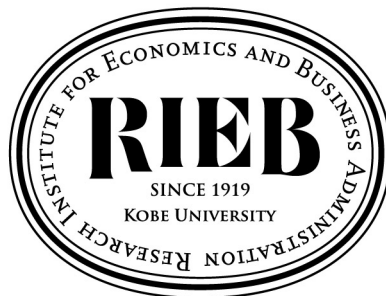DP2021-20

Socially Responsible Investment: Ex-ante Contracting or Ex-post Bargaining?

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Abstract

This paper shows how a socially and environmentally aware firm principal can motivate a profit-oriented manager to pursue positive environmental, social, and governance (ESG) outcomes. In the model, the manager produces a verifiable output that is detrimental to ESG but also engages in an unverifiable output that promotes ESG. I show that an ex-post bargaining contract is preferred to an ex-ante commitment contract if the unverifiable output substantially improves ESG or if there is a large negative externality. The paper also demonstrates how social impact bonds can be more effective than short-term debt when used to finance social programs.

Keywords: Socially responsible investment, ESG, multitask, holdup, incomplete contracts, social impact bonds.

JEL Codes: D86, G11, G23, M12, M14

1 Introduction

Socially responsible investment (SRI) has attracted the interest of investors, employees, and consumers alike. Many investment funds, particularly socially responsible funds, consider asset allocation from an environmental, social, and governance (ESG) perspective. According to the Global Sustainable Investment Review (2020), ESG investment has grown rapidly and now accounts for 35.9% of funds in global assets under management (an especially rapid increase considering that in 1995 there was none). Nonetheless, firm managers often continue to pursue only profit maximization. For example, 55% of FTSE companies do not include ESG measures in their executive performance objectives (O'Connor, Harris, and Gosling (2021)). This paper theoretically demonstrates how ESG-oriented principals can use ex-post bargaining and ex-ante commitments to motivate profit-maximizing managers to pursue SRI.

Suppose there are two different contracts the principal can offer the manager in a two-period model. One is a contract that binds both parties to determine the second-period wage at the beginning of the first period (hereafter the ex-ante commitment contract), while the other is a contract that binds both parties (at the beginning of the first period) to negotiate the second-period wage at the beginning of the second period (hereafter the ex-post bargaining contract).[1] In both contracts, the first-period wage is fixed, and the difference is when and how the second-period wage is determined. The main question I address in this paper is which contract promotes the profit-maximizing manager to engage in the promotion of ESG output. I show that ex-post bargaining is useful in inducing the manager to make efforts to produce the ESG promoting output. However, the ESG-oriented principal can be better off by offering an ex-ante contract when the social cost is sufficiently small or the effectiveness of the ESG output in reducing social costs is low. I further show that the greater the degree of the firm specificity of the incumbent manager's investment, the more likely it is that the principal will choose an ex-post bargaining contract.

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[1] The manager remains employed under both wage contracts on the equilibrium path. Moreover, the ex-ante commitment contract is renegotiation proof because neither the principal nor the manager chooses any action in the second period. This differs from Inderst and Mueller (2010) and Adachi-Sato (2018) which examine optimal managerial compensation and replacement contracts.

To investigate this question, I examine an effort allocation problem (in the form of firm specific capital investment) in the two-period multitask agency model following Holmstrom and Milgrom (1991). In this model, the manager of a firm must produce an observable and verifiable output x and an observable but unverifiable output y, where x incurs observable but unverifiable social costs or a negative externality denoted z, while y reduces z.[2] These are realized at the end of each period. Examples of x include normal day-to-day outputs or production, which may be accompanied by discrimination or bullying that occurs in the course of daily business. Examples of y include embedding in the firm a culture that values environmental and social issues. It is difficult for outsiders to evaluate a firm's culture (unverifiable), even though they may see or hear about it (observable). Another example of y is internal audit department monitoring, which may not be able to monitor all business conduct of all staff, even though human resource departments typically provide a list of policies such that all staff follow all regulations all the time.[3] If y effectively reduces z, or in other words, if the sensitivity of y in reducing z, as denoted by ζ, is high, it is worth expending effort to produce y. In contrast, if ζ is low, it makes little sense to produce y.

In the model, the incumbent manager must make some effort, assumed to be firm specific, in the first period, to produce x and y. In order to produce these outputs, the manager makes firm specific observable but unverifiable effort or investments (hereafter FSI). Let I_x and I_y denote an FSI made by the incumbent manager to produce x and y, respectively.[4] An example of I_x includes efforts to develop internal employment relationships and build a network of connections. Examples of I_y include efforts to promote a culture that values lowering the firm's social costs and to truly listen to the voice of employees. The information in I_x and I_y is then collected over time through frequent and personal contact between the principal and the manager, but is difficult to transmit to outsiders because of a lack of knowledge of the full context. Practically,

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[2] At the end of Section 3, I consider an extension in which y is partially observable and verifiable, and discuss how our main results are affected by this modification.

[3] In reality, there are both verifiable and unverifiable outputs that help reduce social costs. However, the line between verifiable and unverifiable outputs is unclear when it comes to reducing social costs. Therefore, this paper focuses only on the unverifiable outputs that can reduce social costs.

[4] In this paper, investments are only made by the incumbent manager during the first period. He does not make any investments in the second period because doing so only incurs extra costs.

the manager's efforts rarely generate instantaneous outcomes. Therefore, I assume that the FSI determined and exerted during the first period does not affect outputs in the first period and only affects outputs in the second period.

The main result derived from the model (holding the degree of firm specificity fixed) is that the principal's decision to offer an ex-post bargaining or ex-ante commitment contract depends on ζ and z. In brief, the larger ζ or z, the more likely it is that the principal offers an ex-post bargaining contract with a fixed wage to motivate ESG production.[5] [6] Conversely, the smaller is ζ or z, the more likely it is that the principal is made better off offering an ex-ante commitment contract with incentive pay and not encouraging any ESG output.

The intuition behind the main result is as follows. If the principal offers the manager an ex-post bargaining contract, the manager has an incentive to invest in both the verifiable and unverifiable outputs during the first period. This is because the manager will seek a larger bargaining surplus (Nash product) by doing so. The more the manager invests in the production of both the verifiable and unverifiable outputs, the larger the entire bargaining surplus. However, because the bargaining surplus must be split between both parties, the holdup problem arises. Thus, neither investment in the verifiable output nor that in the unverifiable output is optimal under the ex-post bargaining contract.

If, however, the principal offers an ex-ante commitment contract, the manager has no incentive at all to invest in the unverifiable output because his wage depends only on the verifiable output in the second period. Instead, the manager will be motivated to invest in the optimal level of the verifiable output. Thus, the principal offers a contract that will induce the manager to invest in the verifiable output, which maximizes the firm's expected total net payoff without considering social costs.

In short, an ex-ante commitment contract is a form of incentive contracting whereby the principal retains the entire surplus by making a take-it-or-leave-it offer to the manager at the

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[5]The incumbent manager is no longer competitive at the beginning of the second period if he invested during the first period because he gained firm-specific skills no newly hired manager could obtain in the second period.

[6]I demonstrate in Section 3 that the ex-post bargaining contract can be either a fixed wage or an incentive payment.

beginning of the first period, knowing full well that the manager will be unmotivated to work on the unverifiable output. In contrast, an ex-post bargaining contract is a holdup inducing contract whereby the principal is obliged to split the surplus in the second period, knowing full well this induces the manager to make an effort to produce the unverifiable output. Consequently, if the unverifiable output effectively reduces social costs, or if the social costs are large, the principal that wishes to reduce social costs is more likely to offer an ex-post bargaining contract with a fixed wage.

Traditionally, classical holdup problems were resolved by selling the entire project to the agent (here the firm manager). However, when a manager must produce an output he does not care for and which is unverifiable, such as a social benefit, the traditional solution of "selling the entire project to the agent" does not induce a profit-maximizing agent to produce a socially beneficial output. Thus, this paper provides new insights into how to motivate the agent to invest in unverifiable outcomes that are not necessarily reflected in his profit. That is, a socially or environmentally aware firm principal should make the agent a residual claimant to some of the principal's value in the social good by creating an opportunity for holdup against the principal herself. This could be done by offering the type of ex-post bargaining contract considered in this paper.

Next, I examine a question of the consequences of a change in the degree of firm specificity. The model shows that increasing the degree of firm specificity will encourage the principal to offer an ex-post bargaining contract to the manager. The intuition for this finding derives from the comparative statics on the degree of the firm specificity as follows. First, as the degree of the firm specificity increases, the manager's active bargaining power also grows, which in turn raises the FSI he makes under the ex-post bargaining contract, while the FSI level remains unchanged under the ex-ante commitment contract. This is because an increase in the degree of firm specificity endogenously increases the FSI under the ex-post bargaining contract, given both parties know they will split the expected surplus at the beginning of the second period. This means that the greater the degree of firm specificity, the less the manager fears holdup, and thus the more he invests. This contrasts with the ex-ante commitment contract, in which the

second-period wage is determined at the beginning of the first stage, regardless of the level of firm specificity.[7] Second, the expected marginal cost of the incremental investment is identical for both the manager and the principal. This is because the principal must compensate for the manager's expected cost to induce the manager to participate in the contract. Thus, given that the principal's expected marginal revenue of investment exceeds the manager's expected marginal cost of investment, the incremental investment will result in the principal's expected marginal revenue exceeding her expected marginal cost.[8] As a result, as the degree of firm specificity increases, the above mentioned remark about the FSI level indicates that the principal's net expected utility increases under the ex-post bargaining contract, but remains unchanged under the ex-ante commitment contract.[9]

The model's key practical implications can be summarized as follows. First, suppose a firm in which the unverifiable output can effectively reduce the social costs caused by the verifiable output, or in which the social costs are substantial. In this case, it is better for the firm to hold wage negotiations frequently to promote SRI if the firm's founder or the majority of the shareholders of the firm value ESG principles. Furthermore, if verifiable and unverifiable outputs are managed by two different managers, the future wages for the manager that will produce verifiable outputs should be agreed at the beginning of the initial contract, whereas the future wages for the manager expected to produce unverifiable outputs should be negotiated more often. For example, managers that receive fixed rather than incentive pay are generally motivated by promotion or wage renewal through promotion.

