The Impact of a Spinoff on the Parent Firm: A Model of Double Adverse Selection with Correlated Types*

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Abstract

A principal and her worker's type is correlated via the principal's screening ability (a high ability principal is more likely to hire a high ability worker). The firm's stage payoff depends upon the worker's reputation. This paper provides a new explanation for how a spinoff (firm formed when a worker leaves to set up her own firm) can be beneficial for the parent firm. The key idea is that in any market with sufficiently high worker attrition, a firm's future payoff depends crucially on the belief about the principal's ability to recruit good workers repeatedly. I show that spinoffs are more likely to be formed by high ability workers. Due to the correlation in types, this result implies that spinoff formation can provide a positive signal about the principal's type. I further show that there exists an equilibrium which explains a previously unexplained empirical finding - spinoff formation can hurt the parent firm in the short run, but be beneficial over a longer run. My results have policy implications for non-compete covenants. (JEL codes - L14, L26, M13, D81, D02)

Keywords - Spinoffs, Reputation, Signalling, Parent firm, Adverse Selection, Correlated Types

"At the end of the day you bet on people, not on strategies." - Lawrence Bossidy

"First-rate people hire first-rate people, second-rate people hire third-rate people." - Leo Rosten

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1 Introduction

Employees can leave their current employer to set up a firm of their own. A firm formed in this manner is called a spinoff and the firm from which it spawns is called the parent firm[1]. For the most part, the literature on spinoffs has concentrated on the negative impact of spinoffs on their parent firms (Phillips (2002), Agarwal et al. (2016), Wezel et al. (2006)). The standard reasons include revenue deterioration because of a loss of talent and an increase in competition.

In recent years, however, there have been papers which point out that spinoffs may have some benefits for the parent firm as well. The channel could be that of a 'spill in' wherein the parent firm benefits from the knowledge generated by the spinoff, and through business dealing with the spinoffs (Agarwal et al. (2007), Somaya and Williamson (2008), Kim and Steensma (2017)). Alternatively, the spinoff activity may allow the parent firm to refocus its resources on its core competence (Ioannou (2013)). Mckendrick et al. (2009) and Tan and Rider (2017) postulate (without a formal model) that the parent firm may get some reputational benefits from good spinoffs since potential employees may view the parent firm as a good incubator[2].

The primary objective of this research is to formally demonstrate a new channel via which spinoffs can be beneficial for their parent firm. I go on to show that this channel is able to explain an empirical finding which has not been explained in the literature. Furthermore, this paper contributes to the theoretical literature by studying a principal-agent model where the principal and the agent's type is their own private knowledge (double adverse selection), *and* they are correlated. First, I will briefly highlight the important features of the environment in this article and the main contributions of this paper. Subsequently, I will discuss the model and results in more detail.

This is a two period model with a principal and a worker who works at the principal's firm. Both the principal and the worker can be high or low ability and their own type is their private knowledge. The type of the principal and the worker is correlated because a high ability principal is more likely to hire a high ability worker. The joint distribution of the principal and the worker's type is common knowledge. The worker performs a job and a high ability worker is more likely to succeed at the job. Thus, the price received by a firm (stage payoff) depends positively upon the worker's reputation (probability of being high type). However, there is high worker attrition (workers may leave/die with exogenous probability), so the firm's future payoff depends upon the belief about the principal's ability to repeatedly hire good workers i.e. on the principal's reputation. A worker can get an idea whose value is known to her privately. The worker can form

[1]There is some disagreement in the literature about the definition of spinoffs. In this paper, I do not consider "sponsored spin-offs" (Cooper (1971)) in which a parent firm voluntarily establishes and holds stocks in a newly formed company intended to perform some of the business of the parent company.

[2]Mckendrick et al. (2009) also argue that a spinoff may benefit the parent firm if the new hirings needed after the spinoff formation inducts fresh talent in the firm which makes the firm better suited to face newer challenges.

a spinoff by incurring a fixed cost of firm formation. The payoff to the worker from forming the spinoff is positively dependent upon the reputation of the worker hired at the spinoff, and the value of the idea on which the spinoff is formed.

This paper makes three contributions. One, I demonstrate a new channel via which a spinoff can be beneficial for the parent firm. I show that a 'good'[3] spinoff can act as a signal of quality of the screening ability of the principal of the parent firm. The idea is as follows. I show that high ability workers are more likely to form spinoffs, and spinoffs formed by high ability workers are more likely to succeed. Since a high ability principal is better at screening workers, she is more likely to hire a high ability worker. This implies that spinoff formation and good spinoff performance can act as a signal of the screening ability of the principal of the parent firm. This is important because in a market with high enough labour attrition, the ability to repeatedly hire good employees has a strong positive impact on the parent firm's payoff. Thus, the signals coming from spinoff formation and performance can impact the parent firm's payoff by affecting the belief about the principal's screening ability. This result highlights a new channel through which non-compete covenants can affect a firm's payoff negatively[4].

The second contribution of my paper is that it explains several empirical findings including the following. In the disk drive industry, it was observed that the formation of a spinoff increases the hazard rate of exit for the parent firm at first, but in the longer run, the parent firm does better than firms which did not spawn a spinoff (Klepper (2009) and Mckendrick et al. (2009)). To the best of my knowledge, there is no formal model in the spinoff literature which can explain these two empirical observations simultaneously[5]. This paper seeks to fill this gap in the literature (my explanation of this empirical finding follows shortly). This model also predicts results in Chatterjee and Rossi-Hansberg (2012) (high-value ideas are more likely to be executed in spinoffs) and Shekhar (2018) (good workers are more likely to spinoff than bad workers, and workers will spin off even when the principal can offer wages to dissuade them).

Finally, on the theoretical side, this paper contributes by studying a principal-agent problem with double adverse selection and correlated types. This is a departure from the traditional principal-agent set up, and it is an important distinction to make because correlations in the ability of the principal and the agent can lead to very different results in standard environments. For example, in an environment where the worker's ability is not known, it has been argued (Gibbons and Waldman (1999), Golan (2009)) that as the worker's reputation improves, the principal must pay the worker higher wages. This is not entirely true in my model. Good performance by the worker improves her reputation which can increase her own wage. However, the

[3] A good spinoff is one in which the worker at the spinoff succeeds at her job.

[4] Also see Garmaise (2011), Marx et al. (2015), Gilson (1999) and Shekhar (2018) for other criticisms of non compete clauses.

[5] Mckendrick et al. (2009) explains this effect but without any formal model.

principal need not have to pay more because her worker's good performance also improves the belief about the principal's screening ability. When the market trusts the principal to always hire good workers, the principal does not have to retain old workers at higher wages. She can always hire new workers at lower costs[6], i.e. her outside option improves.

I construct a model with correlated reputations, where the signalling aspect of spinoff formation plays a key role. It is a two period game in which there is a firm with a worker and a principal, and a continuum of other workers the principal can hire from if she needs to replace the worker. Both the worker and the principal can be high or low ability (a player's type is their private knowledge), and the reputation of a player refers to the belief about the player being high ability. The worker at a firm performs a job whose outcome can be a success or a failure. A high ability worker is more likely to succeed than a low ability worker. Thus, the reputation of the worker matters because the price the firm's service can command in the market is positively dependent upon the worker's reputation. The reputation of the principal matters because a higher ability principal is assumed to be better at screening workers. In this paper, this is manifested in my assumption that a high ability principal always hires a high ability worker whereas a low ability principal hires a randomly selected worker from the pool of workers.

The assumption that a high ability principal is better at screening stems from empirical evidence (Beaman and Magruder (2012), and Burks et al. (2015)), and is important for two reasons. One, it creates a correlation between the worker's reputation and that of the principal. Two, I study an environment with relatively high (exogenous) worker attrition[7]. Thus, the future payoff of the principal's firm depends crucially on the belief about her ability to repeatedly hire high ability workers from the pool of workers. So, while the worker's reputation affects the firm's payoff today, the belief about the principal's type (her reputation) has a strong effect on her firm's longer-run payoff. A worker can get a new idea whose value she learns privately. The worker may then form a spinoff by incurring a fixed cost and hiring one worker from the pool of workers.

I show that a high ability worker is more likely to form a spinoff compared to a low ability worker because the former has a higher future expected payoff from incurring a cost and forming a new firm. This is because a high ability worker knows that she can hire high ability workers when she becomes the principal of her own firm[8]. Since a high ability worker is more likely to be hired by a high ability principal, the occurrence of a spinoff can act as a positive signal about the screening ability of the principal of the parent

[6]New workers would be willing to work with the principal at low wages today because they know that getting hired by a high reputation principal increases their reputation and payoffs in the future.

[7]The exogeneity of worker attrition guarantees that a worker leaving her firm is not an informative signal about the firm. Mckendrick et al. (2009) writes of the hard disk drive industry - *People leave firms for a host of different reasons, including family considerations, boredom, interest in having greater control, identity fulfillment, new challenges, and the like. These are not nearly as newsworthy as public disagreements, but they are nonetheless common. In the HDD industry itself, personnel movement among firms and to new ones was common and seldom reflected poorly on the parent.*

[8]Also see Shekhar (2018) for another explanation of this result.

firm. Additionally, if the principal is high ability then she expects that the new worker she hires from the market after a spinoff forms will succeed, and she expects a good performance from the spinoff itself (i.e. the worker hired at the spinoff succeeds). These also serve as a signal of the ability of the principal of the parent firm. This helps a high ability principal of the parent firm because the current worker may leave the firm at the end of the period (exogenous attrition), and the parent firm will have to hire a new worker from the population. The reputation of the new worker (and tomorrow's payoff) will depend positively upon the market's belief about the principal's screening ability. A firm with no spinoff will not get this advantage and will therefore perform worse in the longer run[9]. In the short run however, the firm with no spinoff gains, since it does not lose a worker to a spinoff and therefore does not have to hire a lower reputation worker from the pool of workers[10]. Thus, my model predicts the empirical observation in the disk drive industry that the formation of a spinoff hurts the parent firm initially but is eventually beneficial, albeit with the caveat that the result only holds when the principal of the parent firm is a high ability player.

