Regulation of "guru" Analysts' Conflict of Interest

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Abstract

Conflicts of interest are the inherent price to pay to benefit from information synergies offered by multiple financial service providers. We focus on conflicts faced by a investment bank's "guru" sell-side analyst, which is torn between the "pro-investor" research department favoring fair valuation, and the "pro-corporate firms" underwriting department favoring overvaluation.

Thanks to a delegated common agency game under moral hazard, we endogenize the influence of environment variables on conflicts outcome as regards market valuation. We demonstrate first that the risk of overvaluation depends crucially on the extent of the relative pricing preferences of opposite financial interests at stake. Thus, the more the potential profit from underwriting activities exceeds potential brokerage commissions, the more the bank favors issuers over investors, and the more likely market overvaluation is. Consequently, to protect naive uninformed investors, we introduce in a second time a regulator in the framework of a simultaneous intrinsic relationship, which suffers from overvaluation on the one hand, and is allowed to take costly judicial proceedings to penalize banks on the other hand. We then show that coercive regulation greatly mitigates damaging conflicts outcomes, even if it induces free-riding behaviors among fair-valuation partisans.

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1 ISSUE:

Equity research's inherent exposure to conflict of interest.

Information is the crucial feature of modern capital markets. However, collecting, processing and analyzing the huge amount of available information and raw data, including issuers' disclosure statements and statistics released by governments or private sources, is far too complex and costly for most investors. As a result, research analysts constitute a fundamental interface between companies and investors, both retail and institutional. They play a role that cannot be ignored as regard financial intermediation. Thus investors often regard analysts as experts that provide important sources of processed information about the securities they cover, and rely on their advice. However latest affairs on financial markets (*Enron*, *WorldCom* or *Ahold*) have questioned the reliability and honesty of information intermediaries, such as financial analysts, by revealing poor management and even exploitation of conflicts of interest. However, this issue is not exactly new, as "banksters" ' exploitation of conflicts of interest before the stock market crash of 1929, and the vote of the Glass-Steagall Act, remind us.

According to [Crockett, Harris, Mishkin and White, 2004], *"Conflicts of interest arise when a financial service provider, or an agent within such a service provider, has a multiple interest which create incentives to act in such a way to misuse or conceal information needed for the effective functioning of financial market".* Indeed, providing multiple financial services to benefit from synergies and economies of scope, notably as regards information production, creates endogenously potential costs: it creates an "opportunity for exploiting the synergies or economies of scope by inappropriately diverting some of their benefits".

The term "analyst" encompasses individuals with varying functions within the securities industry, which are generally classified into one of three broad categories depending on the nature of their employment. According to their type, analysts are differently confronted with conflicts of interest, which can interfere with the accuracy and the objectivity of their analysis. Interests of independent analysts, which sell their research (subscription,...), and those of buy-side analysts, working for money managers trading for their own investment accounts or on behalf of others, are generally perceived to be bear less severe risks of preferences misalignment with those of their hierarchies and clients ([IOSCO-OICV, 2003]). We will consequently focus on sell-side analysts, which are typically employed in the research department of full-service investment firms[1].

Conflicts arise because full-service investment firms, as financial intermediaries, often undertake many, potentially conflicting, roles. As pointed out in [Crockett, Harris, Mishkin and White, 2004], the conflict of interest that raises the greatest concern occurs between underwriting and brokerage, when investments banks serve two conflicting client groups (issuing firms and investors). Issuers benefit from optimistic analyses,

[1] According to the OICV-IOSCO, the generic term "full-service investment firms" is intended to refer to entities that provide a variety of financial or financial-related services to client as banking groups ([IOSCO-OICV, 2003], p. 2, footnote 2).

while investors look for unbiased recommendations. According to the relative extent of the potential profit generated by each of these two activities, the financial firm is tempted to act to the advantage of one of both client groups. When the potential profit from underwriting greatly exceed brokerage commissions, investment banks have strong short-term incentives to favor issuers over investors. Thus, they reduce the risk to loose their profitable corporate clients to competitors, all the more easely that long-term investors profit at short-term from overvaluation, before suffering the often underestimated ineluctable market correction . As a result, analysts in investment banks may distort their research to please issuers, so that produced information may loose reliability and deteriorates efficiency of securities market.

In this paper, we develop a theoretical model enlightening the link between the relative power of financial interests generated by underwriting and brokerage activities, and analysts' effort to produce and spread reliable information. This delegated common agency model offers valuable insights to help to explain self-fulling mechanisms and surprising investment recommendations observed in hot market.

In the context of financial markets dominated by financial intermediaries whose lifeblood is information, theoretical and empirical studies as regards information transmission and analysts' forecasts -related issues have obviously received a lot of attention[2]. In a first time, We shall focus on the empiric literature analyzing issues related to conflicts of interest in underwriting and research activities.

The source of equity research's exposure to conflicts of interest is mainly twofold. First, according to [Crockett, Harris, Mishkin and White, 2004], an underlying problem of appropriateness of the analyst production, due to information (at least partial) revelation through trading, makes the sale of this not-purely-private good difficult. This obstacle is reinforced by the difficult assessment of analysts' performance, since the forecast accuracy of fundamental values does not guarantee the success at stocks picking. This double problem makes difficult to price analyst work, so that reports are generally provided for free to brokerage clients ([Dugar and Nathan, 1995]), all the more that [Michaeli and Womack, 1999] reveals that customers do not trade at firms providing them with information they rely on. As a result, research is often considered as overheads generating little direct profit.

Consequently investment banks have recourse to equity research as a " marketing tool " to make it pay.

[2]The bulk of the theoritical literature extensively investigates the "standard" relationship between an investor and an analyst/adviser. Works in this vein are mainly concerned by information transmission in the framework of incentives alignment biais ([Krishna and Morgan, 2000] or [Morgan and Stocken, 2003]), reputational cheap-talk ([Ottaviani and Sorensen, 1999], [Levy, 2000] or [Levy, 2002]) or forecasting contest in pre-specified rules such as winner-take-all tournaments ([Ottaviani and Sorensen, 2003]). Empirical works enlightened issues as regard accuracy of information production (for instance [Francis, Hanna and Philbrich, 1997]), exploitation of forecast by investors ([Francis and Soffer, 1997]), analyts' compensation and reputation ([Hong and Kubik, 2003]), forecasting biais ([Hong and Kubik, 2003]), and existence of conflicts of interests ([Shiller, 2000],[Michaeli and Womack, 1999]), information disclosure by management...

The rationality of this criterion is twofold ([Crockett, Harris, Mishkin and White, 2004]). First, analysts' reputation is important for attracting and retaining brokerage customers. Second, it is an essential marketing tool for investment banks in the IPO market. Indeed, analysts' capacity to " make the market " is generally a crucial criterion in the firm's choice of the underwriting bank, and the latter's support is often considered as part of an implicit understanding between underwriters and issuers. In the same vein, after-IPO recommendations impact crucially on further business relationships between the issuer and the underwriter.

Consequently, as "marketing tool" for departments serving clients with conflicting interests, equity research faces strong potential conflicts of interest. For instance analysts could be tempt to issue excessively bullish opinions to maintain business relationships with formers issuers or attract new ones. The conflict will be most pregnant with danger when underwriting is highly profitable relative to brokerage. In such a case, "the short-term payoff for an analyst may outweigh the benefits of investing in a long term reputation in a soaring market".

