Non-competition Agreements and Dedicated Human Capital

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Abstract

How does the optimal stringency of a non-competition agreement (noncompete) vary with the employee's position inside a firm's hierarchy? I propose a theoretical model in which the employee's productivity increases with their position. A noncompete tilts the holdup power towards the firm. In equilibrium, employees in top positions are subject to a noncompete and the firm promises high compensation to ensure that they exert effort. Employees in middle positions are free from the covenant so that they maintain their incentives to exert effort for a lower wage. Strikingly, noncompete reappears at the bottom of the firm's hierarchy. Since the employee's productivity is low, their compensation does not incentivize effort. A policy to ban noncompetes for bottom positions increases social welfare if the training the firm provides is sufficiently valuable outside the firm and the firm dismisses employees infrequently.

1 Introduction

"Curtail the unfair use of non-compete clauses and other clauses or agreements that may unfairly limit worker mobility", said President Joe Biden when instructing the Federal Trade Commission to regulate the use of non-competition agreements (noncompetes).[1,2] The reason for the heated policy debate about the regulation of noncompetes [Krueger and Posner, 2018, Lobel, 2019, Barnett and Sichelman, 2020, Lemley and Lobel, 2021] is the recent surge in their frequency [Johnson and Lipsitz, 2020, Prescott et al., 2021], while the welfare impacts of them are unclear. The evidence also shows that not only have noncompetes been popular to retain top employees [Garmaise, 2009, Kini et al., 2021] but low-paid workers are also subject to them [Prescott and Starr, 2021, Shubber, 2018].[3] Studies provide mixed results on the impact of noncompetes on wages. Some conclude that a decrease in the enforceability of noncompetes increases wages [Johnson et al., 2021, Lipsitz and Starr, 2021, Starr et al., 2019], while others find the opposite effect [Kini et al., 2021, Lavetti et al., 2019, Guimaraes et al., 2021].

In this paper, I study how varying the position inside a firm leads to different optimal contracts, including different noncompete covenants. I analyze whether the firm pays a compensating differential[4] for including a noncompete in the employee's contract. Moreover, I contribute to the ongoing policy debate on the regulation of noncompetes by formally highlighting the tradeoffs from a social perspective. A policymaker bans noncompetes

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[1] CNBC, 22-07-2021

[2] "[N]on-compete agreements are contracts between workers and firms that delay employees' ability to work for competing firms." ([US-Treasury, 2016], p.3).

[3] I provide further motivating evidence based on individual firm's hierarchies in Appendix A.

[4] In other words wage premium.

for the bottom of the hierarchy if the training the firm provides is sufficiently valuable outside the firm and the firm dismisses employees infrequently. If the first condition is satisfied, the employee's opportunity to compete increases social welfare, while the second condition ensures the firm has a high enough expected profit to employ the agent. The optimal regulation permits a more restrictive noncompete for the top than for the bottom positions.

The theoretical model builds on the core idea that both the firm and the employee (she) may hold up the other party. The firm may dismiss the employee, while the employee can leave the firm to work for a competitor. The holdup problem [Williamson, 1979] arises when both parties make an irreversible decision during employment. On the one hand, the firm provides training to the agents hired from a homogeneous labor market. The training is a combination of firm specific and industry specific knowledge, with the composition being determined by exogenous industry characteristics.[5] Training is the determinant of the employee's position inside the firm's hierarchy. On the other hand, the employee's irreversible decision is making an effort choice[6]. She can exert effort that increases her value not only to the firm but also to a competitor. Alternatively, she can shirk, in which case her baseline value in the industry does not change, but she is rewarded by private benefits that are additional outside options in another industry. For example, a programmer may learn to specialize in search engine optimization. Her time to develop the new skills, however, hinders her from expanding her more generic IT knowledge. As a result, she will be more valuable to her IT firm and its competitors, where her new skills are useful and less valuable to firms that cannot benefit from her new skills.[7]

Important feature of the model is that a noncompete distorts the employee's incentives to exert effort. A noncompete decreses the employee's opportunity to utilize her effort at a competitor. However, it does not delay the employee's ability to join firms outside the industry. Hence, an employee subject to a noncompete has more incentives to shirk.

In equilibrium, the firm includes a noncompete in the contract for employees at top positions and restores their incentives to exert effort by providing high compensation. The marginal productivity of effort is the highest at the top positions. Similarly, the cost of the firm from forgone production and potential competition is also the highest for these positions. Therefore, the employees are subject to a noncompete to decrease the probability that they leave. However, the expected wage of the employee compensates her for the noncompete and she exerts effort. This result is similar to Barnett and Sichelman [2016, 2020] who argue that the firm can restore the incentives by other means of compensation. In the current model, increasing the wage is equivalent to any conditional reward (bonus, stock options, etc.) because of the linear utility of the agent.

For positions in the middle of the firm's hierarchy, the firm does not include a noncompete in the contract to provide the maximum incentives to exert effort, while keeping the wage low. The marginal productivity of effort is high enough for middle positions that the firm offers a contract to induce effort. By allowing the employee to compete freely, the employee's benefit from exerting effort is higher compared to the case when she is subject to a noncompete. Therefore, a lower wage is sufficient to induce effort. If the employee stays with the firm ex post, the firm only needs to pay a low wage for her production, while if she leaves, her forgone production and damage are not as high as for employees at the top.

[5] This part of the modeling approach is similar to Lazear [2009].

[6] Earlier literature uses the notions of exerting effort and shirking [Amir and Lobel, 2013],[Barnett and Sichelman, 2020], [Barnett and Sichelman, 2016]. Important is that not only has exerting effort a return inside the firm but also outside of it. Therefore, the notion of generic and specific human capital investment [Becker, 1962] is also suitable for the model with a modification that specific investment denotes industry specific in the current context and not firm specific.

[7] The example is similar to one of the motivations for open source projects by Lerner and Tirole [2005].

The noncompete reappears for employees at the bottom of the firm's hierarchy, and the employees shirk on effort. The employee's production in these positions is only slightly higher in the industry than outside of it. If the employee exerts effort, she forgoes the outside industry option. The wage that incentivizes effort is too expensive for the firm compared to the employee's expected productivity with the firm. Therefore, the firm anticipates that the employee will shirk. Imposing a noncompete decreases the probability that the employee leaves for the competitor in the industry and hence increases the profit of the firm. The wage offered is high enough to prevent the employee from leaving the industry if the firm prefers to retain her.

The firm only pays a compensating differential for noncompete for employees at the top. Employees at the bottom, however, are paid the same wage with noncompete as they would be without the restriction, because the firm does not restore their incentives for exerting effort. This result is consistent with anecdotal evidence [Prescott and Starr, 2021] that employees at the bottom of the firm sign the noncompete when the firm asks them [Arnow-Richman, 2011]. Hence, an employee at the bottom of the firm's hierarchy is always worse-off when the firm asks her to sign the noncompete.

The policymaker regulating the stringency of noncompetes trades off the following two effects. First, a more stringent noncompete incentivizes the training provision from the firm ex ante, resulting in a larger firm size [Lipsitz and Johnson, 2018, Rauch, 2015] that increases social welfare. Second, the noncompete hinders the employee from leaving for the competitor ex post. Stopping the employee from leaving may increase or decrease social welfare. It depends on the employeeâs productivity at the competing firm. If the employee is more productive inside the firm but has a better outside option than her wage, she would decide to join the competitor. Noncompete can block this inefficient action. However, the opposite can also arise in which case noncompete decreases her payoff and also social welfare. Hence, a crucial parameter of the model is how productive the agent is at the competitor compared to the firm.

The ban on noncompetes for bottom positions is optimal if the industry specific component of the training is high and the firm fires the employee infrequently. If the first condition is satisfied, the employee's opportunity to compete increases social welfare. The second condition ensures the firm has enough incentives to provide the training to the employee at the beginning of employment. Since at top positions employees exert effort to increase their productivity in the industry, the condition for banning noncompete is stricter, because the difference in expected production between the firm and its competitor is larger. A ban on noncompete for bottom positions is a highly debated topic, see for example Krueger and Posner [2018], Lemley and Lobel [2021]. Lobel [2019], Barnett and Sichelman [2020] provides a review of recent legislative changes and initiatives. They count 24 changes to state laws affecting noncompetes in the period 2014-2019. While the majority of the changes reduced the enforceability of noncompetes, 6 changes increased the enforceability. After the executive order of the US President,[8] the Federal Trade Commission signaled its interest [9] in regulating the usage of noncompetes with its strategic plan for 2022-2026 [Federal Trade Commission, 2021].

Next, I analyze a modification to the model where the employee does not hold the correct belief about her own noncompete. Empirical evidence [Prescott and Starr, 2021] shows that employees frequently do not know the scope of their noncompete. In the modified setup, she may act as if her noncompete were laxer or stricter than the true restriction. The firm can strategically influence the employees' belief about the enforceability of the noncompete. In particular, the extension shows that deceiving agents that they are subject to a more

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[9]WSJ, 09-06-2022

restrictive noncompete than the true restriction is can lower the employee's utility.

Subsequently, I add heterogeneity to the model by introducing naïve and sophisticated agents. Naïve agents underestimate the stringency of the noncompete and exert effort under contracts sophisticated agents would not. In equilibrium, naïve agents are employed at the lowest positions and sophisticated agents in the higher ones, while all employees provide effort. Misunderstanding noncompete alleviates the commitment problem regarding effort, making naïve agents an attractive hire for the firm. A policymaker banning noncompete removes the naïve agents' advantage.

Furthermore, I extend the baseline model to multiple periods to show how noncompete may decrease wages. In a class action suit against the fast food restaurant company Jimmy Johns,[10] the employees argue that the firm developed holdup power against them over time. In the theoretical model, employees at bottom positions may not receive the market wage in the second period, even if their expected productivity with the firm increases. They are subject to the noncompete and have a low probability of finding a better paid job in the industry, therefore the firm does not need to increase their wage. Employees at the top of the firm may face a more severe hold up in the second period if they exerted effort in the first period.[11] The firm may lower the wage of the "locked in" agent for the second period. A rational agent anticipates the holdup and hence does not specialize. The firm can induce specialization by setting the stringency of noncompete low as a commitment device not to hold up the employee.

This paper proceeds as follows. Section 2 relates my work to the existing literature. Section 3 introduces the model. Section 4 derives the optimal contract. Section 5 considers the regulator's problem. Section 6 presents the extension with a misunderstanding of noncompete. Section 7 extends the model to multiple periods. Section 8 increases the number of firms in the market. Section 9 concludes.

2 Related Literature

Economic theory suggests that noncompetes can help alleviate the hold up problem by aligning the incentives of the employer and employee [Lipsitz, 2017]. The closest model to mine is by Ghosh and Shankar [2017]. In their paper, an increase in the stringency of noncompete provides more incentive to the firm to invest in the employee's human capital while decreasing the employee's incentive to invest. In the current model, I demonstrate how varying the position[12] inside the firm leads to different optimal contracts, while Ghosh and Shankar [2017] focuses on a representative employee, therefore heterogenous contracts and actions are not possible. Moreover, my model also breaks down the expected value of the outside option the competitor offers into arrival rate and wage, allowing noncompete to alter the arrival rate. Garmaise [2009] studies the tradeoff when the firm and worker co-invest into the worker's human capital by taking noncompete exogenously. Noncompete is endogenous in my model and I allow the firm to change the compensation of the employee which also infleunces the employee's choice of effort. Krakel and Sliwka [2009] models a similar tradeoff that the employee exerts more effort if she is not subject to a noncompete. Their paper focuses on the explicit (bonus) and implicit (forgoing noncompete) incentives in a group environment. In my setup, I focus on heterogeneous positions inside the

[10] Case Number 18-cv-0133-MJR-RJ

[11] In a setup where the employee can modify her effort choice between the two periods, she cannot be held up, as she can always switch to shirking. Similarly, the classical holdup problem [Williamson, 1979] would also diminish if the players could reverse the investments. Therefore, the usual holdup scenario arises if the employee's first period action carries over to the second period. The employee can choose to specialize her human capital to the industry, or keep it generic, similar to the classical model by Becker [1962].

[12] The position is determined by the training received by the employee.

firm, while employees do not interact with each other. Lipsitz [2017] emphasizes the difference in effort between centralized and decentralized decision-making in the sense of centralized decisions are closer to the first best. However, noncompete is taken exogenously, unlike in my model, where I derive the optimal stringency of the noncompete.

The early literature predominantly highlights how noncompete affects high-skilled employees [April and Matthew, 2008, Krakel and Sliwka, 2009]. However, low wage workers can be subject to the restriction too, such as physicians [Lavetti et al., 2019], cleaning staff [Shubber, 2018], and sandwich makers [Neil, 2014]. In the models of Lipsitz [2017], Lipsitz and Johnson [2018], the employer is forced to give a minimum wage in each period to the workers. However, the employer values the worker's contribution less than the minimum wage. As the employee learns, his contribution becomes more valuable both inside and outside the firm. A noncompete agreement allows the firm to increase the worker's pay less steeply as his outside opportunity is less lucrative. In my model, however, the result is not driven by an exogenous minimum wage constraint, rather it comes from that the productivity difference between inside the industry and outside of it is small at the bottom pistons of the firm hierarchy.

Wickelgren [2018], and Johnson and Lipsitz [2020] consider how constraints on wages, or more broadly the non-transferability of utility, can result in the inclusion of a noncompete agreement in the optimal contract, even for low wage workers. Wickelgren [2018] uses a dynamic setup to show that firms invest more when the employee is subject to a stronger noncompete. My model is similar in that the firm has a larger size if the noncompete is more restrictive. However, noncompete also influences the effort decision of the employee and thus the impact on production is ambiguous. Johnson and Lipsitz [2020] builds a general equilibrium model where the marginal firm's participation constraint is only met via the inclusion of noncompete. By the law of one price, other firms also include noncompete, despite noncompete reduces the employee-employer surplus. In the partial equilibrium model of this paper, however, the firm includes noncompete solely based on the tradeoff between decreasing the probability of competing and decreasing the employee incentives.

A growing body of empirical literature estimates the relation and impact noncompete clauses have on wages, training, and mobility. Standard economic theory suggests that since the inclusion of noncompete is endogenous, employees must receive a higher wage or other compensation if they are subject to it, keeping everything else constant. Empirical evidence, however, is less clear on the subject. Marx et al. [2009] show that enforcement of noncompete attenuates mobility. Starr et al. [2019] find that increasing enforceability of noncompete agreements increases the training firms provide to their employees. Balasubramanian et al. [2020] show that both wages and mobility increased after a ban on noncompete in Hawaii. The majority of the empirical research focuses on whether the wage increases [Johnson et al., 2021, Lipsitz and Starr, 2021, Starr et al., 2019] or decreases [Kini et al., 2021, Lavetti et al., 2019, Guimaraes et al., 2021] if the enforceability of noncompetes decreases.

An experimental study by Amir and Lobel [2013] finds employees restricted by post-employment covenants underperform those without restrictions. Barnett and Sichelman [2016, 2020] argue that the firm has an interest in restoring its employees' incentives that are distorted by imposing the noncompete. My model combines the two arguments. Employees have less incentives to provide effort when they are subject to a noncompete, however, they may receive compensation for agreeing to the covenant. At bottom positions, the firm does not provide enough incentives for the employee to exert effort, independent of the noncompete. At top positions, however, the firm promises a high enough wage such that the employee exerts effort.

The paper also relates to the literature on firm and industry specific training and investment. Starting from Becker [1962], a central question of specific and generic human capital literature is which party bears the costs. Several authors have challenged Becker's conclusion that the firm only subsidizes specific investment in a frictionless world [Acemoglu and Pischke, 1998, 1999]. This paper's model uses a framework where the firm sponsors the industry-specific training, that is the training increases the employee's human capital in the industry, but not outside of it. Moreover, the training increases the productivity the most at the firm providing it. The approach is similar to the idea of Lazear [2009].

The employee's effort decision is also modeled similar to a human capital decision. The employee may specialize her human capital or keep it generic. Therefore, the model is related to Rajan and Zingales [1998, 2001]. The difference is that the employee specializes to the industry, meaning the expected value of the outside option inside the industry increases, and only the outside option in other industries decreases.

The model setup also connects to the behavioral contract theory literature on reference points [Hart and Moore, 2008, Hart and Holmström, 2010, Hart, 2009], with the reference point being the contract without noncompete. If the employee is asked to sign the noncompete she may feel aggrieved and thus shades on performance, that is choosing the shirk.

3 Model

3.1 Description

At $t = 0$ a risk neutral firm hires a risk neutral agent (she). The labor market consists of ex ante identical agents and there is no other firm in the market at $t = 0$. The firm holds all the bargaining power. The contract the firm offers specifies the position the employee is hired for, θ, and the wage, w. Moreover, the contract includes the covenants whether the firm can dismiss the employee, $D = 1$, or not, $D = 0$, and whether the employee is subject to a noncompete, $NCC = 1$, or not, $NCC = 0$.[13] After an agent is hired, she receives training [14] from the firm to become qualified for her position. The training cost is $c\theta$ where c[15] is the marginal cost of training for the firm.[16] An agent receiving more training has a higher position in the firm.