Second, several companies, such as ALCOA and Royal Dutch Shell, have recently started to tie executive pay to specific ESG targets. This is like offering an ex-ante commitment contract with the wage linked to some signals of social costs. Alternatively, it is like z is treated as verifiable. However, in reality, some z related to environmental issues might be measurable, but

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[7]Furthermore, the manager's reservation utility is fixed at the beginning of the first stage.

[8]By substituting the IR constraint into the principal's expected utility, I show that her expected marginal revenue of investment exceeds the manager's expected marginal cost of investment. See Appendix A.

[9]Figure 1 illustrates that this shift in the principal's expected utility under the ex-post bargaining contract shifts the threshold at which the principal is indifferent between the ex-ante and ex-post contracts. It demonstrates that the more the principal's expected utility moves toward zero or a small z (or ζ or both), the more likely the principal will choose the ex-post bargaining contract.

it is not so simple to precisely capture the entire z even though it is fully observable, even for environmental issues. This tendency is stronger in social and governance issues. Thus I treat z as unverifiable in this paper. Therefore, if the specific ESG targets are imprecise but observable, these firms resemble a firm offering an ex-ante commitment contract in the context of my model. Then, if the unverifiable output can substantially reduce social costs, or if the social costs are large, such firms might consider adopting a contract that is like the ex-post bargaining contract presented here.

Third, we can interpret the degree of firm specificity in this paper as the skill gap between an incumbent manager and a newly hired manager. My result implies that if this positive skill gap widens, the company is more likely to offer an ex-post bargaining contract because the incumbent manager cannot be substituted for or replaced easily. Section 3 discusses some testable implications.

Finally, the model can be applied to the analysis of social impact bonds by reinterpreting the observable and verifiable x as observable and verifiable social output. Under these arrangements, investors receive financial returns based on the accomplishment of predefined social objectives. Indeed, the optimal ex-post bargaining contract characterized in this paper can be implemented using short-term debt, whereas the optimal ex-ante commitment contract can be put into effect using social impact bonds. If the unverifiable output contributes to reducing social disutility, or if the production of verifiable outputs involves greater social disutility, short-term debt is better than social impact bonds and vice versa. In addition, short-term debt is more likely preferred when the specificity of investments for private investors increases.

The remainder of the paper is organized as follows. Section 2 discusses the related literature while Section 3 analyzes the basic model of managerial compensation. Section 4 examines the social impact bonds in the context of the models developed in Section 3. The final section concludes. All the proofs of the propositions and corollaries in the text are provided in Appendices A and B. Appendix C discusses some limited liability constraints.

2   Literature

The theoretical literature on how a principal can motivate managers to do SRI is limited. Morgan and Tumlinson (2019) study firm behavior, when shareholders care about public goods as well as profits, and when managerial compensation reflects these concerns. They show that managers can redirect more profits toward public good than shareholders would when acting separately. Furthermore, if public good is sufficiently desirable, they also indicate that the manager will select the socially optimal level of output. Oehmke and Opp (2020) examine the ability of socially responsible investors to influence firms by relaxing financial constraints for clean production, when firm production generates social costs and socially responsible investors care about externalities regardless of whether they are directly responsible for the social costs. These papers are different from my paper in that I consider how the socially responsible principal induces the manager to pursue SRI by selecting the timing and commitment of contracts in the incomplete contract setting with a multitask principal-agent relationship.

Fudenberg, Holmstrom, and Milgrom (1990) and Rey and Salanie (1990) discuss how and when the principal can achieve the utility level of a long-term contract by repeating short-term contracts.[10] However, my focus in the present paper considers the condition under which the principal is better off offering ex-post bargaining contracts than an ex-ante commitment contract. Kamiya and Adachi-Sato (2013) present a general model of long-, short-, and medium-term wage contracts. Adachi-Sato and Kamiya (2013) develop a multi-task and job allocation model in which the agent has to produce not only verifiable but also unverifiable outputs where both outputs contribute to the firm's revenues in a framework as observed in actual labor markets. The present paper examines completely different production processes from these two papers: the verifiable output contributes to the firm's revenue but generates social costs, while the unverifiable output reduces social costs. Indeed, my model is the first to include social costs and the sensitivity to which the unverifiable output reduces social costs. As a result, unlike the

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[10]Dutta and Reichelstein (1996) show that short-term contracts can be better than a long-term contract in a different context. That is, in their model, agents get fired on the equilibrium path, and hence they allow agents to change sequentially. Their model-setting is different from mine in which the principal wishes to motivate one agent in a dynamic framework.

above-mentioned two papers, my paper shows that ex-post bargaining contracts may be strictly better than offering an ex-ante commitment contract in the context of SRI. In addition, this paper also allows interpretation and examination of the use of social impact bonds using the discussion of security design.

Farrell and Shapiro (1989) and Bernheim and Whinston (1998) present models with verifiable and unverifiable attributes, where it is better not to contract, or to contract incompletely, over even verifiable attributes. My paper may seem somewhat similar to theirs. However, their logics are quite different from mine. Indeed, in Proposition 1 in Farrell and Shapiro, the seller does not prefer to sign a contract on verifiable attributes, because doing so becomes a constraint on optimizing unverifiable attributes. This is different from ex-post bargaining, and cannot be applied to my case. This is because in my model, the principal does not choose any variables so as to optimize her utility after signing a contract. Bernheim and Whinston (1998) demonstrate that if some aspects of performance are noncontractable, it may be optimal to leave other verifiable aspects of performance unspecified. This is quite different from my argument about the trade-off between ex-ante commitment and ex-post bargaining in inducing investments of the manager for verifiable and unverifiable outputs.

This paper contributes to the small but emerging body of literature on social impact bonds. Pauly and Swanson (2017) consider whether social impact bonds can finance projects that might not otherwise be undertaken using traditional bonds. They argue that social impact bonds will achieve greater program success if investors' efforts depend on incentives and can positively affect project outcomes. Tortorice, Bloom, Kirby, and Regan (2020) discuss a model of social impact bonds where there is asymmetric information about the probability of project success. They indicate that social impact bonds expand the set of implementable projects if the government is pessimistic about the likelihood of a project success, or if the government is averse to paying costs associated with a project in excess of benefits. However, these studies leave the question of whether social impact bonds will be effective under social programs with complex outputs. Furthermore, my model considers the condition where social impact bonds are preferred to short-term debts.

3 The basic model of managerial compensation

3.1 Model setting

3.1.1 Basic environment

There is a principal and a manger. The principal delegates the management of her firm to the manager. I assume that both of them are risk neutral. The manager wishes to maximize only her expected revenues less investment costs. However, the principal wishes to maximize the firm's expected revenues less the cost of the production, including social costs. If the principal is a founder family of the firm, this can be justified by assuming that the founder family has an intrinsic motive not to cause social harm.[11] If the principal is a fund, the fund is a socially responsible investor that follows ESG criteria. The manager can be a senior management team, investment bankers, or consultants.

In order to motivate such a manager, the principal either offers an ex-ante commitment contract or an ex-post bargaining contract in a two-period model. The former contract binds both parties to the first- and second period wages for the manager. The latter contract only binds both parties to the first-period wage and lets them decide the second period wage via Nash bargaining at the beginning of the second period.

There are two types of output produced by the firm. One is an observable and verifiable output $x > 0$ that generates not only the firm's revenue but also disutility of a nonpecuniary negative externality, expressed as a constant $z > 0$, which is interpreted as social cost by the principal, who is aware of ESG. The other is an observable but unverifiable output $y > 0$ that reduces the principal's disutility by ζyz. The parameter $\zeta \geq 0$ is the sensitivity at which the unverifiable output reduces social costs. To focus on the role of y, in the subsequent analysis, I assume that z is an observable but unverifiable constant value. There are two verifiable output levels, x^H and x^L, where $x^H > x^L > 0$. The probabilities of x^H and x^L are denoted by $P^H \in [0, 1]$ and $P^L = 1 - P^H$. There are two unverifiable output levels, y^H and y^L, where $y^H > y^L > 0$. The probabilities of y^H and y^L are denoted by $Q^H \in [0, 1]$ and $Q^L = 1 - Q^H$. During the first

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[11]Alternatively, the principal can be interpreted as the board of directors that represents a mix of socially responsible and non-socially responsible shareholders.

period, the manager makes two types of investments to generate outputs, $I_x \geq 0$ and $I_y \geq 0$, to increase the productivity for producing x and y, respectively. I assume that both I_x and I_y are observable but unverifiable, and that P^H and Q^H in the second period are functions of I_x and I_y, denoted by $P^H(I_x)$ and $Q^H(I_y)$, respectively. As is formally stated in Assumptions 1 and 2 imposed below, I assume that the random variables x and y are stochastically independent and that $P^H = Q^H = 0$ in the first period. That is, I assume that the investments made in the first period will increase the manager's productivity from the second period onwards. The manager incurs disutility in making the investments, denoted $D_x(I_x)$ and $D_y(I_y)$. Note that there is no complementarity or substitutability between I_x and I_y, as x and y are stochastically independent and the total cost of the investments is additively separable, i.e., $D_x(I_x) + D_y(I_y)$.

