are linear in output: a risk-neutral worker maximizes expected output, regardless of variance. Under imperfect competition, the worker captures only a fraction of the upside from riskier actions, but bears the full wage risk. As a result, even a risk-neutral worker sacrifices expected output to avoid risk. “Secure” workers choose close to first-best risk levels but exert too little effort; highly “insecure” workers exert more effort, but are too risk-averse.

³In organizational economics, see Leibenstein (1966); Winter (1971); Bertrand and Mullainathan (2003); Ellison (2006). For a recent review, see Artinger et al. (2022). In organizational theory, see Simon (1947); March and Simon (1958); Nelson and Winter (1982); Argote and Greve (2007); Gavetti et al. (2012). For a review, see Hagen et al. (2023).

This logic speaks to a recent literature on innovation and managerial conservatism. In principle, large firms with well-diversified investors and easy access to capital should be close to risk-neutral (Nelson 1959; Arrow 1962; Kerr and Nanda 2015). Yet these firms often appear reluctant to take risks, and indeed appear to pass up valuable but risky investments.⁴ This suggests a puzzle summarized by Lovall et al. (2020): “Why are managers in large, hierarchical organizations so risk-averse?” A leading explanation attributes conservatism to managers’ inherent risk-aversion (Amihud and Lev 1981; Holmström and Costa 1986; Holmström 1989; Parrino et al. 2005; Lewellen 2006). I show that imperfect competition encourages even risk-neutral managers to avoid risk.

The results rely on three motivating assumptions: (i) incomplete employment contracts; (ii) imperfect labor market competition; and (iii) wage renegotiation after credible threats. First, if actions were contractible, the prescribed action would act as a non-wage amenity; as a result, under individual bargaining, it would be chosen to maximize joint surplus (Spence 1975; Viscusi 1980). Hence, under *complete* contracts, labor market power generally does *not* distort behavior within the firm, absent other frictions.⁵ The distortions arise precisely because workers retain discretion over non-contractible actions; labor market power shapes the exercise of that discretion.

Second, under competition, the analysis reduces to the canonical career concerns model: good and poor performance are rewarded symmetrically, and performance-targeting and conservatism disappear. I depart from the standard model by assuming outside offers arrive infrequently—perhaps due to search frictions, thin labor markets, or non-compete agreements.⁶ A further interpretation is asymmetric information (Greenwald 1986; Gibbons and Katz 1991): a model in which outside firms can always make offers, but only infrequently observe performance, delivers similar results.

Third, a model of imperfect competition must specify how wages are renegotiated over the course of employment. I allow for an arbitrary initial wage, but assume that subsequent wage changes are triggered by credible threats, as in standard models of implicit contracts and on-the-job bargaining (e.g., MacLeod and Malcolmson 1989; Baker et al. 2002; Postel-Vinay and Robin 2002). The conclusions are robust to downward wage rigidity, partial rent-sharing, and wage-posting. What is essential is that the current wage remains in place *absent* such a threat. If wages were instead renegotiated from scratch each period, imperfect competition would weaken effort incentives, but would not generally create performance-targeting or conservatism. I argue that a distinguishing feature of employment is that the parties do *not* renegotiate from scratch each period: instead, the current wage serves as an implicit continuation wage renegotiated only occasionally.

The paper contributes most directly to the literature on career concerns initiated by Holmström (1982/1999). That literature has largely been developed in competitive labor markets.⁷ I also contribute to the literature on wage dynamics and renegotiation (Flinn 1986; Thomas and Worrall 1988; Beaudry and DiNardo 1991). It is convenient to set parts of the analysis in continuous time, following a literature on continuous-time moral hazard (Sannikov 2008; Faingold and Sannikov 2011) and

⁴See, e.g., Parrino et al. (2005); John et al. (2008); Panousi and Papanikolaou (2012); Asker et al. (2015); Gormley and Matsa (2016); Krieger et al. (2022).

⁵A similar logic applies to contractible output: because the worker is risk-neutral, the firm can make her the residual claimant. Of course, under collective bargaining, the prescribed action may be inefficient (Spence 1975).

⁶Around 46% of high-earning U.S. workers are subject to these agreements. They are especially common in finance (Starr et al. 2021; Cici et al. 2021), where there is substantial evidence of a concave relationship between wages and performance (Chevalier and Ellison 1999; Ibert et al. 2018).

⁷See, e.g., Gibbons and Murphy (1992); Prendergast and Stole (1996); Dewatripont et al. (1999a,b); Bonatti and Hörner (2017); Cisternas (2018a,b); Halac and Kremer (2020); Hörner and Lambert (2021); Ke et al. (2023).

career concerns (Pei 2016; Cisternas 2018a,b; Halac and Kremer 2020; Hörner and Lambert 2021). More broadly, the paper relates to the literature on employer learning about worker performance (e.g., Farber and Gibbons 1996; Altonji and Pierret 2001; Lange 2007; Aryal et al. 2022; Wu 2024).

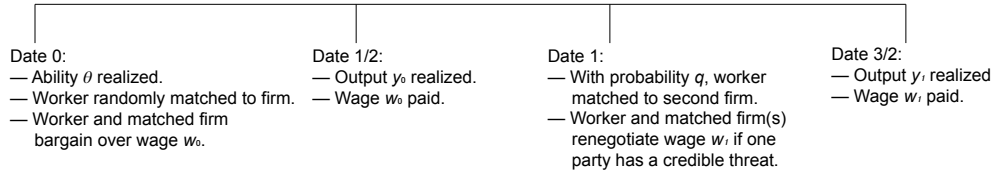
Outline. Section 2 illustrates the ideas in an example. Section 3 introduces a general model, and section 4 shows some preliminary results. Section 5 examines incentives for effort. Section 6 studies risk-taking. Section 7 describes extensions. Section 8 concludes with a discussion of the model’s empirical content. Proofs are in the appendix, and additional results in the online appendix.

2. An introductory example

I begin with a simple example. A worker lives for two periods ($t \in \{0, 1\}$) and may be employed by either of two identical firms. The worker’s ability $\theta \sim \mathcal{N}(\bar{\theta}, \sigma_\theta^2)$ is initially unknown to all parties. Her period- t output is $y_t = \theta + \varepsilon_t$, for $\varepsilon_t \sim \mathcal{N}(0, \sigma_\varepsilon^2)$ an i.i.d. shock. All parties are risk-neutral, and there is no discounting. I first describe a setting without action choice, and then introduce actions.

Play proceeds as in Figure 1. In period 0, ability is realized (but unobserved). The worker is randomly matched to a firm, and they bargain over a period-0 employment contract. Output is non-verifiable (ruling out performance pay), and employment is at will (ruling out long-term contracts), so the contract specifies only the spot wage w_0 . Output y_0 is then realized and publicly observed.⁸

FIGURE 1. Timing of introductory example



In period 1, with probability $q \in [0, 1]$, the worker encounters the second firm; call this event E , and its complement N . In both events, the wage is renegotiated only if one party can credibly threaten termination at w_0 . If the firm can credibly threaten termination, the wage is renegotiated down to the firm’s break-even wage; if the worker can credibly threaten termination, the wage is renegotiated up to her outside offer. In event E , the worker’s outside option is employment at the second firm, which is willing to pay up to her expected output; in event N , the worker’s outside option is non-employment, which I assume she never prefers to employment.

Period-1 beliefs. Given observed output y_0 , expected period-1 output is $\mathbb{E}[y_1 | y_0] = \mathbb{E}[\theta | y_0] = \rho y_0 + (1 - \rho)\bar{\theta}$, for signal-to-noise ratio $\rho := \sigma_\theta^2 / (\sigma_\theta^2 + \sigma_\varepsilon^2)$. Given these beliefs, denote by y_0^* the *retention threshold*—the output level at which the firm is just indifferent between separation and retention at the current wage: $\mathbb{E}[y_1 | y_0^*] = w_0 \iff y_0^* = [w_0 - (1 - \rho)\bar{\theta}] / \rho$.

Period-1 wages. In event E , the worker has offers from both firms; standard Bertrand competition implies $w_1^E = \mathbb{E}[y_1 | y_0] = \rho y_0 + (1 - \rho)\bar{\theta}$, shown in navy in Figure 2(a). Intuitively, if $y_0 < y_0^*$, the firm has a credible threat to terminate employment, so the wage is negotiated down. If $y_0 > y_0^*$, the worker has a credible threat to leave employment, since the outside firm is willing to pay up to her expected marginal product: as a result, her wage is negotiated up.

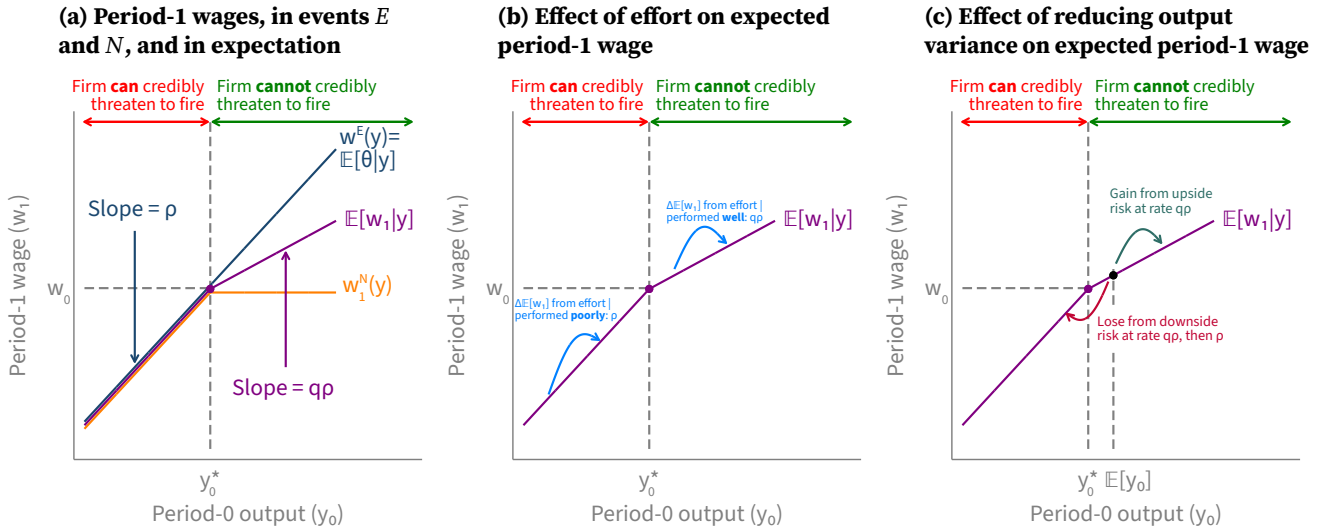
⁸As is common in the literature on career concerns, output is observable but non-verifiable—for instance, because performance measures can be understood within an industry, but not verified to a court. I later consider an alternative case in which output is observable only to the incumbent employer, and unobservable to the broader labor market.

Now consider event N . If the worker performs poorly ($y_0 < y_0^*$), as before, the firm has a credible threat to terminate employment, and the wage is negotiated down to $\mathbb{E}[\theta | y_0]$. If the worker performs well ($y_0 \geq y_0^*$), the firm cannot credibly bargain her wage down. On the other hand, the worker cannot bargain her wage up: she has no credible threat to leave without an outside offer. Under our assumption that renegotiation occurs only in response to credible threats, the wage remains at w_0 : strong performance raises expected output, but does not translate into a higher wage. Combining the two cases, $w_1^N(y_0) = \min\{\mathbb{E}[y_1 | y_0], w_0\}$, shown in orange.

Since the worker is risk-neutral, her continuation payoff is her expected period-1 wage, $\mathbb{E}[w_1 | y_0] = qw_1^E(y_0) + (1 - q)w_1^N(y_0)$, shown in purple in Figure 2(a). For low realizations of y_0 , the expected wage falls one-for-one with expected output; since $\mathbb{E}[y_1 | y_0]$ has slope ρ , so does $\mathbb{E}[w_1 | y_0]$. For high realizations, the wage increases only in event E , so the expected wage has slope $q\rho$.

