Separation of Ownership and Control: Delegation as a Commitment Device

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Abstract

This paper provides a theoretical model for explaining the separation of ownership and control in firms. An entrepreneur hires a worker for providing effort to complete a project. The worker's effort determines the probability that the project is completed on time, but the worker receives unobservable benefits for every period he is employed in the project. Thus, the early completion of the project requires that the worker receives an early completion bonus, which covers for the loss of the private benefits. The entrepreneur would be able to lower this bonus if he were able to commit that he would liquidate the project, if it is delayed. However, this is not possible because the value of the delayed project is greater than its liquidation value. Hiring a manager, who receives a payment conditional only on short-term profits, solves this time-inconsistency problem, but generates a moral hazard problem, because the manager may appropriate part of the profits. We solve for the optimal managerial contract and we identify the conditions under which separation of ownership and control is more profitable for the entrepreneur. The model predictions are consistent with the findings of the empirical literature.

Keywords: control structure, delegation, efficiency wage, entrepreneur, managerial contract, moral hazard, organizational hierarchy, private benefits, separation of ownership and control, time-inconsistency

JEL Classification: D86, G34, J31, L22, L26

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1 Introduction

The issue of the separation of ownership from control has generated a long literature in economics and finance. The first contributions go back to Berle and Means (1932) and even Adam Smith (1776). The typical image of the firm in this literature is one of a large corporation, which is owned by many small stockholders but is run centrally by professional managers, who have a negligible fraction of the total ownership. The associated agency costs and the corporate mechanisms to combat them have been the central focus of the early literature on this topic[1].

Despite the fact that this image of large firms has been recently challenged by empirical analyses[2], it still reflects the situation for a substantial fraction of large corporations[3]. There are mainly two arguments provided for explaining the separation of ownership and control: (i) Main shareholders do not have the ability, expertise or the knowledge to run firms, while managers do. (ii) The opportunity cost of time for large shareholders is high, namely they prefer leisure or starting a new company than dealing with management issues. Though perfectly valid, these arguments do not relate the firms' observable characteristics with their control structure. So, one would expect that the former are unrelated to the latter. However, this is not the case (see for example Demsetz and Lehn (1985)).

This paper proposes an alternative theoretical explanation on why investors may prefer to separate ownership from control and relates firm characteristics to the optimal choice of control structure. The main argument is that managers are better suited to make certain decisions about the firm than its owners, exactly because they do not necessarily have a large stake on its long-run prospects. A manager's payoff depends on his contract with the owner and this may cause him to value certain states differently from his principal. Though, this generates agency costs, it can actually be beneficial whenever the owner suffers from a time-inconsistency problem.

In order to make this argument as clear and stark as possible, a simple two-period model with one entrepreneur and one worker is presented in section two of the paper. The entrepreneur is assumed to have full ownership and control over the firm and is not financially constrained[4]. He also owns a project, which may take one or two periods to complete, and which increases the firm's profits once it is completed. The worker exerts

[1]See Monsen and Downs (1965), Alchian and Demsetz (1972), Jensen and Meckling (1976), Fama (1980), Fama and Jensen (1983), and Demsetz (1983), Demsetz and Lehn (1985).

[2]See Porta, Lopez-De-Silanes, and Shleifer (1999), Holderness (2009)

[3]For example, Mikkelson and Partch (1989) finds that the top three officials own less than 10 percent of the stock combined for 60 percent of the companies. Holderness, Kroszner, and Sheehan (1999) find that the average stock-holdings of a CEO is 1.25 percent (the median is only 0.06). Jensen and Murphy (1990) report similar findings.

[4]In fact, it is irrelevant for our purposes if the firm has only one or many owners. We consider the case of an entrepreneur because it is the simplest possible and it allows us to distinguish the importance of the control structure (owners versus managers) from that of the ownership structure (large versus small shareholders). For the latter case, see the papers by Grossman and Hart (1980), Shleifer and Vishny (1986), Grossman and Hart (1988), Harris and Raviv (1988), Bebchuk (1994), Burkart, Gromb, and Panunzi (1997) and Burkart, Gromb, and Panunzi (1998).

non-verifiable effort, which increases the probability that the project is completed at the end of period one, but he receives an unobservable private benefit for every period he is employed in the project before its completion. As a result, the entrepreneur needs to compensate the worker for the loss of the private benefit, if he wants the project to complete in period one.

It is shown that, if the entrepreneur could commit to liquidate the project, if it is not completed in period one, then the worker would exert high effort at a lower wage. However, this threat is not credible, because the continuation value of the project is higher than the liquidation value. The problem is solved by hiring a manager and giving him a payment conditional only on the first period profits. Thus, the manager is induced to liquidate the project if it is delayed. This solves the time-inconsistency problem of the entrepreneur and allows him to reduce the wage paid to the worker. Delegation of control strictly increases the payoff to the owner.

The model is extended in section 3 with the addition of a moral hazard problem from the manager's side and by making the manager the sole decision maker in the firm. This means that once the manager takes control of the firm, he makes all the relevant decisions, including the hiring of the worker and the design of the wage contract. This allows one to study the more plausible case, where giving up control to the manager may generate undesirable consequences (i.e. agency costs). We provide the optimal managerial contract and we examine the conditions under which separation of ownership and control is optimal.

The main comparative statics of the model are as follows. Separation of ownership and control is more likely when: (i) the manager can not easily appropriate profits from the firm, (ii) the private benefits of the workers are high, (iii) the worker's effort is important for the completion of the task, (iv) the profit per worker is low, (v) the variance of profits is low. Some of these predictions ((i) and (v)) are intuitive and are consistent with empirical findings (Demsetz and Lehn, 1985), while the rest are new predictions and have not been empirically tested yet.

Prediction (iv) is rather counter-intuitive and is worth closer attention. In our model there is only one worker and as a result the total profitability of the firm is equivalent to the profitability per worker. But, as it is discussed in subsection 3.2, in a model with multiple workers under the manager, the value of delegation may increase with the size of the firm (number of workers or total profits), as one would expect, but it decreases with the profitability per worker. In our model, this is because the manager can appropriate less resources as the profitability per worker goes down and, given everything else, agency costs decrease. We believe that it is interesting to examine if this prediction is also confirmed by the empirical evidence.

Finally, section 4 examines the following theoretical issues with regards to the model: (i) How does the inclusion of participation constraints changes the results of the model. (ii) The issue of renegotiation-proofness of the managerial contract. (iii) Other potential solutions to the entrepreneur's problem. For the last issue, it is shown that, under certain conditions, both financial securities and government intervention are sub-optimal to separation of ownership and control.

Other papers have also examined the issue of separation of ownership and control from a theoretical perspective. The early literature (Jensen and Meckling (1976), Fama (1980), Fama and Jensen (1983), and Demsetz (1983)) recognized the existence of agency costs in the firm and examined how the organizational ownership and control structure were used in order to combat them. But they did not explain why the decision power had to be delegated to managers in the first place.

More recently, Acemoglu (1998) explains the separation of ownership and control as a signal of the entrepreneur to financial markets about the quality of his project. This paper does not relate the presence of managers to financial markets but to the internal workings of the firm. Their role is also different: they are not used as signaling devices but as commitment devices.

Ferreira, Ornelas, and Turner (2010), based on Ornelas and Turner (2007), examine the separation of ownership and control in a model of optimal dissolution of partnership. Two partners allocate ex-ante and ex-post ownership rights in order to optimize ex-post incentives in revealing their type and allocating optimal control rights. Thus, their model is one of shareholders reaching an agreement on who should run the firm, while this paper adopts the principal-agent framework. Moreover, the main friction in their model is one of hidden types, while in this paper it is one of hidden actions.