My baseline model is one where the principal may not signal her ability via wages. We assume that the wages received by the worker are exogenously given. This assumption does not allow a high ability principal to signal her ability to the market by offering higher wages than a low ability principal. If the principal could signal her ability via wages then the signals coming from a spinoff would be redundant. The idea is to first focus on the signalling aspect of spinoff formation and to demonstrate in a simple way that a spinoff could affect the payoff of the parent firm positively. In section 5, I endogenize wages and find conditions under which the principal can signal her ability via wages. Subsequently, I show that under some conditions, the principal is unable to signal her ability via wage offers. This makes the signals coming from a spinoff more relevant for the principal of the parent firm.

The rest of the paper is organized as follows. Section 2 describes some of the relevant literature. Section 3 describes the baseline model and section 4 discusses the main results. In section 5, I consider a model with endogenous wages where the principal can signal her ability via wage offers. Section 6 considers the case where spinoff ideas are frequent (and not rare, as in the baseline model). Finally, section 7 discusses some of my modelling choices and section 8 concludes the paper.

[9] In the very long run, the principal's type will be learned by the market (with or without spinoffs). However, if a principal is not infinitely patient, then she will care about her short-medium run payoffs as well, and these will depend upon how quickly the market learns her type. Thus, any channel which affects the speed at which the market learns about a good principal's type is valuable to her.

[10] The worker that the firm hires from the pool necessarily has lower reputation than the worker it loses to a spinoff. This is because if it were not the case, then the principal could have fired the worker and hired from the pool even before the spinoff occurred.

2 Literature

This paper is related to several branches of the Economics and Management literature. In particular, my paper is related to the literature which speaks of the impact of spinoff formation on the parent firm, the literature on signalling in principal-agent models, and the literature which discusses principal-agent models where the type of the principal *and* the agent is not known.

Much of the literature about the impact of spinoff formation on the parent firm paints a bleak picture for the parent firm. Agarwal et al. (2016) show that the more experienced and the larger the team that spins off to form a new firm, the higher the hazard risk of exiting the market for the parent firm. Wezel et al. (2006) (with data from the Dutch accounting industry) and Klepper and Sleeper (2005) (with data on the laser industry) point out that since employees who leave to form a spinoff are likely to replicate the parent firm's routines, they produce close substitutes to the parent firm's product, and thus pose a competitive threat to the parent firm. Campbell et al. (2012a) study the legal services industry and argue that the better the quality of the worker who forms the spinoff, the worse it is for the parent firm's performance. More recent papers in this literature however, have discussed how spinoff formation can be beneficial for the parent firm. In the introduction, I have already spoken of papers like Somaya and Williamson (2008), Kim and Steensma (2017), Ioannou (2013), Mckendrick et al. (2009), and Tan and Rider (2017) , so I don't discuss them again here. My paper differs from these because I construct a formal model to point out a different channel via which spinoffs can be good for their parent firm.

In a related paper on signalling in spinoff formation, Shekhar (2018) shows that high ability workers can signal their ability to the market via a separating equilibrium in which they take the costly decision of spinoff formation while the low ability workers work for the principal. However, there is no uncertainty about the principal's ability in Shekhar (2018) and therefore signalling her own ability is unimportant for the principal of the parent firm. Furthermore, in Shekhar (2018), the formation of a spinoff is always undesirable for the principal of the parent firm, whereas in this paper I show that the parent firm can benefit from spinoff formation and performance.

Board et al. (2017) and Cabral and Wang (2012) present models where there is positive assortative matching between high ability workers and high ability principals. Board et al. (2017) speak of the long run benefits of human capital acquisition. Firms with more high ability workers are able to select from a larger pool of workers because they post higher wages. They are able to post higher wages because higher ability workers get more precise signals about a candidates ability i.e. their cost of screening effectively is low. Hiring a talented workforce plays a big role in determining long-run payoffs because these workers help the firm hire better in the future. While this idea is similar to the idea in this paper, there are some

important differences. The key difference is that a firm's recruiting ability is not private knowledge in Board et al. (2017). So, there is no element of signalling the firm's (principal's) ability via higher wages or spinoffs. Furthermore, in my paper the firm has access to the entire workforce, that is, there are a lot more workers than firms so that the hiring by any one firm does not change the distribution of workers available.

Cabral and Wang (2012) discuss a theoretical model (and then test the hypotheses on data from the US automobile industry) where the principal and the worker's ability is not known (even to themselves) before they start working together (but they learn each other's type immediately after working with one another). Like my paper, they show that high ability workers are more likely to form spinoffs (since they are more productive, they have more to gain from making this costly decision), and that the loss of a worker to a spinoff can increase the hazard rate of exit for the parent firm. This paper differs from mine in several ways. First, the market price for the firm's product is determined via an inverse demand function which depends upon aggregate production in the industry, whereas in my model the firm's price depends upon the belief about the worker's ability, and this gives signalling a key role in my paper. Furthermore, unlike my paper, a worker spinning off can only increase the hazard rate of exit for the parent firm in Cabral and Wang (2012).

Theoretically, my model of double adverse selection with correlated types differs from the standard principal-agent models used in the literature where there is usually uncertainty about the type of the agent only. This is a crucial distinction as it allows the worker's performance (whether within the firm or elsewhere) to affect the belief about the principal's ability, and this can lead to very different results in standard settings. For example, correlation of principal-worker type via screening implies that even though the worker's market value can increase with increases in her own reputation, this does not necessarily imply that the principal must pay higher wages ala Gibbons and Waldman (1999) or Golan (2009). This is because as the worker's reputation increases, the principal's reputation also goes up. As the principal's reputation increases, the belief about the worker the principal hires from the market also goes up. This makes workers willing to work with the principal at lower wages because this will improve their own reputation (a good type principal always hires a good type worker). This means that the principal can hire from the pool of workers at a lower cost. Thus, the principal's outside option to retaining the current worker at higher wages becomes better.

Finally, my paper discusses the possibility of two signals affecting the payoff of the principal of the parent firm - wage signals and spinoff signals. This is somewhat similar to Milgrom and Roberts (1986), where a firm can use both prices and advertising to signal product quality. However, the key difference is that in my paper, the two signals can only occur sequentially, and the decision of providing each signal belongs to different players. Additionally, the first signal (wage) influences the probability of arrival of the second signal in my paper.

3 Principal Agent Model

This is a two-period model with a continuum of players, and all players are risk neutral. A positive measure of the players are workers and the rest are customers (who constitute the market). Workers are either good (G) or bad (B) type. A worker's type is her private knowledge. The distribution of types in the worker population is common knowledge and is such that the probability that a randomly selected worker is good type is p_g. All players maximize the sum of payoffs across both periods. There is no discounting.

A firm in this model consists of one 'idea', one principal, one worker and a fixed investment which the principal makes when she first forms the firm. The principal is a former worker who got an idea and decided to form a new firm. The idea is the technology which the worker hired by the principal uses to deliver an output. Think of the principal as the player who owns the idea (through patent/copyright protection), the fixed initial investment as the cost of patenting the idea, and the worker as one who uses the idea to produce an output. At the beginning of time $t = 1$, assume that there is one firm (F_1), with one principal (P_1), and one worker (W_1) who uses the principal's idea to execute one job (J_1).

In every period, the job's outcome can be a success or a failure. A good type worker always succeeds at the job[11] whereas the probability that the job is successful if a bad type worker performs it is given by $\lambda (\in [0,1))$. Thus, the good type worker is better at the job. All players observe the outcome of the job and the identity of the worker who performed the job. The probability with which a good/bad worker succeeds is common knowledge. If the job J_1 is successful then it is of value M, whereas a failure has no value. M should be interpreted as the value of the idea on which firm (F_1) operates. This is fixed and is drawn by nature from the uniform distribution on $[0,\bar{a}]$ when the worker (now principal of F_1) got the idea and formed the firm F_1. $\bar{a}$ is a fixed positive scaler and, $\bar{a}$ and M are common knowledge. I will simplify the market side price mechanism to assume that the firm will always get the expected utility of the project as price. For example, if the worker's reputation (probability of being good type) is p in period t, the firm F_1 receives $pM + (1-p)\lambda M$ as price in period t.

At the end of period 1, the worker can leave the firm with an exogenously given probability d. We interpret this as the probability of attrition. In this paper, d will be assumed to be close to 1 for the most part. This is not necessary for the results. If d were smaller, similar results could be obtained in a longer finite horizon game with messier (but not more illuminating) maths. d is common knowledge. The case of very low attrition (low d) is discussed in section 7.

The principal can replace the worker with another worker from the pool of workers at no cost. I assume

[11] This is for simplicity and tractability. The qualitative results will not change if I allow for the good type worker to fail with positive probability.

that a principal of type G is better at screening workers. There is evidence that this is true in real life (see Beaman and Magruder (2012)). To be precise, I assume that a good type principal always hires a good type worker, whereas a bad type principal hires a randomly selected worker from the pool of workers. Thus, a principal of type G can perfectly[12] identify and hire a worker of type G whereas the probability that a principal of type B hires a worker of type G is simply p_g (since she randomly hires a worker). The principal's type can also be interpreted as the quality of the firm's worker training program. A good principal has a training program which adds real value to the worker's type and produces high ability workers, whereas a bad principal's training program does not add any value to a worker's ability. The screening ability of the good/bad type principal is common knowledge (though the principal's type is not). Thus, the type of the worker influences two things. It affects the worker's ability to do the job, and her ability to screen other workers if and when she becomes the principal of her own firm. Also, note that the screening ability of the principal creates a correlation between the principal's and the worker's ability.