The employee makes her effort choice at $t = 1$. She has a unit of time that she can spend either improving her skills to succeed in the industry or she can improve skills that are profitable outside the industry. From the firm's perspective, only industry specific skills are beneficial, while working on other skills is considered shirking. Therefore, I denote the choice of industry skills as exerting effort, $e = 1$, and the choice of other skills with $e = 0$, consistently with the existing literature.[17]

The firm can observe the employee's effort choice. The competitor and other firms outside the industry can also observe the employee's effort choice, for example through interviews and tests during the hiring process.[18] Following the literature on incomplete contracting [Hart and Moore, 1990], the court cannot verify whether the employee exerted effort. Hence, the firm cannot make the contract contingent on effort.

The employee is either productive or unproductive with the firm. Her effort choice influences the ex ante

[13] Appendix C.2 shows that the binary choice is without loss of generality.
[14] Section 4.2 elaborates on various potential interpretations of the parameter θ.
[15] The exact condition on the training cost is derived in Section 4.2
[16] The firm paying for the training is the relevant case for noncompetes.
[17] The effort choice impacts future employment options. It is an investment into the employee's own human capital. However, previous literature on noncompete [Barnett and Sichelman, 2020, 2016, Lobel, 2014] labels the notion as effort choice, therefore I follow this convention. The notion of industry specific and generic human capital is also suitable for the model.
[18] If the employeeâs outside option is starting her own firm, such as for hairdressers, physicians, or lawyers, her effort choice need not be observed by another firm.

probability of being productive. The expected production of the employee with the firm, $E(F(\theta))$, is

$$E(F(\theta)) = (p + e\Delta)\theta. \tag{1}$$

The employee's default probability of production is $p > \frac{1}{2}$, which is increased by Δ if she exerts effort. The value of e is 1 if the employee exerts effort and 0 otherwise. If the employee is unproductive, her production is 0.

The firm observes whether the employee is productive at $t = 2$ and bases the decision of the dismissal on the observation. It could be associated with a test or a project that the employee completes and the firm can observe the outcome.

The key friction of the model is that the employee cannot commit to staying with the firm despite being trained by it. The employee receives outside options at $t = 3$ that are endogenous to the contract and her effort decision. The expected value of the offer the competitor makes to an employee who is not subject to a noncompete is,

$$E(O(\theta)) = (q + e\Delta)\gamma\theta. \tag{2}$$

where $\gamma \leq 1$ is a parameter indicating the similarity between the firm and other competing firms inside the industry (in short: competitor). In other words, it shows to what degree the training is firm specific versus industry specific. A larger γ indicates more industry specific training.[19] This part of the setup is similar to Garmaise [2009]. The outside option arises with the baseline probability q. The employee can increase the probability by $\Delta \in (\frac{1-p-q}{2}, 1-p-q)$.[20] The production and the event that a competitor makes an offer to the employee occur independently from each other.[21]

Noncompete is introduced as a choice variable acting on the probability of the arrival rate of the outside option. An employee, who is subject to a noncompete, receives the outside option with a lower probability, $\bar{\lambda}((q + e\Delta)$ where $\bar{\lambda} \in [0, 1]$ is a parameter, and a lower $\bar{\lambda}$ means a more restrictive clause. Additionally, the employee receives an offer from outside the industry only if she chooses $e = 0$. For simplicity, the option arises with probability 1, and I normalize the value of the offer to be 1. Importantly, a noncompete constraints the employee inside the industry, but does not affect the arrival rate of offers from outside the industry.

The employee privately observes whether the competitor makes her an offer. Subsequently, the firm decides whether to dismiss the employee if the contract allows it ($D = 1$). Afterward, the employee decides to stay or to leave to any of her outside options. If the parties stay together, production occurs.

If the employee leaves for the competitor, the firm suffers damages as the employee may take crucial knowledge, information, clients, or other intangible assets to the competitor [Lipsitz and Tremblay, 2021, Krakel and Sliwka, 2009]. The more training the employee receives, the larger this damage is. The damage function is

$$A(\theta) = a\theta, \tag{3}$$

with $0 \leq a < p-c$.[22] Table 1 summarizes the employee's and the firm's payoff as a function of the employee's

[19] For the simplicity of the terminology, I also include establishing own firm in the competitor category

[20] Later I show that the proposed range of Δ is the interesting range to induce heteregenity in the emploee's effort choice.

[21] Section D.2 the Appendix relaxes the assumption of independence of the events.

[22] The damage is driven by the position, θ, therefore the parameter a is kept to have a low value, to make the model applicable for the bottom of the firm's hierarchy.

	Employee	Firm
Stay	$w(\theta)$	$\theta - w(\theta)$
Compete	$\gamma\theta$	$-a\theta$
Other Industry	1	0

Table 1: The employee's and the firm's payoff as a function of the employee's decision

decision.

3.2 Timeline

The timeline of the model is summarized below.

- t=0

  A) The firm and employee contracts on wage, right to dismiss and noncompete for a certain position. The position is taken as given by both parties.

  B) The employee receives the training according to her position.

- t=1

  The employee chooses S or G.

- t=2

  The firm observes whether the employee is productive.

- t=3

  A) Employee privately learns outside option(s).

  B) The firm decides on dismissal (if the contract allows)

  C) Employee decides to stay or leave

- t=4 Payoffs are realized, if the employee stayed, production and the wage is paid

Figure 1 shows the decision of the game after the contract is signed by the employee.

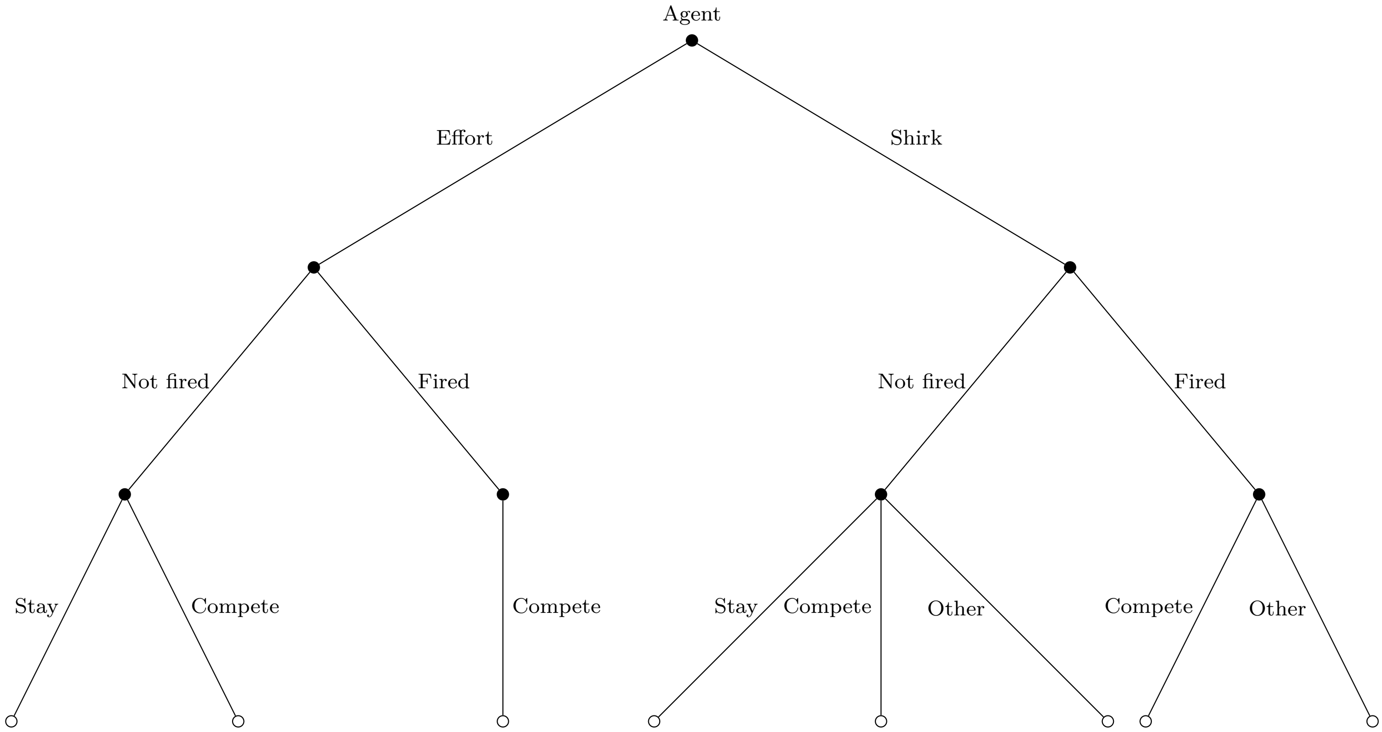

Figure 1: Decisions of the game

Decisions of the game

3.3 Objectives

The firm maximizes its expected profit, and the employee maximizes her expected utility. The expected profit is the difference between the expected production and the expected cost of wage and damage. Moreover, the firm pays for the training. The employee's expected utility consists of the expected wage and the expected outside option. The generic functional forms for the firm and employee respectively are as follows:

$$\pi = \text{expected production} - \text{expected wage} - \text{expected damage} - \text{training cost} \tag{4}$$

$$U = \text{expected wage} + \text{expected outside option} \tag{5}$$

I elaborate on the functions in detail in section 4.1.

The main question of the model is how the optimal contract changes with varying positions. I restrict attention to $\theta > \frac{1}{\gamma}$ to ensure that the employee can have the highest output in the industry. I break ties in favor of the firm if a slight increase in the pay would provide incentives to the employee to take the firm's preferred action.

4 Contracts

This section discusses the four possible combinations of noncompete and dismissal in the contract, together with the employee's best response. I solve the problem with backward induction within each contract. Subsequently, I derive the optimal contract.

4.1 Possible Contracts

4.1.1 Noncompete and dismissal

I solve the model starting from the decision of the employee whether she stays with the firm, competes, or leaves the industry. First, consider positions at the low end of the firmâs hierarchy. These bottom positions translate to small θ's in the model. For these positions, the offer the competitor makes to the employee, $\gamma\theta$, is also small. Hence, the offer provides little incentive to exert effort. If the firm offers a wage below 1, the employee could shirk and leave for the other industry. It results in no production and negative profit for the firm due to the costly training.

Thus, the wage for low θ's must be at least 1. Since the firm could marginally increase the wage over 1 to dominate the outside industry option, I break the tie in favor of the firm. Therefore, I look at the contract with $w(\theta) = 1$. Hence, the employee opts to stay with the firm when comparing the outside industry option to staying with the firm. With θ close to $\frac{1}{\gamma}$, the payoff form competing is close to 1 too. As a result, the employee has insufficient incentives to exert effort since she is unwilling to forgo the outside industry option. Next, I write down the utility and profit function under this contract. The order of arguments are position (θ), noncompete (NCC=0 or NCC=1), dismissal ($D = 0$ or $D = 1$), wage ($w(\theta)$), and effort ($e = 1$ or $e = 0$). For example, $U(\frac{1}{\gamma}, 0, 1, 1, 0)$ means the utility at position $\frac{1}{\gamma}$, without the noncompete restriction, the firm may fire the employee, the wage offered is 1, and the employee chooses to shirk. The arguments of the wage function, if necessary, are $w(\theta, \text{NCC,D})$.

$$U(\theta, 1, 1, 1, 0) = \bar{\lambda} q\gamma\theta + (1 - \bar{\lambda} q) \tag{6}$$

$$U(\theta, 1, 1, 1, 1) = (p + \Delta)(1 - \bar{\lambda}(q + \Delta)) + \bar{\lambda}(q + \Delta)\gamma\theta \tag{7}$$

Comparing (6) to (7) at $\theta = \frac{1}{\gamma}$ yields that the employee's best response is to shirk. The firm's profit with the employee shirking

$$\pi(\theta, 1, 1, 1, 0) = p(1 - \bar{\lambda} q)(\theta - 1) - \bar{\lambda} qa\theta - c\theta \tag{8}$$

Further increasing the wage without changing the behavior of the agent only increases the costs of the firm. Thus the next wage to analyse is the one that induces effort from the agent. The employee exerts effort if the utility under effort is at least as high as under shirking.

$$U(\theta, 1, 1, w(\theta), 0) = p(1 - \bar{\lambda} q)w(\theta) + \bar{\lambda} q\gamma\theta + (1 - p)(1 - \bar{\lambda} q) \tag{9}$$

$$U(\theta, 1, 1, w(\theta), 1) = (p + \Delta)(1 - \bar{\lambda} q)w(\theta) + \bar{\lambda}(q + \Delta)\gamma\theta \tag{10}$$

The employee chooses $e = 1$ if

$$w(\theta) \geq \frac{(1 - p)(1 - \bar{\lambda} q) - \bar{\lambda}\Delta\gamma\theta}{\Delta(1 - \bar{\lambda}(q + \Delta + p))} = w(\theta, 1, 1) \tag{11}$$

The wage is decreasing in Δ. In the limit $\Delta \to 0$ the wage to induce effort becomes infinitely high. As Δ increases the employee's benefit of effort in the industry increases, as both the probability of receiving the wage from the firm and having an offer from the competitor becomes larger. Denote with $\bar{\Delta}$ the threshold for which the agent chooses to exert effort in all positions ($\forall\theta$), provided the firm offers $w(\theta,1,1)$.

$\bar{\Delta}$ is derived from comparing the profit with $w = 1$ in which case the employee chooses to shirk and $w = w(\theta,1,1)$ that induces effort.

$$\pi(\theta,1,1,w(\theta,1,1,1),1) \leq \pi(\theta,1,1,1,0) \tag{12}$$

with

$$\pi(\theta,1,1,w(\theta,1,1),1) = (p+\Delta)(1-\bar{\lambda}(q+\Delta))(\theta - w(\theta,1,1)) - \bar{\lambda}(q+\Delta)a\theta - c\theta \tag{13}$$

The expression for $\bar{\Delta}$ is derived in appendix C.1. I focus on $\Delta < \bar{\Delta}$ for the rest of the paper. Hence, incentivizing employees to provide effort at bottom positions is too costly for the firm.

The firm always prefers to dismiss unproductive employee. The reason is that if the employee has the industry outside option, she leaves voluntarily. Therefore, if firm dismisses the employee she either leaves for the other industry or she will be without an offer. Therefore, the firm can fire the unproductive employee without increasing the probability of damages.

In summary, under the contract with noncompete and dismissal, 2 different wages are candidates for equilibrium. The firm can offer $w = 1$ for low values of θ that triggers shirking from the employee. For larger θ's, the firm may offer $w = w(\theta,1,1)$ that induces effort.

4.1.2 Without noncompete, with dismissal

The employee has more incentives to exert effort without noncompete, as she has free exit to the competitor meaning noncompete does not decrease the arrival rate of the competitor's offer. Consider $w(\theta,0,1) < 1 < \gamma\theta$. The employee may choose effort with a lower wage than 1, her other industry outside option, as the free exit to the competitor increases her incentives to exert effort. The utility of the employee with choosing $e = 1$ is

$$U(\theta,0,1,w(\theta,0,1),1) = (p+\Delta)(1-q-\Delta)w(\theta,0,1) + (q+\Delta)\gamma\theta \tag{14}$$

If the employee shirks, she always leaves the firm since her wage is lower than her outside industry option.

$$U(\theta,0,1,w(\theta,0,1),0) = q\gamma\theta + 1 - q \tag{15}$$

The wage the firm offers is [23]

$$w(\theta,0,1) = \frac{1-q-\Delta\gamma\theta}{(p+\Delta)(1-q-\Delta)} \tag{17}$$

The firm's profit is

$$\pi(\theta,0,1,w(\theta,0,1)) = (p+\Delta)(1-q-\Delta)(\theta - w(\theta,0,1)) - (q+\Delta)a\theta - c\theta \tag{18}$$

[23] $w(\theta,0,1,1) < 1$ if

$$\theta > \frac{1-q-(p+\Delta)(1-q-\Delta)}{\Delta\gamma} \tag{16}$$

puts a lower bound on θ. Substituting in the smallest θ, $\theta = \frac{1}{\gamma}$, and the largest Δ, $\Delta = 1-p-q$, satisfies the inequality, therefore a parameter range exists that satisfies the inequality. Moreover, I do not allow wages to be negative, $\theta < \frac{1-q}{q\gamma}$ ensures a nonnegative wage.

4.1.3 Noncompete but no dismissal

This contract guarantees the employee's wage, while she only leaves for the competitor with a low probability. The low probability, however, works as the incentive to provide effort. Consider a wage that is less than the outside industry option of 1, i.e.: $w(\theta) < 1 < \gamma\theta$. [24] It reflects the idea that providing a high expected wage by the commitment from the firm side incentivizes the employee to choose S and thus the wage, conditional on being paid, can be lower than 1.

Exerting effort yields utility

$$U(\theta, 1, 0, w(\theta, 1, 0), 1) = (1 - \bar{\lambda}(q + \Delta))w(\theta, 1, 0) + \bar{\lambda}(q + \Delta)\gamma\theta \tag{19}$$

while with shirking

$$U(\theta, 1, 0, w(\theta, 1, 0), 0) = \bar{\lambda}q\gamma\theta + (1 - \bar{\lambda}q) \tag{20}$$

If she shirks, she always leaves from the firm and never produces, making the firm's profit negative in expectation. Thus the firm offers a wage high enough that ensures the employee chooses S.