Observation 1. Imperfect competition thus creates an asymmetry in the returns to performance: poor performance is penalized at rate ρ , whereas good performance is rewarded at rate $q\rho$. Under perfect competition ($q = 1$), continuation pay is linear in period-0 performance. Under imperfect competition ($q < 1$), it is concave: bad performance is more costly than equally good performance is rewarding. Intuitively, frictions to mobility preserve the firm's threat to fire the worker after poor performance, but weaken the worker's threat to quit after good performance.

FIGURE 2. Period-1 wages in introductory example, with and without action choice



Note: Panel (a) illustrates period-1 wages as a function of first-period output, after an outside offer (in navy), no outside offer (orange), and in expectation (purple). Panel (b) illustrates incentives for effort to increase the level of output. Panel (c) illustrates incentives for the variance of output.

Action choice: manipulating the level of output. Now suppose that, in period 0, the worker receives an unexpected opportunity to “work hard”, raising output by one unit at effort cost c . Suppose the employer does not anticipate or observe this opportunity, and continues to interpret output as before. Under perfect competition ($q = 1$), this additional unit raises continuation pay by exactly ρ , so the worker exerts effort for $\rho \geq c$. Because continuation pay is linear in output, this condition holds regardless of whether the worker chooses to work hard before or after observing $(\theta + \varepsilon_0)$.

Now consider imperfect competition ($q < 1$), illustrated in Figure 2(b). Below the retention threshold y_0^* , additional output raises continuation pay at rate ρ ; above it, at rate $q\rho$. If effort is chosen *ex ante*, before observing initial output, its expected return is therefore lower than under competition. Say

effort is instead chosen *ex interim*: the worker observes $(\theta + \varepsilon_0)$, then chooses whether to exert effort, and employers see only the final output. In that case, incentives are state-contingent: effort is strongly rewarded below the retention threshold, but weakly rewarded once it is surpassed.

Observation 2. Thus, the worker's incentive to attain acceptable output y_0^* is just as strong as under competition, but her incentive to exceed it is muted. Imperfect competition induces performance-targeting: the worker is strongly motivated to avoid unacceptable performance, but only weakly motivated to exceed it. This distortion becomes more severe as the labor market becomes less competitive, since a lower q further reduces the return to performance above y_0^* .

Action choice: manipulating the variance of output. Now suppose instead that the worker has an unexpected, hidden opportunity to reduce the *variance* of output: in particular, she can choose to produce a fixed output $\bar{y}_0$ with certainty, rather than the stochastic output $y_0 = \theta + \varepsilon_0$. Say $\bar{y}_0 < \mathbb{E}[y_0]$, so producing the fixed output is jointly inefficient (because all parties are risk-neutral).

Under competition ($q = 1$), continuation pay is linear in y_0 , so the worker never sacrifices expected output to reduce risk. Under imperfect competition ($q < 1$), continuation pay is strictly concave, as illustrated in Figure 2(c): upside risk is rewarded at rate $q\rho$, whereas downside risk is punished at rate $q\rho$ and then ρ .⁹ By Jensen's inequality the worker prefers producing $\mathbb{E}[y_0]$ to the stochastic output y_0 . By continuity, she also prefers a sufficiently small reduction in mean output.

Observation 3. The example thus illustrates that labor market frictions can cause even a risk-neutral worker at a risk-neutral firm to behave *as though risk-averse*: the worker would sacrifice expected output to reduce the variance of output. Intuitively, she bears the full downside risk from stochastic performance, but only part of the upside. As q falls, the slope differential between the two segments of the wage-performance relationship widens, and the worker grows more conservative.

Bargaining process. We have taken a particular view of renegotiation, in which wages are revised only after credible threats. Do our conclusions persist under alternative bargaining assumptions?

Consider the alternatives in Figure 3. First, suppose that, even *without* an outside offer, the worker captures a share $\lambda \in (0, 1)$ of the increase in expected output after strong performance ($y_0 \geq y_0^*$), as in rent-sharing models (e.g. Blanchflower et al. 1996; Card et al. 2014; Kline et al. 2019) (Figure 3(a)). Then poor performance is penalized at rate ρ , while strong performance is rewarded at rate $q\rho + (1 - q)\lambda\rho < \rho$. If the worker has full bargaining power ($\lambda = 1$), we return to the competitive case; for less than full bargaining power ($\lambda < 1$), our conclusions remain as before.

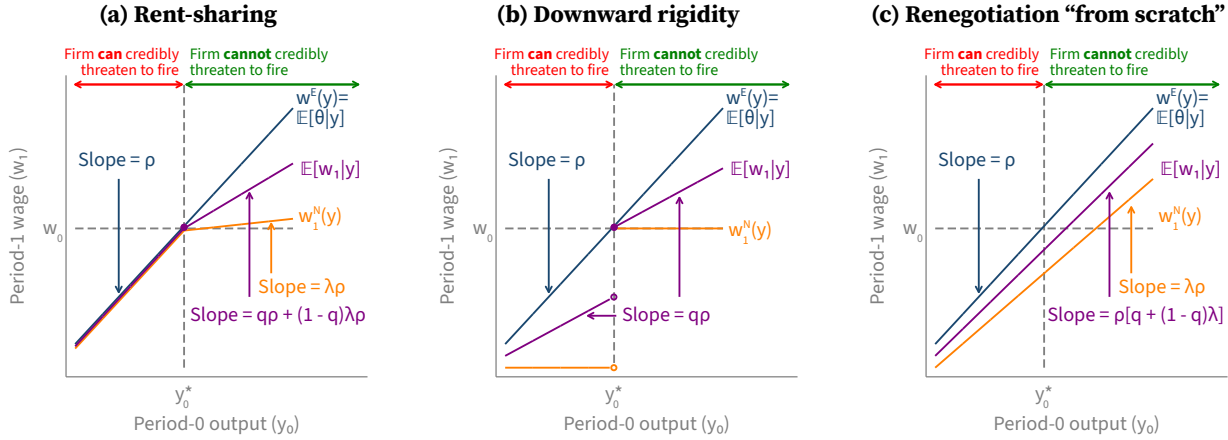
Second, we have assumed the wage can be renegotiated down. Suppose instead the wage is downwardly rigid (Figure 3(b)). In event E , the worker has access to a competitive outside market, so her wage is again $w_1^E(y_0) = \mathbb{E}[y_1 | y_0]$: strong performance bids her wage up; weak performance causes the worker to be fired, but employed elsewhere at her expected output. In event N , the worker has no outside offer. If $y_0 \geq y_0^*$, neither party has a credible threat, so the wage remains w_0 . If $y_0 < y_0^*$, expected output falls below the current wage; since the wage cannot be renegotiated down, the firm fires the worker, and her payoff falls discontinuously to the non-employment payoff. Thus, downward rigidity strengthens the asymmetry between strong and poor performance: even modest underperformance risks separation.¹⁰

⁹This illustration assumes w_0 is such that expected output $\mathbb{E}[y_0] \geq y_0^*$. The argument also holds if $\mathbb{E}[y_0] < y_0^*$: in that case, strong performance is rewarded at rate ρ , then $q\rho$, whereas poor performance is punished at rate ρ .

¹⁰On the other hand, a worker who expects to fall just below y_0^* may instead prefer to "gamble for resurrection"

I later show that a similar logic applies to several other wage-setting protocols: for instance, our conclusions persist if wages are posted, rather than negotiated; if the firm retains some markdown even after a downward renegotiation; and if, even absent an outside offer, the firm and worker Nash-bargain over the wage at period 1, with the period-0 contract as the disagreement point.¹¹ To see the boundaries of our argument, it is worth considering a renegotiation protocol that does *not* support our conclusions. We have assumed the period-0 wage remains the default absent a credible threat. Suppose instead that, absent an outside offer, the parties “tear up” the period-0 contract and bargain from scratch, with separation payoffs (0, 0) and worker bargaining weight λ (Figure 3(c)). Then the worker’s wage absent an outside offer is $\lambda \mathbb{E}[\theta | y_0]$, so her expected wage is linear in performance with slope $\rho[q + (1 - q)\lambda]$. Since the slope falls as q falls (for $\lambda < 1$), imperfect competition still weakens incentives for effort, but strong and poor performance are treated symmetrically, so the forces generating performance-targeting and conservatism disappear.

FIGURE 3. Effects of alternative wage renegotiation assumptions on period-1 wages in the introductory example



Note: Each panel replicates Figure 2(a) under a different bargaining assumption: rent-sharing in panel (a); rigid wages in (b); and renegotiation from scratch in (c).

Observation 4. This discussion highlights that the asymmetry between good vs. bad performance depends on the prior wage serving as the default continuation wage: if the parties renegotiate from scratch, there is no such asymmetry. I argue that a distinguishing feature of continuing employment relationships is that the parties do *not* renegotiate from scratch each period: instead, the current wage serves as an implicit continuation wage, as in models of implicit and relational contracts (MacLeod and Malcomson 1989; Baker et al. 2002) and on-the-job bargaining (Postel-Vinay and Robin 2002; Cahuc et al. 2006). I later present evidence, both from observed wage patterns and from legal and institutional features of wage-setting, consistent with the view that wages in ongoing employment relationships are revised relative to past wages rather than continuously reset.

Conclusions from example. Thus, at least when the current wage serves as a default for future periods, imperfect competition distorts behavior not merely on the employment margin, as in the standard monopsony model, but because it affects the returns to performance, and thus behavior within the firm. Of course, the example is deliberately stylized: the worker’s opportunities to affect output arose out of equilibrium, and the restriction to two periods prevents us from analyzing the dynamics of wages. These limitations motivate a more general model.

(Downs and Rocke 1994), taking on risk in order to cross the retention threshold. I later show that, in the general model with continuous monitoring, the worker never reaches this latter region on the equilibrium path; as a result, downward rigidity makes workers still more prone to performance-targeting and conservatism.

¹¹For a discussion of each of these cases in the context of the example, see Online Appendix A.

3. A general model of the returns to performance under imperfect competition

I now set out a more general model. For tractability, I maintain the Gaussian structure of the introductory example, while extending it to a dynamic environment with endogenous action choice. In this section, I consider incentives for the *level* of output; I turn to incentives for risk later.

3.1. Primitives of the model

Time is continuous on $[0, \infty)$. A single worker interacts with a continuum of identical prospective employers F , with typical firm f . All parties are risk-neutral and share discount rate $\rho > 0$. I impose risk-neutrality to emphasize that conservatism can arise purely from wage dynamics.

The worker's ability at t is $\theta_t \in \Theta := \mathbb{R}$. Initial ability is $\theta_0 \sim \mathcal{N}(\bar{\theta}, \sigma_\theta^2)$, with $\sigma_\theta^2 > 0$. Ability $(\theta_t)_{t \geq 0}$ follows a standard Ornstein-Uhlenbeck process:

$$(1) \quad d\theta_t = -\kappa(\theta_t - \bar{\theta})dt + \gamma dZ_{\theta,t} \quad t \geq 0,$$

where $\gamma > 0$ and $(Z_{\theta,t})_{t \geq 0}$ is a standard Brownian motion.¹² Mean reversion ensures that the variance of ability remains finite. I assume $\kappa = \gamma^2/[2\sigma_\theta^2]$ so that ability has stationary σ_θ^2 ; stationarity is a simplifying assumption that allows us to easily compute beliefs. Neither the worker nor firms observe ability, but its initial distribution and evolution are common knowledge.

At time 0, the worker is matched to some firm f_0 at wage w_0 . I treat w_0 as arbitrary and assume it is agreeable to both the worker and the firm. This allows, for instance, for the possibility that the wage is Nash bargained, or that it has been posted by the firm. To focus on wage dynamics, I suppress non-employment: the worker can leave an incumbent only to join another firm.¹³ Meetings with outside firms arrive according to an independent Poisson process N_t with rate $q > 0$.¹⁴

At each instant t , play proceeds as follows. I write w_{t-} and f_{t-} for the worker's wage and employer just before any adjustment at t , and w_t and f_t for the worker's wage and employer just after adjustment.

STAGE 1 (PRODUCTION): The worker chooses an action a_t from $\mathcal{A} := [\underline{a}, \bar{a}]$. Cumulative output Y_t evolves according to

$$(2) \quad Y_0 = 0, \quad dY_t = [m(a_t) + \theta_t]dt + s dZ_{Y,t} \quad t \geq 0,$$

where $s > 0$, $Z_{Y,t}$ is a standard Brownian motion (independent of $Z_{\theta,t}$), and $m(a_t)$ is the effect of a_t on the drift of output.