It appears thus clearly that the multiple uses of research creates a potential problem if analysts' compensation is not set appropriately. Compensating for the lack of information on analysts' remuneration, [Hong and Kubik, 2003] studies the determinants of downward and upward analysts' mobility between 1983 and 2000. They find that besides forecasts accuracy, optimism contributes positively to carriers, all the more that covered stocks are underwritten by their own banks, and that the considered period is the stock market boom of the late 1990s.

Analysts' optimistic bias and the predominance of "buy" recommendations (see for instance [Anderson and Schack, 2002], quoted in [Crockett, Harris, Mishkin and White, 2004], p19, or [Rajan and Servae, 1997]) are well documented in the literature. This over-optimism is partially explained by censoring behavior of research directors that dislike issuing negative recommendations to avoid hurting institutional clients and their buy-side analysts, as well as issuing companies. Many prefer to drop coverage rather than continue to analyze objectively poor performing companies. The analyzed sample is thus distorted. However [Hong and Kubik, 2003] argues such bias does not account for "the differences in optimism between analysts" working for underwriting and non-underwriting banks, and the optimistic trend in the stock market boom".

[Shiller, 2000] interprets such forecasting and recommendations biases as obvious evidence of conflicts of interest. The latter are allowed by the capacity of analysts' reports to move markets, as revealed by [Womack, 1996]. If the perception of conflicts exploitation increases during bearish stock market periods, as guilty parties are actively researched, we should however notice that bullish periods exhibit higher potentiality of conflicts of interests as underwriting professional fees become predominant relatively to brokerage commissions. (See [Crockett, Harris, Mishkin and White, 2004] for the exuberant bull market of 1928-9 (p. 1), [Michaeli and Womack, 1999] for the 1990s).

In this theoretical paper, we focus on the conflicts of interest faced by sell-side analysts in the framework of a delegated common agency under moral hazard. We aim to analyze the impact of environment variables on the outcome of these conflicts, inherent to multiple financial service providers. We then recourse to the common-agency literature as underlying framework, and combine the latter to some stylized facts generally accepted by empirical literature on financial markets and analysts. The literature on common agency under moral hazard finds its origin in the seminal paper of [Bernheim and Whinston, 1986]. As summarized in [Martimort, 2004], in such common agency games, "several principals offer non cooperatively contribution schedules to a single decision-maker. The latter chooses first which offers to accept, and, second, which decision should ve taken. The schedule offered by each principal stipulates how much that principal is ready to pay for a given value of that decision". In [Bernheim and Whinston, 1986], the agent chooses the probability distribution of a unique output facing competitive incentives of several principals with misaligned preferences. [Dixit, 1996] introduces multitasking through a risk-adverse common exponential-utility agent under Gaussian hazard with continuous effort by extending [Holmström and Milgrom, 1991]. Since them, numerous economic fields in political science and political economy have been explored thanks to application of these papers. This paper belongs to this research trend as we investigate a still unexplored[3] economic field from a moral hazard common agency angle. However we depart noticeably from previous works in other domains, since modeling a research team entails limited liability restrictions. We thus adapt the methodological framework first introduced by [Martimort, 2004] in a political science context, and extend him to envisage regulatory measures to limit potential hazardous consequences of inherent conflicts of interests. [Martimort, 2004] studies the endogenous formation of interest groups willing to impact on a political reform vote. He first demonstrates the efficiency of equilibria under complete contracting: all principals are endogenously active at equilibrium and contribute through truthful schedules. However, assuming incomplete contracting by restricting principals' contribution to cases in which the outcome they favor happens, equilibrium is no longer efficient and free-riding can arise.

We depart from [Martimort, 2004] by introducing a new type of principals, a Regulator, whose means of interventions differ. At the difference of other principals limited by incomplete contracts ruling out negative incentives in a delegated agency context, he is notably allowed to impose sanctions in the framework of an intrinsic relationship. Moreover, unlike political science applied to vote, case in which efficiency means that equilibrium reflects preferences of all agents, our regulatory approach adopts a quite different standpoint. Indeed, the regulator is legaly endowed with own particular means of actions to try to impose his preference. Our problematic will therefore induce quite different developments, interpretations, conclusions, and recommendations.

The paper is organized as follows. In Section 2, we adapt [Martimort, 2004] to model a research process, contributing or not to overvaluation, as a delegated common agency game under moral hazard. In Section 3,

[3] to our knowledge

we analyze the impact of restrictions on contribution schedules on market valuation. In Section 4, we introduce a Regulator in the previous framework. Section 5 briefly concludes. Proofs are relegated in Appendix.

2 MODEL: Endogenization of "guru" equity research inherent conflicts of interest outcome, and desirable coercive regulation to protect naive retail traders.

In the light of previous empirical findings, we propose to endogenize the outcome of equity research's inherent conflicts of interest, thanks to a stylized but insightful modeling based on a new common agency game under moral hazard, combining delegated and intrinsic agency relationships.

2.1 Framework assumptions

We confine ourselves to a specific financial market segment, such as an industrial sector, or even to the market of a specific security.

$H1$. Following [Miller, 1977], we assume short-sale constraints and potential divergence of opinions allowing overvaluation, even in presence of informed investors.

$H2$. The market segment pricing is described by two states of nature: fair valuation and overvaluation.

$H3$. Two categories of investors intervene on this market segment: a representative uninformed investor with bounded rationality whose trades lead the market according to $H1$, and a representative rational informed long-term institutional investor.

$H4$. In the absence of equity research, all information available to the uninformed investor is produced by the representative listed firm (annual reports,) and is naturally upward biased or at least presented in a favorable light. For instance, annual reports emphasize positive elements while reporting succinctly, evasively, or even diverting attention from negatives ones. As a consequence, given $H1$, the market is overvalued for certain in the absence of equity research.

$H5$. Market valuations on that segment are manipulated by a "guru" analyst, blindly followed by the uninformed investor with bounded rationality. At a increasing convex cost $\psi(e) > 0$ verifying Inada conditions on $[0, 1]$, the guru makes a hidden effort e at performing objective research and trying to convince the market that leads the market segment to be fair valued with a probability e, and overvalued with a probability $1 - e$. Exerting effort $e > 0$ costs $\psi(e) > 0$ to the agent. Explanations are twofold. First,

performing research and convincing the market of results pertinence is resources- and time-consuming. Second, the empirical literature shows that analysts' overoptimism impacts positively on carrier, especially when firms are clients of their own banks' underwriting department (see [Hong and Kubik, 2003] for instance). As a result, contributing to fair valuation induces a cost in terms of professional promotion.

$H6$. Both types of investors favor fair valuation (long-term investment perspectives), whereas the representative listed firm prefers overvaluation (easier financing, take-over protection, ..). However, only investing clients of the investment bank, i.e. the informed institutional investor via the brokerage dept., and the listed firm via the underwriting dept., can try to incite the guru to lead the market towards the valuation they respectively prefer. To reproduce empirical findings, we naturally use an incomplete contract approach (section III), ruling out negative incentives, and allowing positive incentives by making the continuation of commercial relationships depends on the market valuation realization.

$H7$. A regulator, suffering from overvaluation (uninformed investors protection, misallocation), and defending the representative uninformed investor with bounded rationality that is institutionally unable to influence the guru but blindly follows him, can undertake costly judicial proceedings to impose a fine to the guru in case of overvaluation, at a increasing convex cost of the fine absolute value (deeper investigations, better prosecutors, ...).