The optimal wage is

$$w(\theta, 1, 0) = \frac{1 - \bar{\lambda}q - \bar{\lambda}\Delta\gamma\theta}{1 - \bar{\lambda}(q + \Delta)} \tag{21}$$

$w(\theta, 1, 0) < 1 < \gamma\theta$ always holds as $\theta\gamma \geq 1$.

The resulting profit of the firm is

$$\pi(\theta, \bar{\lambda}, 0) = (p + \Delta)(1 - \bar{\lambda}(q + \Delta))\theta - (1 - \bar{\lambda}(q + \Delta))w(\theta, 1, 0)) - \bar{\lambda}(q + \Delta)a\theta - c\theta \tag{22}$$

As the payoffs are linear, the contract without commitment but a higher wage, $w(\theta, 1, 1, S)$, replicates the same payoffs. Therefore, the above contract is not unique in reaching these payoffs to the employee and firm[25].

4.1.4 Without noncompete, without dismissal

This contract is weakly dominated by noncompete without dismissal with a higher wage, thus I will exclude it from the analysis.

4.2 Optimal contract

Define the following thresholds

$$\theta_1 = \frac{p(1 - \bar{\lambda}q)}{p(1 - \bar{\lambda}q) - \bar{\lambda}qa - c} \tag{23}$$

$$\theta_2 = \frac{1 + p\bar{\lambda}q - q - p}{\Delta(1 + \gamma - a - p - q) - (1 - \bar{\lambda})(a + p)q - \Delta^2} \tag{24}$$

[24] The wage must also be less than $\gamma\theta$ since the outside option provides the only incentives for choosing S.

[25] The contract with firm commitment can be made unique to reach these payoffs by a slight modification of the model, such as adding an infinitesimal cost to the employee if she becomes unemployed. In that case, the compensation the firm has to offer to induce effort is cheaper with commitment.

$$\theta_3 = \frac{q}{(p+\Delta)(q+\Delta)+(q+\Delta)a-\Delta\gamma} \tag{25}$$

Proposition 1. *Consider the thresholds on positions, θ_1, θ_2 and, θ_3. For $\theta_1 < \theta_2 < \theta_3$*

0)$\theta < \theta_1$ positions do not exist inside the firm.

1)$\theta_1 < \theta < \theta_2$ the optimal contract is noncompete, dismissal, $w(\theta) = 1$.

2)$\theta_2 < \theta < \theta_3$ the optimal contract is free leave, dismissal, $w(\theta, 0, 1)$

3)$\theta_3 < \theta$ the optimal contract is noncompete, no right to dismiss, $w(\theta, 1, 0)$[26]

Proof. Denote the contracts by C_i with $i \in \{1, 2, 3\}$. The proof follows from the derivations of section 4 and by substituting the thresholds into the respective profit functions. All three profit functions are linear in θ, with the linear coefficient increasing from 1) to 3). ■

Positions with $\theta < \theta_1$ are not offered. The reason is that as the firm cannot guarantee that the employee stays and produces, investing in the agent's training does not have a high enough expected off. With C_1 the firm offers the lowest wage such that the employee does not leave to the other industry if she could also produce with the firm. However, this wage does not induce the employee to exert effort. Offering a high enough wage to induce effort is too expensive for the firm at low productivity. The firm anticipates shirking, therefore, noncompete increases the probability that the employee stays with the firm. The firm does not commit to the employee, and fires if the employee turns out to be unproductive to save on her wage.

As the position, θ, increases, the production becomes more valuable for the firm and thus the marginal product of the effort is also higher. Therefore, the firm uses C_2 to provide the most incentives for the employee to exert effort at a lower wage. Anticipating that the contract induces effort, the firm can offer a wage below 1. The firm keeps the option to dismiss the employee if the employee turns out to be unproductive.

C_3 reintroduces noncompete. In exchange, however, the firm offers a high enough expected wage. The firm either commits to the employee by committing not to dismiss her even if she is unproductive and offers a lower wage, or the firm offers a higher wage, $w(\theta, 1, 1)$, but with the right to dismiss her. The employee leaves for the competitor with a low probability ($\lambda(q + \Delta)$). If the firm commits to the employee, the outside option provides the incentive to provide effort. The firm offers a low wage, however, commits to paying it even when the employee cannot produce. If the firm does not commit and keeps the ability to fire her, it needs to offer a higher wage to induce effort. For the rest of the analysis, consider C_3 being the contract without dismissal. Figure 4 shows the profit of the firm graphically.

Remark 1. *The firm only pays a compensating differential for top employees for the noncompete.*

The remark follows from the proposition. An employee at the bottom of the firm receives a wage equal to 1, even if she does not have a noncompete. The firm cannot lower her wage below 1 since she would leave the industry. However, the firm prefers to induce effort for top employees. Therefore, the firm promises a higher wage with noncompete than without it to ensure that the employee exerts effort. The empirical prediction of the model regarding the compensating differential is that firms pay a compensating differential for top employees, but not for bottom ones. Testing the prediction requires a collection of numerous firmsâ hierarchies and data on wages and noncompetes. The data from the National Longitudinal Survey of Youth provides information to

[26] The contract is not uniquely optimal, however. Without tenure and with a higher wage, $w(\theta, 1, 1)$, the same payoffs are obtainable.

do the empirical exercise only for one firm. I use the data of the same firm as the motivating evidence reported. Table 10 presents the regression for the compensating differential for signing the noncompete. The coefficient for the compensating differential is insignificant and close to 0 in magnitude for the lowest part of the firmâs hierarchy. For top positions, the coefficient is still insignificant but approximately ten times larger than for the bottom positions in magnitude. The lack of statistical significance may be linked to the low number of observations.

Several further comments are due about the model setup and results. First, there is empirical evidence [Prescott and Starr, 2021] that noncompete may not be part of the initial contract. The model has identical results if noncompete is signed after the rest of the contract but before the effort choice. Second, effort provision leads to better labor market outcomes for higher positions via accumulating human capital, having good reference letters, etc. However, for lower positions, such as fast food restaurant workers and cleaning personnel, the above is less straightforward. The equilibrium of the model shows that these agents choose to shirk, providing a reason why we do not observe the above phenomenon in the real world.

Third, the potential interpretations of the parameter θ can be extended. The training cost only depends on θ, thus independent of the rest of the contract. Therefore, it is possible to assign meaning to θ without the cost, while keeping the transition points between the contracts, θ_2 and θ_3, intact. θ can be a degree of access the employer gives to its valuable asset to the employee. Giving access may be costless and also increases the employee's payoff if she competes. Alternatively, θ may be the characteristic of the employee, such as education or experience. An employee with a higher θ produces more and also has a better inside industry outside option. [27]

Fourth, the firm and the employee may renegotiate by allowing the firm to match the employee's outside option. The employee's utility is unchanged as her pay remains the same, just comes from a different employer. Hence, the employee's actions remain unchanged. The profit of the firm changes as follows.

$$\pi(\theta, , 1, 0, w = w(\theta, 1, 1)) = p(1 - \bar{\lambda}q)(\theta - 1) + p\bar{\lambda}q(\theta - \gamma\theta) - (1 - p)\bar{\lambda}qa\theta - c\theta \tag{26}$$

$$\pi(\theta, 0, 1, w(\theta, 0, 1), 1) = (p + \Delta)(1 - q - \Delta)(\theta - w(\theta, 0, 1)) + p(q + \Delta)(\theta - \gamma\theta) - (1 - p)(q + \Delta)a\theta - c\theta \tag{27}$$

$$\pi(\theta, 1, 0, w(\theta, 1, 0), 1) = (p+\Delta)(1-\bar{\lambda}(q+\Delta))\theta-(1-\bar{\lambda}(q+\Delta))w(\theta, 1, 0))+p(q+\Delta)(\theta-\gamma\theta)-(1-p)\bar{\lambda}(q+\Delta)a\theta-c\theta \tag{28}$$

The firm only matches the outside option if the employee is productive inside. The profit increases by more under C_2 than under C_1, therefore, the threshold θ_2 moves downwards. In other words, the relevance of noncompete decreases if the firm can match the outside option, since the probability that the firm loses a productive employee is reduced. θ_3 remains unchanged, as the corresponding profits increase by the same amount.

yees from bottom ones.

4.3 Comparative statics

Lemma 1. *The comparative statics of the transition points with respect to noncompete are*

[27] However, the reservation utility is not a function of θ.

$$\frac{\partial\theta_1}{\partial\bar{\lambda}} > 0, \frac{\partial\theta_2}{\partial\bar{\lambda}} < 0, \frac{\partial\theta_3}{\partial\bar{\lambda}} = 0$$

Proof. The proof directly follows from calculating the respective derivatives. ■

An increase in $\bar{\lambda}$ means a decrease in the stringency of the noncompete. The firm's profit under C_1 decreases if the stringency of noncompete is lowered, which can be shown by calculating $\frac{\partial\pi(C_1)}{\partial\bar{\lambda}} < 0$. The firm recoups its training cost less likely the more mobile the employee can be. Thus, if the stringency decreases, the minimum position inside the firm increases, $\frac{\partial\pi(C_1)}{\partial\bar{\lambda}} < 0$. A more intense noncompete blocks the employee more frequently from leaving and thus there is higher expected production inside the firm, which facilitates employment for lower θ. This result is similar to previous findings, such as in Rauch [2015].

C_2 allows free exit, therefore the profit does not change with a change in the stringency of noncompete for this contract. An increase in $\bar{\lambda}$ means lower profit under C_1 and the threshold, θ_2 decreases. θ_3 is independent of $\bar{\lambda}$.

4.4 Expected probability to stay with the firm

The expected probability that the employee stays with the firm is the longest under C_3. An employee only leaves the firm if she receives an industry outside option despite her noncompete, which happens with a probability $(1 - \bar{\lambda}q)$. The employee's expected stay with the firm is $p(1 - \bar{\lambda}q)$ and $(p + \Delta)(1 - q - \Delta)$ under C_1 and C_2 respectively. She is subjected to a noncompete under C_1, but only chooses S that increases her tenure with the firm under C_2. The comparison depends on which effect dominates.[28] If Δ is large, the employee receives an offer from the competitor with a higher likelihood, resulting in a higher probability of separation. On the other hand, if noncompete is more restrictive, the employee stays with the firm more likely under C_1.

4.5 Employee's utility

Denote the employee's utility under the different contracts by $U(C_i)$, $i \in \{1, 2, 3\}$

$$U(C_1) = 1 - \bar{\lambda}q + \bar{\lambda}q\gamma\theta \tag{30}$$

$$U(C_2) = 1 - q + q\gamma\theta \tag{31}$$

$$U(C_3) = 1 - \bar{\lambda}q + \bar{\lambda}q\gamma\theta \tag{32}$$

$U(C_1)$ and $U(C_3)$ have the same functional form. The utility of the employee is a decreasing function of the stringency of the noncompete, and an increasing function of the training, θ, keeping everything else fixed. Therefore, the employee is better off under C_2 than under C_1 or C_3 for a fixed θ, since $\gamma\theta_1 > 1$. Figure 2 visually represents the employee's utility.

[28] The inequality $p(1 - \bar{\lambda}q) < (p + \Delta)(1 - q - \Delta)$ boils down to

$$pq(1 - \bar{\lambda}) < \Delta(1 - \Delta - p - g) \tag{29}$$

that isolates the two competing effects.

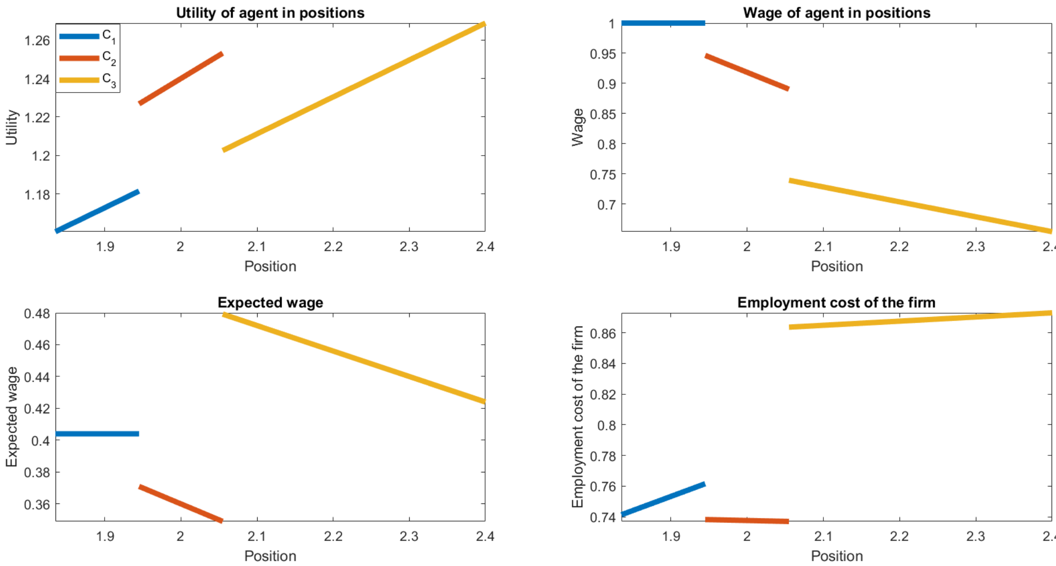

Figure 2: Utility, wage, expected wage and employment costs of the firm

The top left panel of graph shows an employee has a larger utility under C_2 than under C_1, while the relation between C_2 and C_3 is ambiguous. The rest of the graphs shows the wage and related costs of the firm. Employment costs include wage, training, and damage.

4.6 Cost of employment

I define the cost of employment to be the sum of the training cost, wage, and damage. According to the model setup, the employee is compensated both by wage and training, and every employee has the same outside option from the other industry. Under the first contract, the employee is offered $w(\theta) = 1$. Despite the more training an agent receives as the position increases, her wage cannot be decreased to avoid her leaving the firm for the other industry.

Under the other two contracts, the employee is paid less the more training she receives since she can also capitalize on the training elsewhere in the industry. However, these wages are paid with a different probability. Graph 2 shows the expected wage, that is the wage multiplied by the probability it is being paid. The expected wage is the largest when the firm commits to the employee, and the smallest is when the employee is free to exit. In the latter case, her industry outside option arises with a higher probability.

The next subgraph shows that the employment cost of the firm are increasing in position for C_1. Moreover, the costs are increasing for C_3 while decreasing for C_2, if the following inequality is satisfied for the training cost.

$$\bar{\lambda}\Delta\gamma - (q + \Delta)a < c < \Delta\gamma - (q + \Delta)a \tag{33}$$

The employment cost is defined as the sum of wage, damage, and training. The cost of employment increases in the position (θ) for C_1, since the firm's training cost is increasing while the wage cannot be changed. Under C_2, the employee can take full advantage of the training at the competitor. The firm's cost decrease in position, if $\gamma\Delta > -(q + \Delta)a > c$, that is training increases the employee's outside option more than the cost of it to the firm and the expected damages. Under C_3, the firm imposes noncompete, hence the employee has a lower probability to make use of the training to compete. The training cost and damage exceeds the increase in outside option if the inequality of 33 is satisfied.

5 Regulation of noncompete

This section derives the optimal regulation on the restrictiveness of noncompete. The policymaker sets $\bar{\lambda}$ to maximize welfare that I define as the sum of the firm's profit and the employee's utility. I show that under the position-dependent regulation of noncompete, the policymaker bans noncompete for bottom positions if the training the firm provides is sufficiently valuable outside the firm and the firm dismisses employees infrequently. The conditions to ban noncompete completely for the top positions are stricter, in other words less likely to be optimal. Later in the section, I also highlight the tradeoffs the policymaker faces to establish a universal regulation of the restrictiveness of noncompete.

5.1 Position dependent

The policymaker observes the position, θ, and sets the policy as a function θ, $\bar{\lambda}(\theta)$.

Proposition 2. *Under position dependent regulation, the policymaker bans noncompete for bottom positions if*
i) $\gamma > p + a$
ii) $p > \frac{qa\theta - c\theta}{1-q}$.
Condition i) becomes $\gamma > p + a + \Delta$ *for top positions.*

Proof. I set up the problem of the regulator for each contract and subsequently derive the optimal regulation $\theta(\bar{\lambda})$.

