Financing Skilled Labor

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Abstract

This paper analyzes why some cash-constrained firms offer non-executive workers fixed wages, secured by external financing, while others effectively use worker financing by offering equity-based compensation. The model shows that worker bargaining power plays a key role. When firms compete for their labor, workers *demand* equity-based compensation. However, such compensation increases the risk of subsequent "workers runs" — a cost that workers do not internalize when individually negotiating their wages. Guaranteeing fixed wages through external financing avoids this problem, but makes cash-constrained firms more aggressive than unconstrained firms. Using shocks to workers' bargaining power, the paper shows strong empirical support for the predicted relation between worker bargaining power and equity-based compensation.

Keywords: Financing wages, wage structure of non-executive employees, worker runs, worker bargaining power, noncompetition agreements.

JEL Classification: G32, M52, J54, J33

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1 Introduction

Labor is arguably one of the most important factors for the success of investment. Yet the corporate finance literature is largely silent on whether financing labor should be treated differently than financing physical assets. Typically, the focus is on the fundamental nature of the financing friction, e.g., asymmetric information, and it is less important whether the source of the friction pertains to the nature of labor or physical assets. However, unlike physical assets, workers could become investors in the firm by accepting equity or other compensation that depends on the firm's future cash flows. Another distinguishing feature is that workers could refuse to work for the firm if they have lucrative outside offers. These differences give rise to the following problem: If a skilled worker, such as an experienced engineer, has a job that pays him $90,000, but receives an alternative offer for $80,000 plus options to buy up to 3% of the rival firm's stock, how should he decide and what demands should he make? Furthermore, how should the firms structure their offers and counter-offers, especially when they are cash-constrained?

The contribution of this paper is to give an answer to these questions by investigating the close relation between worker bargaining power and the structure and financing of wages. This perspective can shed light on the mixed evidence relating cash constraints to wage structure. In particular, some studies find that cash-constrained firms, such as Facebook in its early years, are more likely to offer equity-based compensation (Core and Guay, 2001; Kim and Ouimet, 2014). Others find no such evidence (Ittner et al., 2003). For example, Netflix competes only on fixed salaries.[1] Indeed, in a rational world, it is, at first sight, a puzzle why a cash-constrained firm would prefer offering workers equity-based compensation compared to securing funding for wages from outside investors. After all, offering equity-based compensation means making workers investors in the firm, without leading to significant incentive benefits, especially in larger teams (Holmström, 1982).

The key ingredient in this paper is that wage structure and wage financing reflect not only what a firm prefers, but also what workers *demand* when firms compete for their labor. One of the model's main insights is that firms will supplement salaries with call options when they are facing workers whose skills are sought by many firms, which allows these workers to make demands. Thus, firms use equity-based compensation as a response to pressures to make their offers more competitive by allowing workers to become investors

[1] See "How Netflix reinvented HR," Harvard Business Review, January-February 2014 and "Facebook's first employees to share $23bn," Financial Times, Feburary 15, 2012. More broadly, highlighting the reliance of many cash-constrained firms on external financing to pay wages, Benmelech et al. (2015) and Falato and Liang (2016) show that a restricted access to credit is associated with a decrease in employment.

at favorable terms. Otherwise, firms prefer paying fixed salaries, guaranteed by external financing. The greater security of fixed salaries reduces the risk that workers "run" prematurely, because they become worried that factors outside of their control negatively affect their wage. To support the idea that worker bargaining power is a first-order determinant of wage structure, the paper exploits the staggered tightening and weakening of the enforcement of non-compete agreements across states. The evidence is that weaker enforcement (i.e., stronger worker bargaining power) leads to a substantial increase in the options granted to non-executive employees.

The paper develops a model in which a firm needs to hire skilled workers to realize a risky project yielding stochastic cash flows. The skilled workers it tries to hire possess knowledge or skills that would increase firm value by more relative to all other job seekers in the labor market. A typical example would be experienced mid-level managers, engineers, or scientists whose professional track record and degrees speak for themselves. In this setting, the key friction is that *workers* are less-informed than the firm how valuable their labor would be for it.[2] The firm faces two problems. First, it has very little cash on hand and, second, it competes for labor with a firm that is not cash-constrained.

The first main insight from this setting is that compensation that depends on the firm's future cash flows — e.g., $\$80,000$ plus options on 3% of the firm's equity — exposes the firm to "worker runs." After they are hired (and learn a bit about the firm), workers may leave prematurely if they believe that others are likely to do the same, as such an exodus could reduce the value of their expected variable pay below their outside option. The resulting risk of a worker run is higher, the more the workers' wage depends on the firm's future cash flows. Thus, by exposing workers to negative developments in the firm outside of their control, equity-based compensation makes the firm especially prone to worker runs. The implication of this insight is clear: The risk of worker runs should create a preference to secure wages through external financing. This is also true in the benchmark in which firms are *not* competing for labor. Firms and workers would then be indifferent between worker and external financing, were it not for the risk of runs. However, the implications for wage structure and wage financing change dramatically when competition for labor shifts bargaining power into the hands of workers.

Wage structure shifts towards equity-based compensation despite the risk of worker runs if competition for their labor allows workers to make demands about their wage.

[2] Indeed, before joining the firm, workers have less information about its growth prospects, internal organization, the other members of the team, and based on what exact criteria they were chosen. The problem that an individual worker may lie about his skills is, naturally, also important, but its consequences may be less severe for firms hiring multiple workers. Moreover, workers' professional track records and degrees should help reduce concerns about worker quality.

Specifically, by modeling competition as firms improving on in each other's offers until only one remains, the paper shows how workers can, first, identify the firm willing to pay most for their labor *without* restricting what type of wage structures firms can choose from; and that it is, then, individually optimal to demand from the last remaining firm that it pays them in call options despite the risk of worker runs.

Consider the *workers'* demand for call options towards the last remaining firm. The problem for workers is that they are uncertain how valuable their labor would be for the firm. The advantage of call options is that they allow workers to maximally participate in the firm's success. Specifically, the benefit over other types of compensation, such as fixed wages, is that call options allow workers to demand a wage that would not be considered unreasonable by firms in which their labor would not create large surplus, while at the same time allowing workers to extract more from firms in which their labor contributes to creating such a surplus. Call options are optimal despite the risk of worker runs when workers negotiate their wages individually, because (somewhat similar to a prisoner's dilemma), an individual worker does not internalize how his wage negotiations increase that risk. This lack of coordination hurts everyone by reducing overall surplus and lowering the maximum wage that firms can afford to offer. Thus, despite being individually optimal when workers have a strong bargaining position, call options could end up making workers collectively worse off.

Though the workers' demands towards the last remaining firm may introduce inefficiency, the preceding process of playing the firms off against each other can be organized surprisingly efficiently without restricting the types of offers that firms compete with. The difficulty is that, unlike comparing fixed wage offers, comparing offers that include, for example, equity or options is far from trivial. The solution lies in comparing such offers based on the value they would have for the firms when these offers would be the highest that they would be able to afford. This way of comparison is optimal, as when a firm makes the highest offer it can afford, the workers' treatment of its offer is fair: It is the same as the firm's own valuation. Thus, no firm drops from competing for labor prematurely or too late. The key features of the overall mechanism are that it is simple, it does not restrict the type of offers that firms can choose from (until workers make their demands for call options), and it extracts as much information as possible from the firms about how they value labor. This insight is especially important if workers have strong bargaining power and can make demands towards one of the firms, but not the other, as then workers will be forced to find a way of comparing fixed wages with equity-based compensation.

Indeed, there is a stark contrast both in terms of wage structure and efficiency implications if workers cannot make demands about their wage, but simply accept the highest wage offer. In this case, firms preserve more rent by competing on fixed wages. Fixed wages also avoid worker runs, but they could distort the competition for labor. In particular, securing fixed wages through external financing increases the highest offer that the constrained firm is willing to make compared to what it would offer had it not been cash-constrained. This increased aggressiveness results from financing being too cheap for high wages. This is because high wage offers are only made by firms with better projects, while low wage offers can be afforded also by firms with less attractive projects. As a result, investors tend to undervalue the constrained firm for low wage offers (making financing expensive for low wages), but overvalue it for higher wage offers (making financing cheap for high wages). Thus, higher wage offers come ex post at the investors' expense. To minimize these distortions, firms will use debt financing.

The final part of the paper presents evidence supporting the claim that worker bargaining power is of first-order importance for the structure of wages. The empirical design is a difference-in-differences model using that non-compete agreements are enforced differently in different parts of the U.S., with some states tightening while others weakening their enforceability over the last twenty years in a staggered fashion. The results show that weaker enforcement, which prior work has shown to increase worker bargaining power, leads to firms granting significantly more options to their average non-executive employees.[3] The effect is particularly strong for younger firms — at around $1000 more options per worker. There is no corresponding increase in equity grants, implying that stronger worker bargaining power changes the composition of wages towards call options.

The paper contributes to the growing literature relating corporate finance and labor by analyzing the interdependence between the structure of wages, financing decisions, and worker bargaining power. One of the paper's novel insights is that firms that do not back up wage promises with external financing would be exposed to worker runs. Though the concept of "runs" is typically used in the context of banks (Diamond and Dybvig, 1983; Goldstein and Pauzner, 2005), it has long been recognized that workers may abandon a firm if they are concerned about its financial health.[4] This would require paying a wage premium (Titman, 1984; Berk et al., 2010). The key difference is that a worker run can also lead to the demise of a healthy firm without debt on its balance sheets. Perhaps surprisingly, the paper shows that raising debt to secure funding for wages may be better for firms and workers, as it could reduce the risk of worker runs. This insight could shed

[3]Stricter enforcement of noncompetition agreements restricts worker mobility, lowers wages, and curbs start-up acitvity (Marx et al., 2009; Garmaise 2011; Starr et al., 2017; Ewens and Marx, 2018).

[4]Stakeholders abandoning distressed firms is an example of indirect costs of financial distress (Bris et al., 2006; Hortascu et al., 2013; Sautner and Vladimirov, 2017).

some new light on why the evidence that highly-levered firms pay higher wages (Agrawal and Matsa, 2013; Chemmanur et al., 2013) is not universal (Michaels et al., 2018).

The paper further contributes to the discussion why firms offer equity-based compensation to non-executive employees, given that such compensation is unlikely to have any incentive effects (Holmström, 1982). The explanation in the present paper is that stronger worker bargaining power would lead to such compensation. This explanation, for which the paper also presents empirical support, complements prior work, which has explained this practice with the wish of firms to exploit the overoptimism of boundedly rational workers (Bergman and Jenter, 2007) and with the wish to index compensation to workers' outside options, as it allows to avoid wage renegotiations (Oyer, 2004). Closely related, Bova and Yang (2017) argue that the combination of strong product market competition and weak employee bargaining power will make equity compensation optimal. It is interesting that the absence of product market considerations, but the presence of information frictions, in the present paper leads to contrasting predictions for the relation between worker bargaining power and the use of equity-based compensation. Still, the present paper's theoretical predictions are for call options and not for equity. Also empirically, an increase in worker bargaining power only leads to an increase in the use of call options grants to non-executive employees, but not of equity grants.[5]

A key novel insight from the paper concerns how to promote competition while allowing for *any* type of wage offers and not simply fixed wages, which are trivial to compare (provided that firms can guarantee paying them). Important advantages of the presented mechanism are its simplicity and the fact that it allows workers to play off firms against each other even when workers have different bargaining power vis-à-vis these firms — i.e., workers may be able to make demands what type of wage they want towards one firm, but not another. These insights add to the literature on auctions with contingent claims (Hansen, 1985; DeMarzo et al., 2005), in which bargaining power vis-à-vis the bidders is symmetric and bidders compete with the same type of claim. The paper further contributes to this literature by allowing for external financing and characterizing the inherent (mis)coordination problem when workers negotiate their wages individually. Though it may be individually optimal to ask for call options, workers do not internalize that such compensation increases the risk of runs. Thus, collectively, workers may be better off if firms were competing for their labor only on fixed wages.[6]

[5] Unvested equity-based compensation can also be used to retain workers (Aldatmaz et al., 2018; Jochem et al., 2018), but there is little evidence whether such schemes are more effective compared to other forms of deferred or promised future pay. An important strand of the literature also considers whether leverage can be used strategically in labor(union) negotiations (Perotti and Spier, 1993).

[6] The analysis of how the structure and funding of wages interacts with worker bargaining power

In what follows, Sections 2 and 3 present the model and its analysis, Section 4 presents the evidence, and Section 5 concludes. All proofs are in the Appendix.

2 Model

The model has three dates. At $t = 0$, a cash-constrained firm could raise financing from external investors to hire workers at $t = 1$. At $t = 1$, the constrained firm competes with an unconstrained firm to hire these workers, as their skills are in short supply. For simplicity, labor is the only input needed by the constrained and the unconstrained firms to start a risky project that produces $x > 0$ at $t = 2$ if it is unsuccessful and $x + \Delta x > x$ if it is successful. The probability of success (also referred to as "type"), $\theta \in \{\underline{\theta}, ..., \overline{\theta}\}$, for the two firms is potentially different and is their private information. Outsiders only know that it is drawn independently from $\{\underline{\theta}, ..., \overline{\theta}\}$ according to the prior probability distribution $\pi = \{\pi_{\underline{\theta}}, ..., \pi_{\overline{\theta}}\}$, with $\pi_{\theta'}$ being the prior probability that the realization is θ'. The binary cash flows assumption is for more transparency only. All results extend to continuous cash flows given standard assumptions about the production technology.[7]

All parties are risk-neutral and there is no discounting. The unconstrained firm has liquid assets in place $c = c_u$, which are high enough that it effectively has access to unlimited internal funding. By contrast, the constrained firm's liquid assets in place $c = c_c$ are low. Only one of the firms can hire the workers to start its respective project. The outside option for both firms of not hiring skilled workers is $\overline{v} > x$.[8] All workers are symmetric. At $t = 1.5$, after being hired by one of the firms, they can decide to leave prematurely before the cash flows are realized. In this case, they forfeit their wage and obtain an outside option $\overline{w}$. If only a proportion $l \in [0, 1]$ of the originally-hired workers stays until $t = 2$, the project's success likelihood of generating $x+\Delta x$ drops from θ to $\frac{l+\underline{l}}{\underline{l}+1}\theta$. That is, even if the firm rehires workers on short notice, they would not be as efficient. It is assumed that $\overline{w} > x + c_c + \frac{\underline{l}}{\underline{l}+1}\overline{\theta}\Delta x$, meaning that, if all initially-hired workers leave the firm ($l = 0$), the constrained firm's expected cash flows will be lower than the workers' outside option even if the firm's type is $\overline{\theta}$.

