Star Wars: Exclusive Talent and Collusive Outcomes in Labor Markets

Arijit Mukherjee*
Michigan State University, East Lansing, Michigan, USA

Luís Vasconcelos
Universidade Nova de Lisboa

Exclusive employment contracts and collusion on wages are alternative mechanisms that firms may use to extract surplus from highly productive workers ("stars"). Exclusive employment contracts (i.e., "covenant not to compete") are common in many industries, but the Courts often refrain from enforcing them, citing harm to workers due to restricted turnover. We analyze the interaction between these two channels of surplus extraction and argue that in the presence of collusion, enforcement of exclusive contracts can, in fact, benefit the workers: Although a strong enforcement of exclusivity restricts labor turnover, it can also hinder the firms' ability to sustain collusion in the labor market. We characterize the optimal level of enforcement and find that both perfect enforcement and no enforcement can be socially suboptimal. Moreover, a stronger enforcement can improve matching efficiency by rendering collusion unsustainable and may lead to a more equitable surplus distribution between the firms and the workers. (*JEL* J4, K21, L42, L14, M5).

1. Introduction

It is often observed that the individual performance of a particular worker (or a small group of workers) makes a disproportionately large impact on his employers profitability. The importance of such highly talented workers, or

*Department of Economics, Michigan State University. Email: arijit@msu.edu. We especially thank Mariano Selvaggi for his contributions at the earlier stages of this project. For their helpful comments, we would also like to thank Ran Abramitzky, Jay Pil Choi, Carl Davidson, Adeline Delavande, David de Meza, Nuno Garoupa, Iliyan Goergiev, José Mata, April Mitchell Franco, Luís Pinto, Guillaume Roger, Pablo Spiller (the Editor), Johan Stennek, Michael Waldman, two anonymous referees, and the seminar participants at Indian Institute of Management (Ahmedabad), Michigan State University, Rand Corporation, University of Michigan (Ross School of Business), Western Michigan University, the 2008 Annual Congress of the European Economic Association (Milan), and Econometric Society World Congress, 2010 (Shanghai). Financial support of the Fundação para a Ciência e Tecnologia under grant POCI/EGE/58934/2004 is gratefully acknowledged.

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"stars," is well recognized in many industries, such as financial services, information technology, arts and entertainment, news media, professional team sports, etc. (see, e.g., Rosen 1981).

But talent is scarce. And even a talented worker needs substantial investments in human capital to reach his full potential. So, if a firm must invest ex ante in young workers with star potential, the firm must also ensure that it extracts the surplus generated by the worker if he becomes a star ex post. Becker's (1964) classic argument is that an extraction of surplus is not feasible when all firms in the industry can compete to poach (or raid) a star worker—as competition dissipates all rents, the initial employer loses his returns on investment and, consequently, the investment incentives are muted. In order to circumvent this problem, the firms often adopt one of two policies: (a) implicitly committing to a "no poaching agreement" where all firms in the industry promise not to poach each others' star employees and (b) writing an exclusive contract, or "covenant not to compete," with the worker that (if enforced by the Court) legally prohibits the worker from accepting employment at a rival firm. The goal of our article is to highlight the interaction between these two channels of surplus extraction and to explore the extent to which the Court should enforce such exclusive employment contracts.

Evidence of collusion among employers has been frequently documented both by the popular press as well as in the Court records. For example, in the 1980s, several Major League Baseball teams in United States were alleged to have colluded on their wage offers to the top players (Gius and Hylan 1996). In the arts an entertainment industry, many of the big studios often bargain with the workers collectively as the Alliance of Motion Picture and Television Producers.[1] And more recently, the US Department of Justice has opened an investigation on whether the leading information technology firms in United States, such as Google and Apple, among others have made naked agreements not to hire each others' employees.[2]

Exclusivity clauses in employment contracts are also extremely common in many industries (see Bishara 2006; Garmaise 2009). However, legal scholars have debated extensively on the efficacy of such contracts (Gilson 1999; Bishara 2006). Indeed, different states in the United States have taken varied positions regarding the legal enforcement of such exclusivity clauses (see Malsberger 2004 for a state-by-state survey). This debate has primarily stemmed from the fact that the enforcement of exclusivity in employment contracts must face a trade-off between labor mobility (i.e., efficient matching) and human capital investment incentives (Posner et al. 2004; Bishara 2006).[3]

1. See, "Directors reach accord with Hollywood studios," by Michael Cieply and Brooks Barnes, *New York Times*, January 18, 2008.

2. See, "United States inquiry into hiring at high-tech companies," by Miguel Helft, *New York Times*, June 3, 2009.

3. In the R&D-intensive industries, such as Information Technology, the exclusivity employment clause may also work as a legal mechanism to protect trade secrecy (see Kräkel and Sliwka 2009).

We contribute to this debate by highlighting a different trade-off associated with the exclusivity enforcement. We abstract away from the question of investment incentives and focus on the alternative mechanisms—exclusive employment contracts and collusion on wages—that the firms may adopt to capture the surplus that is generated once their worker turns out to be a star.[4] The novel trade-off that we highlight is as follows: When the productivity of star workers depends on the firm-specific matching, weak enforcement of the exclusivity clause ensures efficient matching but can also make collusion easier to sustain. In other words, although weak enforcement means that a worker is "freed" more often, a free worker is less likely to benefit from a competitive labor market; market collusion may still lead to inefficient turnover and lower wage offers. The latter effect originates because weak enforcement of exclusive contracts decreases the payoff of a colluding firm on the punishment path (i.e., increases the punishment threat) should it deviate from the collusion.

We consider a model with two long-run firms, each of which hires a short-run worker in every generation. The type of a worker is a priori unknown but is revealed during the workers tenure. In each generation, exactly one of the two firms finds its worker to be a star. A firm can offer an exclusive employment contract that, if enforced by the Court, forbids the worker to switch employers in future. The firms may also collude by agreeing not to raid each other's workers. Both firms discount the future at the rate δ. We present three key results: First, we argue that the more likely the Court is to enforce an exclusivity clause, the harder it is for the firms to collude in the labor market (i.e., the minimum δ that sustains a "no-poaching" agreement between firms increases with the intensity of enforcement). The intuition behind this finding is as follows. Note that the exclusive employment contracts and collusion between firms in the labor market are substitute methods of appropriating the surplus created by star employees. In the presence of collusion, exclusivity is often immaterial because firms agree not to compete for (nonexclusive) stars in the market. But if a firm deviates from the collusive agreement, both firms enter into a punishment phase where both firms compete in wages to hire a (nonexclusive) star employee. In such a punishment phase, the exclusivity clause is highly valuable to both firms because it is the only channel through which they can extract the surplus created by the star employee. Hence, on the punishment path, both firms will necessarily offer exclusive employment contracts to the worker. Thus, a firm's punishment payoff increases when the Court is more likely to uphold the exclusivity clause (i.e., the firm is more likely to be able to

4. Consider the following example from the Portuguese soccer league (see *Jornal a Bola*, March 22, 2007). In 2000, a soccer player, Zé Tó, started a legal process against his club, U. Leiria challenging the no-compete contract that Leiria had with him for the season. The case was eventually tried in the The Supreme Court of Portugal and in 2007 the Court subsequently declared all such no-compete contracts null and void. Immediately after the verdict, all the major clubs from the two major football leagues in Portugal met and publicly announced that they would not hire any player that decided to unilaterally breach contract with his current club.

retain the rents generated by a star employee even on the punishment path). As the threat of future punishment decreases, collusion becomes harder to sustain.

Second, we characterize the socially optimal level of exclusivity enforcement. We find that both the extreme views of perfect enforcement and no enforcement can be socially suboptimal. Indeed, we obtain that the optimal enforcement level is an intermediate one and that it increases with the firms' level of reputation concerns (i.e., the discount factor δ). The intuition is simple. Because both exclusivity and collusion lower social surplus by restricting efficient matching, the socially optimal level of enforcement is the minimum level of enforcement that renders the collusion between the firms nonviable.

Finally, we argue that even when there is collusion among firms, a stronger enforcement of exclusivity clause can make the workers better off. The intuition is as follows. A stronger enforcement of the exclusivity clause has two opposing effects on the workers' expected wage. A strong enforcement makes the collusion among firms harder to sustain. So, if the firms are to collude in an environment of strict enforcement, they must leave a larger share of the surplus to the "free" stars on the collusive path (otherwise, the temptation to cheat becomes too strong, and the collusion cannot be sustained). This effect increases the wage of a free star even when the firms are colluding. But under a strong enforcement, stars are freed less often. Thus, the star's initial employer is more likely to expropriate the entire surplus created by the star. Depending on the parameter values, the former effect may dominate the latter, making the workers better off (ex ante). An important implication of this finding is that the Courts' oft-cited argument that enforcement of exclusivity clauses harms the workers may be misguided.

1.1 Related Literature

This article relates closely to the literature on collusion and the literature on exclusive employment contracts, and it attempts to bridge the two in a labor market context.

Even though there is a vast literature on collusion among firms in the product market (see Jacquemin and Slade 1989, for a survey, and Athey and Bagwell 2001, for more recent references), collusion in the labor market has received relatively less attention in the literature. An important exception is the sports industry, where several authors have studied the alleged collusion among the Major League Baseball clubs in the 1980s (Gius and Hylan 1996; Vrooman 1996). In contrast, the exclusive employment contracts have been studied extensively both by legal scholars (Rubin and Shedd 1981; Gilson 1999; Posner et al. 2004; Bishara 2006) and by labor economists (Burguet et al. 2002; Franco and Mitchell 2005; Kräkel and Sliwka 2009).[5] But the literature on exclusive employment contracts has mostly focused on the role of such contracts in

5. The labor and the law literature on exclusive employment contracts is also closely related to the exclusive contracts literature in antitrust (see Posner 1976; Aghion and Bolton 1987; Rasmusen et al. 1991; Bernheim and Whinston 1998).

fostering investments in human capital and its implications on labor mobility. The impact of the no-compete covenants on the firms' ability to collude has so far been overlooked. In this article, we attempt to fill this gap.

An article that is closely related with our work is that of Burguet et al. (2002). Burguet et al. examine the role of the no-compete clause when the firms compete for talented workers. They find that in the presence of complete information, firms set high buy-out fees to constrain the stars' mobility in order to extract the maximum rent from a more efficient rival. Similar to the literature on compensation damages for breach of contract (Aghion and Bolton 1987; Spier and Whinston 1995), exclusive rights help the worker–employer coalition to capture a larger share of the surplus gains from turnover. Burguet et al. study the link between the level of transparency about the worker's ability and the use on exclusive rights as a rent-extraction mechanism. In contrast, we focus on the effects of the legal enforcement of the exclusivity clause on the extent of collusion in the market for talent.