The manager's investments, I_x and I_y, develop an internal employment relation or organization, build up a network of connection, and attain firm specific know-how to efficiently implement firm production. The information about these investments is collected over time through frequent and personal contacts between the principal and the manager, but is difficult to transmit to outsiders because of a lack of context. The manager's FSI levels (I_x, I_y) are observable but not contractible between the principal and the manager. Hence, information between the principal and the manager is symmetric when ex-post bargaining occurs. In addition, if the incumbent manager is replaced with a new manager from outside, the newly hired manager cannot utilize the predecessor's FSI made in the first-period to produce x or y because he lacks in the firm specific skills. Hence, $P^H = Q^H = 0$ in the second period if the incumbent manager is replaced with a new manager from the outside.

The wage for each period is paid at the end of each period, or after the realization of the outputs in each period.[12] As x is the only verifiable variable, the wage depends on the realization of x only: the wages for x^H and x^L are denoted by w^H and w^L, respectively. Let w_t^i denote w^i, $i = H, L$, in period $t = 1, 2$. Because of risk neutrality, w_2^i need not depend on the realization of x in the first period. I first investigate the model without limited liability constraints. In

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[12] As the agent is risk neutral, I can consider a model in which the wages for both periods are paid together at the end of the second period. This is, however, a special case of an ex-ante commitment contract.

Appendix C, I show that similar results still hold even after I impose these constraints.

Throughout this paper, I make the following assumption.

Assumption 0 $\quad x^L - (1 - \zeta y^L)z - \underline{u} \geq 0,$

where $\underline{u} > 0$ is the reservation payoff of the manager in the competitive labor market in each period. This assumption is justified if x^L is sufficiently large while neither z nor $\underline{u}$ is sufficiently large. It ensures the payoffs of the principal and the manager during the second period under the ex-post bargaining contract are nonnegative.

Next, the following assumptions on the functions D_x, D_y, P^H, and Q^H are standard.

Assumption 1 $\quad$ 1. $\frac{dD_i}{dI_i} > 0$, $\frac{d^2 D_i}{dI_i^2} > 0$, $D_i(0) = 0$, and $\frac{dD_i(0)}{dI_i} = 0$, $i = x, y$.

2. $P^H(0) = 0$, $\frac{dP^H}{dI_x} > 0$, and $\frac{d^2 P^H}{dI_x^2} < 0$.

3. $Q^H(0) = 0$, $\frac{dQ^H}{dI_y} > 0$ and $\frac{d^2 Q^H}{dI_y^2} < 0$.

4. The random variables x and y are stochastically independent.

In addition, for simplicity, I make the following assumption.[13]

Assumption 2 The probabilities of x^H and y^H are zero in the first period.

Under this assumption, the principal need not determine w_1^H in the first period.

I assume that there are a lot of qualified managers when the principal hires a new manager. As a result, the principal is able to extract the full surplus of the firm. Hence, when the principal hires a new manager at any stage, she posts a take-it-or-leave-it wage offer to him.

I also assume that the incumbent manager obtains some firm specific skills if he makes FSI. Thus, if the manager makes FSI, he can retain part of the surplus at the subsequent contracting stage because he has knowledge that gives him an advantage over outsiders. This also implies that a newly hired manager cannot utilize the incumbent manager's FSI. Accordingly, if the

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[13]Relaxing these assumptions still yield the identical results.

principal and the incumbent manager have agreed to the ex-post bargaining contract, they can bargain over the wage at the beginning of the subsequent period.

For simplicity, I use Nash bargaining for the negotiation between the two parties. I assume that the principal's and manager's bargaining powers are equal and that if they fail in bargaining, they need to find new partners, i.e., they can access the labor market and match with a new partner. More specifically, if bargaining fails, the principal makes a take-it-or-leave-it offer to a new manager from the outside market, whereas the incumbent manager is hired by another firm as a new manager through the firm's take-it-or-leave-it offer. However, given that the incumbent manager's I_x and I_y cannot be utilized by the newly hired manager because of the lack of firm specific skills, the principal obtains only $x^L - (1 - \zeta y^L)z - \underline{u}$ by hiring the new manager while the incumbent manager receives only $\underline{u}$. Note that $\underline{u}$ is the manager's reservation utility determined in the competitive market. Thus, the principal's and manager's outside option values in the second period are $x^L - (1 - \zeta y^L)z - \underline{u}$ and $\underline{u}$, respectively. Hence, the threat point of the Nash bargaining is $(x^L - (1 - \zeta y^L)z - \underline{u}, \underline{u})$.

Assumption 3 The principal posts a take-it-or-leave-it offer when a contract is signed with a new manager. The principal and the manager Nash bargain over the wages with the threat point held at $(x^L - (1 - \zeta y^L)z - \underline{u}, \underline{u})$ at the beginning of the second stage when both parties are bound by the ex-post bargaining contract.

3.1.2 Timing

At the start of the first period: The principal decides to offer a manager either an ex-ante wage commitment contract or an ex-post wage bargaining contract through a take-it-or-leave-it offer: both contracts bind the first-period wage to be w_1^L; the second-period wage w_2 is contingent on the verifiable output x for the ex-ante commitment contract, while for the ex-post bargaining contract, it is determined by the negotiation at the beginning of the second period.[14,15] The

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[14]The first-period wage is determined at the beginning of the first period to satisfy the IR constraint for the manager in both types of contract. It does not affect the principal's choice of offering an ex-post bargaining or ex-ante commitment contract, because it is determined before the manager undertakes investment under either contract.

[15]Although the ex-ante commitment contract could be specified to fix the wage across the two periods, it is not optimal for the principal to choose such a fixed wage contract as an ex-ante commitment contract. See the proof

manager accepts the contract that has been offered to him. If the manager is offered an ex-post bargaining contract, he accepts it considering the outcome of the Nash bargaining that will take place. Finally, the manager decides the FSI levels, i.e., I_x and I_y, and exerts them.

At the end of the first period: The output is realized but it is only realized as (x_1^L, y_1^L), as the FSI made in the first period takes effect in the second period. Accordingly, the wage w_1^L is paid to the manager.

At the start of the second period: Nothing happens if the ex-ante commitment contract was agreed in the first period. However, if an ex-post bargaining contract was agreed in the first period, the principal and the manager Nash bargain over the wage w_2^i. If the negotiation breaks down, the manager is fired and a new manager is hired. Note that there is a lag between the manager's investments (I_x, I_y) and the firm's productivity increase in outputs (x, y). As a result, bargaining occurs after (I_x, I_y) are undertaken but before the outputs (x, y) are realized. The manager's investment levels (I_x, I_y) are firm specific. Thus, the effect of (I_x, I_y) is lost if the manager is replaced before (x, y) are realized.

At the end of the second period: The output (x_2^i, y_2^i) where $i = H, L$, is realized for the ex-ante commitment contract and the manager receives a pre-specified w_2^i contingent on x_2^i. The output (x_2^i, y_2^i) where $i = H, L$, is realized for the ex-post bargaining contract with the manager retained from the start of the first period. He receives a share of the bargaining surplus (plus his threat point) determined in the negotiation. However, if the manager was fired at the beginning of the second period, he receives $\underline{u}$ in the new firm. A new manager who was employed on behalf of him at the beginning of the second period also receives $\underline{u}$ because the output is realized as (x_2^L, y_2^L).

3.2   The first-best solution

I first determine the first-best optimal allocation without agency problems. For simplicity, I assume that no agents discount their payoffs or utility. With no moral hazard problems, the

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of Proposition 1.

principal can determine the investment amounts I_x and I_y by herself as follows:

$$\max_{I_x, I_y} x^L - (1 - \zeta y^L)z - D_x(I_x) - D_y(I_y) + \left[\sum_{j=H,L} P^j(I_x)x^j - \sum_{j=H,L} Q^i(I_y)(1 - \zeta y^i)z \right].$$

The first-order conditions with respect to I_x and I_y for the above problem are given by

$$\frac{dD_x(I_x)}{dI_x} = \frac{dP^H(I_x)}{dI_x}(x^H - x^L),$$

and

$$\frac{dD_y(I_y)}{dI_y} = \frac{dQ^H(I_y)}{dI_y}\zeta(y^H - y^L).$$

Hence, the first-best investment levels are characterized by the above two equations.