When competing for labor, the firms can only pay wages out of the cash they have.

differentiates the paper from Parsons (1972), Lazear (2009), and Jaggia and Thakor (1994) who also analyze models with insufficient supply of good matches for specific jobs.

[7] 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). A call option is then defined as $\max\{0, x - d\}$, where d is the strike price. A debt contract is defined as $\max\{x, F\}$, where F is the face value of debt.

[8] The qualitative results are unchanged if the outside option is type-dependent (details upon request).

That is, without raising external financing, they are limited to offering $0 \leq w \leq x + c$ in the low cash flow state and $0 \leq \Delta w \leq \Delta x$ in addition in the high cash flow state. As it is standard, the last inequality states that wage contracts do not pay less in the high than in the low cash flow state (Innes, 1990).

If a firm secures external financing at $t = 0$ with which it can guarantee paying fixed wages, the contract $S = \{S(w), \Delta S(w)\}$ it signs with outside investors will stipulate a payment $S(w)$ in the low cash flow state at $t = 2$ and $S(w) + \Delta S(w)$ in the high cash flow state. This contract can be conditioned on the wage offers made by the firm.[9] Following the standard assumptions in the security design literature (Nachman and Noe, 1994), it is assumed that $0 \leq S(w) \leq x + c$ and $0 \leq \Delta S(w) \leq \Delta x$. Note that with external financing, the constrained firm can promise a wage $w > x + c_c$ in the low cash flow state. It is assumed that there are no fines for not raising financing.

3 Wage Structure, Financing, and Worker Bargaining Power

This section analyzes the effect of worker bargaining power on the structure and financing of wages. The problem is solved backwards by analyzing how different wage structures affect the behavior of workers at $t = 1.5$.

3.1 Wage Structure and Worker Runs

Suppose initially that the workers have accepted a wage offer $\{w, \Delta w\}$, which is conditional on the project's future cash flows. At $t = 1.5$, the workers can still decide to leave the firm and take their outside option. Leaving prematurely before the cash flows are realized at $t = 2$ will pay them $\overline{w}$, while staying with the firm will result in a payoff $w + \frac{l+l}{\underline{l}+1}\theta\Delta w$, with l being the fraction of the initially-hired workers still with the firm. Note that when comparing $\{w, \Delta w\}$ to $\overline{w}$, it is without loss of generality to neglect that an individual worker's wage and outside option are scaled by the number of workers.[10]

The key problem of compensating workers with variable wages that depend on the firm's future cash flows is that it makes the firms vulnerable to worker runs at $t = 1.5$. Specifically, there are two pure strategy Nash Equilibria. In the first equilibrium, all workers

[9] Note that if firms offer fixed wages and incrementally improve on each other's offers, the latest offer contains all relevant information.

[10] For simplicity, a worker's outside option does not depend on whether other workers take that outside option. Incorporating such an assumption would sharpen the incentives to run.

stay with the firm at $t = 1.5$, which results in an expected wage of $w + \theta \Delta w \geq \overline{w}$. Indeed, if all workers believe that all others will follow this strategy, it is not individually optimal to deviate. The second pure strategy equilibrium involves everyone leaving at $t = 1.5$ ($l = 0$). If all workers believe that the others will leave, it is individually optimal to leave as well, as $\overline{w} > x + c_c + \frac{\underline{l}}{\underline{l}+1}\overline{\theta}\Delta x$.

Proposition 1 *Offering wages that depend on the firm's future cash flows makes the firm vulnerable to worker runs.*

The risk of worker runs can be eliminated if wages do not depend on the firm's future cash flows. In this case, the workers' outside option remains less than their wage regardless of whether other workers leave prematurely. As shown in the discussion below, also the intuitive middle ground is possible, i.e., reducing the risk of runs by making wages less dependent on the firm's future cash flows.

Discussion: Equilibrium Selection at $t = 1.5$ Proposition 1 points to the fact that there can be multiple equilibria at $t = 1.5$ depending on the workers' beliefs, which could lead to worker runs. At the cost of introducing more structure to the model, it is possible to address the questions why and when workers may decide to run. In analogy to the bank-run literature, consider the following extension. At $t = 1.5$, nature draws the state $q \in \mathbb{R}$ from a continuously differentiable positive density $p(\cdot)$. The state q corresponds to the true probability of the high cash flow state, with the ex ante expectation of the state q being θ. The state q is not observable to the workers, but, after they are hired, every worker j observes a signal $\widetilde{q}_j = q + \sigma e_j$ how valuable the workers' labor is for the firm, where $\sigma > 0$, $\sigma \to 0$. The noise terms e_j are distributed with density $f(\cdot)$ with support on the real line. The workers are modeled as a continuum. Their expected payoff given a state realization q is $w + \frac{\underline{l}+l}{\underline{l}+1} q \Delta w$. Following standard arguments from the global games literature (Morris and Shin, 2003), it holds:

Proposition 2 *(i) Suppose that there is a state q^* that satisfies*

$$\int_{l=0}^{1} \left(w + \frac{\underline{l}+l}{\underline{l}+1} q^* \Delta w - \overline{w} \right) dl = 0. \tag{1}$$

The workers run on the firm if they observe a signal $\widetilde{q} < q^*$ and stay with the firm if $\widetilde{q} > q^*$. (ii) The workers are more likely to run (i.e., q^* is higher) if they are paid with a larger proportion of variable pay.

The more sensitive the workers' compensation becomes to the firm's type, the more this compensation will fluctuate depending on the signal realization q. This makes workers more likely to panic and run when observing a lower signal. Thus, equity-based compensation exposes the firm more to worker runs compared to compensation promising all cash available to the firm at $t = 2$ to the workers in the low cash flow state, i.e., $w = x + c_c$. The latter type of compensation could be interpreted as a fixed wage that the firm may not be able to pay in full in the low cash flow state, but still has priority in "default."

It should be stressed that, in theory, firms could try to stem worker runs by renegotiating with workers at $t = 1.5$ or offering complicated contracts that condition a worker's wage on the identity and the number of workers at the firm. Such complications are not analyzed in this paper, because they are beside the main point that equity-based compensation creates coordination problems (and incentives to leave) among workers, which are not present when the firm pays fixed wages. To the extent that these coordination problems create costs for firms, it remains the case the fixed wages can help reduce these costs. Indeed, though the notion of worker runs and its relation to compensation structure has hitherto not been analyzed in the academic literature, there is anecdotal evidence that firms are worried that events outside of workers' control that reduce the value of their options could trigger workers to leave the firm, further reducing firm value. Such concerns were voiced, for example, following the 2008 financial crisis, which lead to a drop in the stock price of many Silicon Valley firms. Investors at the time were reluctant to allow firms to reprice workers' options, as this would have meant diluting their own shares.[11]

3.2 Non-Skilled Workers Benchmark: Wages and Financing Without Competition for Labor

Consider, next, date $t = 1$ at which the constrained firm competes with the unconstrained rival to hire the workers. The implication of Proposition 1 for this date is clear — the risk of worker runs should create a preference for offering fixed wages, secured by external financing. In the benchmark in which firms do *not* compete for workers, this would also be true. The notable feature of this benchmark is that, absent the risk of worker runs, both workers and firms would be indifferent between wages guaranteed by external financing and wages contingent on future cash flows (worker financing). It is this feature, together with the associated efficiency implications for the allocation of workers to firms, that will

[11] See "Technology Options Sink. Silicon Valley Considers Repricing but Risks Riling Investors," Wall Street Journal, November 10, 2008. For option repricing in executive compensation, see Carter and Lynch (2001).

break down, once we introduce competition for skilled labor.

To see the claim about workers' and firms' indifference, absent worker runs, suppose that it is common knowledge that the unconstrained firm's maximum wage offer coincides with the workers' outside option $\overline{w}$. As it is standard to model firm bargaining power, assume that the constrained firm makes a take-it-or-leave it offer to the workers. The workers would agree to join it if it offers them at least $\overline{w}$ in expectation. In this benchmark, there is no difference for the workers between accepting a fixed wage or compensation based on the firm's future cash flows. In either case, the workers are paid their outside option $\overline{w}$. When wages are contingent on future cash flows, they receive this payment in expectation, given their posterior beliefs about the constrained firm's type, following its wage offer. In the presence of external financing, they receive $\overline{w}$ for sure, but the asymmetric information problem is just shifted to the external investors who in expectation break even for funding $\overline{w}$.

Proposition 3 *(i) Without competition for labor and a risk of worker runs, both workers and firms would be indifferent between fixed wages guaranteed by external financing and wages contingent on the firm's future cash flows (worker financing). (ii) The risk of worker runs associated with the latter option tilts the firm's preference towards offering fixed wages.*

Absent competition from the unconstrained firm to hire workers, the constrained firm's problem of raising external financing for wages is the same as the canonical security design problem in which a firm seeks capital to start a project (Nachman and Noe, 1994). Thus, the optimal financing contract is debt that pays all cash flows to external investors in the low cash flow state, i.e., $S = x + c_c$. This contract can be interpreted literally as raising cash at $t = 0$ that the firm keeps on its balance sheet and out of which it pays wages at $t = 2$, with cash flows used to pay creditors. Alternatively, the contract could be interpreted as a credit line or some other type of insurance that guarantees the workers' wages in the low cash flow state, but for which the firm pays a premium in the high cash flow state. Analogously, if the firm would tie the workers' wages to its future cash flows, the optimal wage contract would promise $w = x + c_c$ in the low cash flow state. This contract can be interpreted as a fixed wage that cannot be paid in full in the low cash flow state, but has priority in that state.[12]

[12] Both contracts make the respective less-informed party's expected payoff least sensitive to the constrained firm's true type, thus reducing the incentives of low types to mimic high types and minimizing cross-subsidization across types. Thus, high types prefer these contracts. It is straightforward to extend this logic to show that the unconstrained would also offer only fixed wages in equilibrium. Moreover, also for that firm it holds that fixed wages avoid the risk of worker runs.

3.3 Skilled Workers: Competition for Labor and Worker Financing

Having established the benchmark of no competition for workers, return, now, to the baseline case in which the two firms compete for skilled labor. Competition is modeled as firms improving on each other's offers until only one firm remains. The analysis in what follows differentiates between two cases. In the first, competition for labor gives workers bargaining power to make demands about their wage. In the second case, the two firms are still competing by improving on each other's offers until only one remains, but worker bargaining power is more limited in that they cannot make demands, but simply accept the best offer.[13]

This section focuses on the first case in which workers can make demands. Since workers are symmetric, they will make and receive the same offers in equilibrium. Absent information frictions, i.e., if the workers knew how their labor contributes to the firms' output (i.e., the firms' types θ) and workers could coordinate to avoid runs, they will ask for a wage that gives them exactly the value generated by the labor. That is, they will bring the expected payoff of the firm that hires them down to its reservation value of not hiring

$$x + c + \theta \Delta x - (w + \theta \Delta w) = \overline{v} + c. \tag{2}$$

Any contract $\{w, \Delta w\}$ that satisfies the feasibility restrictions and condition (2) would then be optimal. The problem in the present setting is that workers do not know how much their labor contributes to surplus creation.

To tackle this problem, consider the final stage of competition in which there is only one firm left and the workers can make demands towards that firm. Without loss of generality, let the last remaining firm be the constrained firm.[14] In this case, the workers' problem simply boils down to making the constrained firm a take-it-or-leave-it offer. Setting aside for the moment considerations about worker runs at $t = 1.5$, suppose that the workers make a demand for a wage $\{w, \Delta w\}$. Let $\widetilde{\theta}$ denote the lowest type that accepts the workers' offer. That is, from (2), a firm would be indifferent between hiring and not hiring at this wage if its likelihood of achieving the high cash flow state is

$$\widetilde{\theta}(w, \Delta w) \equiv \frac{\overline{v} + w - x}{\Delta x - \Delta w}. \tag{3}$$

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

[14] None of the results in this section depends on the identity of the firm.

Since the firm's expected payoff $x + c - w + \theta\left(\Delta x - \Delta w\right)$ increases in θ, all firms with a higher likelihood than $\widetilde{\theta}$ prefer to hire, while those with a lower likelihood than $\widetilde{\theta}$ prefer their outside option of not hiring. Hence, the workers choose $\{w, \Delta w\}$ potentially as part of a menu of contracts W_θ to maximize

$$\sum_{\theta \geq \widetilde{\theta}} \pi_\theta \left(w_\theta + \theta \Delta w_\theta\right) + \sum_{\theta < \widetilde{\theta}} \pi_\theta \overline{w} \tag{4}$$

subject to (3) and the feasibility constraints $0 \leq w_\theta \leq x + c$ and $0 \leq \Delta w_\theta \leq \Delta x$, and $w_\theta + \theta \Delta w_\theta \geq \overline{w}$ for all types accepting $\{w_\theta, \Delta w_\theta\} \in W_\theta$. If the menu is non-degenerate, it should also be incentive compatible. Solving this problem gives:

Lemma 1 *If the workers can make a take-it-or-leave-it offer to the last remaining firm, they will demand to be paid in call options (i.e., $w = 0$).*

The quick intuition for Lemma 1 is that call options allow workers to participate more in the firm's success. Thus, compared to demanding other types of compensation, by asking for a wage in call options workers can make sure that their demand does not appear prohibitive for firms in which their labor does not create too much value, while at the same extract more value from firms in which this is the case.