At the beginning of period 1, the worker at the firm F_1 may get a new idea with probability q[13]. The probability of getting a new idea is independent of the worker's type and is assumed to be close to zero[14]. I assume that the principal does not get more new ideas. This could be justified by assuming that running a company is hard work and leaves no time for the principal to think of and implement new ideas. A similar argument is made by Chatterjee and Rossi-Hansberg (2012). If the worker gets a new idea (I) at time $t = 1$, then the value of this idea (denoted by V_I) is drawn by nature from the uniform distribution on $[0, \bar{a}]$. The worker gets to know the value of the new idea privately. The worker can become the principal of a new firm which operates upon the idea I. The formation of the new firm requires the worker to hire another worker from the population and make a fixed investment R[15]. This fixed investment can be thought of as the cost of obtaining a patent/copyright on the idea. R is common knowledge.

[12]This is for simplicity and tractability. The qualitative results will not change if I assume that the good type principal is not an expert (but only better than B type principal) at screening workers.

[13]For simplicity, I assume that new ideas can come to only those workers who are employed at a firm. This may be justified by saying that workers need to work for a while before they are capable of generating new ideas. This assumption may make the perceptive reader question how the first firm came into being at all. We could assume that there is a default occupation which has always existed (like agriculture) and that firm F_1 is involved with this industry. However, I avoid going into this discussion as it is not important for the intuition I am trying to highlight. I also assume that new ideas only arrive in period 1. If this were not the case, the worker forming the new firm must take into account the possibility that the worker hired by her may leave to start her own firm some day. This can be messy. Does it change the intuition of the results if we disallow this? In terms of incentives, all this affects is how much rent can the principal capture from increases in the reputation of her worker. However, since we have assumed high attrition, this is not a big factor in the principal's decision making.

[14]This is a natural assumption. Viable ideas for new firms don't come often. Also, the quality/value of the idea is assumed to be independent of the worker's ability. Adding an assumption which lets better workers get better ideas with higher probability will not change the results qualitatively.

[15]The implicit assumption here is that the fixed investment required to start a new firm is independent of the idea (or the value of the idea) on which that firm is based. One may wonder if it is not better to assume that the amount of investment needed to start the new firm is positively related to the value of the idea? While this would be a natural assumption for some industries, this may not always be the case. For example, consider online mega-firms like Uber and ebay where even comparatively small investments can lead to huge profits.

The principal of firm F_1 offers the worker a fixed and exogenously given wage of w in period 1. The assumption of exogenously given wages is to avoid having a model where signalling can come from both wage offers[16], and spinoff formation and worker performance. This assumption is relaxed, and signalling via wage offers is discussed in section 5. In period one, if the worker does not get a new idea then she chooses between accepting the wage contract, and rejecting the contract and becoming unemployed. I assume that the value of the outside option (unemployment) for the worker is zero, and the worker does not choose this option unless it is strictly preferred to other options. If the worker rejects the contract, the principal offers the same wages to the pool of workers and hires (at zero search cost) any worker who is willing to accept the contract. If the worker gets a new idea (I), then she chooses between accepting the contract and giving up on the idea forever[17], rejecting the contract to form her own firm based on idea I, and rejecting the contract and becoming unemployed[18]. If she decides to form the new firm, she offers the fixed wage w to the population of workers and hires a worker, makes the fixed investment (R) and starts the new firm (F_2). If F_2 is formed, the value (V_I) of the worker's idea (I) becomes common knowledge to all players. A worker in F_2 can use the idea (I) to perform a new job J_2. The principal of F_1 hires a new worker from the population. I assume that all workers get wages equal to zero in the last period. This is to simplify the payoff structure further and is not relevant for our qualitative results. In all periods, all firms get the expected utility of their job as price.

Note that the new firm (F_2) is not in direct competition with firm F_1 as it operates on a different idea so the output may be completely different. Thus, there is no angle of competition between firms for customers. The reputation of the worker at firm j at time t is denoted by $R_t(W_j)$ and this reflects the belief held by the market that the worker is of type G. Similarly, let the principal $j's$ reputation at the beginning of time period t be denoted by $R_t(P_j)$. Let the prior beliefs about the worker and principal of firm 1 be given by $P(P = x, W = y)$. This denotes the belief at the beginning of the game about the event that the principal of firm 1 has type x and the worker at firm 1 has type y. The prior belief is in the form of a joint probability distribution because the worker's reputation is correlated with the principal's reputation (due to the principal's

[16]Principals can signal their ability via differential wage offers.

[17]This can be interpreted as follows. Whether the worker forms a spinoff or not depends upon two important factors - whether she gets an idea of sufficient value, and the cost of forming the firm. The new firm is only formed if the idea is good, *and in the same period*, the cost of firm formation is low. The assumption that the worker must give up on the idea if it is not used in that period to form a spinoff can be interpreted as - the cost of firm formation in future periods may be too high to form a spinoff later. This would be the case if there is some support available from a venture capitalist this period, which may not be there tomorrow.

[18]Some papers (see Chatterjee and Rossi-Hansberg (2012)) add the alternative that the worker can sell the idea to the principal but can only credibly reveal the true value of the idea *after* the sale. Thus, adverse selection about the quality of ideas will imply that the principal can only pay according to the value of the average idea. This results in only above average ideas being implemented in spinoffs. However, this result will go through even without this assumption, as workers have an opportunity cost (wages) and a fixed cost (R) of spinning off. Thus, only ideas with sufficient value can lead to a spinoff. The qualitative results in this paper will not change if I allowed for such a possibility.

screening ability). The prior belief is taken as follows:

$$P(P = G, W = G) = a$$

$$P(P = G, W = B) = 0$$

$$P(P = B, W = G) = b$$

$$P(P = B, W = B) = 1 - a - b$$

$$\textit{where } a, b \in (0,1) \textit{ and } a + b < 1$$

Remember that the worker's reputation is important because the job's outcome and therefore the expected utility from the job, depends upon the worker's type. The expected utility from the job is the price the firm can obtain in the market. The outcome of the job helps the market update its beliefs in a Bayesian way. The principal's reputation is important because it affects the belief about a worker's type when the principal has to hire a new worker.

The worker can make a mistake when choosing an action. Formally, if a worker decides to take action a, then the worker actually takes that action with probability $(1-\varepsilon)$ and takes any other action in the feasible[19] action space with positive and equal probability. Note that the probability of making a mistake is independent of the worker's type. I introduce mistakes to refine the set of equilibria. We take mistake probability as tending to zero, and therefore the equilibrium concept is extensive form trembling hand perfect equilibrium.

3.1 Timing of the game

The timing of the game is as follows:

1. At the beginning of time $t = 1$, there exists a firm F_1 with principal P_1 and worker W_1. Then, nature moves and determines if the worker gets a new idea or not. Subsequently, if the worker gets a new idea, nature moves again to decide the value of the worker's idea, which the worker learns of privately. At this stage, the principal (P_1) offers the worker a wage w for the period (w is exogenously given). The worker decides between accepting the contract, starting her own firm[20] and, rejecting the contract and doing nothing. Nature moves to determine if the worker makes a mistake and the actual action the worker ends up taking. After this stage, the firm(s) receives its price and the job is executed by the worker(s). Nature moves to determine the outcome of the job(s) (success or failure) and this is publicly observed. The worker at firm 1 leaves the firm with probability d (≈ 1).

[19] If the worker gets an idea, the feasible set is $\{Spinoff,\ Accept\ contract,\ Become\ unemployed\}$, else it is $\{Accept\ contract,\ Become\ unemployed\}$.

[20] If the worker got a new idea in that period.

2. At the beginning of time $t = 2$, the principal(s) can hire new worker(s). Subsequently, the principal(s) offers their own worker(s) a one period contract with wage 0. The worker(s) decides between accepting the contract and, rejecting the contract and doing nothing. After this stage, the firm(s) receives its price and the job is executed by the worker(s). Nature moves to determine the outcome of the job(s) (success or failure) and these are publicly observed.

3. Game ends.

4 Baseline Results

I will demonstrate the existence of an equilibrium which has the following two properties. One, a good type principal of F_1 prefers to have spinoffs. Formally, in the equilibrium, the expected payoff of a good type principal is higher when a spinoff forms compared to when the spinoff does not form. We will then show (in corollary 1) that under some conditions, this property holds more generally for any equilibrium in which a spinoff occurs. Two, in the equilibrium, in the period in which the spinoff forms (period 1), the parent firm gets a lower payoff than its expected stage payoff if there was no spinoff formation. Thus, this equilibrium will predict an outcome consistent with the following empirical observation in the disk drive industry - *The formation of a spinoff increases the hazard rate of exit for the parent firm initially but in the long run, the parent firm does better than other firms with no spinoffs*. However, we show that the principal of the parent firm prefers to have a spinoff only if the principal is good type. A bad type principal prefers to have no spinoffs. Due to the bad type principal's poor ability to hire talent from the market, if talent is scarce, a bad type principal is hit harder when a high reputation employee spins off.

Strategies are history and type contingent. The worker in firm 1 in period 2 has just two action choices - accept a contract or do nothing[21]. Thus, the worker will always accept any individually rational wage contract in period 2. The strategy of the worker in period 1 is a function of the value of her new idea[22], the wage offer by the principal, her own reputation and her own type. Let this be denoted by $S_w^1(V, w, R_1(W_1), G/B)$. Let $(p_g + (1-p_g)\lambda) = q_1$. Thus, q_1 is the probability of success when a random worker is hired from the market. In the strategy profile that follows, both type workers spin off if the value of their idea is above a threshold. However, we will show that this threshold is lower for the good type worker. The intuition is simple - a good type worker has a higher future expected payoff from spinning off as compared to a bad type worker. This is because a good type worker knows that she can hire a good worker and get high returns in the future because

[21] Since there are no new ideas and the worker has to abandon any idea which arrived in period 1 (which was not used to form a spinoff).