Notation 1 *We have recourse to the decoration "$\bar{\cdot}$" to describe the value of a variable in case of event "fair valuation", and "$\underline{\cdot}$" in case of event "overvaluation".*

2.2 Preferences

Two Principals i, an informed investor ($i = I$) and a Firm ($i = F$), go to a *delegated* common agent. They get the payoff $\widetilde{S}_i$ and give the conditional transfer $\widetilde{t}_i$ according to which valuation event happens. They are endowed with conflicting interests: I favors fair valuation while F prefers overvaluation. It results in a head-to-head competition among opposite client groups. We normalize to 0 payoffs in unfavorable outcomes, so that $\overline{S_I} > 0 = \underline{S}_I$, and $\overline{S_F} = 0 < \underline{S}_F$. Thus, payoffs in case of favorable outcome directly reflect the potential gains each principal try to obtain by giving incentives to the agent.

Both principals get the expected payoff

$$\forall i, \quad U_i = E\left[\widetilde{S}_i - \widetilde{t}_i \mid e\right] = e * \left[\overline{S_i} - \bar{t}_i\right] + (1-e) * \left[\underline{S}_i - \underline{t}_i\right] \tag{1}$$

The delegated common agent get the expected utility, by exercing effort $e \in [0,1]$,

$$U = E\left[\sum_{i \in N} \widetilde{t}_i \mid e\right] - \psi(e). \tag{2}$$

We assume the cost function $\psi : [0,1] \to [0,+\infty[$ is an increasing, convex, with positive third derivative, and respects the Inada conditions ($\psi'(0) = 0$, $\psi'(1) = +\infty$) to insure interior solutions.

2.3 Timing

1. Principals offer non-cooperatively their contribution schemes $\left\{\left(\bar{t}_i, \underline{t}_i\right)\right\}_{i\in\{I,F\}}$.
2. The research team determines the subset of contract he should accepts. However he can choose not to contract at all and gets the outside option payoff we normalize to 0.
3. The research team chooses his effort (e).
4. Finally, the valuation event happens: market price is either fair-valued, with probability e, or overvalued, with probability $1-e$. Principals get their payoffs and conditional transfers are exchanged.

2.4 Benchmark: Complete contracting in absence of Regulator

First, we assume effort is observable (first best). Following [Martimort, 2004], we determine the first-best socially optimal action e^*_{FB} with observable action and "merged" principals in absence of regulation[4]:

$$e^*_{FB} = \underset{e\in[0,1]}{\arg\max}\, E\left[\sum_{i=I,F} \widetilde{S}_i \mid e\right] - \psi(e) \tag{3}$$

It appears that a positive effort is induced as long as principals favoring fair pricing have a greater valuation for it that principals favoring overvaluation, i.e. that $\bar{S}_I > \underline{S}_F$. At the contrary, when principals favoring fair pricing have a smaller valuation for it that principals favoring overvaluation, the socially optimal effort is at a corner $e^*_{FB} = 0$ and overvaluation is certain.

Proof. As $E\left[\sum_{i=I,F} \widetilde{S}_i\right]$ is linear in e and $\psi(e)$ convex in e, $E\left[\sum_{i=I,F} \widetilde{S}_i\right] - \psi(e)$ is concave in e. Indeed, $\frac{\partial^2}{\partial e^2} E\left[\sum_{i=I,F} \widetilde{S}_i\right] - \psi(e) = -\psi''(e) < 0$. Then e^*_N solves $\frac{\partial}{\partial e} E\left[\sum_{i=I,F} \widetilde{S}_i\right] - \psi(e) = 0 \Leftrightarrow \overline{S_I} - \underline{S}_F = \psi'(e^*_{FB})$. Since we assume that $\forall e > 0$, $\psi'(e) > 0$ and $\psi'(0) = 0$, then $e^*_{FB} > 0$ if $\overline{S_I} - \underline{S}_F > 0$, and 0 else. ■

We notice that the concept of "socially optimal action" do not refer to any "moral" understanding. It only describes the action that would be taken if merged principals gave incitations to the agent, in the framework of a classic principal-agent relationship. Thus, we already have the intuition this effort would not satisfy a regulator favoring fair market valuation, i.e. investor protection and efficient financing through capital markets.

Second, we assume effort is no more observable (second best). In a more general setting of complete contracting with a finite number of Principals (in absence of Regulator), [Martimort, 2004] demonstrates first that whether all principals participate at the equilibrium of the delegated common agency, the common agent

[4] Indeed, [Martimort, 2004] does not consider the intervention of a regulator.

always chooses an socially efficient action (Proposition 1, p. 13). Second, he shows that Principals are all active at equilibrium. When Principals' interests are congruent, each of them gets a positive payoff by making the common agent *residual claimant,* and the common agent gets zero rent (Proposition 2, p. 14). Finally, with two Principals having conflicting interests, the common gets a positive rent as well, since he can play one principal against the other (Proposition 3, p. 15). Thus, with complete contracting, "first, the equilibria [...] remain efficient, i.e. there is neither free-riding nor wasteful competition among principals. Second, all principals find it worth to intervene when they are unrestricted in the kind of contributions they can offer". The equilibria are *truthful* in the sense each Principal makes a "marginal" contribution equal to his own relative valuation between alternative outcomes. Thus, the effort chosen by the agent at equilibrium is efficient from the point of view of the "society", i.e. of merged Principals.

In our framework of two conflicting Principals I and F, applying [Martimort, 2004]'s Proposition 3,

3 Incomplete contracting and Conflicting interests

To reproduce empirical findings, we restrain the set of contracts available to both conflicting principals (the informed investor I and the firm F). We have recourse to an incomplete contract approach ruling out negative incentives. We capture the idea that principals cannot punished the agent through a negative payoff[5]. However, principals can provide positive incentives by making the continuation of commercial relationships[6] depends on the market valuation realization.

Due to these constraints, the Investor I, supporting fair valuation, offers a contribution $\bar{t}_I \geq 0$ ($\underline{t}_I = 0$ resp.), when the market is fair valued (overvalued resp.). At the contrary, the Firm F, favoring overvaluation, offers a contribution $\underline{t}_F \geq 0$ ($\bar{t}_F = 0$ resp.) when market prices are upward biased (fair valued resp.).

3.1 In the absence of regulation

3.1.1 Program of the common agent

The delegated common agent maximizes his expected utility under his individual rationality constraint. His program is

$$(P_A) \qquad \underset{e \in [0,1]}{Max}\, U_A = E\left[\sum_{i=I,F} \widetilde{t}_i \mid e\right] - \psi(e) \tag{4}$$

$$\text{subject to } (IR_{A:}) \quad : \qquad U_A = e * \bar{t}_I + (1-e) * \underline{t}_F - \psi(e) \geq -K \tag{5}$$

[5] A negative payoff would be refused in a delegated common agency framework where the agent chooses with whom he contracts.
[6] new trades at the brokerage, or new deals at the underwriting departments.

We note K the unsinkable costs of stopping activity, due to reputation effects, breach of contracts or commercial relation breaking-offs...

As (P_A) is concave in e, since $\psi(e)$ is convex, the common agent's incentive constraint is

$$(IC_A): \qquad \bar{t}_I - \underline{t}_F = \psi'(e) \tag{6}$$

3.1.2 Program of the Investor favoring fair valuation (Principal I)

The investor P_I offers a contract $(\bar{t}_I, \underline{t}_I = 0)$ maximizing his expected payoff, under the common agent's incentive constraint (6) and the acceptance by the agent of his own offer.