Also, the fact that exclusive contracts can affect collusion by influencing the firms' punishment payoff is also documented in the industrial organization literature (see Allain et al. 2009).[6] But, this literature assumes that the exclusive contracts are always enforced (a natural assumption in the product market context) and focus on the conditions under which exclusive contracts can hinder or facilitate collusion. In contrast, in a labor market context, the extent of enforcement of the exclusive contracts is under Court's discretion, and we highlight the trade-off between efficient matching and collusion that emerges with such enforcement.

The rest of the article is organized as follows: The following section presents the model and Section 3 analyzes the interaction between the enforcement of exclusive contracts and sustenance of collusion. In Section 4, we discuss the impact of exclusivity enforcement on social welfare and distribution of surplus between the workers and the firms as well as across workers with varying productivity levels. Section 5 discusses some robustness issues related to our key findings. The final section draws a conclusion.

2. The Model

Players. We consider an infinitely repeated game with two infinitely lived principals ("firms") F_1 and F_2, and a sequence of short-lived agents ("workers") who live for a "generation." In every generation t, there are two agents and each

6. However, the primary focus of the exclusive contract literature in the antitrust context is on the role of exclusivity in fostering relationship-specific investments by the contracting parties (Segal and Whinston 2000; De Meza and Selvaggi 2007). In a related article, Nocke and White (2007) investigate the role of vertical merger in fostering upstream collusion. In their model, the role of vertical merger is somewhat similar to an exclusive contract with the downstream firm and they argue that such vertical merger can hinder upstream collusion by increasing the punishment payoff of the firms.

generation has two periods.[7] At the beginning of period 1, each firm hires exactly one worker who is randomly chosen from the two. But in period 2, a worker may switch from his initial employer to the rival firm. Without loss of generality, in generation t, we denote F_i's hire in period 1 as A_{it}, $i \in \{1,2\}$.

2.1 Stage Game

The stage game is defined as the game played between the two firms and each generation of the workers (i.e., A_{1t} and A_{2t}). The stage game has two periods and can be described in terms of its five key aspects: *technology*, *contracts*, *contract enforcement*, *competition for talent*, and the *payoffs*. We elaborate below on each of these aspects.[8]

2.1.1 Technology.

We assume that period 1 is the "training" period for a young worker where no production takes place. We assume that in each generation, a firm can train at most one worker, ruling out the case where the firms compete to hire all workers in a given generation at the beginning of period 1.[9] Once a worker is trained, production takes place in the second period.[10] The productivity of a worker depends on his talent or "type." While at the beginning of period 1, both workers are a priori identical, a worker's type is publicly revealed at the beginning of period 2 (once his training is complete). Workers are of two types: star and "regular." In every generation, exactly one of the two workers becomes a star. This specification has two implications: (a) star workers are a scarce resource. In the labor market, there are more firms than star workers available for hire and (b) because a firm chooses its worker randomly, at the beginning of period 1, both firms are equally likely to employ the future star.

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7. We will denote the life span of a worker as a generation (indexed by t, $t = 1, 2, \ldots$) and a unit length of time within a generation as a "period."

8. In what follows, whenever the time dimension does not play any specific role, we will suppress the time subscript t for the clarity of exposition.

9. If firms can compete in period 1 to hire both workers, the young workers would earn the entire surplus upfront in terms of the initial wage offer. Hence, the question of surplus extraction by the firm through collusion and/or exclusive contracts becomes irrelevant. Note that the issue of competition for young workers is essentially a question of bargaining power of the young workers. Our assumption (that a firm can only train one worker in a given generation) ensures that in period 1, the entire bargaining power lies with the firm. However, this feature of the model is not necessary for our findings. As we will discuss later in Section 5.3, our findings continue to hold even if the workers possess some bargaining power when contracting with firms in period 1.

10. We do not explicitly model the exact training process in order to stay focused on our key trade-off between exclusive rights and sustenance of collusion. We simply assume that a young worker must receive "on-the-job" training in period 1 to become a productive worker in period 2. Also note that we call out the training phase of a young worker as a separate period only for the sake of expositional clarity. Because no economic decisions are made in period 1, one can simply collapse the time line for the stage game to one period and consider the training phase as the initial subperiod. However, we break up the time line in two periods to convey the idea that a young worker needs investments in human capital (though not explicitly modelled) at the beginning of his career to achieve his star potential.

In order to abstract from any potential moral hazard issue, we assume that no effort is needed for the production to take place. The productivity of a regular worker is 0 in both firms. But the productivity of a star is a priori unknown and depends on two factors: his innate quality v and a firm-specific matching factor m. We assume that $v \in [\underline{v}, \overline{v}]$ and follows a continuous distribution function $F(v)$. In every generation, at the beginning of period 2, the identity of the star along with his productivity is publicly revealed. A star of quality v produces a value of v with his initial employer but produces $v+m$ with the rival firm, where $m = \mu\ (>0)$ with probability α and $-\mu$ with probability $1-\alpha$. In other words, a star is a better match with the rival firm with probability α but is a better match with the initial employer with probability $1-\alpha$. The value of m is publicly revealed. We assume that $\underline{v} > \mu$, that is, even the lowest quality star always generates a strictly positive value regardless of the value of the matching gain m.

2.1.2 Contracts. At the beginning of period 1, F_i $(i \in \{1,2\})$ publicly offers A_{it} a take-it-or-leave-it employment contract. The contract offered by F_i is defined by a tuple (w_i, e_i), where w_i denotes the worker's wage to be paid at the end of the generation, and $e_i \in \{\text{nonexclusive, exclusive}\}$ represents the absence or presence of an exclusivity clause that forbids employment with the other firm during the worker's life span.[11]

Assumption 1. The workers are liquidity constrained.

This assumption is natural and realistic in our context because it is virtually impossible for a young worker to borrow money in the market against his unverifiable talent potential. This assumption rules out any up-front transfers from a worker to the firm.[12] Two important implications of this assumption are: (a) contracted wage $w_i \geqslant 0$ and (b) only a star worker can generate a (strictly) positive surplus for his employer.

2.1.3 Contract Enforcement. At the end of period 1, the identity of the star is publicly revealed. If the employment contract of the new star includes an exclusionary clause, he may try to get around the exclusivity provision by legally "repudiating" the contract. We assume that the star undertakes a costless legal procedure to try to be released from his exclusivity clause. We assume that even when the exclusive clause is not enforced, the firm is still contractually

11. Note that the contract specification does not allow for any "breakup" fee where an exclusive worker may void the contract by paying damage fee to the firm. However, as we will discuss later in Section 5.2, the qualitative nature of our findings continues to hold even if such breakup fee is allowed.

12. As we will elaborate in Section 3.1, the key trade-off between exclusivity enforcement and collusion disappears if the firms can extract the entire expected surplus from the worker through an up-front payment.

obliged to pay the initial wage offer w_i if the worker stays with the firm.[13] Let $p \in [0,1]$ be the probability that an exclusionary clause will be enforced by the Court of law. The enforcement probability is exogenous to the firm's decision as it depends, by and large, on the preexisting legal environment.[14]

2.1.4 Competition for Talent. If an exclusionary contract is enforced, a star worker must stay with his current employer and earn the contracted wage w_i.[15] But if a star is nonexclusive, either because his employment contract does not impose exclusivity or because the Court has voided the exclusivity clause, the worker is free to switch employer. If a nonexclusive star is available in the labor market, both firms can simultaneously make a take-it-or-leave-it offer, or "bid," for the star. We will denote the bid of F_i as b_i $(\geqslant 0)$. If a worker A_{it} accepts the rival firm's bid, he forgoes the contracted wage w_i offered by his initial employer. But if the worker stays with his initial employer, he earns $\max\{b_i, w_i\}$. The worker chooses the firm that offers him the higher payoff. We assume that when facing identical payoffs from the two firms, a worker always leaves for the more efficient firm when the firms compete but stays with the initial employer when the firms collude.[16]

2.1.5 Payoffs. We assume that both the firms and the workers are risk neutral. The payoff of F_i in generation t, say π_{it}, depends on two issues: First, whether F_i's period 1 hire, A_{it}, turns out to be the star or a regular worker and second, whether F_i employs the star in period 2. Note that F_i can employ the star in period 2 under three circumstances: (a) A_{it} is a regular worker but F_i successfully poaches the star from the rival firm, (b) A_{it} is an exclusive star, and (c) A_{it} is a nonexclusive star (i.e., either the period 1 contract was nonexclusive

13. We use this specification for analytical simplicity. However, in some cases, the Court may annul the entire contract when refusing the enforce the exclusivity clause. Our key findings continue to hold even under this setting.

14. Note that under this modeling specification, the legal process of repudiating the contract is initiated by the star worker and the bidding takes place once the star is freed from his exclusive contract. In reality, one may expect that the worker seeks to annul the exclusivity clause only when he has an offer in hand from the raiders. But even in this setting, the key economic effects we highlight in this article continue to hold. See the working paper version (Mukherjee and Vasconcelos 2010) for details.

15. This specification rules out any scope for a "transfer fee" where a raiding firm pays a compensation to the initial employer for hiring away its employee. Note that in our environment, the transfer fee is equivalent to a breakup fee that does not affect the key trade-off that we highlight in this article. We will further elaborate on this issue later in Section 5.1.

16. The assumption that the workers adopt different tie-breaking rules depending on whether the firms collude or compete is made entirely for analytical simplification. This assumption can be conceived as a limiting case of a scenario where the worker bears a job switching cost but she switches to a more efficient employer if her payoff *net* of the switching cost is the same with both firms. If there is a small switching cost (relative to the matching gains), under competition, the more efficient rival firm will outbid the inefficient initial employer. But under collusion, when both firms bid the same wage, it is strictly optimal for the worker to stay with his initial employer. The assumption above corresponds to the limiting case where the switching cost is arbitrarily small.

or the Court declined to enforce the exclusivity clause) and F_i successfully bids for him. Given that only a star worker produces a positive revenue for the firm, the firm's payoff in each of these scenarios can be derived as follows:

$$\pi_{it} = \begin{cases} -w_{it} & \text{if } A_{it} \text{ is regular and } F_i \text{ does not hire the star in period 2,} \\ -w_{it} + v_t + m_t - b_{it} & \text{if } A_{it} \text{ is regular and } F_i \text{ poaches the star in period 2,} \\ v_t - w_{it} & \text{if } A_{it} \text{ is an exclusive star,} \\ v_t - \max\{b_{it}, w_{it}\} & \text{if } A_{it} \text{ is a nonexclusive star and } F_i \text{ retains the worker,} \\ 0 & \text{if } A_{it} \text{ is a nonexclusive star and poached by the rival.} \end{cases}.$$

Finally, the payoff of A_{it} if he accepts F_i's contract offer in period 1, say u_{it}, is

$$u_{it} = \begin{cases} w_{it} & \text{if } A_{it} \text{ is an exclusive worker in period 2,} \\ \max\{b_{1t}, b_{2t}, w_{it}\} & \text{if } A_{it} \text{ is a nonexclusive worker in period 2,} \end{cases}$$

and 0 if he rejects F_i's contract.