The paper is also related to the literature on deadlines, which examine how deadlines are used in order to mitigate dynamic moral hazard problems. Examples of this literature are the papers by Toxvaerd (2006), Toxvaerd (2007), Mason and Valimaki (2008), Bonatti and Horner (2011). The main issue with deadlines is that are often inefficient ex-post, so that both parties prefer to renegotiate them if they expire. This paper proposes that the delegation of authority to an intermediary (the manager) is a commitment device for honoring deadlines.

To summarize, we believe that the main contributions of this paper are the following: (i) It shows how the separation of ownership and control can act as a commitment device, which reduces the efficiency wage and increases the value of the firm. (ii) Delegation of decision power is an endogenous decision in this model, with both costs and benefits. (iii) This trade-off relates firm-characteristics to the optimal choice of control structure and generates several empirical predictions. (iv) Some of the predictions are consistent with the findings of the empirical literature, while others remain to be tested yet.

2 A simple model

An entrepreneur (E) employs a worker (W) in order to complete a project. Both of them are risk neutral and their discount factor is equal to one. W exerts effort in the beginning of period one. Effort is unobservable and there are two effort levels: high (e_H) and low (e_L). The chosen effort level determines the probability that the project will be completed on time. If W exerts high effort then he incurs cost c_H and the project is completed in the end of period one with certainty, yielding revenues equal to

V_1 for E. If, on the other hand, W exerts low effort, then he incurs a cost c_L and the project is completed on time with probability p and is delayed with probability $1-p$, $p < 1/2$. If the project is delayed, then it requires an additional period to complete, yielding revenues V_2 in the end of period two. Assume that $V_1 > V_2$. Therefore, delay is costly for E.

At $t = 1/2$ E finds out whether the project will be delayed or not. Then, he can choose either to liquidate the project ($L = 1$) and forgo the future revenues or to let the project continue ($L = 0$). If E liquidates the project, then he receives revenues V_l. We assume that $V_l < V_2$. The liquidation value of the project can be interpreted as either the value that other firms are willing to pay in order to undertake the project or the scrap value for the resources already invested in it. In either case, what is important is that the project generates positive synergies in E's firm, so that letting the project complete with delay generates more revenues than liquidating it.

For this section we assume that the delay shock is private information to the relevant decision maker at time $t = 1/2$ (E in this case), but the completion date and status of the project are verifiable. We also assume that the entrepreneur can not impose financial penalties to the worker if delay occurs and that there is no participation constraint. E offers a wage schedule, conditional on the completion status of the project at the end of period one, in order to induce W to exert high effort.

In addition, W enjoys a private benefit b for every time period that he is employed in the firm. Again, the private benefit can have multiple interpretations. The one usually provided by the literature is that it is an unobservable part of the output, which is appropriated by the worker[5]. However, this interpretation is not necessary for our purposes. It would also do if the worker has some bargaining power when negotiating the wage with the entrepreneur or if it reflects the psychological benefit of being employed. What is important is that it accrues over time and that it is not in the control of the entrepreneur whether to provide it or not. Figure 1 presents the timing of events.

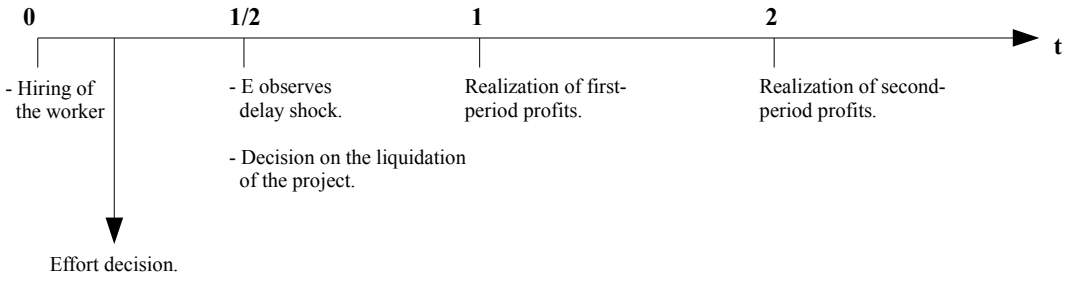

Figure 1: Timing of events

[5]see for example the papers by Holmstrom and Tirole (1997) and Pagano and Volpin (2006)

Let $\{w_1, w_0\}$ be the wage contract offered to W, conditional on the project being completed or not in period one respectively[6]. W's decision on whether to exert high or low effort depends on the wage schedule and the liquidation decision. This is because, when the project suffers from the delay shock and E decides to liquidate it, then W loses the private benefit from the operation of the firm in period 2. More specifically, if W exerts high effort, then his payoff is the private benefit in period one, plus the wage he receives for the timely completion of the project minus the cost of effort: $b+w_1-c_H$. If W exerts low effort then with probability p he receives w_1 and b. With probability $1-p$ the project is delayed and then he receives w_0, b from the operation of the firm in the first period and b from the operation of the firm in the second period if E decides to continue the project ($L=0$) and zero otherwise ($L=1$). Since W incurs c_L if he exerts low effort, his payoff in this case is: $b+pw_1+(1-p)[w_0+(1-L)b]-c_L$. Clearly, the worker will exert high effort iff:

$$w_1 \geqslant w_0 + (1-L)b + \tfrac{c_H-c_L}{1-p}$$

E decides the wage contract and the liquidation of the project if the delay shock occurs. His expected payoff is: $p(e_w)(V_1-w_1)+[1-p(e_w)][LV_l+(1-L)V_2-w_0]$. $p(e_w)$ denotes the fact that the probability of delay depends on the effort level of W. However, because $V_1 > V_2 > V_l$, the optimal choice is to always let the project continue at $t=1/2$, irrespectively of its completion date. This means that liquidation will never take place ($L=0$) and inducing high effort requires that:

$$w_1 \geqslant w_0 + b + \tfrac{c_H-c_L}{1-p}$$

Because reducing w_0 relaxes the incentive compatibility constraint and at the same time reduces entrepreneur's expected payment, the optimal choice for E is either to set $w_0=0$ and $w_1 = b + \frac{c_H-c_L}{1-p}$, if he wants W to exert high effort, or to set $w_1=w_0=0$, if he wants W to exert low effort. His payoff in the first case is V_1-w_1 and in the second case $pV_1+(1-p)V_2$. Therefore, E will choose to provide high incentives to W iff $V_1-V_2 \geqslant w_1/(1-p)$. However, E would do better than that, if he were to decide to liquidate the project if the delay occurs. In this case, W would not receive the second period private benefit and his incentive compatibility would be relaxed. As a result, E would be able to lower the wage required for inducing high effort (it would fall to $w_1 = \frac{c_H-c_L}{1-p}$, so the net benefit is equal to the private benefit), which would benefit him whenever $V_1-V_2 \geqslant (c_H-c_L)/(1-p)^2$.

The problem is that, because the continuation value of the project is strictly greater than the liquidation value, he can not credibly promise to W that he will liquidate it in case of delay. In other words, E suffers from a time-inconsistency problem, which is

[6]This simple contract is without loss of generality. In principle, we could allow the wage contract to be conditional on time, so that W receives also a wage in period 2. But, any such contract can be rewritten in terms of an equivalent contract, which offers wages only conditional on the project status in the end of period one.

similar in nature to a soft-budget constraint [7]. How can he deal with it? The solution is to hire a manager under a contract which provides a payment conditional on short-run (period-one) profits[8].