3.3   An ex-post bargaining contract

Under the ex-post bargaining contract, the principal offers the first-period wage at the beginning of the first period, and they bargain over the second-period wage at the beginning of the second period. The manager can make FSI during the first period to maximize his own expected payoff. However, the principal cares about both her expected revenues and the social costs of production. Then, by Assumption 3, the principal's problem in the first period under the ex-post bargaining contract is to offer a take-it-or-leave-it offer on the first-period wage in order to induce the manager to implement the principal's preferred FSI levels, subject to the individual rationality constraint and the incentive compatibility constraint on FSIs:

$$\max_{w_1^L, I_x, I_y} x^L - w_1^L - (1 - \zeta y^L)z + V_2^p(I_x, I_y), \tag{1}$$

$$\text{s.t.} \quad w_1^L - D_x(I_x) - D_y(I_y) + V_2^m(I_x, I_y) \geq 2\underline{u}, \tag{2}$$

$$w_1^L - D_x(I_x) - D_y(I_y) + V_2^m(I_x, I_y) \tag{3}$$
$$\geq w_1^L - D_x(I_x') - D_y(I_y') + V_2^m(I_x', I_y'), \ {}^{\forall}I_x', I_y',$$

where $V_2^p(I_x, I_y)$ and $V_2^m(I_x, I_y)$ are the principal's and manager's utilities in the second period when the investment levels are I_x and I_y, where $V_2^p(I_x, I_y)$ and $V_2^m(I_x, I_y)$ are determined by

backward induction explained below. The individual rationality constraint is given by (2) and the incentive compatibility constraint is represented by (3).

The manager has bargaining power at the beginning of the second period. Applying Assumption 3, the principal and the manager Nash bargain over wages: for a given (I_x, I_y),

$$\max_{w_2^H, w_2^L} \left\{ \sum_{j=H,L} P^j(I_x)(x^j - w_2^j) - \sum_{i=H,L} Q^i(I_y)(1 - \zeta y^i)z - [x^L - (1 - \zeta y^L)z - \underline{u}] \right\}$$

$$\times \left\{ \sum_{j=H,L} P^j(I_x)w_2^j - \underline{u} \right\}.$$

As both players are risk neutral, they obtain the same surplus from the Nash bargaining solution, which is half of the total surplus. Formally, their utilities are expressed as

$$V_2^p(I_x, I_y) = \frac{1}{2} \left\{ \sum_{j=H,L} P^j(I_x)x^j - \sum_{i=H,L} Q^i(I_y)(1 - \zeta y^i)z - [x^L - (1 - \zeta y^L)z] \right\}$$
$$+ x^L - (1 - \zeta y^L)z - \underline{u}$$
$$\geq 0, \tag{4a}$$

$$V_2^m(I_x, I_y) = \frac{1}{2} \left\{ \sum_{j=H,L} P^j(I_x)x^j - \sum_{i=H,L} Q^i(I_y)(1 - \zeta y^i)z - [x^L - (1 - \zeta y^L)z] \right\} + \underline{u} \geq 0, \tag{4b}$$

where the last inequalities of (4a) and (4b) are evident from Assumption 0, $x^H > x^L$, and $y^H > y^L$.

3.4   An ex-ante commitment contract

Under the ex-ante commitment contract, the principal and the manager agree on and bind themselves to the wages for both periods at the beginning of the first period. The manager makes investments during the first period. In line with Assumption 3, the principal's contracting problem is to make a take-it-or-leave-it offer on the first- and second-period wages in order to induce the manager to implement the principal's preferred investment levels, subject to the individual rationality and incentive compatibility constraints on investments:

$$\max_{w_1^L, I_x, I_y, w_2^H, w_2^L} x^L - w_1^L - (1 - \zeta y^L)z + \left[\sum_{j=H,L} P^j(I_x)(x^j - w_2^j) - \sum_{i=H,L} Q^i(I_y)(1 - \zeta y^i)z \right], \quad (5)$$

$$\text{s.t.} \quad w_1^L - D_x(I_x) - D_y(I_y) + \sum_{j=H,L} P^j(I_x)w_2^j \geq 2\underline{u}, \quad (6)$$

$$w_1^L - D_x(I_x) - D_y(I_y) + \sum_{j=H,L} P^j(I_x)w_2^j \geq w_1^L - D_x(I_x') - D_y(I_y') + \sum_{j=H,L} P^j(I_x')w_2^j, \forall I_x', I_y'. \quad (7)$$

The principal's utility is given by (5). Inequalities (6) and (7) are the individual rationality and incentive compatibility constraints of the manager.

3.5 A comparison of the two types of wage contract

I explain below the mechanism through which the principal decides between the two contracts. The following proposition and its corollary show that the result depends on both the effectiveness of y in reducing social costs, ζ, and the size of the social costs, z.

Proposition 1 *1. Under the ex-ante commitment contract, there exists an optimal level of investment for the verifiable output which maximizes the expected total net payoff generated by the firm if there were no social costs or if the principal or society entirely ignore the social cost. This optimal investment for the verifiable output is larger than that under the ex-post bargaining contract.*

2. Under the ex-ante commitment contract, w_2^H is strictly larger than w_2^L. Under the ex-post bargaining contract, the fixed wage, i.e., $w_2^H = w_2^L$, can be offered.

3. There exists a threshold $\bar{\zeta} > 0$ such that the principal prefers an ex-ante commitment to an ex-post bargaining contract at the beginning of the first period for $\zeta \in [0, \bar{\zeta})$, and prefers an ex-post bargaining to an ex-ante commitment contract for $\zeta \in (\bar{\zeta}, \infty)$.

Proof: See Appendix A. ∎

Corollary 1 *There exists a threshold $\bar{z} > 0$ such that the principal prefers an ex-ante commitment to an ex-post bargaining contract at the beginning of the first period for $z \in [0, \bar{z})$, and prefers an ex-post bargaining to an ex-ante commitment contract for $z \in (\bar{z}, \infty)$.*

Proof: See Appendix A. ∎

Several remarks about Proposition 1 and its corollary are in order. Under the ex-post bargaining contract, the bargaining position/surplus of the manager at the beginning of the second period depends on his productivity in producing y as well as on his productivity in producing x. Thus, the principal can induce the agent to invest in I_y. However, the investment level for both outputs is reduced due to holdup. Furthermore, a fixed wage can be used to motivate the manager.

Under the ex-ante commitment contract, at the beginning of the first period, the principal can offer a second-period wage depending on the output x the manager is going to produce in the second period. However, she cannot offer a second-period wage that reflects the amount of y the manager is going to produce in this period, as y is observable but unverifiable. As a result, the ex-ante commitment contract cannot motivate the manager to invest in I_y at all. However, the principal can motivate the manager to invest more in I_x by making w_2^H much bigger than w_2^L. Indeed, the equilibrium level of I_x produces the optimal level for the verifiable output, which maximizes the expected total net payoff generated by the firm for both the first and second periods, exclusive of the social costs z.

Under the ex-ante commitment contract, the first-best allocation can be achieved if unverifiable output y is not effective at reducing the social cost z, that is if $\zeta = 0$, and therefore there is no need to produce y, formally $I_y = 0$. Given that the principal can set the manager's utility equal to $\underline{u}$ under the optimal ex-ante commitment contract, and that the ex-post bargaining contract cannot achieve the first-best allocation, the principal strictly prefers the ex-ante commitment contract when $\zeta = 0$. However, when ζ increases from 0, (meaning ζ is no longer 0) the investment allocation between I_x and I_y is distorted under the ex-ante commitment contract. This is because in this situation the principal does not have any incentive schemes to control I_y, although I_y can reduce the social costs created by x. However, under the ex-post bargaining contract, the principal has an incentive scheme to control I_y. Hence, it is possible that she prefers the ex-post bargaining contract to the ex-ante commitment contract if ζ is sufficiently

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large. This logic can also apply to the variation of z.

Hence, the principal's choice between an ex-post bargaining and an ex-ante commitment contract depends on both the sensitivity/effectiveness of y in reducing social costs and the size of the social costs z. That is, if the ESG-oriented principal wishes the manager to invest in both I_x and I_y, she will offer him the ex-post bargaining contract if y effectively reduces social costs or if the social costs are sufficiently large. See Fig. 1.

The practical implications of Proposition 1 and its corollary are as follows. First, in an industry or a firm where unverifiable outputs substantially contribute to a reduction in social costs caused by verifiable outputs or where the social costs are substantially large, it is better to hold ex-post wage negotiations frequently; otherwise, it is better not to hold ex-post wage negotiations too often. In addition, even in the same firm, if one manager is mainly involved in producing verifiable outputs with social costs whereas the other manager is mainly involved in producing unverifiable outputs for reducing the social costs, then the firm should commit to future wages agreed at the beginning of the initial contract for the former manager, whereas the firm should negotiate future wages for the latter manager more often.

Second, managers who are involved in producing unverifiable outputs and hence receive more fixed pay may be seen as motivated by promotion or wage renewal by promotion. This tendency towards promotion is significantly observed among managers in companies owned by central or local government. Thus, if these firms incur social costs, and they can reduce these costs overall with SRI, their government owners are more likely to be successful in persuading them to do so.

Finally, a number of companies have recently started to embed ESG more deeply by relating executive pay to specific ESG targets.[16] This is like offering an ex-ante contract with the wage linked to some signals of social costs. Alternatively, it is like social cost is treated as verifiable. However, if the specific ESG targets are imprecise or vague, it may be better for these firms to hold ex-post wage negotiation frequently, like a firm offering the ex-post bargaining contract

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[16]For example, Royal Dutch Shell announced plans to tie executive pay to three-to-five year targets for net carbon footprints from 2020 (see King, 2020). In ALCOA, 20 percent of executive cash compensation is tied to safety, environmental stewardship (including greenhouse gas emissions reductions and energy efficiency), and diversity goals (see https://corpgov.law.harvard.edu/2019/09/10/executive-compensation-and-esg/).

in my model, especially when the social costs are substantially large or the effort to reduce the social costs is effective.