[22] If the worker does not get a new idea then we will think of this as getting an idea of value 0.

her reputation (and the reputation of her worker) will always go up. On the other hand, a bad type worker knows that she may end up hiring a bad worker whose type may get revealed by the job's outcome. This will reduce her reputation and expected payoff from future periods. Thus, a good type worker is willing to spinoff with an idea whose value is lower than the lowest value idea a bad type worker is willing to spin off with. This gives an insight into how spinoff formation itself can act as a signal of the worker's type (and by the screening correlation, a signal of the type of the principal of the parent firm).

Proposition 1. *Suppose the principal of firm 1 is of type G. There exists* $\underline{p_g}$ *and* $\underline{\lambda}$ *such that if* $p_g \in (0, \underline{p_g})$, $\lambda \in (0, \underline{\lambda})$ *and* $a+b > \frac{a}{a+b}$, *then there exists an equilibrium in which the occurrence of a spinoff hurts the parent firm's payoff in the first period, but the total payoff of the parent firm over both periods is greater than its payoff had there not been a spinoff.*

Proof. Consider the following strategy profile for some scalers $\bar{V_1}, \bar{V_2}, \bar{V_3}, R$ and a function p from the domain of idea values $[0, \overline{a}]$ to $[0,1]$:

Period 2 (1)

$Worker's\ Strategy$:

Accept contract if IR wages

Period 1

$Worker's\ Strategy$:

$S_w^1(V, w, R_1(W_1), G) = Spinoff\ if\ V \geq \bar{V_1},\ else\ accept\ contract$

$S_w^1(V, w, R_1(W_1), B) = Spinoff\ if\ V \geq \bar{V_3}$

$S_w^1(V, w, R_1(W_1), B) = p(V)Spinoff\ +\ (1-p(V))accept\ ;\ if\ \bar{V_2} < V < \bar{V_3}$

$S_w^1(V, w, R_1(W_1), B) = accept\ contract\ if\ V < \bar{V_2}$

We will find $\bar{V_1}, \bar{V_2}, \bar{V_3}, R, p(V)$ and beliefs such that the above is an equilibrium strategy profile. The equilibrium concept is extensive form trembling hand perfect equilibrium. We assume $V_1 < V_2 < V_3$ to begin with and we find conditions under which this is true. If the value of the worker's idea is V_1, we must have that:

Payoff to G type from accepting = Payoff to G type from spinning off when B type does not

$\Leftrightarrow w = V_1 - w - R + V_1$

$\Leftrightarrow V_1 = \dfrac{2w+R}{2}$

If the value of the worker's idea is V_2:

Payoff to B type worker from accepting = Payoff to B type worker from spinning off when only G type worker spins off

$$w = V_2 - w - R + (q_1 V_2 + (1-q_1)q_1 V_2)$$
$$\Leftrightarrow V_2 = \frac{2w+R}{1+q_1+(1-q_1)q_1}$$
$$\Leftrightarrow V_2 = \frac{2w+R}{1}; \textit{ when } q_1 \approx 0 \textit{ because } p_g, \lambda \textit{ small}$$

Note that the condition $V_1 < V_2$ is satisfied. If the value of the worker's idea is V_3:

Payoff to B type worker from accepting = Payoff to B type worker from spinning off when both type workers spin off

$$w = ((a+b)+(1-a-b)q_1)V_3 - w - R + [(1-q_1)q_1 V_3 + q_1(\frac{a+b}{a+b+(1-a-b)q_1} + (1-\frac{a+b}{a+b+(1-a-b)q_1})q_1)V_3]$$
$$\Leftrightarrow V_3 = \frac{2w+R}{a+b}; \textit{ when } q_1 \approx 0 \textit{ because } p_g, \lambda \textit{ small}$$

Note that the condition $V_1 < V_2 < V_3$ is satisfied (because $a+b<1$). If the value of the worker's idea is between V_2 and V_3, then take any V such that $V_2 < V < V_3$, we have that if p_g, λ are small then $q_1 \approx 0$ and:

Payoff to B worker from accepting = Payoff from B worker from spinning off when B worker is supposed to spinoff with probability p(V)

$$\Leftrightarrow \; p(V) = \frac{(a+b)(V-(2w+R))}{(1-a-b)(2w+R)} \; ; \; V_2 < V < V_3$$
$$p(V) = 0 \; ; \; else$$

Let $P(W_1 = G/ns)$ denote the reputation of the worker in firm 1 in period 1 when there is no spinoff. Let $P(W_t^{new} = G/s, V)$ denote the reputation of the new worker at firm 1 in period t when the old worker formed a spinoff of value V and the principal hires the new worker from the market. $P(W_2^{new} = G/ns, s)$ represents the reputation of the newly hired worker in period 2 (after the worker from period one left because $d \approx 1$) when there was no spinoff in period 1, and the period 1 worker succeeded at the job[23]. $P(W_2^{new} = G/s, V, (s,s))$ represents the reputation of the newly hired worker in period 2 when there was a spinoff in period 1 of value V, and the period 1 worker at both firms succeeded at their job[24]. Now, we would like to find conditions under which spinoff formation hurts the good type principal's payoff in period 1 but is better for the good type principal over both periods. To get our desired result when there is no discounting, boils down to finding

[23]The good type principal knows that the worker she hires will succeed (since she can screen perfectly).

[24]The good type principal knows that the worker she hires will succeed (since she can screen perfectly), as will the worker hired by her worker should there be a spinoff.

conditions such that the following hold:

$$P(W_1 = G/ns)M + (1 - P(W_1 = G/ns))\lambda M > P(W_1^{new} = G/s, V)M + (1 - P(W_1^{new} = G/s, V))\lambda M$$
$$\Leftrightarrow P(W_1 = G/ns) > P(W_1^{new} = G/s, V) \tag{2}$$
$$\textit{and, similarly}$$
$$P(W_2^{new} = G/s, V, (s,s)) + P(W_1^{new} = G/s, V) > P(W_1 = G/ns) + P(W_2^{new} = G/ns, s)$$
$$\Leftrightarrow P(W_2^{new} = G/s, V, (s,s)) - P(W_2^{new} = G/ns, s) > P(W_1 = G/ns) - P(W_1^{new} = G/s, V) \tag{3}$$

Thus, we require the loss in worker reputation from spinoff formation to be positive in period 1. However, the gain in reputation of the worker hired in period 2 (with spinoff in period 1 compared to no spinoff in period 1) should compensate for the loss in reputation in period 1.

To show 2, it is enough to show this for the case when a spinoff is formed with an idea whose value satisfies $V_1 < V < V_2$. This is because this case maximizes the RHS i.e. the principal's payoff in period 1 subject to a spinoff being formed. The reason for this is that a spinoff formation with $V_1 < V < V_2$ is a signal to the market that the worker at firm 1 was type G and this increases the principal's reputation, which leads to a higher reputation for the new worker which the principal hires to replace the worker lost to the spinoff. A spinoff with any other value V would not increase the reputation of the principal more, and will therefore lead to the hiring of a worker whose reputation will not be as high. It is important to mention that this is a sufficient condition, a weaker condition can easily be solved for by considering the ex-ante expected reputation of the new worker the principal can hire when there is a spinoff (expectation taken over the possible values of V) against the reputation of the worker if there was no spinoff. Now 2 with RHS for $V_1 < V < V_2$:

$$P(W_1 = G/ns) > P(W_1^{new} = G/s, V_1 < V < V_2)$$
$$\Leftrightarrow a + b > \frac{a}{a+b}; \textit{ when } p_g, \lambda \textit{ are small} \tag{4}$$

We know that this holds. Note that $P(W_1 = G/ns) = a + b$ because the probability of a new idea is assumed to be close to zero. Thus, the non-formation of a spinoff is attributed to the worker not getting an idea, and thus it is not very informative about the worker type, leaving the worker's reputation unchanged.

The payoff expected tomorrow by the principal depends upon the worker's reputation tomorrow which in turn depends upon the principal's reputation tomorrow (because the principal has to re-hire from the market owing to high attrition), and the principal's reputation depends upon whether the job(s) was a success or not. Thus, tomorrow's payoff for the principal depends upon the worker(s) success and this means that the bad

type principal will have a different estimate of the expected payoff tomorrow as compared to a good type principal (G type principal knows that worker will succeed whereas the B type principal knows that worker can fail). Now, we wish to show that inequation 3 holds when the principal of firm 1 is good type. It is sufficient to show that it holds when the spinoff forms with an idea with a value which satisfies $V \geq V_3$. This is because for this V, the LHS of inequation 3 is at its lowest, and the RHS is at its highest. So now we have:

$$\begin{aligned} & P(W_2^{new} = G/s, V \geq V_3, (s,s)) - P(W_2^{new} = G/ns, s) > P(W_1 = G/ns) - P(W_1^{new} = G/s, V \geq V_3) \\ & \Leftrightarrow 1 - \frac{a}{a+b} > a+b-a; \textit{ when } p_g, \lambda, q \textit{ are small} \\ & \Leftrightarrow a+b < 1 \end{aligned} \tag{5}$$

We know this holds. Thus, when good workers are scarce and much better than bad type workers (low p_g, λ), and the current reputation of the worker at F_1 is high enough ($a+b > \frac{a}{a+b}$), then, in the above equilibrium, a good type principal prefers to have a spinoff, even though there is one period loss. □

Next, we prove that there under the conditions required by proposition 1, the G type principal *always* prefers equilibria in which spinoffs occur to any equilibrium in which a spinoff does not occur.

Corollary 1. *There exists $\underline{p_g'}$ and $\underline{\lambda'}$ such that if $p_g \in (0, \underline{p_g'})$ and $\lambda \in (0, \underline{\lambda'})$, the G type principal always prefers any equilibrium in which a spinoff occurs to any equilibrium in which a spinoff does not occur.*

Proof. $q \approx 0$ and $p_g, \lambda \approx 0$ imply that in any equilibrium without a spinoff, the good type principal gets a payoff of $(a+b)M - w + \frac{a}{a+b}M$. In any equilibrium where a spinoff occurs, the guaranteed success of the spinoff worker and the principal's own new hire (because the good type principal is always able to hire good workers), combined with the condition that good workers are rare (low p_g) and bad workers almost never succeed (low λ) implies that the good type principal expects to earn a payoff of M tomorrow. Next, we consider the lowest payoff a good type principal can get in the period in which the spinoff forms in any equilibrium.