To see this, suppose that E can not impose financial penalties to M (the manager), that the latter does not face a participation constraint, and consider the following contract. M takes over the control of the firm at the beginning of the period one (the authority to determine L at time $t = 1/2$) just after W is hired, and receives reward $y(\Pi_1) = \epsilon_1$ if the profit at the end of period one is equal to $\Pi_1 = V_1 - \frac{c_H - c_L}{1-p}$, $y(\Pi_1) = \epsilon_2$ if $\Pi_1 = V_l$ and $y(\Pi_1) = 0$ if $\Pi_1 = 0$, with $\epsilon_1 > \epsilon_2$ strictly positive but arbitrarily close to zero. Under this contract, M prefers to let the project continue if there is no delay, since $\epsilon_1 > \epsilon_2 > 0$, while he prefers to liquidate it if the delay occurs ($\epsilon_2 > 0$). This solves the time-inconsistency problem of the entrepreneur and allows him to offer a lower wage to W in order to induce him to exert high effort. As a result, E strictly prefers to hire the manager and provide high incentives to the worker if $V_1 - V_2 \geqslant \frac{c_H - c_L}{(1-p)^2} + \epsilon_1$. If, on the other hand, $V_1 - V_2 < \frac{c_H - c_L}{(1-p)^2} + \epsilon_1$, E prefers to run the firm by himself and provide no wage to the worker.

The main intuition is that the manager does not suffer from the time-inconsistency problem that the entrepreneur faces, because his payoff is constructed through the contract and does not depend on the primitives of the economy. As a result, the delegation of control to the manager can relax the incentive compatibility of the worker and this increases the entrepreneur's payoff. In other words, the separation of ownership and control is optimal from the entrepreneur's point of view in this economy.

Note that this does not necessarily mean that the separation of ownership and control is optimal from a societal point of view as well. One can easily find values of the parameters such that the induced effort level diverges from the societal optimal. Of course, given the presence of incomplete information, this should come as no surprise. But one can show that the delegation of control shrinks the range of parameters values for which suboptimal incentives are induced.

3 A model with managerial moral hazard

3.1 Optimal managerial contract

In this section we present a modified version of the model of section 2, by extending it in two directions. First, we allow the manager to suffer from a moral hazard problem as well. Second, when control is delegated to the manager, we assume that he makes all the decisions relevant for the operation of the firm thereafter. This means that, apart from making the liquidation decision, the manager is the one who provides the terms of

[7] See the papers by Dewatripont and Maskin (1995), Dewatripont and Roland (2000) and Kornai, Maskin, and Roland (2003).

[8] For other possible solutions to this problem and a discussion on why our solution is optimal see section 4.

the contract to the worker and not the entrepreneur. Moreover, the entrepreneur does not directly observe the decisions of the manager but only the realized profits and he must, therefore, design the managerial contract accordingly.

We are interested in the first direction because the model of section two generates a rather implausible result: separation of ownership and control always generates positive value for the entrepreneur and is essentially costless. In this section we allow for more general results by including a moral hazard problem from the manager's side. Thus the rents earned by the manager reduce the value of delegation for the entrepreneur and generate a trade-off between cheaper worker incentives and better control incentives. We consider the second extension in order to show that our results do not depend crucially on the manager having limited control of the firm, in other words, that our results survive even under full delegation of decision power.

In order to make these points, we consider an extreme form of moral hazard, where the manager can appropriate a part of profits from the firm and transform them into private benefits or non-pecuniary rewards at an exogenously given and constant return factor q, with $0 < q < 1$. That is, for every single unit of profit that the manager appropriates, proportion q is transformed into utility for the manager and proportion $1 - q$ is lost as appropriation cost.

More specifically, we now consider a firm which exists for two periods. The firm is owned in its entirety in the beginning of period one by E. The firm generates a random stream of profits in each period, ρ_t, which is normally distributed with mean τ and variance σ^2. We assume that $\partial^2[\int \rho f(\rho) d\rho]/(\partial\tau)^2 < 0$.

On top of that, E is given the option to undertake a project which will increase the profits of the firm when it is completed. The details of this project are left as in section 2 (the project is defined by the same variables: $\{p, e_w, c_w, V_1, V_2, V_l\}$, and their interpretation and interactions remain the same as before). Again, all agents involved are risk-neutral and there is no discounting of future payoffs.

In addition, we now assume that the status of the project is non-verifiable for E if he has delegated control, but remains verifiable for M. Hence, the wage contract can be made conditional on the status of the project, but the managerial contract can not. Furthermore, E does not observe the wage contract provided by M. These assumptions, apart from plausible (in many cases the shareholders do not have access to the monitoring and control devices of the management or it is too costly to obtain it), makes the manager's incentive problem more interesting. E must now make sure that M has the incentives to provide correct effort incentives to W, as E can not control it directly or explore it in order to control M. In other words, since in our model we have two layers of contracts, one from the E to M and one from M to W, the second layer is treated as an additional incentive compatibility constraint in the design of the first contract. Therefore, by allowing this more complicated (and realistic) structure of incentives we can show that our results are robust to other types of asymmetries in the information structure.

The only observable and verifiable variable from E's point of view, when he is not the decision maker, is the profit level of the firm (after the potential extraction of rents).

Hence, the managerial contract can be made conditional on this variable: $y_t(\pi_t^e)$. We also assume that E can choose the duration (δ) of the contract which he gives to M. That is, E may hire M for only the first period ($\delta = 1$), after which M is fired and E resumes control of the company. We call this the **short-term** contract. Or E may hire M for both periods ($\delta = 2$), which we call the **long-term** contract. Overall, the managerial contract is characterized by a profit sharing function, which is conditional on the duration of the contract: $\{y_t(\pi_t^e|\delta)\}$. We also restrict the analysis to contracts which give zero profits to M whenever he is not employed anymore ($y_t = 0$, if $t > \delta$) [9]

When it comes to the wage contract, the relevant decision maker (M or E) can, in principle, make the wage conditional on both the profit level and the status of the project. As we did in the previous section, and without loss of generality due to risk-neutrality, we assume that the wage contract is conditional only on the status: $\{w_s\}$. The variable s denotes the status of the project at the end of period one, and it takes the value 1 if the project is completed and 0 otherwise. This makes the formulation of the incentives of W identical to the problem in section 2 and, at the same time, it implies that W receives his reward at the end of period one.

At the end of each period the decision maker (M or E) privately observes the realized return π_t^m (firm profits plus project profits minus worker's wage) and, if it is positive, decides how much to transform into private (unobservable) benefits $r(\pi_t^m)$ and how much to keep as verifiable profits: $\pi_t^e = \pi_t^m - r(\pi_t^m)$. Because ρ_t is random and since $\pi_t^m = V_t + \rho_t - w_t$, π_t^m is a normally distributed variable as well, with variance σ^2 and mean, which depends on the status of the project, the liquidation decision and the wage contract: $\mu_t(s, L, w)$. More specifically, $\mu_1 = \tau + s[(1-L)V_1 - w_1] + (1-s)[LV_l - w_0]$, $\mu_2 = \tau + (1-s)(1-L)V_2$.