5.1.1 C_1

$$\phi(\theta, C_1, G) = \pi_1(\theta, C_1, G) + U_1(\theta, C_1, G) = p(\theta - 1) + \bar{\lambda}q(\theta\gamma - a\theta - p\theta) - c\theta + 1 \tag{34}$$

Hence the problem of the regulator is

$$\begin{aligned} &\max_{\bar{\lambda}(\theta)} \phi(\theta, C_1, G) \\ &\text{s.t.} \quad \pi_1(\theta, C_1, G) \geq 0, \quad U_1(\theta, C_1, G) \geq 1, \quad C = C_1 \end{aligned} \tag{35}$$

The optimal regulation takes into account the firm's and agent's participation constraint. The change in the stringency of noncompete can also alter the optimal contract. The optimal policy is

$$\bar{\lambda}(\theta, C_1, G) = \begin{cases} \min\left\{\frac{p(\theta-1)-c\theta}{q(p(\theta-1)+a\theta)}, 1\right\} & \gamma > p + a \\ 0 & \gamma \leq p + a \end{cases} \tag{36}$$

The optimal regulation is banning noncompete if the training the firm provides has a sufficiently high industry specific component and the firm's participation constraint is met. Substituting in $\bar{\lambda} = 1$ to the firm's participation constraint yields the condition

$$p > \frac{qa\theta - c\theta}{(1-q)(\theta - 1)} = \hat{p}(\theta) \tag{37}$$

Intuitively, the firm's investment in training must pay off to facilitate participation. This condition is satisfied if p, the probability of success, is high. In other words, if the firm fires the agent with a low probability.

Furthermore, if the regulation changes the behavior of the employee to exert effort, the objective of the regulator becomes

$$\phi_1(\theta, S) = (p + \Delta)\theta + (1 - p - \delta)\bar{\lambda}(g + \Delta)(\gamma\theta - a\theta) - c\theta \tag{38}$$

In which case it is optimal to choose $\bar{\lambda} = 1$. Thus the optimal regulation taking the firm participation constraint into account is

$$\bar{\lambda}(S = 1, \theta_1 < \theta < \theta_2) = \min\left\{\frac{(p + \Delta)(\theta - 1) - c\theta}{(\Delta + q)((p + \Delta)(\theta - 1) + a\theta}, 1\right\} \tag{39}$$

5.1.2 C_2

$$\phi_2(S = 1) = (p + \Delta)(1 - q - \Delta)\theta + (q + \Delta)(\gamma\theta - a\theta) - c\theta \tag{40}$$

which is not dependent on $\bar{\lambda}$. Thus, any $\bar{\lambda} \in [0, 1]$ is equilibrium. However, the outcome may be inefficient if the employee leaves the firm when she could produce, as her training is capitalized the most at the firm.

5.1.3 C_3

$$\phi_3(\theta, C_3, e = 1) = (p + \Delta)\theta - c\theta + \bar{\lambda}(q + \Delta)\theta(\gamma - p - \Delta - a) \tag{41}$$

The optimal policy is

$$\bar{\lambda}(\theta, C_3, S) = \begin{cases} 1 & \gamma > p + a + \Delta \\ 0 & \gamma \leq p + a + \Delta \end{cases} \tag{42}$$

The condition to ban noncompete is stricter for the highest position inside the firm compared with the lowest position. An employee who exerts effort increases the expected production inside the firm, which yields a larger difference in expected production between the firm and the competitor. ■

5.2 Universal

Under universal regulation, the regulator sets $\bar{\lambda}$ that cannot depend on the position, θ. θ may not be observable for the regulator, or it would be too costly to establish a position-dependent boundary of the stringency of noncompete. The regulator puts a constant weight f on each position. The subscript of ϕ_i denotes the number of the contract, $1, 2, 3$, to save on notation. The problem of the regulator becomes

$$\begin{aligned} \max_{\bar{\lambda}} \Phi = &\int_{\theta_1(\bar{\lambda})}^{\theta_2(\bar{\lambda})} \phi_1(\bar{\lambda}, \theta) f d\theta \\ &+ \int_{\theta_2(\bar{\lambda})}^{\theta_3(\bar{\lambda})} \phi_2(\bar{\lambda}, \theta) f d\theta + \int_{\theta_3(\bar{\lambda})}^{\bar{\theta}} \phi_3(\bar{\lambda}, \theta) f d\theta \end{aligned} \tag{43}$$

The first derivative with respect to $\bar{\lambda}$ using the Leibniz rule becomes

$$
\begin{aligned}
\frac{\partial \Phi}{\partial \bar{\lambda}} = &+ \frac{\partial \theta_2(\bar{\lambda})}{\partial \bar{\lambda}} \phi_1(\bar{\lambda}, \theta_2) f - \frac{\partial \theta_1(\bar{\lambda})}{\partial \bar{\lambda}} \phi_1(\bar{\lambda}, \theta_1) f + \int_{\theta_1(\bar{\lambda})}^{\theta_2(\bar{\lambda})} \frac{\partial \phi_1}{\partial \bar{\lambda}} f d\theta \\
&+ \frac{\partial \theta_3(\bar{\lambda})}{\partial \bar{\lambda}} \phi_2(\bar{\lambda}, \theta_3) f - \frac{\partial \theta_2(\bar{\lambda})}{\partial \bar{\lambda}} \phi_2(\bar{\lambda}, \theta_2) f + \int_{\theta_2(\bar{\lambda})}^{\theta_3(\bar{\lambda})} \frac{\partial \phi_2}{\partial \bar{\lambda}} f d\theta \\
&- \frac{\partial \theta_3(\bar{\lambda})}{\partial \bar{\lambda}} \phi_3(\bar{\lambda}, \theta_3) f + \int_{\theta_3(\bar{\lambda})}^{\bar{\theta}} \frac{\partial \phi_3}{\partial \bar{\lambda}} f d\theta
\end{aligned} \tag{44}
$$

Next, I break down the above equation by terms and establish their sign.

$$
\frac{\partial \theta_1(\bar{\lambda})}{\partial \bar{\lambda}} \phi_1(\bar{\lambda}, \theta_1) f < 0 \tag{i}
$$

As $\frac{\partial \theta_1(\bar{\lambda})}{\partial \bar{\lambda}} < 0$. Since a decrease in the stringency of the noncompete decreases the size of the firm, and thus yields less production, shrinking the overall surplus.

$$
\frac{\partial \theta_2(\bar{\lambda})}{\partial \bar{\lambda}} (\phi_1(\bar{\lambda}, \theta_2) - \phi_2(\bar{\lambda}, \theta_2)) f > 0 \tag{ii}
$$

$\frac{\partial \theta_2(\bar{\lambda})}{\partial \bar{\lambda}} < 0$ and $(\phi_1(\bar{\lambda}, \theta_1) - \phi_2(\bar{\lambda}, \theta_1)) < 0$ is established before. [29] Thus, an increase in $\bar{\lambda}$ increases welfare since it extends the range where the sum of the firm's profit and employee's utility is higher.

$$
\frac{\partial \theta_3(\bar{\lambda})}{\partial \bar{\lambda}} (\phi_2(\bar{\lambda}, \theta_3) - \phi_3(\bar{\lambda}, \theta_3)) f = 0 \tag{45}
$$

because of $\frac{\partial \theta_3(\bar{\lambda})}{\partial \bar{\lambda}} = 0$.

The sign of the remaining terms depend whether $\gamma > a + p$ and $\gamma > a + p + \Delta$

$$
\frac{\partial \phi_1(\bar{\lambda})}{\partial \bar{\lambda}} = q\theta(\gamma - a - p) \tag{iii}
$$

$$
\frac{\partial \phi_2(\bar{\lambda})}{\partial \bar{\lambda}} = 0 \tag{46}
$$

$$
\frac{\partial \phi_3(\bar{\lambda})}{\partial \bar{\lambda}} = \theta(\gamma - p - a - \Delta) \tag{iii}
$$

The regulator trades off the following three effects. First, a restrictive noncompete can induce participation of the firm by protecting the training provided to its employees (i), yielding larger social welfare. (ii) shows that a laxer noncompete decreases the firm's incentive to impose the restriction, hence enlarging the range of positions where the firm does not impose it on the employee (C_2). Since this is the range with the largest welfare, overall welfare is also increased. Third, noncompete blocks the employee from ex post competing. It is socially efficient to compete if the employee is not productive with the firm, however, it is inefficient if she is productive. From an ex ante point of view, the equations labeled with (iii) capture this effect. Hence, a crucial parameter of the model is γ, how productive the agent is inside the industry at a competitor. The more productive she is, the weaker the regulator sets the restriction of noncompete.

[29] The utility of the employee increases at the transition point.

6 Beliefs about noncompete

I extend the model with the employee holding an incorrect belief about her noncompete. First, I consider how the optimal contract changes if the firm can influence the belief to demonstrate that the firm can make the employee worse off. Subsequently, I relax the assumption that agents are identical and I allow heterogeneity in comperehedning the scope of noncompete. In equilibrium, agents who underestimate how restrictive their nonompete is are employed at the bottom of the firm's hierarchy so that they mistakenly exert effort.

6.1 Firm's influence

Consider a version of the baseline model where the employee has an incorrect belief about how restrictive her noncompete is. The firm may intentionally misinform the employee on how restrictive her noncompete is, [30] that is common practice according to Prescott and Starr [2021]. Additionally, the employee may be cognitively bounded to comprehend the contract fully [Tirole, 2009], especially since it may involve several post-employment restrictions [Lobel, 2021, Balasubramanian et al., 2021].

This section investigates whether strategically including unenforceable noncompete ($\tilde{\lambda} = 0$) in the contract is optimal for the firm and the consequences of the employee falsely believing that she is subject to a stringent noncompete. As a concrete example, noncompete agreements are void in California. However, empirical evidence shows they are nevertheless often included in the employment contract [Colvin and Shierholz, 2019] [Sanga, 2018].

Under C_1 the firm offers wage $w = 1$. The resulting utility and profit are

$$U(\theta, C_1, G) = \tilde{\lambda} q\gamma\theta + (1 - \tilde{\lambda} q) \tag{47}$$

$$\pi(\theta, C_1, G) = p(1 - \tilde{\lambda} q)(\theta - 1) - \tilde{\lambda} qa\theta - c\theta \tag{48}$$

Thus, knowing that the employee chooses G, the firm prefers $\tilde{\lambda} = 0$. In equilibrium therefore the firm can induce investment by offering the wage $w = \frac{1}{p+\Delta}$ and the employee never leaves leading to the profit

$$\pi(\theta, C_1, S, \tilde{\lambda} = 0) = (p + \Delta)(\theta - \frac{1}{p + \Delta}) - c\theta \tag{49}$$

The firm offer $w = 1$ if $\theta < \frac{1-p}{\Delta}$ and $w = \frac{1-p}{\Delta}$ otherwise.

Under C_3 the firm prefers $\tilde{\lambda} = 0$, as the profit and utility takes the same form as under C_1. Hence, the employee always has a utility of 1 if the firm can influence her belief about the enforceability of noncompete, while the firm pays $w = 1$. As a result, the employee is worse off compared to the baseline case. The reason is that the firm compensated the employee by only the minimum amount needed ($w = 1$) while the noncompete eliminated the employee's outside option that was larger, $\gamma\theta > 1$.

6.2 Sophistication

This extension relaxes the assumption that agents are identical building on beliefs about noncompete. Prescott et al. [2021] reports that 8.8% of employees having entered in a noncompete acknowledged that they have

[30] exploitative contracting in the terminology of Koszegi [2014])

signed the noncompete agreement unknowingly. Moreover, understanding a noncompete agreement and what it implies is often further hindered by multiple other post-employment restrictive covenants [Balasubramanian et al., 2021, Lobel, 2021]. [31]

The extension distinguishes sophisticated and naïve agents. Sophisticated (high ability, she) agents are more productive, they can produce an additional A unit inside the industry. Thus, the production inside the firm is $F(\theta, A) = \theta + A$ and the competitor offer is $O(\theta, A) = \gamma\theta + A$. The rest of the model is intact for the high ability agents. [32] naïve agents (low ability, he) do not understand their contract and believe that they do not have restrictions, and act accordingly.

As an example, under C_1, the naïve agent believes his payoff if choosing S is

$$U(\theta, C_1, S)_L = (p + \Delta)(1 - q - \Delta) + (q + \Delta)\gamma\theta \tag{50}$$

while the correct function is

$$U(\theta, C_1, S) = (p + \Delta)(1 - \bar{\lambda}(q - \Delta)) + \bar{\lambda}(q + \Delta)\gamma\theta \tag{51}$$

The L subscript stands for the naïve/low ability agent.

The following proposition summarizes the results. If the high ability agents' additional productivity is not too large, the lowest positions are filled up by low ability agents.

Define the thresholds

$$\theta_{1,L} = \frac{(p + \Delta)(1 - \bar{\lambda}(q - \Delta))}{(p + \Delta)(1 - \bar{\lambda}(q + \Delta)) - \bar{\lambda}(q + \Delta)a - c} \tag{52}$$

$$\tilde{\theta} = \frac{(p + \Delta)(1 - q - \Delta)A - 1 + q + (q + \Delta)A + (p + \Delta)(1 - \bar{\lambda}(q + \Delta))}{(1 - \bar{\lambda})(q + \Delta)a - \Delta\gamma + (p + \Delta)(1 - \bar{\lambda})(q + \Delta)} \tag{53}$$

Proposition 3. *If $A < \hat{A}$, the optimal contract for $\theta_{1,L} < \theta < \tilde{\theta}$ employs the low ability agent.*

Proof is in the appendix.

From the firm's perspective, the free inclusion of noncompete is useful, if effort leads to a high enough expected production compared to the productivity advantage of the high ability agent. Thus the parameter A must be constrained. The firm employs the naïve agent for low θ's, who chooses effort. As θ gets higher, high ability agents also provide effort, and thus the comparative advantage of the naïve agent disappears, and high ability agents are employed.

Graphs 5, 6, 7 summarize the results graphically. Low ability employees' true utility is lower than his belief ex ante. His true utility may fall below his reservation utility of 1 for smaller θ's. It leads to the question of whether banning noncompete is socially beneficial.

[31] Other post-employment restrictive covenants are non-disclosure agreements (NDAs), which prohibit workers from using or disclosing confidential information; nonsolicitation agreements (NSAs), which prohibit workers from soliciting former clients; and nonrecruitment agreements (NRAs), which prohibit workers from recruiting former co-workers.Balasubramanian et al. [2021]

[32] High ability agents are not costlier in this extension.

6.3 Banning noncompete

Consider a Policymaker that can distinguish between high and low ability agents. Numerous articles have been recently published about firms that offer low paid jobs use noncompetes [Shubber, 2018, Neil, 2014]. If the planner can also observe θ, the planner bans noncompetes for θ's that results in a less than 1 utility of the employee. The more realistic case is when the planner cannot observe θ. The tradeoff is between prohibiting noncompete for low θ's where the employees' utility falls below their reservation utility of 1 and allowing low ability agents to be hired for higher θ's where they mistakenly provide effort. Low ability agents would not be employed without effort provision, and since there is no credible way to commit, the misunderstanding of the contract leads to choosing S. The objective function of the planner is

$$\max_{\bar{\lambda}} \int_{\theta_{1,L}}^{\tilde{\theta}} (U_L(\theta) - 1) f(\cdot) d\theta \tag{54}$$

The underlying assumption for the objective is that the supply of high ability agents is abundant, thus if the firm wants to hire more high ability agents due to a change in the regulation of noncompete, it is possible. The regulator only focuses on the utility of naïve agents, the objective does not include the utility of high ability agents nor the firm's profit. $U_L(\theta)$ denotes the true utility. The distribution function $f(\cdot) > 0$ can represent the distribution of the population of low ability types. The planner weights everyone equally and the weights do not depend on any of the decision variables.

The derivative of the objective is

$$\frac{\partial \tilde{\theta}}{\partial \bar{\lambda}}(U_L(\tilde{\theta}) - 1) - \frac{\partial \theta_{1,L}}{\partial \bar{\lambda}}(U_L(\theta_{1,L}) - 1) + \int_{\theta_{1,L}}^{\tilde{\theta}} \frac{\partial U_L(\theta)}{\partial \bar{\lambda}} d\theta \tag{55}$$

The sign of the parts of the derivatives can be broken down as follows:

$$\frac{\partial \tilde{\theta}}{\partial \bar{\lambda}}(U_L(\tilde{\theta}) - 1) < 0 \tag{i}$$

$\frac{\partial \tilde{\theta}}{\partial \bar{\lambda}} < 0$, $(U_L(\tilde{\theta}) - 1 > 0)$ as otherwise there would be no low ability agents benefiting from noncompete. Thus, increasing $\bar{\lambda}$ (decreasing the stringency of noncompete) decreases the range of θ for which low ability agents are employed with a higher expected utility than the reservation utility.

$$-\frac{\partial \theta_{1,L}}{\partial \bar{\lambda}}(U_L(\theta_{1,L}) - 1) > 0 \tag{ii}$$

$\frac{\partial \theta_{1,L}}{\partial \bar{\lambda}} > 0$ and $(U_L(\theta_{1,L}) - 1) < 0$, making the second term positive (by the minus sign in front). Thus increasing $\bar{\lambda}$ decreases the range of θ where the low ability employee's utility is falling below their reservation utility.

$$\int_{\theta_{1,L}}^{\tilde{\theta}} \frac{\partial U_L(\theta)}{\partial \bar{\lambda}} d\theta > 0 \tag{iii}$$

As $\frac{\partial U_L(\theta)}{\partial \bar{\lambda}} > 0$. (iii) shows that the ex post utility is always higher if noncompete is less intense.

