DISCUSSION PAPER SERIES

DP15751

Financing Skilled Labor

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FINANCIAL ECONOMICS

ISSN 0265-8003

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Discussion Paper DP15751
Published 01 February 2021
Submitted 31 January 2021

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Financing Skilled Labor

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JEL Classification: G32, M52, J54, J33

Keywords: Financing wages, compensation structure of non-executive employees, high-skilled employees, contagious turnover, worker runs, worker bargaining power

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1 Introduction

Ever since Holmström's (1982) famous argument that free-rider problems neutralize the incentive effects of equity-based compensation below executive level, economists have debated why firms offer such compensation to workers. Two explanations stand out. First, financially constrained firms may pay workers with equity, as turning workers into investors may be more beneficial than seeking external financing to pay wages (Core and Guay, 2001). Second, slow-vesting equity and options can help retain workers, particularly when the firm's stock price increases (Oyer and Schaefer, 2005; Aldatmaz et al., 2018; Jochem et al., 2018). Yet the debate seems far from settled. Rationalizing why firms benefit from turning workers into investors may be difficult without resorting to behavioral arguments about exploiting workers' optimism (Bergman and Jenter, 2007). Furthermore, it has been argued that deferred fixed compensation is more efficient than slow-vesting equity at achieving retention, as it does not expose workers to price risk beyond their control (Murphy, 2003; Lazear, 2004).[1]

What is common for these and most other explanations is that they focus on what is best for firms. It is an open question how the structure and financing of compensation change when competition for skilled workers forces firms to design compensation in a way that is most attractive to *workers*. Such competition often characterizes knowledge-intensive industries.[2] This paper shows that the shift in perspectives leads to two main novel insights: When firms compete to attract high-skilled workers, equity-based compensation can harm firm-level retention by making turnover contagious. Yet competition for high-skilled workers may leave firms no choice but use such compensation to attract talent even if firms would have preferred offering deferred fixed compensation, guaranteed with external financing.

To fix ideas, the paper develops a model in which several firms compete to hire the same set of skilled workers. Typical examples of such workers would be engineers, scientists, or mid-level managers. The firms have limited cash but have access to external financing. They compete with sequential new offers until only one firm remains. The main focus is on how workers can play firms off against each other if competition allows workers to pose conditions to at least some firms about what compensation offers should look like. It is assumed that workers create more value at better firms, but firms know more about their projects and, thus, how much value each worker creates.[3] As a result, the workers are not sure about

[1] There is ample evidence that equity-based compensation makes retention harder when a firm's stock price drops (Carter and Lynch, 2004; Chen, 2004), which further exacerbates firm performance (Larcker et al., 2013; Gulen and O'Brien, 2017).

[2] See "There's a war for people': strong jobs market belies a shortage of skilled workers," Guardian, September 16, 2019.

[3] Before joining a firm, workers typically have less information about its growth prospects, its internal organization, and the quality of internal collaboration, which could give rise to such an information asymmetry.

the highest compensation they can extract. The value of hiring to a firm depends not only on the quality of its projects but also on retaining workers. It is assumed that firm value drops if a worker leaves and needs to be replaced. Younger growth firms with a high risk of failure best fit this description. For example, software developers may struggle to choose between compensation offers by Spotify and Pandora (music streaming firms), and these firms' success outlooks are likely to depend critically on hiring and retaining talent.

The first main insight is that when firms compete to hire and retain workers, equity-based compensation exposes firms to the risk of contagious "worker runs" — the risk that workers leave when other workers are leaving. Though the strategic management literature has documented workers' tendency to leave in waves (Felps et al., 2009; Hausknecht and Trevor, 2011), the effect of compensation structure on contagious turnover has not been analyzed before. In the model, workers may leave if learning more about the firm makes them believe that the compensation they would forgo by leaving is worth less than their outside option. Crucially, this expectation depends on whether the firm can retain other workers instrumental for its success.

Equity-based compensation exacerbates the risk that workers leave in waves if they become skeptical about the firm's prospects. The reason is that equity-based pay makes workers especially dependent on other workers, as its value is tied to that of the firm, which, in turn, is tied to whether workers stay or leave. This effect is stronger for riskier (e.g., more indebted) firms whose equity value is highly-sensitive to performance. Notably, worker runs can be (ex post) efficient if workers subsequently move to a firm where they can create more value. However, differences in the exposure to runs caused by differences in workers' compensation structure and firms' financing choices can lead to an (ex ante) inefficient matching of workers to firms.

The paper's second main insight is that competition to attract workers may force firms to offer equity-based compensation even though firms would have preferred offering fixed compensation and securing external financing. The key role played by whether workers or firms can dictate compensation terms is easiest to illustrate with the benchmark in which there is only one firm that tries to hire the workers.

If the *firm* can dictate the terms of workers' compensation, it prefers to offer (deferred) fixed wages financed by a credit line. Deferred fixed wages expose the firm to a lower risk of contagious turnover than (slow-vesting) equity, as workers' compensation depends less on whether the firm can retain other workers instrumental for the firm's success. The reason is that fixed wages have priority over equity and are, hence, more valuable if the firm's cash

However, the qualitative insights are robust to endowing workers with private information.

flows are low.[4] The lower sensitivity to cash flows reduces the incentives to leave because other workers may be leaving. Fixed wages provide even better insurance to workers if the firm can guarantee its wage promises by securing a credit line. Since external financiers face no coordination (worker run) problems, it is efficient to expose financiers and not workers to cash flow volatility. A credit line is an optimal way to insure workers' wages because of the standard feature that debt-like contracts mitigate financiers' concerns about the quality of the firm's projects. Perhaps counterintuitively, this implies that although highly-levered (for reasons outside the model) firms have a higher contagion risk, they can reduce this risk by guaranteeing wages through credit lines.

The predictions change dramatically if *workers* have the bargaining power to dictate the terms of the compensation they want. Then, it is *individually* optimal for a worker to ask for call options despite the associated higher risk of contagious turnover for the firm. Specifically, the problem for workers is that they are uncertain about the highest compensation they can ask for. Thus, workers face the risk that the firm may reject demands for very high compensation, as it may not be able to afford it. Call options are optimal because they mitigate this problem. Specifically, call options are of little value if the firm's prospects are not very good. Thus, even firms with poorer prospects would be able to meet aggressive demands for call options. At the same time, call options allow workers to extract more of the upside from firms with better prospects. With the shift in perspectives from firms to workers, the importance of contagious turnover for the optimal choice of compensation structure shifts as well. Though workers account for the firm-level risk of worker runs, they do not account for how their compensation affects that risk. This leads to a prisoner's dilemma in which every worker is individually better off demanding call options.

The paradox of attracting workers crucial for value creation with call options is that the risk of worker runs is particularly detrimental for firms depending on such workers. Hence, on the one hand, equity-based compensation will correlate with higher firm value because it is used to attract more productive high-skilled workers.[5] On the other hand, the risk of workers runs may erode some of the value added by such workers. This may potentially harm workers by depressing the maximum compensation that firms are willing to offer.

Summarizing, competition for skilled workers is both the reason why equity-based compensation could exacerbate contagious turnover and why (when competition shifts bargaining power into the hands of workers) firms offer such compensation despite their preference for

[4]Though outside the model, it should be noted that wages do not act as a "debt overhang," as there is typically little that prevents firms from raising new debt financing with higher priority than fixed wages.

[5]Workers' bargaining power is likely to depend on the demand for their skills. Thus, a firm is likely to offer equity-based compensation to its first-best choice of workers for which it faces intense competition and fixed wages to its second-best option of less productive workers for which it faces less competition.

deferred fixed compensation and external financing. Furthermore, the risk of worker runs and workers' failure to internalize this risk stem from the same problem of a lack of coordination among workers.

Extending the model to the case in which multiple firms compete to hire workers is essential not only for robustness but also because it addresses the theoretically open question of how workers should compare different types of compensation offers when competing firms have different bargaining power. The answer is to rank compensation contracts based on the answer to the following question: "*What is the expected value of this compensation contract if the firm would be indifferent between hiring and not hiring at this contract?*" Such ranking guarantees that when competition forces a firm to raise its offer to the point at which it is indifferent between hiring and not hiring, the workers value that final compensation offer fairly. As a result, a firm drops out from competing to hire the workers only after all firms with a lower willingness to pay for labor have dropped out.

The extension to multiple firms also shows that firms offering fixed wages backed by external financing compete more aggressively for workers. The reason is that financiers overestimate a firm's prospects when it offers (close to) the highest wage that it can afford, as they form their expectations over all types that can afford that wage. Hence, when a firm has raised its wage offer to the point at which it is just indifferent between hiring and not hiring (i.e., it is the lowest type that can afford this wage), it is cross-subsidized by higher types. The resulting cheap financing distorts upward the highest wage that the firm is willing to offer.

Related Literature. This paper analyzes the interdependence between compensation structure and financing decisions when firms compete for workers. One of the paper's novel insights is that workers' compensation structure affects the risk of worker runs. Though it has long been recognized that workers may abandon a firm if they are concerned about its financial health (Titman, 1984; Berk et al., 2010), the concept of worker runs adds to this idea by highlighting that worker departure and retention may depend on that of other workers. The contagion effects are reminiscent of those in bank runs (Diamond and Dybvig, 1983; Goldstein and Pauzner, 2005) and have been shown to be detrimental for firm performance by the management literature (Felps et al., 2009; Hausknecht and Trevor, 2011; Hancock et al., 2013; Heavey et al., 2013). High-tech and other knowledge-intensive industries are often affected.[6] By formalizing the concept of worker runs, this paper contributes to understanding how the compensation structure of skilled workers affects that risk. One implication is that, although highly-leveraged firms are riskier and, thus, more likely to experience worker runs, reducing operating leverage by paying workers with equity can exacerbate retention risk.

[6] See "Leaving the dream: Infosys battles worker exodus," Reuters, May 11, 2014.

Intuitively, equity is less valuable than fixed wages if the firm defaults. Moreover, backing fixed wages with credit lines shifts the firm's credit risk from workers to creditors.[7]

The paper further contributes to the discussion of why firms offer equity-based compensation to workers below executive level, given that such compensation is unlikely to have any incentive effects (Holmström, 1982), and other types of deferred compensation may be more efficient at retaining workers (Murphy, 2003; Lazear, 2004). The paper reconciles these contradictions by showing that firms offer equity-based compensation when pressed by competition to design compensation in a way that is most attractive for workers. Younger firms with weaker bargaining power are likely to be most affected. This perspective complements prior work, which has explained the use of equity-based compensation with the desire to: avoid wage renegotiations when the firm's equity value is correlated with the workers' outside options (Oyer, 2004); align the incentives of managers with the interests of investors (Lazear, 2004); exploit the overoptimism of boundedly rational workers (Bergman and Jenter, 2007); provide a hedge against not being promoted (Chen, 2020); or hedge uncertainty when workers have Knightian uncertainty preferences (Fulghieri and Dicks, 2019). Closely related, Bova and Yang (2017) argue that the combination of strong product market competition and weak employee bargaining power would make equity compensation optimal. Perhaps surprisingly, the present paper shows that worker bargaining power has the opposite effect if the primary concern in compensation negotiations are information frictions instead of product market considerations. This leads to interesting differences in focus and empirical predictions. For example, Bova and Yang (2017) discuss their results in the context of unionized workers. By contrast, the present paper's results better apply to skilled workers who negotiate their compensation individually.

One of the gaps in the literature addressed by this paper is how workers can compare compensation offers when firms choose from different types of compensation and when workers have different bargaining power vis-à-vis different firms. The paper shows that these questions go hand in hand, as worker bargaining power crucially alters firms' equilibrium compensation structure. Thus, the need to compare different types of offers is both a realistic problem and one that occurs in equilibrium. The results on how to compare different types of offers made by firms with different bargaining power contribute to the literature on auctions with contingent claims, which has discussed the case in which bidders have the same bargaining power and, in equilibrium, make the same types of offers. There are two other differences to this literature that concern the benefits and implications of using information-sensitive

[7] Equity-based compensation could expose workers to more risk also because it introduces a correlation between workers' compensation and savings (Parlour and Walden, 2011; Betermier et al., 2012). Note that the idea that insuring wages through a credit line helps expose workers to less risk helps explain why the evidence that highly-levered firms offer a wage risk premium is not universal (Michaels et al., 2019).

securities such as equity and options. First, in auctions, information-sensitive securities benefit sellers, because they enhance competition among bidders (Hansen, 1985; DeMarzo et al., 2005).[8] By contrast, in the present paper, call options allow the uninformed party (the workers) to reduce the likelihood that more aggressive demands are rejected. This result is unrelated to stimulating competition, as it is true even if there is only *one* firm to which a worker makes a single offer. As the paper shows, the result also does not depend on whether workers or firms are privately informed about the benefit of hiring. Second, in the present paper, compensation negotiations entail externalities. As a result, compensation in call options could altogether make workers worse off than fixed wages, as they exacerbate the risk of worker runs. The paper also shows that external financing plays a role, as it makes firms offering fixed wages compete more aggressively.[9]

2 Model

The model has three dates. At $t = 1$, M penniless firms compete to hire N workers whose skills are in short supply. For simplicity, the labor of the N workers is the only input that each firm needs to start a risky project. That is, if one of the firms hires the workers, the other firms cannot start their projects. The firms can secure external financing from a competitive capital market to guarantee their wage promises. After the workers are hired, they can decide to leave prematurely at $t = 1.5$ before the cash flows are realized. If a worker ("she") leaves at this point, she forfeits her compensation and takes her outside option $\frac{\overline{w}}{N}$ ($\overline{w}$ for all workers). While this outside option is not modeled explicitly, it can be thought of as the workers' expected compensation from joining one of the other firms trying to hire the workers. All cash flows are realized at $t = 2$. All parties are risk-neutral, and there is no discounting.