In the beginning of period one E decides whether to delegate control to M or not and for how long. If he does not delegate control, then he remains the decision maker for the firm. He then decides the terms of the wage contract to the worker, $\{w_1, w_0\}$, and whether to liquidate the project or not at $t = 1/2$ (after having observed whether there is a delay of the project or not). If, however, E delegates control to M, it is the latter that makes these decisions. In this case, the entrepreneur offers a managerial contract: $\{y_t(\pi_t^e|\delta)\}$. Through the design of this contract, E tries to indirectly induce M to take the decisions that are optimal for the former. Once again we assume away participation constraints for M or W and we assume limited liability from their part (non-negative rewards). The full timing of events is presented in figure 2.

Therefore, E has to decide whether to delegate decision authority to M or not and, if so, what contract he should provide. However, if E decides not to separate ownership from control, his decision problem remains identical to the one of section 2. To see this more clearly, note that the payment required for inducing the worker to exert high incentives remains the same as before: $w_1 \geqslant b + \frac{c_H - c_L}{1-p}$. Also, E would never extract any rents from his firm, as this destroys value for him. Hence, his expected utility under the com-

[9] In the Appendix we show that this is always optimal in our model. We also show that, in this setting, short-term contracts always dominate long-term contracts.

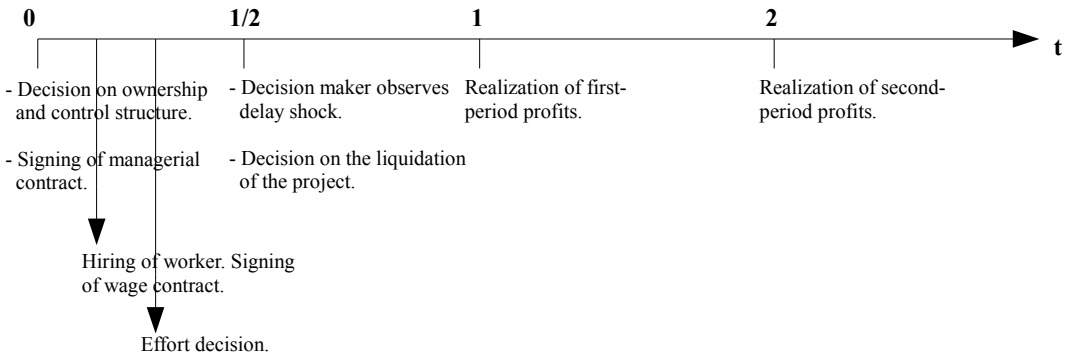

Figure 2: Timing of events

bination of ownership with control is: $\max\{\tau + V - (b + \frac{c_H - c_L}{1-p})\ ,\ \tau + pV_1 + (1-p)V_2\}$. The first term in the brackets is the expected utility of E if he provides high effort incentives to W, in which case the optimal wage contract is $\{w_1 = b + \frac{c_H - c_L}{1-p}, w_0 = 0\}$. The second term is the expected utility of E if he provides low effort incentives. The optimal wage contract is then $\{w_1 = 0, w_0 = 0\}$. It is obvious that the only difference between these terms and the respective terms of section two is the addition of the term τ, which is the mean of the random profits of the firm, excluding the project. Therefore, the optimal choice for E is the same as before.

For the remainder of the paper we assume that the first term in the brackets is higher than the second, which implies that E strictly prefers to induce W to exert high effort when he is in control of the firm. This will facilitate the comparison to the case of delegation. Now, our task is to find what is the optimal contract for E when he decides to delegate control to M and under what conditions is delegation preferred to entrepreneurial control. The optimal contract is the solution to the following problem:

$$\max_{y_1(\pi_1^e|\delta), y_2(\pi_2^e|\delta), \delta} \left\{ \sum_{s=0}^{1} p_s(e_w) \left[\sum_{t=1}^{2} \int_{-\infty}^{+\infty} (\pi_t^e - y_t(\pi_t^e|\delta)) f(\pi_t^e|\mu_t) d\pi_t^e \right] \right\} \tag{1}$$

subject to:

$$\{w_s, r_t(\pi_t^m), L\} = argmax \left\{ \sum_{s=0}^{1} p_s(e_w) \left[\sum_{t=1}^{2} \int_{-\infty}^{+\infty} (y_t(\pi_t^e|\delta) + q r_t(\pi_t^m)) f(\pi_t^m|\mu_t) d\pi_t^m \right] \right\} \tag{2}$$

$$e_w = argmax\,\{p(e_w)(b + w_1) + (1 - p(e_w))(b + w_0 + (1 - L)b) - c(e_w)\} \tag{3}$$

$$\pi_t^e = \pi_t^m - r_t(\pi_t^m) \tag{4}$$

In the expressions above, $p_s(e_w)$ denotes the probability of state s as a function of the worker's effort and $f(\pi_t^m|\mu_t)$ is the conditional probability of the firm having profits equal to π_t^m (similarly for $f(\pi_t^e|\mu_t)$ and π_t^e).

Since the only potential benefit from delegating control to M is the reduction of the wage for W, we examine only the optimal managerial contract which induces M to liquidate the project, if delay occurs, and which induces M to provide high effort incentives to W. Any other incentives for M can not generate more value to E than the value E receives by retaining control of the firm.

Thus, problem (1)-(4) is equivalent to maximizing equation (1) under four incentive compatibility conditions: (i) in the end of each period M should be indifferent between appropriating part of the profits or not. (ii)-(iii) After M is informed whether the project is completed on time or not, he should liquidate the project, if it is delayed, and he should not liquidate it otherwise. (iv) When M offers the wage contract to W, he should provide high effort incentives to W. That is, M should prefer to provide the wage contract $\{\hat{w}_1 = \frac{c_H - c_L}{1-p}, \hat{w}_0 = 0\}$ over the wage contract $\{w_1 = 0, w_0 = 0\}$ [10].

Given the above incentive compatibility conditions, Proposition 1 presents the optimal managerial contract. The proof is provided in the appendix.

Proposition 1 *The optimal managerial contract is a* ***short-term linear contract*** *with payment $y_1^*(\pi_1^e|\delta = 1) = q\pi_1^e$, if profits are positive and zero otherwise.*

We leave the comparative statics for the next subsection and we make a few notes on the form and interpretation of the managerial contract. The managerial contract is similar to a call option with exercise price zero. This is because it makes no payment to the manager, if profits are negative, and starts to pay-out when profits are positive. Moreover, the manager receives a constant proportion of the profits. The first part of the managerial contract is a direct implication of limited liability (non-negative rewards), while the second part is due to the ability of the manager to divert profits into private benefits. As a result, the contract treats the manager as if he is a debt-holder when profits are negative, but as if he is an equity-holder when profits are positive. This does not, of course, make the manager a residual claimant in the firm. Since the entrepreneur retains all profits after paying out manager's reward, it is E who is the residual claimant in the firm and not M.

[10] Restricting attention to only these two contracts is without loss of generality. This is because any other contract does not alter the incentives of W to provide high or low effort, but reduces the level of profits that M can appropriate. In other words, M's optimal choice is to minimize the wage cost for any level of W's incentives in order to maximize π_t^m. This reduces the analysis to the two contracts above.

Finally, we note that the shape of the managerial contract depends on the assumptions of risk-neutrality and limited liability. If limited liability is not assumed, but we retain the assumption of risk-neutrality, then one can find contracts, which make the expected payment to the manager arbitrarily close to zero. However, if the manager is risk-averse, the expected managerial reward will be strictly positive, even in the absence of limited liability.