In conclusion, a policymaker focusing only on low ability agents may ban noncompete, if $iii + ii > i$. The downside of banning noncompete is that low ability agents that are employed with noncompete and have a positive rent are not hired if noncompete is banned. On the other hand, banning noncompete ensures that no agent makes a mistake interpreting the covenant, thus no low ability employee has a lower utility than her reservation utility. If $\bar{\lambda} = 1$, the term *iii* is 0. Hence, misunderstanding the contract alleviates the commitment problem of the employee regarding effort.

7 Multiple periods

This section extends the model with an additional period to show how the firm's holdup power increases over time. First, I demonstrate how the wages of employees in bottom positions may be kept low with a noncompete, and relate this situation to an ongoing class action suit. Second, I focus on top positions where choosing S in the one period game is optimal, however, in the second period, the firm may decrease the wage of the employee. The firm can solve the holdup problem by committing to the employee. The commitment can be via paying the preset wage or by paying a high wage upfront. Regulating the restrictiveness of noncompete can also help.

Employees in a class action suit against the fast food franchise company Jimmy John's claim that their firm developed increasing holdup power against them over time.[33] The plaintiff argues that the company decreased his working hours knowing that he cannot work for a competitor given his noncompete, and thus he would need to accept an entry level job in a different industry if he wants to leave.

The above situation is introduced in the model in the following way. In the second period, the employee's human capital is constant. The firm does not provide more training nor can the employee modify her effort choice. [34] In this sense, the effort choice the employee makes in the first period is a human capital decision. The employee can keep her human capital generic (G), or she can specialize to the industry (S). The employee receives the outside options in the second period, dependent on the initial contract and her human capital choice. If she stays with the firm in the second period, she produces at the end of the period. The question of the section is the wage the firm offers in the second period. The wage is driven by the outside option the employee has in that period. The wage the competitor offers is pinned down by the training, $w_M = \gamma\theta$. The firm learns the employee's productivity by the end of the first period, therefore, only productive employees continue working for the firm in the second period, and others are dismissed. I denote the second period arrival rates with q_2, and Δ_2. The firm's profit if it offers the wage w_M is

$$\pi_2(w = \gamma\theta) = \theta - \gamma\theta \tag{56}$$

The profit is positive as $\gamma < 1$. Motivated by the lawsuit, I consider γ to be close to 1, that is the training the firm provides is valuable in the industry. In the fast food restaurant industry, the transferability of skills to a competing restaurant is high.

7.1 Unanticipated second period

First, consider that neither party anticipates the second period therefore, the first period choices and contracts are unchanged.

[33]The case was brought to court in 2018. Case Number: 18-cv-0133-MJR-RJ.

[34]If the employee takes a new effort decision, the stage game results are repeated. Therefore, the interesting case is when the employee's decision carries over to the second cycle.

7.1.1 C_1

Lemma 2. *If the training the firm provides to the employee is valuable in the industry, the firm does not increase the wage of employees at the bottom of the firm's hierarchy for the second period.*

Proof. Under C_1 the firm offers $w_2 = \gamma\theta$ if

$$\theta - \gamma\theta > (1 - \bar{\lambda}q_2)(\theta - 1) - \bar{\lambda}q_2 a\theta \tag{57}$$

Above leads to the condition on θ

$$\theta < \frac{1 - \bar{\lambda}q_2}{\gamma - \bar{\lambda}q_2 - \bar{\lambda}q_2 a} = \theta(C_1)_2 \tag{58}$$

Since γ is assumed to be close to one, the denominator is positive. However, $\theta_1 > \theta(C_1)_2$ [35], where θ_1 is the threshold for employment. Hence, the firm does not offer the market wage, but $w = 1$. ■

The intuition behind the result is that the employee stays with a high probability $(1 - \bar{\lambda}q)$ even if the firm offers $w = 1$. The firm cannot decrease the wage below 1, since the employee still has to outside industry option to leave as she chose the generic investment in the first period. However, the cost of offering the market wage is increasing in θ, therefore, is the lower bound. The threshold is lower the more restrictive noncompete is ($\frac{\partial\theta(C_1)_2}{\lambda} > 0$). If competition increases, the threshold also becomes lower ($\frac{\partial\theta(C_1)_2}{\gamma} < 0$). Even without the friction on the arrival rate of the outside option ($q_2 = 1$), the firm does not offer the market wage for all θ's since noncompete reintroduces the friction. Hence, a similar situation to Jimmy John's lawsuit arises. Despite the employee's value increasing to θ for the second period, the firm does not increase the wage since the employee is subject to a noncompete and his other industry outside option is not better than her wage inside the firm.

The result also shows that if the parties anticipate a second period renegotiation, the above characterized equilibrium largely prevails. The employee expects that the firm does not increase her wage in the second period, thus the only incentive to specialize is the chance to compete. However, this probability is decreased by being subjected to a noncompete.

7.1.2 C_2

Under C_2 the optimal contract does not include noncompete. The employee, however, may face a holdup. After specialization, her only outside option in the second period is from the industry competitor. If the arrival rate is low, the firm's expected loss from letting the employee go is lower than the wage cost it can save by decreasing her wage. For simplicity, consider that firm can offer 0 wage.

The firm offers $w = \gamma\theta$ if

$$\theta - \gamma\theta > (1 - q_2 - \Delta_2)\theta - (q_2 + \Delta_2)a\theta \tag{59}$$

It simplifies to

$$(q_2 + \Delta_2)(1 + a) > \gamma \tag{60}$$

[35] The condition boils down to $c + \bar{\lambda}qa > p(1 + \bar{\lambda}qa - \gamma$, the inequality holds since γ is close to 1.

If γ is small enough or the probability of the outside offer is high $(q_2+\Delta_2)$ the firm offers the market wage. If $q_2+\delta_2=1$, the firm offers the market wage even if γ is close to 1. Therefore, the holdup arises as a consequence of the specialization. However, the severity of the holdup is lower if the employee does not face a noncompete.

7.1.3 C_3

Under C_3 the employee has tenure and hence the firm's commitment eliminates the holdup. The firm may offer the market wage to ensure the employee stays if

$$\theta-\gamma\theta>(1-\bar{\lambda}(q_2+\Delta_2))(\theta-w(\theta,\bar{\lambda},1))-\bar{\lambda}(q_2+\Delta_2)a\theta \tag{61}$$

7.1.4 Efficiency and hold up

In the second period, efficiency, that is whether the employee is allocated to the firm with the highest production, can be reached. Since only the agents who are productive are kept by the firm and the employee is most productive with the firm, a policymaker can reach the efficient outcome by setting $\bar{\lambda}=0$. However, the restriction harms the employee. If the planner's objective weights the employee's utility higher, the strictest covenant is no longer optimal.

7.2 Holding up specialized agents without tenure

I discuss in this part the holdup problem between the firm and an employee in a top position when the firm does not commit to the employee. I derive the optimal contract that is crucially driven by the parameter γ that is the value of the training outside the firm but inside the industry. The firm has more incentive to include noncompete in the contract if γ is high. A high γ means the market wage of the employee in the second period is high.

I implement the following changes from the one period game to the period game. The firm and employee contracts at the beginning of the first period. For simplicity, there is no discounting between the periods. Noncompete carries over to the second period, but the firm can change the wage in the beginning of the second period. The employee's human capital stays constant in the second period with no further training or specialization decision. The employee receives the industry outside option with the same probability as in the first period, $q+S\Delta$. I use the same probabilities to decrease the number of parameters. I solve the model with backward induction starting from the second period wage offer.

7.2.1 Second period wage offer

In equilibrium the firm either offers the market wage, $w(\theta)=\gamma\theta$, or $w(\theta)=0$ for the second period. I allow the firm to offer any wage in the second period. The wage renegotiation occurs at the beginning of the period, when the firm already learned that the employee is productive inside the firm. Offering any wage aids the analysis, however, wages are known to be sticky. Decreasing the wage can be also associated with decreasing the non-contractual benefits of a certain position inside the firm's hierarchy which are not modeled here.

If the firm offers the market wage, $w=\gamma\theta$, the employee stays with certainty. Any wage below the market wage means the employee leaves for the competitor if the opportunity arises. Hence the other candidate for optimal wage is $w(\theta) = 0$ in which case the employee leaves for the competitor upon receiving an offer. Offering the market wage yields a higher profit if

$$\theta - \gamma\theta > (1 - \bar{\lambda}(q + \Delta)\theta) - \bar{\lambda}(q + \Delta)a\theta \tag{62}$$

The cost of the employee leaving is the sum of the foregone production and the damage she causes as shown by the above inequality. It simplifies to

$$\bar{\lambda} > \frac{\gamma}{(q + \Delta)(1 + a)} = \bar{\lambda}^T \tag{63}$$

Thus if noncompete is lax enough, the firm offers the market wage in the second period. However, even the contract without noncompete yields to a holdup problem in the second period if $\gamma > (q + \Delta)(1 + a)$.

Consider the wage $\gamma\theta > w(\theta) > 1$. The employee's utility under choosing S and G respectively is

$$\begin{aligned} U(\theta, 1, 0, w(\theta), S) = (p + \Delta)(1 - \bar{\lambda}(q + \Delta)w(\theta)) + \bar{\lambda}(q + \Delta)\gamma\theta \\ + \bar{\lambda}(q + \Delta)\gamma\theta + (p + \Delta)\bar{\lambda}(q + \Delta)\gamma\theta \end{aligned} \tag{64}$$

$$\begin{aligned} U(\theta, 1, 0, w(\theta), G) = p(1 - \bar{\lambda}q)w(\theta) + \bar{\lambda}q\gamma\theta + (1 - p)(1 - \bar{\lambda}q) \\ + \bar{\lambda}q\gamma\theta + (1 - \bar{\lambda}q) + p(\bar{\lambda}q)\gamma\theta \end{aligned} \tag{65}$$

The wage becomes

$$w(\theta) = \frac{(1 - p)(1 - \bar{\lambda}q) + (1 - \bar{\lambda}q) - 2\bar{\lambda}\Delta\gamma\theta}{\Delta(1 - \bar{\lambda}(q + \Delta + p))} \tag{66}$$

Thus if the firm has enough resources to pay the wage for two periods upfront to the agent, it can avoid the holdup. I continue the analysis looking for further solutions.

Thus there is a holdup problem, however, it has multiple solutions. Firstly the firm can commit to the wage of the employee (tenure). Secondly, if the firm cannot commit, it can pay the wage upfront for the second period, as the holdup from the employee's side is eliminated by using the noncompete. Thirdly, by regulating noncompete the firm might prefer to offer the market wage to the agent (calculate the derivative).

7.3 Optimal contract for top positions

Proposition 4. *If γ is large, the firm offers the contract with $w(\theta) = 1$and $\lambda = \bar{\lambda}$, and the employee does not specialize. Otherwise, the firm offers a contract that induces specialization.*

The full proof is in Appendix C. I set up the profit function to provide intuition for the result.

I divide the problem into two cases with respect to noncompete, $\lambda \geq \lambda^T$ and $\lambda < \lambda^T$. Note that the firm's problem may not yield a corner solution of λ, hence I allow the firm to set the noncompete variable continuously, $\lambda \in [\bar{\lambda}, 1]$.

7.3.1 $\lambda \geq \lambda^T$

First, consider the case when noncompete is mild with $\lambda \geq \lambda^T = \frac{\gamma}{(q+\Delta)(1+a)}$. I focus on wages such that $\gamma\theta > 1 > w$ as in the baseline case. The first line of the firm's profit is identical to the one period case. In the second period, the productive employee always stays.

$$\begin{aligned} \pi(\theta,1,0,w(\theta,S) =& (p+\Delta)(1-\lambda(q+\Delta)(\theta-w(\theta)) - \lambda(q+\Delta)a\theta - t\theta \\ &+ (p+\Delta)(1-\lambda(q+\Delta))(\theta-\gamma\theta) \end{aligned} \tag{67}$$

The first period employee utility is identical to the one period case. In the second period the employee receives a wage $\gamma\theta$ from the firm if stayed for the second period, or receives $\gamma\theta$ if competed in the first period.

$$\begin{aligned} U(\theta,1,0,w(\theta),S) =& (p+\Delta)(1-\lambda(q+\Delta))w(\theta) + \lambda(q+\Delta)\gamma\theta \\ &+ (p+\Delta)(1-\lambda(q+\Delta))\gamma\theta + \lambda(q+\Delta)\gamma\theta \end{aligned} \tag{68}$$

If the employee leaves the industry in the first period, she will not receive a competitor outside offer from the industry. Thus the utility of the agent investing in generic capital takes the following form and the employee never stays with the firm.

$$U(\theta,1,0,1,G) = \lambda q\gamma\theta + 1 - \bar{\lambda}q + \lambda q\gamma\theta + 1 - \bar{\lambda}q \tag{69}$$

The problem of the firm is then

$$\max_{\lambda, w(\theta)} \pi(\theta,1,0,w(\theta,S) \tag{70}$$

s.t.

$$U(\theta,1,0,w(\theta),S) \geq U(\theta,1,0,w(\theta),G) \tag{71}$$

For large enough θ's, the optimal contract features $= \lambda^T$, as shown in the appendix. Since the profit is a decreasing function of λ^T, hence it also decreases in γ.

7.3.2 $\lambda < \lambda^T$

If $\lambda < \lambda^T$ noncompete is so restrictive that the employee anticipates to be held up in the second period if she specializes.

The profit of the firm is

$$\pi(\theta,1,0,1,G) = p(1-\bar{\lambda}q)(\theta-1)) - \bar{\lambda}qa\theta + p(1-\bar{\lambda}q)^2(\theta-1) - p(1-\bar{\lambda}q)\bar{\lambda}qa\theta - c\theta \tag{72}$$

The profit of the firm under this contract does not depend on γ.

7.3.3 Optimal contract

The firm offers the contract that incentivizes specialization ($\lambda = \bar{\lambda}^T$) if the parameter γ is low. The firm does not hold up the employee in the second period but offers her the market wage, $w(\theta) = \gamma\theta$, as the market wage is low enough. If γ is high, however, the firm would hold up the employee. Hence the employee, who correctly anticipates the holdup, does not specialize in equilibrium.

7.4 Policymaker's problem

The policymaker's and firm's incentives are diverging with respect to γ. If γ is higher, the firm has more incentive to hold up the employee in the second period. Therefore, the employee does not choose to specialize. However, from a social point of view, when γ is larger specialization has a higher value, hence there is a larger social loss from restricting the employee from competing. As a result, the policymaker prefers to step in to constraint how restrictive the noncompete may be.

Lemma 3. *The policymaker can shift the firm's incentives to offer the contract with a laxer noncompete ($\lambda = \lambda^T$) by regulating the stringency of noncompete, $\bar{\lambda}$.*

Proof. The lemma directly follows from the observation that the firm's profit is only dependent on $\bar{\lambda}$ under the second contract. ■

By regulating the firm and not allowing a stringent noncompete, the policymaker can decrease the firm's profit under the contract $w = 1$ and $\lambda = \bar{\lambda}$. The regulation could improve efficiency by causing the firm to switch to the contract with a laxer noncompete ($\lambda = \lambda^T$) that incentivizes the employee to specialize.

8 Multiple firms

This section extends the model with additional firms and employees. With two firms competing for the employee, the game may not have a symmetric equilibrium. This is the case if it is more profitable to be the competitor under the optimal contract derived in Section 4. Next, I analyze the game with two firms and two employees to show that the results of the previous section not only prevail, but a prisoner's dilemma may also arise.

8.1 Competing for the employee

In this extension, two firms are competing for the employee at the beginning of the game. After one firm signs the agent, the firm with the agent becomes the incumbent firm and the other firm the competitor where the employee may leave for. The payoff of the competitor is $\varepsilon\theta$, where ε is small enough such that $\varepsilon + \gamma < 1$. Hence, the training has the highest return inside the firm. The payoff of the competitor becomes

$$\pi_C = \text{Pr(join of the employee)}\varepsilon\theta \tag{73}$$

The competitor has a lower payoff if the employee is subject to a noncompete. The incumbent's payoff, however, remains independent from the competitor's payoff, that is the damage function ($a\theta$) is not a function of ε. I distinguish two cases. First, if it is better to be a competitor under the optimal contract derived in Section 4, and second, when it is at least as profitable to be the incumbent as the competitor.

8.2 $\pi_C > \pi_I > 0$

If it is more profitable to be the competitor, there is no symmetric equilibrium. The reasoning is as follows. Consider first that neither firm offers employment to the agent. In this case, both firms have the incentive to deviate and offer a contract to the agent. However, both firms offering the contract cannot be equilibrium, as both have incentives to deviate to become the competitor. Thus, there is no symmetric equilibrium. The asymmetric equilibrium is then that one firm offers the contract, as specified in the baseline, and the other firm does not offer employment.

8.2.1 $\pi_C \leq \pi_I$

The firms have incentives to be the incumbent. Thus, there is a symmetric equilibrium of the game, where both firms offer to contract to the employee such that $\pi_C = \pi_I$.

8.3 2 firms and 2 employees

Consider the setup with two firms hiring one-one agent. The net payoff from poaching an employee is $\varepsilon\theta$[36]. The most common way to model firms trying to poach other firms' employees is poaching simultaneously. [Bar-Isaac and Leaver, 2021], [Bar-Isaac and Levy, 2022]. Therefore, the model remains unchanged from the point of view of the agents.