Time line: The timing of the stage game is summarized as follows:

- Period 1.0: F_i makes a take-it-or-leave-it offer (w_i, e_i) to A_{it}. If A_{it} rejects, he gets his outside option zero. If at least one worker accepts his corresponding employer's offer, the game goes on to period 2. Otherwise, the game ends, and all players earn 0.
- Period 2.0: The identity of the star, his productivity (v) and the matching gain (m) are publicly revealed.
- Period 2.1: The star worker attempts to "repudiate" the exclusivity clause in the initial contract, if any.
- Period 2.2: Exclusive worker stays with his initial employer. A free worker may receive take-it-or-leave-it offers b_1 and b_2 from both firms and leaves for the highest bidder.
- End of period 2: Production takes place, wages (w_i and/or b_i) paid, and the game ends.

2.2 Repeated Game

The repeated game is simply the stage game repeated in every generation. We assume that both firms have a common discount factor of $\delta \in (0,1)$ per generation. So, the lifetime payoff of F_i is $\Pi_i = \sum_{t=0}^{\infty} \delta^t \pi_{it}$. Neither the firms nor the workers discount their payoffs across periods within a given generation.

2.2.1 Strategies and Equilibrium.

We will focus on pure strategies for their analytical simplicity. The strategy of firm F_i has two components. Depending on the history of the game, in every generation, F_i decides (a) the contract (w_i, e_i) offered to A_{it} and (b) the bid b_i if there is a free star employee in period 2. In contrast, the strategy of A_{it} has three components: (a) whether to accept or reject F_i's offer in period 1, (b) whether to attempt to repudiate the exclusivity clause (if any) at the end of period 1, and (c) which firm's bid to accept at the beginning of period 2 (if there are any bids).

Because we are primarily interested in the "collusive" equilibrium outcomes that permit firms to appropriate the surplus created by stars, we use Subgame Perfect Nash Equilibrium in trigger strategies as a solution concept. In the subgame, following a defection from the collusion, the firms revert back to the (static) Bertrand–Nash equilibrium of the one-shot game.

Given the above description of the model, we now highlight how the enforcement of the exclusivity clause affects the sustenance of collusion among the firms.

3. Enforcement of Exclusivity and Sustenance of Collusion

In this section, we explore the relationship between the level of enforcement of exclusive employment contracts and the firms' ability to sustain collusion in the labor market. The first step toward exploring this relationship is to characterize the solution to the stage game played between the firms and the workers in a given generation.

3.1 Optimal Contract in a Stage Game

The stage game has a unique equilibrium where both firms offer exclusive contracts with an initial wage $w_i = 0$. In what follows, we present the argument in two steps. We will first argue that under both optimal exclusive and optimal nonexclusive contracts, the initial wage is 0. Then, we will compare the firms' payoffs from the optimal exclusive contract and the optimal nonexclusive contract to show that the former always dominates.

It is clear from direct inspection of firm's payoff function, π_{it}, that it is always nonincreasing (and strictly decreasing in some cases) in the initially contracted wage w_i. Thus, a firm can benefit from a high w_i offer only if it helps the firm to keep a star worker in period 2 as firms compete in wages to hire the star.

Now, suppose F_1's hire, A_1, becomes a star. When A_1 (i.e., the star worker) is free in the market and is a better match with F_1 (i.e., $m = -\mu$) in equilibrium both firms bid $v - \mu$. So, the star remains with F_1, and F_1 earns $v - (v - \mu) = \mu$ from retaining the star.[17] So, the only case in which F_1 is unable to retain a star worker in the bidding game is when the star is free in the market and the star is a better match with the rival firm F_2 (i.e., if $m = \mu$). But in this case, F_2 can bid v and profitably raid the star. So, if F_1 attempts to set w_1 high enough to ensure no turnover, then F_1 needs to set $w_1 > v$. But with such a wage, F_1 is better off by letting the worker leave. Thus, irrespective of the presence or

17. It is worth noting that there is a continuum of equilibria in the bidding subgame where both firms place identical bids b, and b can be any value between the highest and the lowest valuation of the star in the two firms (e.g., when the initial employer is a better match, any value of b between $v - \mu$ and v can be sustained as an equilibrium of the bidding game). However, it is more natural to consider the equilibrium where no firm submits a bid that is higher than its valuation for the star. Such an equilibrium is "trembling hand perfect" in the sense that if there is a small probability that the worker may mistakenly accept the inefficient firm's bid, then the firm is strictly better off by not placing a bid that is higher than its valuation for the star. Such an equilibrium also satisfies the "market-Nash" refinement of Waldman (1984).

absence of the exclusivity clause, the firm is better off by setting $w_i = 0$. Next, we argue that an exclusive contract (with $w_i = 0$) is optimal for firms. Before proceeding, note that if the worker is of regular type, the firm's payoff from the worker is zero irrespective of whether the contract includes an exclusivity clause or not. So, to evaluate the optimality of an exclusive contract, we can focus on a firm's payoff when its first period hire becomes the star.

Consider first the payoff of an exclusive contract. Suppose F_1 offers an exclusive contract with zero wage to worker A_1 in period 1 and that A_1 becomes a star with productivity v. If exclusivity is enforced, which occurs with probability p, F_1 retains the star and earns v on him. In contrast, if exclusivity is not enforced, then both firms compete in wages. The equilibrium bids must be equal to the star's value at the firm where he is least productive. If the star is a better match with F_1 (i.e., $m = -\mu$), which occurs with probability $(1-\alpha)$, both firms bid $b_1 = b_2 = v - \mu$, and the star remains with F_1 whose profit is $v - (v - \mu) = \mu$. But if the star is a better match with the rival firm F_2 (i.e., if $m = \mu$), which occurs with probability α, then there is turnover. Both firms bid $b_1 = b_2 = v$ for the star and the star joins the more efficient firm F_2. F_1's payoff in this case is zero. Thus, F_1's payoff from a star worker with productivity v under the contract $\{w_1 = 0,\ \text{exclusive}\}$ is $\pi_1^{\mathrm{e}}(v) = pv + (1-p)(1-\alpha)\mu$.

What is the payoff from a nonexclusive contract? This is equivalent to the payoff from an exclusive contract where the probability of contract enforcement is zero. Thus, the payoff from a nonexclusive star with productivity v is $\pi_1^{\mathrm{ne}}(v) = (1-\alpha)\mu$. Becaues $\mathbb{E}(v) > \mu$, $\mathbb{E}\pi_1^{\mathrm{e}}(v) > \mathbb{E}\pi_1^{\mathrm{ne}}(v)$. Hence, the optimal contract in the stage game is an exclusive contract with wage $w_1 = 0$. As firms are ex ante symmetric, in equilibrium, both firms offer contract $\{w_i = 0,$ exclusive$\}$ and earn $\mathbb{E}\pi_1^{\mathrm{e}}(v)$ on a star worker. Moreover, the payoff of F_i in case A_i becomes a regular worker is $(1-p)\alpha\mu$ (i.e., only the expected payoff from successfully raiding F_2's star worker). Thus, the expected payoff of a firm F_i in equilibrium is

$$\pi_*^{\mathrm{e}} = \frac{1}{2}\mathbb{E}\pi_i^{\mathrm{e}}(v) + \frac{1}{2}(1-p)\alpha\mu = \frac{1}{2}[p\mathbb{E}(v) + (1-p)\mu]. \tag{1}$$

Two issues are important to note in this context. First, in our model, the firms do not incur any additional cost of writing exclusive contracts due to the liquidity constraint on the workers.[18] More importantly, the trade-off between

18. To see this, note that the liquidity constraint implies that F_i must leave rents to the worker. Indeed, in the second period, a worker is expected to earn $\frac{1}{2}(1-p)(v-(1-\alpha)\mu)$ under the optimal exclusive contract and $\frac{1}{2}(v-(1-\alpha)\mu)$ under the optimal nonexclusive contract. Thus, if there were no liquidity constraints on the worker, the firm could extract an up-front payment of $\frac{1}{2}(1-p)(v-(1-\alpha)\mu)$ while offering exclusive contracts and, even a larger amount, $\frac{1}{2}(v-(1-\alpha)\mu)$ while offering contracts with no exclusivity clause. This means that in the absence of liquidity constraints on the worker, there is a cost of eliciting exclusivity from a worker, that is equal to $\frac{1}{2}p(v-(1-\alpha)\mu)$, which is precisely the difference between the up-front payments the firm could charge under unexclusivity and nonexclusivity. However, the liquidity constraint on the worker mutes this effect by ruling out any up-front payments.

exclusivity enforcement and collusion is relevant *only* when the firms cannot extract the value of a worker up front. If up-front payments from the workers at the contracting stage are feasible, the firms can appropriate the expected surplus through a suitable (signing-up) fee. Therefore, neither collusion nor exclusive contracts are necessary to extract surplus. As the gains from collusion evaporate, exclusivity no longer plays any role on the firms' ability to sustain collusion. Note that this is why the liquidity constraint assumption is important in our model. The firms cannot impose a sign-up fee to extract surplus up front precisely because the liquidity constraints are binding for the workers.

Second, the equilibrium in the static game is informative about the role of exclusivity enforcement in the absence of employer collusion. In an environment, where employer collusion is exogenously infeasible, the equilibrium in the repeated game is one where the stage game equilibrium is repeated in every period. So, in such an environment, the degree of enforcement of the noncompete clause has no impact on the nature of the equilibrium—that is, the firms continue to offer exclusive contracts with zero wage. Moreover, the question of optimal enforcement becomes straightforward: The Court should never enforce such a contract because enforcement necessarily reduces total surplus as it thwarts efficient turnover without generating any surplus enhancing effect. As we will see below, in our model, the surplus enhancing effect of such contract enforcement stems from the fact that it can break up employers' collusion. Thus, in an environment with no collusion, the benefit of enforcing an exclusive contract disappears. In such as setting, the enforcement of exclusivity merely increases the share the surplus retained by the firms. But, if one considers a richer model where the firms' incentives for investments in human capital is explicitly considered, it might be optimal to enforce exclusive contracts with a positive probability even in absence of employers' collusion so as to protect the firms' investment incentives. We will further elaborate on this issue at the end of this section.