3.2 Optimal control structure and comparative statics

We can now evaluate the conditions under which the entrepreneur prefers to separate ownership from control. As we have already noted, if E maintains the control of the firm, he receives a payoff equal to:

$$V_E^{EW} = \tau + V_1 - \left(b + \frac{c_H - c_L}{1-p}\right)$$

On the other hand, if he delegates the control to the manager he receives: $V_E^{EMW} = \int_{-\infty}^{+\infty} (\pi_1^e - y_1(\pi_1^e)) f(\pi_1^e | \tau + V_1 - \hat{w}_1) d\pi_1^e$. Given the optimal managerial contract, $\pi_1^e = \pi_1^m$ and $\hat{w}_1 = \frac{c_H - c_L}{1-p}$ and the above expression rewrites as:

$$V_E^{EMW} = \tau + V_1 - \frac{c_H - c_L}{1-p} - q \int_0^{+\infty} \pi_1^m f\left(\pi_1^m \middle| \tau + V_1 - \frac{c_H - c_L}{1-p}\right) d\pi_1^m$$

By directly comparing V_E^{EW} to V_E^{EMW}, we see that E prefers to separate ownership from control iff:

$$b \geqslant E[y_1(\pi_1^m)] \tag{5}$$

$$\text{where} \quad E[y_1(\pi_1^m)] = q \int_0^{+\infty} \pi_1^m f\left(\pi_1^m \middle| \tau + V_1 - \frac{c_H - c_L}{1-p}\right) d\pi_1^m$$

The comparative statics of equation 5 are clear and we summarize them in the following corollary of Proposition 1:

Corollary 1 *The entrepreneur is more likely to separate ownership from control if* [11]*:*

[11] Here, the term "likely" refers to whether the set of parameters that satisfy equation 5 increases or not as one of them changes. One can justify this term by imagining that there is a probability distribution over the set of parameters value, which provides the percentage of firms with the same characteristics and which gives the total probability of a firm belonging to one control structure or the other, as evaluated by the cumulative distribution conditional on equation (5). The mental exercise is, therefore, to examine what happens to this probability, conditioning on a small change around a specific value of one parameter. As similar interpretation is given by Tirole (2001).

- *The ability of the manager to appropriate profits (q) decreases.*
- *The private benefit of the worker (b) increases.*
- *The probability of delay ($1-p$) decreases or the differential cost of effort ($c_H - c_L$) increases. More generally, whenever the efficiency wage of the worker ($\hat{w}_1$) increases.*
- *The average value of the firm (τ) or of the project (V_1) decreases.*
- *The variance of the firm profits (σ^2) increases.*

While the interpretation of most of these comparative statics is straightforward, for some of them it is actually counter-intuitive. We consider each one in turn.

3.2.1 The ability of the manager to appropriate profits

This is the most straightforward implication of the model. The higher the ability of the manager to hide profits and transform them into managerial benefits, the greater the cost of delegation and the smaller the willingness of the entrepreneur to separate ownership from control. It is also one of the predictions of the model which fits with both the model of Demsetz (1983) and the empirical findings of Demsetz and Lehn (1985). Firms with greater opaqueness of operation, where it is impossible or very costly to verify whether the incurred expenditure is necessary for the operation of the firm (businesses in service sector, research oriented institutions), are better kept under the tight control of the entrepreneur, even if this implies higher rents to employees. On the other hand, businesses with established management practices and good monitoring devices (manufacturing sector) lend themselves more easily to the separation of ownership and control.

This is also related to the finding that young firms are much more likely to be controlled by entrepreneurs than managers, while the opposite is true for old firms. A potential explanation is that, in the former case entrepreneurs have not yet acquired the necessary experience and skills for setting-up appropriate monitoring devices in their absence, while the reverse is true for the latter case. In other words, if one lets q to be a decreasing function of the experience of the entrepreneur, then our model can be made consistent with this empirical finding.

3.2.2 The private benefit of the worker

The fact that the value of delegation increases with b is a direct implication of the way we set-up the model. The real purpose of the manager and his true distinction from the entrepreneur is that he is initially an outsider, who has no stake in the firm. Through the design of the managerial contract, he is employed in order to make the threat of termination of the delayed project credible and, therefore, reduce the efficiency wage by the level of the private benefit that W enjoys in each period. Therefore, it comes

as no surprise that the higher is the value of the private benefit, the higher is value of delegation for the entrepreneur.

Note that our model presents a distinctive feature here in comparison with the early literature. While the opaqueness of managerial decisions (q) reduces the value of delegation, the opaqueness of the worker's decisions (b) actually increases it. In the early theories of ownership and control (Jensen and Meckling, 1976; Demsetz, 1983) this distinction is not present. According to these theories, increasing the opaqueness of the organization at any layer reduces the willingness of the owner to relinquish control. In our model, this prediction holds for the higher layers of the organization but not for the lower ones. Therefore, our model generates a new empirical prediction: firms whose workers gain more by being employed are more likely to be run by managers than entrepreneurs.

However, one needs to exercise caution when interpreting the term "gains". It may refer to non-monetary rewards that employees receive or extract from the organization. These could be psychological benefits, like esteem from working in a very well-known and established firm, or non-pecuniary rents, like free access to phone services, which are provided by the nature of the job. But the term may also refer to monetary rewards, as long as they are not directly controlled by the firm. This could be due to the workers having bargaining power in negotiating their wages (strong presence of unionized labor) or due to minimum wage policies that increase the wage level above what the firm would otherwise pay. In any of these cases, our model predicts that running the firm by managers may actually decrease effective wage cost, by reducing the incidents of work being delayed, and, therefore, that delegation of control should be more frequently present under these conditions.

3.2.3 The other factors of efficiency wages

More interesting is the fact that the other factors, which determine the efficiency wage (the probability of delay, $1-p$, and the differential cost of effort, c_H-c_L), also contribute in the same way as b. One might think that these factors play no role, as this part of the efficiency wage has to be paid by both the entrepreneur and the manager, if they are to induce W to exert high effort. However, a higher efficiency wage leaves less profits for appropriation by the manager and makes him cheaper to hire. As a result, holding everything else constant, a higher cost of employment makes the option of delegation of control more attractive to the entrepreneur.

While this result seems rather counter-intuitive, its empirical implication is clear: Firms with lower profits per worker (or perhaps, more clearly, per effective unit of control) provide less potential for rent extraction by the managers and delegation of control should be observed more frequently in these organizations. That does not, however, mean that smaller firms are more likely to be run by managers than larger firms. To see this consider the following slight extension of the model.

Suppose that the firm has n available projects, each one of which operates as the project of section 2 and 3.1. The total value of all projects is equal to: $V(n) =$

$nV - \psi(n)$, where $\psi(n)$ is an increasing and convex function of the number of workers, representing the dis-economies of scale generated by having multiple workers in the firm. Hence, $V(n)$ is a concave function. As a result, equation (5) now writes as:

$$nb \geqslant q \int_0^{+\infty} \pi_1^m f\left(\pi_1^m | \mu(n)\right) d\pi_1^m \tag{6}$$

$$\text{where} \quad \mu(n) = \tau + nV_1 - \psi(n) - \frac{c_H - c_L}{1-p}$$

An increase in the number of available projects increases the cost of the firm by b in the case it is run by the entrepreneur, while it increases the cost of the firm by $q\frac{\partial \mu(n)}{\partial n} \int_0^{+\infty} \pi_1^m f\left(\pi_1^m | \mu(n)\right) \frac{\pi_1^m - \mu(n)}{\sigma^2} d\pi_1^m$, if it is run by a manager. Clearly, there exists a cut-off value n^m above which the marginal cost of an E-run firm is higher than the marginal cost of a M-run firm, which means that, above n^m the set of parameters that satisfy equation (6) increases. The interpretation, then, is that firms which have more projects or employees than some threshold are more likely to be manager-controlled and entrepreneur-controlled. In other words, our model is consistent with the empirical finding that separation of ownership and control is more likely for larger firms (Demsetz and Lehn, 1985).