More precisely, the problem for workers is that by demanding a higher wage, they are more likely to be rejected if their value-added in the firm (i.e., θ) is not sufficiently high. On the other hand, an offer that is too low leaves more of the surplus generated by their labor to the firm. In particular, for any given wage offer $\{w, \Delta w\}$, there will be a cutoff type $\widetilde{\theta}\left(w, \Delta w\right)$ such that the firm hires the workers for this wage only if $\theta \geq \widetilde{\theta}$. Using the definition of $\widetilde{\theta}$ given by (3), all types $\theta > \widetilde{\theta}$ accepting the offer obtain then an information rent of size

$$\begin{aligned} & x - w + \theta\left(\Delta x - \Delta w\right) - \overline{v} \\ = \; & \left(\theta - \widetilde{\theta}\right)\left(\Delta x - \Delta w\right). \end{aligned} \tag{5}$$

Since the surplus generated from hiring the employees is shared between the firms and the workers, extracting a higher wage boils down to minimizing the firm's rent. This can be achieved by optimally designing the workers' wage structure. As expression (5) illustrates, the workers can do so by minimizing the firm's share of the upside $(\Delta x - \Delta w)$. In particular, for any given cutoff $\widetilde{\theta}$, associated with a wage offer $\{w, \Delta w\}$, the workers can extract a higher surplus generated by their labor by shifting compensation from the low to the high cash flow state. This can be done in a way that the same set of types accepts the workers' offer, while giving workers more of the upside. A simple compensation in call options (for which $w = 0$) achieves exactly this goal, as it maximally shifts compensation from the low to the high cash flow state.[15] No menu of contracts can improve on it, as any such non-degenerate menu would have to include a wage with $w > 0$ that leaves more of the upside, and as a result more of the surplus, for the firm.

Demanding a compensation in call options is individually optimal despite the fact that it increases the risk of worker runs at $t = 1.5$ (Proposition 1). The reason is that, when workers negotiate their wages individually, they face a problem akin to a prisoner's dilemma. In a candidate equilibrium in which all workers demand a fixed wage and, thus, would not run at $t = 1.5$, an individual worker is better off deviating and demanding a wage in call options. Collectively, this hurts workers, as a positive likelihood of a run equilibrium reduces the expected surplus that can be generated from hiring workers. This makes labor less valuable and reduces the wage that workers can hope to extract from the firm. Thus, if workers could coordinate their actions at $t = 1$, they might be better off demanding a fixed salary.

Corollary 1 *It is individually optimal for workers to demand call options despite the risk of worker runs. Thus, individually strong bargaining power to make demands could collectively hurt workers by destroying surplus and leading to lower wages compared to when all workers demand fixed wages.*

Despite the inefficiency introduced by the workers' final offer, the preceding process of comparing different types of wage offers and identifying the firm that is willing to pay for labor most is surprisingly simple and efficient. In particular, there is a way to make sure that no firm drops out prematurely from the race to hire the skilled workers, while placing no restrictions on what type of wage offers the firms can make. This can be done as follows. Let the last standing offer be $\{w_a, \Delta w_a\}$. For a rival firm to beat this offer, the workers only require that its new offer $\{w_b, \Delta w_b\}$ be feasible and satisfy[16]

$$w_b + \widetilde{\theta}\left(w_b, \Delta w_b\right) \Delta w_b > w_a + \widetilde{\theta}\left(w_a, \Delta w_a\right) \Delta w_a. \tag{6}$$

Any wage structure satisfying these conditions is admissible. If a firm refuses to offer the workers a wage satisfying (6), it drops out and the workers make a take-it-or-leave-it offer

[15] As noted in footnote 7, it is straightforward to extend this result to continuous cash flows in which case, the contract will take the form $\max\{0, x - d\}$.

[16] Since the firms' outside options of not hiring are the same, from (2) and (3), condition (6) is equivalent to requiring that $\widetilde{\theta}\left(w_b, \Delta w_b\right) > \widetilde{\theta}\left(w_a, \Delta w_a\right)$. Note that firms would always choose only among the offers for which $\widetilde{\theta}\left(w_b, \Delta w_b\right)$ is the next-higher type to $\widetilde{\theta}\left(w_a, \Delta w_a\right)$. For details, see Appendix A.

to the remaining firm. Otherwise, it is the other firm's turn to improve on its rival's offer. This continues until only one firm remains. Workers stay in the race until their final offer exhausts all surplus from hiring the workers.

Condition (6) states that workers compare wage offers based on the value they would have for a firm for which these offers would be the maximum it would be able to afford. This way of comparison means that when a firm makes the highest offer it can afford, the treatment of its offer will be fair: it would be the same as its own valuation. Thus, the firms never drop out from competing for labor prematurely or too late, and the last remaining firm is the one willing to pay most for labor. Moreover, the workers extract the maximum possible information: When only one firm remains, the workers effectively know its rival's type and that the remaining firm's type is higher. This is because for both firms it is optimal to stay in the race until their final offer extracts all the surplus from hiring the workers. The workers' optimal final offer is, then, given by Lemma 1. Summarizing:

Proposition 4 *Workers maximize their wage by asking firms to improve on in each other's offers as dictated by (6). Once only one firm remains with a final offer of* $\{w_c, \Delta w_c\}$*, the workers make a take-it-or-leave-it offer to that firm that they are paid in call options. Demanding call options is individually optimal despite the fact that such compensation increases the risk of worker runs and may collectively hurt workers.*

Discussion. The importance of Proposition 4 is that it shows how workers can play two firms off against each other even if workers have different bargaining power vis-à-vis the firms. For example, suppose that workers cannot make demands towards the unconstrained firm. As will become clear in the next section, that firm will compete then by offering fixed wages. Thus, the question would be how to compare the fixed wage offers of the unconstrained firm with the contingent wages offered by the constrained firm.[17] Proposition 5 gives an answer to this question.

The most notable feature of the above mechanism is its simplicity and efficiency in identifying the firm willing to pay most for labor. The mechanism allows for competition with any types of wage offers by facilitating easy comparison among these offers. Once only one firm remains, the workers simply demand (more) call options from that firm. Still, it has to be noted that, from an optimal mechanism design point of view, this may not be the optimal mechanism. Though its structure (effectively an English auction, followed by a take-it-or-leave-it offer) follows the prescriptions of Bulow and Klemperer (1996), the key

[17] While the workers could ask the constrained firm to secure financing for competing in fixed wages, that makes little sense given the final demand for call options. As a practical problem, the constrained firm may not even have access to external financing.

difficulty is that firms compete with contingent claims. Defining an optimal mechanism that allows for such claims and optimal reserve prices (the reserve prices would correspond to the workers' final take-it-or-leave-it offer) is still an open theoretical question.[18]

Finally, none of the results presented in this paper depends on whether there are two or more competing firms and whether all firms are financially constrained. However, observe that for the above mechanism to work, firms should have something that stops them from making unreasonably high wage offers. This is captured by the assumption that the outside option of not hiring is $\overline{v} > x$. Absent such an outside option or some other form of skin in the game (such as paying part of the wage from its own cash) to make sure that the numerator of (3) is positive (i.e., $\overline{v} + w > x$), filtering out the firm with the highest valuation of labor could become impossible, as any variable wage offer could be coming from any type.

3.4 Competition for Labor and External Financing

The previous section discussed the case in which workers could make demands regarding what type of compensation they would prefer. In the second case of interest, workers cannot make demands, perhaps because they are not sophisticated enough or do not have enough bargaining power. Thus, this section discusses the consequences of having the constrained firm secure external financing at $t = 0$ and compete à la Bertrand with the unconstrained firm on fixed wages.[19] That is, both firms improve on each other's latest offer until only one firm remains. The workers then accept the fixed-wage offer made by that firm, which would just beat the latest offer of its rival. The main benefit of external financing is that it allows the constrained firm to guarantee a fixed wage to the workers, making a comparison to the competing offers of the unconstrained firm straightforward. However, the asymmetric information problem does not disappear, but shifts to the negotiations with the external investors. This has a profound impact on the way the constrained firm competes for labor.

Take for the moment the financing contract $S = \{S(w), \Delta S(w)\}$ signed at $t = 0$ as given, and note that it can be conditioned on the fixed wage w offered to the workers. Thus, when hiring labor and raising w,[20] the constrained firm's expected payoff, net of its

[18] For recent advances, restricting attention to equity auctions, see Sogo et al. (2016) and Liu (2016).

[19] The end of the section discusses why the assumption that firms compete on fixed wages is without loss of generality.

[20] Note that raising $w - c_c$ instead of w is the same as pledging c_c as collateral or having the repayment $S(w)$ at least equal to c_c.

payments to workers, investors, and its outside option $\overline{v}+c_c$, is given by

$$x+c_c+\theta\Delta x+w-w-(S(w)+\theta\Delta S(w))-\overline{v}-c_c. \tag{7}$$

It is now immediately visible that the constrained firm's maximum fixed wage offer can exceed $x+\theta\Delta x$ if for this offer the financing contract is mispriced in the sense of $S(w)+\theta\Delta S(w)<w$. That is, such an increase in aggressiveness would come, ex post, at the investor's expense. Also the opposite can be true if $S(w)+\theta\Delta S(w)>w$. Then financing is too expensive, which makes the firm more passive when competing for labor. In this case, the firm would pass on its cost of external financing to the workers in the form of a lower maximum wage offer.

The constrained firm's expected payoff (7) highlights two further important points. Unlike the canonical corporate finance model in which the constrained firm's investment outlay is fixed, this outlay depends here on the financing terms offered by the investors. Specifically, the investors' financing terms determine the maximum fixed wage the constrained firm would be willing to offer and, thus, how much funding it would have to raise. Another crucial aspect is that high types value labor more highly, which makes them willing to offer higher maximum wages. This aspect could be used to design contracts that separate high from low types.

In a competitive capital market, investors make financing offers that maximize the constrained firm's expected payoff, while they themselves just break even. It is shown, next, that such external financing will lead to cheaper financing for high wage offers (at the expense of low wages). This raises the constrained firm's maximum wage offer above what it would offer, had it not been cash-constrained.

Specifically, the problem faced by the investors at $t=0$ is to offer (possibly a menu of) wage-dependent financing contracts, subject to the constraints that: (i) $0\leq S(w)\leq x+c_c$ and $0\leq\Delta S(w)\leq\Delta x$; (ii) the contracts are incentive compatible, i.e., type θ' should have no strict incentives to accept the contract meant for type $\widehat{\theta}$ and subsequently bid up to the maximum wage offer of (a potentially different) type θ''; (iii) investors at least break even. These conditions are stated formally in Appendix A. The main insights from solving this problem are as follows.

Even though the constrained firm is privately informed about its type, in expectation, it would not suffer from cross-subsidizing lower types. The reason is that a high type can separate, as it would be willing to keep increasing its wage offers longer compared to low types when competing with the unconstrained firm for skilled labor. Thus, high types can be compensated for being offered more-expensive financing terms for low wages that also low types can afford with cheaper financing for high wages. The by-product of the progressively cheaper financing for higher wage offers, however, is that every type (except the lowest) is prepared to make a higher maximum wage offer compared to the maximum offer it would make, had it not been cash-constrained

Debt financing reduces the constrained firm's incentives to pretend being a higher type than it really is and minimizes the investor's expected losses from treating low types as high. This reduces the need to make financing of low wage offers more expensive and, in turn, the financing of higher wage offers cheaper. This additional flexibility to have less cross-subsidization across wage offers makes debt financing superior over its alternatives. Though this result is in the spirit of the canonical security design problem discussed in Nachman and Noe (1994), the key difference is that the constrained firm does not suffer in expectation from cross subsidizing lower types. As a result, competition for labor leads all types (except the lowest) to offer a higher maximum wage.

Proposition 5 *(i) If the constrained firm secures external financing at* $t = 0$ *to compete on fixed wages, it competes for labor more aggressively compared to its unconstrained counterpart: All types (except the lowest) are prepared to offer a higher wage compared to the maximum they would offer had they not been cash-constrained. (ii) Investors finance all wage offers with debt.*

Remark. The result in Proposition 5 is based on the assumption that investors compete to offer the firm financing at $t = 0$. The problem is simpler if the constrained firm raises financing at $t = 1$ only after the unconstrained firm has dropped out, and the constrained firm has made its own final fixed-wage offer. This case builds on that described in Section 3.2. For any given wage offer w and a financing contract $\{S(w), \Delta S(w)\}$, condition (7) together with the investors' break even constraint determine the lowest type θ^* that can afford that wage offer. As in Proposition 3, there can be no separation of types among $\left[\theta^*, \overline{\theta}\right]$, and high types cross subsidize low types. As a result, for any given wage offer w, it will hold that $S(w) + \theta^* \Delta S(w) < w$ whenever $\theta^* < \overline{\theta}$. This means that when the constrained firm competes to hire workers, all types (except $\overline{\theta}$) are willing to offer up to a higher maximum wage compared to the case in which the firm is not cash-constrained. The difference to Proposition 5 is that, with ex post contracting, there is cross subsidization across types and the distortions are bigger for lower types. By contrast, with ex ante contracting (Proposition 5), the cross-subsidization is not across types, but across different wage offers, which leads to bigger distortions for higher types.