Projects. The cash flows of a firm that hires all workers are $x > 0$ if it is unsuccessful and $x + \Delta x > x$ if it is successful. The workers are symmetric, and each worker hired at $t = 1$ helps in generating a fraction $\frac{1}{N}$ of these cash flows. The ex ante probability of success depends on two factors. First, it depends on the firm's type $\theta_i \in \{\underline{\theta}, ..., \overline{\theta}\}$, which is each firm's private information. Outsiders only know that types are drawn independently from

[8] The reason is that any given bid translates into a higher payment for higher types — e.g., matching a 10% equity offer, worth \$100 to a low type, extracts more than \$100 from a higher type. This effect is the essence of Milgrom and Weber's (1982) Linkage Principle.

[9] The analysis of how the structure and funding of wages interact with worker bargaining power differentiates the paper from Parsons (1972), Lazear (2009), and Jaggia and Thakor (1994). Further related, Döttling et al. (2019) argue that precautionary cash hoarding by firms helps insure workers. Interestingly, Ferreira and Nikolowa (2019) argue that firms may inefficiently poach managers when competing for talent, but their model does not derive implications for compensation structure.

$\{\underline{\theta}, ..., \overline{\theta}\}$ according to the prior probability distribution $\pi_i = \{\pi_{i,\underline{\theta}}, ..., \pi_{i,\overline{\theta}}\}$, where $\pi_{i,\theta'}$ is the prior probability that firm i is of type θ'. Second, the firm's success probability depends on how many high-skilled workers it can retain. If firm i hires N workers but only $n \in [0, N]$ stay until $t = 2$, while the remaining $N - n$ are replaced at $t = 1.5$, the project's success probability drops from θ_i to $0.5\left(1 + \frac{n}{N}\right)\theta_i$.[10] It is assumed that $\overline{w} > x$, so that without resorting to external financing, the firm cannot guarantee a riskless fixed wage of $\overline{w}$.

The firms' outside option of not hiring is $\overline{v} > x$. This outside option can be interpreted as the expected cash flows of hiring lower-skilled workers. For simplicity, it is assumed that there is a large supply of such lower-skilled workers, allowing firms to hire such workers at their outside options. $\frac{\overline{v}}{N}$ can be then interpreted as the value created by such lower-skilled workers net of their compensation. All of this is common knowledge.

Negotiations at $t = 1$. The negotiations with all high-skilled workers (henceforth, "workers") are simultaneous. While individual workers cannot dictate to a firm how it should finance itself, they might be able to pose demands about their compensation. To establish a benchmark, Section 3.3 restricts attention to one firm at $t = 1$ ($M = 1$) and differentiates between the cases in which the workers or the firms can make a take-it-or-leave-it offer about the workers' compensation.[11] Subsequently, Section 3.4 extends the model to negotiations with multiple firms ($M > 1$), where the firms sequentially improve on each other's offers until only one remains. Every offer sequence proceeds then as follows.

If a worker has stronger bargaining power and can make take-it-or-leave-it offers ("demands") to a firm about her compensation (Section 3.4.1), she asks that firm to choose from the set of all contracts that the worker considers superior to the last standing offer and her outside option of $\frac{\overline{w}}{N}$. That is, the worker sets the minimum requirements for a new offer to beat the last standing offer. For example, the worker may require that a new compensation offer must offer at least 10% equity or it must offer at least $90,000. If the firm refuses to pick such an offer, it drops out. Otherwise, the worker may come back to it after trying to obtain a better offer from another firm. Once only one firm remains, the worker makes that firm a final take-it-or-leave-it offer.

If a firm has stronger bargaining power (Section 3.4.2), it makes a take-it-or-leave-it offer to the workers and drops out from trying to hire a worker if she rejects the offer. If the worker does not reject the offer, the firm has the option to make a new offer after other firms have made their offers. If there is no better offer, it hires the workers at the last offer it has made. The combination of these two cases in which a worker can dictate terms to some firms

[10] The exact functional form is not important. All that matters is that the productivity loss is proportional to how many of the originally-hired workers leave and need to be replaced.

[11] Analyzing intermediate distributions of bargaining power is challenging, as there is no universally accepted solution concept, such as Nash bargaining, when information is asymmetric.

but not others is also considered.

Compensation and Financing Contracts. A compensation contract $\{w_i, \Delta w_i\}$ stipulates that firm i pays the workers w_i in the low cash flow state and Δw_i in addition in the high cash flow state. Individual contracts cannot be conditioned on those of other workers. All compensation is deferred in the sense that workers that leave at $t = 1.5$ forgo their compensation. Their contracts are then transferred to new (less-efficient) workers hired in their place.[12]

If firm i secures external financing to guarantee its workers' compensation $\{w_i, \Delta w_i\}$, it does so at competitive terms. Specifically, the firm makes a take-it-or-leave-it offer to financiers together with the offer it makes to workers.[13] An external financing contract $\{S_i, \Delta S_i\}$ stipulates that firm i pays the financiers S_i in the low cash flow state and $S_i + \Delta S_i$ in the high cash flow state at $t = 2$. $\{S_i, \Delta S_i\}$ are the promised payments to the financier net of the transfers needed to guarantee the workers' compensation. A negative value for S_i or $S_i + \Delta S_i$ means that there is a transfer from the financiers to the firm. The financing contract is commonly observable. In all that follows, the subscript i, denoting the firm's identity, is dropped whenever it does not lead to confusion. It is assumed that all parties are protected by limited liability and that all contracts are monotone. Intuitively, the last assumption means that no party should have incentives to sabotage the project in the high cash flow state (Innes, 1990; Nachman and Noe, 1994). Formally, it should hold that $w, \Delta w \geq 0$ and $0 \leq w + S \leq x$ and $0 \leq \Delta w + \Delta S \leq \Delta x$. It should be stressed that the binary cash flows assumption is for more transparency only. All results extend to continuous cash flows given standard assumptions about the ordering of distribution functions.[14]

Leaving the firm at $t = 1.5$. The above setting is sufficient to generate all of the paper's main results. However, it leads to multiple equilibria in which the workers' decision whether to leave or not leave at $t = 1.5$ depends on their beliefs about what other workers will do. Addressing the problem of equilibrium selection requires adding more structure to the model in analogy to the bank run literature.

Suppose that, at $t = 1.5$, there is a shock ε to the firm's type, which changes the probability of the high cash flow state from θ to $\theta\phi(\varepsilon)$. Nature draws the shock ε from a continuously differentiable positive density g with support on the real line. The ex-ante expectation of $\phi(\varepsilon)$ is one, $\int_{-\infty}^{\infty} \phi(\varepsilon)\, dG(\varepsilon) = 1$, and it holds that $\phi'(\varepsilon) > 0$, $\lim_{\varepsilon \to -\infty} \phi(\varepsilon) =$

[12] Considering negotiations with new workers at $t = 1.5$ does not lead to additional interesting results.

[13] A previous working paper version shows that the results do not qualitatively depend on whether financing is arranged before or after the firm hires the workers.

[14] A better type is then defined as one having a probability distribution over future cash flows that dominates that of a lower type in terms of conditional stochastic dominances (see Nachman and Noe, 1994).

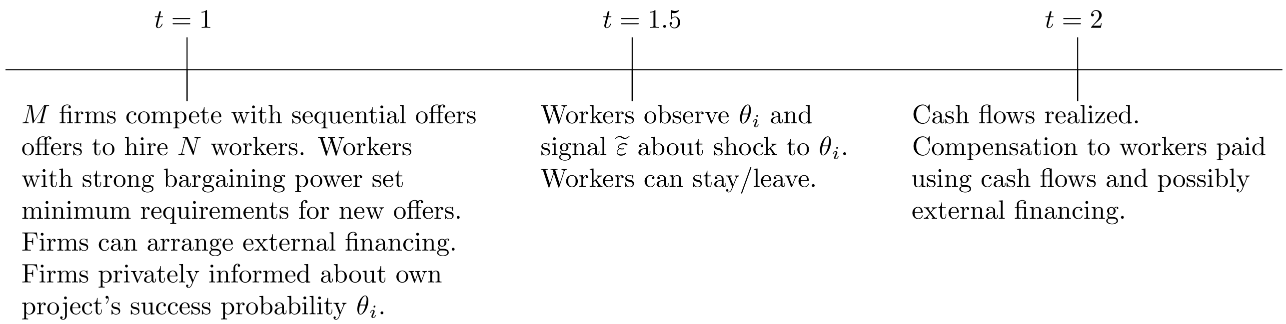

Figure 1: **Timeline.**

0, and $\lim_{\varepsilon\to\infty}\phi(\varepsilon)=\frac{1}{\theta}$.[15] The true realization of the shock is not observable to anyone. At $t=1.5$, the workers observe the firm's type θ and a signal $\widetilde{\varepsilon}_j=\varepsilon+\sigma e_j$ about the shock ε, where $\sigma>0$, $\sigma\to 0$. The noise terms e_j are distributed with density $f(\cdot)$ with support on the real line. This additional structure simplifies the analysis by making it possible to use standard techniques helping in equilibrium selection. Figure 1 summarizes the sequence of events.

3 Compensation Structure, Financing, and Worker Runs

The workers' compensation structure matters for two reasons. First, it affects the firms' financing needs. For example, unlike a firm promising fixed wages, a firm offering equity-based compensation does not need to raise external financing to pay these wages. Thus, competition for workers affects financing needs not only through its effect on compensation levels but also compensation structure. Second, workers' compensation structure matters not only for hiring but also for retaining workers. The novel insight is that it affects the incentives of workers to leave when others are leaving. In turn, this contagion risk affects the firms' expected profitability and, thus, the compensation that they are willing to offer. In what follows, the model is solved backward by analyzing, first, how different compensation structures affect the decision of workers to leave at $t=1.5$.

3.1 Compensation Structure and Worker Runs

Since workers are symmetric, it is used for now (and then verified) that in equilibrium, all workers are hired by the same firm with the same contract. Thus, if the firm's overall compensation promises are $\{w,\Delta w\}$, an individual worker's contract is $\left\{\frac{w}{N},\frac{\Delta w}{N}\right\}$. At $t=1.5$, the workers can decide to leave the firm and take their outside option. Leaving prematurely

[15] The lower and upper bounds guarantee that $\theta\phi(\varepsilon)\in[0,1]$ for any θ and ε.

before the cash flows are realized at $t = 2$ will pay a worker $\frac{\overline{w}}{N}$, while staying with the firm has an expected payoff of $\frac{w}{N} + 0.5\left(1 + \frac{n}{N}\right)\theta\frac{\Delta w}{N}$. It is without loss of generality to neglect the scaling by N when comparing $\left\{\frac{w}{N}, \frac{\Delta w}{N}\right\}$ with $\frac{\overline{w}}{N}$.

It is useful to start by showing that the workers may leave the firm even without observing new information (i.e., θ and $\widetilde{\varepsilon}$), at $t = 1.5$. This can occur if the workers' compensation depends on the firm's future cash flows (i.e., $\Delta w > 0$). There can be two pure strategy Nash equilibria. In the first equilibrium, all workers stay with the firm at $t = 1.5$ $(n = N)$. Staying results in an expected compensation of $w + \mathrm{E}\theta\Delta w$, where $\mathrm{E}\theta$ is the workers' posterior belief about the firm's type. If all workers believe that all others will stay, it is not individually optimal to deviate and leave at $t = 1.5$, as it holds that $w + \mathrm{E}\theta\Delta w \geq \overline{w}$ (else the workers would not have joined at $t = 1$). The second pure strategy equilibrium is that everyone leaves at $t = 1.5$ $(n = 0)$. In particular, if all workers believe that the others will leave, it is individually optimal to leave as well if $\overline{w} > w + 0.5\left(1 + \frac{1}{N}\right)\mathrm{E}\theta\Delta w$.

Proposition 1 *If workers do not observe θ and $\widetilde{\varepsilon}$ at $t = 1, 5$ and*

$$\overline{w} > w + 0.5\left(1 + \frac{1}{N}\right)\mathrm{E}\theta\Delta w, \tag{1}$$

there are multiple equilibria of the continuation game starting at $t = 1.5$. One of these equilibria is that all workers leave the firm and forgo their compensation in favor of their outside option.

If a firm can guarantee paying a fixed wage $w > \overline{w}$ in all cash flow states, condition (1) is not satisfied, and the workers do not leave prematurely. Condition (1) is more likely to hold if the workers' compensation has a lower fixed component, w, and a higher variable component, Δw. Thus, equity-based compensation (for which Δw is particularly high) exposes the firm to the risk of worker runs.