In order to be as clear as possible, we recapitulate the empirical prediction of our model regarding efficiency wages: The lower is the profit per worker for the firm, the more likely separation of ownership and control is. Therefore, given everything else, an increase in the efficiency wage increases the possibility of delegation of control to the manager. On the other hand, an increase in the number of control units (workers and control units are equivalent in our model) increases the possibility of delegation, if this number is sufficiently high, and has ambiguous effects, if this number is below a certain threshold (n^m).

3.2.4 The average profitability of the firm and the project

A similar kind of reasoning as above applies with regards to the parameters τ and V_1. If the average profits of the firm or the profits of the project increase, then there is greater scope for rent extraction by the manager and the value of delegation goes down. Again, in terms of empirical predictions, the distinction between the effects of an increase of total profits due to an increase in the total number of projects or due to an increase on the profitability of each project applies in this case as well (see also the discussion in the previous subsection).

3.2.5 The variance of profits

Finally, an increase in the variance of profits (σ^2) increases the expected payoff of the manager, $E[y_1(\pi_1^m)]$, and decreases the value of separation of ownership and control.

This is because an increase in σ^2 makes high-profit states more likely. Since the managerial reward is an increasing function of profits, so as to prevent rent extraction, higher variance increases the expected reward of the manager and, hence, the expected cost for the entrepreneur. This prediction of the model is also consistent with many of the empirical studies on this topic (Demsetz and Lehn, 1985).

4 Discussion

There are some theoretical issues of the model of section 3.1, which we have left for discussion in this section for the interested reader. We discuss each one in turn in order to demonstrate that our model is robust to certain theoretical concerns.

4.1 Participation constraints

In section 3 we simplified the analysis by omitting the participation constraints of the manager and the worker. Since both of them have a non-negative utility in equilibrium, the results of the previous section remain the same if we were to assume that the outside option for both M and W is equal to zero. Here, we discuss how these results change with the inclusion of more general participation constraints.

First, let o^w and o^m denote the outside options for the worker and the manager respectively. Clearly, if the outside option of the worker is less than the efficiency wage under delegation ($\hat{w}_1$), then the cost of hiring him remains unchanged under both control structures. Therefore, which one is preferred also depends on the outside option of the manager. If o^m is below the expected value of the optimal contract, then our results remain unchanged. If o^m lies above the expected value of the managerial contract, then the cost of hiring the manager is o^m and delegation is still the optimal control structure if $o^m \leqslant b$.

In the case where o^w is equal or above $\hat{w}_1$, but below $\hat{w}_1 + b$, then the benefit from delegation falls to $\hat{w}_1 + b - o^w$ and the optimal control structure is determined by the comparison between $\hat{w}_1 + b - o^w$ and $\max\{E[y_1(\pi_1^m)]\ ,\ o^m\}$. Finally, in the case where o^w is equal or above $\hat{w}_1 + b$, then there is no benefit from delegation and the only optimal control structure is the combination of ownership with control.

4.2 Renegotiation proofness of the managerial contract

In the models of section 2 and 3.1, the issue of the renegotiation-proofness of the managerial contract arises after the delay shock has occurred. This is because, after the manager finds out that the project will be delayed, he realizes that he needs to undertake a sub-optimal action: to liquidate a project which has a strictly positive continuation value. He can improve on his situation by communicating with E in order to change the terms of the contract. The renegotiated contract would provide

an increase to the payoff of both parties by giving incentives to the manager not to liquidate the project and sharing the surplus generated in period two.

Moreover, the terms of the contract could be such that E would infer from them that only a manager, who knows that the delay will occur, has an incentive to propose such terms, and this would make M's proposal credible. But in this case, the liquidation of the project will not happen in equilibrium, and knowing this, W will shirk unless provided with an increase in his wage equal to b. In other words, the prospect of the renegotiation of the managerial contract undoes the credibility of liquidation in case of delay and destroys any benefits generated by the delegation of control.

The issue of renegotiation-proofness has generated its own theoretical literature and we do not intend to address it here in its full generality[12]. We note, however, that one can find theoretical solutions around this problem. A solution, which is relevant to our context is the use of a golden parachute. The interpretation here is that part of the terms of the original managerial contract is a clause which defines a large compensation for the manager if the other terms of the contract are renegotiated or modified in any way. Such a clause could make the managerial contract too costly to renegotiate for the entrepreneur and forestall any change in its terms.

The catch is, of course, that the manager should not be able to rescind this clause along with the other terms of the contract. This would require a legal system where the golden parachute is recognized as a "senior" right to any other contractual rights of the manager, or, in other words, that, even if the manager rescinds his right to the golden parachute with some later contract, any court will recognize his claim to it, if he asks to. Such an institutional arrangement would ensure that managers always demand their compensation after any alteration of the original agreement and would stop the entrepreneurs' efforts to change them (as long as changing the institution itself is much more costly for E and M than continuing with their current arrangement).

In reality, we do not observe laws of this kind. But since such a theoretical solution exists, the fact that we do not observe it means that either there are other, more efficient, solutions to this problem or that it is not nearly as important as economic theory suggests. In either case, we believe that it is not a crucial concern for our model.

4.3 Optimality of the mechanism

We now consider two alternative solutions to the problem we have presented in sections 2 and 3.1. We also discuss under what conditions they are preferred to delegation or not. The first one is a governmental policy, which taxes away all profits of the firm in period two. The second one is issuing claims on the profits of the firm to financial markets.

As far the the first one is concerned, taxing away the profits of period two destroys the continuation value of the project and makes the threat of liquidation credible. This is because, as soon as E finds out that the project is delayed, he prefers to sell it.

[12]See, for example, Dewatripont and Maskin (1990) and Maskin and Moore (1999).

The result is the same as delegating decision power to the manager: E can reduce the efficiency wage of the worker and increase his payoff by b.

However, the policy is not costless for the entrepreneur. Since the continuation of the project increases average profits for the firm in period two, the governmental policy can solve the time inconsistency problem of E only if it taxes away *all* of the profits of the firm in this period. Therefore, the expected cost of the policy is equal to τ. Hence, taxing away profits is a better mechanism than delegation only if the expected profits of the firm in period two (excluding the project value) are less than the expected payment of the manager. Otherwise, separation of ownership and control remains an optimal solution.

The second solution is more interesting. According to it, the entrepreneur issues financial claims on the future stream of profits of the firm in the beginning of period one and sells them to financial markets. One such financial claim is for instance a claim on all profits of period two, which can be sold for a price equal to τ. Another potential claim is the one which replicates the state-contingent payoff of the entrepreneur in period one when delegation is used, which is sold for a price equal to V_E^{EMW} [13].

Both of these claims work equally well. The first one replicates the effects of the governmental policy, discussed above, while the second one replicates the incentives provided by the managerial contract. Moreover, both of them have the additional benefit that the entrepreneur retains the value of the claims he is selling by receiving the price. Indeed, for the models of section 2 and 3.1, selling financial claims is a costless way for the entrepreneur to commit not to continue the project, if a delay occurs. In other words, delegation is useless in terms of our model, if well functioning financial markets are available.