Lemma 1. *In any equilibrium in which a spinoff occurs, the G type principal's first period reputation is bounded below by a.*

Proof. The principal of the parent firm has a reputation of a when both type workers spinoff with equal probability in an equilibrium. Suppose there is some equilibrium in which a spinoff occurs and leaves the principal of the parent firm with a reputation less than a. Then, it must be the case that, in that equilibrium, for some idea value V, a bad type worker is more likely to spinoff than a good type worker. However, this is not

possible. Since a good type worker is more likely to hire a good type worker (who is more likely to succeed as compared to a bad type worker), in any equilibrium, a good type worker gets a strictly higher payoff by spinning off compared to a bad type worker. Note that this is true even when the belief in some equilibria is that only bad type workers spinoff[25]. This is because of the possibility of errors in worker decisions which eliminates the possibility of degenerate beliefs which are never updated. This ensures that the good type worker always gets a strictly higher expected payoff tomorrow by spinning off as compared to the bad type worker. Thus, whenever a bad type worker spins off with positive probability (i.e. is at least indifferent between spinning off and accepting the fixed wage contract), a good type must spin off with probability 1 (since this worker then strictly prefers to spin off). This is a contradiction. □

Thus, we have that in any equilibrium in which a spinoff occurs, a G principal of the parent firm has a reputation of at least a in period one. Therefore, in any spinoff equilibrium the payoff for the principal of the parent firm is bounded below by $aM - w + M$. We know from before that the payoff for a G type principal of the parent firm in any equilibrium without a spinoff is $(a+b)M - w + \frac{a}{a+b}M$. Now, any equilibrium with a spinoff is more desirable (to the G type principal of the parent firm) than an equilibrium without a spinoff if:

$$aM - w + M > (a+b)M - w + \frac{a}{a+b}M$$

$$\Leftrightarrow a + b < 1$$

We know this is true. □

Another corollary to proposition 1 is that under the same conditions, a bad type principal always prefers not to have spinoffs.

Corollary 2. *If the principal is bad type, then under the conditions required in proposition 1, the principal prefers not to have spinoffs.*

Proof. When there is a spinoff: a) the bad type principal suffers a payoff loss in period one just like the good type principal, b) Since talent is scarce, when the bad type principal has to hire in period 1 after the worker leaves to form a spinoff, she will most likely hire a bad worker (because low p_g). This worker will most likely fail (because low λ) which will result in the principal's type being revealed as the bad type. This gives the bad type principal an expected period 2 payoff close to zero.

On the other hand, when there is no spinoff formation, the bad type principal's payoff is : $(a+b)M -$

[25] Though such an equilibrium cannot exist with low p_g, λ as this ensures a negative payoff for a bad type worker who spins off (and whose type is known to be bad).

$w + \frac{b}{1-a}(\frac{a}{a+b})M$. This is clearly higher than the bad type principal's expected payoff from spinoff formation which is, at most $\frac{a}{a+b}M - w$ (because $\frac{a}{a+b} < a+b$). □

Another corollary to proposition 1 shows that spinoffs are good signals for the principal of the parent firm.

Corollary 3. *The formation of a spinoff acts as a signal of quality for the principal of the parent firm.*

Proof. This corollary follows from the fact that $V_1 < V_2 < V_3$. This implies that a good type worker is more likely (strictly more likely when the spinoff idea has value between V_1 and V_3) than a bad type worker to form a spinoff. Since a good type principal is more likely to hire a good type worker, the formation of a spinoff improves the reputation of the principal of the parent firm. □

The intuitive idea behind proposition 1 is the following. To show that the parent firm suffers a loss in the period in which the spinoff is formed, the following conditions would be sufficient - a) the reputation of the worker does not fall too much[26] when there is no spinoff, b) The probability of hiring a new good type worker from the population is not too high. We need the latter condition to make sure that the firm loses on payoff when it has to let go of a worker of high reputation when that worker decides to form a spinoff.

q being very small (the condition that ideas are rare) guarantees the first part. If ideas are rare then the non-formation of a spinoff is not very informative about the worker's ability. The condition that $a+b > \frac{a}{a+b}$ (probability that the current worker is good type is more than the probability that the next worker hired will be good type, even when we know that the current worker is good type) makes sure that the reputation of the newly hired worker is lower than the reputation of the original worker. Low p_g, λ gives us the condition that the price obtained with a new hire will be sufficiently lower than what could have been obtained with a worker of higher reputation. This is because the bad type worker is sufficiently worse than the good type worker.

Next, we need conditions to ensure that the gain from spinoff formation to a parent firm over two periods compensates for the loss in the period of spinoff formation. To show this, we compare the difference in the reputation of the workers hired in period 2 when there is a spinoff in period 1 to when there is no spinoff in period 1. We need this difference to be positive and greater than the loss in reputation from having a spinoff (the new worker hired by firm 1 after spinoff formation has a lower reputation than the worker who was already at the firm). Since d (rate of attrition) is assumed to be close to 1, the principal must hire new workers in period 2. The reputation of the worker(s) hired in period 2 is entirely dependent on the reputation of the

[26] Spinoffs are more likely to occur when the worker type is good as they have a higher expected payoff from spinoff formation and are therefore more likely to bear the initial investment cost (R). Thus, when no spinoff is formed, the worker's reputation goes down.

principal due to the difference in the screening ability of the two types of principals. A spinoff increases the principal's reputation via two channels. One, the occurrence of a spinoff itself may be an informative signal of the principal's type (example - when a spinoff occurs with an idea of value such that only a good type worker could have formed the spinoff ($V_1 < V < V_2$)). Two, after the spinoff is formed, the twin signals of successes of the workers in both firms also improves the reputation of the principal. If a spinoff is not formed then the principal's reputation can only improve via the single signal of the success of the worker at firm 1. When a spinoff occurs, since p_g, λ is low, the fact that the new worker hired by the principal in period 1 is successful and the worker hired at the spinoff also succeeds, almost guarantees that the principal of firm 1 is of type G. This convinces the market that the new worker hired by F_1 in period 2 will be good type. On the other hand, if there is no spinoff formation then the success of the old worker pushes the principal's reputation up, but not all the way to 1.

Cabral and Wang (2012) provide some empirical support for my result that low ability principals are more likely to be hurt by spinoff formation, and that spinoffs with good performance are good for the parent firm whereas bad spinoffs are always undesirable. They show that amongst firms which did not have a top selling car make in the entire period which covers their data set, the ones which spawned a good spinoff are less likely to exit than ones which spawned a bad (spinoff exits within a year) spinoff.

5 Endogenous wages

Hitherto, we have assumed that the wage of the worker is exogenously given and fixed. Now, we consider the case where the principal can offer any wages (above a base wage). This makes the problem more interesting because now the principal may be able to signal her own type via wage offers. For example, there may exist a separating equilibrium in which the good type principal offers high wages and the bad type principal offers base wages. For this section, we assume that good workers are scarce and much better than bad workers i.e. p_g, λ are very small. Thus, a bad type worker will command a negligible price (and therefore will get approximately zero wages if worker type is known) in the market.

Suppose the minimum wage that the principal needs to offer is given by $\underline{w}$. As with any signalling game, there are several equilibria possible. First, we focus our attention on determining sufficient conditions for a separating equilibrium where one type principal offers the base wage and the other offers a higher wage.

5.1 Separating on wages

In this subsection we ask the question - when can a good type principal signal her ability via a high wage offer? This is interesting to know because under these circumstances, the principal does not have to rely on signals coming from spinoffs to reveal her ability. I show that if the value of the principal's idea is high enough then a good type principal can separate with a higher wage offer than the bad type principal. The following proposition formalizes this:

Proposition 2. *There exists a $\bar{V}$ such that if $M > \bar{V}$, then there exists a separating equilibrium in which the good type principal signals her ability by offering a higher wage than the bad type principal.*

Proof. We will prove the existence of an equilibrium in which the bad type principal offers base wages $\underline{w}$ and the good type principal offers some wages $w_g (> \underline{w})$.

Consider the following strategies:

<u>In Period 2</u> (6)

Worker strategy:

Accept any individually rational wages, else do nothing

Principal(s) strategy:

Offer zero wages irrespective of history or own type

<u>In Period 1</u>

Worker strategy before spinoff decision:

$S_w^1(V, w, R_1(W_1), G) = Spinoff \ if \ V \geq \frac{w+\underline{w}+R}{2}, \ else \ accept \ contract.$

$S_w^1(V, w > w_g, R_1(W_1), B) = Spinoff \ if \ V \geq \frac{w+\underline{w}+R}{1}, \ else \ accept \ contract$

$S_w^1(V, w \leq w_g, R_1(W_1), B) = Spinoff \ if \ V \geq \frac{w+\underline{w}+R}{(\frac{b}{1-a})},$

$p(V,w)Spinoff \ + \ (1-p(V,w))accept \ if \ \frac{w+\underline{w}+R}{1} < V < \frac{w+\underline{w}+R}{\frac{b}{1-a}}, \ else \ accept \ contract$

Worker strategy after deciding to form spinoff i.e. principal of firm 2 strategy:

Offer base wages $\underline{w}$ irrespective of own type

Principal's strategy:

$S_p^1(G) = w_g$

$S_p^1(B) = \underline{w}$

Let $P(P = G/wage = w)$ denote the belief regarding the probability that the principal of firm 1 is type G, given that the wage offer is w. Then, beliefs are given as:

About Principal in period 1 (from wage offers)

$P(P = G/wage = w) = 1 \; if \; w \geq w_g$

$P(P = G/wage = w) = 0 \; if \; w < w_g$

About Principal in period 2 (from wage offers)