Equilibrium Selection at $t = 1.5$. Consider now the full model in which the workers observe θ and a signal $\widetilde{\varepsilon}$ about the shock ε at $t = 1.5$. This additional structure helps answer the questions of when and why workers would leave at $t = 1.5$. It continues to be true that the workers are always better off staying if $w > \overline{w}$. However, if $w + 0.5\frac{\theta}{\theta}\Delta w > \overline{w} > w$, a worker is better off staying if their signal realization is sufficiently high and better off leaving if it is sufficiently low. To make this precise, define ε^* as

$$\sum_{n=1}^{N} \frac{1}{N}\left(w + 0.5\left(1 + \frac{n}{N}\right)\theta\phi\left(\varepsilon^*\right)\Delta w - \overline{w}\right) = 0. \tag{2}$$

and $n(\varepsilon, \varepsilon^*)$ as the expected number of workers that receives a signal higher than ε^* when the true shock is ε. Following standard arguments from the literature on global games (Morris and Shin, 2003), it holds that a worker runs if she receives a signal lower than ε^*. Such low signals make the worker pessimistic about the success probability of the firm and its ability to retain enough workers instrumental for generating high cash flows:

Proposition 2 *(i) If $w + 0.5\frac{\theta}{\overline{\theta}}\Delta w > \overline{w} > w$, a worker leaves the firm at $t = 1.5$ if she observes a signal $\widetilde{\varepsilon} < \varepsilon^*$ and stays with the firm if $\widetilde{\varepsilon} > \varepsilon^*$. The probability of achieving the high cash flow state when the firm's type is θ and the workers' compensation is $\{w, \Delta w\}$ is given by $p(\theta, w, \Delta w) = \int_{-\infty}^{\infty} 0.5\left(1 + \frac{n(\varepsilon,\varepsilon^*)}{N}\right)\phi(\varepsilon)\,\theta dG(\varepsilon)$. (ii) For any given level of expected compensation at $t = 1$, a higher variable component Δw goes hand in hand with a higher risk of runs (i.e., higher ε^*).*

The intuition behind the second part of Proposition 2 is that the value of compensation with a higher variable component makes workers more dependent on the retention of other workers instrumental for the firm's success. This higher sensitivity makes workers more likely to run when observing a lower signal. In such cases, the expectation that other workers are also likely to have received a low signal and leave further reinforces the incentives to leave. Thus, call options (for which $w = 0$ and Δw is highest) have the highest risk of runs, while fixed wages that the firm can guarantee paying in all cash flow states have the lowest risk. By the same token, firms have a higher risk of worker runs if they are riskier in the sense that they mainly create value in the high cash flow state (i.e., x is low and Δx is high). Such firms would have to rely mainly on compensation with a high variable component Δw unless they secure their wage promises with external financing.

3.2 Discussion and Efficiency Implications

Ex ante and ex post efficiency. Contagious worker turnover is considered a first-order problem for firm performance by the management literature (Felps et al., 2009; Hausknecht and Trevor, 2011; Hancock et al., 2013; Heavey et al., 2013). Yet such runs can be socially efficient if the workers move to a firm where they can create more value. Thus, even if the analysis would allow for renegotiations at $t = 1.5$, such renegotiations might still not be able to stop workers from leaving if the firm has incurred a negative shock that reduces the firm's expected value below $\overline{w}$. Securing external financing to insure the ability to pay $\overline{w}$ is unlikely to be impossible at this point, as it is similar to trying to buy insurance after an adverse event has already occurred.

Yet even if worker runs are, in some cases, ex post socially efficient, the risk of such runs can lead to ex ante inefficient allocation of workers to firms. Specifically, since the risk of runs reduces the firm's probability of success from θ to $p(\theta, w, \Delta w) < \theta$, the firm's maximum willingness to pay for workers is lower if it offers equity-based compensation compared to fixed wages, secured with external financing. Thus, a better firm offering equity may lose out to a worse firm offering fixed wages, leading to an inefficient matching of workers to firms.

Worker Runs, Fixed Wages, and Debt Financing. One of the paramount examples of indirect costs of financial distress is that workers leave a highly-leveraged firm if they fear that it is likely to go bankrupt (Berk et al., 2010). Since fixed wages can be seen as a form of debt or might be financed by debt, it seems natural to ask whether fixed wages might exacerbate this problem.

This is not the case. If the purpose of debt financing is to guarantee that the firm can pay its workers' wages, the risk of default is borne by the firm's creditors and not the workers. If a firm has raised debt for a different purpose such as investment (outside of the model), the firm has a higher risk of a worker run, but also in this case, promising fixed wages helps mitigate that risk.[16] The reason is that fixed wages have a higher priority in default than equity and are, thus, more valuable to workers when the firm's cash flows are low. Indeed, equity holders are typically wiped out in bankruptcy (Hotchkiss et al., 2008), which would make equity-based compensation worthless.

Another potential concern is that fixed wages could create a debt overhang problem preventing a firm from raising new funding needed by the firm to be successful. However, while wages are, indeed, similar to debt, they have lower priority than most types of debt, and firms typically do not have to seek consent from workers before raising new debt. Thus, the risk of a "wage overhang" is easily overcome by raising more-senior debt.

Retention Effect of Equity-Based Compensation. The contagion effects analyzed in this paper are unrelated to arguments in the literature that equity-based compensation helps retention when the firm's stock price increases (Oyer, 2004; Oyer and Schaefer, 2005) but makes retention more difficult when the stock price decreases (Murphy, 2003; Lazear, 2004; Larcker et al., 2013; Gulen and O'Brien, 2017). The novel result is that equity-based compensation makes a worker more sensitive to whether other key workers leave, independent of the reason for their departure. In particular, Proposition 1 clearly illustrates that runs can happen even if there is no new information (such as a change in the stock price) at $t = 1.5$. The risk of worker runs is higher when the risk that workers start doubting the firm's prospects is higher. As argued above, this is more relevant for riskier and more-

[16] A firm with a legacy debt obligation D, has a higher risk of runs, as such a firm can promise at most $\max\{0, x - D\}$ to the workers in the low cash flow state. Hence, Δw for such a firm must be higher.

indebted firms. Furthermore, younger growth firms and start-ups for which not so much is known and which are still to realize their growth potential by hiring the right talent are particularly likely to be affected. Stable firms on an upward trajectory and mature firms are less likely to be affected, as workers are less likely to become sceptical about such firms.

3.3 Compensation Negotiations With One Firm ($M = 1$)

Continuing to move backward through the model, consider date $t = 1$ at which the workers are hired. The risk of worker runs reduces the firm's expected profitability and, thus, reduces the compensation that firms are willing to offer. The problem is that, unlike firms, individual workers do not fully internalize how their individual negotiations affect firm-level outcomes. As a result, compensation structure will depend on whether workers or firms can dictate terms in compensation negotiations.

3.3.1 Benchmark: Compensation and Financing When Firms Dictate Terms

It is useful to start with the benchmark case in which there is only one firm that makes a take-it-or-leave-it offer to the workers. The firm needs to offer the workers a contract that compensates them for forgoing their outside option $\overline{w}$

$$w + \sum_{\theta \in \{\underline{\theta}, \ldots, \overline{\theta}\}} \widetilde{\pi}_\theta p(\theta, w, \Delta w) \Delta w - \overline{w} \geq 0. \tag{3}$$

Furthermore, the firm should offer the financiers a contract for which they break even when guaranteeing the workers' compensation (provided that such a contract is signed):

$$S + \sum_{\theta \in \{\underline{\theta}, \ldots, \overline{\theta}\}} \widehat{\pi}_\theta p(\theta, w, \Delta w) \Delta S \geq 0, \tag{4}$$

where $\widetilde{\pi}_\theta$ and $\widehat{\pi}_\theta$ are the workers' and financiers' posterior beliefs about the probability of facing type θ after receiving offers $\{w, \Delta w\}$ and $\{S, \Delta S\}$, respectively.

Assume for this benchmark that there are no information frictions between the firm and outsiders at $t = 1$. That is, $\widetilde{\pi}_\theta$ and $\widehat{\pi}_\theta$ place probability one on the true type. The firm's residual payoff, net of its outside option $\overline{v}$, is

$$x - w - S + p(\theta, w, \Delta w)(\Delta x - \Delta w - \Delta S) - \overline{v}, \tag{5}$$

and the firm's problem is to design the offers $\{S, \Delta S\}$ and $\{w, \Delta w\}$ in a way that maximizes this payoff, subject to (3), (4), $w, \Delta w \geq 0$, $0 \leq S + w \leq x$, and $0 \leq \Delta S + \Delta w \leq \Delta x$.

The main insight from this benchmark is that it is optimal for the firm to offer a fixed wage $w = \overline{w}$ ($\Delta w = 0$) that the firm can guarantee paying in all cash flow states. The role of external financing is to insure the workers' wages. Since the firm fully internalizes the risk of runs, fixed wages insured by external financing are uniquely optimal, as such compensation helps the firm maximize its payoff (5) by avoiding that risk. In particular, it is optimal to expose an external financier to the risk of low cash flows, as such a financier does not face a coordination (run) problem. Absent information frictions, external financing is not pinned down. An example of a feasible contract for which financiers break even is a credit line with $S = x - \overline{w}$ and $\Delta S = \frac{\overline{w}-x}{\theta}$. With such a contract, the firm can draw down $\overline{w} - x$ in the low cash flow state to pay $\overline{w}$ to the workers for which it pays a premium $\frac{\overline{w}-x}{\theta}$ in the high cash flow state.

Proposition 3 *If there is only one firm that makes the workers a take-it-or-leave-it offer, that firm hires the workers by promising fixed wages that are secured by external financing.*

Considering asymmetric information between workers and firms does not alter Proposition 3. When firms choose the workers' compensation contracts, the firm's choices are interpreted as signals about the quality θ of its projects. In the only perfect Bayesian equilibrium that arises, the firm offers fixed wages guaranteed by external financing, because such compensation avoids both the risk of worker runs and misvaluation by workers. Adding information asymmetry between the firm and financiers also does not qualitatively change much. The detailed discussion of this extension is relegated to Section 3.4.2, as it adds little to this benchmark apart from pinning down that the firm will use a credit line to insure its compensation promises.

3.3.2 Compensation Structure if Workers Can Dictate Terms

Consider, next, the case in which the *workers* can make a take-it-or-leave-it offer ("demand") to the firm. This section shows that competition for skilled workers is not just the reason for why equity-based compensation increases the risk of contagious turnover but also for why firms offer such compensation in the first place.

Under symmetric information, a worker would ask for compensation $\{w_i, \Delta w_i\}$ that extracts all surplus that she creates. Thus, the firm would be indifferent between hiring and not hiring high-skilled workers if

$$\frac{x}{N} + p(\theta)\frac{\Delta x}{N} - (w_i + p(\theta)\Delta w_i) = \frac{\overline{v}}{N}. \tag{6}$$

where the dependence of p on the workers' compensation contracts is omitted if it does not cause confusion. The worker would optimally choose a fixed wage contract, as it has the lowest risk of runs and, thus, maximizes the compensation that she can extract.

The main insight form this section is that a fixed wage would not be optimal, however, if a worker does not know the firm's type. To make the argument in a clean way, it is assumed in analogy to the free-rider literature that *infinitesimal* changes in the probability that a *single* worker leaves do not affect the overall probability of runs, $p(\theta)$.[17] Let W_θ be a (possibly degenerate) menu of contracts and let $\Omega_{W_\theta} \subseteq \{\underline{\theta}, ..., \overline{\theta}\}$ be the set of types accepting a contract from this menu. Denote the contract accepted by type θ with $\{\frac{w_\theta}{N}, \frac{\Delta w_\theta}{N}\}$.[18] The worker's problem is to choose W_θ to maximize its expected payoff

$$\sum_{\Omega_{W_\theta}} \pi_\theta \left(w_\theta + p(\theta)\,\Delta w_\theta\right) + \sum_{\{\underline{\theta},...,\overline{\theta}\}\backslash\Omega_{W_\theta}} \pi_\theta \overline{w} \tag{7}$$

subject to the firm's individual rationality and incentive compatibility constraints and the feasibility restrictions on $\{w_\theta, \Delta w_\theta\}$. From condition (6), for any given contract $\{w_\theta, \Delta w_\theta\}$ from this menu, the firm would prefer hiring to not hiring at this contract if and only if its probability of achieving the high cash flow state is at least

$$p(\theta) \geq \widetilde{p}(w_\theta, \Delta w_\theta) \equiv \frac{\overline{v} + w_\theta - x}{\Delta x - \Delta w_\theta}. \tag{8}$$

Proposition 4 *Suppose that a worker can make the firm a take-it-or-leave-it offer. The worker demands a simple call options contract, defined by a payoff of zero in the low cash flow state and a positive payoff in the high cash flow state. No menu can improve on this contract. In equilibrium, all workers demand such a contract even though it is associated with the highest risk of runs.*

The main consideration that makes call options optimal is that workers are uncertain about how much their labor contributes to value creation at the firm. Thus, they are concerned that if they make too aggressive demands, the firm will not hire them, as it may not be able to afford such compensation. What makes call options optimal is that they are not very valuable to firms in which the workers' labor does not create too much value. Thus, even if the workers pose aggressive demands for call options, the firm is less likely to reject these demands. At the same time, call options expose workers more to the firm's upside and allow them to extract more from a firm in which their labor generates more value.