The contract is accepted if the common agent's gets a better expected utility by contracting with both principals, rather than with the firm only. Thus

$$U_A^{LL} \geq \underset{e \in [0,1]}{Max}\, U_{A,\{F\}} = (1-e) * (\underline{t}_F) - \psi(e), \tag{7}$$

with the agent's effort given by (6).

The program of Principal I becomes then

$$\begin{gathered}(P_I): \quad \underset{\{e,\, \bar{t}_I\}}{Max} \quad U_I = e * \left(\bar{S}_I - \bar{t}_I\right) \\ \textit{subject to } (6) \textit{ and } (7)\end{gathered} \tag{8}$$

3.1.3 Program of the Firm favoring overvaluation (Principal F)

The firm P_F offers a contract $(\bar{t}_F = 0, \underline{t}_F)$ maximizing his expected payoff, under the common agent's incentive constraint (6) and the acceptance by the agent of his own offer.

The contract is accepted if the common agent's gets a better expected utility by contracting with both principals, rather than with the investor only. Thus

$$U_A^{LL} \geq \underset{e \in [0,1]}{Max}\, U_{A,\{I\}} = e * \bar{t}_I - \psi(e) \tag{9}$$

with the agent's effort still given by (6).

The program of Principal F becomes then

$$\begin{gathered}(P_F): \quad \underset{\{e,\, \underline{t}_F\}}{Max} \quad U_F = (1-e) * (\underline{S}_F - \underline{t}_F) \\ \textit{subject to } (6) \textit{ and } (9)\end{gathered} \tag{10}$$

3.1.4 Conflicts of interest outcome in the absence of regulator

Proposition 2 *Assuming that principals have conflicting preferences and that* $(1-e).\psi^{'}(e^*)$ *is concave in* e[7]*. If the environment parameters are such that the firm, favoring overvaluation, dominates the investor, in the sense that* $\bar{S}_I < \underline{S}_F - \psi^{''}(e^*)$*, the investor endogenously prefers not to go to the research team. Consequently, the agent does not exert effort* ($e^* = 0$) *and overvaluation is certain.*
If the investor, favoring fair valuation, dominates the firm, in the sense that $\bar{S}_I > \underline{S}_F - \psi^{''}(e^*)$*, the equilibrium effort* e^* *solves:*

$$\bar{S}_I - e^*.\psi^{''}(e^*) - Max\left[\underline{S}_F - (1-e^*).\psi^{''}(e^*)\ ,0\right] = \psi'(e^*) \tag{11}$$

In this case, the Firm (P_F) *intervenes has a brake to fair valuation realization, as long as his valuation for overvaluation exceeds the marginal agency cost he pays to the agent, i.e. as long as* $\underline{S}_F \geq (1-e^*) * \psi^{''}(e^*)$.

Proof. See Appendix (5.1). This proposition is a slight generalization of [Martimort, 2004]'s Proposition 5. ■

According to the relative extent of the potential incomes the bank gets by acting to the advantage of one of his client groups, the bank will favor one Principal over the other. **Since the bank's potential incomes provided by principals are directly linked to their potential gains obtained by influencing the agent, the relative importance of these potential gains is determinant as regards the issue of the conflicts of interests**. When the potential fees from underwriting (Firm P_F) greatly exceed brokerage commissions (Investor P_I), the bank is strongly incited to favor issuers over investors. As a result, analysts in investment banks distort their research and communication to please issuers, and the information they produce do not fight firms' naturally upward biased financial communication. At the contrary, in the opposite polar case, it is not worth Firm's while to try to influence the research team when his valuation for overvaluation does not exceed the marginal agency cost to pay to the agent. When principals' potential gains are not too different, both principals intervene at equilibrium, the countervailling power of the Firm P_F acting like a brake to fair valuation supported by Investor's contribution.

Example 3 *Consider the case in which the cost function is quadratic:* $\psi(e) = \frac{c}{2}e^2$*, with* $c > 0$*. Focussing on interior solutions (since* ψ*, chosen for tractability reasons, does not respect Inada conditions when* $e \to 1^-$*), we get:*

$$\left\| \begin{array}{c} \textit{If} \\ e^* \end{array} \right\| \begin{array}{c} \bar{S}_I < 2(c - \underline{S}_F) \\ e^*_{\{F\}} = \dfrac{\bar{S}_I}{2c} \end{array} \left\| \begin{array}{c} \left\{ \begin{array}{l} \bar{S}_I \geq 2(c - \underline{S}_F) \\ \bar{S}_I \geq \frac{1}{2}(\underline{S}_F - c) \end{array} \right. \\ e^*_{\{I,F\}} = \dfrac{c + \bar{S}_I - \underline{S}_F}{3c} \end{array} \right\| \begin{array}{c} \bar{S}_I < \frac{1}{2}(\underline{S}_F - c) \\ e^*_{\{I\}} = 0 \end{array} \right\| \tag{12}$$

[7] to insure firm's program concavity. This condition holds for numerous functions ψ responding to initial assumptions. It always holds when ψ is a quadratic cost function (but Inada conditions then do not hold when $e \to 1^-$)

Given environment conditions on $\bar{S}_I$ and $\underline{S}_F$, we get $e^*_{\{F\}} = 0 < e^*_{\{I,F\}} = \dfrac{c + \bar{S}_I - \underline{S}_F}{3c} < e^*_{\{I\}} = \dfrac{\bar{S}_I}{2c}$. This illustrates the countervailing power of the Firm P_F that threatens fair valuation probability.

To put it in a nutshell, the more firms benefit from overvaluation, the more a Regulator, favoring fair valuation by assumption, is willing to intervene in favor of fair valuation threatened by firms. We thus introduce a Regulator, suffering from overvaluation, but allowed to penalize the research team in case of overvaluation.

3.2 Intervention of a Regulator favoring fair valuation.

Economic environment conditions can lead informed investors favoring fair valuation not to participate at the equilibrium and therefore induce overvaluation with certainty. These findings naturally raise the question of introducing a Regulator favoring fair valuation by assumption. This regulator, suffering from overvaluation (uninformed investors protection, misallocation), and defending the representative uninformed investor with bounded rationality that is institutionally unable to influence the guru but blindly follows him, can undertake costly judicial proceedings to impose a fine to the guru in case of overvaluation, at a increasing convex cost of the fine absolute value (deeper investigations, better prosecutors, ...).

However, introducing a new actor obviously modifyies the initial actors' best response. We thus have to analyze new behaviors induced by the intervention of the Regulator. Whether both initial principals are still involved in a *delegated* common agency game with the common agent[8], the regulator enters a *intrinsic* relationship in the sense the agent only way to refuse a contract proposed by the Regulator, i.e. a regulation, is not to play at all.

3.2.1 Regulator's preferences

We focus on a natural penalizing regulation compelling the agent to pay a sanction $\mid \underline{p} \mid$ when overvaluation occurs. The Regulator "offers" a special contract ($\bar{p} = 0, \underline{p} < 0$) the agent cannot refuse without refusing all others contracts (*intrinsic* relationship). We assume the regulator, protecting investors, suffers from overvaluation ($\underline{S}_R < 0$), and can penalize the agent when price are biased. But he cannot benefit from the monetary value of sanctions, which directly go to government's budget (as actually). Moreover, we also assume the Regulator incurs a cost $\rho(\underline{p})$ to impose a sanction $\underline{p}$, increasing with the sanction absolute value. This is explained by the fact that imposing heavy fines requires to draw up a time- and money-consuming sound file.