$P(P = G/wage = 0) = 1 \; if$ wage offer in 1 was w_g and worker succeeded

$P(P = G/wage = 0) = 0 \; if$ wage offer in 1 was not w_g or the worker failed

$P(P = G/wage > 0) = 0$

Define the following:

$$P(ns,w) = \frac{b}{1-a}[1-q+q\frac{w+\underline{w}+R}{2\bar{a}}] + \frac{1-a-b}{1-a}[1-q+q\frac{w+\underline{w}+R}{\bar{a}} + q\int_{w+\underline{w}+R}^{\frac{(w+\underline{w}+R)(1-a)}{b}} \frac{1-p(V,w)}{\bar{a}}dV] \tag{7}$$

$$P(W = G/wage = w, \text{no spinoff}) = \frac{\frac{b}{1-a}[1-q+q\frac{w+\underline{w}+R}{2\bar{a}}]}{\frac{b}{1-a}[1-q+q\frac{w+\underline{w}+R}{2\bar{a}}] + \frac{1-a-b}{1-a}[1-q+q\frac{w+\underline{w}+R}{\bar{a}} + q\int_{w+\underline{w}+R}^{\frac{(w+\underline{w}+R)(1-a)}{b}} \frac{1-p(V,w)}{\bar{a}}dV]} \tag{8}$$

$P(ns,w)$ (in 7) denotes the probability that there is no spinoff according to the above strategies after the wage offer $w(for \; w < w_g)$. $P(W = G/wage = w, \text{no spinoff})$ (in 8) denotes the probability that the worker at firm 1 is good type given that the worker did not form a spinoff after the principal offered wages $w(for \; w < w_g)$. Note that $P(ns,w) = 1 \; when \; q \approx 0$, and $P(W = G/wage = w, \text{no spinoff}) = \frac{b}{1-a} \; when \; q \approx 0, \; w < w_g$ Now, we choose:

$$w_g = \frac{[1 + \frac{b}{1-a}(1-q+q\frac{w+R}{2\bar{a}}) - P(ns,\underline{w})P(W = G/wage = \underline{w}, \text{no spinoff})]M + P(ns,\underline{w})\underline{w}}{(1 - \frac{bqM}{2\bar{a}(1-a)})} \tag{9}$$

First, note that $w_g = M + \underline{w} \; when \; q \approx 0$. Now, we need to show that the strategies outlined in 6 constitute an equilibrium. Given the wage offers, the proof that the worker plays optimally is very similar to that of proposition 1. The worker strategies in 6 are similar to those described by 1. The only difference now is that when the principal offers wages w_g, then the cut offs V_1, V_2, V_3 (as described in 1) are given by $\frac{w_g+\underline{w}+R}{2}, \frac{w_g+\underline{w}+R}{1}, \frac{w_g+\underline{w}+R}{1}$. Thus, $V_2 = V_3$. Note that the principal offering wages w_g in this separating equilibrium perfectly signals to the market that the principal of firm 1 is good type, and therefore so must the worker at firm 1 (because a good type principal can screen perfectly). So the good type worker does not really need to signal her own type if her principal announces a wage of w_g. On the other hand, when the principal offers $\underline{w}$ in this separating equilibrium, then the cut offs V_1, V_2, V_3 (as described in 1) are given by

$\frac{\bar{w}+\underline{w}+R}{2}, \frac{\bar{w}+\underline{w}+R}{1}, \frac{(\bar{w}+\underline{w}+R)(1-a)}{b}$. Thus, the good type worker spins off if the worker gets an idea with value more than $\frac{\bar{w}+\underline{w}+R}{2}$, else the good worker accepts the contract. The bad type worker spins of with probability one if the worker gets an idea, and the value of that idea is more than $\frac{(\bar{w}+\underline{w}+R)(1-a)}{b}$. If the value of the idea (V) is between $\frac{\bar{w}+\underline{w}+R}{1}$ and $\frac{(\bar{w}+\underline{w}+R)(1-a)}{b}$ then the bad type worker spins off with probability $p(V,\underline{w})$; where $p(V,w) = \frac{b}{1-a-b}[\frac{V}{w+\underline{w}+R} - 1]$, and accepts the contract with probability $(1-p(V,\underline{w}))$. If the value of the idea is lower than $\frac{\bar{w}+\underline{w}+R}{1}$ (or no idea at all), then the bad type worker accepts the contract.

Next, we must show that the wage offers are optimal. For this, we need to show two things: a) The bad type principal does not want to deviate, b) The good type principal does not want to deviate.

In period 2, no type of principal ever gains by offering more than zero wages because beliefs about the principal who offers more is that the principal must be bad type (since this is off the equilibrium path I can specify these beliefs). Now let us consider the incentives to deviate for a bad type principal in period 1. The best profitable deviation for the bad type principal is to offer the wages w_g. We will show that this is not profitable for the bad type principal.

$$\begin{aligned}
&\text{Payoff from offering wages } \underline{w} \geq \text{ Payoff from offering wages } w_g \\
&\Leftrightarrow P(ns,\underline{w})[P(W=G/wage=\underline{w}, no\ spinoff)M - \underline{w}] \geq (V-w_g) + \frac{b}{1-a}(1-q+q\frac{w_g+\underline{w}+R}{2\bar{a}})M \\
&w_g \geq \frac{[1+\frac{b}{1-a}(1-q+q\frac{\bar{w}+R}{2\bar{a}}) - P(ns,\underline{w})P(W=G/wage=\underline{w}, \text{no spinoff})]M + P(ns,\underline{w})\underline{w}}{(1-\frac{bqM}{2\bar{a}(1-a)})}
\end{aligned}$$

This holds by our choice of w_g (see equation 9).

Now, let us consider possible deviations for the good type principal. Clearly, the principal has no incentive to offer wages more than w_g. If the principal offers anything less than w_g then she is immediately thought of as the bad type principal. Therefore, in this case the best deviation is to offer $\underline{w}$. Let us show that this is not optimal.

$$\begin{aligned}
&\text{Payoff from offering wages } w_g \geq \text{Payoff from offering wages } \underline{w} \\
&\Leftrightarrow M - w_g + M > P(ns,\underline{w})[P(W=G/wage=\underline{w}, no\ spinoff)M - \underline{w}] \\
&\Leftrightarrow w_g < [2 - P(ns,\underline{w})(P(W=G/wage=\underline{w}, no\ spinoff)]M + P(ns,\underline{w})\underline{w} \qquad (10)
\end{aligned}$$

Since q is small ($q \approx 0$), we get that $w_g = M + \underline{w}$. Equation 10 reduces to:

$$w_g < [2 - \frac{b}{1-a}]M + \underline{w}$$
$$\Leftrightarrow M + \underline{w} < [2 - \frac{b}{1-a}]M + \underline{w}$$

This holds because $\frac{b}{1-a} < 1$ (because $a+b<1$). We also need it to be individually rational for the good type principal to be willing to offer the wages w_g. Thus, we need $M - w_g + M > 0$. Substituting $w_g = M + \underline{w}$, we get that $M - w_g + M > 0 \Leftrightarrow M > \underline{w}$. For it to be individually rational for the bad type principal to be willing to offer the wages $\underline{w}$, we need $\frac{b}{1-a}M - \underline{w} > 0$ i.e. we need $M > \frac{\underline{w}(1-a)}{b}$. Thus, if M is high enough then it is IR for both types of principals to play the suggested equilibrium strategy.

By continuity of all the expressions in q, there exists a $\underline{q}$ such that if $q < \underline{q}$ then there exists a $\bar{V}$ (would be a function of q) such that if $M > \bar{V}$ then there exists a separating equilibrium where the good type principal offers higher wages than the bad type principal. □

The intuition here is that if the value of the idea is high enough then the high ability principal is willing to pay a higher wage to separate from the low ability principal. The bad type principal does not copy the strategy of the good type principal because the expected future payoff of the bad type principal is lower. Also, note that the bad type principal does not mimic the good type principal even if her own firm idea (M) is of very high value. This is because the minimum wage required for the bad type principal to mimic the good type principal (w_g) is increasing in the value of the idea on which F_1 is established ($w_g = M + \underline{w}$ when $q \approx 0$). Thus, the more valuable the idea on which the parent firm is built, the more costly it becomes for the principal of the parent firm to signal her ability via wage offers.

An interesting question to ask is: in the above separating equilibrium, are spinoffs more likely under a G type principal or a B type principal? On the one hand, the worker needs a better idea to leave a G principal (since the G principal offers higher wages, the opportunity cost of spinning off is higher). On the other hand, the worker with the good principal has to be good type, so she can spin off with a lower value idea as compared to the worker of a bad principal (since that worker may be good or bad). It is easy to show that if the value of the principal's idea (M) is high, then spinoffs are more likely to come from firms owned by a B type principal because the good type principal is willing to pay high wages to separate from the bad type principal, and these high wages increase the opportunity cost of forming a spinoff for the worker. On the other hand, if the principal's idea is medium value (so that $\frac{(1-a)\underline{w}}{b} < M < 2\underline{w} + R$) and b is small then spinoffs are more likely to come from firms owned by a G type principal[27].

[27]It is important to note that this result only holds when the probability of getting an idea is independent of worker type. If the

5.2 Pooling on wages

In this subsection we ask the question - under what conditions do we have an equilibrium in which the good and bad type principal pool on wage offers? One reason for doing this is to justify the common wage assumption in the baseline principal agent model. Furthermore, finding a pooling equilibrium is interesting as it would highlight conditions under which signals coming from spinoffs becomes really important for the principal (since there is no signalling via wages in a pooling equilibrium). Consider the following strategy profile where we define strategies depicting a pooling on base wage ($\underline{w}$) equilibrium for some real numbers $\bar{V_1}, \bar{V_2}, \bar{V_3}, R$ and a function p from the domain of the idea value space to $[0,1]$:

Period 2 (11)

$Principal's\ Strategy$:

$S_p^2(H, G/B) = Wage = 0$

$Worker's\ Strategy$:

Accept contract if IR wages

Period 1

$Principal's\ Strategy$:

$S_p^1(G/B) = \underline{w}$

$Worker's\ Strategy$:

$S_w^1(V, w, R_1(W_1), G) = Spinoff\ if\ V \geq \bar{V_1},\ else\ accept\ contract$

$S_w^1(V, w, R_1(W_1), B) = Spinoff\ if\ V \geq \bar{V_3},\ else\ if\ \bar{V_2} < V < \bar{V_3}\ ;\ p(V)Spinoff\ +\ (1-p(V))accept$

$,\ else\ accept\ contract$

---

good type worker gets an idea with a much higher probability than a bad worker, then we could always have more spinoffs under good type principal.