[17] This assumption is weaker than the standard assumption in the literature analyzing free rider problems (e.g., Grossman and Hart, 1980) that the actions of a single agent have no effect on aggregate outcomes.

[18] It is convenient to use the scaling by N, as this allows to cancel out N in what follows. Moreover, in equilibrium, all workers will offer the same contract, so that the firm's cumulative wage obligation will be $\{w_\theta, \Delta w_\theta\}$.

More precisely, the firm chooses a compensation contract $\left\{\frac{w}{N}, \frac{\Delta w}{N}\right\}$ only if $p(\theta) \geq \widetilde{p}(w, \Delta w)$. Using the definition of $\widetilde{p}$ given by (8), the firm obtains then an information rent of

$$\begin{aligned} & \frac{1}{N}(x - w + p(\theta)(\Delta x - \Delta w) - \overline{v}) \\ = & \frac{1}{N}(p(\theta) - \widetilde{p}(w, \Delta w))(\Delta x - \Delta w). \end{aligned} \tag{9}$$

A compensation contract makes workers better off if it extracts more of the surplus from hiring and reduces the firm's rent. As expression (9) illustrates, the worker can do so by minimizing the firm's share of the upside $(\Delta x - \Delta w)$ by shifting compensation from the low to the high cash flow state, while making sure that the same set of types accept her offer. A simple compensation in call options (for which $w = 0$) achieves precisely this goal. No menu of contracts can improve on this offer, as any non-degenerate menu would have to include a compensation contract with $w > 0$ and would leave more of the surplus to the firm. Financing constraints are irrelevant for this result. That is, firms offer equity-based compensation to accommodate the demands of workers with strong bargaining power and not because raising external financing is costly or problematic.

The shift in perspectives from firms to workers leads to a shift in the importance of firm-level retention considerations for compensation design. This creates a problem for firms, as the workers do not fully internalize the impact of their individual compensation negotiations on the firm's overall risk. In particular, the workers face the following prisoner's dilemma. In a candidate equilibrium in which all workers demand, for example, a fixed wage and, thus, would not run at $t = 1.5$, a worker is individually better off deviating and demanding compensation with at least some small positive upside participation Δw (i.e., that looks a bit more like a call option). The only compensation from which a worker cannot deviate in this way is in call options.

Somewhat paradoxically, the implication is that firms that crucially depend on high-skilled workers for value creation and, thus, have most to lose from contagious turnover are those that have to offer equity-based compensation to attract workers, which increases their risk of runs. This could harm also workers, as it makes their labor less valuable and reduces the compensation that firms are prepared to offer.

Summarizing the main driving forces, competition for workers is both the reason why equity-based compensation exacerbates contagious turnover and why firms offer such compensation. Furthermore, the risk of worker runs and the workers' failure to internalize this risk emerge from the same problem of a lack of coordination among workers. Taken together, the results in this section explain why equity-based compensation is useful for attracting workers that are key for boosting firm value even though deferred fixed compensation can help retain these workers by not exposing them to "price" risk.

Compensation Structure, Firm Performance, and (Lack of) Effort Incentive Effects. Holding firm and workers quality fixed and only varying workers' bargaining power would predict that a firm performs better when its bargaining power is stronger — that is, when it offers fixed wages, which are associated with a lower risk of runs. However, the problem with this prediction is that it is not clear why the same firm would have different bargaining power toward different but equally-productive workers. In practice, firms are likely to have strong bargaining power toward workers that are easier to replace and do not uniquely contribute to its value creation (as with the firms' outside option of hiring lower-skilled workers). The firms' bargaining power is likely to be weaker mainly toward higher-skilled workers, as the more intense competition for such workers could shift bargaining power in their hands.[19] Taking this perspective, the prediction would be:

Corollary 1 *A firm is likely to offer equity-based compensation to more productive higher-skilled workers and fixed wages to lower-skilled workers. This selection effect will lead to a positive correlation between equity-based compensation and firm performance.*

Corollary 1 sheds light on why equity-based compensation can correlate with firm performance even in the absence of incentive effects. It should be stressed that the paper's assumption that individual workers create value does not stand in contradiction with Holmström's (1982) reasoning that free-rider problems offset the incentive effects of equity-based compensation. This argument rests on the idea that the value created by each worker is only a small component of overall firm value. This is true also in this paper. Moreover, there is a free-rider problem also here, as workers neglect the effect of their compensation on firm-level retention risk.

Relaxing the assumption that an *infinitesimal* change in the probability that a single worker leaves has no effect on the overall probability or runs $p(\theta)$ is not problematic as long as $p(\theta)$ is not very sensitive to such changes. However, if an individual worker has a large impact on the overall probability of worker runs, she would partially internalize the contagion cost of demanding equity-based compensation, reducing the incentives to demand such compensation. Thus, the model is not a good description of hiring top executives for which equity-based compensation is likely to have strong incentive effects and who are more likely to consider how their compensation, hiring, and retention affect firm-level outcomes.

[19] Naturally, some firms may always be tough negotiators, implying that the same workers may sometimes have different bargaining power toward different firms (discussed in the next section).

What if workers have private information? The result that workers demand call options when they are asymmetrically informed about their value-added to the firm does *not* depend on whether the workers or the firms are better informed. To see this, note that if workers had privileged information, the problem would be similar to Nachman and Noe's (1994) classical capital raising game in which a privately informed party tries to raise financing (here, tries to get hired). In this game, the privately informed party would offer a debt claim and retain a levered equity claim (i.e., call options).

3.4 Negotiations With Multiple Firms ($M > 1$)

Extending the results from Propositions 3 and 4 to the full-fledged model in which multiple firms compete to hire the workers can help answer two main questions. The first is whether firms relying on external financing compete more or less aggressively compared to firms that do not have to rely on external financing. The second question is how the workers should deal with firms with different bargaining power that offer different types of contracts and how the workers can play these firms off against each other to extract better compensation terms. Both questions are crucial for studying whether workers are efficiently matched to firms. We proceed with the second question, as its answer is needed to solve the first.

3.4.1 Identifying the Firm Willing to Pay Most for Labor

The case described in Section 3.3 in which there is only one firm can be interpreted as one in which the remaining $M-1$ firms have already dropped out. Proposition 4 characterizes then the offer made by a worker in a strong bargaining position to the last remaining firm. Continuing to work backward through the model, consider, now, the phase at which there are still multiple firms trying to hire the workers. The analysis starts with the case in which a worker has a strong bargaining position vis-à-vis all firms and then tackles the case in which the workers cannot dictate terms to all firms.

The main insight in what follows is that there is a simple and efficient way for a worker to identify the firm willing to offer the highest compensation even if she has to compare different types of compensation offers. Intuitively, the worker's objective after any given offer is to optimally set the minimum requirements toward new offers. For example, following an offer for \$80,000 and options for 0.3% of the firm's equity, the worker may require that new fixed wage offers must be for at least \$100,000; equity compensation must offer at least 1% of the firm's equity, etc. The crucial step lies in setting these minimum requirements. The difficulty is that, unlike ranking fixed-wage offers, ranking offers that include, for example, equity or options is far from trivial.

This problem can be solved as follows. Let the last standing compensation offer by "Firm A" be $\{w_a, \Delta w_a\}$. Suppose that there is another firm, "Firm B," to which the workers can make take-it-or-leave-it offers. For Firm B to beat Firm A's offer, the worker requires Firm B to choose from the set of all contracts $\{w_b, \Delta w_b\}$ that satisfy

$$w_b + \widetilde{p}\,(w_b, \Delta w_b)\, \Delta w_b > w_a + \widetilde{p}\,(w_a, \Delta w_a)\, \Delta w_a, \tag{10}$$

where $\widetilde{p}\,(w, \Delta w)$ is defined in (8). If Firm B rejects, it drops out; if it accepts, the worker may come back to it. The worker then goes to Firm A, and the game proceeds until only one firm remains. Intuitively, condition (10) states that the worker ranks compensation offers based on the answer to the following question:

"What is the expected value of the offered compensation if the firm is just indifferent between hiring and not hiring at that compensation?" (Q)

This ranking effectively undervalues all contracts for which the firm makes a profit from hiring but ranks those for which the firm is indifferent between hiring and not hiring based on their true value. Hence, no firm drops out from competing to hire the workers before all firms with lower valuations have dropped out. Furthermore, the worker extracts the maximum possible information about the firms' types, as she can perfectly infer the types of all firms that drop out, knowing that the last remaining firm's type is higher. The worker's optimal final offer is, then, given by Proposition 4. Since all workers identify the same firm as the one with the highest willingness to pay, they all end up working for the same firm. Summarizing:

Proposition 5 *Workers can identify the firm willing to pay most for their labor, while extracting the maximum information about its valuation, by demanding that firms improve on in each other's offers as dictated by condition (10). Once only one firm remains, the workers' final offer is given by Proposition 4.*

Discussion. The main assumption needed for the mechanism to work is that the firms have something to lose from making unreasonably high compensation offers. This is captured by the condition that $\overline{v} > x$, which ensures that the numerator of (8) is always positive. Without this assumption, it would be impossible to filter out the firm that values labor most, as there would be nothing that stops low types from making the same offers as high types.

A contribution on the normative side is that this mechanism builds on Bulow and Klemperer's (1996) classical prescription for revenue maximization by allowing for state-contingent offers. The workers' final take-it-or-leave-it offer could be interpreted as an optimally chosen reserve price, exploiting all information revealed until that point. Thus, the mechanism represents a step toward deriving a simple optimal mechanism that allows for state-contingent claims and optimal reserve prices. Such a mechanism remains a challenging open theoretical question, as the critical regularity assumptions in the optimal mechanism design literature are not satisfied.[20]

A key aspect of Proposition 5 is that it does not require that workers have the same bargaining power toward all firms. As can be anticipated from Proposition 3, firms with strong bargaining power will compete by offering fixed wages. Thus, the model captures the realistic scenario in which workers may need to compare different types of compensation offers made in equilibrium. The following analysis develops this point in more detail.

3.4.2 External Financing and Wage Distortions

Consider the case in which there is a firm, "Firm B," that can make take-it-or-leave-it offers.[21] The analysis of this case is a natural extension of the benchmark in Section 3.3.1. In particular, every time it has to make an offer, Firm B maximizes its expected payoff by offering the workers a fixed wage, insured by a credit line. The wage is the minimum that the workers would accept above the last standing offer.

Suppose that the last standing offer was made by "Firm A." Ranking the two offers is a trivial if both firms can make take-it-or-leave-it offers, as both firms would be offering fixed wages. By contrast, if the workers can make take-it-or-leave-it offers to Firm A, the workers can rank Firm A's relative to Firm B's offers based on the answer to question (Q) (see Proposition 5). This solution guarantees that the firm that hires the workers is the one that can offer higher compensation.

The firm that hires the workers may not be that with the higher type, however. First, if Firm A has weak bargaining power, it will have to offer call options to attract the workers, which exposes the firm to a higher risk of worker runs and erodes some of the expected value from hiring. Second, Firm B's reliance on external financing can lead to further distortions.

[20] Specifically, the bidders' virtual valuation is a complicated object that depends on the contract's structure and is, in general, not monotone in θ. For recent advances, restricting attention to equity auctions, see Sogo et al. (2016) and Liu (2016). Prior approaches, such as DeMarzo et al. (2005), restrict attention to symmetric mechanisms without reserve prices. Interestingly, Gorbenko and Malenko (2011) discuss reserve prices when sellers compete for bidders.

[21] Recall that this means that this firm commits to dropping out if a worker rejects its offer. If the worker does not reject the offer, the firm has the option to make a new offer after the other firms have made their offers. If there are no such offers, the worker takes Firm B's last offer.

Extension: Asymmetric Information Between Firms and Financiers. The following extension shows that in the presence of information frictions between firms and investors, external financing distorts *upward* the firms' willingness to pay for labor. To deal with potential multiplicity of equilibria, the equilibrium set is refined using Cho and Kreps' (1987) D1 refinement. Intuitively, this refinement limits out-of-equilibrium beliefs to the types that can gain most from deviating (see Appendix A).

The argument proceeds in two steps. The first step is to establish that offering fixed wages secured by a credit line is an equilibrium for Firm B. Despite the complication that there are two types of investors (external financiers and workers who invest by forgoing their outside option), the analysis of this step is largely standard and relegated to the appendix. A sketch of the intuition is as follows. Let $\overline{w}'$ be the minimum that workers would accept over their outside option. Firm B offers the workers a fixed wage with $w = \overline{w}'$ (and $\Delta w = 0$), secured with a credit line. With such compensation and financing, all cash flows in the low cash flow state are promised to the workers, with financiers filling the gap of $\overline{w} - x$. The reason such an equilibrium can be supported is that deviations to other types of financing or compensation will be associated with a higher risk of runs or are more disadvantageous to high types. Thus, such deviations make workers and financiers pessimistic about the firm's prospects and are rejected. Indeed, this is also the most beneficial equilibrium for the firm that can be supported. The main difference to the standard analysis (Nachman and Noe, 1994) is that the firm does not actually raise capital at $t = 1$. It does so only at $t = 2$ if it is in the low cash flow state and cannot pay the workers' compensation. This explains the interpretation of the financing contract as a credit line.