Regulator's expected payoff is then:

$$U_R = E\left[\widetilde{S}_i \mid e\right] - \rho(\underline{p}) = (1-e) * \left[\underline{S}_R - \rho(\underline{p})\right] \tag{13}$$

[8] The common agent optimally chooses a subset of contracts.

3.2.2 Timing of the game including the Regulator

1. Principals and regulator offer non-cooperatively their contribution schemes $\left\{\left(\bar{t}_i, \underline{t}_i\right)\right\}_{1 \leq i \leq n}$ and $\underline{p}$ respectively.

2. The research team determines the subset of contract he should accepts (delegated part of the game), except for the intrinsic regulatory contract he cannot refuse. However, he can choose not to play at all and gets a outside option payoff we normalize to $-K < 0$ (sunk costs to cease trading).

3. The research team chooses how to work (e).

4. Finally, the valuation event happens: market price is either fair-valued, with probability e, or overvalued, with probability $1-e$. Principals get their payoffs and conditional transfers are exchanged.

3.2.3 Program of the common agent

The delegated common agent maximizes his expected utility under his individual rationality constraint. His program is

$$(P_A^{with\ R}) \qquad \underset{e\ \in\ [0,1]}{Max} \quad U_A^{with\ R} \quad = \quad E\left[\sum_{i=I,F} \widetilde{t}_i + \widetilde{p} \mid e\right] - \psi(e) \tag{14}$$

$$\text{subject to } (IR_A^{with\ R}) \quad : \qquad U_A^{with\ R} = e * \bar{t}_I + (1-e) * \left(\underline{t}_F + \underline{p}\right) - \psi(e) \geq -K \tag{15}$$

As $(P_A^{with\ R})$ is concave in e, since $\psi(e)$ is convex, the common agent's incentive constraint is

$$FOC_A^{with\ R}: \qquad \bar{t}_I - \underline{t}_F - \underline{p} = \psi'(e). \tag{16}$$

By playing a best-response to simultaneous principals' contributions, he gets the expected utility

$$U_{A\_BR}^{with\ R} = R(e) + \underline{t}_F + \underline{p} \tag{17}$$

with $R(e) = e\psi'(e) - \psi(e)$ positive, increasing and convex since $R(0) = 0$, $R'(e) = e\psi''(e) > 0$ and $R''(e) = e\psi'''(e) + \psi''(e) > 0$.

Proof. Direct by introducing (16) in $U_A^{with\ R}$. ■

The common agent' individual rationality constraint $(IR_A^{LL\ ,\ with\ R})$ can then be reformulated as follows:

$$\left(IR_A^{LL,\ conflict}\right): \quad U_{A\_BR}^{with\ R} = R(e) + \underline{t}_F + \underline{p} \geq -K \tag{18}$$

3.2.4 Program of the Investor favoring fair valuation (Principal I)

The investor P_I offers a contract $(\bar{t}_I, \underline{t}_I = 0)$ maximizing his expected payoff, under the common agent's incentive constraint (16) and the acceptance by the agent of his own offer given intrinsic regulation.

The contract is accepted if the common agent's gets a better expected utility by contracting with both principals, rather than with the firm only, under regulatory requirements. Thus

$$U_{A\_BR}^{with\ R} \geq \underset{e\ \in\ [0,1]}{Max}\, U_{A,\{F,R\}} = (1-e) * \left(\underline{t}_F + \underline{p}\right) - \psi\left(e\right), \tag{19}$$

with the agent's best response effort given by (16).

Investor's individual rationality constraint is then $IR_I^{LL,\ conflict}$

$$\begin{array}{lll} \left(IR_I^{LL,\ conflict}\right): & \bar{t}_I - \underline{t}_F - \underline{p} > 0, & \text{if } \underline{t}_F + \underline{p} \geq 0 \\ \left(IR_I^{LL,\ conflict}\right): & IR_A^{LL\ ,\ with\ R} & \text{if } \underline{t}_F + \underline{p} < 0 \end{array} \tag{20}$$

Proof. See Appendix (5.2). ■

We notice that the Regulator's intervention facilitates the Investor' participation at the equilibrium. Indeed, the more severe the equilibrium sanction $\underline{p} < 0$ is, the more easily the investor satisfies his individual rationality constraint. Thus, as long as $\underline{t}_F + \underline{p} \geq 0$, a more severe sanction relaxes $\bar{t}_I > \underline{t}_F + \underline{p} \geq 0$. Moreover, as this condition also implies a positive effort through the agent incentive constraint (16), we can deduce that if a positive effort emerges at the equilibrium, then the common agent has accepted the contract $(\bar{t}_I \geq 0, \underline{t_I} = 0)$ offered by the Investor.

When sanctions are so severe that $\underline{t}_F + \underline{p} < 0$, i.e. when penalities more than offset positive transferts from the Firm in case of overvaluation, the investor's contract is always accepted if the agent participates $(IR_A^{LL\ ,\ with\ R})$[9]. In such a case, as we assumed $\bar{t}_I \geq 0$ for incomplete contracting reasons, $\bar{t}_I > \underline{t}_F + \underline{p}$ is necessarily satisfied, and equilibrium effort is positive.

To resume, finding a positive equilibrium effort entails that the investor's contract $(\bar{t}_I \geq 0, \underline{t_I} = 0)$ had been accepted by the delegated agent.

The program of Principal I becomes then

$$\begin{array}{c} \left(P_I^{with\ R}\right): \quad \underset{\{\ e,\ \bar{t}_I\}}{Max} \quad U_I^{with\ R} = e * \left(\bar{S}_I - \bar{t}_I\right) \\ \textit{subject to } (16) \textit{ and } (20) \end{array} \tag{21}$$

Lemma 4 *Given other players' equilibrium transfers* $(\bar{t}_F = 0, \underline{t_F} \geq 0)$ *and* $(\overline{p} = 0, \underline{p} \leq 0)$*, the Investor induces*

[9] We note that if the agent participates, he makes a positive effort as regard its his incentive constraint, since $\bar{t}_I - \underline{t}_F - \underline{p} \geq 0$ is guaranted by $\bar{t}_I > 0$ and $\underline{t}_F + \underline{p} < 0$).

the effort e solving

$$FOC_I^{with\ R}\begin{cases}\bar{S}_I-\bar{t}_F-\underline{p}=\psi'(e)+e.\psi''e & if \quad \bar{S}_I-\bar{t}_F-\underline{p}\geq 0\\ e=0 & otherwise\end{cases} \tag{22}$$

as long as the agent accepts his contract (i.e. if $\bar{t}_I-\underline{t}_F-\underline{p}>0$ *in case of* $\underline{t}_F+\underline{p}>0$*, if the agent participates in case of* $\underline{t}_F+\underline{p}\leq 0$*) thanks to the optimal incomplete contract* $(\bar{t}_I\geq 0,\underline{t_I}=0)$ *with* $\bar{t}_I=\bar{S}_I-e^*.\psi''(e)$*.*

Proof. See Appendix (5.3) ■

3.2.5 Program of the Firm favoring overvaluation (Principal F)

The Firm P_F offers a contract $(\bar{t}_F=0,\underline{t}_F)$ maximizing his expected payoff, under the common agent's incentive constraint (16) and the acceptance by the agent of his own offer given intrinsic regulation.