STAGE 2 (FLOW PAYOFFS): The worker receives flow utility $[w_{t-} - c(a_t)]dt$, where $c(a_t)$ is her flow effort cost. The incumbent employer f_{t-} receives flow profit $[dY_t - w_{t-}dt]$.

STAGE 3 (MEETING): If $M_t := \Delta N_t = 1$, the worker meets an outside firm; otherwise, no outside offer is available. Let $\hat{f}_t \in (F \cup \{\emptyset\})$ denote the outside firm encountered at t , with $\hat{f}_t = \emptyset$ if no meeting occurs.

STAGE 4 (WAGE DETERMINATION): Wages and employment are renegotiated to (w_t, f_t) .

¹²As Cisternas (2018a, p. 159) notes, several empirical studies find support for the view that ability is well-approximated by a Gaussian AR(1) process (e.g., Farber and Gibbons 1996; Altonji et al. 2013; Kahn and Lange 2014; Bagger et al. 2014; Friedrich et al. forthcoming). An Ornstein-Uhlenbeck process is the continuous-time analogue.

¹³Equivalently, the value of non-employment is low enough that it never binds on the state space considered.

¹⁴Here, $q \in (0, \infty)$ is a Poisson rate, whereas it denoted a meeting probability in the introductory example.

Firms maximize expected discounted profits, and the worker maximizes expected discounted utility. The functions m and c are strictly increasing and twice continuously differentiable on $(\underline{a}, \bar{a})$, with m strictly concave, c strictly convex, and $\lim_{a \rightarrow \underline{a}} m'(a) = \lim_{a \rightarrow \bar{a}} c'(a) = \infty$, $\lim_{a \rightarrow \bar{a}} m'(a) = \lim_{a \rightarrow \underline{a}} c'(a) = 0$. Thus the unique first-best action $a_{FB} \in (\underline{a}, \bar{a})$ satisfies $m'(a_{FB}) = c'(a_{FB})$.

Output, employment, wages, and meetings are publicly observed, but actions are private. In particular, even non-incumbent firms observe output; I return to this later. Let $h^{t-} := (Y_\tau, w_\tau, f_\tau, \hat{f}_\tau)_{\tau < t}$ denote the **public history** up to t . Let $h_R^t := (h^{t-}, Y_t, \hat{f}_t)$ denote the **public history at renegotiation**, which includes also the increment to output at t and any meeting with another firm. Let $\mathbb{F} = (\mathcal{F}_t)_{t \geq 0}$ denote the public filtration generated by the public process $(Y_t, w_t, f_t, \hat{f}_t)_{t \geq 0}$. The worker's corresponding private histories append her past actions; define the **private history** up to t as $\tilde{h}^{t-} := (h^{t-}, (a_\tau)_{\tau < t})$, and the **private history at renegotiation** $\tilde{h}_R^t$ similarly, with private filtration $\tilde{\mathbb{F}}$. Let $(\mathcal{H}^-, \mathcal{H}^R)$ denote the feasible public histories, and $(\tilde{\mathcal{H}}^-, \tilde{\mathcal{H}}^R)$ the private histories.

3.2. Defining an assessment

I first define an assessment, then an equilibrium assessment.

Definition 1. An **assessment** $s = \langle \pi^F, \pi^W, a, \mathcal{W} \rangle$ consists of:

- (1) **firm beliefs**: a map $\pi^F: \mathcal{H}^- \rightarrow \Delta(\Theta)$;
- (2) **worker beliefs**: a map $\pi^W: \tilde{\mathcal{H}}^- \rightarrow \Delta(\Theta)$;
- (3) a pure-strategy **action rule** for the worker, $a: \tilde{\mathcal{H}}^- \rightarrow \mathcal{A}$, such that the induced process $a_t = a(\tilde{h}^{t-})$ is $\tilde{\mathbb{F}}$ -predictable; and
- (4) a **renegotiation rule** $\mathcal{W}: \mathcal{H}^R \rightarrow \mathbb{R} \times F$, whose output is the renegotiated wage and firm (w_t, f_t) .

Given an assessment s , denote by $\mathbb{P}^s$ the probability law over ability, output, meetings, wages, employment transitions, and actions induced by s .

Three aspects of Definition 1 merit discussion. First, I restrict attention to pure-strategy action rules. This has an implication for the predictability of the worker's actions. Although the action rule depends formally on the private history, the worker's only private information is her own past actions. Under a pure strategy, these actions are recursively determined by public histories and the commonly known action rule. Hence, on the path induced by an assessment, firms can recover the worker's past actions and predict her current action from public information.¹⁵

Lemma 1. In any assessment $s = \langle \pi^F, \pi^W, a, \mathcal{W} \rangle$, there exists an $\mathbb{F}$ -predictable process $a_t^{F,s}$ such that $a_t^{F,s} = a(\tilde{h}^{t-})$, $\mathbb{P}^s \otimes dt$ -almost everywhere.

For any private history to t , $\tilde{h}^{t-}$, let $Y^t(\tilde{h}^{t-})$ and $a^t(\tilde{h}^{t-})$ denote the output and action histories. For a public history h^{t-} , let $Y^t(h^{t-})$ denote the output history, and let $a^t(h^{t-} | s) = (a_\tau^{F,s})_{\tau < t}$ denote the conjectured action history under assessment s provided by Lemma 1.

A second feature of Definition 1 is its reduced-form renegotiation rule. Search frictions create a bilateral monopoly between the worker and firm, so the parties' participation constraints generally create a "zone of indeterminacy" (Okun 1975, p. 367)—a set of mutually-agreeable wages, rather

¹⁵One way to see the intuition is to consider the discrete-time case. In the first period, the worker trivially has no private information, so her action is publicly predictable. In the second period, her private information is just her first-period action, which is publicly predictable, so her second-period action is publicly predictable, and so on. The argument fails if the worker could privately randomize over actions (and she observed the realization of this randomization).

than a unique wage. Selecting a wage requires an additional bargaining assumption. I specify the outcome of bargaining directly through a renegotiation rule as part of the definition of an assessment, rather than including a particular bargaining game. This simplifies the analysis and avoids tying the results to any single bargaining protocol. I show later that my preferred rule—renegotiation “by mutual consent”—admits several microfoundations.

Third, I define beliefs only at pre-action histories. One could also define beliefs at renegotiation, conditioning additionally on the meeting and output increment at t ; but this would add nothing, since meetings are independent of ability and the output process is continuous.

3.3. Defining the equilibrium concept

Some additional notation is helpful to define an equilibrium. Let $K_t(\cdot \mid (Y_\tau, a_\tau)_{\tau < t})$ denote the Bayesian posterior for θ_t given $(Y_\tau, a_\tau)_{\tau < t}$ and the laws of motion (1) and (2). In an assessment $s = \langle \pi^F, \pi^W, a, \mathcal{W} \rangle$, firm beliefs π^F are **public-history Bayes-consistent** if $\pi^F(h^{t-}) = K_t(\cdot \mid Y^t(h^{t-}), a^{F,s}(h^{t-}))$ for every feasible h^{t-} . Worker beliefs π^W are **private-history Bayes-consistent** if $\pi^W(\tilde{h}^{t-}) = K_t(\cdot \mid Y^t(\tilde{h}^{t-}), a(\tilde{h}^{t-}))$ for every feasible $\tilde{h}^{t-}$. Thus, firms condition on the action history implied by the assessment, whereas the worker conditions on her realized actions (including any deviations).

Given an assessment s and public history h^{t-} , denote by $J(w, h^{t-})$ the firm’s continuation value from employing the worker at wage w . Define $\bar{w}(h^{t-}) := \sup\{w : J(w, h^{t-}) \geq 0\}$ as the highest wage such that this continuation value is non-negative. The rule $\mathcal{W}$ is **renegotiation by mutual consent** if

$$(3) \quad \mathcal{W}(h_R^t) = \begin{cases} (w_{t-}, f_{t-}), & \text{if } M_t = 0 \text{ and } J(w_{t-}, h^{t-}) \geq 0, \\ (\bar{w}(h^{t-}), f_{t-}), & \text{if } M_t = 0 \text{ and } J(w_{t-}, h^{t-}) < 0, \\ (\bar{w}(h^{t-}), f_t), & \text{if } M_t = 1, \text{ where } f_t \in \{f_{t-}, \hat{f}_t\}. \end{cases}$$

This protocol was first proposed by Postel-Vinay and Robin (2002) and has become the standard treatment of wage renegotiation in ongoing employment relationships.¹⁶ To see why it is described as renegotiation by mutual consent, consider each case. Without an outside offer, if the firm’s continuation value at the current wage is positive, no change is mutually acceptable: the worker would reject any cut, the firm any raise. If the firm’s continuation value is negative, a wage cut is mutually acceptable: anticipating that the firm would otherwise dissolve employment, the worker agrees to a cut—but only to $\bar{w}(h^{t-})$, at which the firm is just indifferent to continuing employment. When an outside firm arrives, the worker can credibly threaten to leave, and competition raises her wage to $\bar{w}$, leaving her the full surplus.¹⁷

Finally, given an assessment $s = \langle \pi^F, \pi^W, a, \mathcal{W} \rangle$ in which the renegotiation rule is renegotiation by mutual consent, I will say that the action rule a is a **Markov action rule** if there is a measurable function $a : \mathbb{R} \times \Delta(\Theta) \times \Delta(\Theta) \rightarrow \mathcal{A}$ such that, for every private history $\tilde{h}^{t-}$ with associated public history h^{t-} and wage w_{t-} , we have $a(\tilde{h}^{t-}) = a(w_{t-}, \pi^F(h^{t-}), \pi^W(\tilde{h}^{t-}))$.

¹⁶ For examples in structural work on wage dynamics and dispersion, see Dey and Flinn (2005); Cahuc et al. (2006); Postel-Vinay and Turon (2010); Bagger et al. (2014); Bagger and Lentz (2019); Taber and Vejlin (2020); in work on sorting between workers and firms, see Lise and Robin (2017); Lise and Postel-Vinay (2020); Lindenlaub and Postel-Vinay (2023); in work on business-cycle dynamics of unemployment and wages, see Robin (2011); Bilal et al. (2022); Elsby and Gottfries (2022); in applications to job security and labor market power, see Jarosch (2023); Berger et al. (2024).

¹⁷ Because $\bar{w}$ is the firm’s break-even continuation wage, it can exceed the worker’s current expected output: the firm may accept temporary flow losses in anticipation of future profits.

Definition 2. An assessment $\hat{s} = \langle \hat{\pi}^F, \hat{\pi}^W, \hat{a}, \hat{\lambda} \rangle$ is a **Markov equilibrium with renegotiation by mutual consent** if:

- (1) the firms' beliefs are public-history Bayes-consistent;
- (2) the worker's beliefs are private-history Bayes-consistent;
- (3) the worker's action rule is sequentially optimal: for every bounded $\tilde{F}$ -stopping time τ , the continuation action rule induced by $\hat{a}$ maximizes the worker's expected discounted continuation payoff, given the worker's beliefs, the firm's beliefs, and the renegotiation rule;
- (4) the action rule is Markov; and
- (5) the renegotiation rule is renegotiation by mutual consent.

For concision, I will generally call such an assessment an **equilibrium**.

Requirement (1) is the standard PBE requirement for beliefs and, because output has full-support noise, fully pins down firms' beliefs. (2) strengthens standard PBE consistency by restricting the worker's beliefs also following her own deviations. PBE leaves beliefs unrestricted at the resulting off-path private histories. This is unreasonable: since the worker knows her own actions and hence fully understands the generating process for output, her beliefs should follow Bayes' rule even after a deviation. Requirement (2) imposes such a restriction. The Markov restriction in (4) is standard in career concerns models, though often implicit (Hörner and Lambert 2021).