Let $P(P = G/wage = w)$ denote the belief regarding the probability that the principal of firm 1 is type G, given that the wage offer is w. Then, beliefs are given as:

About Principal in period 1 (from wage offers)

$P(P = G/wage = w) = a \; if \; w = \underline{w}$

$P(P = G/wage = w) = a \; if \; w > \underline{w}$ (consistent with type independent trembles in the principal's action choice)

About Principal in period 2 (from wage offers)

$P(P = G/wage = 0) = \dfrac{a}{a+b+(1-a-b)\lambda} \; if$ wage offer in 1 was $\underline{w}$ and worker succeeded

$P(P = G/wage = 0) = 0 \; if$ wage offer in 1 was not $\underline{w}$ or the worker failed

$P(P = G/wage > 0) = 0$

The proof that this is an equilibrium is similar to the proof of proposition 1 so I don't repeat it here. An interesting question to consider is - which equilibrium is preferred by the principal, i.e. when does the pooling equilibrium payoff dominate the separating equilibrium. For this question, we only consider the least cost (wage) pooling equilibrium (pooling on base wage $\underline{w}$) and the least cost separating equilibrium[28]. Clearly, the equilibria defined by 11 and 6 reflect the lowest cost pooling and separating equilibria respectively[29]. The following corollary highlights conditions under which the principal (good or bad type) does not prefer to signal ability via wages.

Corollary 4. *If $a+b > \frac{b}{a+b}$, then the principal gets a higher payoff in the least cost pooling equilibrium as compared to the least cost separating equilibrium.*

Proof. Consider the payoff of the high ability principal first. Payoff in the least cost separating equilibrium

[28]The separating equilibrium where the high ability principal can separate from the low ability principal by offering the lowest possible wages in any separating equilibrium.

[29]The proof that 6 represents the lowest cost separating equilibrium is simple. In the least cost separating equilibrium, it must be the case the bad type principal is offering the lowest possible wages, and that the payoff for the bad type principal from offering the minimum wage is greater than the payoff from offering the wage offered by the good type principal. Suppose the latter is w^*. Then, we must have that $M - w^* + \frac{b}{1-a}M < \frac{b}{1-a}M - \underline{w} \Rightarrow w^* \geq \underline{w} + M = w_g$

$= M - w_g + M$. Payoff in the least cost pooling equilibrium = $(a+b)M - \underline{w} + \frac{a}{a+b}M$.

Payoff in the least cost pooling equilibrium > Payoff in the least cost separating equilibrium

$$\Leftrightarrow (a+b)M - \underline{w} + \frac{a}{a+b}M > M - w_g + M$$
$$\Leftrightarrow (a+b)M - \underline{w} + \frac{a}{a+b}M > M - (M+\underline{w}) + M$$
$$\Leftrightarrow (a+b) + \frac{a}{a+b} > 1$$
$$\Leftrightarrow (a+b) > \frac{b}{a+b}$$

Next, consider the preference of the low ability principal. Payoff in the least cost separating equilibrium = $(\frac{b}{1-a})M - \underline{w}$. Payoff in the least cost pooling equilibrium = $(a+b)M - \underline{w} + \frac{b}{1-a}\frac{a}{a+b}M$.

Payoff in the least cost pooling equilibrium > Payoff in the least cost separating equilibrium

$$\Leftrightarrow (a+b)M - \underline{w} + \frac{b}{1-a}\frac{a}{a+b}M > (\frac{b}{1-a})M - \underline{w}$$
$$\Leftrightarrow (a+b) + \frac{ab}{(a+b)(1-a)} > \frac{b}{1-a}$$
$$\Leftrightarrow (a+b) > (\frac{b}{a+b})(\frac{b}{1-a})$$

This holds because $(a+b) > (\frac{b}{a+b})$ and $\frac{b}{1-a} < 1$ (because $1-a-b > 0$). □

The intuitive idea here is pretty simple - if the prior reputation of the principal is high enough ($a > (\sqrt{b} - b)$), then the principal does not prefer the equilibrium where she would have to pay high wages to signal her ability. This is because the gain in reputation from this expensive signalling is not high enough.

5.3 A refinement which eliminates all wage separating equilibria

We note that different kinds of signalling equilibria are possible when the principal can make wage choices. We introduce a refinement in this subsection to reduce the set of equilibria. In this subsection, we assume that the principal can make a mistake (type independent) in the wage offer. Formally, if the principal wishes to offer wages w_1, then the principal actually offers w_1 with probability $1-\varepsilon$ and any other feasible wage offer (above $\underline{w}$) with positive probability, where ε is very small.

In reality, the wage offer made by the principal is usually guided by several factors (apart from signalling concerns). For example, Board et al. (2017) present a model where higher talent firms post higher wages. However, in an application in the same paper where the workers value working with talented workers, this peer effect benefit allows high talent firms to pay their workers *lower* wages in the steady state. Thus, Board

et al. (2017) present models which give us one possible justification for why wages are not always perfect signals of the firm's talent level. In many environments, it would appear intuitive that wages are not perfectly informative of the principal's type. Our refinement formalizes this notion in one way. Next, we show that this refinement eliminates all separating on wage equilibria in our environment. Therefore, in this environment, signals coming from spinoffs could be very beneficial for a high ability principal of the parent firm as there is no possibility to signal via wage offers.

Before I present arguments to show that there are no separating equilibria in this environment, note that the pooling on wage equilibrium defined in section 5.2 still holds under these conditions (in that equilibrium we defined off equilibrium beliefs via trembles in the principal's action choice). However, what of separating equilibria and semi-separating equilibria?

Proposition 3. *If the principal's action choice is subject to trembles, there does not exist any separating or semi-separating wage equilibrium.*

Proof. Under this refinement, we can never have a fully separating equilibrium. Suppose that there exists an equilibrium where the good type principal and the bad type principal offer different wages. In this case, the reputation of the bad type principal is zero if she follows the suggested strategy. However, when mistakes are possible, the bad type principal can get a non zero reputation at no cost via an infinitesimal change in wage. This is because any wage other than that suggested by the equilibrium strategy is believed to be the result of a tremble in the principal's action choice. However, since both types of principals can make mistakes with equal probability, the reputation of the principal who offers a wage slightly different than the wage offer expected from the bad type principal is the same as the prior reputation of the principal. Thus, the bad type principal will have an incentive to deviate, making fully separating equilibrium impossible.

Next, we consider the possibility of a semi-separating equilibrium. Suppose there exists a semi-separating equilibrium. In such an equilibrium, the strategy of both type principals involves randomization on some wage interval. Suppose the strategy of the good and bad principals instructs them to randomize on a wage interval $[w_1, w_2]$. Let the probability distribution with which a t type principal offers a wage w be given by $f_t(w)$. First note that the principal expects a positive payoff tomorrow only if the worker succeeds today. If the worker fails today, the principal's type is revealed to be bad, and since the principal has to hire again tomorrow from a pool of workers where good types are scarce ($p_g \approx 0$) and much better than bad type workers ($\lambda \approx 0$), the principal must get a payoff of zero tomorrow. Also, remember that since $q \approx 0$, the principal will

ignore the possibility of spinoff formation in her expected payoff calculations.

$$\text{Payoff from wage offer } w \text{ for } G \text{ principal} = P(W = G/wage = w)M - w + \frac{P(P = G, W = G/wage = w)}{P(P = G, W = G/wage = w) + P(P = B, W = G/wage = w)}M$$

$$\Rightarrow \text{Payoff from wage offer } w \text{ for } G \text{ principal} = (\frac{af_g(w) + bf_b(w)}{af_g(w) + (1-a)f_b(w)})M - w + (\frac{af_g(w)}{af_g(w) + bf_b(w)})M$$

$$\text{Payoff from wage offer } w \text{ for } B \text{ principal} = P(W = G/wage = w)M - w + (\frac{b}{1-a})\frac{P(P = G, W = G/wage = w)}{P(P = G, W = G/wage = w) + P(P = B, W = G/wage = w)}M$$

$$\Rightarrow \text{Payoff from wage offer } w \text{ for } B \text{ principal} = (\frac{af_g(w) + bf_b(w)}{af_g(w) + (1-a)f_b(w)})M - w + \frac{b}{1-a}(\frac{af_g(w)}{af_g(w) + bf_b(w)})M$$

Now consider any wage w in the interval $[w_1, w_2]$. If the wage is increased by a small amount δ such that $w + \delta \in [w_1, w_2]$, the increased wage cost for both type of principals is δ. For the good type principal to be indifferent between w and $w + \delta$, the increase in payoff via reputational benefits must be equal to δ. The same is true for the bad type principal. However, note that the increase in payoff for the good type principal must be strictly higher than that of the bad type principal if $a \neq 0$. This is because they expect the same payoff in the current period, and the good type principal's expected payoff from tomorrow is strictly higher than the bad type principal's expectated payoff from tomorrow because the good type principal knows that her worker will succeed today whereas the bad type is aware that her worker may be bad type and can fail. Thus, it is not possible to keep both types of principals *simultaneously* indifferent to any small change in wages. This is a contradiction because we assumed that both types of principals are randomizing in $[w_1, w_2]$. Therefore, we cannot have a semi separating equilibrium in this environment. □

6 Frequent Ideas

Hitherto, we have obtained results by looking at an environment where the probability of getting an idea is low ($q \approx 0$). In this section, we will study the signalling impact of spinoff formation when ideas are common. Theoretically, this is an important distinction for the following reason. When ideas are rare, there is very little information to be gained from the non-formation of a spinoff. However, when ideas are common, the non-formation of a spinoff is very informative about the value of the idea the worker may have had. This, in turn, can be signal about the worker's ability. For example, we have shown the existence of an equilibrium where a good type worker spins off at a lower idea value threshold compared to the bad type worker. If such an equilibrium is played when ideas are common, then the non-formation of a spinoff can significantly reduce the reputation of the worker with the principal. Therefore, the non-formation of a spinoff can be payoff reducing for the principal. On the other hand, the formation of a spinoff requires the hiring of a new worker from the pool of workers. This new worker will not have a reputation as high as the incumbent worker, thereby causing a reduction in the principal's payoff. Thus, for the principal of the parent firm, there is a

trade off. In this section, we determine conditions under which the principal would prefer to have spinoffs when ideas are frequent, i.e. we study an environment where $q \approx 1$. We assume that wages are exogenously given (as described in section 3) to avoid complicating the model with signalling via wages. The following proposition highlights sufficient conditions under which a good type principal prefers to have spinoffs.