Next, I consider the degree of the firm specificity on the choice of an ex-post bargaining or an ex-ante commitment contract. Let $\alpha \in [0, 1)$ denote a fraction of the investments I_x and I_y by the incumbent manager that can be utilized by a newly hired manager in the second period. Then, for the newly hired manager, the probabilities of x^H and x^L are denoted by $\alpha P^H(I_x)$ and $(1 - \alpha)P^H(I_x) + P^L(I_y)$, whereas the probabilities of y^H and y^L are denoted by $\alpha Q^H(I_x)$ and $(1 - \alpha)Q^H(I_x) + Q^L(I_y)$. Note that α is equal to 0 in the baseline model discussed above. Then, the principal's outside option is represented by

$$\sum_{j=H,L} P^j(I_x)x^{j\alpha} - \left(1 - \sum_{i=H,L} Q^i(I_y)\zeta y^{i\alpha}\right) z - \underline{u}, \tag{8}$$

where $x^{H\alpha} = \alpha x^H + (1 - \alpha)x^L$, $x^{L\alpha} = x^L$, $y^{H\alpha} = \alpha y^H + (1 - \alpha)y^L$, and $y^{L\alpha} = y^L$. On the other hand, the manager's outside option is $\underline{u}$ because his reservation utility is determined in the competitive market.

Now, I obtain the following proposition.

Proposition 2 *If the degree of the firm specificity on investment, $1 - \alpha$, comparatively increases, the principal is more likely to offer the manager an ex-post bargaining contract.*

Proof: See Appendix B. ∎

Intuitively, an increase in the firm specificity, $1 - \alpha$, increases the investments I_x and I_y he makes under the ex-post bargaining contract, while the investment levels remain unchanged under the ex-ante commitment contract. This is because an increase in the degree of the firm specificity on investment increases the manager's actual bargaining power. Consequently, an increase in the firm specificity endogenously increases the investment under the ex-post bargaining contract, as both parties know they will split the expected surplus at the beginning of the second period. This means that the greater the degree of the firm specificity on investment, the less he fears the holdup, and thus the more he invests. This is in contrast to the ex-ante commitment

contract, in which w_2 is determined at the beginning of the first stage regardless of the degree of the degree of the firm specificity on investment.

Second, the expected marginal cost of the incremental investment is the same for both the manager and the principal, as the principal has to compensate for the expected cost to induce the manager to participate in the contract. Moreover, by substituting the manager's IR constraint into the principal's expected utility, I show that her expected marginal revenue of investment is larger than the manager's expected marginal cost of investment. See Appendix A. Thus, the incremental investment will induce the principal's expected marginal revenue to exceed her expected marginal cost. As a result, as $1 - \alpha$ increases, the principal's net expected utility increases under the ex-post bargaining contract, while it remains unchanged under the ex-ante commitment contract.

This shift in the principal's expected utility under the ex-post bargaining contract shifts the threshold at which the principal is indifferent about ex-ante and ex-post contracts. The threshold shifts towards zero, where the ex-ante contract is more likely to be chosen, as was shown in Fig. 1. This means there is greater likelihood the principal will choose the ex-post bargaining contract, because the distance between the threshold and zero represents the possibility of the ex-ante commitment contract – but this is narrower due to the new threshold. Thus, the more the threshold shifts towards zero, the greater the chance the principal will choose the ex-post bargaining contract.

The degree of the firm specificity on investment can be interpreted as the skill gap between an incumbent manager and a newly hired manager.[17] Then, the implication of this is that if the skill gap between the incumbent manager and a newly hired manager increases, the more likely an ex-post bargaining contract is chosen. Thus, the company is more likely to choose an ex-post bargaining contract as the skill gap between the incumbent manager and a newly hired manager increases so that the incumbent manager cannot be substituted or replaced easily.

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[17]On the other hand, a shrinkage of the manager's supply can be viewed as an increase in $\underline{u}$. Because an increase in $\underline{u}$ increases the principal's utility under the ex-post bargaining and the ex-ante commitment contract by the same extent, it has no effects on the choice of the ex-post bargaining and the ex-ante commitment contracts.

Berry, Bizjak, Lemmon, and Naveen (2006) empirically find that diversified firms need a manager of greater ability because managing a diversified firm is a more difficult task than managing a focused firm. As it is more costly for diversified firms to find a suitable manager, they suggest that the cost for replacing an incumbent manger is higher in diversified than in focused firms. This implies that the skill gap between the incumbent manager and a newly hired manager is higher in diversified firms than focused firms. Hence, diversified companies are more likely to choose an ex-post bargaining contract if they face the social cost problem discussed in this paper.

As argued in Laux (2012), promoting an insider to the manager is not only less time-consuming but also less costly because the insider has already acquired firm specific human capital. As a result, firms that have a well-organized insider succession plan are more likely to offer an ex-ante commitment contract.

Furthermore, Laux (2012) also suggests that for firms in which the incumbent manager has already established that he is the right person for the position, replacing him is very costly. This conversely means that replacing the incumbent manager is not costly for firms in which the incumbent manager is a relatively new hire (maybe from outside) with uncertain talent or fit, and for firms that have recently changed their business strategy so that it is unclear if the incumbent remains a good match. These firms are more likely to choose an ex-ante commitment contract.

Finally, an extention of the model can be considered by allowing y to be partially observable and verifiable. Then, under the ex-ante commitment contract, the manager's wage depends on both x and the verifiable part of y. Hence, the ex-ante commitment contract can motivate the manager to invest in I_y to some extent. This implies that the inefficiency caused by the ex-ante commitment contract as a result of the lack of motivation for investing in I_y can be alleviated. Accordingly, when the verifiable part of y is larger, the threshold $\bar{z}$ below which the principal prefers an ex-ante commitment to an ex-post bargaining contract becomes smaller.

4 Extensions: social impact bonds

The analysis of this article can also be applied to social impact bonds by reinterpreting the observable and verifiable output x as observable and verifiable social output. That is, bonds issued by public entities to finance social services or programs. This section examines the effectiveness of social impact bonds in comparison with short-term borrowing.[18]

The general structure of the social impact bond is as follows. An issuer borrows funds from a private for-profit investor to execute a social program. The issuer is most often a public entity with altruistic preferences, for example, local government. The issuer then furnishes the funds to a nonprofit service provider that needs to finance up-front costs to execute the program. For simplicity, I assume the issuer and the nonprofit service provider are the same, that is, the principal.[19] The issuer and the investor, such as an investment bank, then agree to a performance-contingent debt contract that allows the issuer to pay only if a pre-defined performance target is met. If the program successfully attains the target, the issuer pays both principal and interest; otherwise, the issuer pays nothing in most cases.[20]

Furthermore, the social impact bond induces the private investor to exert an effort to positively influence program performance. Indeed, the private investor not only expresses his concern about the social program and the current inability of the government to deal with it, but also can offer specific ideas about methods and techniques to solve the problem. Pauly and Swanson (2017) present evidence that existing social impact bonds engage private investors with program-specific expertise to improve program performance (see Section 6 and Appendix A in

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[18]For simplicity, in the subsequent discussion, I assume there is no default, regardless of whether the issuer uses short-term debts or social impact bonds. This implies that the issuer has enough funds to repay debt or bond payments, even though for political reasons it cannot make enough funds available for the project prior to proven success.

[19]Tortorice, Bloom, Kirby, and Regan (2020) make the same assumption.

[20]For example, the first US-based social impact bond program is the NYC ABLE Project for Incarcerated Youth, launched in 2012. In this social impact bond, the issuer (government payer) is New York City's Department of Corrections, while the investor is Goldman Sachs. The social impact bond implements a recidivism-reduction program targeted to Rikers Island adolescent inmates. The issuer pays back only if the recidivism rate falls. If the recidivism rate falls by 10 percent, Goldman Sachs receives its capital back; if it exceeds 11 percent, Goldman Sachs also receives a financial return consistent with typical community development. See Pauly and Swanson (2017).

their study).[21],[22]

Alternatively, the issuer can finance the social program using short-term debt lent by the same private investors at each period. In this case, the issuer needs to pay both principal and interest to the private investors, shouldering all financial risk. In addition to the social impact bond and short-term debt, I assume that the issuer can also obtain a part of the funds from government transfer.

The timing of the model is as follows. At the beginning of period 1, the issuer offers the social impact bond or short-term debt to the private investor to finance the social program. During periods 1 and 2, the program is executed. If the issuer uses short-term debt, it rolls over the short-term debt at the beginning of period 2. At the end of period 2, the program's final success or failure is realized. Under the social impact bond, the issuer pays both principal and interest only if the program successfully attained its targets; whereas under short-term debt, the issuer pays both principal and interest regardless of outcomes.

The issuer needs to finance up-front capital expenditures $\underline{u}$ in each period to execute the social program. If the social program is executed, the performance outcome of the social program for the issuer is measured by the observable and contractible social output $x > 0$ in each period. However, this program may generate disutility for program participants or running costs (exclusive of $\underline{u}$), $z > 0$, in each period that reduces the issuer's utility, where z is observable but noncontractible.[23] However, if the observable but noncontractible social output $y > 0$ is produced, the principal's disutility is reduced by ζyz in each period. The observable but non-contractible effort $I_x \geq 0$ and $I_y \geq 0$ can be viewed as the private investor's effort to increase productivity for the production of x and y, respectively.[24]

The ex-post bargaining contract given in the preceding section can be transformed into short-

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[21] Managers of nonprofit service providers may also exert productive effort. However, to focus on the role of the private investor, I assume here that their productive effort is fixed and invariant irrespective of the financing method.