The second step is to show that external financing distorts upward the firm's willingness to pay for labor. Firm B stays in the competition to hire the workers until its final fixed wage offer $w(\theta)$ exhausts its benefit from hiring high-skilled workers

$$x + \theta\Delta x - w(\theta) - (S + \theta\Delta S) - \overline{v} = 0. \tag{11}$$

Since in the discussed equilibrium, a firm seeking financing for $w(\theta)$ cannot signal its type through its choice of contracts (since all types offer a fixed wage and seek credit lines), financing will entail cross-subsidization from high to low types. In particular, when type θ^* makes the highest compensation offer it can afford, i.e., $w(\theta^*)$, the financiers overvalue its type, as they form their expectation over all types $\left[\theta^*, \overline{\theta}\right]$ that make a weakly positive payoff from hiring at this wage. In particular, the financier's break even condition is

$$\sum_{\theta \geq \theta^*} \widetilde{\pi}_\theta (S + \theta\Delta S) \geq 0. \tag{12}$$

As it is standard, it is assumed that in a competitive capital market, condition (12) is satisfied with equality, implying that $S + \theta^* \Delta S < 0$. Because type θ^*'s highest compensation offer, $w(\theta^*)$, is cross-subsidized by higher types, this offer is higher than the expected surplus from hiring. Specifically, from $S+\theta^*\Delta S < 0$ and expression (11) it holds that $x+\theta^*\Delta x-\overline{v} < w(\theta^*)$.

Proposition 6 *In the equilibrium in which the expected payoff of a firm that can make take-it-or-leave-it offers is highest, that firm offers fixed wages secured by a credit line. External financing distorts upward the highest fixed wage that the firm is prepared to offer.*

Discussion. This section tackles the problem of identifying the firm with the highest willingness to pay for labor when firms have different bargaining power and make different types of offers. The proposed solution to this problem contributes to the literature on auctions with contingent claims, which has discussed settings in which bidders (here firms) have the same bargaining power and, in equilibrium, make the same type of offers (DeMarzo et al., 2005). Another contribution to this literature is the analysis of strategic complementarities among workers and external financing. The reason considering these aspects is important is that they can revert the prediction that offers in contingent claims make sellers (here, workers) better off. The reason is that coordination problems among workers associated with equity-based compensation reduce the firm's expected profitability and, thus, its willingness to pay for labor. Furthermore, firms relying on external financing compete more aggressively. Because of these two reasons, the workers' compensation could be *higher* if firms compete with fixed wages.

Corollary 2 *There can be misallocation of workers to firms if firms (with weak bargaining power) offering equity-based compensation compete against firms (with strong bargaining power) offering fixed wages insured with external financing.*

The third difference to the auction literature is that the use of call options in this setting is unrelated to stimulating competition among bidders but to minimizing the probability that the last-remaining firm rejects the workers' demands. In particular, call options are optimal even if there is only one firm (Proposition 4).

Finally, it is conceivable that firms could try to signal that they are a high type to financiers by offering equity-based compensation to workers. Since the risk of worker runs is less pronounced for such firms, such a strategy could help them differentiate from lower types for whom offering equity-based compensation is associated with a higher risk of runs. In the present setting, such equilibria either cannot be supported or they do not lead to higher expected payoffs for the firms.

4 Empirical Implications

Contagious Turnover. The management literature has identified such contagious turnover as a first-order problem for firm performance (Felps et al., 2009; Hausknecht and Trevor, 2011; Hancock et al., 2013; Heavey et al., 2013). Examples of such worker runs can be found in industries as different as tech (Infosys in 2014) and legal services (Sedgwick in 2017).

The paper's first empirical prediction is that equity-based compensation increases the risk of worker runs (Propositions 1 and 2). This risk is particularly problematic for riskier or more indebted firms whose equity is more sensitive to performance. Indeed, empirical work shows that workers paid with equity-based compensation are more likely to leave when stock prices fall (Carter and Lynch, 2004; Chen, 2004), hurting firm performance (Larcker et al., 2013; Gulen and O'Brien, 2017).[22] The failure of firms to reprice option contracts — less than 30% do so (Aboody et al., 2010) — is typically due to resistance from investors reluctant to be watered down. While worker departures are in some cases socially efficient, an uneven risk of contagious turnover (due to differences in workers' compensation structure or firms' capital structure) can lead to an inefficient match of workers to firms (Corollary 2).

Although highly-leveraged firms are riskier and have a higher risk of runs, one of the paper's implications is that trying to reduce operating leverage by paying workers with equity will increase the risk of contagious turnover. The reason is that equity is less valuable than fixed wages if a firm is in default, making workers paid with equity more likely to leave. Moreover, backing fixed wages by securing credit lines shifts the default risk from workers to outside investors. These effects help explain why the prediction that highly-leveraged firms need to pay a wage premium to compensate workers for the higher risk of default (Titman, 1984; Berk et al., 2010; Agrawal and Matsa, 2013) is not universally supported by the evidence (Michaels et al., 2018).

Implication 1 *Equity-based compensation exposes firms to contagious worker turnover. This risk is higher in riskier and highly-leveraged firms. Insuring workers' fixed compensation through external financing, such as credit lines, can reduce this risk.*

Competition for Workers and Equity-Based Compensation. Paradoxically, the firms facing the highest pressure to offer equity-based compensation (which leads to the highest risk of runs) to attract high-skilled workers are precisely those that stand to lose most from not being able to retain such workers. Thus, competition for skilled workers explains why firms often offer slow-vesting equity and options to attract workers (Aldatmaz

[22] Speculators in financial markets can profit from such contagion effects by misleading workers to join or leave a firm by inflating or eroding its stock price (Terovitis and Vladimirov, 2020).

et al., 2018; Jochem et al., 2018) even though deferred fixed compensation can more efficiently boost retention by not exposing workers to price risk (Murphy, 2003; Lazear, 2004) and to the risk of contagious turnover (Propositions 1-2).[23].

Since offering equity-based compensation is necessary to win over skilled workers that increase firm value, Proposition 4 can also help explain why such compensation is associated with better firm performance (Hochberg and Lindsey, 2010) despite Holmström's (1982) argument that equity-based compensation does not have incentive effects below executive level. Indeed, though equity-based compensation might erode part of the benefit from hiring by exacerbating the risk of contagious turnover, this is still better than not hiring the best workers (Corollary 1).

Implication 2 *Workers compensation structure will correlate with their bargaining power: Firms competing to attract high-skilled workers crucial for value creation are more likely to offer equity-based compensation despite the associated higher risk of worker runs. Firms offer fixed wages backed by credit lines to workers with weak bargaining power.*

Supportive of Implication 2, Kedia and Rajgopal (2005) find that firms are more likely to offer equity-based compensation when nearby competing firms offer equity-based compensation and when the enforcement of non-competition agreements is weaker — arguably when there is steeper competition to hire workers. Furthermore, Giannetti and Metzger (2015) find that long-term compensation, which includes stock and stock options, is higher when there is more competition for talent, and Mehran and Tracy (2001) find that the tightening of the labor markets in the 1990s is associated with an increase of stock-based compensation.[24]

To tie such evidence more closely to the model's prediction that competition drives firms to offer equity-based compensation to attract (rather than retain) workers, one could test whether the effects are stronger for firms about whose growth options there is more information asymmetry. Younger firms and firms about which there is more dispersion in analyst forecasts are likely to fit this description. Notably, as the paper shows, asymmetric information should have the *opposite* effect in models in which firms can dictate terms — then, information asymmetry will lead to less equity-based compensation (Proposition 3). Furthermore, one could test whether more intense competition drives also firms with decreasing stock prices to offer equity-based compensation. Such evidence would be less-consistent with alternative explanations that equity-based compensation helps retain workers when

[23] Deferred (often guaranteed) bonuses are one such wide-spread instrument used for retention (Van Wesep and Waters, 2020).

[24] Further consistent withe the model's prediction, firms employing workers with weaker bargaining power due to a greater threat of being replaced by automation, are more likely to use higher leverage (Qiu et al., 2020).

stock prices increase (Oyer, 2004). Extending Kedia and Rajgopal's (2005) empirical analysis offers support for these predictions, suggesting that competition to attract skilled workers may also play an important role for offering equity-based compensation.[25]

The paper's focus on skilled workers and the potential coordination frictions that arise from workers individually negotiating their compensation differentiate the model's predictions from those of Bova and Yang (2017). In a model without information frictions, in which the main strategic consideration for wage structure is how it affects the firm's competitive edge in the product market, Bova and Yang (2017) show that weak worker bargaining power will have the opposite effect (i.e., it will be associated with equity-based pay). The authors point to empirical evidence supporting their predictions in the context of negotiations between firms and unions. The difference in findings corresponds to the difference in setups. By definition, union negotiations do not involve coordination externalities related to workers individually negotiating their wages. Furthermore, since unions are long-run players that repeatedly interact with firms and often have firm insiders on board, information asymmetries between firms and workers are likely to play a smaller role.

Other Predictions. Another insight from the paper is that, when external financing for fixed wages is easily available, it distorts upward the firms' willingness to pay for labor when the firms compete to hire skilled workers (Proposition 6). This effect can mitigate well-understood supply-side concerns that compensation and employment may be lower if external financing is hard to come by as, for example, during a financial crisis.

Implication 3 *If external financing is available at competitive terms, firms offering fixed wages backed by external financing will be more aggressive when competing for workers.*

As a side-implication, the paper also offers new predictions for how workers' compensation structure will correlate with within-firm wage inequality. Specifically, since equity-based compensation allows workers to extract a higher share of the surplus generated by their labor, the compensation difference between skilled workers and management ("the firm" in the paper) will be lower. This perspective differs from the prior literature (Terviö 2008; Gabaix and Landier 2008; Edmans et al., 2009). This literature has typically focused on how the manager's compensation affects within-firm wage inequality, and it has not looked into how that inequality correlates with workers' compensation structure.[26]

[25] The analysis is contained in the paper's working paper version and is available upon request.

[26] This perspective also differentiates the paper from the literature on how a firm's capital structure could strengthen its bargaining position in wage negotiations with unions (Perotti and Spier, 1993), based on which one could also derive predictions for wage inequality. Another strand of the literature explains within-firm wage inequality with the organization of knowledge hierarchies within firms (Garicano and Rossi-Hansberg, 2006). For recent surveys, see Edmans et al. (2017) and Garicano and Rossi-Hansberg (2015).

Implication 4 *Within-firm wage inequality between skilled workers and management will be lower in firms compensating skilled workers with more call options.*

5 Conclusion

Skilled workers are often in a position to compare offers from different potential employers. Yet the literature is silent on why firms make different types of offers and how workers can compare different offers and play firms off against each other to extract better compensation. Furthermore, there is little guidance on how different types of compensation make workers' decisions to join and subsequently stay at a firm dependent on the hiring and retention of other workers. This paper addresses these gaps by studying the effect of competition for skilled workers on the structure and financing of their compensation.

Workers' compensation structure matters from a corporate finance perspective because it affects how much external financing firms need, what type of financing they use, and whether workers become part of its investor base. Compensation structure also affects workers' incentives to leave prematurely if they believe that others are leaving. These externalities affect firm value and, thus, impact both firms and workers. However, the problem for firms is that workers do not fully internalize these externalities in their individual compensation negotiations. In particular, while workers mainly focus on maximizing their compensation, firms must also consider externalities related to retention. These different perspectives mean that workers' compensation structure depends on whether workers or firms have stronger bargaining power in negotiations.

If *workers* have a strong bargaining position and can make demands what type of compensation they prefer, workers demand compensation in call options. Since call options are worth little to firms with intermediate prospects, workers face a lower risk that aggressive demands for call options are rejected. At the same time, call options give workers a significant upside participation, which benefits workers if the firm turns out to be very good. Thus, firms offer workers equity-based compensation not because they cannot raise external financing to pay fixed wages, but because they design compensation in a way that is most attractive to workers with strong bargaining power.

The problem with equity-based compensation, however, is that it is associated with the highest risk of contagious turnover among workers. The reason is that the value of a worker's compensation depends on the firm's ability to retain other skilled workers. Yet individual workers do not internalize how their negotiations affect the risk of worker runs. The lack of coordination among workers partially lowers the expected value that skilled workers can create. As a result, it makes hiring less profitable for firms and reduces the maximum wage that firms can offer. Thus, when all workers try to extract the best deal for themselves by aggressively negotiating for call options, not only firms but also workers can end up worse off. The risk of contagious turnover is particularly high for inherently risky or highly-indebted firms and when there is a high risk that workers can become sceptical about the firm's prospects. Paradoxically, the risk of runs is most detrimental for firms whose value crucially depends on retaining skilled workers. However, it is precisely these firms that have no choice but offer equity-based compensation (which has the highest risk of runs) to attract such workers.