The contract is accepted by the common agent if the later gets a better expected utility by contracting with both principals, rather than with the investor only, under regulatory requirements. Thus

$$U_{A\_BR}^{LL,\ with\ R}\geq \underset{e\ \in\ [0,1]}{Max}\ U_{A,\{I,R\}}=e*\bar{t}_I+(1-e)*\underline{p}-\psi(e) \tag{23}$$

with the agent's effort still given by (16). We demonstrate in Appendix (5.3) that only non-negative Firm's contributions satisfy this participation constraint

$$\left(IR_F^{LL,\ with\ R}\right):\quad \underline{t}_F\geq 0 \tag{24}$$

Program of Principal F becomes then

$$\begin{gathered}(P_F):\quad \underset{\{e,\ \underline{t}_F\}}{Max}\quad U_F^{with\ R}=(1-e)*(\underline{S}_F-\underline{t}_F)\\ subject\ to\ (16)\ and\ (23)\end{gathered} \tag{25}$$

Lemma 5 *Given other players' equilibrium transfers* $(\bar{t}_I\geq 0,\underline{t_F}=0)$ *and* $(\bar{p}=0,\underline{p}\leq 0)$*, the Firm induces the effort e solving*

$$\underline{S}_F-\bar{t}_I+\underline{p}=-\psi'(e)+(1-e)*\psi''(e) \tag{26}$$

as long as $\underline{t}_F\geq 0\Leftrightarrow \underline{S}_F\geq(1-e)*\psi''(e)$ *through the contract* $(\bar{t}_F=0,\underline{t_F}\geq 0)$ *with* $\underline{t}_F=\underline{S}_F-(1-e)*\psi''(e)$*, if the following SOC is verified:*

$$\psi''(e)\geq\frac{1-e}{2}*\psi'''(e) \tag{27}$$

Proof. See Appendix (5.3). ■

3.2.6 Program of the Regulator favoring fair valuation (Principal R)

The Regulator R "offers" a contract $(\bar{p} = 0, \underline{p} \leq 0)$. The cost of applying a penalty $\underline{p}$ is positive, increasing in the absolute value of the sanction, and convex. Thus $\rho :]-\infty, 0] \rightarrow]+\infty, 0]$, with $\rho' < 0$, $\rho'(0) = 0$, and $\rho'' > 0$. Inada conditions hold to guaranty interior solution ($\rho'(0) = 0$, $\rho'(-\infty) = \infty$).

The regulator is engaged in a intrinsic relationship with the common agent. His requirement has therefore to satisfy agent's global participation constraint (18), given contributions offered by other Principals. Otherwise the agent does not participate and effort is de facto nul.

The program of Principal R is then

$$(P_R): \quad \underset{\{e,\, \underline{p}\}}{Max}\, (1-e) * \left[\underline{S}_R - \rho(\underline{p})\right]$$
$$\textit{subject to } (16) \textit{ and } (18)$$

Lemma 6 *Given other players' equilibrium transfers* $(\bar{t}_I \geq 0, \underline{t_I} = 0)$ *and* $(\bar{t}_F = 0, \underline{t_F} \geq 0)$*, the Regulator induces a positive effort solving*

$$-\underline{S}_R + \rho(\bar{t}_I - \underline{t}_F - \psi'(e)) + (1-e) * \psi''(e) * \rho'(\bar{t}_I - \underline{t}_F - \psi'(e)) = 0$$
$$\textit{subject to } (18)$$

through the contract $(\overline{p} = 0, \underline{p} \leq 0)$*, if the following SOC is verified:*

$$\psi''(e) \leq \frac{1-e}{2} * \left[\psi'''(e) - \psi''(e)^2 * \frac{\rho''(\bar{t}_I - \underline{t}_F - \psi'(e))}{\rho'(\bar{t}_I - \underline{t}_F - \psi'(e))}\right]$$

Proof. See Appendix (5.4) ■

To illustre the effect of introducing a regulator, we propose to use *infra* the quadratic cost $\rho :]-\infty, 0] \rightarrow]0, +\infty]$, $\underline{p} \rightarrow \frac{d\underline{p}^2}{2}$, with $d > 0$, to describe regulation costs. As a result, the couples $(\underline{p}, e^*)$ satisfying the Regulator's FOC are described by the following equation:

$$\underline{p} = -(1-e) * \psi''(e) + \sqrt{(1-e)^2 * \psi''(e)^2 + \frac{2\underline{S_R}}{d}}$$

We then demonstrate that the regulator does not accept equilibrium effort inferior to $e_{\min}$, which increases with the social cost of overvaluation ($\searrow \underline{S_R}$), and decreases with the regulation implementing cost ($\nearrow d$).

Proof. See Appendix 5.4.2 ■

3.2.7 Conflicts of interest outcome when a regulator watches over fair valuation

As $\psi'' > 0$, $\rho' < 0$ and $\rho'' \geq 0$, Firm's and Regulator's SOC are compatible and e must satisfy following SOC:

$$\underbrace{0 \leq}_{SOC_F} \psi''(e) - \frac{1-e}{2}\psi''' \underbrace{\leq \frac{1-e}{2} * \psi''(e)^2 * \frac{\rho''(\left[\bar{S}_I - e.\psi''(e)\right] - Max\left[\underline{S}_F - (1-e).\psi''(e)\ ,0\right] - \psi'(e))}{-\rho'(\left[\bar{S}_I - e.\psi''(e)\right] - Max\left[\underline{S}_F - (1-e).\psi''(e)\ ,0\right] - \psi'(e))}}_{SOC_R}$$

Example 7 *For instance, both SOC are satisfied* $\forall e \in [0,1]$ *for* $\psi(e) = e * \ln(1-e)$ *or* $\psi(e) = \frac{(1-e)}{2} * H(e)$ *-with* $H(e)$ *the classical entropy function measuring the cost of information-, and for* $\rho(e)$ *a quadratic cost function.*

Proposition 8 *The unique perfect Nash equilibrium* e_R^* *solves:*

$$\underline{S}_R = \rho\left(\left[\bar{S}_I - e_R^*.\psi''(e_R^*)\right] - Max\left[\underline{S}_F - (1-e_R^*).\psi''(e_R^*)\ ,0\right] - \psi'(e_R^*)\right)$$
$$+ (1-e_R^*).\psi''(e_R^*).\rho'\left(\left[\bar{S}_I - e_R^*.\psi''(e_R^*)\right] - Max\left[\underline{S}_F - (1-e_R^*).\psi''(e_R^*)\ ,0\right] - \psi'(e_R^*)\right)$$

and exceeds e^**, the unique perfect Nash equilibrium of the game without Regulator.*

Proof. See Appendix (5.5) ■

This result draws our attention on two main points.

First, the shape of the regulator's cost $\rho(\cdot)$ necessary to implement the regulation, and the social cost $\underline{S}_R$ of overvaluation ($\underline{S}_R \leq 0$), are determining as regards conflict-of-interest outcome. The smaller the regulation implementing cost is, and the greater the social cost of overvaluation is, the smaller is the risk of overvaluation. Moreover, in the presence of regulation implementing costs, the Regulator is not constrained by the agent's global participation constraint. Indeed, since the agent is penalized in only one of both states, implementing the penalty necessary to violate the agent's global individual rationality constraint would be to costly ($\rho(\cdot)'' > 0$)[10]. However, if regulation was freely implemented, the Regulator would have to care not to prevent the agent from playing. In such a case, regulation would have the opposite effect that the expected one. Indeed, without research, overvaluation would be certain.