[22] In fact, not all social impact bond investors may get involved in the organization or implementation of the service provider. However, in this paper, I assume that private investors are effort-exerting agents.

[23] For example, in prisoner rehabilitation program, the better performance outcome of the program may increase effort disutility of prisoners or additional running costs of prisons.

[24] The private investor's effort can also be viewed as his effort to apply his specific ideas about methods and technique in order to solve the design and management problem.

term debt, and the ex-ante commitment contract into social impact bond. For short-term debt, the issuer borrows $\underline{u}$ from the private investor at the beginning of period 1, and pays back w_1^L at the end of period 1. Then, if the issuer rolls over the short-term debt at the beginning of period 2, she can make a fixed payment to the private investor at the end of period 2. However, if the issuer fails to roll over the short-term debt, she must finance $\underline{u}$ from a new private investor in the outside loan market. On the other hand, for the social impact bond, the issuer offers a performance-contingent bond at the beginning of period 1: he borrows $2\underline{u} - w_1^L$ from the private investor at the beginning of period 1 and pays w_2^H (w_2^L) to the private investor at the end of period 2 if the pre-specified performance outcome is (is not) met, that is, $x = x^H$ (x^L). In this case, w_1^L needs to be funded by the government transfer at the beginning of period 1. This interpretation particularly holds true if x^L is sufficiently small.

Suppose the issuer uses short-term debt to finance the social program. Then, at the beginning of period 1, the issuer offers short-term debt to maximize her expected utility represented by (1), subject to the following constraints: the private investor's participation constraint, (2), which ensures that his net expected payoff at the beginning of period 1 is equal to the total lending amount $2\underline{u}$, and his incentive compatibility constraint, (3), which implies that he chooses his efforts during the first period to maximize his own net expected payoff at the beginning of period 1. Because the private investor obtains some program-specific skills in period 1, he has bargaining power at the beginning of period 2.[25] Hence, the issuer and the private investor Nash bargain over the period 2 debt payment. If bargaining fails, the issuer borrows $\underline{u}$ by making a take-it-or-leave-it offer to a new private investor in the outside market, while the initial private investor lends $\underline{u}$ by accepting a take-it-or-leave-it offer from another borrower. Because I assume that the risk-free interest rate is equal to zero and that no new private investor can utilize the initial lender's program-specific expertise obtained in period 1, the issuer's and initial lender's outside options are represented by $x_L - z - \underline{u}$ and $\underline{u}$, as indicated by the bargaining problem characterized in Section 3.1.

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[25] This discussion is reminiscent of the literature regarding the bank's bargaining power in the bank loan contract. See Rajan (1992).

Next, suppose that the issuer uses the social impact bond to finance the social program. In this case, at the beginning of period 1, the issuer and the private investor agree on the debt payment contingent on the observable performance social outcome x at the end of period 2. Hence, the issuer offers the social impact bond to maximize her expected utility represented by (5) subject to the individual rationality constraint for the private investor, (6), and the incentive compatibility constraint on the private investor's efforts, (7).

These arguments show that the optimal contract derived in the preceding section can be implemented as follows: the optimal ex-post bargaining contract can be implemented using short-term debt, whereas the optimal ex-ante commitment contract can be implemented using the social impact bond.

Accordingly, applying Propositions 1 and 2, I obtain the following proposition and corollary.

Proposition 3   1. There exists a $\overline{\zeta} > 0$ such that the issuer prefers the social impact bond to short-term debt at the beginning of the first period for $\zeta \in [0, \overline{\zeta})$, and prefers short-term debt to the social impact bond for $\zeta \in (\overline{\zeta}, \infty)$.

2. If the private investor's investment is more specific, the issuer is more likely to offer the private investor the short-term debt.

Corollary 2 There exists a $\overline{z} > 0$ such that the issuer prefers the social impact bond to short-term debt at the beginning of the first period for $z \in [0, \overline{z})$, and prefers short-term debt to the social impact bond for $z \in (\overline{z}, \infty)$.

The implications of this proposition and its corollary are provided as follows. First, the social impact bond gives more incentive for the private investor to make efforts to achieve the higher performance outcome with social disutility by offering him contingent debt payments. Moreover, under the social impact bond, the equilibrium effort level for the higher performance outcome maximizes the expected total net utility enjoyed by the issuer who does not consider social disutility.

Second, short-term debt motivates the private investor to make efforts both to achieve the higher performance outcome with social disutility and to reduce the social disutility; however,

the effort level for the higher performance outcome is not the one that maximizes the expected total net utility generated by the issuer (who, again, does not consider social disutility).

Third, if the effectiveness of y in reducing social disutility, ζ, improves or if the social disutility is significantly large, the issuer is more likely to prefer short-term debt to the social impact bond. In other words, if the unverifiable output reduces more social disutility or if the production of verifiable outputs involves more social disutility, the issuer is more likely to choose short-term debt.

Finally, if the specificity of the private investor's investments increases, the less likely it is the social impact bond is chosen. Thus, when the current private investor cannot be substituted or replaced easily, the issuer is less likely to choose the social impact bond if the specificity of the private investor's investments increases.

5   Conclusion

In this article, I explore how a profit-maximizing manager can be motivated to pursue SRI with wage contracts. I demonstrate that incentive contracting (an ex-ante commitment contract) and holdup (an ex-post bargaining contract) are alternative ways to motivate a manager to make socially responsible investments. That is, an ex-ante commitment contract does not allow for holdup for the investment for the verifiable output that accompanies social costs. Rather, it deprives the manager of the incentive to invest in the unverifiable output that reduces social costs. An ex-post bargaining contract allows for a holdup for the investment in the verifiable output, but provides the manager with investment incentive for the unverifiable output. Hence, an appropriate use of contracts of different types can mitigate the inefficiency caused by the trade-off.

If the unverifiable output substantially contributes to reducing social costs or if the social costs are substantially large, the principal offers an ex-post bargaining contract with a fixed wage. Otherwise, the principal offers an ex-ante commitment contract with incentive pay. In addition, if the degree of the firm specificity of investment increases, the principal is more likely to offer the manager an ex-post bargaining contract.

This paper provides new insight into how to motivate a profit-maximizing manager to produce an unverifiable output that does not maximize profit. That is, in order to motivate such a manager to invest in ESG outcomes that do not necessarily reflect in his expected profit, a socially or environmentally aware firm principal should make him a residual claimant to some of her value in the social good. This can be achieved by creating opportunity for holdup against the principal herself, such as offering the type of ex-post bargaining contract studied in this paper. In normal situations, when the manager faces a holdup problem, the classical solution of "sell the entire firm to the manager" resolves the agency problem and the first-best solution is obtained. However, when the manager has to engage in activity that does not bring him a direct profit such as doing social good (and thus he is not interested in doing it), the classical solution of "selling the entire project to the manager" does not motivate him to engage in such production as he simply does not care for such issues. Consequently, this paper demonstrates that the under-effort problem of the manager can be mitigated by transferring the part of the principal's surplus through Nash bargaining process.

An useful implication of this study is to investigate whether a social impact bond is preferred to short-term debt when financial investing involves ESG impact. Also, FSI in this paper is considered to be firm and manager specific that neither I_x or I_y are transferrable to other firms. However, removal of this assumption might be of interest to any scholar who wants to examine the influence of the "transferability" of the FSI on motivating a manager to invest in SRI.

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Appendices

A. Proof of Proposition 1 and Corollary 1

An ex-post bargaining contract

In the first period, given (4) and $\sum_{i=H,L} Q^i(I_y) = 1$, (3) is rearranged so that the manager chooses I_x and I_y satisfying the following incentive compatibility constraint:

$$\max w_1^L - D_x(I_x) - D_y(I_y) + \frac{1}{2}\left\{ \sum_{j=H,L} P^j(I_x)x^j - z + \sum_{i=H,L} Q^i(I_y)\zeta y^i z - \left[x^L - (1 - \zeta y^L)z\right]\right\}$$

$$-\underline{u}. \tag{A1}$$

The first-order conditions then yield

$$\frac{dD_x(I_x)}{dI_x} = \frac{1}{2}\frac{dP^H(I_x)}{dI_x}(x^H - x^L), \tag{A2a}$$

and

$$\frac{dD_y(I_y)}{dI_y} = \frac{1}{2}\frac{dQ^H(I_y)}{dI_y}\zeta(y^H - y^L)z. \tag{A2b}$$

Note that by Assumption 1 the second-order conditions are satisfied. Let the solutions of the above equations be I_x^* and I_y^*. On the other hand, it follows from (2) that the principal must set

$$w_1^L = D_x(I_x^*) + D_y(I_y^*) - V_2^m(I_x^*, I_y^*) + 2\underline{u}. \tag{A3}$$

As discussed in the text, the Nash bargaining solution is (4). That is,

$$V_2^p(I_x^*, I_y^*) = \frac{1}{2}\left\{ \sum_{j=H,L} P^j(I_x^*)x^j - z + \sum_{i=H,L} Q^i(I_y^*)\zeta y^i z - \left[x^L - (1 - \zeta y^L)z\right]\right\}$$

$$+x^L - (1 - \zeta y^L)z - \underline{u},$$

$$V_2^m(I_x^*, I_y^*) = \frac{1}{2}\left\{ \sum_{j=H,L} P^j(I_x^*)x^j - z + \sum_{i=H,L} Q^i(I_y^*)\zeta y^i z - \left[x^L - (1 - \zeta y^L)z\right]\right\} + \underline{u}.$$