Finally, note that the analysis in this section assumed that the firms choose to compete on fixed wages. This assumption is without loss of generality. As DeMarzo et al. (2005)

show, when two privately informed parties compete by offering securities contingent on future cash flows, the unique equilibrium that survives Cho and Kreps' (1987) D1 criterion is to compete with the "flattest" possible claim (in the sense of least dependent on the buyer's type). Extending this result to the present setting in which firms have access to external financing implies that firms should compete by offering fixed wages that they finance externally. A novel insight is that, when financing is arranged at $t = 0$, there will be no cross-subsidization across types, but across wages, which makes all types more aggressive. Equally important, since fixed wages could allow firms to avoid workers runs, both firms and workers may be better off if firms are competing on fixed wages — because the surplus will be larger, firms would be able to compete to higher wages.

4 Empirical Implications and Evidence

The paper makes several novel predictions about the relation between worker bargaining power and the structure and financing of wages, as well as potential labor market inefficiencies. This section summarizes the main empirical implications and offers supportive evidence based on shocks to worker bargaining power.

4.1 Empirical Implications

The paper's main empirical prediction is that non-skilled workers are more likely to be paid in fixed wages (Proposition 3), while skilled workers that have stronger bargaining power vis-à-vis the firm are more likely to be paid with call options (Proposition 4).

Implication 1 *(i) The compensation of skilled workers that have stronger bargaining power vis-à-vis their employers are more likely to include equity-based compensation and, in particular, call options. (ii) This effect is likely to be stronger for firms about whose growth options there is more information asymmetry and when firm performance is more likely to be affected by (the division hiring) the new workers.*

The second part of Implication 1 reflects the main assumptions of the model. These assumptions are that firms are better informed about the value that the workers are likely to generate within the firm, and that firm performance is likely to reflect (if not the individual workers', then at least) the performance of the firm's division hiring the workers. In practice, this is more likely to be the case for younger, smaller, and less-diversified firms.

Though demanding equity-based compensation (i.e., worker financing) may be individually optimal for skilled workers, as it allows them to extract more surplus from the firms, it may not be in workers' collective interest. The problem is that such compensation increases the risk of worker runs (Propositions 1 and 2), which may decrease the size of the pie that workers and firms are negotiating over.

Implication 2 *Tying wages to the firm's future cash flows exacerbates the risk of worker runs compared to securing external (debt) financing to fund fixed wages. Hence, overall, workers may be better off when firms compete on fixed wages compared to competing on equity-based compensation.*

Following Titman (1984) and Berk et al. (2010) several empirical papers have found evidence that workers take into account the firm's capital structure when seeking employment (Brown and Matsa, 2016) and that leverage affects wages (Agrawal and Matsa, 2013; Chemmanur et al., 2013). Implication 2 contributes to this strand in the literature by pointing out the following novel aspect. Though external debt financing makes the firm riskier and, thus, exacerbates fears about its financial health, trying to reduce the dependence on external (debt) financing by tying wages to the firm's future cash flows (e.g., equity or option grants) could exacerbate the risk of worker runs. In fact, worker runs could occur even if the firm has no outstanding debt, and debt financing could eliminate that risk. This insight could help explain why not all empirical evidence supports the positive relation between leverage and wages (Michaels et al., 2018)

It is not only worker financing that could lead to labor market distortions. External financing for fixed wages makes constrained firms more aggressive compared to their non-constrained counterparts when competing on fixed salaries (Proposition 5). Note that this effect could mitigate well-understood caveats of external financing, such as the problem that wages and employment may be lower if the supply of external financing is limited as, e.g., during a financial crisis.

Implication 3 *If external financing is easily available, firms dependent on external financing would be more aggressive when competing for skilled workers.*

Finally, the analysis of this paper has new implications for how workers' wage *structure* will correlate with within-firm wage inequality. It offers a new perspective compared to the prior literature, which has typically focused on how the manager's compensation affects this type of inequality (Terviö 2008; Gabaix and Landier 2008; Edmans et al., 2009).[21] Specifically, since the workers extract a higher share of the surplus generated by the labor

[21] As noted in the Introduction, 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

when wages are financed through worker compared to external financing, within-firm wage inequality will be lower in this case.

Implication 4 *Higher call options compensation will be associated with lower within-firm wage inequality.*

4.2 Evidence

This section provides evidence supporting Implication 1.[22] As it is standard, financial information about publicly listed firms comes from Compustat and CRSP, and state unemployment data comes from the Bureau of Labor Statistics. These data are augmented by information on the options granted to the firms' five highest-paid executives from ExecuComp, which is available for the period 1992–2017. Following Bergman and Jenter (2007), for each firm-year, the amount of firm-wide option grants can be inferred from the percentage that each option grant to executives represents relative to all options granted by the firm (variable "pcttotop"). These percentages are reported until 2006. All firm-years for which the standard deviation of the estimates for the top-five employees is higher than 10% of their mean are dropped. The options granted to non-executive employees is then defined by the difference of the fair value of all options granted in a given year by the firm and the options granted to its five highest-paid employees.[23] This difference is then normalized by the number of employees in the firm in that year. The sample is then extended until 2017 by using that, after 2005, Compustat starts reporting the fair value of all options granted by the firm (variable "optfvgr"). In cases in which the options granted to top five executives, reported in ExecuComp, is higher than the value of all options granted, the options granted to non-executive employees are set to zero. However, the results are unchanged if such observations are dropped. Table 2 provides a summary statistics of the main variables.

INSERT TABLES 1 AND 2 AND FIGURE 1

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). This worker, however, also does not discuss the relation to the wage *structure* of workers.

[22] Broadly consistent with Implication 1, Giannetti and Metzger (2015) find that long-term compensation, which includes stock and stock options, in the financial industry is higher when there is more competition for talent.

[23] ExecuComp reports the Black and Scholes value of the options granted to top executives until 2006 (variable "option_awards_blk_value"). Following an accounting rule change, it started reporting the fair value of options ("option_awards_fv") after 2006.

The empirical challenge in testing the model's implications comes from measuring differences in the competition for skilled labor. This problem is tackled by looking at differing state-level legislation concerning non-compete agreements. Such agreements are part of employment contracts that restrict the ability of employees to work for a rival firm within a certain period of time and within a certain geographical area after leaving. Marx (2011) finds that 43% of engineers have signed a non-compete agreement; the figure for senior executives is more than 70% (Garmaise, 2011). Though California famously considers such agreements void, they are legal and enforced to various degrees in most other states. The empirical strategy is to exploit the staggered changes in such noncompetition agreements over time and across states. As already Figure 1 suggests, weaker enforcement of noncompete agreements is positively correlated with firms granting more options to their non-executive employees.

Motivating this empirical strategy is the evidence that a stricter enforcement of noncompetition agreements restricts the mobility of workers and executives (Marx, Strumsky, and Fleming 2009; Garmaise 2011), while at the same time leading to lower wages (Garmaise 2011; Balasubramanian et al., 2018) and acting as a brake on start-up activity (Starr et al., 2017; Ewens and Marx, 2018). Thus, the evidence strongly suggests that the stricter enforcement of noncompetition agreements restricts the bargaining power of workers.[24] Based on this, the main hypothesis tested in what follows is that the *weaker* enforcement of noncompetition agreements (i.e., stronger worker bargaining power) will lead to more options granted to non-executive employees.

The enforceability of non-compete agreements is proxied by an index used in Garmaise (2011), which ranges between 0 and 12. Higher values indicate higher enforceability. Crucially, several states change their practices regarding the enforcement of non-compete agreements in a staggered fashion, with ten states strengthening the enforcement, while seven states weakening it (Table 1). Most of these changes resulted from court verdicts (and were not handed down by state Supreme Courts), and are plausibly exogenous to the use of equity options in the compensation of skilled workers. Details on the political

[24] The social impact of noncompete agreements need not necessarily be negative. Noncompete agreements encourage firms to invest in the training of their employees by making it harder for workers to leave and join a rival firm. Thus, noncompete agreements may go hand-in-hand with subsequently expanding skill sets. Furthermore, by making it harder for skilled workers to be rehired, the stricter enforcement of non-compete agreements may increase the bargaining power of less-experienced workers, not bound by such agreements, such as workers coming straight out of college or school. Whether this compensates workers for the fact that, once they become more skilled and more likely to be bound by noncompete agreements, their bargaining power will be lower is beyond the scope of this paper. It is interesting, however, that 70% of the time, workers were asked to sign a noncompete agreement after receiving the offer letter or even at or after the first day at work — that is, arguably after workers had already turned down rival offers (Marx, 2011).

economy of the changes can be found in Ewens and Marx (2018) and Marx (2018). In such cases, in which the enforcement of non-compete agreements is strengthened, Garmaise's (2011) index is increased by one; otherwise it is decreased by one. To obtain an index of weaker enforcement ($WeakEnf$), all index values are multiplied by minus one. Approximately 26% of the firms are in states in which there was a change in the enforceability of non-compete agreements.

INSERT TABLE 3

The staggered changes in the enforceability of non-compete agreements across states allows for a difference-in-differences estimation. The panel regression model tested is

$$Options\ per\ employee_{i,s,t} = \alpha + \beta_1 Weak\ Enforcement_{s,t} + \beta X_{i,s,t} + \mu_i + \delta_t + \varepsilon_{i,s,t} \quad (8)$$

where $Options\ per\ employee_{i,t}$ is the average dollar fair value of the options granted to employees below the top five highest-paid in firm i headquartered in state s in year t. Analogous to Garmaise (2011), the key variable of interest is the variable weaker enforcement ($Weak\ Enforcement_{s,t}$). The vector $X_{i,s,t}$ is a set of firm- and state-level control variables described in Table 2, which include variables that have been previously found to affect the use of options granted to non-executive employees (Bergman and Jenter, 2007). Among these controls is $Age_{i,t}$, which is defined as the difference between the current fiscal year and the minimum between the firm's IPO date as reported in Compustat and the first time it appears in Compustat. Together with its interaction with $Weak\ Enforcement_{s,t}$, the age variable captures the idea that there is less information asymmetry about older firms. $Size_{i,t}$ is the log of sales in 2004 U.S. dollars, which, together with the interaction term with $Weak\ Enforcement_{s,t}$, also tests the second part of Implication 1; $State\ unemployment_{s,t}$ is the state level unemployment in year t, which together with its interaction with $Weak\ Enforcement_{s,t}$ again tests for the idea that the effect should be attenuated when employers have stronger bargaining power (arguably when state unemployment is higher); μ_i and δ_t are firm in year fixed effects. All regressions also contain industry fixed effects at the three-digit SIC level. The key coefficient of interest is β_1, which should be positive. By contrast, the coefficients of the above interaction variables should be negative, as the theory should apply best for smaller and younger firms in states with strong employment, and less so when firms are older and larger in states with high unemployment.

Table 3 presents the main results. It shows that when a state relaxes the enforceability of noncompetition agreements (i.e., the weak enforcement index increases by one), firms grant significantly more call options to their non-executive workers. In the firm fixed effects specification, a typical firm, for which Compustat has 26 years of data, in a state with average unemployment (i.e., 6%) grants its workers on average \$300 more options. This effect is both statistically and economically significant, as it represents around 7% increase relative to the options granted to the average employee in the sample. This back-of-the-envelope calculation takes into account that the effect of all interaction terms is negative as predicted. That is, when firms are younger and smaller (i.e., there is arguably more information asymmetry about them and they are arguably still more focused) and when unemployment is low (i.e., workers have arguably more bargaining power), firms grant their non-executive workers more stock options. The effect of age is particularly strong. For a younger firm with 5 years of data on Compustat, weaker enforcement leads to $\$1,000$ more options per worker. All these results strongly support Implication 1. The results are robust to using the log of the dollar value of granted options per employee as a dependent variable. The results are also robust when running the regressions for different time intervals.

Importantly, there is no corresponding effect for equity granted to non-executive employees, calculated as the overall stock granted by the firm in a given year (Compustat variable "stckco") minus the stock granted to the top five employees, which can again be extracted from ExecuComp (variables "rstkgrnt" and "stock_awards_fv" before and after 2006, respectively).[25] Thus, as predicted by this model, weaker enforcement, indeed, affects the *structure* of wages, by leading to an increase in the options (but not equity) granted to non-executive workers.

5 Conclusion

The paper develops a model studying the effect of worker bargaining power on the wage structure and the financing of wages. It shows that worker financing, i.e., offering equity-based compensation, exacerbates the risk of worker runs. Perhaps surprising, securing debt financing to fund fixed wages would reduce this risk. This insight helps to qualify the prediction from the prior literature that high leverage necessitates paying higher wages to workers to compensate them for the risk of default. Another cost for firms is that worker financing allows them to extract more of the surplus generated by their labor.

One of the papers' main results is to characterize how workers can encourage competition among firms for their labor without restricting the type of wages firms can choose

[25] The Compustat variable "stckco" is only available after 2001. All results in Table 3 are unchanged, restricting the sample to this period.

from. The mechanism is surprisingly simple. Workers should let firms compete by offering whatever type of wages they prefer and then ask the last remaining firm to add (more) call options to its offer. That is, firms offer equity-based compensation (i.e., use worker financing) as a response to competition when seeking to attract skilled workers. The key difficulty lies in comparing different types of wage offers, such as compensation in fixed wages with compensation including options. However, the paper shows a surprisingly simple solution that preserves competition and guarantees that the last remaining firm is the one that values labor most. The implications of this solution are especially important when workers' bargaining power vis-à-vis the firms is different — i.e., they may be able to make demands about their wage towards one firm, but not another.