The main issue, however, with this solution is that financial markets usually suffer from adverse selection. While we have avoided to complicate the model of 3.1 for the sake of expositional clarity, it is easy to make the point here. If the initial profitability of the firm is observable to the entrepreneur but not to outsiders, then any claim issued by a high quality entrepreneur will suffer a market discount and this is the true cost of financial markets. If this is sufficiently high then the entrepreneur may still prefer to delegate control to a manager, who suffers from moral hazard, than issue underpriced securities. In other words, we effectively handicapped delegation as a potential solution to E's problem when we added managerial moral hazard to the problem, while we assumed perfect information about the quality of the firm. But a fair comparison between delegation and the use of financial markets requires to consider the information problems on both sides[14].

[13] It is essentially $\pi_1^e - y_1(\pi_1^e)$, where $y_1(\pi_1^e)$ is provided by equation 9 in the Appendix.

[14] The model of section 3.1 can easily accommodate both sides of the problem. Just let two different types of firms, one with high profits, τ_H, and one with low profits, τ_L, where the type of the firm is private information to the entrepreneur at the start of the period. Then, for a sufficiently high enough difference of profits between the two types, type H entrepreneurs find it optimal to hire a manager and avoid the mispricing of their securities, while type L entrepreneurs prefer the financial markets. Note that even though one prediction of this extension is the same as in Acemoglu (1998) (high quality firms

From the above discussion, we conclude that delegation is an optimal way to solve the time-consistency problem of the entrepreneur (or, at least, a subset of entrepreneurs) if the managerial moral hazard is not severe enough (q is low), if the expected profits of the firms are high (τ is high), and if financial markets suffer from severe adverse selection. Therefore, even though the solution we propose is not always an optimal solution, it remains the only optimal solution under specific parameter values.

5 Conclusion

The paper presents a simple model of delegation of corporate control from an entrepreneur to a manager. Thus, it provides a theoretical reasoning for the separation of ownership and control in modern firms. The main reasoning behind the model is that managers can impose penalties to procrastinating workers more credibly than entrepreneurs, because, by the construction of their contract, they do not care about the long-run value of the firm as much as its owners. On one hand, this reduces the efficiency wage paid to workers and generates firm value. On the other hand, the introduction of managers in the firm generates agency costs in the form of appropriation of profits for the provision of private benefits to the top management. This trade-off between low-tier and higher-tier benefits characterizes the optimal choice of control structure and provides interesting comparative statics. Some of our predictions are consistent with the findings of the empirical literature, while others remain to be tested yet.

It is also noteworthy to mention that the paper is related to the theoretical literature regarding delegation. The literature so far focuses on how to optimally design the action-set of the agent, but takes delegation of decision power as given. Examples of this literature are Holmstrom (1984), Faure-Grimaud, Laffont, and Martimort (2003) and Alonso and Matouschek (2008). However, as we noted above, delegation of decision power is endogenously determined in this model. We believe that one can extend this theoretical example to more general cases and provide a more complete theory of endogenous delegation.

hire a manager, low quality firms do not), there is an important difference. In our model firms do not require external capital and only low quality firms sell securities to the markets, while in Acemoglu (1998) firms need financial capital for investment and, in equilibrium, all of them borrow from financial markets. In other words, in Acemoglu (1998), delegation is used as a signaling device towards financial markets, while for us markets is a competing mechanism to delegation and operates as a commitment device.

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Appendix

Proof of Proposition 1

First we write the incentive compatibility constraints (i)-(iv) in page 11. We then show that the optimal managerial contract is always a short-term contract. Finally we solve for the optimal short-term contract.

Recall that $\mu_t(s, L, w)$ is the mean of the random variable π_t^m as a function of s,L and w, as expressed in page 9, $\pi_t^e = \pi_t^m - r_t(\pi_t^m)$, and that $\hat{w} = \{\hat{w}_1 = \frac{c_H - c_L}{1-p}, \hat{w}_2 = 0\}$. I_δ is an indicator function which takes the value 1 if the contract is long-term and takes the value 0 if the contract is short-term. $u_t^m = y_t(\pi_t^m - r_t(\pi_t^m)|\delta) + qr_t(\pi_t^m)$ is M's utility for a given realization of π_t^m. The four incentive compatibility conditions for the problem are:

$$r_t(\pi_t^m) = argmax\{y_t(\pi_t^m - r_t|\delta) + qr_t\}, \quad \forall \pi_t \in (0, +\infty), t \in \{1, 2\} \qquad (\mathbf{IC}_1)$$

$$L = 1|s = 0 \quad \Leftrightarrow \quad \int_{-\infty}^{+\infty} u_1^m f(\pi_1^m|\mu_1(0,1,\hat{w}))d\pi_1^m + I_\delta \int_{-\infty}^{+\infty} u_2^m f(\pi_2^m|\mu_2(0,1,\hat{w}))d\pi_2^m \geqslant$$
$$\int_{-\infty}^{+\infty} u_1^m f(\pi_1^m|\mu_1(0,0,\hat{w}))d\pi_1^m + I_\delta \int_{-\infty}^{+\infty} u_2^m f(\pi_2^m|\mu_2(0,0,\hat{w}))d\pi_2^m$$

where: $\mu_1(0,1,\hat{w}) = \tau + V_l - \hat{w}_0$, $\mu_2(0,1,\hat{w}) = \tau$, $\mu_1(0,0,\hat{w}) = \tau - \hat{w}_0$, $\mu_2(0,0,\hat{w}) = \tau + V_2$ $\qquad (\mathbf{IC}_2)$

$$L = 0|s = 1 \quad \Leftrightarrow \quad \int_{-\infty}^{+\infty} u_1^m f(\pi_1^m|\mu_1(1,0,\hat{w}))d\pi_1^m + I_\delta \int_{-\infty}^{+\infty} u_2^m f(\pi_2^m|\mu_2(1,0,\hat{w}))d\pi_2^m \geqslant$$
$$\int_{-\infty}^{+\infty} u_1^m f(\pi_1^m|\mu_1(1,1,\hat{w}))d\pi_1^m + I_\delta \int_{-\infty}^{+\infty} u_2^m f(\pi_2^m|\mu_2(1,1,\hat{w}))d\pi_2^m$$

where: $\mu_1(1,0,\hat{w}) = \tau + V_1 - \hat{w}_1$, $\mu_2(1,0,\hat{w}) = \tau$, $\mu_1(1,1,\hat{w}) = \tau + V_l - \hat{w}_1$, $\mu_2(1,1,\hat{w}) = \tau$ $\qquad (\mathbf{IC}_3)$

$$\int_{-\infty}^{+\infty} u_1^m f\left(\pi_1^m|\mu_1(1,0,\hat{w})+\right) d\pi_1^m + I_\delta \int_{-\infty}^{+\infty} u_2^m f(\pi_2^m|\mu_2(1,0,\hat{w}))d\pi_2^m \geqslant$$

$$p\int_{-\infty}^{+\infty} u_1^m f(\pi_1^m|\mu_1(1,0,0))d\pi_1^m + (1-p)\int_{-\infty}^{+\infty} u_2^m f(\pi_1^m|\mu_1(0,1,0))d\pi_1^m + I_\delta \int_{-\infty}^{+\infty} u_2^m f(\pi_2^m|\mu_2(1,0,0))d\pi_2^m$$

where: $\mu_1(1,0,0) = \tau + V_1$, $\mu_1(0,1,0) = \tau + V_l$, $\mu_2(1,0,0) = \tau$ $\qquad$ $(\mathbf{IC}_4)$

In order to show that short-term contracts dominate long-term contracts, first we analyze $\mathbf{IC}_1$. By differentiating $\mathbf{IC}_1$ with respect to r_t, we find that the manager is indifferent between extracting more rents or reporting the true profits if $\frac{\partial y_t}{\partial \pi_t^e} = q$. This means that the managerial contract is an increasing function of reported profits, with slope at least equal to q in order to prevent the manager from extracting private benefits. Otherwise, the manager has the incentive to destroy profits in the neighborhood of any realized profit where his contract is non-increasing. By doing so, he does not reduce his compensation while extracting private benefits for himself. Clearly, the expected payment is minimized when $y_t = q\pi_t^e$.