The payoffs for the firms are below. The first argument denotes whether the firm's agent is subject to a noncompete, and the second argument is whether the competitor firm's agent is.

$$\pi(FREE, FREE) = p(1-(q+\Delta))(\theta - w(\theta)) - (q+\Delta)a\theta - t\theta + (q+\Delta)\varepsilon\theta \tag{74}$$

$$\pi(NCC, FREE) = p(1-\bar{\lambda}q)(\theta - 1) - \bar{\lambda}qa\theta - t\theta + (q+\Delta)\varepsilon\theta \tag{75}$$

$$\pi(FREE, NCC) = p(1-(q+\Delta))(\theta - w(\theta)) - (q+\Delta)a\theta - t\theta + \bar{\lambda}q\varepsilon\theta \tag{76}$$

$$\pi(NCC, NCC) = p(1-\bar{\lambda}q)(\theta - 1) - \bar{\lambda}qa\theta - t\theta + \bar{\lambda}q\varepsilon\theta \tag{77}$$

In the baseline case with one active firm, θ_2 was the threshold such that $\theta > \theta_2$ the firm preferred the contract with free exit. I focus on θ's slightly lower than θ_2. The equilibrium unfolds as follows. Starting from both firms choosing the free exit contract, firms have the incentive to deviate to subject their employee to a noncompete. The benefit from poaching the other employee remains, while the loss from not having their own employee choosing G is smaller than the benefit of noncompete, since $\theta < \theta_2$. As a result, the competitor firm also chooses to sign a noncompete with the employee, with similar reasoning. Therefore, both firms constrain their employees.

However, denote the threshold where $\pi(FREE, FREE) = \pi(NCC, NCC)$ with θ^{FF}. The threshold is less than θ_2 since $q+\Delta > \bar{\lambda}q$. Therefore, for $\theta^{FF} < \theta < \theta_2$ there is a prisoner's dilemma. While $\pi(FREE, FREE) >$

[36] The employee still receives $\gamma\theta$

$\pi(NCC, NCC)$, the firms cannot commit not to bind their own employees and end up constraining them, while every player would be better off without noncompetes.

9 Conclusion

This paper studies how the optimal stringency of a noncompete varies with the employeeâs position inside a firmâs hierarchy. I show that in equilibrium employees at the top and bottom of the firm are subject to a noncompete, while employees in the middle are free from the covenant. Employees at the top are the most productive, therefore the firm decreases their probability of competing with a noncompete, while restoring their incentives to exert effort. Employees in the middle are free to compete to provide the maximum incentive to exert effort. The firm reintroduces the noncompete for bottom positions for which the productivity is the lowest. The firm does not incentivize the effort exertion of the employee, because it would be too costly for the firm given the low productivity of the agents.

I also analyze how the regulation of noncompetes can increase social welfare. A policy to ban the covenants for bottom positions is optimal if the training the firm provides is sufficiently valuable outside the firm and the firm dismisses employees infrequently. If the first condition is satisfied, the employeeâs opportunity to compete increases social welfare. The second condition ensures the firm has enough incentives to provide training to the employee at the beginning of employment. Since at top positions employees exert effort to increase their expected productivity, the condition for banning noncompete is stricter, because the difference in expected production between the firm and its competitor is larger.

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A Motivating evidence

This section extends the discussion of the motivating evidence.

A.1 Data

The National Longitudinal Survey of Youth 1997 includes questions on noncompete agreements from the round 2017. Following previous empirical papers and popular press that identify industries where noncompete may be frequent for workers at the bottom of the firm hierarchy, I analyze a firm with 261 respondents in the census, 34 respondents work in an occupation that is food preparations and serving related and 19 respondent in cleaning and building service occupations. The census further provides information on education (0-7 scale) and length of employment that is also converted to the same scale.

A.2 Hierarchy measure

Hierarchy is the internal organization of the firm [Smeets and Warzynski, 2008]. A direct hierarchy measure is not available in the NLS database. I construct a measure of hierarchy as a weighted average of education and length of tenure at the firm. Previous empirical papers show that these variables correlate with the firm's hierarchy. [37] Smeets and Warzynski [2008], Smeets and Warzynski [2011], Smeets et al. [2019] use a confidential database with access to a 5 layer hierarchy (worker to corporate vice president). In table 1 they show that the average firm tenure, experience, and education all increase as the hierarchy measure increases. Previous studies are also consistent with the above patterns [Baker et al., 1994a,b].

A.3 Statistical test

Figure 3 exhibits the U-shaped relationship between hierarchy and noncompete incidence, as suggested by the model.

[37] Age is another relevant variable for hierarchy, however, the respondents of the census are the same age

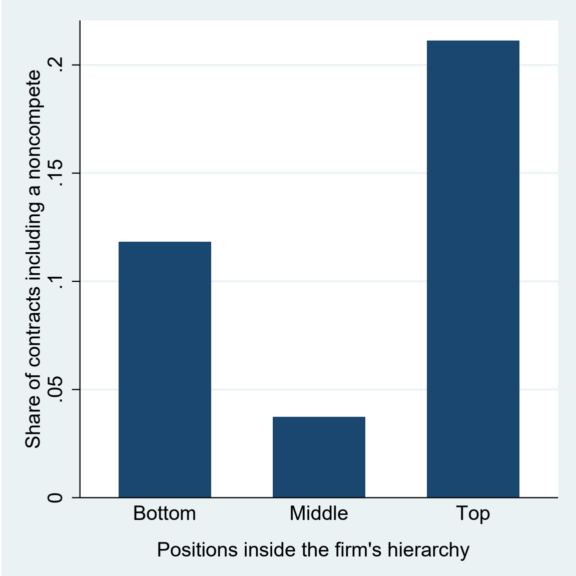

Figure 3: Noncompete incidence by positions in the firm's hierarchy

Employees at the bottom and at the top of the hierarchy are more frequently subject to a noncompete. The graph shows a firm's hierarchy and noncompete incidence from the data source the National Longitudinal Survey of Youth 1997. The hierachy measure is based on Baker et al. [1994a] and Smeets and Warzynski [2008].

Table 2 summarizes the regression results, with the first two columns displaying the linear probability model (LPM), the second two the logistic regression. Columns one and three exclude the quadratic term. In both the LPM and the logit model, the linear coefficients are insignificant without the quadratic term. Including the quadratic term yields significant linear and quadratic coefficients. The last column of table 2 estimates the probability of having noncompete for the lowest positions in the hierarchy is 10%, for middle positions it is only 4%, while at the top of the firm it is 18%.

	(1) LPM	(2) LPM	(3) Logit	(4) Logit
Hierarchy	0.033 (0.170)	-0.373* (0.014)	0.363 (0.172)	-5.034*
Hierarchy sq		0.103** (0.007)		1.343* (0.017)
Constant	0.038 (0.433)	0.373** (0.005)	-2.915 (0.000)	1.527 (0.411)
Observations	261	261	261	261

p values in parentheses
* p<0.05, ** p<0.01, *** p<0.001

Table 2: Hierarchy estimation table

The table shows the estimates for regressing noncompete incidence on the hierarchy measure. The regressions highlight the quadratic relationship between noncompete and hierarchy.

A.4 Robustness checks

A.4.1 Hierarchy measure

I extend the set of variables used for the hierarchy measure and carry out principal component and principal factor analysis for robustness. The variables are in table 3.

Variable name	Description
Employment lenght	Length of tenure of the employye at the firm
Education	Highest degree received
Supervise	Frequency of supervising other employees
Short and rep	Frequency of short and repetitive task
Physical	Frequency of physical task
Problem solving	Frequency of problem solving
Docs read	Longest document employees have read

Table 3: Variables included in the construction of the hierarchy measure

Principal component analysis (PCA) is a technique to reduce the dimensionality of a large set of correlated variables to components that are linear combinations of the original variables. The first principal component maintains the largest possible variance of the data [James et al., 2013]. Figure **??** shows that the first component loadings are all positive, as the variables correlate positively correlated with one other. The first component explains 27 % of the total variance.

Principal components/correlation	Number of observation= 207
	Number of comp. = 7
	Trace=7
Rotation: (unrotated = principal)	Rho= 1.

Component	Eigenvalue	Difference	Proportion
Comp1	1.9376	.669678	0.2768
Comp2	1.26793	.312636	0.1811
Comp3	.95529	.0989063	0.1365
Comp4	.856384	.0948599	0.1223
Comp5	.761524	.124909	0.1088
Comp6	.636615	.0519596	0.0909
Comp7	.584656	.	0.0835

Table 4: PCA output with Componenets

The output shows that the first component explains 27.68% of the variance of the variables.

Table 5 shows that all loadings are positive in the first component.

	Comp1	Comp2	Comp3	Unexplained
Employment lenght	.2699984	.4253433	-.3201179	0
Education	.4719358	-.3389817	-.1991325	0
Supervise	.1971271	.582004	.5214084	0
Short and rep	.2752353	-.3015385	.7114025	0
Physical	.4349763	-.4120884	-.0195224	0
Problem Solving	.4199458	.2840947	.0514484	0
Docs Read	.473503	.1548991	-.2772769	0

Table 5: PCA output with loadings

The table shows that the first component has all positive loadings as anticipated.

I also run factor analysis for robustness. Factor analysis is a method to uncover whether a larger set of observable variables is linearly related to a smaller set of latent variables [Tryfos, 2001]. In particular, whether the above 7 variables can give information about the unobservable hierarchy. From figure 6, only the first factor uses positive loadings on all variables, hence I focus on this factor. The principal component and the factor analysis yield similar loadings on the variables.

	Factor 1	Factor 2	Factor 3
Employment lenght	.2564065	.2507784	-.0663934
Education	.5202047	-.2215546	-.041111
Supervise	.1853165	.3629879	.1063376
Short and rep	.2673364	-.154774	.1495327
Physical	.4691728	-.2616933	.0133566
Problem Solving	.4298277	.201043	.0239833
Docs Read	.5015999	.1224624	-.0754527

Table 6: Factors

The first factor has positive, and very similar loadings to the PCA result.

Next, I regress these newly created measures of hierarchy on noncompete incidence. The results are in table 7, both confirm that noncompete incidence exhibits a U-shaped relationship to hierarchy. Noncompete is most frequent at the bottom and top of a firm. Note that the measures created are standardized, hence the smallest values are negative.

	(1) PCA	(2) PCA	(3) Factor	(4) Factor
PCA Hierarchy	0.027			
	(0.126)			
PCA Hierarchy sq.	0.024^{*}	0.029^{**}		
	(0.011)	(0.001)		
Factor Hierarchy			0.050	
			(0.124)	
Factor Hierarchy sq			0.085^{**}	0.103^{***}
			(0.008)	(0.001)
Constant	0.084^{**}	0.074^{**}	0.082^{**}	0.072^{*}
	(0.004)	(0.010)	(0.005)	(0.011)
Observations	207	207	207	207
R^2	0.061	0.050	0.067	0.056

p-values in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 7: Regression with PCA and Factor based hierarchy

The first two columns show that the first principal component based hierarchy measure exhibits a quadratic relationship with noncompete incidence. Column 3 and 4 do the same with the first factor.

A.4.2 Second firm

Table 8 and 9 summarizes the result of a similar analysis for a different firm. The firm's healthcare workers have a high incidence of noncompete (36%). The analysis confirms the quadratic relationship. [38]

[38] There is a bias regarding employment length in the data of this firm since the rounds of the survey occur every two years. Hence, only employees who worked for this firm for at least two years are included in the data. Thus, I only report the results with the PCA and factor analysis and subsequent regressions with the hierarchy measures. The small loadings on the employment length can be due to the bias.

Variable	**PCA**	**Factor**
emp17	0.0825	0.0886
education	0.4736	0.6092
superv17	0.0965	0.1054
shortrep17	0.3667	0.4307
physical17	0.4796	0.6178
probsolv17	0.3765	0.4428
docread17	0.5034	0.6669

Table 8: The loadings from PCA and factor analysis

	(1) PCA	(2) Factor
PCA Hierarchy sq.	0.036***	
	(0.001)	
Factor Hierarchy sq		0.123***
		(0.000)
Constant	0.086*	0.085*
	(0.027)	(0.028)
Observations	136	136
R^2	0.087	0.092

p-values in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 9: Regression with PCA and Factor based hierarchy

The first column shows that the first principal component based hierarchy measure exhibits a quadratic relationship to noncompete incidence. The second column is similar just with the first factor.

A.5 Wage premium

The wage premium paid for signing a noncompete at different levels of the firm's hierarchy may be different. Below table shows that the wage premium is larger at the top of the hierarchy than at the bottom, however the relationship is insignificant. The number of observations are low and can cause the statistically insignificant result.

	(1) Bottom	(2) Top
Noncompete	-35.736	449.392
	(0.878)	(0.580)
Education	184.012*	10.162
	(0.045)	(0.932)
Supervise	-3.766	-268.977
	(0.961)	(0.138)
Short and rep	147.078	295.276
	(0.178)	(0.245)
Physical	944.904*	170.266
	(0.013)	(0.273)
Problem Solving	34.741	-508.145
	(0.737)	(0.160)
Docs Read	76.749	-215.612
	(0.503)	(0.185)
Gender	-183.964	-1224.492*
	(0.431)	(0.010)
Race	67.223	57.943
	(0.429)	(0.667)
Constant	-246.995	5448.605
	(0.713)	(0.060)
Observations	57	54
R^2	0.429	0.290

p-values in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 10: Regression for wage premium at the bottom and top of firm hierarchy

The first column displays the regression for the wage premium at the bottom of the hierarchy. There is an insignificant, but negative relationship between the wage and noncompete. The relationship is positive, but still insignificant at the top of the firm.