If workers cannot make demands about their wage (e.g., because their bargaining power is limited even in the presence of competition for their labor), firms will offer fixed wages. Fixed wages avoid the risk of worker runs. However, raising external financing to guarantee fixed wages can distort the efficient allocation of labor. In particular, constrained firms may become more aggressive compared to their unconstrained counterparts. The reason is that external investors offer cheaper financing for high wage offers to compensate the firm for pooling it with lower types, when paying low wages that also such types can afford.

While there could be various reasons why firms grant non-executive employees equity-based compensation (Oyer and Schaefer, 2005; Bergman and Jenter, 2007), the idea that worker bargaining power would significantly affect the structure and financing of wages is new. The paper supports the empirical relevance of this channel by investigating the staggered relaxation and strengthening of the enforcement of noncompetition agreements across states over time. A weakening of the enforcement of noncompetition agreements leads to firms granting significantly more options to their average non-executive employee. The effect is particularly strong for younger firm — at around $1,000 more options per worker. Together with the model, this evidence highlights the importance of worker bargaining power for corporate financing decisions and their joint impact on labor market inefficiencies.

References

[1] Aldatmaz, Serdar, Paige Ouimet, Edward D Van Wesep, 2018, The option to quit: the effect of employee stock options on turnover, *Journal of Financial Economics* 127(1), 136–151.

[2] Agrawal, Ashwini K., and David A. Matsa, 2013, Labor unemployment risk and corporate financing decisions, *Journal of Financial Economics* 108(2), 449–470.

[3] Balasubramanian, Natarajan, Jin Woo Chang, Mariko Sakakibara, Jagadeesh Sivadasan, and Evan Starr, 2018, Locked in? The enforceability of covenants not to compete and the careers of high-tech workers, Working Paper, Syracuse University, University of Michigan, University of California Los Angeles, and University of Maryland.

[4] Benmelech, Efraim, Nittai K. Bergman, and Amit Seru, 2015, Financing labor, Working Paper, Northwestern University, MIT, and Stanford University.

[5] Bergman, Nittai K., and Dirk Jenter, 2007, Employee sentiment and stock option compensation, *Journal of Financial Economics* 84(3), 667–712.

[6] Bova, Francesco, and Liyan Yang, 2017, Employee bargaining power, inter-firm competition, and equity-based compensation, *Journal of Financial Economics* 126(2), 342–363.

[7] Bris, Arturo, Ivo Welch, and Ning Zhu, 2006, The costs of bankruptcy: Chapter 7 liquidation versus Chapter 11 reorganization, *Journal of Finance* 61(3), 1253–1303.

[8] Brown, Jennifer, and David Matsa, 2016, Boarding a sinking ship? An investigation of job applications to distressed firms, *Journal of Finance* 71(2), 507–550.

[9] Bulow, Jeremy, and Paul Klemperer, 1996, Auctions versus negotiations, *American Economic Review* 68(1), 180–194.

[10] Carter, Mary Ellen, and Luann J. Lynch, 2001, An examination of executive stock option repricing, *Journal of Financial Economics* 61(2), 207–225.

[11] Chemmanur, Thomas J., Yingmei Cheng, Tianming Zhang, 2013, Human capital, capital structure, and employee pay: an empirical analysis, *Journal of Financial Economics* 110(2), 478–502.

[12] Cho, In-Koo, and David M. Kreps, 1987, Signaling games and stable equilibria, *Quarterly Journal of Economics* 102, 179–221.

[13] DeMarzo, Peter, Ilan Kremer, and Andrzei Skrzypacz, 2005, Bidding with securities: auctions and security design, *American Economic Review* 95(4), 936–959.

[14] Diamond, Douglas W., and Philip H. Dybvig, 1983, Bank runs, deposit insurance, and liquidity, *Journal of Political Economy* 91, 401–419.

[15] Falato, Antonio, and Nellie Liang, 2016, Do creditor rights increase employment risk? Evidence from loan covenants, *Journal of Finance* 71(6), 2545–2590.

[16] Garmaise, Mark J., 2011, Ties that truly bind: noncompetition agreements, executive compensation, and firm investment, *Journal of Law, Economics, and Organization* 27(2), 376–425.

[17] Giannetti, Mariassunta, and Daniel Metzger, 2015, Compensation and competition for talent: evidence from the financial industry, *Finance Research Letters* 12, 11–16.

[18] Hansen, Robert G., 1985, Auctions with contingent payments, *American Economic Review* 75(4), 862–865.

[19] Jaggia, Priscilla Butt, and Anjan V. Thakor, 1994, Firm-specific human capital and optimal capital structure, *International Economic Review* 35(2), 283–308.

[20] Edmans, Alex, Xavier Gabaix, and Augustin Landier, 2009, A multiplicative model of optimal CEO incentives in market equilibrium, *Review of Financial Studies* 22(12), 4881–4917.

[21] Edmans, Alex, Xavier Gabaix, and Dirk Jenter, 2017, Executive compensation: a survey of theory and evidence, Handbook of the Economics of Corporate Governance, eds. Benjamin Hermalin and Michael Weisbach, Elsevier, North Holland.

[22] Ewens, Michael, and Matt Marx, 2018, Founder replacement and startup performance, *Review of Financial Studies* 31(4), 1532–1565.

[23] Gabaix, Xavier, and Augustin Landier, 2008, Why has CEO pay increased so much?, *Quarterly Journal of Economics* 123(1), 49–100.

[24] Garicano, Luis, and Esteban Rossi-Hansberg, 2006, Organization and inequality in a knowledge economy, *Quarterly Journal of Economics* 121(4), 1383–1435.

[25] Garicano, Luis, and Esteban Rossi-Hansberg, 2015, Knowledge-based hierarchies: using organizations to understand the economy, *Annual Review of Economics* 7, 1–30.

[26] Goldstein, Itay, and Ady Pauzner, 2005, Demand-deposit contracts and the probability of bank runs, *Journal of Finance* 60(3), 1293–1327.

[27] Hadlock, Charles, and Joshua R. Pierce, 2010, New evidence on measuring financial constraints: moving beyond the KZ index, *Review of Financial Studies* 23(5), 1909–1940.

[28] Harris, Milton, and Bengt Holmström, 1982, A theory of wage dynamics, *Review of Economic Studies* 49(3), 315-333.

[29] Hermalin, Benjamin, and Michael Weisbach, 1998, Endogenously chosen boards of directors and their monitoring of the CEO, *American Economic Review* 88(1), 96–118.

[30] Holmström, Bengt, 1979, Moral hazard and observability, *Bell Journal of Economics* 10(1), 74–91.

[31] Holmström, Bengt, 1982, Moral hazard in teams, *Bell Journal of Economics* 13(2), 324–340.

[32] Hortacsu, Ali, Gregor Matvos, Chad Syverson, and Srirarm Venkataraman, 2013, Indirect costs of financial distress in durable goods industries: the case of auto manufacturers, *Review of Financial Studies* 26(5), 1248–290.

[33] Inderst, Roman, and Vladimir Vladimirov, 2018, Growth firms and relationship finance: a capital structure perspective, *Management Science*, forthcoming.

[34] Innes, Robert D., 1990, Limited liability and incentive contracting with ex-ante action choices, *Journal of Economic Theory* 52(1), 45–67.

[35] Ittner, Christopher D., Richard A. Lambert, David F. Larcker, 2003, The structure and performance consequences of equity grants to employees of new economy firms, *Journal of Accounting and Economics* 34(1–3), 89–127.

[36] Jochem, Torsten, Tomislav Ladika, and Zacharias Sautner, 2018, The retention effects of unvested equity: evidence from accelerated option vesting, *Review of Financial Studies*, forthcoming.

[37] Kim, E. Han, and Paige Ouimet, 2014, Broad-based employee stock ownership: motives and outcomes, *Journal of Finance* 69(3), 1273–1319.

[38] Liu, Tingjun, 2016, Optimal equity auctions with heterogeneous bidders, *Journal of Economic Theory* 166, 94–123.

[39] Malsberger, Brian M., 2004, Covenants not to compete: a state-by-state survey. Washington, DC: BNA Books.

[40] Marx, Matt, 2011, The firm strikes back: non-compete agreements and the mobility of technical professionals, *American Sociological Review* 76(5), 695–712.

[41] Marx, Matt, Deborah Strumsky, and Lee Fleming, 2009, Mobility, skills, and the Michigan non-compete experiment, *Management Science* 55(6), 875–879.

[42] Marx, Matt, 2018, Reforming non-competes to support workers, Policy proposal, The Hamilton Project, Brookings.

[43] Michaels, Ryan, T. Beau Page, Toni M. Whited, 2018, Labor and capital dynamics under financing frictions, *Review of Finance*, forthcoming.

[44] Mueller, Holger M., Paige P. Ouimet, and Elena Simintzi, 2017, Within-firm pay inequality, *Review of Financial Studies* 30(10), 3605–3635.

[45] Morris, Stephen, and Hyun S. Shin, 2003, Global games: Theory and applications, in Mathias Dewatripont, Lars P. Hansen, and Stephen J. Turnovsky, eds.: Advances in Economics and Econometrics, Cambridge University Press, Cambridge.

[46] Nachman, David C., Noe, Thomas H., 1994, Optimal design of securities under asymmetric information, *Review of Financial Studies* 7(1), 1–44.

[47] Oyer, Paul, 2004, Why do firms use incentives that have no incentive effects?, *Journal of Finance* 59(4), 1619–1649

[48] Oyer and Schaefer, 2005, Why do some firms give stock options to all employees?: An empirical examination of alternative theories, *Journal of Financial Economics* 76(1), 99–133.

[49] Perotti, Enrico C., and Kathryn E. Spier, 1993, Capital structure as a bargaining tool: the role of leverage in contract renegotiation, *American Economic Review* 85(5), 1131–1141.

[50] Sautner, Zacharias, and Vladimir Vladimirov, 2017, Indirect costs of financial distress and bankruptcy law: evidence from trade credit and sales, *Review of Finance*, forthcoming.

[51] Sogo, Takeharu, Dan Bernhardt, and Tingjun Liu, 2016, Endogenous entry to security-bid auctions, *American Economic Review* 106(11), 3577–3589.

[52] Skrzypacz, Andrzej, 2013, Auctions with contingent payments–an overview, *International Journal of Industrial Organization* 31(5), 666–675.

[53] Starr, Evan, Natarajan Balasubramanian, and Mariko Sakakibara, 2017, Screening spinouts? How noncompete enforceability affects the creation, growth, and survival of new firms, *Management Science* 64(2), 552–572.

[54] Terviö, Marko, 2008, The difference that CEOs make: an assignment model approach, *American Economic Review* 98(3), 642–668.

[55] Titman, Sheridan, 1984, The effect of capital structure on a firm's liquidation decision, *Journal of Financial Economics* 13(1), 137–151.

Appendix A Omitted Proofs

Proof of Proposition 2. The workers' payoff function satisfies all standard assumptions in the global games literature. Specifically, $w + \frac{\underline{l}+l}{\underline{l}+1} q\Delta w - \overline{w}$ is increasing in l and q; by assumption, there is a q^* that satisfies (1); there are $q', q'' \in \mathbb{R}$ and $\varepsilon > 0$, such that $w + \frac{\underline{l}+l}{\underline{l}+1} q\Delta w - \overline{w} \leq -\varepsilon$ for all $l \in [0,1]$ and $q \leq q'$ and $w + \frac{\underline{l}+l}{\underline{l}+1} q\Delta w - \overline{w} > \varepsilon$ for all $l \in [0,1]$ and $q \geq q''$. Finally, $\int_{\underline{l}}^{1} g(l) \left(w + \frac{\underline{l}+l}{\underline{l}+1} q\Delta w - \overline{w} \right) dl$ is continuous with respect to q and the density g, and $\int_{z=-\infty}^{\infty} z f(z)\, dz$ is well defined. Hence, Proposition 2.2 in Morris and Shin (2003) applies, and 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 $\widetilde{q} < q^* - \delta$ and stay if $\widetilde{q} > q^* + \delta$.

(ii) Consider a wage offer $\{w, \Delta w\}$ that the workers value at $t = 1$ as $w + \rho\Delta w$, where ρ is the workers' expectation of reaching Δx given all available information at $t = 1$ and rational expectations regarding l. Suppose that $w < x + c_c$ and construct a contract $\{\widetilde{w}, \Delta\widetilde{w}\}$ with $\widetilde{w} = w + \varepsilon$ and $\Delta\widetilde{w} = \Delta w - \frac{\varepsilon}{\rho}$. Suppose to a contradiction that for this contract $\widetilde{q}^* \geq q^*$, where $\widetilde{q}^*$ is defined in analogy to (1) as

$$0 = \int_0^1 \left(w + \varepsilon + \frac{\underline{l}+l}{\underline{l}+1} \widetilde{q}^* \left(\Delta w - \frac{\varepsilon}{\rho} \right) - \overline{w} \right) dl.$$

Hence, $\widetilde{q}^* = \frac{\overline{w}-w-\varepsilon}{\frac{\underline{l}+l}{\underline{l}+1}\left(\Delta w - \frac{\varepsilon}{\rho}\right)}$ and

$$\frac{\partial \widetilde{q}^*}{\partial \varepsilon} = -\frac{2\left(w + \widetilde{\theta}\Delta w - \overline{w} \right)}{\frac{\underline{l}+0.5}{\underline{l}+1} \widetilde{\theta} \left(\Delta w - \frac{\varepsilon}{\rho} \right)^2} < 0$$

contradicting that $\widetilde{q}^* \geq q^*$. The claim of the proposition follows from the fact that w is highest when offering fixed (albeit risky) wages that pay $x + c_c$ to the workers in the low cash flow state. **Q.E.D.**

Proof of Proposition 3. The proof shows, first, that, absent the risk of worker runs, the firm would be indifferent between offering fixed wages of financing wages externally. It then follows immediately that, given the risk of worker runs, the firm would prefer fixed wages.