3.2 Collusive Equilibrium in the Infinitely Repeated Game

Having characterized the optimal contract in the static game, we now investigate the repeated game where the two firms may tacitly agree not to compete for a free star in the labor market. More specifically, we look at collusive equilibria where F_1 refrains from poaching a free star who was initially hired by F_2, and vice versa. We call this equilibria no-poaching (collusive) equilibria. Technically, in a no-poaching equilibrium, firms implicitly agree on a wage—the collusive wage—to be paid to a free star. So, a firm may still make a job offer to a free star who was initially hired by the rival, but the wage in such an offer will never exceed the collusive wage and therefore will be insufficient to attract the star. A deviation occurs if a firm offers a wage that exceeds the collusive wage, attracting the star initially hired by the rival firm. In what follows, we will also analyze the "optimal" no-poaching collusive equilibrium of this game from the firms' perspective. That is, we will analyze the no-poaching collusive equilibrium that is associated with the lowest sustainable collusive wage offered to a free star.[19]

First, consider the punishment payoff of the firm—that is, the firm's payoff if it deviates from the collusion. Under trigger strategies, following any deviation both firms revert back to playing the static Nash equilibrium of the stage game in every generation. Thus, from equation (1), one obtains that the continuation value of a firm when they play the static Nash equilibrium in every generation is (recall that $w_i = 0$ in the stage game equilibrium):

$$\underline{\tilde{\Pi}} = \frac{\delta}{1-\delta}\pi^{e}_{*} = \frac{\delta}{1-\delta}\frac{1}{2}[p\mathbb{E}v + (1-p)\mu]. \tag{2}$$

Note that $\underline{\tilde{\Pi}}$ is increasing in p. That is, a stronger enforcement of the exclusivity clause increases the payoff of the firm on the punishment path. As we will see below, this effect will have an important implication for the sustenance of the collusion.

Next, we analyze the payoff of the firm on the collusive path of the optimal no-poaching equilibrium. Here, the heterogeneity in a star's productivity introduces an important issue. When the star's productivity varies across generations, so do a colluding firm's gains from deviation. Therefore, if the firms attempt to collude on a uniform collusive wage regardless of the quality of the star, such a collusion may not be sustainable. But instead, the firms can attempt to collude on a wage schedule $w^{C}(v)$ that varies with the quality of the star.[20] Such a wage schedule can ensure that the firms' gains from deviation do not vary with the star's quality, and consequently, can facilitate collusion. We will elaborate on the derivation of the equilibrium $w^{C}(v)$ shortly.

In order to analyze the optimal no-poaching equilibrium, we need to compare the firms' payoff from the optimal no-poaching equilibrium *with* and *without* the exclusivity clause. First, consider the case where the firms offer exclusive contracts on the collusive path. Similar to the case of static game, under the optimal exclusive contract the firms offer zero wages when hiring each generation of workers in period 1. In period 2, under collusion, the firms refrain from competing for the star and both firms bid a collusive wage $w^{C}(v)$. As a consequence, the star always stays with his initial employer. Now, suppose in a given generation, F_1's hire turns out to be a star with quality v. The payoff of

19. We use the term optimal to qualify the equilibrium from the point of view of the colluding firms (and not in the sense of "social optimal"). Also note that by analyzing only the no-poaching equilibria, we focus on a specific class of collusive equilibria. In Section 5.1, we discuss the implications for the analysis of considering other types of collusive equilibria, in particular, equilibria that allow for implicit agreements to reallocate stars between the firms.

20. Two issues are important to note in regard to this formulation. First, as we will see below, in equilibrium, w^{C} also depends on the other parameters of the model, p, μ, and δ. However, for expositional clarity, we will suppress these arguments of w^{C} function except in cases where they are directly relevant for the discussion. Second, one may also consider a more general formulation where the firms collude on wages that not only depend on v but also depend on the realized matching gain m. As we discuss in the working paper version (Mukherjee and Vasconcelos 2010), the qualitative nature of our results continues to hold even under this general formulation. In this section, we abstract away from this general formulation for expositional clarity.

F_1 in this generation is $pv+(1-p)[v-w^C(v)]$ and the payoff of the rival firm F_2 is 0. As in every generation, both firms are equally likely to hire the future star, the continuation payoff of the two firms in a collusive equilibrium is

$$\tilde{\Pi}^C = \frac{\delta}{1-\delta}\frac{1}{2}\mathbb{E}[v-(1-p)w^C(v)]. \tag{3}$$

Now, for a given wage schedule $w^C(v)$, collusion is sustained if a firm's continuation payoff in equilibrium is at least as large as its payoff from the most profitable deviation. For any given v, the maximum immediate gains from deviation occur when the star is a better match with the rival firm, that is, when $m=\mu$. In that case, the rival firm gains $v+\mu-w^C(v)$ when it deviates from the collusive path by making a take-it-or-leave-it offer that outbids the initial employer by a penny. So, a collusive wage schedule $w^C(v)$ is sustainable in equilibrium if and only if $\tilde{\Pi}^C \geqslant [v+\mu-w^C(v)]+\underline{\tilde{\Pi}}$ for all v; that is,

$$\frac{\delta}{1-\delta}\frac{1}{2}(1-p)\mathbb{E}[v-\mu-w^C(v)] \geqslant \sup_v[v+\mu-w^C(v)]. \tag{4}$$

Thus, for a given δ, when the firms use exclusive contracts, collusion can be sustained if there exists a wage schedule $w^C(v)$ that satisfies the above condition. Because we are interested in the optimal no-poaching equilibrium, $w^C(v)$ is simply the minimum wage the firms must bid for a free star of quality v such that the condition equation (4) is satisfied.

The analysis for the case where the firms do not use exclusive contracts on the collusive path is similar. In this case, the firms' payoff on the collusive path is $\delta\mathbb{E}[v-w^C(v)]/2(1-\delta)$, and a collusive outcome can be sustained as long as there exists a $w^C(v)$ schedule that satisfies the following "no deviation" constraint:

$$\frac{\delta}{1-\delta}\frac{1}{2}\mathbb{E}[(1-p)(v-\mu)-w^C(v)] \geqslant \sup_v[v+\mu-w^C(v)]. \tag{5}$$

Note that for a given $w^C(v)$, a firm's payoff on the collusive path in the absence of any exclusive contract is less than its payoff when exclusive contracts are offered. Moreover, a given collusive wage schedule w^C is easier to sustain when firms use exclusive contracts on the collusive path (i.e., the condition (4) is weaker than the condition (5)).

The following proposition suggests that the firms can collude in equilibrium as long as δ is sufficiently large, and the firms will always prefer to write exclusive contracts even on the collusive path.

Proposition 1. Given $p\in[0,1)$, there exists a value of δ, say $\tilde{\delta}(p)$, such that a no-poaching equilibrium exists if and only if $\delta \geqslant \tilde{\delta}(p)$. Moreover, in the optimal no-poaching equilibrium, in every generation, in period 1, the firms offer an exclusive contract with zero wage; and in period 2, firms bid $\tilde{w}^C(v)$ for a free star of productivity v, where

$$\tilde{w}^C(v) = \begin{cases} 0 & \text{if } v < v^*, \\ v-v^* & \text{if } v \geqslant v^*, \end{cases}$$

and $v^* \in (\underline{v}, \overline{v}]$ depends on the density function F (for v) and the parameters p, μ, and δ.

Proposition 2. The cutoff value $\tilde{\delta}(p)$ is increasing in p.

Propositions 1 and 2 have several important implications. First, they capture the key trade-off between exclusivity enforcement and collusion: As the probability of enforcement (p) increases, collusion becomes harder to sustain. The intuition behind this finding is as follows. Here, an increase in p has two effects. As discussed earlier, an increase in p increases a firm's punishment payoff. Thus, firms need to be more patient in order to sustain a collusion. But, there is also a countervailing effect. The level of enforcement (p) also increases the firms' payoffs on the collusive path, and collusion becomes easier to sustain. However, the former effect dominates because the marginal effect of enforcement on the firms' payoffs is higher in the punishment phase than under collusion. Under the punishment phase, the firms have to pay the free stars their competitive wage whenever the exclusivity is not enforced. But under collusion, the firms have to pay the collusive wage $w^{C}(v)(< v - \mu)$ only if the exclusivity clause is not enforced. Thus, the marginal impact of p on the punishment payoff is higher than its impact on collusive payoff.

Second, even under collusion, a free star may get to keep a share of the surplus. Note that in the optimal no-poaching equilibrium, a free star below a productivity threshold earns 0, but above this productivity threshold, the collusive wage $\tilde{w}^{C}(v)$ is positive and increasing in the star's productivity. The intuition behind this finding is simple. As discussed before, the gains from deviation increase with the quality of the star. If firms attempt to collude on a fixed wage, firms may honor this agreement when the star is of low productivity, but they may be tempted to renege when the star is of high productivity (because there is more to be gained by deviating). One way to get around this problem is to set the fixed wage high enough so that even for the highest productivity star, a deviation is unprofitable. But such an agreement might be unprofitable for the firm at the first place because it leaves too much surplus with the worker and too little for the colluding firms. Instead, the firms are better off by colluding on a wage schedule that is (weakly) increasing in the productivity of the star. By doing so, the firms ensure that the gains from deviation do not become too large even when the star is of the highest quality. Consequently, collusion becomes easier to sustain.[21] The collusive wage schedule also has important implications for the surplus allocation between the worker and the firms. We will revisit this issue in the following section.

Finally, Proposition 1 also indicates why a firm would always prefer to write an exclusive contract. As discussed above, even the colluding firms must leave a share of the total surplus with a free star. So, if exclusivity is enforced, the initial employer of the star appropriates an additional surplus $\tilde{w}^{C}(v)$ that would have gone to the worker in the absence of exclusivity. Thus, as long as the

21. This observation is reminiscent of Rotemberg and Saloner (1986) who discuss a result in similar spirit in the context of price fixing in the product markets.

probability of enforcement is positive, firms are ex ante strictly better off by offering exclusive contracts even on the collusive path. Clearly, this observation holds even if there is a transaction cost of writing exclusive contracts, as long as such a cost is not too large.

We conclude this section by revisiting the issue of human capital investment by the firms in their workers. How would our analysis change if we consider that firms can invest in workers during period 1 and that investment affects the worker's productivity in period 2 in the event he becomes a star? Two issues are worth noting here. First, in the absence of collusion, the higher is the enforcement level of exclusivity, the higher is a firm's investment in the worker. This result, which follows directly from Segal and Whinston (2000), stems from the fact that with higher enforcement of exclusivity, the firms are more protected from competition for their workers, appropriate more of the surplus that the workers generate, and therefore appropriate more of the marginal gains from the investments. In other words, noncompete clause can increase the firms' investment incentives by alleviating potential hold-up threats. Second, for the same level of enforcement, firms invest more under collusion than in the absence of it. This is because, similar to case of higher enforcement of exclusivity, when firms collude in the labor market, they appropriate more of the surplus generated by the workers than when they compete.

4. Implications for Welfare and Distribution of Surplus

4.1 Welfare Implications and Optimal Enforcement

The enforcement of exclusivity has important welfare implications. In what follows, we take the "joint surplus" per generation, say S, that the two firms and the two workers together produce in a given generation as our measure of social welfare. In any generation, the joint surplus is maximized when the star worker works for the firm where he is a better match. Note that both collusion and exclusive contracts reduce the joint surplus by restricting efficient turnover. Consequently, a high rate of exclusivity enforcement affects the social welfare in two opposing ways: (a) it directly restricts turnover because a star is less likely to be able to free himself from the exclusivity clause and (b) it indirectly facilitates the turnover of a free star by hindering collusion in the labor market.