B Figures from simulations of the model

Figure 4: The firm profit under the optimal contract

B.1 Sophistication

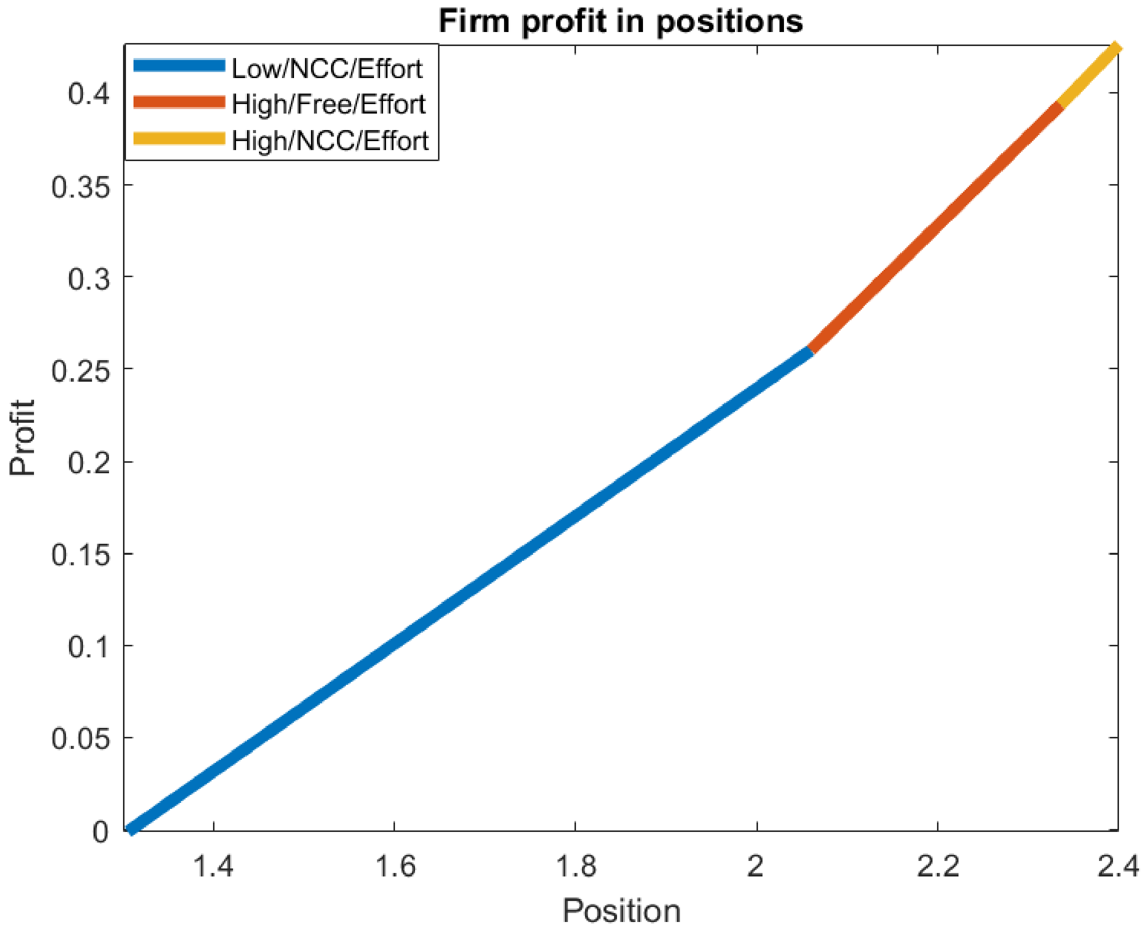

Figure 5: Profit of the firm under the different contracts

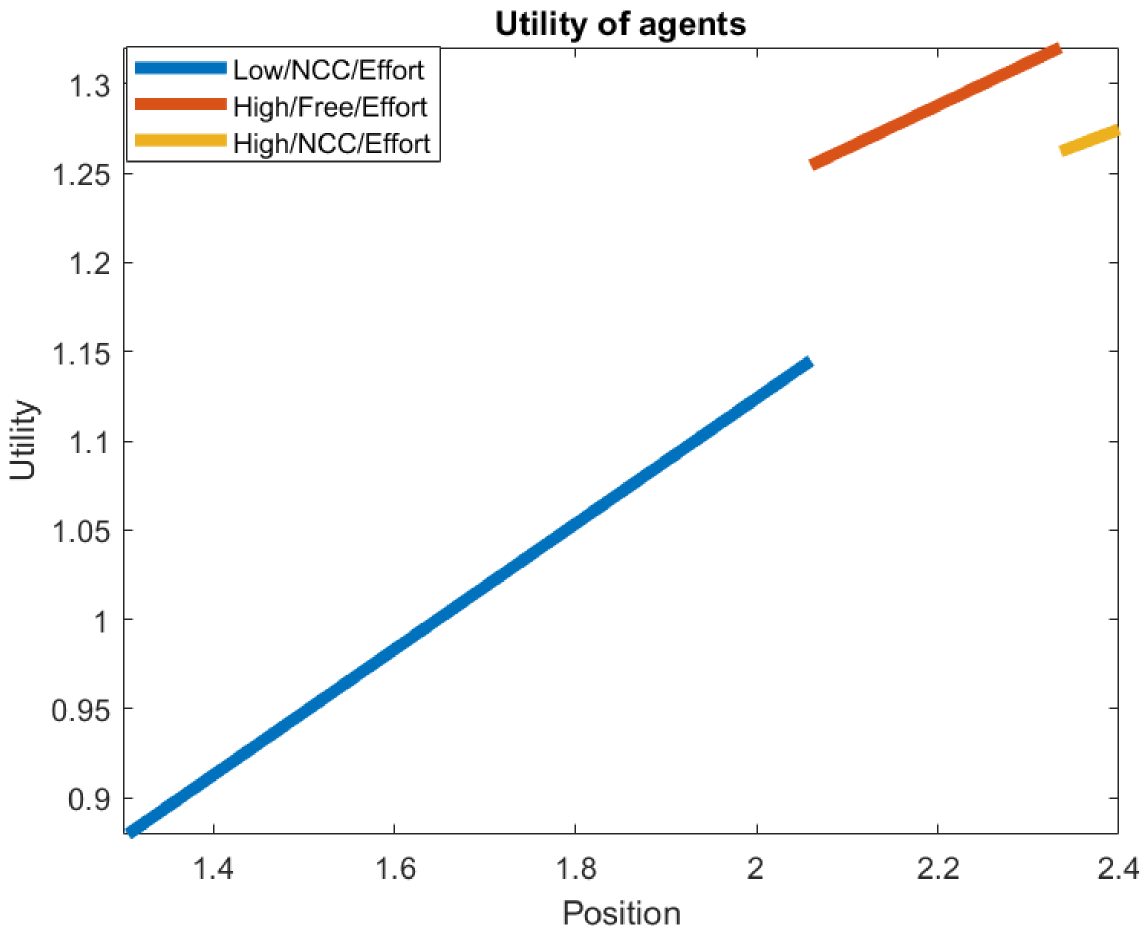

Figure 6: Utility of the agent under the different contracts

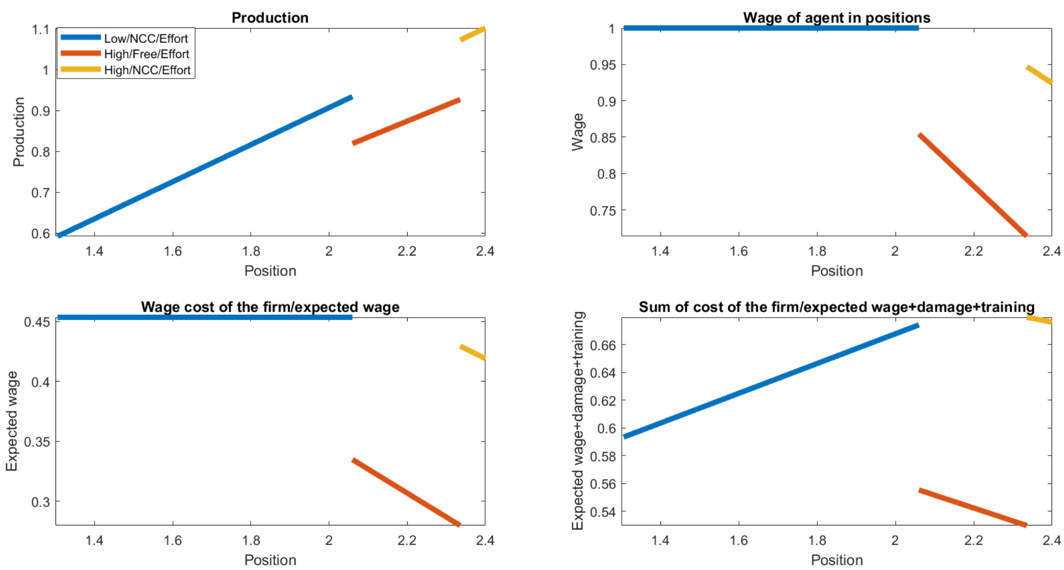

Figure 7: Production and wage costs

C Proofs

C.1 $\bar{\Delta}$

The condition on Δ is derived from the inequality

$$\pi(\theta, 1, 1, w(\theta, 1, 1, S), S) \leq \pi(\theta, 1, 1, 1, G) \tag{78}$$

leading to the condition

$$\begin{aligned} &\theta \left[-\Delta\bar{\lambda}a + \Delta(1-\bar{\lambda}(\Delta+q+p)) + \frac{(p+\Delta)(1-\bar{\lambda}(\Delta+q))\bar{\lambda}\gamma}{(1-\bar{\lambda}(q+\Delta+p)} \right] \\ &+ \frac{(p+\Delta)(1-\bar{\lambda}(\Delta+q))(1-p)(1-\bar{\lambda})}{\Delta(1-\bar{\lambda}(q+\Delta+p))} - p(1-\bar{\lambda}q) \leq 0 \end{aligned} \tag{79}$$

For small enough θ the condition holds intuitively, ie.: the firm does not offer a contract that would facilitate the effort provision as the costs (wage and potential damage) outweigh the benefit of increased probability of production. As θ increases, the condition will not hold anymore, since the damage function increases only slowly, and the linear part will dominate. However, solving for an explicit condition in closed form from above is not possible. Therefore, consider setting $\bar{\lambda} = 0$, the most restrictive noncompete where the employee can never compete.

Denote the lowest position the firm offers in equilibrium by θ_1. θ_1 under the contract $w = 1$ and $G = 1$, becomes $\theta_1(w = 1, G = 1) = \frac{p}{p-c}$, while the same lower bound under $w = w(\theta, 1, 1, S)$ and $S = 1$ is $\theta_1(w = w(\theta, 1, 1, S), S = 1) = \frac{1-p}{\Delta(p+\Delta-c)}$.There exists a set of θ's satisfying (79) if

$$\theta_1(w = 1, G = 1) < \theta_1(w = w(\theta, 1, 1, S), S = 1) \tag{80}$$

The solution to the inequality in terms of Δ is

$$\Delta < \frac{p^2 - t + \sqrt{(-p^2+c)^2 + 4p(1-p)(p-c)}}{2p} \tag{81}$$

To derive a tractable condition, however, I impose parameter restriction $p > \frac{1}{2}$, in which case $\bar{\Delta} = 1 - p - c$ satisfies (80) and serves as a tractable upper for Δ.

Furthermore, $\frac{\partial \pi(w=1,G=1) - \pi((w(\theta),S=1)}{\partial \bar{\lambda}} > 0$. The intuition is that as the employee exerts effort, the relevance of noncompete increases for the firm. Hence, decreasing the strength of the restriction shrinks the profit more when the employee exerts effort. As a result, the upper bound on $\bar{\Delta}$ lowers.

C.2 Continuous noncompete

This section shows that the solution of the model is identical with a continuous noncompete , $\lambda \in [\bar{\lambda}, 1]$, ie.: the firm chooses one of them corners for the stringency of the noncompete.

C.2.1 C_1 and C_2

Consider the profit under C_1.

$$\pi(C_1) = p(1-\lambda q)(\theta - 1) - \lambda q a\theta - t\theta \tag{82}$$

The firm profit is decreasing in λ, thus sets it to the minimum $\bar{\lambda}$ which is the most restrictive. Therefore, if the employee chooses G, the firm prefers to set noncompete as restrictive as possible.

The Lagrangian for the problem when the employee chooses S is

$$\begin{aligned} \mathcal{L}(\lambda, w) &= p(+\Delta)(1-\lambda(q+\Delta))(\theta - w) - \lambda(q+\Delta)a\theta - t\theta \\ &- \mu(\lambda q\gamma\theta + 1 - \lambda q - (p+\Delta)(1-\lambda(q+\Delta))w - (q+\Delta)\lambda\gamma\theta) \end{aligned} \tag{83}$$

The first order conditions are

$$\frac{\partial \mathcal{L}}{\lambda} = -(p+\Delta)(q+\Delta)(\theta - w) - (q+\Delta)a\theta - \mu(p+\Delta)(q+\Delta)w - (q+\Delta\gamma\theta + q\gamma\theta - q) = 0 \tag{84}$$

$$\frac{\partial \mathcal{L}}{\partial w} = -(p+\Delta)(1-\lambda(q+\Delta)) - \mu(-(p+\Delta)(1-\lambda(q+\Delta)) = 0 \tag{85}$$

Note that it follows that $\mu = 1$ and $\frac{\partial \mathcal{L}}{\lambda} = 0$ simplifies to

$$-(p+\Delta)(q+\Delta)\theta - (q+\Delta)a\theta + \Delta\gamma\theta + q = 0 \tag{86}$$

Note that the expression has no variables in it and it is satisfied if $\theta = \theta_3$

If $\theta < \theta_3$, the expression is positive yielding $\lambda = \bar{\lambda}$ as solution.

C.2.2 C_3

The Lagrangian becomes

$$\begin{aligned} \mathcal{L} &= (p+\Delta)(1-\lambda(q+\Delta))\theta - (1-\lambda(q+\Delta)w - \lambda(q+\Delta)a\theta - t\theta \\ &- \mu(\lambda q\gamma\theta + (1-\lambda q) - (1-\lambda(q+\Delta))w - \lambda(q+\Delta)\gamma\theta \end{aligned} \tag{87}$$

the first order conditons are

$$\begin{aligned} \frac{\partial \mathcal{L}}{\partial \lambda} &= -(p+\Delta)(q+\Delta)\theta + (q+\Delta)w - (q+\Delta)a\theta \\ &- \mu(q\gamma\theta - q + (q+\Delta)w - (q+\Delta)\gamma\theta = 0 \end{aligned} \tag{88}$$

$$\frac{\partial \mathcal{L}}{\partial w} = -(1-\lambda(q+\Delta)) - \mu(-(1-\lambda(q+\Delta)w)) = 0 \tag{89}$$

Therefore $\mu = 1$ and $\lambda = \bar{\lambda}$ for $\theta \geq \theta_3$. The reason for the corner solution is that the problem is linear and the constraint $(U(S=1) \geq U(G=1))$ binds.

C.3 Proof of proposition 2

Proof.

$$U(C_1,S)_L = (p+\Delta)(1-q-\Delta)+(q+\Delta)(\gamma\theta) > U(C_1,G)_L = q\gamma\theta+1-q \tag{90}$$

Leading to the condition

$$\theta > \frac{(1-p-\Delta)(1-q)}{\Delta\gamma} = \theta_{L,S} \tag{91}$$

The firm, on the other hand, knows that the employee is subject to the noncompete, thus its profit is

$$\pi_L(\theta) = (p+\Delta)(1-\bar{\lambda}(q+\Delta)(\theta-1)-\bar{\lambda}(q+\Delta)a\theta - t\theta \tag{92}$$

The minimum θ that the firm's participation constraint is satisfied is

$$\theta_{1,L} = \frac{(p+\Delta)(1-\bar{\lambda}(q-\Delta))}{(p+\Delta)(1-\bar{\lambda}(q+\Delta))-\bar{\lambda}(q+\Delta)a-t} \tag{93}$$

A sophisticated agent follows the behavior similar to the baseline model since the payoff of the agent is only changed by a constant in the competitor offer.

Taking again C_1, the payoff of the high ability agent when choosing G and S respectively gives

$$U(C_1,G)_H = \bar{\lambda}q(\gamma\theta+A)+1-q \tag{94}$$

$$U(C_1,S)_H = (p+\Delta)(1-\bar{\lambda}(q+\Delta))+\bar{\lambda}(q+\Delta)(\gamma\theta+A) \tag{95}$$

The high ability agent does not exert effort as long as θ is below the following threshold,

$$\theta(C_1) > \frac{(1-\bar{\lambda}q)-(p+\Delta)(1-\bar{\lambda}(q+\Delta))-\bar{\lambda}\Delta A}{\bar{\lambda}\Delta\gamma} = \theta(C_1)_H \tag{96}$$

Consider the most interesting case when the low ability employee invests but the high ability does not, $\theta(C_1)_L < \theta < \theta(C_1)_L$. The firm then chooses a low ability agent if

$$\pi(C_1,S)_L = (p+\Delta)(1-\bar{\lambda}(q+\Delta))(\theta-1)-\bar{\lambda}(q+\Delta)a\theta-t\theta > \pi(C_1,G)_H = p(1-\bar{\lambda}q)(A+\theta-1)-\bar{\lambda}qa\theta-t\theta \tag{97}$$

This yields the following condition on θ

$$\theta > \frac{p(1-\bar{\lambda}q)A+\Delta(1-\bar{\lambda}(q+\Delta+p))}{\Delta(1-\bar{\lambda}(q+\Delta+p))-\bar{\lambda}\Delta a} = \theta_{HG,LS} \tag{98}$$

The threshold shows the firm's tradeoff. If the high ability agent is more productive (high A), the threshold becomes higher meaning employing a high ability agent for higher θ's. On the other hand, if Δ increases, the importance of effort becomes higher and thus the threshold is lowered. Note that having a lower threshold on employing a low ability agent is also intuitive. The higher θ, the training is, the more dangerous the employee is to leave, and thus the relevance of noncompete increases. In this section I want to focus on the equilibrium in which all agents specialize, thus I restrict the range of A to be small enough such that high ability agents who do not exert effort are not hired. The minimum training such that firm's participation constraint is satisfied is $\theta_1(A) = \frac{p(1-\bar{\lambda}q)(1-A)}{p(1-\bar{\lambda}q)-\bar{\lambda}qa-t}$. Combining it with $\theta_{HG,LS}$ leads to the following restriction on A

$$\frac{p(1-\bar{\lambda}q)\Delta(1-\bar{\lambda}(q+\Delta+p+a)-p(1-\bar{\lambda}q)-\bar{\lambda}qa-t)\Delta(1-\bar{\lambda}(q+\Delta+p)}{p(1-\bar{\lambda}q)[1+p(1-\bar{\lambda}q)-\bar{\lambda}qa-t]} > A_{HG,LS} \tag{99}$$

The wage that incentivizes the high ability agent to S [39]

$$w(\theta)_H = \frac{(1-\bar{\lambda}q)-\bar{\lambda}\Delta(\gamma\theta+A)}{(p+\Delta)(1-\bar{\lambda}(q+\Delta)} \tag{100}$$

The firm chooses the low ability agent if the wage required to induce effort from a high ability employee is too high, i.e.

$$A+1 < w(\theta)_H \tag{101}$$

or

$$\theta < \frac{(1-p)(1-\bar{\lambda}q)-\bar{\lambda}\Delta A-(A+1)\Delta(1-\bar{\lambda}(q+\Delta+p))}{\bar{\lambda}\Delta\gamma} = \theta_{HS,LS} \tag{102}$$

The contract C_1 with a low ability agent is optimal, if $\exists\theta$ such that

$$\theta_{1,L} \leq \theta \leq \theta_{HS,LS} \tag{103}$$

Above condition yields to another lower bound on A.

$$A_{HS,LS} < \left[\frac{\bar{\lambda}\Delta\gamma(p+\Delta)(1-\bar{\lambda}(q+\Delta)}{(p+\Delta)(1-\bar{\lambda}(q+\Delta)-\bar{\lambda}(q+\Delta)a-t} - (1-p)(1-\bar{\lambda}q)+\Delta(1-\bar{\lambda}(q+\Delta+p))\right]\frac{1}{\Delta(1-\bar{\lambda}(q+\Delta+p-1)} \tag{104}$$

C.4 C_2

Note that this contract cannot be equilibrium with a low ability agent since the firm can impose noncompete costlessly.