3.4. Discussion of main assumptions

I now discuss the main assumptions. First, the labor market is imperfectly competitive, in the sense that the worker encounters outside firms only intermittently. One interpretation is that there are search frictions, as in the Diamond-Mortensen-Pissarides (DMP) framework. Similarly, if there is a thin market of employers for the worker's skills and location, then credible outside options may arrive only infrequently. Alternatively, these frictions may arise from imperfect information. Online Appendix A describes an alternative model in which the worker can always contact outside firms, but her performance is only intermittently observable to them.¹⁸ I show that equilibrium behavior in this "private performance" model is very similar to the baseline model in which performance is public, but meetings occur infrequently. Intuitively, when performance is not publicly observed, outside firms anticipate that transitions are adversely selected (Gibbons and Katz 1991), and so will not make competitive offers. The worker is therefore in a position to renegotiate only with her incumbent employer, just as if she had no outside contact at all. Thus, one can interchangeably think of the imperfect competition in the model as arising from search or information frictions.

Second, the model considers a single worker. If the labor market instead consists of many workers with independent abilities, and firm output is additive across workers, each employment relationship can be analyzed separately; we can interpret the model as a reduced-form representation of that more general setting. Similarly, the meeting rate q is exogenous; in the many-worker setting it could instead be determined by firms' vacancy posting, as in the standard DMP model. Alternatively, the worker herself may influence q through costly search; section 7 considers this case.

Third, the model excludes long-term contracts: the firm and worker cannot agree on a contract which guarantees future employment or wages. This reflects typical employment contracts, which

¹⁸This recalls the literature on asymmetric information about worker productivity, which typically does not allow for the worker to choose her behavior on the job (Waldman 1984; Greenwald 1986; Milgrom and Oster 1987; Gibbons and Katz 1991; Pinkston 2009; Kahn 2013).

specify current terms, but not future employment or wages (Devereux and Hart 2007; Hallock 2009; Hall and Krueger 2012). Section 7 considers various other assumptions on commitment.

In addition, several assumptions are made for tractability. The Gaussian structure allows us to compute beliefs simply. Working in continuous time simplifies the wage renegotiation process. As Holmstrom and Milgrom (1987) point out, the continuous-time setting can be viewed as an approximation to a discrete-time multinomial model with many periods. Ability is exogenous: there is no human capital accumulation. I also abstract from direct costs of switching employers, firing costs, and match-specific investments in order to focus on imperfect competition.

3.5. Foundations for renegotiation by mutual consent

Finally, I assume wages are renegotiated by “mutual consent”: the incumbent wage is revised only when one party can credibly threaten termination, in which case it adjusts just enough to preserve the relationship. Online Appendix A gives a detailed example of wage dynamics under the protocol.

This view of wage setting reflects the fact wages are typically renegotiated only infrequently. If employment consisted of a sequence of spot contracts—for instance, as for contingent or temporary workers—then it would be natural to imagine wages being reset continuously. In most long-term relationships, however, the employment contract is continuing (Halonen-Akatwijuka and Hart 2020): the current wage remains in force unless both parties agree to change it, or one party can credibly threaten to terminate.¹⁹ Three facts support this view. First, wages in ongoing jobs are substantially less cyclical than wages in new matches (Beaudry and DiNardo 1991; Pissarides 2009; Grigsby et al. 2021), which is consistent with renegotiation relative to inherited wages rather than continuous bargaining from scratch. Second, the assumption reflects legal and institutional features of employment: in many settings, wages are contractual terms that can be revised only with mutual consent (see Malcomson (1997) for a discussion in the UK and Holden (2004) for Europe).²⁰ Third, renegotiation by mutual consent is standard in structural work, where it appears to capture empirically relevant wage dynamics. By contrast, bargaining “from scratch” has counterintuitive implications when outside offers arrive intermittently: a worker paid below marginal product would receive a raise when an outside offer arrives, but lose it once the offer expires. In continuous time, where outside offers arrive and disappear instantaneously, outside offers would have almost no value to the worker. Under mutual consent, the higher wage instead persists as the new default.

The protocol also has formal foundations, presented in more detail in Online Appendix A. First, it can be derived from a simple non-cooperative renegotiation game between the worker and the incumbent firm: at each instant, either party may propose a new wage. If a proposed wage is accepted, the relationship continues at that wage; if not, employment continues at the current wage only if both parties agree. The unique equilibrium of this game implements the mutual-consent

¹⁹Halonen-Akatwijuka and Hart (2020) write that “employment contracts are the leading case of ‘continuing contracts’, in which each party can often terminate the transaction at will, but... they usually do not... the current contract is a reference point for contractual revision” (pp. 284–286). See also Hallock (2009, p. 69), and Hart and Moore (2008) for a related, though behavioral, notion of contracts as reference points.

²⁰Malcomson (1997) states that, under English law, terms of employment “can be varied only by mutual agreement... If one party tries to change the current wage terms, the other party makes clear that the change is not acceptable, and yet employment nevertheless continues, then the current wage terms must continue to be honored” (p. 1920). Thus a worker can reject a proposed wage cut absent a credible threat to terminate, and a firm can reject a proposed raise absent a credible threat to quit. In the United States, employment at will in principle permits continuous wage adjustment, wage changes in practice are infrequent (Postel-Vinay and Turon 2010).

rule. Earlier work has described several other non-cooperative foundations.²¹ Second, the rule has an axiomatic characterization: it is the unique renegotiation rule under which employment continues whenever joint surplus is positive, wage revisions occur only when both parties prefer them to the relevant disagreement outcome, and wages do not fall when joint surplus rises.

For these reasons, I consider wage renegotiation by mutual consent as a leading case. In section 7, I turn to the implications of several other bargaining protocols, which allow for either *more* flexibility in renegotiation—as in the case of continuous wage adjustment—or *less* flexibility—as in the case of downward wage rigidities or wage posting models.

4. Preliminaries: beliefs, evolution of value functions, and equilibrium existence

I begin by establishing a few preliminary results, concluding with equilibrium existence. First, beliefs are determined by the Kalman-Bucy filter.

Lemma 2. *Fix a private history $\tilde{h}^{t-}$, with associated public history h^{t-} . The worker's and firms' beliefs are Gaussian with common deterministic posterior variance Σ_t and posterior means $\hat{\mu}_t^i$, $i \in \{W, F\}$, satisfying*

$$(4) \quad d\Sigma_t = \left[-2\kappa\Sigma_t + \gamma^2 - \frac{\Sigma_t^2}{s^2} \right] dt, \quad \Sigma_0 = \sigma_\theta^2,$$

$$(5) \quad d\hat{\mu}_t^i = \kappa(\bar{\theta} - \hat{\mu}_t^i)dt + \frac{\Sigma_t}{s^2} d\hat{v}_t^i, \quad \hat{\mu}_0^i = \bar{\theta},$$

where the innovation $d\hat{v}_t^i = dY_t - [m(a_t^i) + \hat{\mu}_t^i]dt$ is computed from the conjectured action for firms ($a_t^F = \hat{a}_t^F$) and the realized action for the worker ($a_t^W = a_t$).

As is standard, the posterior variance depends on calendar time and parameters but not the realized history: Σ_t is deterministic, and converges to the steady-state variance $\Sigma^* := \gamma^2/(\kappa + \sqrt{\kappa^2 + \gamma^2/s^2}) > 0$. For ease of notation, write $\dot{\Sigma}_t := -2\kappa\Sigma_t + \gamma^2 - \frac{\Sigma_t^2}{s^2}$, so $d\Sigma_t = \dot{\Sigma}_t dt$.

On the other hand, the posterior mean for ability is stochastic, and itself follows an Itô process. Beliefs are Bayesian and hence, if there were no mean-reversion in the ability process, $\hat{\mu}_t^i$ would be a Martingale; with mean reversion, it drifts toward $\bar{\theta}$ at rate κ . Its diffusion is driven by the innovation to output, defined as the realized output increment dY_t less its expected increment; the firm expects an increment $m(\hat{a}_t^F) + \hat{\mu}_t^F$, since the firm uses the conjectured action path a^F , whereas the worker expects $m(\hat{a}_t^F) + \hat{\mu}_t^W$. At an on-path private history $\tilde{h}^{t-}$ with associated public history h^{t-} , these coincide, so we can write $\hat{\mu}_t(h^{t-}) := \hat{\mu}_t^W(\tilde{h}^{t-}) = \hat{\mu}_t^F(h^{t-})$.

Since beliefs are Gaussian with common variance, the Markov action rule can be written $a(w, \mu^W, \mu^F, \Sigma)$. Similarly, continuation values depend on the history only through the state $(w, \mu^W, \mu^F, \Sigma)$. Denote by $W(w, \mu^W, \mu^F, \Sigma)$ the **worker's continuation value** and by $J(w, \mu^F, \Sigma)$ the **incumbent employer's continuation value**.²² These value functions can be written compactly in HJB form.

²¹Hart and Moore (1988) propose a message game leading to a similar conclusion. MacLeod and Malcomson (1993) propose a non-cooperative game in which parties can ask to renegotiate, but, in doing so, they lose their bargaining power in subsequent renegotiations. Thomas and Worrall (1988) show the same rule can arise from an implicit contract between a risk-neutral firm and a risk-averse worker, and Elsby et al. (2024) under costly renegotiation.

²²Note that the firm's continuation value does not condition on the worker's beliefs μ^W : because output has full-

Lemma 3. Fixing an equilibrium $\hat{s}$, the value functions satisfy the recursions:

(6)

$$\rho W(w, \mu^W, \mu^F, \Sigma) = \max_{a \in \mathcal{A}} \left\{ \underbrace{w - c(a)}_{\text{Flow payoff}} + \underbrace{\mathcal{L}_W^a W(w, \mu^W, \mu^F, \Sigma)}_{\text{Contrib. of change in cont. value from no outside offer}} + q \underbrace{\left[W(\bar{w}(\mu^F, \Sigma), \mu^W, \mu^F, \Sigma) - W(w, \mu^W, \mu^F, \Sigma) \right]}_{\text{Contrib. of change in cont. value from outside offer}} \right\}$$

(7)

$$\rho J(w, \mu^F, \Sigma) = \underbrace{m(\hat{a}^F(w, \mu^F, \Sigma)) + \mu^F - w}_{\text{Flow payoff}} + \underbrace{\mathcal{L}_F J(w, \mu^F, \Sigma)}_{\text{Contrib. of change in cont. value from no outside offer}} - \underbrace{q J(w, \mu^F, \Sigma)}_{\text{Contrib. of change in cont. value from outside offer}},$$

where $\mathcal{L}_W^a$ and $\mathcal{L}_F$ are the generators for the value functions absent an outside offer, defined by

$$(8) \quad \mathcal{L}_W^a W(w, \mu^W, \mu^F, \Sigma) = \dot{\Sigma} W_\Sigma + \kappa(\bar{\theta} - \mu^F) + \frac{\Sigma}{s^2} [\mu^W - \mu^F + m(a) - m(\hat{a}^F(w, \mu^F, \Sigma))] W_{\mu^F} \\ + \frac{\Sigma^2}{2s^2} \left[W_{\mu^F, \mu^F} + 2W_{\mu^F, \mu^W} + W_{\mu^W, \mu^W} \right],$$

$$(9) \quad \mathcal{L}_F J(w, \mu^F, \Sigma) = \dot{\Sigma} J_\Sigma(w, \mu^F, \Sigma) + \kappa(\bar{\theta} - \mu^F) J_\mu(w, \mu^F, \Sigma) + \frac{\Sigma^2}{2s^2} J_{\mu^F \mu^F}(w, \mu^F, \Sigma).$$

Recall that, by Lemma 2, the worker and firms share beliefs on the equilibrium path; define the **worker's continuation value on the equilibrium path** as $W^*(w, \mu, \Sigma) := W(w, \mu, \mu, \Sigma)$, and likewise the **incumbent employer's continuation value on the equilibrium path** by $J^*(w, \mu, \Sigma)$.

These expressions also clarify how the worker's action affects continuation payoffs. Consider choosing an action a to solve the maximization problem in (6). The cost of a marginally higher action is the flow effort cost $c'(a)$. The benefit of a marginally higher action is in its effect on the change in the firm's posterior mean for ability μ^F ; inspecting equation (8) shows that the increase in the firm's posterior mean for ability is $m'(a)[\Sigma/s^2]$, and that the value of a marginal increase in the firm's posterior mean for ability is W_{μ^F} . As a result, heuristically, the worker's optimal action satisfies $c'(a) = m'(a)[\Sigma/s^2] W_{\mu^F}$. Lemma 4 puts this formally.