The socially optimal level of enforcement is the one that maximizes the joint surplus by balancing the trade-off between restricting turnover and hindering collusion. The following proposition further elaborates on this issue.

Proposition 3. The joint surplus per generation (S) as a function of the likelihood of exclusivity enforcement (p) is given as follows: for $\delta < \tilde{\delta}(0)$, $S = \mathbb{E}v + (1-p)\alpha\mu$, and for $\delta \geqslant \tilde{\delta}(0)$,

$$S = \begin{cases} \mathbb{E}v & \text{if } p < \tilde{p} \\ \mathbb{E}v + (1-p)\alpha\mu & \text{if } p \geqslant \tilde{p}, \end{cases}$$

where the cutoff value $\tilde{p}$ increases with δ and decreases with μ.

Recall that for $\delta < \tilde{\delta}(0)$, collusion is not feasible regardless of the level of exclusivity enforcement. Thus, there is always efficient turnover for a free star, and a higher p only reduces the probability that a worker would be able to void his exclusivity clause and switch to the better matched employer. Consequently, the joint surplus is maximized when the Court never enforces an exclusive contract. But if $\delta \geqslant \tilde{\delta}(0)$, the level of exclusivity enforcement does affect the firms' ability to sustain collusion. For values of p below a threshold, say $\tilde{p}$, collusion is sustainable, and the joint surplus is at its lowest. But collusion breaks down once p crosses this threshold, and a free star can move to the rival firm whenever he is more productive with the rival. Thus, the joint surplus increases. However, if p is above the threshold $\tilde{p}$, a further increase in p has no additional effect on collusion and merely reduces the likelihood that a star would be able to repudiate his exclusivity clause. As a result, p only restricts turnover and the joint surplus starts to decrease with p. Thus, the optimal enforcement is the minimum enforcement level that renders any collusion infeasible (i.e., $\tilde{p}$).

Furthermore, note that the higher is δ the easier it is for the firms to sustain a collusion (for a given p). Thus, when δ is high, a stronger enforcement of exclusive contracts is necessary to break up collusion. In contrast, as μ increases so does the foregone matching gains under collusion. Thus, collusion becomes harder to sustain and, therefore, even a weaker enforcement of exclusivity can make collusion infeasible. So, the minimum p that breaks up a collusion $(\tilde{p})$ increases with δ but decreases with μ.

The discussion above is summarized in the corollary to Proposition 3 as given below.

Corollary 1. For $\delta < \tilde{\delta}(0)$, it is socially optimal not to enforce the exclusive contracts. Otherwise, the optimal enforcement is the minimum enforcement level that renders any collusion infeasible. Moreover, the optimal enforcement level increases with δ and decreases with μ.

How could the Court implement the optimal policy? Note that the probability of enforcement (p) can be interpreted as the share of the star's value that the initial employer expects to retain by offering an exclusivity clause. So, an intermediate value of p reflects the case where the Court allows the firm to retain only a faction of the star's value through the use of the exclusive contracts. Corollary 1 suggests that if δ is low enough, the Court should not enforce any exclusive contract. Otherwise, the Court should choose a level of enforcement (p) that balances the matching gains from turnover with the risk of facilitating labor market collusion. The Court can implement such an intermediate value of p by requiring the employer to offer some specific considerations to the worker in exchange of the exclusivity provision. A smaller p represents a more generous consideration; for example, the Court may enforce the exclusivity clause only if it is effective over a short time span or in a narrow geographical area.[22]

22. See Garmaise (2009) and Malsberger (2004) for a discussion on how different states of United States have adopted different standard on what constitutes a reasonable consideration that the employer must offer to the workers in exchange of an exclusive agreement.

4.2 Implications for Allocation of Surplus

Another question related to the issue of optimal exclusivity enforcement is the following: how does the enforcement of exclusivity affect the allocation of surplus between the star worker and the two firms? As Proposition 1 highlights, in the presence of firm-specific matching gains and heterogeneity among the stars' productivity, the firms may not be able to retain the entire surplus produced by a free star. The allocation of surplus depends on the stars' equilibrium wages along the (optimal) no-poaching equilibrium. Therefore, in order to investigate the role of exclusivity enforcement on surplus allocation, we first need to study the impact of p on the collusive wage schedule w^{C}. In what follows, we denote the w^{C} function as $w^{\mathrm{C}}(v;p)$, and the associated productivity cutoff level as $v^*(p)$ in order to explicitly recognize their dependence on p.

Proposition 4. The wage schedule associated with the optimal no-poaching equilibrium, $w^{\mathrm{C}}(v;p)$, is increasing in p and $v^*(p)$ is decreasing in p.

Proposition 4 suggests that a star's wage (under collusion) increases as exclusivity is more tightly enforced by the Court.[23] The argument is as follows. When the level of enforcement of exclusive contracts increases, the future punishments on the deviants become less severe. Thus, collusion becomes more difficult to sustain. In order to sustain optimal collusive equilibria, firms must therefore permit high-ability stars to earn higher wages and content themselves with lower profits. In that way, neither firm finds it profitable to deviate from the agreement.

Proposition 4 also allows us to explore what happens to the expected discounted payoffs to stars and the firms as the probability of enforcement changes. That free stars of relatively high ability earn higher equilibrium wages when p goes up implies that they may actually gain from tighter enforcement of exclusivity clauses. The flip side, of course, is that the stars are less likely to become free. The following proposition summarizes our finding.

Proposition 5. Consider the optimal no-poaching equilibrium. As the probability of enforcement increases from p_0 to p_1, the payoff to all workers with $v \in [\underline{v}, v^*(p_1)]$ remains the same, but the payoff to all workers with $v \in (v^*(p_1), \overline{v}]$ changes in the following fashion: Either all workers with $v \in (v^*(p_1), \overline{v}]$ are better off or there exists $\widetilde{v} \in (v^*(p_1), \overline{v}]$ such that all workers with $v \in (v^*(p_1), \widetilde{v})$ are better off, whereas all workers with $v \in (\widetilde{v}, \overline{v}]$ are worse off. Moreover, the firms' expected payoff may decrease as p increases.

There are two important implications of Proposition 5: First, our finding is contrary to the commonly held view that exclusivity enforcement harms the workers and favors the employers. We argue that when collusion among

23. In fact, as shown in the Proof of Proposition 4, w^{C} strictly increases in p for $v \geqslant v^*$, and v^* strictly decreases in p as long as $v^* \in (\underline{v}, \overline{v})$.

firms is a concern, exactly the opposite can be true. Second, the changes in the enforcement level need not have the same impact on the well-being of all stars. A shift in the legal environment toward stricter exclusivity enforcement may induce a redistribution of expected surplus from top stars to stars of relatively low ability.

The intuition behind this finding is as follows: When p rises, there are two opposite forces at work: (a) a larger fraction of the surplus created in the market accrues to the colluding firms because the stars are freed less often and (b) collusion is harder to sustain; it leads to a (weakly) higher collusive wage schedule w^C and lower expected profits for the colluding firms. The interaction between these two effects ultimately determines whether the firms and the star workers lose or gain from a change in the enforcement level. For example, consider a relatively low value of v such that the collusive wage of a free star, $w^C(v)$, is low. In such a scenario, as p increases, the marginal loss from the decreasing likelihood of becoming free is low (which is simply equal to $w^C(v)$), and therefore, the second effect of increased collusive wage may dominate. Consequently, the stars are better off when the enforcement likelihood increases. In contrast, when v is high, the colluding firms need to offer premium wage to the free stars. Therefore, the marginal loss from being free in the market less often is high. This loss may be large enough to offset any marginal gains from the increase in the collusive wage. In this case, the first effect dominates, and the star workers are worse off in a heightened enforcement regime.

5. Discussion

The model we have used above offers some important insights on the optimal enforcement of exclusivity clauses and its welfare implications. Nevertheless, our model abstracts away from several issues that are not only interesting from a technical point of view but may also be empirically relevant. This section discusses the implications of some of these issues on our findings.

5.1 Pareto Improving Reallocation of Star Workers

Recall that in our model, under both collusion and no-compete clause, a star worker stays with his initial employer even if he is better matched with the potential raider. However, one might assume that a firm may actually prefer to have turnover when turnover is jointly profitable for the firm and the raider. For example, if the star is more productive with the raider, the firm may let the worker leave for the raider but charge a transfer fee from the raiding firm. If the star is under a no-complete contract, such transfer fee can be a part of the contract renegotiation. And under collusion, the better matched firm may “poach” the star by outbidding the initial employer and compensate the employer by offering a side payment. More generally, under collusion the firms may agree on a more sophisticated bidding behavior where, heuristically speaking, the more productive firm always bids the collusive wage plus a penny to lure away the star. If firms are symmetric (i.e., in every generation, both firms are equally likely to be the better matched firm for the star) both firms earn more profit under this type of collusion as they retain the gains from efficient turnover.

One might be interested to know whether the findings of this article extend to such an environment. Indeed, the qualitative nature of all our findings, except those on efficiency, continues to hold. Analogous to our discussion in Section 3.2, even with transfer payments and/or collusion with efficient turnover a stronger enforcement of no-compete clause continues to increase a firm's punishment payoff more than it increases the firm's equilibrium payoff. So, a strong enforcement makes collusion harder to sustain. By the same token, a stronger enforcement may still shift the distribution of surplus in favor of the workers. But note that if we allow for a renegotiation of the no-compete contract (between the two firms), the allocation of the star worker will always be efficient. Consequently, the enforcement of exclusive contracts will not affect the aggregate social surplus and the question of optimal enforcement is no longer relevant in such a setting. Similarly, if turnover is efficient even under collusion, collusion does not lead to any loss of surplus. Thus, in such an environment, it is optimal not to enforce exclusivity—an enforcement does not improve efficiency under collusion but merely restricts turnover.

However, it is important to note that in reality, both contract renegotiation and collusion with efficient turnover have their own sets of implementation problems. For example, an efficient renegotiation need not take place if the size of the matching gains is not publicly known. Also the firms may not form a collusion with side payments because the payment trails may make the collusion vulnerable to antitrust scrutiny. More importantly, in absence of side payments, a collusive agreement that allows for efficient turnover is harder to sustain if the firms are asymmetric; that is, when some firms are consistently more likely to be a better match for the star (i.e., more efficient). Thus, one may expect the efficiency issues to continue to play an important role in determining the optimal enforcement (of a no-compete contract) in a broad range of labor market environments.

5.2 Exclusive Employment Contracts with Breakup Fee

In the presence of firm-specific matching gains, the firms may prefer to offer a contract that allows the worker to switch jobs after paying a breakup fee rather than an exclusive contract that outright prohibits job switching (see Aghion and Bolton 1987 for a similar argument in a product market context). What happens if such breakup fees are allowed?