If the constrained firm ties the workers' wage to the firm's future cash flows, the offered wage must compensate the workers for their outside option $\overline{w}$

$$w + \sum_{\theta \in \{\underline{\theta}, \ldots, \overline{\theta}\}} \widetilde{\pi}_\theta \theta \Delta w \geq \overline{w}, \tag{A.1}$$

where $\widetilde{\pi}_\theta$ is the workers' posterior belief about the likelihood of facing type θ given the offer $\{w, \Delta w\}$. By optimality for the firm, this constrained will be satisfied with equality. If the constrained firm's type is θ', its residual payoff, net of its outside option $\overline{v} + c_c$, becomes

$$x + c_c + \theta' \Delta x - w - \theta' \Delta w - \overline{v} - c_c, \tag{A.2}$$

and the constrained firm's problem is to design an offer $\{w, \Delta w\}$ that maximizes this payoff, subject to (A.1), $0 \leq w \leq x + c_c$, and $0 \leq \Delta w \leq \Delta x$. Note that the lowest type prepared to offer $\{w, \Delta w\}$ is given by setting (A.2) equal to zero. Clearly, if this cutoff type is $\theta^* > \underline{\theta}$, we have that the posterior beliefs $\widetilde{\pi}_\theta$ are zero for all $\theta < \theta^*$.

Suppose, next that the constrained firm chooses external financing. In this case, it offers the workers a wage equal to their outside option $\overline{w}$, and it makes a take-it-or-leave-it offer to the investors. This offer would have to satisfy the investor's break even condition

$$S + \sum_{\theta \in \{\underline{\theta}, \ldots, \overline{\theta}\}} \widetilde{\pi}_\theta \theta \Delta S \geq \overline{w}. \tag{A.3}$$

Again, this constrained must be satisfied with equality. The residual payoff of the constrained firm, net of its outside option c_c, is

$$x + c_c + \theta' \Delta x - S - \theta' \Delta S - \overline{v} - c_c. \tag{A.4}$$

and its problem is to design an offer $\{S, \Delta S\}$ that maximizes this payoff, subject to (A.3), $0 \leq S \leq x + c_c$ and $0 \leq \Delta S \leq \Delta x$. The lowest type prepared to offer $\{S, \Delta S\}$ is again defined by setting (A.4) equal to zero. Given that the constraints on $\{S, \Delta S\}$ and $\{w, \Delta w\}$ are the same, this problem is equivalent to that of maximizing (A.2).

We can now refer to the canonical security design setting, which shows that the only equilibrium, surviving the D1 refinement is offering a pooling debt contract to investors (i.e., $S = x + c_c$, $\Delta S = \frac{\overline{w}-x-c_c}{\sum_{\theta\in\{\underline{\theta},\ldots,\overline{\theta}\}}\widetilde{\pi}_\theta\theta}$). The details of the proof are omitted, and the interested reader is referred to Nachman and Noe (1994). Debt minimizes the cross-subsidization of low by high types by minimizing the amount of mispricing, which is captured by $\left(\theta' - \sum_{\theta\in\{\underline{\theta},\ldots,\overline{\theta}\}}\pi_\theta\theta\right)\Delta S$.[26] Similarly (A.2) is maximized by offering $w = x+c_c$ and $\Delta w = \frac{\overline{w}-x-c_c}{\sum_{\theta\in\{\underline{\theta},\ldots,\overline{\theta}\}}\widetilde{\pi}_\theta\theta}$. In either case, the workers receive $\overline{w}$ in expectation. Finally, note that competition among investors could alternatively be modeled as investors making an offer that maximizes the constrained firm's expected payoff, subject to the constraint that they at least break even. It is straightforward to show that this leads to the same contracts being offered and the same expected payoffs for all parties (see also the proof of Proposition 5). **Q.E.D.**

Proof of Lemma 1. Let for a given wage $\boldsymbol{\omega}=\{w, \Delta w\}$,

$$\begin{aligned} u(\boldsymbol{\omega},\theta) &= w + \theta\Delta w \\ v(\boldsymbol{\omega},\theta) &= x - w + \theta(\Delta x - \Delta w) \end{aligned}$$

be the worker's and the constrained firm's gross expected payoffs, respectively.

The proof argues, first, that from the set of all feasible single wage offers, the one that maximizes the workers' payoff features $\widetilde{w} = 0$. The proof argues to a contradiction. Suppose that, for a given cutoff $\widetilde{\theta}$, a wage offer $\boldsymbol{\omega}=\{w, \Delta w\}$ with $w > 0$ were optimal. Construct an alternative wage offer $\widetilde{\boldsymbol{\omega}} = \{0, \Delta\widetilde{w}\}$ for which $v(\widetilde{\boldsymbol{\omega}}, \widetilde{\theta}) = v(\boldsymbol{\omega}, \widetilde{\theta})$, i.e., the firm's acceptance set $[\widetilde{\theta}, \overline{\theta}]$ is unchanged. Clearly, at $\widetilde{\theta}$, the workers' expected payoff is also unchanged, i.e., $u(\widetilde{\boldsymbol{\omega}}, \widetilde{\theta}) = u(\boldsymbol{\omega}, \widetilde{\theta})$. However, since $v(\widetilde{\boldsymbol{\omega}}, \widetilde{\theta}) = v(\boldsymbol{\omega}, \widetilde{\theta})$ together with $\widetilde{w} = 0 < w$ must imply that workers' participation on the upside must be higher with $\widetilde{\boldsymbol{\omega}}$, i.e., $\Delta\widetilde{w} > \Delta w$, it must be that $u(\widetilde{\boldsymbol{\omega}}, \theta) - u(\boldsymbol{\omega}, \theta) > 0$ holds for all $\theta > \widetilde{\theta}$. Hence, the workers' expected wage is higher under the new wage offer $\widetilde{\boldsymbol{\omega}}$. To see that $\widetilde{\boldsymbol{\omega}}$ is feasible, we only need to check the feasibility restriction that $0 \leq \Delta\widetilde{w} \leq \Delta x$. From $v(\widetilde{\boldsymbol{\omega}}, \widetilde{\theta}) = v(\boldsymbol{\omega}, \widetilde{\theta})$,

[26] A menu of offers would never be offered. To be incentive compatible, such an offer must involve lower types taking non-debt contracts, which ultimately leaves more rent to the uninformed party. For a related argument, see Inderst and Vladimirov (2018).

$\widetilde{w}=0$, and the definition in (3), we have

$$0<\Delta\widetilde{w}=\frac{w}{\widetilde{\theta}}+\Delta w \;=\; \frac{w}{\overline{v}+w-x}\left(\Delta x-\Delta w\right)+\Delta w$$
$$=\; \frac{w}{\overline{v}+w-x}\Delta x+\frac{\overline{v}-x}{\overline{v}+w-x}\Delta w<\Delta x,$$

where the last inequality follows from $\Delta w\leq\Delta x$ and $\overline{v}>x$. Depending on the assumptions about the probability distribution π_θ, the option contract that maximizes (4) subject to (3), $w_\theta+\theta\Delta w_\theta\geq\overline{w}$ for all $\{w_\theta,\Delta w_\theta\}\in W_\theta$, and the feasibility constraints $0\leq w_\theta\leq x+c$ and $0\leq\Delta w_\theta\leq\Delta x$ need not be unique.

Finally, observe that the workers prefer offering a simple contract featuring $w=0$ compared to offering a menu of contracts. Consider any non-degenerate menu W_θ. We can restrict attention to the case in which the firm prefers a contract in W_θ over its outside option of not hiring if and only if $\theta\geq\widetilde{\theta}$. Let $\widetilde{\boldsymbol{\omega}}\in W_\theta$ be the contract chosen by type $\widetilde{\theta}$. Consider now by dropping all other contracts except $\widetilde{\boldsymbol{\omega}}$ from the menu. Doing so leaves the cutoff $\widetilde{\theta}$ unchanged, since, if type $\widetilde{\theta}$ prefers $\widetilde{\boldsymbol{\omega}}$ to not hiring, the same holds for all types $\theta>\widetilde{\theta}$. But then, by revealed preference by the firm for contracts other than $\widetilde{\boldsymbol{\omega}}$, the workers must be better off. In particular, if for any other type $\theta>\widetilde{\theta}$ there existed a contract $\widetilde{\boldsymbol{\omega}}\in\mathbf{w}_i$ such that $v(\boldsymbol{\omega},\theta)>v(\boldsymbol{\omega},\theta)$, then this would necessarily imply that $u(\boldsymbol{\omega},\theta)>u(\boldsymbol{\omega},\theta)$. **Q.E.D.**

Proof of Proposition 4. The assumption in this section is that competition for labor depletes all bargaining power from the firms, so that they meet the workers' demand for a higher wage offer if they can afford to. That is, at every stage at which a firm makes a new offer, it faces a screening game with the following characteristic. If the final standing offer is $\{w_a,\Delta w_a\}$, the workers ask the firm, whose turn it is to make an offer, to choose *any* offer $\{w_b,\Delta w_b\}\in W_b$, where W_b is defined as the set of all feasible offers that satisfy (6) for all $\{w_b,\Delta w_b\}\in W_b$, i.e., $\widetilde{\theta}\left(w_b,\Delta w_b\right)>\widetilde{\theta}\left(w_a,\Delta w_a\right)$ (see footnote 16). If the firm chooses a wage offer from this menu, the game continues with the workers offering the other firm to choose from a menu W_c, which contains all feasible offers that satisfy $\widetilde{\theta}(w_c,\Delta w_c)>\widetilde{\theta}(w_b,\Delta w_b)$. Otherwise, the firm drops out, and the workers make a take-it-or-leave-it offer to the last remaining firm. Firms stay in the race until their final offer exhausts all surplus from hiring workers. That is, their final offers are defined by

$$x+c+p\left(\theta\right)\Delta x-\left(w+p\left(\theta\right)\Delta w\right)=\overline{v}+c, \tag{A.5}$$

where $p(\theta)$ is the likelihood of achieving the high cash flow state given the risk of runs for a call options contract with the same cutoff $\widetilde{\theta}(w, \Delta w)$.[27] Abandoning the race earlier is (weakly) suboptimal if the other firm is still competing, as the firm loses the possibility of being able to hire even though it may value labor more highly. Conversely, staying in the race beyond the point defined by (A.5) is also suboptimal, as subsequent contracts satisfying (6) would result in a negative NPV for the firm. Note that if the last-standing offer is $\{w_c, \Delta w_c\}$, when workers make a take-it-or-leave-it offer to the last remaining firm, they update their beliefs about that firm's type using that $p(\theta) \geq \widetilde{\theta}(w_c, \Delta w_c)$.

To see that comparing offers on the basis of (6) is optimal for workers, let $A \equiv w_a + \widetilde{\theta}(w_a, \Delta w_a)\Delta w_a$. The proof argues in what follows that, for the purpose of fostering competition between the two firms, it is optimal for workers to compare the wage $\{w_a, \Delta w_a\}$ on the basis of having a value of A. Consider the alternatives. By assigning a higher value to that offer, $A + \varepsilon$ $(\varepsilon > 0)$, the workers risk that the other firm drops out if its valuation is $A + \delta < A + \varepsilon$. In this case, the workers would be left facing only the first firm whose own valuation might be below $A + \delta$. Even if its valuation is above $A + \delta$, the workers would only know for certain that it is at or above A. Instead, by following the rule defined by (6), the workers would increase their outside option in case of rejection and would be to collect more information about both firms' types. Arguing in a similar fashion, we can show that comparing $\{w_a, \Delta w_a\}$ based on a lower value than A would not benefit the workers. In this case, they would risk that the firm that has offered $\{w_a, \Delta w_a\}$ drops out even though its valuation of labor is higher than that of the other firm, leaving the workers with a lower wage.

For completeness, observe that, when having to choose from the menu W_b, the firm whose turn it is to make an offer ("firm B") prefers to choose only among the contracts for which $\widetilde{\theta}(w_b, \Delta w_b)$ is the next-higher "type" $p(\theta)$ to $\widetilde{\theta}(w_a, \Delta w_a)$. 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 $\widetilde{\theta}(w_b, \Delta w_b)$. This would allow the workers to extract more surplus with their final take-it-or-leave-it offer. Firm B is indifferent among all offers that have the same cutoff type $\widetilde{\theta}(w_b, \Delta w_b)$, since all these offers communicate the same information to the workers (i.e., that the firm's type is at least $\widetilde{\theta}(w_b, \Delta w_b)$, which is in turn the only thing the workers use when making their own final take-it-or-leave-it offer). **Q.E.D.**

Lemma A.1 *Debt financing ($S = x + c_c$) reduces the incentive to mimic higher types.*

[27] Since firms anticipate the final call options offer, it is without loss of generality to assume that type θ competes as if it was type $p(\theta)$ in a setting without the risk of runs.

Compared to debt financing, non-debt securities ($S < x + c_c$) reduce the incentive to mimic lower types.

Proof of Lemma A.1. The proof proceeds in two steps. Step 1 states the relevant incentive constraints. Step 2 shows the claims in the Lemma.