Proposition 4. *There exists a p', λ' such that if $p_g < p'$ and $\lambda < \lambda'$, then there exists an equilibrium in which a good type principal gets a higher ex-ante expected payoff from spinoff formation as compared to when there is no spinoff formation.*

Proof. We will assume that the worker plays the same strategy as the one played in proposition 1. We will take $p_g, \lambda \approx 0$ and show the result. The proposition will hold by continuity of all expressions in p_g, λ. First, let us calculate the payoff for the principal when there is no spinoff formation. Let the probability of the worker being good type given that there was no spinoff formation be denoted by $P(W_1 = G/ns)$. Then:

$$P(W_1 = G/ns) = \frac{(a+b)\frac{V_1}{\bar{a}}}{(a+b)\frac{V_1}{\bar{a}} + (1-a-b)(\frac{V_2}{\bar{a}} + \int_{V_2}^{V_3}(1-p(V))dV)}$$

substituting for $V_1, V_2, V_3, p(V)$, we get:

$$P(W_1 = G/ns) = \frac{(a+b)}{(a+b) + (1-a-b)(2 + \frac{2}{2w+R}\int_{2w+R}^{\frac{2w+R}{a+b}}(1 - \frac{(a+b)(V-(2w+R))}{(1-a-b)(2w+R)})dV)}$$

$$\Rightarrow P(W_1 = G/ns) = (a+b)^2$$

Note that when ideas were rare, the non formation of a spinoff did not change the reputation of the worker at all, leaving it at $(a+b)$. However, when ideas are frequent, the non formation of a spinoff reduces the worker's reputation to $(a+b)^2$. This is because a good type worker is more likely to form the spinoff than a bad type worker, so the non formation of a spinoff results in the market believing that the worker is more likely to be bad type. Next, we need to calculate the belief about the type of the principal of F_1 when there is no spinoff formation. Let this be denoted by $P(P_1 = G/ns)$. Then:

$$P(P_1 = G/ns) = P(P_1 = G/W_1 = G)P(W_1 = G/ns) + P(P_1 = G/W_1 = B)P(W_1 = B/ns)$$

$$\Rightarrow P(P_1 = G/ns) = a(a+b)$$

Now, we can calculate the expected payoff from no spinoffs. A good type principal knows that her worker will succeed. This gives the principal a second period reputation of $\frac{a(a+b)}{a(a+b)+b(a+b)}$ when $p_g, \lambda \approx 0$. Let the

expected payoff from no spinoffs for a good type principal be denoted by $Payoff(ns)$. Then:

$$Payoff(ns) = (a+b)^2M - w + \frac{a(a+b)}{a(a+b)+b(a+b)}M$$
$$\Rightarrow Payoff(ns) = (a+b)^2M - w + \frac{a}{(a+b)}M$$

Remember that since good type workers are more likely to spinoff, and good type principals are better at screening workers, the formation of a spinoff can never decrease the reputation of the principal. The lowest expected payoff from spinoff formation occurs when the formation of the spinoff does not increase the reputation of the principal at all. This happens when the value of the idea on which the spinoff is based is higher than $V_3 = \frac{2w+R}{a+b}$. In this case, any type of worker will spinoff, giving no information about the worker's or the principal's type. Let the expected payoff from such a spinoff for a good type principal be denoted by $Payoff(spinoff, V \geq V_3)$. Then:

$$Payoff(spinoff, V \geq V_3) = aM - w + M$$

Since this is the lower bound of the expected payoff from spinoff formation for a good type principal, a sufficient condition that a good type principal prefers to have a spin off ex ante is:

$$Payoff(spinoff, V \geq V_3) \geq Payoff(ns)$$
$$\Leftrightarrow aM - w + M \geq (a+b)^2M - w + \frac{a}{(a+b)}M$$
$$\Leftrightarrow (1+a+b) \geq \frac{a}{a+b}$$

This is always true since the LHS is above 1 and the RHS is below 1. □

Thus, a good type principal always prefers spinoffs to happen when good workers are scarce and much more talented than bad worker. This effect is even stronger[30] when ideas are frequent than when they are rare because in the former case, the non formation of a spinoff actually reduces the reputation of the worker (thereby reducing the payoff of the principal) whereas in the latter case, the non formation of a spinoff does not change the reputation of the worker. Just as in corollary 2, we can easily show that if $a+b \geq \frac{a}{a+b}$ and p_g, λ are low enough, then the bad type principal does not prefer the spinoff to occur in equilibrium.

[30] Payoff from no spinoff formation when ideas are frequent is less than payoff from no spinoff formation when ideas are rare.

7 Discussion

In this section, I discuss some of my modelling choices.

7.1 Firing to reveal type

In the paper, we notice that a good type principal gains in period 2 when she has to hire a new worker in the first period after the worker leaves to form a spinoff. Some of this gain in reputation comes because the principal is able to hire a good type worker (deduced from the success of the first-period job) in a market where good type workers are scarce. This leads the market to conclude that the principal of the parent firm must have good screening ability and therefore must be good type. Could the good type principal have achieved the same gain by simply firing the first-period worker, and not waiting for him to leave to form a spinoff? There are two reasons why this may not work. First, labour laws may prevent the principal from firing the worker just to send a good signal. Two, even if the principal was permitted to do this, the bad type principal would have the incentive to copy this strategy of the good type principal, rendering the signal noisy and less profitable.

7.2 Low attrition

At least two results in this article rely on worker attrition being sufficiently high in the environment. One, we show that the good type principal may be willing to pay higher wages (as compared to the bad type principal) to signal her screening ability to the market. The idea is that high attrition makes the principal's reputation very important for tomorrows payoff, and at the same time, it excludes the possibility of holding on to talent. If we have an environment where attrition is very low, it is likely that the bad type principal would be the one who would be willing to pay higher wages to retain talent (worker with high enough reputation). This is because, unlike the good type principal, a bad type principal does not have the screening ability to hire more talent from a market in which talent is scarce. The intuition is the same as Tadelis (1999) - the bad type player cannot count on building a reputation and is therefore willing to pay more to hold on to one, whereas the good type player can always build a reputation and is therefore willing to pay less to acquire/hold on to one.

Two, we show that good type workers are more likely to form a spinoff compared to bad type workers. This is also (partially) the consequence of high enough attrition rate. Here, the intuition is that if worker attrition is low *and* the principal can offer longer run contracts, then the principal can reward the worker for good performance (for example, wages could be a function of worker reputation). Obviously, since the good

type worker is more likely to succeed, such a contract would make the opportunity cost of spinoff formation higher for the good type worker as compared to the bad type worker. Which type of worker is more likely to form the spinoff would depend on the exact specification of the model, particularly on the nature of the wage contract, the screening ability of the bad type worker when she becomes a principal coupled with the availability of talent in the labour market, how quickly reputation can be earned, and how much the players discount the future.

7.3 Infinite Horizon Model

While this paper presents a simple two-period model, it is clear that the results would hold in a longer horizon framework. This is because the key idea in this paper relies on the firm's future payoffs being dependent upon the principal's reputation via the screening channel. Thus, in any infinite horizon model with discounting, it will be easy to show that the good type principal prefers period outcomes which increase her reputation quickly (such as spinoffs). I should point out that the principal's reputation also improves if there are no spinoff's (via the worker's performance). However, the occurrence of a spinoff increases the speed at which the principal's reputation increases (via own worker performance and via spinoff formation and performance). This is valuable in any model in which the principal is not infinitely patient.

8 Conclusion

This paper demonstrates a new channel via which a spinoff can be beneficial for its parent firms. I analyze a two-period principal-worker model where the type of the principal and the worker is not known, *and* the two types are correlated via the principal's screening ability. In an environment with high enough labour attrition, the principal's reputation for screening well is very important for the firm's future payoffs. The formation of a spinoff and its performance can act as a signal of quality of the principal's screening ability because good workers are more likely to form spinoffs, and spinoffs formed by good workers are more likely to succeed. In the baseline model, I do not allow the principal to signal her ability via wages. This assumption is relaxed later in the paper. I show that if a refinement is introduced in the model then the principal is unable to signal her type via wage offers, thereby making signalling via spinoffs even more relevant.

There are several variations of this model which would be interesting to study in the future. For example, what is the optimal contract in an environment in which the worker can leave? I have already mentioned in the previous section that an environment with low worker attrition may offer different results. Therefore, such an environment would be interesting to analyze formally. Finally, I have assumed in the paper that worker

attrition is exogenous. Making this an endogenous choice could be very interesting as this could be yet another channel which can offer a signal about the principal's ability, the worker's ability and the prospects of the parent firm. I hope to work on these ideas in the future.

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