Then, it follows from (A3) that the principal's expected utility, (1), is obtained:

$$x^L - w_1^L - (1 - \zeta y^L)z + V_2^p(I_x^*, I_y^*)$$

$$= x^L - (1 - \zeta y^L)z - D_x(I_x^*) - D_y(I_y^*) + V_2^m(I_x^*, I_y^*) + V_2^p(I_x^*, I_y^*) - 2\underline{u}$$

$$= x^L - (1 - \zeta y^L)z - D_x(I_x^*) - D_y(I_y^*)$$

$$+ \left[\sum_{j=H,L} P^j(I_x^*)x^j - z + \sum_{i=H,L} Q^i(I_y^*)\zeta y^i z \right] - 2\underline{u}. \tag{A4}$$

Finally, as discussed in the text, the Nash bargaining solution shows that the principal can choose a fixed wage, i.e.,

$$w_2^H = w_2^L = V_2^m(I_x^*, I_y^*) = \frac{1}{2}\left[\sum_{j=H,L} P^j(I_x^*)x^j + \sum_{i=H,L} Q^i(I_y^*)\zeta y^i z - x^L - \zeta y^L z\right] + \underline{u}.$$

∎

An ex-ante commitment contract

Let I_y^{**} be the optimal investment level that satisfies (7). Then, from Assumption 1.1, $I_y^{**} = 0$. Suppose that $w_2^j = x^j - r$, $j = H, L$, where r is the principal's utility in period two. Then, substituting $w_2^j = x^j - r$, $j = H, L$, into (7), I obtain the following first-order condition with respect to I_x:

$$\frac{dD_x(I_x)}{dI_x} = \frac{dP^H(I_x)}{dI_x}(x^H - x^L). \tag{A5}$$

Let I_x^{**} be the solution.

On the other hand, I can consider the following maximization problem of the joint utility of the principal and the manager for $I_x^{**} = 0$:

$$x^L - (1 - \zeta y^L)z - D_x(I_x) + \sum_{j=H,L} P^j(I_x)x^j - z + \sum_{i=H,L} Q^i(0)\zeta y^i z. \tag{A6}$$

Note that $D_y(0) = 0$. Then, it is evident that the first-order condition with respect to I_x is again obtained by (A5). Under Assumptions 1.1 and 1.2, this implies that I_x^{**} also maximizes the joint utility of the principal and the manager when $I_y^{**} = 0$.

Using (6) with $I_y^{**} = 0$, the principal must set

$$w_1^L = D_x(I_x^{**}) - \sum_{j=H,L} P^j(I_x^{**})w_2^j + 2\underline{u}. \tag{A7}$$

Then, the principal's utility, (5), for $I_y^{**} = 0$ is expressed as follows:

$$\begin{aligned} &x^L - w_1^L - (1 - \zeta y^L)z + \sum_{j=H,L} P^j(I_x^{**})(x^j - w_2^j) - z + \sum_{i=H,L} Q^i(0)\zeta y^i z \\ &= x^L - (1 - \zeta y^L)z - D_x(I_x^{**}) + \sum_{j=H,L} P^j(I_x^{**})x^j - z + \sum_{i=H,L} Q^i(0)\zeta y^i z - 2\underline{u}. \end{aligned} \tag{A8}$$

As has been shown above, when $I_y^{**} = 0$, I_x^{**} maximizes the joint utility of the principal and the manager, and satisfies (6) and (7) for $w_2^j = x^j - r$, $j = H, L$. Given that the manager's reservation utility is set equal to a constant level $2\underline{u}$, these findings show that the optimal ex-ante

commitment contract consists of $(I_x, I_y) = (I_x^{**}, I_y^{**}) = (I_x^{**}, 0)$ and $w_2^j = x^j - r$, $j = H, L$.
Finally, it follows from $w_2^j = x^j - r, j = H, L$, that w_2^H is larger than w_2^L. ∎

A comparison of two types of contract

First, comparing (A2a) and (A5), the manager undertakes more investment in I_x under the ex-ante commitment contract than under the ex-post bargaining contract, i.e., $I_x^* < I_x^{**}$.

When $\zeta = 0$, the principal prefers the ex-ante commitment contract to the ex-post bargaining contract, i.e., (A8) is larger than (A4). Indeed, when $\zeta = 0$, it follows from (A2b) with $\frac{dD_y(0)}{dI_y} = 0$ that $I_y^* = 0$ is chosen even in the ex-post bargaining contract. Thus, using $\zeta = I_y^* = I_y^{**} = 0$,

$$\text{(A8)} - \text{(A4)} = -D_x(I_x^{**}) + \sum_{j=H,L} P^j(I_x^{**})x^j - \left(-D_x(I_x^*) + \sum_{j=H,L} P^j(I_x^*)x^j \right) > 0.$$

Given Assumptions 1 and 2, the last inequality holds because (A5) implies that I_x^{**} maximizes $-D_x(I_x) + \sum_{j=H,L} P^j(I_x)x^j$.

To investigate the effect of an increase in ζ on the choice of contracts, using (A4) and (A8), I only need to investigate

$$\kappa(\zeta) = -D_y(I_y^*) + \sum_{i=H,L} \left[Q^i(I_y^*) - Q^i(0) \right] \zeta y^i z,$$

because (A2a) and (A5) imply that neither I_x^* nor I_x^{**} depends on ζ.

Then, it follows from (A2b) with Assumptions 1.1 and 1.3 that

$$\kappa'(\theta) = \frac{1}{2} \frac{dQ^H(I_y^*)}{dI_y^*} \zeta(y^H - y^L)z \cdot \frac{dI_y^*}{d\zeta} + \sum_{i=H,L} \left[Q^i(I_y^*)) - Q^i(0) \right] y^i z,$$

where

$$\frac{dI_y^*}{d\zeta} = \frac{\frac{1}{2}\frac{dQ^H(I_y^*)}{dI_y^*}(y^H - y^L)z}{\frac{d^2 D_y(I_y^*)}{dI_y^{*2}} - \frac{1}{2}\frac{d^2 Q^H(I_y^*)}{dI_y^{*2}}\zeta(y^H - y^L)z} > 0. \tag{A9}$$

Note that κ is a strictly increasing function of ζ, and goes towards $+\infty$ as ζ goes towards $+\infty$. This implies that the principal's utility under the ex-post bargaining contract, (A4), is larger than that under the ex-ante commitment contract, (A8), when ζ is sufficiently large.[26] In contrast, when $\zeta = 0$, the principal strictly prefers the ex-ante commitment contract to the ex-post

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[26] Note that Assumption 0 does not prevent this logic because it is more likely to hold when ζ is larger.

bargaining contract. Thus, there exists a $\overline{\zeta} > 0$ such that the principal prefers the ex-ante commitment contract to the ex-post bargaining contract for $\zeta \in [0, \overline{\zeta})$, and prefers the ex-post bargaining contract to the ex-ante commitment contract for $\zeta \in (\overline{\zeta}, \infty)$. ∎

Proof of Corollary 1:

Social cost z appears only as ζz in (A2b) and the deduction of $[(A8)-(A4)]$. Accordingly, applying the procedure used in "A comparison of Two Types of Contract" analyzed above, I can verify the statement of this corollary. ∎

B. Proof of Proposition 2

I begin with examining the effect of an increase in the degree of the firm specificity on investment on the principal's utility under the ex-post bargaining contract. Then, the second period bargaining becomes:

$$
\max_{w_2^H, w_2^L} \left\{ \sum_{j=H,L} P^j(I_x)(x^j - w_2^j) - z + \sum_{i=H,L} Q^i(I_y)\zeta y^i z - \left[\sum_{j=H,L} P^j(I_x)x^{j\alpha} \right. \right.
$$
$$
\left. \left. - \left(1 - \sum_{i=H,L} Q^i(I_y)\zeta y^{i\alpha} \right) z - \underline{u} \right] \right\} \times \left[\sum_{j=H,L} P^j(I_x)w_2^j - \underline{u} \right]. \tag{B1}
$$

Note that the principal's and the manager's outside option is given by (8) and $\underline{u}$, respectively.