Step 1. *Stating the incentive constraints.* Suppose that the constrained firm can choose from a menu of contracts that stipulates repayments to the investor as a function of the wages offered to the workers. Let $w(\theta)$ denote the constrained firm' highest equilibrium wage offer (the explicit dependence of this offer on the financing contract is omitted if it does not lead to confusion). For simplicity, assume that the fixed wage paid by the constrained firm if it succeeds in hiring the workers is equal (rather than just marginally above) the unconstrained firm's maximum wage offer $w_u(\theta_u)$, where the subscript θ_u stands for the unconstrained firm's type. Suppose that the constrained firm's type is θ_c' and that, in equilibrium, it chooses contract $S = \{S(w), \Delta S(w)\}$, which depends on the wage offered to the workers. The incentive constraints must prevent the constrained firm from deviating along two dimensions: (i) from choosing the contract $\widehat{S}$ meant for some other type $\widehat{\theta}_c$ and (ii) increasing its wage offer up to the same level as the maximum wage offer $w(\theta_c'')$ of (potentially yet another) type θ_c''[28]

$$\begin{aligned} & E_{\theta_u}\left[x + c_c - S(w_u(\theta_u)) + \theta_c'(\Delta x - \Delta S(w_u(\theta_u))) \,|w(\theta_c') \geq w_u(\theta_u)\right] \\ \geq \;& E_{\theta_u}\left[x + c_c - \widehat{S}(w_u(\theta_u)) + \theta_c'\left(\Delta x - \Delta\widehat{S}(w_u(\theta_u))\right) |w(\theta_c'') \geq w_u(\theta_u)\right]. \end{aligned} \tag{A.6}$$

The rest of this step is dedicated to reformulating this incentive constraint in a more convenient form.

First, note that if $w(\theta_c'') \geq w(\theta_c')$, the incentive constraint (A.6) can be rewritten as

$$\begin{aligned} & E_{\theta_u}\left[\left(\begin{array}{c} \widehat{S}(w_u(\theta_u)) + \theta_c'\Delta\widehat{S}(w_u(\theta_u)) \\ -S(w_u(\theta_u)) - \theta_c'\Delta S(w_u(\theta_u)) \end{array}\right) \middle| w(\theta_c') \geq w_u(\theta_u)\right] \\ \geq \;& E_{\theta_u}\left[\left(\begin{array}{c} x + c_c - \widehat{S}(w_u(\theta_u)) \\ +\theta_c'\left(\Delta x - \Delta\widehat{S}(w_u(\theta_u))\right) \end{array}\right) \middle| w(\theta_c'') \geq w_u(\theta_u) \geq w(\theta_c')\right], \end{aligned} \tag{A.7}$$

[28] For notational simplicity, it is implicitly assumed that there is some type θ'' for which type θ''s maximum wage offer with $\widehat{S}$ corresponds to the maximum wage offer of θ'', i.e., $w(\widehat{S}, \theta') = w(S, \theta'')$. If this is not the case, we only need to replace $w(\theta'')$ with $w(\widehat{S}, \theta')$ in (A.6)–(A.11).

and if $w\left(\theta_c'\right) \geq w(\theta_c'')$, the incentive constraint (A.6) can be rewritten as

$$E_{\theta_u}\left[\left(\begin{array}{c}\widehat{S}\left(w_u(\theta_u)\right)+\theta_c'\Delta\widehat{S}\left(w_u(\theta_u)\right)\\-S\left(w_u(\theta_u)\right)-\theta_c'\Delta S\left(w_u(\theta_u)\right)\end{array}\right)|w(\theta_c'')\geq w_u\left(\theta_u\right)\right] \tag{A.8}$$
$$\geq\ -E_{\theta_u}\left[\left(\begin{array}{c}x+c_c-S\left(w_u(\theta_u)\right)\\+\theta_c'\left(\Delta x-\Delta S\left(w_u(\theta_u)\right)\right)\end{array}\right)\middle|\,w\left(\theta_c'\right)\geq w_u\left(\theta_u\right)\geq w(\theta_c'')\right].$$

Second, define

$$m\left(S,w,\theta_c\right):=S\left(w\right)+\theta_c\Delta S\left(w\right)-w \tag{A.9}$$

as the mispricing of contract S when the investor provides financing for w. Using this definition, the incentive constraint (A.7) can be rewritten only in terms of $\widehat{S}$, w, and the "mispricing" terms $m\left(\cdot\right)$:

$$E_{\theta_u}\left[\left(\begin{array}{c}-\left(\widehat{\theta}_c-\theta_c'\right)\Delta\widehat{S}\left(w_u(\theta_u)\right)\\+m(\widehat{S},w_u(\theta_u),\widehat{\theta}_c)-m\left(S,w_u(\theta_u),\theta_c'\right)\end{array}\right)\middle|\,w\left(\theta_c'\right)\geq w_u\left(\theta_u\right)\right] \tag{A.10}$$
$$\geq\ E_{\theta_u}\left[\left(\begin{array}{c}\left(\widehat{\theta}_c-\theta_c'\right)\Delta\widehat{S}\left(w_u(\theta_u)\right)+x+\theta_c'\Delta x\\-w_u(\theta_u)-m(\widehat{S},w_u(\theta_u),\widehat{\theta}_c)\end{array}\right)\middle|\,w(\theta_c'')\geq w_u\left(\theta_u\right)\geq w\left(\theta_c'\right)\right]$$

and (A.8) can be similarly stated as

$$E_{\theta_u}\left[\left(\begin{array}{c}-\left(\widehat{\theta}_c-\theta_c'\right)\Delta\widehat{S}\left(w_u(\theta_c',\theta_u)\right)\\+m(\widehat{S},w_u(\theta_u),\widehat{\theta}_c)-m\left(S,w_u(\theta_u),\theta_c'\right)\end{array}\right)\middle|\,w(\theta_c'')\geq w_u\left(\theta_u\right)\right] \tag{A.11}$$
$$\geq\ E_{\theta_u}\left[\left(m\left(S,w_u(\theta_u),\theta_c\right)+w_u(\theta_u)-x-\theta_c'\Delta x\right)|\,w\left(\theta_c'\right)\geq w_u\left(\theta_u\right)\geq w(\theta_c'')\right].$$

Step 2. *Financing all wage offers with debt relaxes the upward incentive constraints.* The proof proceeds to a contradiction. Suppose that, for some wage offer $w=w'$, the contract $\widehat{S}$ meant for type $\widehat{\theta}_c$ does not stipulate a debt repayment, i.e., the payment in the low cash flow state is $\widehat{S}\left(w'\right)<x+c_c$. Construct an alternative contract $\widetilde{S}$ that is debt for w', i.e., $\widetilde{S}\left(w'\right)=x+c_c$, but is otherwise identical to $\widehat{S}$ for all other wage offers. Furthermore, let $\widetilde{S}$ be such that type $\widehat{\theta}_c$ is indifferent between $\widehat{S}$ and $\widetilde{S}$ for every w:

$$\widehat{S}\left(w\right)+\widehat{\theta}_c\Delta\widehat{S}\left(w\right)=\widetilde{S}\left(w\right)+\widehat{\theta}_c\Delta\widetilde{S}\left(w\right)=w+m(\widehat{S},w,\widehat{\theta}_c). \tag{A.12}$$

Hence, we have $\widetilde{S}\left(w\right)=x+c_c\geq\widehat{S}\left(w\right)$ and $\Delta\widetilde{S}\left(w\right)\leq\Delta\widehat{S}\left(w\right)$ with the inequalities being strict for w'. Applying this insight to the incentive constraints (A.10) and (A.11) in Step 1, we obtain that for any wage offer w and mispricing of the original contracts $m(\widehat{S}, w, \widehat{\theta}_c)$ and $m(S, w, \theta'_c)$, debt financing relaxes the "upward" incentive constraints that the constrained firm should have no incentive to deviate to the *financing contract* of a higher type ($\widehat{\theta}_c > \theta'_c$) and offer up to the maximum wage of a different type $\theta''_c \neq \theta'_c$.

A straightforward modification of the above arguments shows that, relative to debt financing, non-debt contracts such as equity relax the incentive that a high type takes the financing contract of a *lower* type ($\widehat{\theta}_c < \theta'_c$) and potentially make the same highest wage offer as a different type $\theta''_c \neq \theta'$. To see this, note from expression (A.12) that a deviation to such contracts would feature $\Delta\widetilde{S}(w) \geq \Delta\widehat{S}(w)$. In particular, the security with the lowest $\widetilde{S}$ that satisfies (A.12) would maximally relax the downward incentive constraint. **Q.E.D.**

Proof of Proposition 5. The proof follows from Lemma A.1 and the following claims.
Claim 1: *If investors compete to offer the constrained firm financing, they break even for every type, i.e., the constrained firm does not suffer in expectation from cross subsidizing lower types.*
Proof. For cross-subsidization across types to occur, these types must accept the same financing contract. Suppose that types θ'' and θ' choose contract S and that type θ'' cross-subsidizes θ' with $\theta'' > \theta'$ (the subscript of θ_c is dropped if it does not lead to confusion). Since investors break even in expectation, this implies that they would make an ex post profit on type θ''.

Consider now an investor who deviates by making an offer $\widetilde{S}$ with the following properties: (i) It is identical to S for all $w < w(\theta')$, i.e., for all wage offers below θ''s maximum wage offer; (ii) it is more expensive for $w(\theta')$, but cheaper for $w(\theta'')$, which type θ'', but not θ', can afford. Specifically: (a) If $w(\theta') < w(\theta'')$ under the original contract, the deviation contract (constructed to be of the same security type as the original) stipulates a marginally higher repayment for $w(\theta')$ and lower repayment for $w(\theta'')$ that makes θ'' better off, but type θ' still cannot afford; (b) If $w(\theta') = w(\theta'')$ under the original contract,[29] the contract stipulates that the financing terms for $w(\theta'')$ are higher than in the original contract, but those for and $w(\theta'') + \varepsilon$ are cheaper, so that again type θ'', but not θ', can afford the deviation. In both cases a) and b), type θ'''s new maximum wage offer, call it $\widetilde{w}(\theta'')$, is higher than his maximum offer $w(\theta'')$ under the original contract S; (iii) No financing for higher wages than $\widetilde{w}(\theta'')$. Since the investor makes a profit on type θ''

[29] This occurs if S stipulates sufficiently more-expensive financing terms for all wages $w > w(\theta')$, so that θ'' cannot afford to make a higher offer than θ' even though that offer does not exhaust all surplus, i.e., $x + \theta''\Delta x - S(w(\theta')) - \theta''\Delta S(w(\theta')) > 0$.

under the original contract, this deviation can be constructed such that not only type θ'' is better off, but also the investor at least breaks even when type θ'' accepts the deviation contract.[30] By construction, type θ' is better off with the original contract.

The scope for such a deviation implies that the original contract could not have been offered. Indeed, since type θ'' would prefer the deviation contract, investors offering the original contract would anticipate that θ'' will not accept their contract and, as a result, they would not be able to break even (recall that θ'' cross subsidizes θ'). Thus, there can be no contract in which the investor does not break even for every type. **Q.E.D.**

Claim 2. *Investors offer only debt contracts.*

Proof. The proof is again by contradiction. Consider the highest type θ'' that accepts a contract that is not debt for some wage offers. By Lemma A.1, debt financing relaxes the upward incentive constraint. Thus, there is an all-debt contract that offers type θ'' the same expected payments for all wage offers w, while being unattractive for all lower types compared to the original contract(s). However, since the upward incentive constraint is relaxed, the investor has scope for making an alternative all-debt offer that is still unattractive for all lower types, but makes both type θ'' and the investor better off if type θ'' accepts the offer.[31] **Q.E.D.**

Claim 3. *There is an all-debt financing contract for which the investors break even. For all such debt contracts, the constrained firm's maximum wage offer is $w(\theta) \geq w_u(\theta)$ with the inequality being strict for $\theta > \underline{\theta}$.*

Proof. Based on Claims 1 and 2, the proof constructs debt contracts that satisfy the investors' ex ante break even constraint for every type

$$E_{\theta_{-i}}\left[\left(S\left(w_u(\theta_{-i})\right) + \theta_i \Delta S\left(w_u\left(\theta_{-i}\right)\right) - w_u(\theta_{-i})\right) | w(\theta_i) \geq w_u(\theta_{-i})\right] = 0 \text{ for every } \theta_i. \tag{A.13}$$

Suppose that the investors offer type $\underline{\theta}$ a debt contract $S_{\underline{\theta}}$ for which they break even for $w \leq w(\underline{\theta})$ (it is shown below that type $\underline{\theta}$ only offers a wage of $w(\underline{\theta}) = w_u(\underline{\theta})$). If there are multiple such debt contracts, consider only those that maximize type $\underline{\theta}$'s expected payoff.

Let the next higher type be θ'. Clearly, offering a debt contract that stipulates that

[30] Though also some higher types $\theta \in [\theta'', \theta''')$ may find the deviation more attractive than the original contract S, these types would behave the same as type θ'' (i.e., offer a maximum wage of $\widetilde{w}(\theta'')$). Clearly, the investor would make a profit also on these types.