Lemma 4. Fix an equilibrium s and a feasible worker belief μ_W , firm belief μ_F , posterior variance Σ , and incumbent wage w . The worker's action given this wage and beliefs, $a = a(w, \mu^W, \mu^F, \Sigma)$, is then implicitly pinned down as the unique action that satisfies:

$$(10) \quad c'(a) = \frac{\Sigma}{s^2} m'(a) W_{\mu^F}(w, \mu^W, \mu^F, \Sigma).$$

Hence, given any candidate action rule, we can compute the worker's value function through (6); given a candidate value function, we can find the corresponding action rule through (10). An equilibrium is a fixed point of this problem. Proposition 1 states that such a fixed point exists.

Proposition 1. There is an equilibrium to the game described above.

support noise, every public history is consistent with on-path play, so firms always evaluate the history under the conjectured action rule and $\mu^W = \mu^F$. The value function J is thus the firm's *perceived* continuation value.

5. The effects of imperfect competition on effort towards the level of output

How does imperfect labor market competition affect incentives for the level of output? I address this question in three steps. I begin with some benchmark cases. I then derive some properties of the worker's value function, and finally consider implications for the worker's actions.

5.1. Benchmarks: effort under contractible output/actions and perfect competition

I begin with three benchmarks. First, in the **verifiable-output case**, I amend the model above to allow the contract to condition the worker's wage on her output. Second, in the **verifiable-action case**, I amend the model to allow the contract to condition on the worker's chosen action. I describe these benchmark cases formally in Online Appendix A.

Lemma 5. *In the verifiable-output or verifiable-action case, the worker's equilibrium value function is linear in the posterior mean for ability. The worker's equilibrium action at each t is $a_t = a_{FB}$.*

In the verifiable-action case, the parties directly contract on the first-best action. In the verifiable-output case, since both parties are risk-neutral, "selling the firm" implements the first-best action.

Third, suppose that the worker's output and action are *not* verifiable, but amend the model such that the labor market is **competitive**, in the sense that the worker receives an outside offer at each instant, rather than infrequently. In that case, the setting becomes a continuous-time version of Holmström (1982/1999), and is very similar to the setting of Cisternas (2018a, Section II.B).

Lemma 6. *In the competition case, there is a unique equilibrium value function and action rule.*

- (i) *The worker's equilibrium value function W^C is linear in the posterior mean for ability. Moreover, her wage at each time t is her expected output at t .*
- (ii) *The worker's action depends on calendar time, but not otherwise on the history. In particular, the action a_t^C is implicitly defined by $c'(a_t^C) = \psi_t m'(a_t^C)$, where*

$$\psi_t := \left[\frac{\Sigma_t}{s^2} \int_{\tau=t}^{\infty} \exp \left\{ - \int_t^{\tau} \left(\rho + \kappa + \frac{\Sigma_u}{s^2} \right) du \right\} d\tau \right].$$

The action converges to the steady-state action a^C implicitly defined by $c'(a^C) = \psi^ m'(a^C)$, for $\psi^* := \lim_{t \rightarrow \infty} \psi_t = \Sigma^* / [\rho s^2 + \kappa s^2 + \Sigma^*]$.*

- (iii) *At each t , the worker's equilibrium a_t^C is strictly below the first-best action a_{FB} .*

The worker's actions fall below the first-best actions for two reasons. First, exerting more effort in the current instant increases future compensation, not current compensation: to the extent that the worker is impatient ($\rho > 0$), she is deterred from effort. Second, exerting more effort does not permanently increase the market's view of the worker's ability, since ability is partly mean-reverting ($\kappa > 0$). As in Holmström (1982/1999), we recover the first-best case as the worker becomes patient ($\rho \rightarrow 0$) and the ability process approaches Brownian motion ($\kappa \rightarrow 0$).

Cisternas (2018a) also demonstrates that this is an equilibrium. The technical contribution of Lemma 6 is to show uniqueness. Substantively, this is of interest because I will later show that imperfect competition generates history-dependence. Since the unique competitive equilibrium is

history-independent, we can conclude that any history-dependence is due to imperfect competition.

5.2. The worker's continuation value under imperfect competition

I now turn to the case of interest, in which actions and output are non-contractible, and there is imperfect competition. I begin with the worker's equilibrium continuation value, $W^*(w, \mu, \Sigma)$.

Proposition 2. *The worker's equilibrium continuation value is concave in the posterior mean for ability.*

Thus, although the worker is risk-neutral over consumption, she is risk-averse over reputation.²³ To see the intuition, fix some feasible (w, Σ) , and denote by $\underline{\mu}(w, \Sigma)$ the lowest posterior mean at which the incumbent firm is willing to continue the employment relationship at wage w : $\underline{\mu}(w, \Sigma) := \inf\{\mu : J^*(w, \mu, \Sigma) \geq 0\}$. On the equilibrium path, $\mu \geq \underline{\mu}$: otherwise, the firm would already have renegotiated wages down. Think of the difference between the worker's current posterior and the posterior that would cause renegotiation, $B(w, \mu, \Sigma) := \mu - \underline{\mu}(w, \Sigma)$, as the worker's "reputational buffer". When this buffer is small, the worker is close to a downward wage renegotiation, so her continuation value is highly sensitive to performance. When the buffer is large, the worker does not anticipate immediate renegotiation, and hence her payoff is less sensitive to performance.

The intuition resembles buffer-stock models of saving (Deaton 1991; Carroll 1997, 2001). In those models, wealth insures against adverse shocks, so its marginal value is high near the liquidity constraint but falls once the household has a sufficient buffer. Here, the relevant buffer is reputation, and the worker fears reaching the renegotiation threshold rather than the liquidity constraint.

Figure 4(a) illustrates Proposition 2 graphically by depicting the worker's equilibrium value function $W^*(w, \mu, \Sigma)$, holding fixed (w, Σ) and varying the posterior mean μ . To construct the figure, I solve for equilibrium numerically under particular parameter values; since the purpose of the figure is to highlight qualitative features, I leave the details to Online Appendix A. Under competition (navy), the worker's continuation value is linear in μ (Lemma 6); in the imperfectly competitive case (in purple) it is concave (Proposition 2).²⁴ In the two-period model in section 2, the worker's value function was kinked; here, the kink is "smoothed". Intuitively, in the two-period model, once the worker is marginally above the second-period renegotiation threshold, she can no longer face a wage cut. In the dynamic model, by contrast, a worker just above the threshold is protected from a wage cut today, but still faces the risk of crossing the threshold in the future. Figure 4(a) also shows expressions for the slopes of the value functions, which I return to at the end of this subsection.

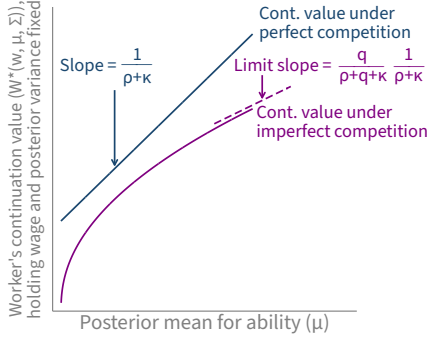
To see the intuition, note that changes in reputation are only capitalized into wages after a renegotiation. Given an on-path state (w, μ, Σ) , denote by $R(w, \mu, \Sigma)$ the expected time until the next renegotiation. Fix (w, Σ) , and consider how $R(w, \mu, \Sigma)$ varies with μ . Under competition, wages are continuously reset to expected output. Since the posterior mean follows the diffusion process in (5), expected output is continuously changing, so $R(w, \mu, \Sigma) = 0$, as in the navy line in Figure 4(b).

²³Since (5) shows that the innovation to reputation is linear in the innovation to output, the same logic shows that the worker's continuation value is concave in performance, as in the empirical literature discussed in the introduction.

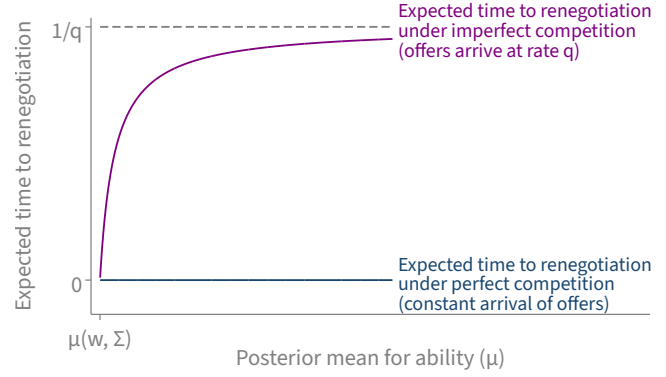
²⁴The continuation value in the competitive case is also shifted above the continuation value in the imperfectly competitive case. This reflects both that firms can extract some rent in the imperfectly competitive case, and that joint surplus is smaller in the imperfectly competitive case.

FIGURE 4. The worker's equilibrium continuation value and expected time to renegotiation

(a) The worker's equilibrium continuation value



(b) Expected time to renegotiation



Note: Panel (a) illustrates the worker's equilibrium continuation value $W^*(w, \mu, \Sigma)$, holding fixed (w, Σ) and varying μ , under perfect (navy) and imperfect (purple) competition. Panel (b) depicts the expected time to renegotiation $R(w, \mu, \Sigma)$, holding fixed (w, Σ) and varying μ , in the same cases.

Under imperfect competition, the wage is reset only when the firm's participation constraint binds or an outside offer arrives. The former event occurs when μ hits the renegotiation threshold $\underline{\mu}(w, \Sigma)$; the latter arrives at Poisson rate q . As μ approaches $\underline{\mu}(w, \Sigma)$ from above, the worker is arbitrarily close to the firm's participation constraint, the expected time to renegotiation approaches zero. As μ becomes large, the firm's participation constraint is increasingly unlikely to bind before the next outside offer, so the expected time to renegotiation approaches the expected waiting time for an outside offer, $1/q$. Generally, the expected time to renegotiation is zero in the competitive case, but increasing in reputation under imperfect competition (purple curve in Figure 4(b)).²⁵

As a result, when μ is close to $\underline{\mu}(w, \Sigma)$, a marginal increase in the posterior mean is valuable because it substantially reduces the probability of an imminent wage cut. When μ is far above the threshold, however, an additional unit of reputation is less valuable: the worker is already unlikely to face a downward renegotiation soon, and further good news is capitalized into higher wages only when an outside offer arrives. Thus the marginal value of reputation is high near the renegotiation threshold and lower when the worker is already secure, generating the concave shape of $W^*(w, \mu, \Sigma)$.

5.3. The worker's action choices under imperfect competition

I now turn to the worker's effort. In the introductory example, the worker had weaker incentives to exert effort when her reputation was strong. Does the same logic apply to the general model?

Fix an equilibrium, and recall that $a(w, \mu, \Sigma)$ denotes the worker's equilibrium effort given state (w, μ, Σ) . I will call the worker's effort **performance-independent** if $a(w, \mu, \Sigma)$ is constant in μ , and say it **targets acceptable performance** if $a(w, \mu, \Sigma)$ is strictly decreasing in μ .²⁶ Figure 5(a) illustrates these definitions with two sample paths of cumulative output, which coincide on $[0, t_1]$ and diverge on $[t_1, t_2]$. Suppose the divergence reflects only noise: the worker on the navy path is "lucky," in the sense that she receives more favorable output shocks than the worker on the light-blue path. The

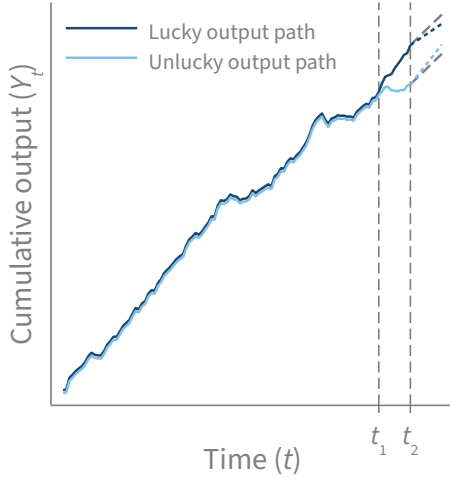
²⁵Appendix Lemma A3 makes these statements formal.

²⁶These possibilities are mutually exclusive, but not exhaustive: for instance, workers with stronger reputations could exert *more* effort.