The qualitative nature of our results continue to hold even if we allow for such breakup fee. The intuition is as follows: Suppose that a contract is specified as (w, P), where, as before, w is the initial wage offer to be paid at the end of the second period, and P is a breakup fee/penalty that the worker has to pay to the initial employer if she decides to join the rival firm at the beginning of period 2. As before, under collusion, the firms agree not to hire each other's stars and offer collusive wage $w^C(v)$ (both when the contract is enforced and when it is not). Note that under contracts with breakup provision, the punishment payoff of the firms will be higher (compared to the case of pure exclusive contracts) because the firms will be able to capture some of the matching gains. So, under this class of contracts, for a given level of contract enforcement, collusion is harder to sustain. However, the firms' punishment payoff continues to increase in the level of enforcement, which implies that the stronger is the enforcement, the harder it is to sustain collusion. Because collusion erodes matching efficiency, the optimal enforcement is the minimum level of enforcement that makes collusion infeasible. Moreover, because collusion is harder to sustain when p increases, the optimal collusive wage $w^{C}(v)$ is increasing in p. Consequently, a stronger enforcement may ensure a higher share of the surplus for the workers.

An important issue to note is that when exclusive contracts allow for breakup (with penalty), the efficiency implications for collusion and full enforcement of exclusive contracts are no longer the same. Collusion necessarily destroys all matching gains that could have been obtained from efficient turnover, whereas full enforcement of contracts with breakup fee does leave room for efficient turnover. But, in general, with full enforcement there will be some matching inefficiency because in the presence of a breakup fee, it may not be optimal for a star with lower productivity (i.e., low v) to switch jobs even when she is more productive with the rival firm.

5.3 Workers' Bargaining Power in Period 1

We have assumed that the firm has the entire bargaining power with the worker in period 1 of every generation. However, this assumption is not essential for our findings. To see this, consider the following modification to the model: Suppose that the firm can extract (subject to the worker's liquidity constraint) at most a fixed share λ ($\leqslant 1$) of the value generated by the coalition of the firm and its (young) worker, whereas the rest (i.e., $1-\lambda$) is earned by the worker. We argue that the key economic effects we highlight in this article continue to hold even if the worker has considerable bargaining power as long as the collusion is sustainable.

As before, first consider the stage game. The value generated by the coalition of the firm and its young worker (under the exclusive contract with $w_i = 0$) is $\frac{1}{2}\mathbb{E}v$.[24] Now, recall that in the stage game, the firm's expected payoff from its period 1 worker (also under the exclusive contract with $w_i = 0$) is $\frac{1}{2}[p\mathbb{E}v + (1-p)(1-\alpha)\mu]$. So, as long as λ is large enough so that

$$\lambda\frac{1}{2}\mathbb{E}v > \frac{1}{2}[p\mathbb{E}v + (1-p)(1-\alpha)\mu], \tag{6}$$

24. This value is the difference between their joint payoff if they start an employment relationship in period 1 and their joint payoff if they do not (i.e., their disagreement payoff). Note that although the worker's disagreement payoff is 0 (worker's outside option), the firm's disagreement payoff includes the possibility that the firm maybe able to raid a star worker in period 2 from its rival.

one obtains the same stage game payoff as in our original model. When equation (6) holds, the worker's liquidity constraint is binding and the firm is able to appropriate only $\frac{1}{2}[p\mathbb{E}v+(1-p)(1-\alpha)\mu]$ amount out of the total surplus generated by employing the worker. Therefore, in this case, the worker's bargaining power makes no difference to the analysis because the worker's liquidity constraint already ensures that the worker gets to keep a share of the value. Hence, the firm's stage game payoff is the same as given in equation (1) above (i.e., $\frac{1}{2}[p\mathbb{E}v+(1-p)\mu]$). In contrast, if λ is low enough so that equation (6) does not hold, the firm's payoff is $\lambda\frac{1}{2}\mathbb{E}v+\frac{1}{2}(1-p)\alpha\mu$.

Next, consider the payoffs on the collusive path. The value generated by the coalition of the firm and its young worker is also $\frac{1}{2}\mathbb{E}v$. Moreover, recall that on the collusive path, the firm's expected payoff from its period 1 worker under an exclusive contract with $w_i=0$ is $\frac{1}{2}\mathbb{E}[v-(1-p)w^C(v)]$. So, as long as λ is large enough so that

$$\lambda\frac{1}{2}\mathbb{E}v>\frac{1}{2}\mathbb{E}[pv+(1-p)(v-w^C(v))], \tag{7}$$

one obtains the same collusive path payoff as in our original model (i.e., the firm's payoff on the collusive path is $\frac{1}{2}\mathbb{E}[v-(1-p)w^C(v)]$). As discussed above, this is because the worker's liquidity constraint is binding when equation (7) holds. In contrast, if λ is low enough so that equation (7) does not hold, the firm's payoff is simply $\lambda\frac{1}{2}\mathbb{E}v$.

So, we can conclude the following: If the worker's bargaining power is such that equations (6) and (7) hold, then all our results continue to hold. Moreover, if λ is such that equation (6) holds but equation (7) is violated, then the collusion payoff does not depend on exclusivity enforcement (p), whereas the punishment payoff increases with stronger exclusivity enforcement. Thus, in this case, the qualitative nature of our results also holds. Finally, in cases where equation (6) is violated, the firms' payoffs are higher under competition than under collusion (irrespective of whether equation (7) holds or not). In such cases, the trade-off we study here becomes irrelevant because firms prefer competition to collusion, and, as a consequence, collusion is not sustainable.

5.4 Implications for Product Market Interaction

The firms that compete in the labor market are likely to interact in the product market as well. In such an environment, the enforcement of exclusivity clause can also affect the firms' product market interaction. In fact, a strong enforcement of exclusive employment contracts also hinders the firms' anti-competitive behavior in the product market.

For example, suppose that the firms colluding in the labor market also collude in the product market. To keep the analysis simple, assume that there is no firm-specific matching gains (i.e., $\mu=0$). Under competition in the product market, the profit from a star worker of productivity v is v but the profit from a regular worker is 0. In contrast, under collusion in the product market, let the profit of a firm from a star worker of productivity v be $\pi^c(v)$ $(>v)$ and that from a regular worker be $\pi^c(0)$ (>0). Finally, assume that in period 2 of every generation, the firms set the labor market wages and product market price simultaneously. In this setting, there are two relevant ways of deviation for the colluding firms. First, the firm that initially hired the star may deviate in the product market. Let $\pi^d(v)$ be the associated gains from deviation. So, similar to equation (5), the no-deviation constraint for the firm boils down to $\frac{\delta}{1-\delta}\frac{1}{2}\mathbb{E}[\pi^c(v)-(1-p)w^C(v)+\pi^c(0)-pv] \geqslant \sup_v[\pi^d(v)-\pi^c(v)]$. Second, the firm that initially hires the regular worker deviates in both the labor and the product market by poaching the star and charging the profit maximizing price conditional on hiring the star worker (this set up is similar to the multi-market contact environment studied by Bernheim and Whinston 1990). Let $\pi^d_*(v)$ be associated gains from deviation. In this case, the no-deviation constraint for the firm is $\frac{\delta}{1-\delta}\frac{1}{2}\mathbb{E}[\pi^c(v)-(1-p)w^C(v)+\pi^c(0)-pv] \geqslant \sup_v[\pi^d_*(v)-w^C(v)-\pi^c(0)]$. Because under collusion $\mathbb{E}w^C(v) < \mathbb{E}v$ (else, there is no gains from colluding), a higher p makes both of the above no-deviation constraints become more binding. That is, a stronger enforcement makes collusion harder to sustain—both in the labor market as well as in the product market.

6. Conclusion

In this article, we offer a stylized model of the labor market for highly talented workers or “stars”. We highlight a scenario where employers groom talented young workers under the threat of having their star employees subsequently poached by the rival firms. In such an environment, firms may adopt one of two channels of surplus extraction from their future star employees: Exclusive employment contracts and collusion among employers that forbids poaching each others’ workers. The key effect we highlight in this article emanates from the interplay of these two channels of surplus extraction.

We argue that a stricter legal enforcement of exclusive employment contracts may hinder collusive behavior among firms that compete to hire scarce talent in the labor market. This effect has important implications for the optimal enforcement of exclusive contracts and for the distribution of surplus between firms and workers. We find that it is socially optimal to enforce the exclusive employment contracts up to the extent that is needed to render collusion infeasible. Moreover, a stronger enforcement of such contracts can shift the distribution of surplus in favor of the workers. These findings suggest that neither of the extreme policies of zero enforcement and full enforcement is optimal and they also call into question the oft-cited views of the Court that the enforcement of exclusivity contracts hurts the workers’ interest.

Appendix

This appendix contains the proofs omitted in the text.

Proof of Proposition 1. We start by showing that given $p < 1$ and parameters μ, $\underline{v}$, and $\bar{v}$, there exists $\widetilde{\delta}(p)$ such that a collusive equilibrium is sustainable if and only if $\delta \geqslant \widetilde{\delta}(p)$. We do this in the following three major steps.

Step 1.1. For $\delta \simeq 0$, no wage schedule is sustainable. When $\delta \simeq 0$, the left-hand side of equation (4) is close to 0. Hence, a wage schedule $w^C(\cdot)$ satisfies equation (4) only if $w^C(v) \simeq v+u, \forall v \in [\underline{v}, \overline{v}]$. But for such $w^C(v)$, the left-hand side of equation (4) is negative, implying that equation (4) is violated.

Step 1.2. For $\delta \simeq 1$, wage schedule $w^C(v) = 0, \forall v \in [\underline{v}, \overline{v}]$, is sustainable. First, observe that when $w^C(v) = 0, \forall v \in [\underline{v}, \overline{v}]$, equation (4) is equivalent to $[\delta/(1-\delta)](1-p)/2 \geqslant (\overline{v}+\mu)/(\mathbb{E}v-\mu)$. Next, observe that $\mathbb{E}v > \underline{v} > \mu$, which implies that the right-hand side of the above inequality is finite. Finally, note that $\lim_{\delta\to 1}(\delta/1-\delta) = +\infty$.

Step 1.3. If $w^C(\cdot)$ is sustainable when $\delta = \delta_0$, then it is also sustainable when $\delta = \delta_1$, with $\delta_1 > \delta_0$. This follows by direct observation of equation (4).

The fact that in the most profitable collusive equilibrium firms offer an exclusive contract with zero wage is trivial. Simply note that firms gain nothing by committing a positive wage in period 1. Similarly, firms do not lose anything by offering an exclusive contract. Next, we show that in the most profitable collusive equilibrium firms bid $\tilde{w}^C(v)$ (as defined in the statement of the proposition) for a free star. This is done by using a fixed point argument. Fix the left-hand side of equation (4) and call it z. Given z, $w^C(\cdot)$ is optimal if and only if, for each $v \in [\underline{v}, \overline{v}]$, $w^C(v)$ is the lowest (nonnegative) value such that $z \geqslant v+\mu-w^C(v)$. That is, $w^C(v) = 0$ if $z \geqslant v+\mu$, and $w^C(v) = v+\mu-z$ if otherwise.