Applying the Nash bargaining solution to (B1), I obtain

$$
V_2^p(I_x, I_y) = \frac{1}{2} \left\{ \sum_{j=H,L} P^j(I_x)x^j - z + \sum_{i=H,L} Q^i(I_y)\zeta y^i z - \left[\sum_{j=H,L} P^j(I_x)x^{j\alpha} \right. \right.
$$
$$
\left. \left. - \left(1 - \sum_{i=H,L} Q^i(I_y)\zeta y^{i\alpha} \right) z \right] \right\} + \sum_{j=H,L} P^j(I_x)x^{j\alpha} - \left(1 - \sum_{i=H,L} Q^i(I_y)\zeta y^{i\alpha} \right) z
$$
$$
- \underline{u}, \tag{B2}
$$

$$
V_2^m(I_x, I_y) = \frac{1}{2} \left\{ \sum_{j=H,L} P^j(I_x)x^j - z + \sum_{i=H,L} Q^i(I_y)\zeta y^i z - \left[\sum_{j=H,L} P^j(I_x)x^{j\alpha} \right. \right.
$$
$$
\left. \left. - \left(1 - \sum_{i=H,L} Q^i(I_y)\zeta y^{i\alpha} \right) z \right] \right\} + \underline{u}. \tag{B3}
$$

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Repeating a procedure similar to that used in the proof of Proposition 1, I can also show that the first-order conditions with respect to I_x and I_y under the ex-post bargaining contract are as follows:

$$\frac{dD_x(I_x)}{dI_x} = \frac{1}{2}\frac{dP^H(I_x)}{dI_x}(1-\alpha)(x^H - x^L), \tag{B4}$$

$$\frac{dD_y(I_y)}{dI_y} = \frac{1}{2}\frac{dQ^H(I_y)}{dI_y}\zeta(1-\alpha)(y^H - y^L)z. \tag{B5}$$

Define $\widehat{I}_x^*$ and $\widehat{I}_y^*$ as I_x and I_y that satisfy (B4) and (B5). Let $\Psi(I_x, I_y)$ denote the principal's utility attained in period 1 under the ex-post bargaining contract.[27] Repeating a similar procedure used in the proof of Proposition 1, I can derive

$$\begin{aligned}
\Psi(\widehat{I}_x^*, \widehat{I}_y^*) &= x^L - (1 - \zeta y^L)z - D_x(\widehat{I}_x^*) - D_y(\widehat{I}_y^*) \\
&\quad + \left[\sum_{j=H,L} P^j(\widehat{I}_x^*)x^j - z + \sum_{i=H,L} Q^i(\widehat{I}_y^*)\zeta y^i z\right] - 2\underline{u}.
\end{aligned} \tag{B6}$$

Now, differentiating $\Psi(I_x, I_y)$ with respect to α and evaluating it at $(I_x, I_y) = (\widehat{I}_x^*, \widehat{I}_y^*)$ yields

$$\begin{aligned}
\frac{\partial\Psi(\widehat{I}_x^*, \widehat{I}_y^*)}{\partial\alpha} &= \left[-\frac{dD_x(\widehat{I}_x^*)}{d\widehat{I}_x^*} + \frac{dP^H(\widehat{I}_x^*)}{d\widehat{I}_x^*}(x^H - x^L)\right]\frac{\partial\widehat{I}_x^*}{\partial\alpha} \\
&\quad + \left[-\frac{dD_y(\widehat{I}_y^*)}{d\widehat{I}_y^*} + \frac{dQ^H(\widehat{I}_y^*)}{d\widehat{I}_y^*}\zeta(y^H - y^L)z\right]\frac{\partial\widehat{I}_y^*}{\partial\alpha}.
\end{aligned} \tag{B7}$$

Given Assumptions 1.1–1.3 and repeating a similar procedure used in deriving (A9), it follows from (B4) and (B5) with $\alpha \in [0, 1)$ that $\frac{\partial\widehat{I}_x^*}{\partial\alpha} < 0$ and $\frac{\partial\widehat{I}_y^*}{\partial\alpha} < 0$. Accordingly, it is found from (B4), (B5), and (B7) with $x^H > x^L$ and $\alpha \in [0, 1)$ that $\frac{\partial\Psi}{\partial\alpha} < 0$. Because the principal's utility in period 1 under the ex-ante commitment contract is independent of α, this implies that the ex-post bargaining contract is more likely to be preferred as $1 - \alpha$ is larger. ∎

C. Limited liability constraints

I discuss below the role of limited liability constraint. Although I can also introduce the limited liability of the principal, I must then deal with two-sided limited liability that is only

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[27]Even though the principal can set w_1^L to be arbitrarily negative in the absence of limited liability, she must then increase V_2^m to satisfy (A3). Hence, an increase in $1 - \alpha$ does not always lead to an increase in the principal's utility $\Psi(I_x, I_y)$ under the ex-post bargaining contract even without limited liability constraints.

complicated. Because it is not worthwhile to analyze the two-sided limited liability model in this context, I focus on one-sided limited liability, that is the limited liability of the manager.

Now, I consider two types of constraint: (i) all wages are nonnegative,[28] and (ii) $w_1^L + w_2^i \geq 0, i = H, L$.

For the ex-post bargaining contract, I can set $w_2^H = w_2^L = V_2^m(I_x^*, I_y^*) \geq 0$, where I_x^* and I_y^* are the optimal investment levels chosen under the ex-post bargaining contract (see (A2a) and (A2b) in Appendix A). Then, it follows from (2) that the principal must set

$$w_1^L + w_2^i = D_x(I_x^*) + D_y(I_y^*) + 2\underline{u} \geq 0, \qquad i = H, L.$$

Thus, the limited liability constraint of type (ii) is always satisfied. Moreover, if

$$D_x(I_x^*) + D_y(I_y^*) - V_2^m(I_x^*, I_y^*) + 2\underline{u} > 0, \tag{C1}$$

then w_1^L can be nonnegative, that is, (i) is satisfied.

For the ex-ante commitment contract, I can set $w_2^H = x^H - r$ and $w_2^L = x^L - r$, where r is the principal's utility in period two (see Appendix A). Then, it follows from (6) with $I_y^{**} = 0$ and Assumption 1.1 that the principal must set

$$r = w_1^L - D_x(I_x^{**}) + \sum_{j=H,L} P^j(I_x^{**})x^j - 2\underline{u}, \tag{C2}$$

where I_x^{**} is the optimal investment level chosen under the ex-ante commitment contract (see (A5)). Hence, using (C2) with $x^H > x^L$ and $w_2^j = x^j - r$, $j = 1, 2$, I obtain

$$w_1^L + w_2^H > w_1^L + w_2^L = x^L + D_x(I_x^{**}) - \sum_{j=H,L} P^j(I_x^{**})x^j + 2\underline{u}.$$

The right-hand side is positive for a sufficiently large $\underline{u}$, as I_x^{**} does not depend on $\underline{u}$. Thus, the limited liability constraint of type (ii) is not binding for a sufficiently large $\underline{u}$. Note that I can also find a sufficiently large $\underline{u}$ such that (i) is also satisfied. If I consider the case in which $\underline{u}$ is not sufficiently large, these limited liability constraints are binding under the ex-ante commitment contract. Thus, the principal's utility under the ex-ante commitment contract in the presence of these limited liability constraints is smaller than in their absence.

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[28] This case can be interpreted as a minimum wage because the zero wage can be viewed as the minimum wage.

I now provide the following proposition and corollary that have the equivalent results with Proposition 1.2, 1.3, and Corollary 1 for the limited liability constraints of type (i) and (ii).

Proposition 4   *If a limited liability constraint is imposed, optimal contracts satisfy the following properties.*

1. Under the ex-ante commitment contract, w_2^H is larger than w_2^L. Under the ex-post bargaining contract, a fixed wage, i.e., $w_2^H = w_2^L$, can be offered.

2. For the limited liability constraint of type (ii), there exists a $\overline{\zeta} > 0$ such that the principal prefers an ex-ante commitment to an ex-post bargaining contract at the beginning of the first period for $\zeta \in [0, \overline{\zeta})$, and prefers an ex-post bargaining to an ex-ante commitment contract for $\zeta \in (\overline{\zeta}, \infty)$. Next, if condition (C1) is satisfied, the same result can be obtained for the limited liability constraint of type (i).

Corollary 3   *For the limited liability constraint of type (ii), there exists a $\overline{z} > 0$ such that the principal prefers an ex-ante commitment to an ex-post bargaining contract at the beginning of the first period for $z \in [0, \overline{z})$, and prefers an ex-post bargaining to an ex-ante commitment contract for $z \in (\overline{z}, \infty)$. Next, if condition (C1) is satisfied, the same result can be obtained for the limited liability constraint of type (i).*

Proof of Proposition 4: I begin with the case of the limited liability constraint of type (ii). When $\zeta = 0$ so that $I_y^* = I_y^{**} = 0$, I can prove that the principal's utility is larger under the ex-ante commitment contract than under the ex-post bargaining contract. Indeed, set $w_2^L = \frac{1}{2}x^L > 0$, $w^H = \frac{1}{2}x^H > 0$, and

$$w_1^L = D_x(I_x^*) - \frac{1}{2} \sum_{j=H,L} P^j(I_x^*)x^j + 2\underline{u}.$$

I show that under the ex-ante commitment contract, the manager chooses I_x^* (see (A2a) in Appendix A), the manager's utility at the beginning of period 1 is equal to $2\overline{u}$, and the principal obtains the same utility as she does under the ex-post bargaining contract (see (A4), (A7), and (A8) in Appendix A). In fact, under the ex-ante commitment contract, the principal can make the wage difference, $w_2^H - w_2^L$, larger than $\frac{1}{2}(x^H - x^L)$ so that the level of I_x chosen by the manager becomes larger than I_x^*. The principal can also keep the manager's expected wage

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constant. Hence, her gain is larger under the ex-ante commitment contract than under the ex-post bargaining contract.

When $\zeta > 0$, Proposition 1.3 still holds with a small $\bar{\zeta}$. This is because if I consider the ex-post bargaining contract, the principal obtains the same gain as in the absence of the limited liability constraints. Alternatively, if I consider the ex-ante commitment contract, the principal's gain is smaller under the limited liability constraint.

For the limited liability constraint of type (i), if (C1) is satisfied, the same results are obtained using the same argument as that of the limited liability constraint of type (ii). ∎

Proof of Corollary 3: When $z > 0$, Corollary 1 still holds with a small $\bar{z}$. The same logic as in proof of Proposition 4 holds. ∎