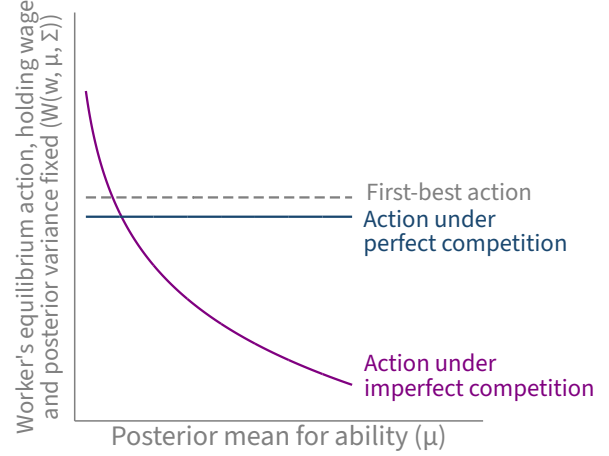
belief dynamics (5) then imply the posterior mean at t_2 is higher on the navy path. Suppose also that there are no wage renegotiations between t_1 and t_2 , so the two histories have the same wage and posterior variance at t_2 but different posterior means.

FIGURE 5. Performance-targeting and equilibrium effort

(a) Intuition for definition of performance-targeting



(b) Equilibrium action policy under perfect and imperfect competition



Note: Panel (a) illustrates the definition of performance-targeting through two sample paths of output. Panel (b) depicts the equilibrium action policy under perfect and imperfect competition.

The dashed lines show possible values for the drift of output at t_2 . If effort is performance-independent, then the drift of output is the same after both paths, as indicated by the dashed parallel lines in gray. If the worker targets acceptable performance, the worse-performing worker exerts more effort, and hence her drift (dashed light blue) is higher than the drift of the better-performing worker (dashed navy). In this sense, targeting acceptable performance generates “catch-up”, and both workers drift towards an “intermediate” level of performance: the worse-performing workers exerts more effort; the better-performing worker rests on her laurels.

Lemma 6 showed that, in the competitive benchmark, the worker’s action at time t is independent of her history. Thus, under competition, the worker does not target acceptable performance.

The case of interest is imperfect competition. Lemma 4 showed that the worker’s incentive to exert effort is to bolster her reputation, and Proposition 2 implies that the marginal value of reputation is decreasing. These two results jointly suggest that the worker will have weaker incentives to exert effort when her reputation is already strong.²⁷ Proposition 3 shows this formally.

Proposition 3. (i) *In the competitive case, the worker never targets acceptable performance. Under imperfect competition, in every equilibrium, the worker targets acceptable performance.*
(ii) *Fix an equilibrium, and some (w, Σ) that can be attained on the equilibrium path. Under imperfect competition, there exists a value for the posterior mean μ^* such that, if $\mu > \mu^*$, then the worker’s*

²⁷This intuition is imprecise because the equilibrium continuation value $W^*(w, \mu, \Sigma)$ uses the *shared* posterior mean for ability on the equilibrium path, whereas a deviation in the worker’s effort changes firms’ posterior belief about ability, but not the worker’s own posterior. Lemma A1 shows that the worker’s value of a better reputation *in the firm’s eyes* is also decreasing in her current reputation.

action at (w, μ, Σ) is strictly below the perfectly competitive action, whereas if $\mu < \mu^$, then the worker's action at (w, μ, Σ) is strictly above the perfectly competitive action.*

Proposition 3 is illustrated in Figure 5(b). The navy line, corresponding to perfect competition, is flat: the worker's action is history-independent and hence independent of the posterior mean. The purple curve, corresponding to imperfect competition, is downward-sloping.²⁸ The model therefore predicts that “secure” workers slack off, while “insecure” workers exert more effort.

This result gives a dynamic interpretation of performance targeting. Existing work attributes performance targeting to explicit targets such as quotas, targets, or bonuses.²⁹ Here, targeting arises without any explicit target: the threat of renegotiation looms larger for less secure workers, who accordingly exert more effort—consistent with evidence that effort is higher where job security is worse (Engelland and Riphahn 2005).

Part (ii) describes the *level* of effort under imperfect competition. Workers with sufficiently strong reputations exert effort below the competitive level; workers with sufficiently weak reputations exert effort above it. The intuition for the former result is similar to the introductory example: under imperfect competition, a high-performing worker anticipates that higher expected future output will not be fully capitalized into higher wages, and hence her incentives for effort are muted.

The intuition for the latter result is somewhat more complicated. Consider a worker whose current reputation is at the renegotiation threshold: (w, μ, Σ) are such that $\mu = \underline{\mu}(w, \Sigma)$. At the renegotiation threshold, changes in reputation are immediately capitalized into wages, as under competition. But an additional force strengthens effort incentives: in the competitive case, a decline in the wage from temporarily poor performance can be alleviated by subsequent strong performance; in the imperfectly competitive case, a decline in the wage from temporarily poor performance may persist *even after strong performance*, because the worker cannot bargain the wage back up without an outside offer. Anticipating this persistence creates a precautionary motive for effort that is absent in the competitive case. Indeed, this precautionary motive may even cause effort to exceed the first-best case for workers with a sufficiently poor reputation, as depicted in Figure 5(b).

Lemma 7. *If the arrival rate of outside offers q is sufficiently high, then, on the equilibrium path, the worker's action is strictly below the first-best effort level. If the arrival rate is sufficiently low, then, on the equilibrium path, the worker's action is strictly above the first-best effort level if the posterior mean for ability μ is sufficiently low, fixing her wage w and posterior variance Σ .*

Lemma 7 recalls an earlier literature which documents that effort in career concerns models can be inefficiently high (Akerlof 1976; Holmström 1982/1999; Landers et al. 1996). The intuition is quite different. In those papers, effort is inefficiently high because the employer learns a great deal about the worker's ability early in the relationship, so the worker has an incentive to frontload effort. Here, the generating process for output is stationary, and the incentives to exceed first-best

²⁸This contrast recalls the dynamic interpretation of Mirrlees (1974/1999) in Holmstrom and Milgrom (1987): when compensation is non-linear in cumulative output, incentives for marginal effort depend on performance history, whereas a linear scheme provides constant incentives for effort. There, the compensation scheme is chosen by a principal; here, the analogous incentive schedule emerges from the labor market's response to the worker's reputation.

²⁹For examples, see Oyer (1998, 2000); Larkin (2014) on sales quotas; Steenburgh (2008); Anderson et al. (2010); Chung et al. (2014) on lump-sum bonuses; Myers et al. (2007); Jensen (2003); Bennett et al. (2017) on budget or earnings targets; and Kelman and Friedman (2009); Neal and Schanzenbach (2010) on accountability thresholds.

effort instead come from the worker's desire to protect herself from renegotiation.

5.4. A quantitative illustration of the effects of imperfect competition, for secure workers

These results suggest a simple quantitative illustration of how imperfect competition attenuates the returns to performance for workers who are “secure” in their jobs, in the sense that they are far from the point at which their employer could credibly threaten termination. Consider first the competitive benchmark. In that case, Figure 5(a) shows that the slope of the value function is $1/[\rho + \kappa]$. To see the intuition, note that in the competitive case, the worker is paid her expected output; since her action is constant in her posterior mean (Lemma 6), up to a constant, the worker's wage is equal to the posterior mean for ability. Since ability is mean-reverting at rate κ , an increase in the posterior mean for ability at t increases the expected wage τ periods ahead by $\exp(-\kappa\tau)$. Discounting at rate ρ , the slope of her continuation value is $\int_{\tau=0}^{\infty} \exp(-\kappa\tau) \exp(-\rho\tau) d\tau = \frac{1}{\kappa + \rho}$.

In the imperfectly competitive case, the value function has limiting slope $\lim_{\mu \rightarrow \infty} W_{\mu}^*(w, \mu, \Sigma) = \frac{q}{\rho + q + \kappa} \frac{1}{\rho + \kappa}$, which converges to the competitive slope from below as $q \rightarrow \infty$.³⁰ To see the intuition, consider a worker whose reputation is far above the renegotiation threshold, so that the firm's participation constraint is unlikely to bind. A marginal increase in the posterior mean then affects wages only once the worker receives an outside offer. At horizon τ , the effect of a one-unit increase in the current posterior mean on expected ability has depreciated to $\exp(-\kappa\tau)$. The probability that this reputation gain has been capitalized into wages by horizon τ is $1 - \exp(-q\tau)$, since outside offers arrive at rate q . Discounting at rate ρ , the limiting slope of the worker's continuation value is therefore $\int_{\tau=0}^{\infty} \exp(-\rho\tau) \exp(-\kappa\tau) [1 - \exp(-q\tau)] d\tau = q/[(\rho + \kappa)(\rho + \kappa + q)]$.

Thus, relative to the competitive benchmark, imperfect competition attenuates the returns to stronger performance for a high-performing worker by a share

$$(11) \quad \frac{\rho + \kappa}{\rho + \kappa + q}.$$

To see the intuition, suppose first the worker is patient ($\rho \rightarrow 0$) and ability is persistent ($\kappa \rightarrow 0$). Absent mean reversion, a temporary improvement in performance permanently raises the posterior mean for ability, and hence the wage the worker will command once an outside offer arrives.³¹ As a result, temporarily strong performance has a permanent effect on the worker's expected output, and hence permanently increases the wage she will receive when an outside offer arrives. Imperfect competition delays the arrival of this outside offer, but for any arrival rate $q > 0$, the delay is almost surely finite; as $\rho \rightarrow 0$, the permanent wage gain dwarfs the value lost during the delay, and hence the proportional loss from imperfect competition vanishes. When ρ and κ are strictly positive, the reputational gain erodes while the worker waits for an offer—through discounting ($\rho > 0$) and mean-reversion ($\kappa > 0$)—so the returns to performance are attenuated.

This simple expression also governs the worker's choices of actions, if we are willing to parameterize the drift term $m(\cdot)$ and effort cost $c(\cdot)$. In the simplest case of linear drift and quadratic effort costs, imperfect competition reduces the worker's effort by the same share in (11).³²

³⁰Appendix Lemma A4 makes these statements formal.

³¹To see this, note that at $\kappa = 0$, (5) implies $d\hat{\mu}^i = \frac{\Sigma_j}{s_j^2} d\hat{v}_t^j$, so the innovation is fully persistent.

³²That is, $m(a) = \beta a$ for some $\beta > 0$, and $c(a) = \chi a^2$, for some $\chi > 0$. I use this case as a simplifying example, even

Appendix Table A1 presents various estimates of the discount rate ρ , arrival rate of outside offers q , and mean-reversion rate κ .³³ These estimates suggest that, for the highest-performing workers, the returns to stronger performance are discounted by about 20% due to imperfect competition. This rough calibration therefore suggests that the effects of imperfect competition on the returns to performance can be reasonably large, though of course many details are stylized, and the calculation only applies to workers with strong existing reputations relative to their wage.

6. The effects of imperfect competition on risk-taking

The last section studied the worker's willingness to exert costly effort towards increasing output. In practice, the worker chooses not just whether to exert effort, but also where to direct it. I focus on one dimension of project choice: whether to prioritize safer or riskier projects. For instance, research scientists choose between furthering an established line of work *vs.* pursuing a novel method (Azoulay et al. 2011); managers choose between conservative and risky business strategies (Hirshleifer and Thakor 1992; Bertrand and Mullainathan 2003); and loan officers choose between higher- and lower-risk new clients (Cole et al. 2015). How does imperfect competition affect these choices over risk levels?

This section gives a mixed answer. I show that workers who are *secure* in their jobs—in the sense that the posterior mean for their ability is far from the level at which the employer could demand renegotiation—choose close to first-best risk levels, whereas workers who are *insecure* in their jobs behave as though risk-averse. Thus, job security creates a tradeoff: secure workers have weak incentives to work hard, but stronger incentives to take efficient risks; insecure workers work hard, but play it safe.

6.1. Extension of model to allow for choices over risk

Amending the model to allow for this possibility requires some care.³⁴ I will assume that the worker's instantaneous output dY_t depends also on project quality x_t :

$$(12) \quad dY_t = [\theta_t + m(a_t) + \zeta x_t]dt + s dZ_{Y,t},$$

where $\zeta \geq 0$ is a constant reflecting the weight on project quality, and the project quality process is

$$(13) \quad x_0 = 0, \quad dx_t = [g(r_t) - \kappa x_t]dt + \tau(r_t)dZ_{X,t}, \quad t \geq 0,$$

though it does not satisfy some of the limiting conditions on the drift and cost functions described in section 3.