[31] Again, though this offer may be more attractive not only for type θ'', but also for some higher types $\theta \in [\theta'', \theta''')$, given that the investor at least breaks even for type θ'', he would make a profit for any type from the set $[\theta'', \theta''')$.

the investor at most breaks even in expectation for type θ' for wages $w \leq w(\underline{\theta})$ is not incentive-compatible, as this contract will be accepted also by type $\underline{\theta}$. However, for any other debt financing contract, type θ' would be repaying investors more in expectation than he has borrowed for $w \leq w(\underline{\theta})$. Thus, for the investors to break even ex ante, it must be that they accept not to break even for payments higher than $w(\underline{\theta})$. The cheaper financing implies that a constrained firm of type θ' would be able to afford also a higher wage offer compared to the one it would have offered if unconstrained, i.e., $w(\theta') > w_u(\theta')$. That is, the more-expensive financing for low wage offers cross subsidizes the financing terms for higher wage offers. Repeating the latter argument for all higher types generates all incentive-compatible separating (debt) contracts that maximize the constrained firm's expected payoff. In what follows, Σ denotes the set of these contracts with a maximum wage for every type θ implicitly defined by

$$x + c_c + \theta\Delta x - S(w(\theta)) - \theta\Delta S(w(\theta)) = \overline{v} + c_c. \tag{A.14}$$

The constrained firm's maximum wage offer must be the same for all contracts in Σ. Suppose to a contradiction that type θ_c is indifferent between S and $\widehat{S}$ (where $S, \widehat{S} \in \Sigma$) which are associated with the maximum wage offers $w(\theta_c)$ and $\widehat{w}(\theta_c)$, respectively. The investor's participation constraint (A.13) can be rewritten as

$$\begin{aligned}
0 &= E_{\theta_u}\left[(x + c_c + \theta_c\Delta x - w_u(\theta_u))\,|w(\theta_c) \geq w_u(\theta_u)\right] \\
&\quad - E_{\theta_u}\left[(x + c_c + \theta_c\Delta x - S(w(\theta_u)) - \theta_c\Delta S(w_u(\theta_u)))\,|w(\theta_c) \geq w_u(\theta_u)\right] \\
&= E_{\theta_u}\left[(x + c_c + \theta_c\Delta x - w(\theta_u))\,|w(\theta_c) \geq w_u(\theta_u)\right] \\
&\quad - E_{\theta_u}\left[\left(x + c_c + \theta_c\Delta x - \widehat{S}(w(\theta_u)) - \theta_c\Delta\widehat{S}(w(\theta_u))\right)|\widehat{w}(\theta_c) \geq w_u(\theta_u)\right] \\
&= E_{\theta_u}\left[\left(\widehat{S}(w(\theta_u)) + \theta_c\Delta\widehat{S}(w(\theta_u)) - \widehat{w}(\theta_u)\right)|\widehat{w}(\theta_c) \geq w_u(\theta_u)\right] \text{ only if } w(\widehat{\theta}_c) = \widehat{w}(\widehat{\theta}_c)
\end{aligned}$$

where the second equality follows from the assumption that the constrained firm is indifferent between S and $\widehat{S}$.

A straightforward modification of this argument shows that type $\underline{\theta}$ is better off with a financing contract S for which it makes a maximum wage offer $w_u(\underline{\theta})$ compared to a contract $\widetilde{S}$ that induces him to bid $w(\underline{\theta}) \neq w_u(\underline{\theta})$. Specifically, since offering a financing contract for which the investor breaks even for all $w \leq w_u(\underline{\theta})$ and that induces type $\underline{\theta}$ to offer $w_u(\underline{\theta})$ can always be supported, it must be that $w(\underline{\theta}) = w_u(\underline{\theta})$. Thus the constrained firm's maximum wage offers are higher compared to when unconstrained, except when it is the lowest type $\underline{\theta}$. **Q.E.D.**

Appendix B Enforceability of noncompete agreements (Malsberg, 2004)

Question 1. Is there a state statue of general application that governs the enforceability of covenants not to compete?

Threshold 1. States that enforce non-competition agreements outside a sale-of-business context receive a score of one.

Question 2. What is an employer's protectable interest and how is it defined?

Threshold 2. States in which the employer can prevent the employee from future independent dealings with all the firm's customers, not merely with the customers with whom the employee had direct contact, receive a score of one.

Question 3. What must the plaintiff be able to show to prove the existence of an enforceable covenant not to compete?

Threshold 3. Laws that place greater weight on the interests of the firm relative to those of the former employee are above the threshold. For example, a law that requires that the contract be reasonably protective of the firm's business interests and only meet the condition of not being unreasonably injurious to the employee's interests would receive a score of one.

Question 4. Does the signing of a covenant not to compete at the inception of the employment relationship provide sufficient consideration to support the covenant?

Threshold 4. States for which the answer to Question 4 is clearly "Yes" are above the threshold.

Question 5. Will a change in the terms and conditions of employment provide sufficient consideration to support a covenant not to compete entered into after the employment relationship has begun?

Threshold 5. States for which the answer to Question 5 is clearly "Yes" are above the threshold.

Question 6. Will continued employment provide sufficient consideration to support a covenant not to compete entered into after the employment relationship has begun?

Threshold 6. States for which the answer to Question 6 is clearly "Yes" are above the threshold.

Question 7. What factors will the court consider in determining whether time and geographic restrictions in the covenant are reasonable?

Threshold 7. Jurisdictions in which courts are instructed not to consider economic or other hardships faced by the employee are above the threshold.

Question 8. Who has the burden of proving the reasonableness or unreasonableness of the covenant not to compete?

Threshold 8. States in which the burden of proof is clearly placed on the employee are above the threshold.

Question 9. What type of time or geographic restrictions has the court found to be reasonable? Unreasonable?

Threshold 9. Jurisdictions in which three-year statewide restrictions have been upheld receive a score of one.

Question 10. If the restrictions in the covenant not to compete are unenforceable because they are overbroad, are the courts

permitted to modify the covenant to make the restrictions more narrow and to make the covenants enforceable?

Threshold 10. States for which the answer to Question 10 is clearly "Yes" are above the threshold.

Question 11. If the employer terminates the employment relationship, is the covenant enforceable?

Threshold 11. States for which the answer to Question 11 is clearly "Yes" are above the threshold.

Question 12. What damages may an employer recover and from whom for breach of a covenant not to compete?

Threshold 12. If, in addition to lost profits, there is a potential for punitive damages against the former employee, the state receives a score of one. States that explicitly exclude consideration of the reasonableness of the contract from the calculation of damages are also above the threshold.

Table 1: **Enforcement of noncompetition agreements over 1992–2017.** This table reports the strength of the enforcement of noncompetition agreements as defined by Garmaise (2011) for U.S. states covering the period from 1992 to 2017. The construction of the index is based on 12 questions and thresholds, first proposed by Malsberger (2004), which are stated in Appendix B. The index increases by one point for every question whose answer is above the threshold. The weakening and strengthening of the enforceability of noncompetition agreements in different states over time comes from Ewens and Marx (2018) and Marx (2018). To obtain an index of weak enforcement, the scores (and the respective adjustments after changes in enforcement) are multiplied by minus one.

State	Score	Strengthened	Relaxed	State	Score	State	Score
Florida	7	1996		Alaska	3	Montana	2
Louisiana	4	2003	2001	Arizona	3	Nebraska	4
Ohio	5	2004		Arkansas	5	Nevada	5
Vermont	5	2005		California	0	New Jersey	4
Idaho	6	2008		Connecticut	3	New Mexico	2
Wisconsin	3	2009		Delaware	6	New York	3
Georgia	5	2010		DC	7	North Carolina	4
Colorado	2	2011		Indiana	5	North Dakota	0
Illinois	5	2011		Iowa	6	Oklahoma	1
Texas	5	2011		Kansas	6	Pennsylvania	6
Oregon	6		2008	Maine	4	Rhode Island	3
South Carolina	5		2010	Maryland	5	South Dakota	5
New Hampshire	2		2012	Massachusetts	6	Tennessee	7
Kentucky	6		2014	Michigan	5	Virginia	3
Hawaii	3		2015	Minnesota	5	Washington	5
Utah	6		2016	Mississippi	4	West Virginia	2
Alabama	5			Missouri	7	Wyoming	4

Table 2: **Descriptive statistics.** Options per employee is the dollar value (in 2004 thousand U.S. dollars) of options granted to employees divided by the average number of employees during the fiscal year. Weak enforcement is an index ranging between -12 and 0 depending on the enforcement of noncompetition agreements in the given state during the given year. Age is defined as the difference between the current fiscal year and the minimum between the firm's IPO year as reported by Compustat and the first year it appears on Compustat. Size is the log of sales in 2004 U.S. dollars. State unemployment is the state-level unemployment in the given year. Lagged return is the firm's annualized stock return in $t-1$. PPE/Assets is property plant and equipment over total assets. Tobin's Q is the market value of equity plus assets minus the book value of equity over book assets. Intangibles/Assets and R&D/Assets are the intangibles and R&D over total assets, respectively. All variables are winsorized at the 1st and 99th percentile.

	Mean	SD	Median
Options per employee	4.556	10.862	0.958
Weak enforcement	-3.973	2.193	-4.000
Age	26.353	16.461	22.000
Size (Log of sales)	7.274	1.697	7.207
State unemployment	6.262	2.038	5.700
Lagged return	1.208	0.922	1.115
PPE/Assets	0.255	0.231	0.184
Tobin's Q	1.960	1.493	1.530
Intangibles/Assets	0.168	0.188	0.096
R&D/Assets	0.031	0.070	0.000
Observations		22,318	

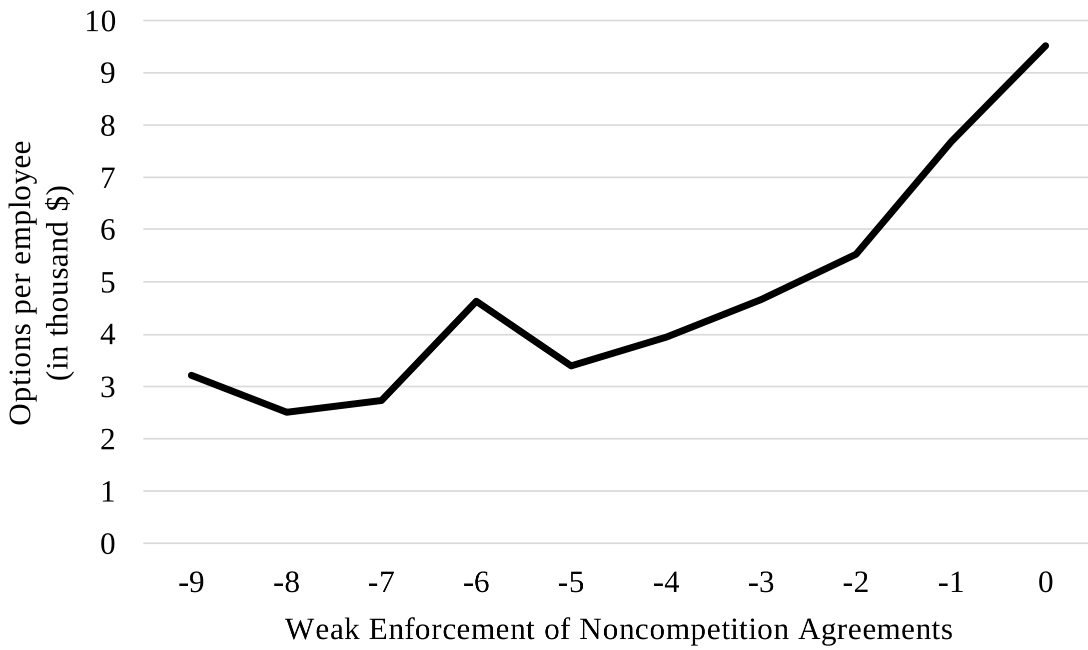

Figure 1: **Options to non-executive employees and the enforcement of noncompetition agreements.** Options per employee is the dollar value (in thousand U.S. dollars) of options granted to employees divided by the average number of employees during the fiscal year. The figure plots the average over all states and years. The weak enfocement index can range between -12 and 0 depending on the enforcement of noncompetition agreements in the given state during the given year.

Table 3: **Option grants per employee and weak enforcement.** The table prestents the results from estimating the following panel regression model:

$$Options\ per\ employee_{i,s,t} = \alpha + \beta_1 Weak\ Enforcement_{s,t} + \beta X_{i,s,t} + \mu_i + \delta_t + \varepsilon_{i,s,t}.$$

Options per employee is the dollar value (in 2004 thousand U.S. dollars) of options granted to employees divided by the average number of employees during the fiscal year. Weak enforcement is an index ranging between -12 and 0 depending on the enforcement of noncompetition agreements in the given state during the given year. Age is defined as the difference between the current fiscal year and the minimum between the firm's IPO year as reported by Compustat and the first year it appears on Compustat. Size is the log of sales in 2004 U.S. dollars. State unemployment is the state-level unemployment in the given year. All regressions control for Lagged return, which is the firm's annualized stock return in $t-1$; PPE/Assets, which is property plant and equipment over total assets; Tobin's Q, which is the market value of equity plus assets minus the book value of equity over book assets; Intangibles/Assets and R&D/Assets, which are the intangibles and R&D over total assets, respectively. All variables are winsorized at the 1st and 99th percentile. All regressions include year and industry fixed effects at the three-digit SIC level. Model (1) presents the results without firm and state fixed effects; model (2) includes state fixed effects, and model (3) includes firm fixed effects. Robust standard errors clustered at the firm level are reported in parantheses. ***,**,* represents statistical significance at the 1%, 5%, and 10% level, respectively.

	Options per employee		
	(1)	(2)	(3)
Weak Enforcement	1.628***	1.106**	1.713**
	(0.406)	(0.464)	(0.833)
Age	-0.096***	-0.087***	-0.335*
	(0.023)	(0.022)	(0.193)
Weak Enforcement×Age	-0.013***	-0.013***	-0.034***
	(0.004)	(0.004)	(0.012)
State unemployment	-0.664***	-0.855***	-0.672***
	(0.146)	(0.150)	(0.125)
Weak Enforcement×State unemployment	-0.098***	-0.107***	-0.089***
	(0.020)	(0.020)	(0.015)
Size	-1.888***	-1.947***	-1.450**
	(0.280)	(0.279)	(0.638)
Weak Enforcement×Size	-0.035	-0.048	-0.058
	(0.057)	(0.056)	(0.125)
Control variables	Yes	Yes	Yes
State fixed effects	No	Yes	Yes
Firm fixed effects	No	No	Yes
Year & industry fixed effects	Yes	Yes	Yes
Observations	22,318	22,318	22,318
Adjusted R-squared	0.231	0.241	0.130