If *firms* have stronger bargaining power in negotiations, firms prefer to offer fixed wages secured by a credit line. The role of external financing is to insure workers' wages and reduce the risk that workers want to leave prematurely. Overall, compensation structure dramatically depends on workers' bargaining power vis-à-vis the firms. One of the paper's main results is that when firms have different bargaining power and make different types of offers, workers can still efficiently compare offers and successfully identify the firm willing to pay most for their labor. Another insight from extending the model to competition among multiple firms is that firms that finance their fixed wage offers with external financing compete more aggressively for workers compared to financially unconstrained firms. Overall, the paper highlights the importance of worker bargaining power for corporate financing decisions, the structure of non-executive compensation, and labor market inefficiencies.

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Appendix A Proofs

Proof of Proposition 2. (i) The workers' payoff function satisfies all standard assumptions in the global games literature. Specifically, $w + 0.5\left(1 + \frac{n}{N}\right)\phi(\varepsilon)\theta\Delta w - \overline{w}$ is increasing in n and ε; there is a ε^* that satisfies (2) and there are $\varepsilon', \varepsilon'' \in \mathbb{R}$ and $\xi > 0$, such that $w + 0.5\left(1 + \frac{n}{N}\right)\phi(\varepsilon)\theta\Delta w - \overline{w} > \xi$ for all $n \in [1, N]$ and $\varepsilon \geq \varepsilon'$ and $w + 0.5\left(1 + \frac{n}{N}\right)\phi(\varepsilon)\theta\Delta w - \overline{w} \leq -\xi$ for all $n \in [1, N]$ and $\varepsilon \leq \varepsilon''$. Finally, $\int_{z=-\infty}^{\infty} zf(z)\,dz$ is well defined. Hence, for any $\delta > 0$, there is a $\overline{\sigma} > 0$, such that for all $\sigma \leq \overline{\sigma}$, there is a cutoff equilibrium in which the workers run if they observe $\widetilde{\varepsilon} < \varepsilon^* - \delta$ and stay if $\widetilde{\varepsilon} > \varepsilon^* + \delta$ (See Proposition 2.2 and Appendix B in Morris and Shin, 2003).

Let $p(\theta, w, \Delta w)$ denote the probability of achieving the high cash flow state when the firm's type is θ and the workers' compensation is $\{w, \Delta w\}$. Recall that $n(\varepsilon, \varepsilon^*)$ stands for the expected number of workers that receives a signal higher than ε^* and stay with the firm when the true state is ε. We have that $p(\theta) = \int_{-\infty}^{\infty} 0.5\left(1 + \frac{n(\varepsilon,\varepsilon^*)}{N}\right)\phi(\varepsilon)\theta dG(\varepsilon)$.

(ii) Denote the expected value of that compensation at $t = 1$ with $W = w + p(\theta, w, \Delta w)\Delta w$. Construct a contract $\{\widetilde{w}, \Delta\widetilde{w}\}$ with $\widetilde{w} = w + \zeta$ and $\Delta\widetilde{w} = \Delta w - \frac{\zeta}{p(\theta,w,\Delta w)}$. The firm would be indifferent between the two contracts if $\widetilde{\varepsilon}^*$ and ε^* were the same, where $\widetilde{\varepsilon}^*$ is defined in analogy to (2) as

$$0 = \sum_{n=1}^{N} \frac{1}{N}\left(w + \zeta + 0.5\left(1 + \frac{n}{N}\right)\phi\left(\widetilde{\varepsilon}^*\right)\left(\Delta w - \frac{\zeta}{p(\theta, w, \Delta w)}\right) - \overline{w}\right). \tag{A.1}$$

From (A.1), it holds that $\phi\left(\widetilde{\varepsilon}^*\right) = \frac{\overline{w} - w - \zeta}{\sum_{n=1}^{N} \frac{1}{N} 0.5\left(1+\frac{n}{N}\right)\left(\Delta w - \frac{\zeta}{p(\theta,w,\Delta w)}\right)}$ and

$$\frac{\partial\phi\left(\widetilde{\varepsilon}^*\right)}{\partial\zeta} = -\frac{\left(w + p(\theta, w, \Delta w)\Delta w - \overline{w}\right)}{\left(0.75 + \frac{1}{N}\right)\left(\Delta w - \frac{\zeta}{p(\theta,w,\Delta w)}\right)^2} < 0. \tag{A.2}$$

Because ϕ increases in ε, the inequality in (A.2) implies that contract $\{\widetilde{w}, \Delta\widetilde{w}\}$ has a lower probability of a worker run (lower $\widetilde{\varepsilon}^*$). Thus, $\Delta\widetilde{w}$ can be decreased even further until the new contract has the same expected value W as $\{w, \Delta w\}$. This reduces the probability of runs even further. **Q.E.D.**

Proof of Proposition 3. Under symmetric information, fixed compensation, $w = \overline{w}$ and $\Delta w = 0$, guaranteed by external financing is optimal, because it maximizes $p(\theta, w, \Delta w)$, while minimizing the firm's payments to workers (i.e., (3) is satisfied with equality). It is optimal for the firm to satisfy also the financier's break even condition (4) with equality.

Any financing contract with $S \in [-\overline{w}, x-\overline{w}]$ and $\Delta S = \frac{-S}{\theta}$ achieves this goal.

If there is asymmetric information between firms and workers, the only perfect Bayesian equilibrium is again a fixed wage guaranteed by external financing. To see this, suppose that there is an equilibrium for which the workers' participation constraint is satisfied with equality and in which there is a type θ' that offers a compensation contract with $\Delta w > 0$ and $p(\theta, w, \Delta w) < \theta$. If multiple types offer the same contract, take θ' to be the highest type in the pool. By deviating to a fixed wage contract secured by a credit line with $S = x - \overline{w}$ and $\Delta S = \frac{\overline{w}-x}{\theta'}$, type θ' can do better by increasing the probability of achieving the high cash flow state from $p(\theta, w, \Delta w)$ to θ. If more than one types offer the original contract, type θ' further benefits from avoiding being pooled with lower types. The workers accept the deviation, as the deviation contract is a fixed wage (which does not depend on out-of-equilibrium beliefs) that gives them the same as their outside option. By construction, financiers also break even, giving the desired contradiction.

To see that an equilibrium in which all types offer fixed wages and workers break even can be supported, suppose that workers observe a deviation to a compensation contract with $\Delta\widetilde{w} > 0$ and $\widetilde{w} \leq \overline{w}$. Since the original fixed wage contract insured by external financing avoids misvaluation of firms and since for any deviation, the probability of achieving the high cash flow state (weakly) decreases, for any deviation that makes the firm better off, the workers must be worse off compared with the original contract. Thus, for any out-of-equilibrium beliefs that put positive probability only on types that can benefit from deviating, the workers reject the deviation. The discussion of information asymmetry between firms and financiers is a sub-case of Proposition 6. **Q.E.D.**

Proof of Proposition 4. Suppose initially that a worker offers a single take-it-or-leave-it contract. Let

$$\begin{aligned} u(\boldsymbol{\omega},\theta) &= \frac{1}{N}\left(w + p(\theta)\Delta w\right) \\ v(\boldsymbol{\omega},\theta) &= \frac{1}{N}\left(x - w + p(\theta)(\Delta x - \Delta w)\right) \end{aligned}$$

be a worker's and the firm's gross expected payoffs when the firm hires that worker with a compensation contract $\boldsymbol{\omega} = \left\{\frac{w}{N}, \frac{\Delta w}{N}\right\}$.

The proof argues, first, that from the set of all feasible compensation offers, the one that maximizes the worker's payoff features $w = 0$. Suppose to a contradiction that, for a given cutoff $\widetilde{p}(w, \Delta w)$, a compensation contract $\boldsymbol{\omega} = \left\{\frac{w}{N}, \frac{\Delta w}{N}\right\}$ with $w > 0$ were optimal and in equilibrium demanded by all workers. The firm accepts this contract if $p(\theta) \geq \widetilde{p}(w, \Delta w)$. Construct now an alternative compensation contract $\widetilde{\boldsymbol{\omega}}$ that is identical to $\boldsymbol{\omega}$ for all workers except for worker j for whom $\left\{\frac{w-\zeta}{N}, \frac{\Delta w+\frac{\zeta}{\widetilde{p}(w,\Delta w)}}{N}\right\}$. By assumption, if ζ is *infinitesimal*, the deviation by a *single* worker j does not change the firm's expectation of achieving the high cash flow state, $p(\theta)$. Thus, the set of types that accepts worker j's deviation offer is unchanged. For the deviating worker, it holds $u(\widetilde{\boldsymbol{\omega}}, \theta) - u(\boldsymbol{\omega}, \theta) = \frac{1}{N}\left(-\zeta + p(\theta)\frac{\zeta}{\widetilde{p}(w,\Delta w)}\right)$. This expression is positive if and only if $p(\theta) > \widetilde{p}(w, \Delta w)$, which holds for all types that accept the worker's deviation offer. Since this is the same set of types that accepts the original offer, the worker is better off with the proposed deviation.

To see that $\widetilde{\boldsymbol{\omega}}$ is feasible, note that $0 \leq \widetilde{w} \leq x$ is satisfied by construction. Furthermore, from $v(\widetilde{\boldsymbol{\omega}}, \widetilde{\theta}) = v(\boldsymbol{\omega}, \widetilde{\theta})$ and the definition of $\widetilde{p}(w, \Delta w)$ in expression (8), we have

$$\begin{aligned} 0 < \Delta\widetilde{w} = \frac{w-\widetilde{w}}{\widetilde{p}(w,\Delta w)} + \Delta w &= \frac{w-\widetilde{w}}{\overline{v}+w-x}(\Delta x - \Delta w) + \Delta w \\ &= \frac{w-\widetilde{w}}{\overline{v}+w-x}\Delta x + \frac{\overline{v}+\widetilde{w}-x}{\overline{v}+w-x}\Delta w \leq \Delta x, \end{aligned}$$

where the last inequality follows from $\Delta w \leq \Delta x$ and $\overline{v} > x$. Hence, $0 \leq \Delta\widetilde{w} \leq \Delta x$ is also satisfied. Clearly, this type of deviation is individually optimal for all workers, implying that the original contract could not have been offered in equilibrium. Since the argument with such infinitesimal deviations can be repeated for any compensation contract featuring $w > 0$, the only contract that will be offered by workers in equilibrium must feature $w = 0$.

Finally, observe that offering a menu of contracts cannot make the worker better off compared to offering a simple contract for which $w = 0$. Consider any non-degenerate menu W_θ. Let $\widetilde{\boldsymbol{\omega}} \in W_\theta$ be the contract chosen by the lowest type, $\widetilde{\theta}$, that accepts the worker's offer. Consider now a deviation by worker j that drops all other contracts except $\widetilde{\boldsymbol{\omega}}$ from the menu. Note that if a type prefers $\widetilde{\omega}$ over to its outside option of not hiring, the same holds for all higher types. Thus, the set of types, Ω_{W_θ}, that accepts the worker's offer remains unchanged. But then, by revealed preference of the firm for contracts other than $\widetilde{\boldsymbol{\omega}}$, the worker must be better off dropping these contracts. In particular, if there existed a contract $\boldsymbol{\omega} \in W_\theta$ such that $v(\boldsymbol{\omega}, \theta) > v(\widetilde{\boldsymbol{\omega}}, \theta)$ for one of the types that accepts the worker's offer, this would necessarily imply that $u(\boldsymbol{\omega}, \theta) < u(\widetilde{\boldsymbol{\omega}}, \theta)$. Thus, worker j is better off offering only contract $\widetilde{\omega}$. Since this deviation is profitable for all workers, a menu of contracts is not offered by any of the workers in equilibrium. **Q.E.D.**

Proof of Proposition 5. To see that the proposed strategy efficiently identifies the firm willing to pay most for labor, while extracting the maximum information about its valuation, start by considering the firms' perspective. A firm is willing to stay in the race to hire workers as long as the compensation it needs to offer does not exhaust all surplus from hiring. That is, a firm's final offer is defined by

$$x - w + p_o(\theta)(\Delta x - \Delta w) = \overline{v}, \tag{A.3}$$

where $p_o(\theta)$ is the probability of achieving the high cash flow state given the risk of runs for a call options contract $\{0, \Delta w_o\}$ for which $x + p_o(\theta)(\Delta x - \Delta w_o) = \overline{v}$. Since workers anticipate that in equilibrium, all workers identify the same firm as the one with the highest willingness to pay for labor and make a call options offer to that firm, type θ competes as if it was type $p_o(\theta)$ in a setting without runs. It is suboptimal for the firm to refuse to choose a contract from W_b if there is a contract in this menu for which it holds

$$x - w_b + p_o(\theta)(\Delta x - \Delta w_b) \geq \overline{v} \tag{A.4}$$

In this case, the firm loses the possibility of hiring at a compensation for which it is still better off compared to not hiring. Conversely, choosing a contract from W_b even though there is no contract in this set for which (A.4) is satisfied is also suboptimal, as the firm only retains the option to hire the workers at a compensation for which hiring leads to a negative net present value.