³³The model supposes the worker is infinitely-lived. For this calibration, I assume that the worker has a constant Poisson retirement rate δ . The effective discount rate is then $\rho = \bar{\rho} + \delta$, where $\bar{\rho}$ is the worker's subjective discount rate.

³⁴One possibility is to directly modify the output-generating process to allow the diffusion term s to depend on the agent's chosen risk level $dY_t = [m(a_t) + \theta_t]dt + s(r_t) dZ_{Y,t}$. To see why this seemingly natural possibility is unreasonable, recall that a single sample path of an Itô process reveals its diffusion through quadratic variation. As a result, under this formulation, firms would infer $s(r_t)$ at each point in time t . Hence, if s was strictly increasing, firms would fully infer r , thereby eliminating moral hazard. This is a well-known issue in continuous-time contracting models with controllable volatility; see, *e.g.*, Sung (1995); Cvitanic et al. (2017), who note that when output is observed continuously, its instantaneous diffusion is recovered from the quadratic variation of any single sample path (Karatzas and Shreve 1991; Dixit 1993), so a one-dimensional volatility control would be perfectly inferable.

where $r_t \in \mathcal{R} := [r, \bar{r}]$ is the worker's choice of risk at time t , and $Z_{X,t}$ is a standard Brownian motion (independent of $(Z_{Y,t}, Z_{\theta,t})$). I interpret x_t as the latent quality of the worker's line of work, which is portable across employers in the sense that it affects the worker's future output regardless of which firm employs her. The risk choice r_t affects the drift and diffusion of project quality through the twice-differentiable functions g and τ . I assume τ is strictly increasing, so higher r_t raises variance. I also assume that g is strictly concave with an interior maximum. Because both parties are risk-neutral, this maximum is the first-best risk level, denoted $r_{FB} := \arg \max_{r \in \mathcal{R}} g(r)$.

The timing is as in Section 3, except that at the production stage the worker also chooses an unobserved risk level r_t . Neither the worker nor employers observe x_t . The baseline model is nested by $\zeta = 0$ (or $\mathcal{R}$ is degenerate); in this section, I assume $\zeta > 0$ (and $\mathcal{R}$ is non-degenerate). I define equilibrium analogously to Definition 2, extending beliefs to include the pair (θ_t, x_t) , and permitting the worker to choose both effort and risk.³⁵ Since these definitions mostly repeat the earlier notation, I leave the details to Online Appendix C.

Discussion of main assumptions. I emphasize several assumptions. First, the worker does not observe project quality x_t : like the firm, she learns about her success only from output. Allowing the worker to observe x_t would introduce private information about future output in addition to moral hazard. Second, the worker's choice of risk involves no direct effort cost: the worker has personal preferences over *how hard* to work, as captured by the cost of effort $c(a_t)$, but is indifferent to working on *different projects*. This focuses the analysis on the trade-off between increasing expected output and reducing its variance. It would be simple to extend the analysis to allow for the possibility that different risk levels impose different effort costs on the worker.

Third, mean reversion in x_t keeps the variance of project quality bounded. Project quality is mean-reverting at rate κ , the same rate at which ability mean-reverts; this allows us to simplify the filtering problem by summarizing the worker's payoff-relevant ability by $\phi_t := \theta_t + \zeta x_t$, which I call the worker's **productivity**, rather than separately tracking two components. I will denote by π_t the posterior mean for productivity at time t , and by ξ_t the posterior variance at time t ; as in the case of choices of effort, one can show that the worker and firms share a posterior mean and variance on the equilibrium path. As a result, in a Markov equilibrium, the worker's choices of effort and risk can be written $a_t(\tilde{h}^{t-}) = a(w, \pi, \xi)$ and $r_t(\tilde{h}^{t-}) = r(w, \pi, \xi)$.

Finally, an alternative way to introduce risk-taking would be to suppose that the worker chooses the extent to which her ability influences the drift of output. In this formulation, the weight on ability θ_t in output would depend on the worker's chosen risk level; riskier projects would put a higher weight on ability. Though interesting, this formulation introduces new motivations for exploration *vs.* exploitation which complicate the analysis even in the first-best case. I omit these details in order to focus the analysis on willingness to take on risk.

6.2. Benchmarks: risk-taking under contractible output/actions and perfect competition

As before, I begin by assessing three benchmark cases.

³⁵Several other papers allow an agent to choose both effort and risk, including Holmström (1989); Hirshleifer and Thakor (1992); Hirshleifer and Suh (1992); Sung (1995); Diamond (1998); Barron et al. (2020). These papers do not consider the effects of imperfect labor market competition on risk-taking.

Lemma 8. *Suppose that either (i) actions are contractible, or (ii) output is contractible, or (iii) the labor market is perfectly competitive. Then the worker chooses the first-best risk level r_{FB} at each instant.*

Parts (i) and (ii) follow the same logic as Lemma 5. With contractible actions, the parties contract directly on r_{FB} . With contractible output, the worker can be made the residual claimant on dY_t , which aligns her incentives with joint surplus. Note that contractibility of output is enough even though x_t is unobservable: under risk-neutrality, the worker internalizes the expected output consequences of her risk choice, and the residual variance generated by $\tau(r_t)$ is socially irrelevant.

The intuition for (iii) is that, under perfect competition, the worker captures her full expected output at each instant (Lemma 6), so her continuation value is the expected present value of output. This is linear in the posterior mean and, because the parties are risk-neutral, independent of the posterior variance for project quality; moreover, there is no private cost to taking risk. The worker therefore maximizes the drift of output by choosing r_{FB} .

6.3. The worker's risk-taking under imperfect competition

I now turn to the case of substantive interest: behavior under imperfect competition.

Proposition 4. *Under imperfect competition, on the equilibrium path, the worker always takes on inefficiently little risk: $r(w, \pi, \xi) < r_{FB}$ for every feasible (w, π, ξ) .*

The intuition is closely related to the discussion of Proposition 2. Higher risk raises the variance of project quality and hence of future output. Since the worker's continuation value is concave in beliefs about the worker's future output, the worker is averse to risk. Intuitively, the worker anticipates that poor performance may trigger renegotiation, whereas, under imperfect competition, there is no guarantee that strong performance will be capitalized into higher wages.

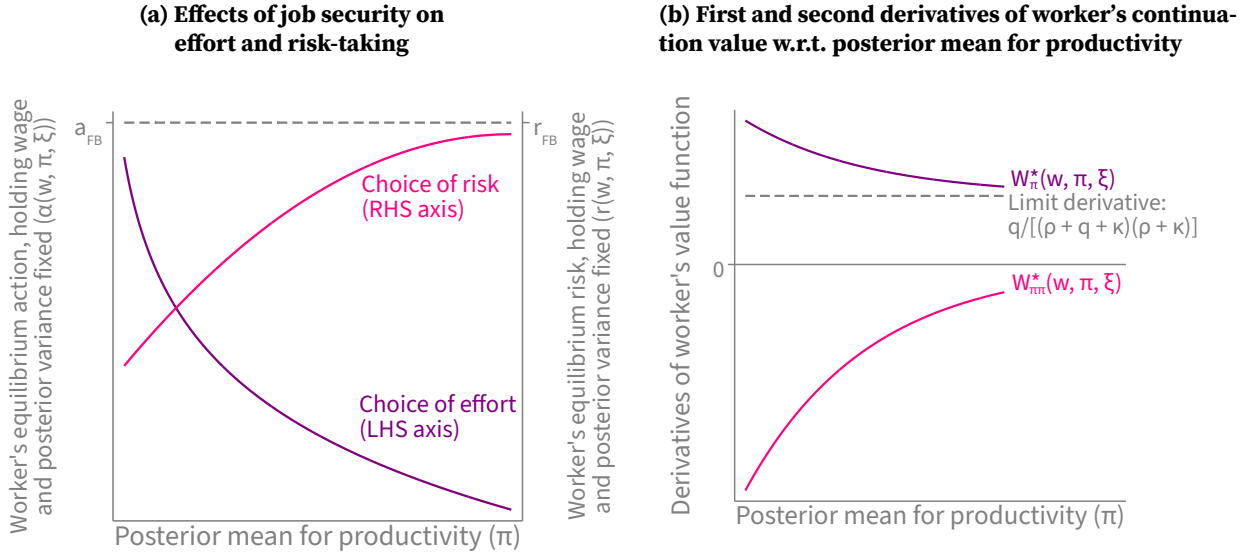
Proposition 5. *On the equilibrium path, the worker's chosen risk at instant t is strictly increasing in the posterior mean for the worker's productivity: $r(w, \pi, \xi)$ is increasing in π . Moreover, fixing the worker's wage, as the posterior mean for the worker's productivity grows arbitrarily large, her chosen risk level approaches the first-best: $\lim_{\pi \rightarrow \infty} r(w, \pi, \xi) = r_{FB}$.*

Proposition 5, together with Proposition 3, gives a mixed picture of the relationship between job security and the incentives facing workers, summarized graphically in Figure 6(a):³⁶ workers who are *insecure* in their jobs work hard, but take too little risk; workers who are *secure* take almost the right amount of risk, but slack off.

Intuitively, effort incentives depend on the *first derivative* of the value function in the posterior mean, whereas risk incentives depend on its *second derivative*. Figure 6(b) plots these derivatives. The first derivative is large near the renegotiation threshold and declines toward the limiting slope $q/[(r+q+\kappa)(r+\kappa)]$ of section 5. Intuitively, as the worker's reputation grows stronger, she becomes less likely to face a downwards renegotiation, and the marginal value of a stronger reputation falls. As a result, the second derivative converges to zero from below. Since this second derivative governs the worker's attitude toward risk, she approaches risk-neutrality as she grows more secure.

³⁶Formally, Proposition 3 applies to a model without choices of risk. Appendix Lemma A5 extends the results of Proposition 3 to an environment with risk.

FIGURE 6. Effort and risk-taking at different levels of job security



Note: Panel (a) depicts equilibrium effort and risk-taking as functions of the posterior mean for productivity ϕ , holding (w, ξ) fixed. I assume that the arrival rate of outside offers q is sufficiently high that the worker's choice of effort is always below the first-best level (Lemma 7). Panel (b) depicts the first and second derivatives of the worker's equilibrium value function $W^*(w, \phi, \xi)$ with respect to the posterior mean for productivity ϕ .

Several empirical patterns are consistent with this effort–risk tradeoff. Greater protection from dismissal is associated with lower effort or greater absenteeism (Ichino and Riphahn 2005; Jacob 2010), but also with greater risk-taking and innovation (Azoulay et al. 2011; Tian and Wang 2014; Acharya et al. 2013, 2014).³⁷ For a familiar example, consider the tenure process. Brogaard et al. (2018) find that, after being granted tenure, academic economists reduce their quantity of publications—consistent with a reduction in effort—but shift their composition of work towards higher-risk projects. Tripodi et al. (2025) report a similar pattern across other disciplines. The model gives a simple interpretation: workers at the beginning of their career are more likely to be insecure, and hence are incentivized to work hard, but avoid risk; more secure workers may take on risk, but at the cost of weaker incentives for effort. Of course, the evidence is also consistent with other explanations, including the possibility that tenure coincides with teaching, service, and administrative responsibilities (Link et al. 2008).

Recent work also finds evidence that labor-market power reduces innovation (Armangué-Jubert et al. 2025; Bräuer et al. 2026). Bräuer et al. (2026) rationalize this pattern in a model in which firms fear that a successful innovation will push the firm further up the labor supply curve, which dampens the returns to innovation.³⁸ On this account, *owners* of firms in less competitive labor markets have smaller incentives to innovate. I instead provide an explanation for why *workers* would have smaller incentives to search for a risky innovation, even if owners had no such preference.

³⁷There is especially strong evidence of the latter point among managers (Acharya et al. 2014; Cain and McKeon 2016; Gormley and Matsa 2016; Cabral et al. 2021; Hsu et al. 2024).

³⁸Bräuer et al. (2026) also note that there is a countervailing force from the fact that firms with more monopsony power enjoy a larger share of profits at any given point in time, and so may have higher returns to innovation.