The remainder of the proof is established in the following steps.

Step 2.1. If $[\delta/(1-\delta)](1-p)/2 \geqslant (\overline{v}+\mu)/(\mathbb{E}v-\mu)$, then optimal schedule is $w^C(v) = 0, \forall v \in [\underline{v}, \overline{v}]$. As shown above, this wage schedule is sustainable in this case. Clearly, if this wage schedule is sustainable, then it is the most profitable. In the definition of $\widetilde{w}^C(v)$ in statement of the proposition, this corresponds to the case where $v^* = \overline{v}$.

Step 2.2. If $(\underline{v}+\mu)/(\underline{v}-\mu) \leqslant [\delta/(1-\delta)](1-p)/2 < (\overline{v}+\mu)/(\mathbb{E}v-\mu)$, then the optimal wage schedule is given by $\widetilde{w}^C(v)$ with $v^* \in (\underline{v}, \overline{v})$. Given z, let $\widehat{v}$ denote the maximum type of star such that wage zero can be sustained. That is, $\widehat{v}$ is such that

$$\widehat{v}+\mu = z. \tag{A1}$$

The optimal wage schedule must specify $w^C(v) = 0$ if $v \leqslant \widehat{v}$ and

$$v+\mu-w(v) = z \tag{A2}$$

if $v > \widehat{v}$. But given such schedule, the left-hand side of equation (4) is determined. Thus, $w^C(v)$ as defined above is indeed optimal if it induces a left-hand side of equation (4) that is identical to z. That is, we need to show that there is a fixed point. Define,

$$Z(\widehat{v}) = \frac{1}{2}\frac{\delta}{1-\delta}(1-p)\left[\int_{\underline{v}}^{\widehat{v}}(v-\mu)\mathrm{d}F(v) + (1-F(\widehat{v}))(\widehat{v}-\mu)\right].$$

$Z(\widehat{v})$ is the left-hand side of equation (4) given wage schedule with cutoff $\widehat{v}$. The second term inside the square brackets is obtained by using equations (A1) and (A2) to obtain $w^C(v) = v-\widehat{v}$, and then noting that $v-\mu-w^C(v) = \widehat{v}-\mu$. To find the fixed point, we use equation (A1) and $Z(\widehat{v})$ to define

$h(\widehat{v}) = \widehat{v} + \mu - Z(\widehat{v})$ and look for a zero of this function. Note that $h(\underline{v}) = \underline{v} + \mu - \frac{1}{2}\frac{\delta}{1-\delta}(1-p)(\underline{v} - \mu) \leqslant 0$ and $h(\overline{v}) = \overline{v} + \mu - \frac{1}{2}\frac{\delta}{1-\delta}(1-p)(\mathbb{E}v - \mu) > 0$, where the inequalities follow from the fact that in this step, we focus on the case where $(\underline{v} + \mu)/(\underline{v} - \mu) \leqslant [\delta/(1-\delta)](1-p)/2 < (\overline{v} + \mu)/(\mathbb{E}v - \mu)$. Continuity of h immediately implies that h has a zero in $[\underline{v}, \overline{v})$. v^* in the definition of $\widetilde{w}^{C}(v)$ is the largest zero of h in $[\underline{v}, \overline{v})$. Note that $v^* > \underline{v}$ even if $h(\underline{v}) = 0$. This is because $h'(\underline{v}) = 1 - \delta/(1-\delta)(1-p)/2 < 0$, where the inequality follows from the fact that $1 < (\underline{v} + \mu)/(\underline{v} - \mu) \leqslant [\delta/(1-\delta)](1-p)/2$.

Step 2.3. If $1 < [\delta/(1-\delta)](1-p)/2 < (\underline{v} + \mu)/(\underline{v} - \mu)$, the optimal wage schedule if it exists is given by $\widetilde{w}^{C}(v)$ with $v^* \in (\underline{v}, \overline{v})$. The analysis developed in the previous step applies here. In this case, $h(\underline{v}) > 0$ and as before $h'(\underline{v}) < 0$. Although a zero of h is not guaranteed, $h'(\underline{v}) < 0$ implies that if it exists, then it is larger than $\underline{v}$.

Step 2.4. If $[\delta/(1-\delta)](1-p)/2 < 1$, no collusion is sustainable.

In this case, h is an increasing function. Because $h(\underline{v}) > 0$, h has no zero. So if there is a sustainable collusion wage, it must satisfy $v + \mu - w^{C}(v) = z$ for all v. This implies that $w^{C}(v) = v + \mu - z$. But given this wage, we can get the right-hand side of equation (4). Define

$$\widetilde{Z}(z) = \frac{1}{2}\frac{\delta}{1-\delta}(1-p)\mathbb{E}(z - 2\mu) = \frac{1}{2}\frac{\delta}{1-\delta}(1-p)(z - 2\mu).$$

Again, a fixed point must exist. So we need to find z such that $\widetilde{Z}(z) = z$. Because $[\delta/(1-\delta)](1-p)/2 < 1$, it is clear that such a $z > 0$ does not exist, meaning that collusion is not sustainable.

In all the cases, considered in each of the above steps, when collusion is sustainable, the form of the most profitable collusive wage is as specified in the proposition. □

Proof of Proposition 2. We can write equation (4) as

$$\rho\mathbb{E}[v - \mu - w^{C}(v)] \geqslant \sup_{v}[v + \mu - w^{C}(v)], \tag{A3}$$

where $\rho = [\delta/(1-\delta)](1-p)/2$. We next prove that there exists $\widetilde{\rho} > 0$ such that collusion is feasible if and only if $\rho \geqslant \widetilde{\rho}$. This result follows immediately from the following three facts. First, no wage schedule $w^{C}(\cdot)$ can satisfy equation (A3) if $\rho \simeq 0$. This follows from Step 2.4 of the Proof of Proposition 1 or by applying a reasoning analogous to that in Step 1.1 in that proof. Second, for $\rho \geqslant (\overline{v} + \mu)/(\mathbb{E}v - \mu)$, wage schedule $w^{C}(v) = 0, \forall v \in [\underline{v}, \overline{v}]$, satisfies equation (A3). This follows from Step 1.2 in the Proof of Proposition 1. Third, if a wage schedule $w^{C}(\cdot)$ satisfies equation (A3) when $\rho = \rho_0$, then it also satisfies equation (A3) when $\rho = \rho_1$, with $\rho_1 \geqslant \rho_0$. This follows from direct inspection of equation (A3).

Having established the existence of $\widetilde{\rho}$, it is clear that collusion is sustainable if and only if $[\delta/(1-\delta)](1-p)/2 \geqslant \widetilde{\rho}$, or equivalently, $\delta \geqslant 2\widetilde{\rho}/(2\widetilde{\rho} + 1 - p)$ and $p < 1$. From this, it follows immediately that (a) collusion is never sustainable if $\delta < \lim_{p\to 0}[2\widetilde{\rho}/(2\widetilde{\rho} + 1 - p)] = 2\widetilde{\rho}/(2\widetilde{\rho} + 1)$, which is $\widetilde{\delta}(0)$ and

(b) when $\delta > 2\widetilde{\rho}/(2\widetilde{\rho}+1)$, the minimal delta that sustains collusion $\widetilde{\delta}(p)$ is increasing in p. □

Proof of Proposition 3. In each period, total surplus S corresponds to the production by the star worker. A star of type v produces v if he stays with the initial employer and produces an extra μ if he joins a better matched employer. When firms collude, a star always stays with the initial employer. So $S = \mathbb{E}v$. When collusion is not sustainable, the star switches to a better matched employer if there is one and exclusivity is not enforced. This event occurs with probability $(1-p)\alpha$. So, when firms do not collude, $S = \mathbb{E}v + (1-p)\alpha\mu$. Now, note that for $\delta < \widetilde{\delta}(0)$, collusion is never sustainable. For $\delta \geqslant \widetilde{\delta}(0)$, collusion is sustainable if and only if $\delta \geqslant \widetilde{\delta}(p)$. Because $\widetilde{\delta}(p)$ is increasing in p, this implies that when $\delta \geqslant \widetilde{\delta}(0)$, there exists $\widetilde{p}$ such that collusion is sustainable if and only if $p \leqslant \widetilde{p}$. Finally, because $\widetilde{\delta}(p)$ is increasing in p, the cutoff $\widetilde{p}$ increases with δ. Moreover, because (a) everything else constant the left-hand side of equation (4) decreases with μ and the right-hand side of equation (4) increases with μ and (b) by definition of $\widetilde{p}$, when $p = \widetilde{p}$, for any wage schedule $w^C(\cdot)$, either equation (4) is violated or holds with equality, then $\widetilde{p}$ necessarily decreases with μ. □

Proof of Proposition 4. Suppose that $\delta > \widetilde{\delta}(0)$, so that a collusive equilibrium exists for some values of p. Let $\mathbb{P} \subseteq [0,1]$ denote the set of values of p for which a collusive equilibrium exists and $p_0, p_1 \in \mathbb{P}$ such that $p_1 > p_0$.

As a preliminary result, we start by showing that

$$\frac{\delta}{1-\delta}\frac{1}{2}(1-p_0)\mathbb{E}[v-\mu-w^C(v;p_0)] > \frac{\delta}{1-\delta}\frac{1}{2}(1-p_1)\mathbb{E}[v-\mu-w^C(v;p_1)]. \tag{A4}$$

By optimality of $w^C(v;p_0)$, $w^C(v;p_0)$ maximizes $\mathbb{E}[v-\mu-w^C(v)]$ among all the wage schedules $w^C(\cdot)$ that satisfy equation (4) when $p = p_0$. Similarly, $w^C(v;p_1)$ maximizes $\mathbb{E}[v-\mu-w^C(v)]$ among all the wage schedules $w^C(\cdot)$ that satisfy equation (4) when $p = p_1$. This, together with the fact that if a wage schedule satisfies equation (4) when $p = p_1$, then it necessarily satisfies equation (4) when $p = p_0$, immediately implies that $\mathbb{E}[v-\mu-w^C(v;p_0)] \geqslant \mathbb{E}[v-\mu-w^C(v;p_1)]$. The inequality in equation (A4) follows trivially from this and the fact that $p_1 > p_0$.