Example 9 *To derive illustrative closed-form solutions, we use quadratic costs and focus on interior solutions. We assume* $\rho(\underline{p}) = \frac{d}{2}\underline{p}^2$ *and* $\psi(e) = \frac{c}{2}e^2$*. Consequently* e_R^* *solves a second order polynomial. One of its real positive root satisfies the common agent participation constraint, the other not. The equilibrium effort is then*

$$e_R^* = \frac{14\,c + 8\,(\bar{S}_I - \underline{S}_F) - 2\sqrt{4c(c - \bar{S}_I + \underline{S}_F) + (\bar{S}_I - \underline{S}_F)^2 + \frac{30}{d}\underline{S}_R}}{30c} \tag{28}$$

[10] All the more so because the regulator free-rides on the positive incentives given the investor to cut proceedings costs.

This solution notably allows to illustrate the impact of regulation-implementation cost (d). Indeed, as $\underline{S}_R \leq 0$, an increase in implementation costs d reduces e_R^*. Moreover, we note that the more damaging overvaluation is ($\underline{S}_R \leq 0$), the higher the effort (notably induced by the regulation) is.

Second, whether environment parameters are such that fair valuation is more appreciated by the Regulator that the Investor, we demonstrate that the latter intervenes less often than in the absence of the Regulator. Indeed, Regulator's intervention implies free-riding within the group favoring fair valuation. However, if this should or should not be the case, firms are no more able to rule out investors at the equilibrium. Regulation prevents market valuation not to reflect long-term investors's preferences for fair valuation.

3.3 Results

3.3.1 In the absence of coercive regulation.

At the first best (merged principals, no hidden action), in the absence of regulator, the optimal social effort is logically positive if and only if the preference for fair valuation of the representative informed investor exceeds the preference for overvaluation of the listed firm. Moreover, the risk of overvaluation increases with the financial gain of the listed company in case of overvaluation.

At the second best, the informed investor and the corporate client compete through binding promises of business relationships continuation, conditional on ex-post market valuation (delegated common agency). According to the relative extent of the potential profit the bank gets by acting to the advantage of one of its both client groups, the guru will favor one Principal over the other. And since the bank's potential income provided by principals directly depends on their expected potential gains obtained by influencing the agent, the relative importance of these potential gains is determinant as regards the issue of the conflict of interests.

When the investor's preference for fair valuation does not exceed excessively the firm's preference for overvaluation, both principals intervene at equilibrium, the countervailing power of the firm acting like a brake to fair valuation supported by the informed investor contribution. The more potential fees from underwriting (firm) exceeds brokerage commissions (investor), the more the bank is strongly incited to favor issuers over investors, and the more the guru distorts the market equilibrium to please issuers. At the contrary, it could be not worth firm's while to try to influence the guru when his preference for overvaluation does not exceed the marginal agency cost to pay to the agent (opposite polar case).

We thus demonstrate that the risk of overvaluation is either smaller or bigger than the first best risk, according to relative preferences of both conflicting clients. Indeed, at the first best, principals' merger guaranty that preferences of each principal are taking into account at the equilibrium. However, at the second best,

depending on whether the firm endogenously considers its participation worthy or not, the latter does or not counteract pro-effort incentives given by the investor. If the firm does not favor sufficiently overvaluation (relatively to the informed investor's preferences for fair valuation) to participate, the overvaluation risk drops, i.e. the equilibrium effort rises, despite the introduction of agency costs. In such a case, coercive regulation is not required to protect uniformed investors. However, if the firm favors sufficiently overvaluation (relatively to the informed investor's preferences for fair valuation) to participate, agency costs induce a rise in the overvaluation risk. In such a case, we face the issue of protecting the representative uniformed investor with bounded rationality (representing naive uniformed retail investors), victim of blindly following the guru's recommendation.

3.3.2 Introduction of a coercive regulation.

We consequently introduce a third principal implementing a natural penalizing regulation, based on costly judicial proceedings in case of overvaluation. The bank is then simultaneously engaged in a delegated agency relationship with the firm and the informed investor, and a intrinsic relationship with the regulator, whose regulation cannot be refused without refusing all contracts. We then demonstrate that 1) the overvaluation risk is always smaller as a Regulator participates to this " market pricing game ", and 2) the smaller the regulation implementing cost is, and/or the greater the social cost of overvaluation is, the smaller is the equilibrium risk of overvaluation. Protection of naive investors extols then the virtues of penalizing regulations, even if the latter entail free-riding behaviors among fair-valuation partisans.

4 Conclusion

Conflicts of interests are the inherent price to pay to benefit from information synergies, allowed by multiple-financial-services firms. We focus on conflicts of interests faced by sell-side analysts in the area of research and underwriting. In the framework of a delegated common agency under moral hazard, we analyze the impact of environment variables on conflicts outcome as regards market valuation. When the potential fees from underwriting greatly exceed brokerage commissions, we show that research team has such a strong incentive to favor issuers over investors, that the latter prefer not to recourse to research and market overvaluation predominates. However, the introduction of a regulator, allowed to penalize banks, greatly tempers damaging conflicts-of-interests outcomes as regards market valuation, even if it introduced free riding among actors favoring fair valuation.

This models responds to the idea that the actual concern is whether inevitable costly conflicts of interest may dominate the benefits from the informational synergies. Facts show that conflicts may be minimized either by the firm's desire to maintain and build its reputation, or by legal sanctions. However latest affairs prove that some banks choose to take the risk to exploit conflicts, despite risks on reputation and legal sanctions.

An interesting extension would be to accurately model the bank's trade-off as regards informational synergies, short-term profit of exploiting conflicts, and legal or/and reputation risks. This question awaits for further research.

5 Appendix

5.1 Incomplete contracting without regulator

This case is a particular and much simpler case that "incomplete contracting with a Regulator". Proofs as regards the determination of the equilibrium condition are direct by eliminating all references to the regulator in following proofs.

We only propose to demonstrate the existence and uniqueness of the Nash equilibrium solving the following equation:

$$f(e) = \bar{S}_I - e^*.\psi^{''}(e^*) - Max\left[\underline{S}_F - (1-e^*).\psi^{''}(e^*)\ ,0\right] - \psi'(e^*) = 0.$$

By assumption, $e \in [0,1]$. We shall then demonstrate that f has a unique root on $[0,1]$. First we remind that our previous assumptions on ψ imply that, $\forall e \in [0,1]$, $(1-e).\psi^{''}(e)$ is increasing with e[11], and $\lim_{e\to 1^-}(1-e).\psi^{''}(e) = \infty$. As a consequence, if $\underline{S}_F \leq \psi^{''}(0)$, $\forall e \in [0,1]$, $Max\left[\underline{S}_F - (1-e^*).\psi^{''}(e^*)\ ,0\right] = 0$ and $f'(e) = \bar{S}_I - e^*.\psi^{''}(e^*) - \psi'(e^*)$. Then, as $f(0) = \bar{S}_I \geq 0$, $\lim_{e\to 1^-} f(e) = -\infty$, and f monotonously decreasing, there is a unique Nash equilibrium.