Observe that, for any menu of contracts W_b, the firm prefers to choose only among the contracts for which $\widetilde{p}(w_b, \Delta w_b)$ is lowest. This is because, if the other firm (Firm A) drops out on the next move, Firm B would otherwise unnecessarily give away that its type is higher than $\widetilde{p}(w_b, \Delta w_b)$. This would allow the worker to extract more surplus with her final take-it-or-leave-it offer. Firm B is indifferent among all offers that have the same cutoff $\widetilde{p}(w_b, \Delta w_b)$, since all these offers communicate the same information to the workers (i.e., that the firm's type $p_o(\theta)$ is at least $\widetilde{p}(w_b, \Delta w_b)$).

Consider now the workers' perspective. It is shown in what follows that no other way of comparing offers (compared to that proposed in the Proposition) allows a worker to extract higher compensation with her final take-it-or-leave-it offer. Without loss of generality, restrict attention to two firms, Firm A whose type is θ_A and Firm B whose type is θ_B, where $\theta_B > \theta_A$. With the proposed strategy, the worker can infer Firm A's type θ_A and makes Firm B a final take-it-or-leave-it offer for call options that maximizes

$$\max_{\Delta w} \sum_{\theta \in [\theta_A, \theta^*]} \widetilde{\pi}_\theta \overline{w} + \sum_{\theta \in [\theta^*, \overline{\theta}]} \widetilde{\pi}_\theta p_o(\theta) \Delta w \tag{A.5}$$

$$s.t. \qquad x + p_o(\theta^*)(\Delta x - \Delta w) = \overline{v}$$

where the posterior beliefs $\widetilde{\pi}_\theta$ are formed using Bayes rule over $\left[\theta_A, \overline{\theta}\right]$.

Consider now the possibility that a worker pursues alternative ways to compare the firms' offers. Clearly, if for such alternatives, Firm B drops out before Firm A, the worker is worse off, as $\theta_B > \theta_A$. The worker is also worse off if Firm A drops out before Firm B, but the worker is only able to learn that Firm A's type is at least θ' where $\theta' < \theta_A$ (instead of at least θ_A), as then the worker's final offer is based on less information. Thus, it only remains to consider the case in which there is a strategy that allows the worker to extract Firm A's type and extracts from Firm B than that its type is at least $\theta' > \theta_A$ (instead of at least θ_A). Extracting this information from Firm B requires that the worker compares one of Firm A's offers $\{w_a, \Delta w_a\}$ to the new offer(s) $\{w_b, \Delta w_b\}$ she demands from Firm B in a way that firm B stays only if its type is above θ' (recall that the firm prefers to choose only among the contracts for which $\widetilde{p}(w_b, \Delta w_b)$ is lowest). To see that this cannot make the worker better off, consider an idealized scenario for the worker in which she has somehow inferred that Firm A's type is θ_A and only has to deal with the problem that she does not know Firm B's type. The worker then optimally chooses $\{w_b, \Delta w_b\}$ trading off the risk that Firm B drops out if its type is below θ' against the benefit that the worker can subsequently make a more-informed final take-it-or-leave-it final offer if Firm B does not drop out

$$\max_{w_b,\Delta w_b,\Delta w} \sum_{\theta\in[\theta_A,\theta']} \widetilde{\pi}_\theta \overline{w} + \sum_{\theta\in\left[\theta',\overline{\theta}\right]} \widetilde{\pi}_\theta \left(\sum_{\theta\in[\theta',\theta^*]} \overline{w} \frac{\widetilde{\pi}_\theta}{\sum_{\theta\in\left[\theta',\overline{\theta}\right]} \widetilde{\pi}_\theta} + \sum_{\theta\in\left[\theta^*,\overline{\theta}\right]} p(\theta)\,\Delta w \frac{\widetilde{\pi}_\theta}{\sum_{\theta\in\left[\theta',\overline{\theta}\right]} \widetilde{\pi}_\theta} \right)$$

$$\begin{aligned} s.t.\quad & x - w_b + p_o(\theta')(\Delta x - \Delta w_b) = \overline{v} \\ & x + p_o(\theta^*)(\Delta x - \Delta w) = \overline{v}. \end{aligned}$$

This problem reduces to program (A.5), proving that the worker cannot do better than with the proposed strategy. **Q.E.D.**

Proof of Proposition 6. The proof proceeds in two steps. Step 1 shows that offering $w = \overline{w}'$, $\Delta w = 0$, $S = x - \overline{w}'$ and $\Delta S = \frac{\overline{w}' - x}{\sum_{\theta\in\{\underline{\theta},\ldots,\overline{\theta}\}} \widetilde{\pi}_\theta \theta}$ can be supported as equilibrium, where the posterior beliefs $\widetilde{\pi}_\theta$ are formed using Bayes rule. Since workers and financiers observe the same information, they have the same posterior beliefs. Step 2 shows that external financing distorts upward the highest fixed wage the firm is prepared to offer. Appendix B.1 shows that any equilibrium candidate must feature $S + w = x$ and that the equilibrium characterized in Step 1 is the one that yields the highest expected payoff for the firm.

Out-of-equilibrium beliefs are refined using D1, which is defined as follows. Let $U(\theta,w,\Delta w, S,\Delta S)$ denote the firm's expected payoff for contracts $\{w, \Delta w\}$ and $\{S, \Delta S\}$. Let Π be the probability that a deviation to contract $\{\widetilde{w}, \Delta\widetilde{w}\}$, $\{\widetilde{S}, \Delta\widetilde{S}\}$ is accepted. Let $\Pi(\theta, \widetilde{w}, \Delta\widetilde{w}, \widetilde{S}, \Delta\widetilde{S})$

be the minimum probability Π needed for type θ to benefit from deviating

$$\Pi(\theta, \widetilde{w}, \Delta\widetilde{w}, \widetilde{S}, \Delta\widetilde{S}) = \min\left\{\Pi : \Pi U(\theta, \widetilde{w}, \Delta\widetilde{w}, \widetilde{S}, \Delta\widetilde{S}) + (1-\Pi)\,\overline{v} \geq U\left(\theta, w, \Delta w, S, \Delta S\right)\right\} \tag{A.6}$$

Then, D1 dictates that the out-of-equilibrium beliefs should place probability one on the (set of) type(s) for which $\Pi(\theta, \widetilde{w}, \Delta\widetilde{w}, \widetilde{S}, \Delta\widetilde{S})$ has the lowest value. Note that since $U(\theta, w, \Delta w, S, \Delta S) \geq \overline{v}$, for a type to benefit from deviation it must be that $U(\theta, \widetilde{w}, \Delta\widetilde{w}, \widetilde{S}, \Delta\widetilde{S}) > U(\theta, w, \Delta w, S, \Delta S)$.

Step 1: *There is a perfect Bayesian equilibrium with a compensation contract* $w = \overline{w}'$, $\Delta w = 0$ *and a financing contract* $S = x - \overline{w}'$, $\Delta S = \frac{\overline{w}' - x}{\sum_{\theta \in \{\underline{\theta}, \ldots, \overline{\theta}\}} \widetilde{\pi}_\theta \theta}$. *This equilibrium survives refining out-of-equilibrium beliefs with D1.*

Proof. Define $R = w + S$ and $\Delta R = \Delta w + \Delta S$ as the sum of the claims offered to the workers and the financiers. Note that D1 has no bite for deviations that benefit all types. In such cases, we can assume that workers' and financiers' out-of-equilibrium beliefs place probability one on the lowest type, prompting workers and financiers to reject the deviation. It remains to consider deviations that benefit only some types. Since $R = x$ (and feasibility dictates that $R \leq x$), consider a deviation to $\widetilde{R} = R - \zeta$ and $\Delta\widetilde{R} = \Delta R + \delta$ $(\zeta, \delta > 0)$ for which there is a threshold $\widehat{\theta}$ at which

$$x - \widetilde{R} + p(\widehat{\theta}, \widetilde{w}, \Delta\widetilde{w})(\Delta x - \Delta\widetilde{R}) - x + R - \widehat{\theta}\left(\Delta x - \Delta R\right) = 0.$$

If the workers are hired with such an offer compared to the proposed equilibrium compensation contract, the difference in expected payoffs between the equilibrium and deviation contract for the firm is

$$\begin{aligned}
& \zeta + p(\theta, \widetilde{w}, \Delta\widetilde{w})(\Delta x - \Delta\widetilde{R}) - \theta\left(\Delta x - \Delta R\right) \\
= \; & \zeta + p(\theta, \widetilde{w}, \Delta\widetilde{w})\frac{\widehat{\theta}\left(\Delta x - \Delta R\right) - \zeta}{p(\widehat{\theta}, \widetilde{w}, \Delta\widetilde{w})} - \theta\left(\Delta x - \Delta R\right) \\
= \; & \zeta\left(1 - \frac{p(\theta, \widetilde{w}, \Delta\widetilde{w})}{p(\widehat{\theta}, \widetilde{w}, \Delta\widetilde{w})}\right).
\end{aligned} \tag{A.7}$$

where we use that $p\left(\theta\right) = \int_{-\infty}^{\infty} 0.5\left(1 + \frac{n(\varepsilon, \varepsilon^*)}{N}\right)\phi\left(\varepsilon\right)\theta dG\left(\varepsilon\right)$ (Proposition 2) to obtain the last equality. Expression (A.7) is positive for any $\theta < \widehat{\theta}$ and negative otherwise. In particular, (A.7) is positive for the lowest type who would be just indifferent between hiring and not hiring with the originally proposed contract, i.e., $U\left(\theta, S, \Delta S, w, \Delta w\right) = \overline{v}$. Since this type would benefit for any positive probability of acceptance of the deviation, for this type $\Pi(\theta, \widetilde{w}, \Delta\widetilde{w}, \widetilde{S}, \Delta\widetilde{S})$ is lowest. Hence, it is consistent with D1 to assume that outsiders place probability one on the deviation coming from that type. Given that the workers and financiers just break even with the original contracts (which pool that type with higher types), for such out-of-equilibrium beliefs, the workers and financiers cannot break even and reject the deviation. Hence, the proposed equilibrium candidate can be supported. Furthermore, it survives refining out-of-equilibrium beliefs with D1. **Q.E.D.**

Step 2. *The external financing contract from Step 1 distorts upward the highest fixed wage that the firm is prepared to offer.*

Proof. Let $w(\theta)$ be the fixed wage at which type θ is indifferent between hiring and not hiring. Using that $S = x - w$ and $\Delta S = \frac{w-x}{\sum_{\theta \geq \theta^*} \widetilde{\pi}_\theta \theta}$ to plug into (11) and rearranging terms, it holds

$$w(\theta^*) = x + \frac{\sum_{\theta \geq \theta^*} \widetilde{\pi}_\theta \theta}{\theta^*} (\theta^* \Delta x - \overline{v})$$

for any type $\theta^* \in [\underline{\theta}, \overline{\theta}]$. Since $\sum_{\theta \geq \theta^*} \widetilde{\pi}_\theta \theta \geq \theta^*$, we see immediately that $w(\theta^*) \geq x + \theta^* \Delta x - \overline{v}$ with the inequality being strict for all types except the highest. To see that $w(\theta)$ increases in θ, observe that for any two types $\theta^{**} > \theta^*$

$$\begin{aligned} & w(\theta^{**}) - w(\theta^*) \\ = & \sum_{\theta \geq \theta^{**}} \frac{\pi_\theta \theta}{\sum_{\theta \geq \theta^{**}} \pi_\theta \theta^{**}} (\theta^{**} \Delta x - \overline{v}) - \sum_{\theta \geq \theta^*} \frac{\pi_\theta}{\sum_{\theta \geq \theta^*} \pi_\theta \theta^*} \theta (\theta^* \Delta x - \overline{v}) \qquad \text{(A.8)} \\ = & \left(\frac{\sum_{\theta \geq \theta^{**}} \pi_\theta \theta}{\sum_{\theta \geq \theta^{**}} \pi_\theta} - \frac{\sum_{\theta \geq \theta^*} \pi_\theta \theta}{\sum_{\theta \geq \theta^*} \pi_\theta} \right) \Delta x - \left(\frac{\sum_{\theta \geq \theta^{**}} \pi_\theta \theta}{\sum_{\theta \geq \theta^{**}} \pi_\theta \theta^{**}} - \frac{\sum_{\theta \geq \theta^*} \pi_\theta \theta}{\sum_{\theta \geq \theta^*} \pi_\theta \theta^*} \right) \overline{v}. \qquad \text{(A.9)} \end{aligned}$$

Observe that the first term in brackets in (A.9) is positive, as $\theta^{**} > \theta^*$. Hence, if $\frac{\sum_{\theta \geq \theta^{**}} \pi_\theta \theta}{\sum_{\theta \geq \theta^{**}} \pi_\theta \theta^{**}} \leq \frac{\sum_{\theta \geq \theta^*} \pi_\theta \theta}{\sum_{\theta \geq \theta^*} \pi_\theta \theta^*}$, (A.9) is positive. If, instead, $\frac{\sum_{\theta \geq \theta^{**}} \pi_\theta \theta}{\sum_{\theta \geq \theta^{**}} \pi_\theta \theta^{**}} > \frac{\sum_{\theta \geq \theta^*} \pi_\theta \theta}{\sum_{\theta \geq \theta^*} \pi_\theta \theta^*}$, then (A.8) is positive, as

$$(\theta^{**} \Delta x - \overline{v}) > (\theta^* \Delta x - \overline{v}) > x - \overline{w} + \theta^* \Delta x - \overline{v} \geq 0,$$

where the second inequality follows from $x \leq \overline{w}$, while the last inequality follows from the assumption that hiring at the workers' initial outside option $\overline{w}$ creates social surplus. **Q.E.D.**

Appendix B For Online Publication

The first part of this Appendix presents further results relating to Section 3.4.2. The second part presents empirical evidence in support of the prediction that stronger worker bargaining power leads to more compensation in call options.