We next show that $w^C(v;p)$ is increasing in p. That is, we show that $w^C(v;p_1) \leqslant w^C(v;p_0), \forall v \in [\underline{v},\overline{v}]$. Take an arbitrary $v_0 \in [\underline{v},\overline{v}]$. Suppose first that $w^C(v_0;p_0) = 0$. The result is trivial in this case: $w^C(v_0;p_1) \geqslant w^C(v_0;p_0) = 0$ simply because wages must be nonnegative. Suppose now that $w^C(v_0;p_0) > 0$. Because $w^C(v;p_0)$ is the most profitable collusive equilibrium and $w^C(v_0;p_0) > 0$, the no cheating condition $\tilde{\Pi}^C - \tilde{\Pi} \geqslant [v+\mu-w^C(v;p_0)]$ must bind for $v = v_0$. That is,

$$\frac{\delta}{1-\delta}\frac{1}{2}(1-p_0)\mathbb{E}[v-\mu-w^C(v;p_0)] = v_0+\mu-w^C(v_0;p_0). \tag{A5}$$

Because $w^{\mathrm{C}}(v;p_1)$ is sustainable by definition, $\tilde{\Pi}^{\mathrm{C}}-\tilde{\Pi}\geqslant[v_0+\mu-w^{\mathrm{C}}(v_0;p_1)]$. Using this no-cheating condition together with equations (A4) and (A5), we can write $v_0+\mu-w^{\mathrm{C}}(v_0;p_0)=\frac{\delta}{1-\delta}\frac{1}{2}(1-p_0)\mathbb{E}[v-\mu-w^{\mathrm{C}}(v;p_0)]>\frac{\delta}{1-\delta}\frac{1}{2}(1-p_1)\mathbb{E}[v-\mu-w^{\mathrm{C}}(v;p_1)]\geqslant v_0+\mu-w^{\mathrm{C}}(v_0;p_1)$, which implies that $w^{\mathrm{C}}(v_0;p_0)<w^{\mathrm{C}}(v_0;p_1)$. This completes the proof that $w^{\mathrm{C}}(v;p)$ is increasing in p.

We next show that $v^*(p)$ is decreasing in p. We do so by showing that $v^*(p_1)\leqslant v^*(p_0)$. If $v^*(p_0)=\bar{v}$, the result is trivial. So, suppose that $v^*(p_0)<\bar{v}$. By construction, $v^*(p_0)$ is the lowest value of v for which a collusive wage of zero is sustainable when $p=p_0$. Because $v^*(p_0)<\bar{v}$, this implies that

$$\frac{\delta}{1-\delta}\frac{1}{2}(1-p_0)\mathbb{E}[v-\mu-w^{\mathrm{C}}(v;p_0)]=v^*(p_0)+\mu. \tag{A6}$$

Using equations (A6), (A4), and the fact that when $p=p_1$ the no-cheating condition $\tilde{\Pi}^{\mathrm{C}}-\tilde{\Pi}\geqslant[v^*(p_1)+\mu]$ must be satisfied, we can write $v^*(p_0)+\mu=\frac{\delta}{1-\delta}\frac{1}{2}(1-p_0)\times\mathbb{E}[v-\mu-w^{\mathrm{C}}(v;p_0)]>\frac{\delta}{1-\delta}\frac{1}{2}(1-p_1)\mathbb{E}[v-\mu-w^{\mathrm{C}}(v;p_1)]\geqslant v^*(p_1)+\mu$, which implies that $v^*(p_0)>v^*(p_1)$. □

Proof of Proposition 5. Suppose that $\delta>\widetilde{\delta}(0)$, so that a collusive equilibrium exists for some values of p. Let $\mathbb{P}\subseteq[0,1]$ denote the set of values of p for which a collusive equilibrium exists and $p_0,p_1\in\mathbb{P}$ such that $p_1>p_0$.

We start by analyzing how workers' (stars) expected payoffs change with an increase of p from p_0 to p_1. Suppose first that $v^*(p_0)=\bar{v}$. Clearly, in this case, all workers' expected payoffs (weakly) increase, as $w^{\mathrm{C}}(v;p_0)=0$, $\forall v\in[\underline{v},\bar{v}]$, and wages must be nonnegative. Suppose now that $v^*(p_0)<\bar{v}$. Workers of productivity $v\in[\underline{v},v^*(p_1)]$ remain the same, as $w^{\mathrm{C}}(v;p_0)=w^{\mathrm{C}}(v;p_1)=0$, $\forall v\in[\underline{v},v^*(p_1)]$. Workers of productivity $v\in(v^*(p_1),v^*(p_0)]$ are strictly better off, as $w^{\mathrm{C}}(v;p_0)=0$ and $w^{\mathrm{C}}(v;p_1)=v-v^*(p_1)>0$, $\forall v\in(v^*(p_1),v^*(p_0)]$. Consider now the case of workers of productivity $v\in(v^*(p_0),\bar{v}]$. The change in the payoff of such a worker with productivity v, when p increases from p_0 to p_1, is $(1-p_1)w^{\mathrm{C}}(v;p_1)-(1-p_0)w^{\mathrm{C}}(v;p_0)$ and can be written as

$$(1-p_1)[v^*(p_0)-v^*(p_1)]-(p_1-p_0)[v-v^*(p_0)]. \tag{A7}$$

Clearly, for $v\simeq v^*(p_0)$ (and $v>v^*(p_0)$), equation (A7) is positivebecause $v^*(p_0)-v^*(p_1)>0$ and $p_1<1$ (recall that for $p_1=1$ a collusive equilibrium does not exist). If equation (A7) is also positive for $v=\bar{v}$, then all workers are better off. If equation (A7) is negative for $v=\bar{v}$, then by continuity of equation (A7) in v, there exists $\widetilde{v}\in(v^*(p_0),\bar{v})$ such that the payoffs of workers with productivity $v\in(v^*(p_0),\widetilde{v})$ increase when p increases from p_0 to p_1 and the payoffs of workers with productivity $v\in(\widetilde{v},\bar{v})$ decrease when p increases from p_0 to p_1.

Finally, to observe that there are cases in which firms' expected payoffs fall when the enforcement level increases, suppose p_0 is such that $v^*(p_0)$ is smaller than $\bar{v}$ but sufficiently close to it so that $\widetilde{v}=\bar{v}$. If p increases to p_1, workers with ability $v\geqslant v^*(p_0)$ are better off, whereas workers with ability $v<v^*(p_0)$ are either better off or remain the same. Thus, because some types of workers are

better off and no type of worker is worse off, firms' expected payoffs must decrease. □

References

Aghion, P., and P. Bolton. 1987. "Contracts as a Barrier to Entry," 77 *American Economic Review* 388–401.

Allain, M., C. Chambolley, and C. Christin. 2009. *Downstream Competition, Exclusive Dealing and Upstream Collusion*. Mimeo. CNRS, Ecole Polytechnique, Paris, France.

Athey, S., and K. Bagwell. 2001. "Optimal Collusion with Private Information," 32 *RAND Journal of Economics* 428–65.

Becker, G. 1964. *Human Capital*. Chicago, IL: University of Chicago Press.

Bernheim, B., and M. Whinston. 1990. "Multimarket Contact and Collusive Behavior," 21 *RAND Journal of Economics* 1–26.

———. 1998. "Exclusive Dealing," 106 *Journal of Political Economy* 64–103.

Bishara, N. 2006. "Covenants not to Compete in a Knowledge Economy: Balancing Innovation from Employee Mobility Against Legal Protection for Human Capital Investment," 27 *Berkeley Journal of Employment & Labor Law* 289–325.

Burguet, R., R. Caminal, and C. Matutes. 2002. "Golden Cages for Showy Birds: Optimal Switching Costs in Labor Contracts," 46 *European Economic Review* 1153–85.

De Meza, D., and M. Selvaggi. 2007. "Exclusive Contracts Foster Relationship-Specific Investment," 38 *RAND Journal of Economics* 85–97.

Franco, A., and M. Mitchell. 2005. *Covenants not to Compete, Labor Mobility, and Industry Dynamics*. Mimeo, University of Iowa.

Garmaise, M. 2009. *Ties that Truly Bind: Non-competition Agreements, Executive Compensation and Firm Investment*. Mimeo, UCLA Anderson School of Management.

Gilson, R. 1999. "The Legal Infrastructure of High Technology Industrial Districts: Silicon Valley, Route 128, and Covenants not to Compete," 74 *New York University Law Review* 575–629.

Gius, M., and T. Hylan. 1996. "An Interperiod Analysis of the Salary Impact of Structural Changes in Major League Baseball: Evidence from Panel Data," in J. Fizel, L. Hadley, and E. Gustafson, eds., *Baseball Economics: Current Research*. Westport, CT: Greenwood Praeger.

Jacquemin, A., and M. Slade. 1989. "Cartels, Collusion, and Horizontal Merger," in R. Schmalensee and R. Willig, eds., *Handbook of Industrial Organization*, Vol. 1. North Holland, The Netherlands: Elsevier.

Kräkel, M., and D. Sliwka. 2009 "Should You Allow Your Agent to Become Your Competitor? On Non-compete Agreement in Employment Contracts," 50 *International Economic Review* 117–41.

Malsberger, B. 2004. *Covenants not to Compete: A State-by-State Survey*. Washington, DC: BNA Books.

Mukherjee, A., and L. Vasconcelos. 2010. "Star Wars: Exclusive Talent and Collusive Outcomes in Labor Markets" Working Paper, Universidade Nova de Lisboa.

Nocke, V., and L. White. 2007. "Do Vertical Mergers Facilitate Upstream Collusion?" 97 *American Economic Review* 1321–39.

Posner, E., A. Triantis, and G. Triantis. 2004. "Investing in Human Capital: The Efficiency of Covenants Not to Compete." Olin Working Paper No. 137, University of Chicago Law & Economics.

Posner, R. 1976. *Antitrust Law: An Economic Perspective*. Chicago, IL: University of Chicago Press.

Rasmusen, E., M. Ramseyer, and J. Wiley. 1991. "Naked Exclusion," 81 *American Economic Review* 1137–45.

Rosen, S. 1981. "The Economic of Superstars," 71 *American Economic Review* 845–58.

Rotemberg, J., and G. Saloner. 1986. "A Supergame-Theoretic Model of Price Wars during Booms," 76 *American Economic Review* 390–407.

Rubin, P., and P. Shedd. 1981. "Human Capital and Covenants not to Compete," 10 *Journal of Legal Studies* 93–110.

Segal, I., and Whinston, M. D. 2000. “Exclusive Contracts and Protection of Investments,” 31 *RAND Journal of Economics* 603–33.

Spier, K., and M. Whinston. 1995. “On the Efficiency of Privately Stipulated Damages for Breach of Contract: Entry Barriers, Reliance, and Renegotiation,” 26 RAND Journal of Economics 180–202.

Vrooman, J. 1996. “The Baseball Players’ Labor Market Reconsidered,” 63 *Southern Economic Journal* 339–60.

Waldman, M. 1984. “Job Assignments, Signalling, and Efficiency Job Assignments, Signalling, and Efficiency,” 15 *RAND Journal of Economics* 255–67.