The wage that induces effort from a high ability agent is

$$w(C_2,\theta)_H = \frac{1-q-\Delta\gamma\theta-(q+\Delta)A}{(p+\Delta)(1-q-\Delta)} \tag{105}$$

The threshold on θ above which employing a low ability agent is better than employing a high ability one without noncompete is

$$\theta > \frac{(p+\Delta)(1-q-\Delta)A-1+q+(q+\Delta)A+(p+\Delta)(1-\bar{\lambda}(q+\Delta))}{(1-\bar{\lambda})(q+\Delta)a-\Delta\gamma+(p+\Delta)(1-\bar{\lambda})(q+\Delta)} = \tilde{\theta} \tag{106}$$

The condition $\theta_{1,L} < \tilde{\theta}$ imposes a lower bound on A

[39] Note that I focus on the case with $w(\theta)_H < 1$ because the high ability employee is now more productive inside the industry, making it cheaper to keep her.

$$\left[\frac{(p+\Delta)(1-\bar{\lambda}(q-\Delta))}{(p+\Delta)(1-\bar{\lambda}(q+\Delta))-\bar{\lambda}(q+\Delta)a-t}(1-\bar{\lambda})(q+\Delta)a-\Delta\gamma+(p+\Delta)(1-\bar{\lambda})(q+\Delta)-(1+q+(p+\Delta)(1-\bar{\lambda}(q+\Delta))\right]$$
$$\times\frac{1}{(p+\Delta)(1-q-\Delta)+q+\Delta}=\tilde{A}>A \tag{107}$$

The lower bound on A is $\hat{A}=\min\{A_{HG,LS},A_{HS,LS},\tilde{A}\}$. The lower bound on A exists as A goes to 0 the low ability agent would dominate the high ability one because he specializes. ■

C.5 Proof of proposition 3

Proof. I divide the problem into two cases with respect to noncompete, $\lambda\geq\lambda^T$ and $\lambda<\lambda^T$. Note that the firm's problem may not yield a corner solution of λ, hence I allow the firm to set the noncompete variable continuously, $\lambda\in[\bar{\lambda},1]$.

C.5.1 $\lambda\geq\lambda^T$

First, consider the case when noncompete is mild with $\lambda\geq\lambda^T=\frac{\gamma}{(q+\Delta)(1+a)}$. I focus on wages such that $\gamma\theta>1>w$ as in the baseline case. The first line of the firm's profit is identical to the one period case. In the second period, the productive employee always stays.

$$\begin{aligned}\pi(\theta,1,0,w(\theta,S)=&(p+\Delta)(1-\lambda(q+\Delta)(\theta-w(\theta))-\lambda(q+\Delta)a\theta-t\theta\\&+(p+\Delta)(1-\lambda(q+\Delta))(\theta-\gamma\theta)\end{aligned} \tag{108}$$

The first period employee utility is identical to the one period case. In the second period the employee receives a wage $\gamma\theta$ from the firm if stayed for the second period, or receives $\gamma\theta$ if competed in the first period.

$$\begin{aligned}U(\theta,1,0,w(\theta),S)=&(p+\Delta)(1-\lambda(q+\Delta))w(\theta)+\lambda(q+\Delta)\gamma\theta\\&+(p+\Delta)(1-\lambda(q+\Delta))\gamma\theta+\lambda(q+\Delta)\gamma\theta\end{aligned} \tag{109}$$

If the employee leaves the industry in the first period, she will not receive a competitor outside offer from the industry. Thus the utility of the agent investing in generic capital takes the following form and the employee never stays with the firm.

$$U(\theta,1,0,1,G)=\lambda q\gamma\theta+1-\bar{\lambda}q+\lambda q\gamma\theta+1-\bar{\lambda}q \tag{110}$$

The problem of the firm is then

$$\max_{\lambda,w(\theta)}\pi(\theta,1,0,w(\theta,S) \tag{111}$$

s.t.

$$U(\theta,1,0,w(\theta),S)\geq U(\theta,1,0,w(\theta),G) \tag{112}$$

The Lagrangian takes the form of

$$L = \pi(\theta, 1, 0, w(\theta, S) - \mu(U(\theta, 1, 0, w(\theta), G) - U(\theta, 1, 0, w(\theta), S)) \tag{113}$$

with first order conditions.

$$\frac{\partial L}{\partial w} = -(p+\Delta)(1-\lambda(q+\Delta) - \mu(-(p+\Delta)(1-\lambda(q+\Delta)) = 0 \tag{114}$$

$$\begin{aligned}\frac{\partial L}{\partial \lambda} &= -(p+\Delta)(q+\Delta)(\theta - w(\theta) - (q+\Delta)a\theta - (p+\Delta)(q+\Delta)(\theta - \gamma\theta) \\ &- \mu(2q\gamma\theta - 2q(-((p+\Delta)(q+\Delta)w(\theta) + (q+\Delta)\gamma\theta - (p+\Delta)(q+\Delta)\gamma\theta + (q+\Delta)\gamma\theta) = 0\end{aligned} \tag{115}$$

From (114) it follows that $\mu = 1$ and thus the corresponding constraint binds. It follows that the problem is convex in λ yielding corner solution. The sign of the derivative of the profit function determines whether $\lambda = 1$ or $\lambda = \lambda^T$ is the optimal choice. Note that $\lambda = 1$ means the noncompete is not imposed, hence the interesting case for the analysis is when $\lambda = \lambda^T$. $\lambda = \lambda^T$ if

$$\theta > \frac{2q}{2\Delta\gamma - 2(p+\Delta)(q+\Delta) - a(q+\Delta)} = \theta_2^T \tag{116}$$

The corresponding wage and profit function respectively are

$$w(\theta) = \frac{2(1-\lambda^T q - \lambda^T \Delta\gamma\theta) - (p+\Delta)(1-\lambda^T(q+\Delta))\gamma\theta}{(p+\Delta)(1-\lambda^T(q+\Delta))} = w(\theta, \lambda^T) \tag{117}$$

$$\begin{aligned}\pi(\theta, 1, 0, w(\theta), S, \lambda = \lambda^T) &= (p+\Delta)(1-\lambda^T(q+\Delta))\theta - [2(1-\lambda^T q - \lambda^T\Delta)\gamma\theta) - (p+\Delta)(1-\lambda^T(q+\Delta)\gamma\theta] - \lambda^T(q+\Delta)a\theta \\ &+ (p+\Delta)(1-\lambda^T(q+\Delta)(\theta-\gamma\theta) - c\theta\end{aligned} \tag{118}$$

Importantly, the profit is a decreasing function of λ^T, hence it also decreases in γ.

C.5.2 $\lambda < \lambda^T$

If $\lambda < \lambda^T$ noncompete is so restrictive that the employee anticipates to be held up in the second period if she specializes. The firm has two strategies that may be optimal. First, the firm may offer the employee $w = 1$ and imposes the most restrictive noncompete, $\lambda = \bar{\lambda}$. The employee in turn chooses G.

The profit of the firm is

$$\pi(\theta, 1, 0, 1, G) = p(1-\bar{\lambda}q)(\theta - 1)) - \bar{\lambda}qa\theta + p(1-\bar{\lambda}q)^2(\theta - 1) - p(1-\bar{\lambda}q)\bar{\lambda}qa\theta - c\theta \tag{119}$$

The last term is the damage if the employee leaves in the second period. The utility of the employee is

$$U(\theta, 1, 0, 1, G) = \lambda q\gamma\theta + 1 - \bar{\lambda}q + (\lambda q + p(1-\lambda q)\lambda q)\gamma\theta + p(1-\lambda q)^2 + 1 - \lambda q - p(1-\lambda q) \tag{120}$$

Second, the firm may offer the wage that incentivizes the employee to choose S despite knowing the firm holds up the employee in the second period. In other words, the firm can add the second period wage to the first period wage and offer it to the employee up front. Consider a contract with $\gamma\theta > w_1(\theta) > 1$ and $w_2(\theta) = 0$ where the subscripts denote the time period. Moreover, the firm imposes the strictest noncompete, $\lambda = \bar{\lambda}$.

The utility of the employee if choosing S is

$$U(\theta, 1, 0, w_1(\theta), S) = (p+\Delta)(1-\bar{\lambda}(q+\Delta))w_1(\theta) + \bar{\lambda}(q+\Delta) + \bar{\lambda}(q+\Delta) + (p+\Delta)(1-\bar{\lambda}(q+\Delta))\bar{\lambda}(q+\Delta) \quad (121)$$

In the second period, the employee only receives an income if she competes. She either already starts the period working for the competitor or she receives the offer in the second period.

If the employee chooses G her utility is

$$U(\theta, 1, 0, w_1(\theta), G) = p(1-\bar{\lambda}q)w_1(\theta) + \bar{\lambda}q\gamma\theta + (1-p)(1-\bar{\lambda}q) + \bar{\lambda}q\gamma\theta + p(1-\bar{\lambda}q)\bar{\lambda}q\gamma\theta + (1-\bar{\lambda}q - p(1-\bar{\lambda}q)\bar{\lambda}q) \quad (122)$$

The wage to induce S is then

$$w_1(\theta) > \frac{\left(2\bar{\lambda}\Delta + \bar{\lambda}(q+\Delta)\Delta(1-\bar{\lambda}(q+\Delta+p) + p\bar{\lambda}(q+\Delta) + p(1-\bar{\lambda}q)\bar{\lambda}\Delta)\right)\gamma\theta - (1-p)(1-\bar{\lambda}q) - 1 + \bar{\lambda}q + p(1-\bar{\lambda}q)\bar{\lambda}q}{\Delta(1-\bar{\lambda}(p+q+\Delta))} \quad (123)$$

Hence, offering a high wage in the first period can solve the holdup problem. I continue the analysis when offering a high wage is not possible, for example, because the firm cannot credibly commit to it since the firm's revenue is too low. Therefore, I compare the contracts when the firm offers $= \bar{\lambda}$ and $w = 1$ to $\lambda = \lambda^T$ with $w = w(\theta, \lambda^T)$.

C.5.3 Optimal contract

The firm offers the contract that incentivizes specialization if the parameter γ is low. The firm does not hold up the employee in the second period but offers her the market wage, $w(\theta) = \gamma\theta$ as the market wage is low enough. If γ is high, however, the firm would hold up the employee. Hence the employee, who correctly anticipates the holdup, does not specialize in equilibrium.

Formally, $\pi(\theta, 1, 0, w(\theta), S, \lambda = \lambda^T)$ is decreasing in γ, while $\pi(\theta, 1, 0, w(\theta), G, \lambda = \bar{\lambda})$ is not a function of γ. Hence if γ is large enough, the firm prefers the contract with $w = 1$ and the strictest noncompte $\bar{\lambda}$. $\pi(\theta, 1, 0, w(\theta), S, \lambda = \lambda^T) \geq \pi(\theta, 1, 0, w(\theta), G, \lambda = \bar{\lambda})$ yields the condition on θ

$$\theta \geq \frac{2 - \frac{2\gamma q}{1+a} - p(1-\bar{\lambda}q)(2-\bar{\lambda}q)}{2(p+\Delta)(1-\frac{\gamma}{1+a}(1-\gamma)) - \frac{\gamma}{1+a}a + \frac{2\gamma^2\Delta}{1+a} - p(1-\bar{\lambda}q)(2-\bar{\lambda}q) + \bar{\lambda}qa + p(1-\bar{\lambda}q)\bar{\lambda}qa} = \theta_2^S \quad (124)$$

■

D Model extensions

D.1 Effort

This section compares the threshold θ_2 on the equilibrium path, from which the employee exerts effort to the socially optimal value. The friction exists in a setup without a noncompete.

The increased expected production in the industry if the employee chooses S is $\Delta\theta + (1-p)\bar{\lambda}\Delta\gamma\theta$. If the employee chooses G, the expected production in the other industry, taking the contracts as given, is $(1-p)(1-\bar{\lambda}q)$. Hence, it is socially beneficial if the employee chooses S if

$$\theta > \frac{(1-p)(1-\bar{\lambda}q)}{\Delta(1+(1-p)\bar{\lambda}\gamma)} = \theta^S \tag{125}$$

$\theta^S < \theta_2$, that is the employee chooses S at a higher threshold of θ than it is socially optimal since the employee does not endogenize all the benefits of investing into S.

D.2 Correlated production

This section relaxes the independence assumption on p and q, that is the employee is a good fit with the firm and receives the offer from the competitor, respectively.

Denote the arrival of the competitor's offer conditional on being a good fit with the firm with α, i.e.

$$\Pr(\text{Production at the firm}|\text{ No production at the competitor}) = \alpha \tag{126}$$

Consider first the profit under C_1. If the value of α is close to p, the optimal contract is similar to the independent probabilities case. The firm's profit and the firm's lower bound on positions are

$$\pi(\theta, C_1, \alpha, G) = p(\theta - \gamma\theta) - \frac{\bar{\lambda}q + \alpha(1-\bar{\lambda}q) - p}{1-p} a\theta - t\theta \tag{127}$$

$$\theta_1(\alpha) = \frac{\alpha(1-\bar{\lambda}q)}{\alpha(1-\bar{\lambda}) - \bar{\lambda}qa - t} \tag{128}$$

Under C_2, the employee chooses S. I define the new conditional probability as

$$\Pr(\text{Production at the firm}|\text{ No production at the competitor})_{|S=1} = \alpha + \Delta \tag{129}$$

Solving the model requires the same steps as with independent probabilities. The respective functions are

$$U(\theta, C_2, \alpha, S) = (\alpha+\Delta)(1-q-\Delta)w(\theta,\alpha) + (q+\Delta)\gamma\theta \tag{130}$$

$$U(\theta, C_2, \alpha, G) = q\gamma\theta + 1 - q \tag{131}$$

$$w(\theta, C_2, \alpha) = \frac{(1-q-\Delta\gamma\theta)}{(\alpha+\Delta)(1-q-\Delta)} \tag{132}$$

$$\pi(\theta, C_2, \alpha, S) = (\alpha+\Delta)(1-q-\Delta)(\theta - w(\theta,\alpha)) - (q+\Delta)a\theta - t\theta \tag{133}$$

$$U(\theta, C_3, \alpha, S) = (1-\bar{\lambda}(q+\Delta))w(\theta,\alpha) + \bar{\lambda}(q+\Delta)\gamma\theta \tag{134}$$

$$U(\theta, C_3, \alpha, G) = \bar{\lambda}q\gamma\theta + 1 - \bar{\lambda}q \tag{135}$$

$$w(C_3, \theta, \alpha) = \frac{1-\bar{\lambda}q - \bar{\lambda}\Delta\gamma\theta}{(1-\bar{\lambda}(q+\Delta))} \tag{136}$$

$$\pi(\theta, C_3, \alpha, S) = (\alpha+\Delta)(1-\bar{\lambda}(q-\Delta))\theta - (1-\bar{\lambda}(q+\Delta))w(\theta,\alpha) - \bar{\lambda}(q+\Delta)a\theta - t\theta \tag{137}$$

$$\theta_2(\alpha) = \frac{1 + \alpha\bar{\lambda}q - q - \alpha}{\Delta(1 + \gamma - a - \alpha - q) - (1 - \bar{\lambda})(a + p)q - \Delta^2} \tag{138}$$

$$\theta_3(\alpha) = \frac{q}{(\alpha + \Delta)(q + \Delta) + (q + \Delta)a - \Delta\gamma} \tag{139}$$

The interesting case is when α is small such that there is a high correlation between production at the firm and at the competitor.

D.3 Small α

The optimal contract changes if there is a high correlation between production at the firm and the occurrence of the competitor's offer, that is, if α becomes small. A high wage, $w(\theta) = \gamma\theta$, keeps the employee from leaving if he is a good fit. Denote the contract with noncompete, dismissal, and $w(\theta) = \gamma\theta$ by C_0. Without investment, the firm's profit takes the form of

$$\pi(\theta, C_0, , \alpha) = p(\theta - \gamma\theta) - \frac{\bar{\lambda}q + \alpha(1 - \bar{\lambda}q) - p}{1 - p} a\theta - t\theta \tag{140}$$

where by the law of total probability

$$\Pr(\text{Production at competitor}|\ \text{No Production at firm})_{|G=1} = \frac{\bar{\lambda}q + \alpha(1 - \bar{\lambda}q) - p}{1 - p} \tag{141}$$

$$\Pr(\text{Production at competitor}|\ \text{No Production at firm})_{|G=1} = \frac{\bar{\lambda}(q + \Delta) + (\alpha + \Delta)(1 - \bar{\lambda}(q + \Delta)) - (p + \Delta)}{1 - p - \Delta} \tag{142}$$

The higher α is, the lower the profit of the firm is under the above contract. The firm prefers a high correlation (low α) between the productions so that the employee rarely leaves to the competitor.

Remark 2. $\exists\alpha^T(\theta)$ *such that* $\forall\alpha < \alpha^T(\theta)$, C_0 *is part of the optimal contract.*

Proof. By equating the profits under C_0 and C_1 the following threshold, α^T, arises

$$\pi(C_0) \geq \pi(C_1) \iff \alpha \leq \frac{p\theta[a(1 - \bar{\lambda}q) + (1 - \gamma)(1 - p)]}{(1 - \bar{\lambda}q)[(1 + a)\theta + p(1 - \theta) - 1]} \tag{143}$$

■