7. Robustness, extensions, and long-term contracts

We have made several substantive assumptions: search frictions generate labor market power; wages are renegotiated in response to credible threats; outside offers arrive exogenously; and there are no long-term contracts. I now consider the robustness of our results to these assumptions. The main results survive relaxing the first three assumptions. Long-term contracts eliminate the distortions only under the assumption that both workers and firms can commit to long-term employment contracts—an assumption that seems implausible in many settings.

7.1. Alternative sources of market power

I have followed a large literature on wage bargaining and job search in attributing labor market power to search frictions. The leading alternative view attributes it to job differentiation: workers have idiosyncratic preferences over non-wage amenities, so they view employers as imperfect substitutes (Card et al. 2018; Lamadon et al. 2022).³⁹ In some settings, these frameworks have similar implications (Trottner 2025; Kline 2025); in others, they differ (Berger et al. 2024).

Thankfully, it turns out that the source of labor market power does not materially affect our conclusions. Appendix A constructs a variant of the model in section 2 in which there are no search frictions, but the worker has preferences over amenities and treats firms as imperfect substitutes; I call this the *differentiated amenities model*. The same conclusions apply to that setting. To see the intuition, consider the case in which the worker has a strong preference to work at one firm, and anticipates that this preference is unlikely to change in the future. In that case, the worker anticipates that she will effectively only have one firm to negotiate with in the future, leaving her in a similar situation to the case in which search frictions prevent her from contacting other firms.

7.2. Alternative views of wage renegotiation

The baseline model also follows much of the search literature in assuming that wages are renegotiated by mutual consent after credible threats. Online Appendix A considers three alternatives.

First, I consider a *rent-sharing model*: even absent an outside offer, the worker receives a share $\lambda \in (0, 1)$ of unanticipated increases in her expected output. This rent-sharing can be motivated by bargaining even without an outside offer (Stole and Zwiebel 1996; Cahuc et al. 2006; Kline et al. 2019; Garin and Silvério 2024), fairness norms (Akerlof and Yellen 1990), or efficiency wages (Shapiro and Stiglitz 1984; Katz 1986). Our conclusions persist in the case of partial rent-sharing. Intuitively, if the worker received the *full* return to changes in her expected output ($\lambda = 1$), then she would be fully incentivized to choose actions efficiently. For anything less ($\lambda < 1$), the worker is partially motivated by reputational concerns, which continue to have the same shape as before.

Second, I consider a model with *downward rigidities*: the worker’s wage cannot be adjusted downward within the employment relationship due to the presence of downward rigidities.⁴⁰

³⁹Caldwell et al. (2026a) describe search frictions, differentiated amenities, and concentration as the three “workhorse models of monopsony” (p. 13). The last case can be nested as the special case of search frictions in which the rate of arrival of outside offers approaches zero. In a quantitative decomposition of different sources of monopsony power in Danish data, Taber and Vejlin (2020) find that there are important roles for both search frictions and differences in amenity preferences. Berger et al. (2024) find a somewhat larger role for search frictions in Norway.

⁴⁰There is ongoing debate about the prevalence of wage cuts: see, for instance, Elsby and Solon (2019).

Rigid wages can be motivated by implicit contracts (Harris and Holmström 1982; Beaudry and DiNardo 1991) or by the effects of pay cuts on morale and separations (Bewley 1999; Breza et al. 2018; Dube et al. 2019). Online Appendix A shows that our conclusions are robust for allowing for downward wage rigidity. Intuitively, under the mutual consent protocol, wages are renegotiated down only when the firm would otherwise prefer to terminate employment. If wages *cannot* be negotiated down, the worker is instead fired, and she prefers employment to non-employment. As a result, downward rigidities only strengthen the conclusion that bad news is punished more than good news is rewarded, and hence continue to generate incentives for performance-targeting and conservatism.

Both alternatives retain wage negotiation, which seems an appropriate description of many high-wage labor markets (Hall and Krueger 2012).⁴¹ Nonetheless, in some segments of the labor market, particularly for low-skill or entry-level workers, most wages are posted rather than negotiated. As an alternative approach, I consider a **wage-posting model** in the spirit of Moen (1997); Acemoglu and Shimer (1999). Firms post wages without knowing the worker’s productivity—either due to imperfect information, or because a single posted wage applies to all new hires. The worker is offered the job if her productivity exceeds the posted wage, and accepts her most-preferred offer; there is no renegotiation. The worker draws ν vacancies: as $\nu \rightarrow \infty$, we recover the competitive case; $\nu \rightarrow 0$ recovers monopsony.⁴² Our conclusions persist in such a model. Intuitively, as in the downwardly-rigid case, the worker fears that underperformance will lead to separation, whereas there is no guarantee that improved performance will be capitalized into a wage increase.

7.3. Endogenous job search

The baseline model treats the arrival rate of outside offers q as exogenous, following much of the job search literature (e.g., Burdett and Mortensen 1998; Postel-Vinay and Robin 2002). A natural extension allows the worker to exert costly search effort to raise the arrival rate of outside offers (as in, e.g., Christensen et al. 2005; Hornstein et al. 2011; Faberman et al. 2022).

Online Appendix A incorporates endogenous search into the model in Section 2; I call this the model with **costly job search**.⁴³ This introduces some new features into the model. Workers who have performed poorly have little to gain from an outside offer, because an outside firm would be unwilling to bid their wage up; consequently, they search less than workers with strong reputations. As a result, search intensity rises with reputation.

This introduces a force that counteracts performance targeting. In the baseline model, effort towards producing output is always decreasing in reputation. If the likelihood of receiving an outside offer is sufficiently responsive to search effort, then effort towards producing output can have a non-monotonic relationship with reputation. Workers with very weak reputations exert effort to avoid downward wage renegotiation, as in the baseline case. Workers with very strong reputations also exert effort: they search intensively, and good performance raises the wage they

⁴¹In the U.S., somewhere between one- and two-thirds of workers engage in wage bargaining (Hall and Krueger 2012). Most German firms indicate some willingness to entertain individual bargaining (Caldwell et al. 2026b).

⁴²In the wage-posting model, workers of any reputed ability draw ν vacancies; however, since workers with stronger reputations are more likely to be accepted into a vacancy, the wage-posting model effectively endogenizes the arrival of outside offers as a function of the worker’s performance. The next subsection describes an alternative way in which to endogenize the arrival of outside efforts, through the worker’s costly effort.

⁴³Extending the continuous-time model in Section 3 would require solving a stochastic differential game with a controlled jump intensity. There are some technical difficulties in such a setting (Wernerfelt 2025).

can obtain when an outside offer arrives. Workers with intermediate reputations face neither a substantial threat of downward renegotiation nor a strong prospect of obtaining a higher wage elsewhere, and therefore exert less effort. Thus, endogenous search can generate a “U-shaped” relationship between reputation and effort. On the other hand, the monotonic relationship between performance and conservatism persists: even under costly search, workers tend to avoid risk, and this tendency is stronger among less “secure” workers.

7.4. Long-term contracts

Finally, the baseline model ruled out long-term contracts. Online Appendix A allows for the possibility of commitment. Consider first the possibility that both the worker and firm can commit to an employment contract; I call this the case of **two-sided commitment**. Can workers and firms achieve first-best action choices under two-sided commitment? I show that they can, so long as their employment contract can *condition on outside offers*, in the sense that the worker’s pay *within the employment relationship* can contractually be guaranteed to change in response to the value of outside offers the worker receives.⁴⁴

Since the parties have committed not to renegotiate the contract, there is a sense in which outside offers are irrelevant: neither party can credibly threaten to leave employment. The relevance of outside offers is that, under our maintained assumption that the worker’s output is itself non-verifiable, the outside offers received by the worker is a contractible signal of performance. To see the intuition, consider the two-period model described in section 2. Recall that, with probability q , the worker receives an offer from an outside firm, and that an increase in period-0 output increases the value of this outside offer by ρ . That is, if we regard *not* receiving an outside offer as though the worker has received an outside offer of zero, an increase in current output increases the outside offer by $q\rho$ in expectation. Now suppose that the worker’s employment contract requires that, in the event that the worker receives an outside offer of the amount s in period 1, then her period-1 wage must increase by the amount $s/[q\rho]$.⁴⁵ In that case, an increase in the worker’s output by 1 unit increases her wage by 1 unit, in expectation: the worker has again become the residual claimant on her output. As a result, the worker is fully incentivized to choose first-best actions.

The feasibility of this contract is clearly dependent on two substantive assumptions.⁴⁶ First, the worker’s salary must be conditioned on the value of her outside offer: otherwise, the firm cannot incentivize effort, since the worker’s output and action are non-verifiable. In practice, it is rare for employment contracts to explicitly condition salaries on workers’ outside options: perhaps because doing so would induce moral hazard problems by causing workers to search excessively for outside offers (Postel-Vinay and Robin 2004; Kiraly 2007); perhaps because outside firms will be unwilling to make outside offers to a worker who is bound not to accept them (Walker 1999); or perhaps because the value of the outside offer is itself non-verifiable (Burdett and Coles 2003), especially to the extent that there are important and subjective non-wage terms of the contract (Kahan et al. 2012). Second, it must be possible for both parties to commit. In practice, generally workers cannot commit to supply labor due to anti-slavery provisions in employment law (Harris and Holmström 1982; Sterk 1993; Hart and Moore 1994). Motivated by this constraint, I then turn to

⁴⁴Of course, a difficulty is that outside firms may be unwilling to make offers if they know that the worker and firm have committed to one another (Walker 1999).

⁴⁵That is, the wage schedule is $w_1(s) = \bar{w} + s/[q\rho]$, for some base wage $\bar{w}$.

⁴⁶As the intuition of the last paragraph makes clear, these contracts also rely on our maintained assumption of risk neutrality.

the case of *one-sided commitment*, in which the firm can commit never to renegotiate or leave the relationship, but the worker cannot commit to do so. I show that one-sided commitment does not suffice to restore efficiency.

8. Discussion

I have argued that imperfect competition in the labor market has substantial effects on workers' behavior *within the firm*, in addition to its well-known effects on wages and employment. Frictions to job search reduce workers' ability to threaten to leave the firm, but preserve firms' ability to threaten to fire workers. As a result, bad performance is capitalized more readily into lower wages or greater separation risk than good performance is capitalized into higher compensation. This asymmetry induces workers to target acceptable performance: workers with weaker reputations exert more effort than in the competitive case, and workers with stronger reputations exert less effort. In addition, imperfect competition reduces risk-taking, especially among worse-performing workers. Labor-market competition therefore shapes not only wages and employment, but also effort, experimentation, and the organization of production within firms.

My analysis omits much of the complexity of the employment relationship. Workers face simple choices over exertion and risk-taking, and their performance is entirely non-contractible. If some dimensions of performance are contractible, firms may use tournaments, options, or other convex incentive schemes to partially counteract the conservatism created by reputational incentives.⁴⁷

Although stylized, the model organizes several insights from empirical evidence: the concave response of wages to performance; the tendency towards performance-targeting; and conservatism even when both workers and firms are risk-neutral. The model also makes several novel empirical predictions. At the market level, reductions in labor market competition should tend to exacerbate the asymmetric concave response of wages to performance, and encourage conservatism. Indeed, Cici et al. (2021) find that the imposition of non-compete agreements among financial executives tends to reduce risk-taking. At the worker level, the model also gives rise to a negatively-skewed distribution of wage changes, in line with recent evidence (Guvenen et al. 2014, 2021; Arellano et al. 2017; De Nardi et al. 2021; Halvorsen et al. 2024; Sarpietro et al. 2026). Moreover, the model suggests that negative performance news (or exogenous increases in wages) should tend to increase workers' effort while reducing their risk-taking, and should have the largest effects for workers close to the threshold for wage renegotiation. Each prediction seems a natural direction for empirical work.

⁴⁷In this sense, the paper is connected to the literature on convex incentive schemes (Lazear and Rosen 1981; Green and Stokey 1983; Hall and Murphy 2003; Coles et al. 2006) and contractual responses to career concerns (Gibbons and Murphy 1992). Indeed, Kini et al. (2021) finds that firms respond to the arrival of non-compete agreements by increasing explicit bonuses in executives' contracts.

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