Consider any long-term contract $y^L = \{y_1(\pi_1^e|\delta = 2), y_2(\pi_2^e|\delta = 2)\}$ which satisfies $\mathbf{IC}_1$-$\mathbf{IC}_4$. We have established that y^L is increasing in profits in both periods. Consider now the short-term contract $y^S = \{y_1(\pi_1^e|\delta = 1) = y_1(\pi_1^e|\delta = 2)\}$. That is y^S offers the same payment schedule as y^L for the first period, after which the manager is fired. y^S offers a lower expected payment to M than y^L, since M receives no second period payment. Therefore, y^S strictly increases E's utility over y^L.

Furthermore, y^S also satisfies the incentive compatibility conditions. To see this, first, y^S satisfies $\mathbf{IC}_1$ for period one by construction. Second, $\mathbf{IC}_3$ and $\mathbf{IC}_4$ are also satisfied by construction, because they do not depend on the second period expected payment: the terms which follow I_δ have the same expected value and cancel from both sides of the two constraints. It remains to show that $\mathbf{IC}_2$ is also satisfied by y^S. By substituting the values for μ_t in $\mathbf{IC}_2$ and by rearranging, the constraint writes in the case of y^L as follows:

$$\int_{-\infty}^{+\infty} u_1^m \left[f(\pi_1^m|\tau + V_l - \hat{w}_0) - f(\pi_1^m|\tau - \hat{w}_0)\right] d\pi_1^m \;\geqslant\; \int_{-\infty}^{+\infty} u_2^m \left[f(\pi_2^m|\tau + V_2) - f(\pi_2^m|\tau)\right] d\pi_2^m \tag{7}$$

$\mathbf{IC}_1$ implies that $r_2(\pi_2^m) = 0$, $\pi_2^e = \pi_2^m$. Therefore, since $\tau + V_2 > \tau$ and $u_2^m = y_2(\pi_2^m)$ is an increasing function of π_2^m, the right hand side of (7) is strictly positive. However, because $u_2^m = 0$ under a short-term contract, the same constraint writes in the case of y^S as:

$$\int_{-\infty}^{+\infty} u_1^m \left[f(\pi_1^m|\tau + V_l - \hat{w}_0) - f(\pi_1^m|\tau - \hat{w}_0) \right] d\pi_1^m \;\geqslant\; 0 \tag{8}$$

Therefore, if $y_1(\pi_1^e|\delta = 2)$ satisfies (7) then it also satisfies (8) and therefore y^S also satisfies $\mathbf{IC}_2$. This means that y^S provides a smaller expected payment to M and it also strictly relaxes $\mathbf{IC}_2$. Hence, any incentive compatible long-term contract is dominated by a short-term contract. For simplicity, we drop the notation δ and second period payments for the rest of the proof and we solve for the optimal short-term contract.

By limited liability, $y_1(\pi_1^m) = 0$ if $\pi_1^m < 0$. By $\mathbf{IC}_1$, $y_1(\pi_1^m) \geqslant q\pi_1^m$ if $\pi_1^m \geqslant 0$. Consider the contract with the minimum-expected payment which satisfies $\mathbf{IC}_1$ and limited liability:

$$y_1 = \begin{cases} 0, & \text{if } \pi_1^m < 0 \\ q\pi_1^m, & \text{if } \pi_1^m \geqslant 0 \end{cases} \tag{9}$$

We show that the above contract satisfies $\mathbf{IC}_2$-$\mathbf{IC}_4$. By substituting for u_1^m in (8) with the above payments, $\mathbf{IC}_2$ writes as:

$$q \int_{0}^{+\infty} \pi_1^m \left[f(\pi_1^m|\tau + V_l - \hat{w}_0) - f(\pi_1^m|\tau - \hat{w}_0) \right] d\pi_1^m \;\geqslant\; 0$$

Since $\frac{\partial}{\partial \mu_1} \left[\int_0^{+\infty} \pi_1^m f(\pi_1^m|\mu_1) d\pi_1^m \right] > 0$, the left hand side of the above equation is strictly positive and $\mathbf{IC}_2$ is satisfied. Similarly for $\mathbf{IC}_3$:

$$q \int_{0}^{+\infty} \pi_1^m \left[f(\pi_1^m|\tau + V_1 - \hat{w}_1) - f(\pi_1^m|\tau + V_l - \hat{w}_1 \right] d\pi_1^m \;\geqslant\; 0$$

Since $V_1 > V_l$, $\mathbf{IC}_3$ is satisfied as well. Finally, $\mathbf{IC}_4$ requires that:

$$q \int_{0}^{+\infty} \pi_1^m f(\pi_1^m|\tau + V_1 - \hat{w}_1) d\pi_1^m \;\geqslant\; qp \int_{0}^{+\infty} \pi_1^m f(\pi_1^m|\tau + V_1) d\pi_1^m + q(1-p) \int_{0}^{+\infty} \pi_1^m f(\pi_1^m|\tau + V_l) d\pi_1^m$$

Because $\partial^2 [\int \rho f(\rho) d\rho] / (\partial \tau)^2 < 0$, we have that:

$$\int_0^{+\infty} \pi_1^m \left[f(\pi_1^m|\tau + pV_1 + (1-p)V_l) - f(\pi_1^m|\tau + V_l) \right] d\pi_1^m \; > \; \int_0^{+\infty} \pi_1^m \left[f(\pi_1^m|\tau + V_1) - f(\pi_1^m|\tau + pV_1 + (1-p)V_l) \right] d\pi_1^m$$

Since $p < 1/2$:

$$(1-p) \int_0^{+\infty} \pi_1^m \left[f(\pi_1^m|\tau + pV_1 + (1-p)V_l) - f(\pi_1^m|\tau + V_l) \right] d\pi_1^m \; > \; p \int_0^{+\infty} \pi_1^m \left[f(\pi_1^m|\tau + V_1) - f(\pi_1^m|\tau + pV_1 + (1-p)V_l) \right] d\pi_1^m \; \Leftrightarrow$$

$$p \int_0^{+\infty} \pi_1^m f(\pi_1^m|\tau + V_1) d\pi_1^m + (1-p) \int_0^{+\infty} \pi_1^m f(\pi_1^m|\tau + V_l) d\pi_1^m \; <$$
$$\int_0^{+\infty} \pi_1^m f(\pi_1^m|\tau + pV_1 + (1-p)V_l) d\pi_1^m \; < \; \int_0^{+\infty} \pi_1^m f(\pi_1^m|\tau + V_1 - \hat{w}_1) d\pi_1^m \qquad \blacksquare$$