B.1 Further Results

In what follows, it is shown that in any equilibrium candidate, it must be that $S + w = x$ and that the equilibrium characterized in Step 1 is the one that yields the highest expected payoff for the firm.

Claim 1: *In any pooling equilibrium that survives D1, the payment to the workers and financiers in the low cash flow state must be* $w + S = x$.

Proof. Suppose to a contradiction that there is an equilibrium with $R = w + S < x$, and let θ'' be the highest type (in a pool) that makes this offer. Let θ' be the type just below θ''. Consider a one-time deviation contract $\{\widetilde{S}, \Delta\widetilde{S}\}$ (following which the firm reverts to competing for the workers as in the proposed equilibrium) for which $\widetilde{S} = S + \zeta$ and for which $\{w, \Delta w\}$ is unchanged. That is, the risk of runs is unchanged. Furthermore, construct the deviation such that type θ' is just indifferent between $\{R, \Delta R\}$ and $\{\widetilde{R}, \Delta\widetilde{R}\}$ if the deviation is accepted, i.e., $\Delta x - \Delta\widetilde{R} = \frac{\zeta}{p(\theta', w, \Delta w)} + (\Delta x - \Delta R)$.[27] Type θ'' strictly prefers this deviation for any $\zeta > 0$ because, if the firm hires the workers with this contract, the firm has a higher expected payoff compared to with its equilibrium contract:

$$\begin{aligned} & x - \widetilde{R} + p(\theta'', w, \Delta w)\left(\Delta x - \Delta\widetilde{R}\right) \\ = \ & x - R + p(\theta'', w, \Delta w)\left(\Delta x - \Delta R\right) + \left(\frac{p(\theta'', w, \Delta w)}{p(\theta', w, \Delta w)} - 1\right)\zeta \\ > \ & x - R + p(\theta'', w, \Delta w)\left(\Delta x - \Delta R\right). \end{aligned}$$

Furthermore, since by incentive compatibility, for any type $\theta_l < \theta''$ with an equilibrium

[27] $\{R, \Delta R\}$ stands for $\{S, w, \Delta S, \Delta w\}$.

contract $\{R_l, \Delta R_l\}$ it holds

$$\begin{aligned}
& x - R_l + p(\theta_l, w_l, \Delta w_l)\,(\Delta x - \Delta R_l) \\
\geq\ & x - R + p(\theta_l, w, \Delta w)\,(\Delta x - \Delta R) \\
=\ & x - \widetilde{R} + p(\theta_l, w, \Delta w)(\Delta x - \Delta \widetilde{R}) - \left(\frac{p(\theta_l, w, \Delta w)}{p(\theta', w, \Delta w)} - 1\right)\zeta \\
>\ & x - \widetilde{R} + p(\theta_l, w, \Delta w)(\Delta x - \Delta \widetilde{R}).
\end{aligned}$$

Hence, no type lower than θ'' strictly benefits from deviating to contract $\{\widetilde{R}, \Delta\widetilde{R}\}$. Thus, for any out-of-equilibrium beliefs consistent with Cho and Kreps' (1987) D1 refinement, the lowest type deviating is at least θ''. Since θ'' is the highest type (in a pool) offering the original contract $\{R, \Delta R\}$, and for $\{R, \Delta R\}$ the workers' and financiers' participation constraints are satisfied, the workers at least break even for such beliefs. Furthermore, if the firm hires the workers with the deviation contract, the financiers' expected payoff is at least

$$\begin{aligned}
& \widetilde{S} + p\,(\theta'', w, \Delta w)\left(\Delta \widetilde{R} - \Delta w\right) \\
=\ & S + \zeta + p\,(\theta'', w, \Delta w)\left(\Delta R - \frac{\zeta}{p\,(\theta', w, \Delta w)} - \Delta w\right) \\
=\ & S + p\,(\theta'', w, \Delta w)\,\Delta S + \zeta\left(1 - \frac{p\,(\theta'', w, \Delta w)}{p\,(\theta', w, \Delta w)}\right).
\end{aligned}$$

Since θ'' is the highest type in a pool offering $\{S, \Delta S\}$, we have $S + p\,(\theta'')\,\Delta S > 0$ (from (4)). Hence, ζ can be chosen sufficiently small that the financiers break even with the deviation. **Q.E.D.**

Claim 2: *In any separating equilibrium candidate that survives D1, the payment to the workers and financiers in the low cash flow state must be* $w + S = x$.

Proof. Suppose to a contradiction that there was an equilibrium in which type θ'' separates from all other types and the workers and financiers break even for type θ''. Let $\{w'', \Delta w''\}$ and $\{S'', \Delta S''\}$ be the equilibrium contracts offered by type θ'' and $\{w', \Delta w'\}$ and $\{S', \Delta S'\}$ be the contracts offered by type θ', where $\theta'' > \theta'$. Observe, first, that there can be no separating equilibrium in which the contracts offered by θ'' are associated with a lower risk of runs, i.e., $p\,(\theta, w'', \Delta w'') \geq p\,(\theta, w', \Delta w')$. Specifically, if the workers are hired when such a menu is offered, it holds that

$$\begin{aligned}
& x - R'' + p(\theta', w'', \Delta w'')(\Delta x - \Delta R'') \\
= \;& x + p(\theta', w'', \Delta w'')\Delta x - \overline{w}' + (p(\theta'', w'', \Delta w'') - p(\theta', w'', \Delta w''))\Delta R'' \\
> \;& x + p(\theta', w'', \Delta w'')\Delta x - \overline{w}' \\
\geq \;& x + p(\theta', w'', \Delta w'')\Delta x - R' - p(\theta', w', \Delta w')\Delta R' \\
\geq \;& x - R' + p(\theta', w', \Delta w')(\Delta x - \Delta R')
\end{aligned}$$

contradicting incentive compatibility. The equality in the second line follows from the assumption that the workers and financiers break even for type θ'', i.e., $R'' + p(\theta'', w'', \Delta w'')\Delta R'' = \overline{w}'$; the inequality in the fourth line follows from the financiers' and workers' break even conditions for contracts $\{w', \Delta w'\}$ and $\{S', \Delta S'\}$ evaluated for type θ'; the inequality in the fifth line follows from the assumption that $p(\theta, w'', \Delta w'') \geq p(\theta, w', \Delta w')$.

Furthermore, there is no separating equilibrium in which the contract offered by the higher type θ'' has a higher risk of runs, $p(\theta, w'', \Delta w'') < p(\theta, w', \Delta w')$, and where $R'' < x$. To see this, observe that θ'' can then offer an alternative contract (following which the firm reverts to the proposed equilibrium strategies) with $\Delta\widetilde{R} = \Delta R''$, but $\Delta\widetilde{w} = \Delta w'' - \zeta$ and $\widetilde{w} = w'' + p(\theta'', w'', \Delta w'')\zeta$ (i.e., $\Delta\widetilde{S} = \Delta S'' + \zeta$ and the workers would be indifferent if hired with this contract even if the risk of run did not change for type θ'') and $\widetilde{S}$ is chosen such that type θ' is indifferent between $\{\widetilde{R}, \Delta R''\}$ and $\{R'', \Delta R''\}$

$$x - \widetilde{R} - (x - R'') + (p(\theta', \widetilde{w}, \Delta\widetilde{w}) - p(\theta', w'', \Delta w''))(\Delta x - \Delta R'') = 0. \tag{B.1}$$

Note that this is feasible as long as $R'' < x$ and ζ (and, thus, $p(\theta', \widetilde{w}, \Delta\widetilde{w}) - p(\theta', w'', \Delta w'')$) is sufficiently small.

Since $p(\theta, \widetilde{w}, \Delta\widetilde{w}) - p(\theta, w'', \Delta w'')$ is positive (as $\Delta\widetilde{w} < \Delta w$) and increasing in θ (see expression for $p(\theta, w, \Delta w)$ in Proposition 2), type θ'' is strictly better off with $\{\widetilde{R}, \Delta R''\}$ compared to $\{R'', \Delta R''\}$. By contrast, by incentive compatibility, for types θ_l lower than θ' it holds that

$$\begin{aligned}
& x - R_l + p(\theta_l, w_l, \Delta w_l)(\Delta x - \Delta R_l) \\
\geq \;& x - R'' + p(\theta_l, w'', \Delta w'')(\Delta x - \Delta R'') \\
= \;& x - \widetilde{R} + (p(\theta', \widetilde{w}, \Delta\widetilde{w}) - p(\theta', w'', \Delta w'') + p(\theta_l, w'', \Delta w''))(\Delta x - \Delta R'') \\
> \;& x - \widetilde{R} + p(\theta_l, w'', \Delta w'')(\Delta x - \Delta R'').
\end{aligned}$$

Hence, by Cho and Kreps' (1987) D1 refinement, out-of-equilibrium beliefs must set positive probability mass only on type θ'' or higher types. For any such out-of-equilibrium beliefs, the workers are better off with the deviation, as by construction they would be indifferent if the deviation came from θ'' and the risk of runs was unchanged. Furthermore, for any such beliefs, the financiers are also better off if the workers are hired with the deviation contract, as their expected payoff is at least

$$\begin{aligned}
& \widetilde{S} + p(\theta'', \widetilde{w}, \Delta\widetilde{w})\left(\Delta R'' - \Delta\widetilde{w}\right) \\
= \;& x - (x - R'') + \left(p\left(\theta', \widetilde{w}, \Delta\widetilde{w}\right) - p\left(\theta', w'', \Delta w''\right)\right)\left(\Delta x - \Delta R''\right) \\
& -w'' - p\left(\theta'', w'', \Delta w''\right)\zeta + p(\theta'', \widetilde{w}, \Delta\widetilde{w})\left(\Delta R'' - \Delta w'' + \zeta\right) \\
= \;& S'' + \left(p\left(\theta', \widetilde{w}, \Delta\widetilde{w}\right) - p\left(\theta', w'', \Delta w''\right)\right)\left(\Delta x - \Delta R''\right) \\
& + p(\theta'', \widetilde{w}, \Delta\widetilde{w})\Delta S'' + \zeta\left(p(\theta'', \widetilde{w}, \Delta\widetilde{w}) - p\left(\theta'', w'', \Delta w''\right)\right) \\
> \;& S'' + p(\theta'', w'', \Delta w'')\Delta S'' \geq 0,
\end{aligned}$$

where the first equality follows when plugging for $\widetilde{R}$ from (B.1) and using that $\widetilde{S} = \widetilde{R} - \widetilde{w}$; the first inequality follows from $p(\theta, \widetilde{w}, \Delta\widetilde{w}) > p\left(\theta, w'', \Delta w''\right)$; and the last inequality follows from the assumption that the original contract must satisfy the financier's break even condition. **Q.E.D.**

Claim 3: *The equilibrium characterized in Proposition 6 is the one that yields the highest expected payoff to the firm.*

Proof. The claim follows trivially in the case of pooling equilibria, as for all pooling equilibria, it must hold that $R = x$, and the one characterized in Proposition 6 has the lowest risk of runs. Consider, therefore, a separating equilibrium candidate in which type θ' offers $\{S', \Delta S'\}$ and $\{w', \Delta w'\}$ while type θ'' offers $\{S'', \Delta S''\}$ and $\{w'', \Delta w''\}$. Since for both types it must hold that $R'' = R' = x$, incentive compatibility dictates that

$$\begin{aligned}
p\left(\theta'', w'', \Delta w''\right)\left(\Delta x - \Delta R''\right) &\geq p\left(\theta'', w', \Delta w'\right)\left(\Delta x - \Delta R'\right) \\
p\left(\theta', w'', \Delta w''\right)\left(\Delta x - \Delta R''\right) &\leq p\left(\theta', w', \Delta w'\right)\left(\Delta x - \Delta R'\right).
\end{aligned}$$

Since $p\left(\theta'', w, \Delta w\right)$ is linear in θ, the incentive constraints can be satisfied only if both of the above conditions are satisfied with equality. Since this must hold for any two types θ' and θ'' that benefit from hiring workers, it is payoff-equivalent for firms to one in which all types pool. However, as argued above, the pooling equilibrium with the highest expected payoff for firms when all types offer $R = x$ is that characterized in Proposition 6. **Q.E.D.**