If $\underline{S}_F > \psi^{''}(0)$, $f(e) = (\bar{S}_I - \underline{S}_F) + (1-2e^*).\psi^{''}(e^*) - \psi'(e^*)$ as long as $\underline{S}_F - (1-e^*).\psi^{''}(e^*) > 0$, i.e. as long as $e < e_{threshold}$, and $f(e) = \bar{S}_I - e^*.\psi^{''}(e^*) - \psi'(e^*)$ otherwise. Consequently, $\forall e < e_{threshold}$, $f'(e) = (1-2e^*).\psi'''(e^*) - 3\psi''(e^*)$, and $f'(e) = -2.\psi^{''}(e^*) - e.\psi'''(e^*) < 0$ otherwise. Thus f is potentially increasing for e small but is necessarily decreasing for $e > \frac{1}{2}$, even if $\frac{1}{2} < e_{threshold}$, since $\forall e > \frac{1}{2}$, $(1-2e^*).\psi'''(e^*) < 0$. Then, if $f(0) = \bar{S}_I - \underline{S}_F + \psi^{''}(0) \geq 0$, there exists necessarily a unique Nash equilibrium since $f(0) \geq 0$, f is potentially increasing for e small and necessarily decreasing for $e \geq \frac{1}{2}$ and $\lim_{e\to 1^-} f(e) = -\infty$. If $f(0) = \bar{S}_I - \underline{S}_F + \psi^{''}(0) < 0$, it depends on the absolute value of $f(0)$ and on the relative shapes of $\psi^{''}$ and ψ''' that play on the potential increasing part of f for e small. Generally speaking, three cases are possible: no root, one unique root or two roots. We restrict ourself to parameters value such as $f(0) \geq 0$ to avoid this discussion that requires to define ψ.

[11] in other words: $\frac{\partial}{\partial e}(1-e).\psi^{''}(e) = -\psi^{''}(e) + (1-e) * \psi'''(e) < 0$.

5.2 Investor's program when a regulator intervenes

5.2.1 Participation constraint

We demonstrate that $U_{BR}^{LL,\ with\ R} \geq \underset{e\ \in\ [0,1]}{Max}\, U_{\{F,R\}} = (1-e) * \left(\underline{t}_F + \underline{p}\right) - \psi\left(e\right)$ is equivalent to

$$\begin{cases} \left(IR_{\ I}^{LL,\ conflict}\right): & \bar{t}_I - \underline{t}_F - \underline{p} > 0, \quad \text{if } \underline{t}_F + \underline{p} \geq 0 \\ \left(IR_I^{LL,\ conflict}\right): & IR_A^{LL\ ,\ with\ R} \qquad\qquad \text{if } \underline{t}_F + \underline{p} < 0 \end{cases} \tag{29}$$

In a first time, we must determine the value of the r.h.s. of the inequality. In a second time, we solve the inequation.

If $\underline{t}_F + \underline{p} > 0$, $U_{\{F,R\}}$ is decreasing in e, and $e^* = \arg\ \underset{e\ \in\ [0,1]}{Max}\, U_{\{F,R\}} = (1-e) * \left(\underline{t}_F + \underline{p}\right) - \psi\left(e\right) = 0$. Therefore $U_{BR}^{LL,\ with\ R} \geq \underline{t}_F + \underline{p} \Leftrightarrow R(e) \geq 0 \Leftrightarrow e \geq 0 \Leftrightarrow \bar{t}_I - \underline{t}_F - \underline{p} > 0$ because of (16).

If $\underline{t}_F + \underline{p} < 0$, $U_{\{F,R\}} = (1-e) * \left(\underline{t}_F + \underline{p}\right) - \psi\left(e\right) \leq 0$. Investor's participation constraint is then satisfied if $U_{BR}^{LL,\ with\ R} \geq 0$ (sufficient condition), i.e. if agent's participation constraint holds (18).

5.2.2 The Investor's program

Optimal induced effort is obtained by taking the FOC of the concave combination of the agent's incentive constraint (16) and the investor's expected payoff $U_I^{with\ R} e * \left(\bar{S}_I - \bar{t}_I\right)$.

$$\begin{aligned} \left(P_I^{with\ R}\right)' &: \quad \underset{e}{Max} \quad V_I^{with\ R} = e * \left(\bar{S}_I - \underline{t}_F - \underline{p} - \psi'\left(e\right)\right) \\ FOC_I^{with\ R} &: \quad \frac{\partial}{\partial e} V_I^{with\ R} = 0 \ \Leftrightarrow\ \psi'(e) + e\psi''(e) = \bar{S}_I - \underline{t}_F - \underline{p} \\ SOC_I^{with\ R} &: \quad \frac{\partial^2}{\partial e^2} V_I^{with\ R} \leq 0 \Leftrightarrow -2\psi''(e) - e\psi'''(e) \leq 0 \end{aligned}$$

As $\forall e \in [0,1]$, $\psi''(e) \geq 0$ and $\psi'''(e) \geq 0$, the SOC is always satisfied.

Since $\forall e \in [0,1]$, $\psi'(e) + e\psi''(e) \geq 0$, we note that the investor induces a positive effort as long as $\bar{S}_I - \underline{t}_F - \underline{p} \geq 0$.

Combining the investor's FOC and the agent's incentive constraint (16), it comes

$$\begin{cases} FOC_I^{with\ R}: & \bar{S}_I - e\psi''(e) = \underline{t}_F + p + \psi'(e) \\ FOC_A^{with\ R}: & \bar{t}_I = \underline{t}_F + \underline{p} + \psi'\left(e\right). \end{cases} \Leftrightarrow \bar{t}_I^* = \bar{S}_I - e^*\psi''(e^*) \tag{30}$$

5.3 Firm's program when a regulator intervenes

Remark 10 MeanValueTheorem

If f is continuous on [a, b] and differentiable on]a, b[, then there exists a number c in]a, b[such that

$$f(b) - f(a) = f\,'(c) * (b - a) \tag{31}$$

Notation 11 *We note* $\phi = \psi'^{\,-1}$ *and* $R(e) = e * \psi'(e) - \psi(e)$. $R(e)$. $R(e)$ *is positive, increasing and convex since* $R(0) = 0$, $R'(e) = e\psi''(e) > 0$ *and* $R''(e) = e\psi'''(e) + \psi''(e) > 0$.

Lemma 12 *We show that* $\frac{\partial}{\partial x} R(\phi(x)) = \phi(x) \in [0, 1]$

Proof. $R(\phi(x)) = \phi(x) * \psi'(\phi(x)) - \psi(\phi(x))$

Then $\frac{\partial}{\partial x} R(\phi(x)) = \phi'(x) * \psi'(\phi(x)) + \phi(x) * \phi'(x) * \psi''(\phi(x)) - \phi'(x) * \psi'(\phi(x)) = \phi(x) * \phi'(x) * \psi''(\phi(x))$.

First, $\phi(x) = \psi'^{\,-1}(x) \Leftrightarrow \psi'(\phi(x)) = x$, so that $\psi''(\phi(x)) = \phi'(x) * \psi''(\phi(x)) = 1$. Thus $\psi''(\phi(x)) = \frac{1}{\phi'(x)}$. It follows:

$$R'(\phi(x)) = \frac{\partial}{\partial x} R(\phi(x)) = \phi(x) * \phi'(x) * \psi''(\phi(x)) = \phi(x) * \phi'(x) * \frac{1}{\phi'(x)} = \phi(x). \tag{32}$$

Second, as $\psi' = [0, 1[\rightarrow [0, +\infty[$, then $\phi = \psi'^{\,-1} : [0, +\infty[\rightarrow [0, 1[$. Then $0 \leq \phi(x) < 1$. ■

5.3.1 Firm's participation constraint

We shall demonstrate that the participation constraint $U_{BR}^{LL,\ with\ R} \geq \underset{e\ \in\ [0,1]}{Max}\, U_{A,\{I,R\}} = e * \bar{t}_I + (1-e) * \underline{p} - \psi(e)$ is equivalent to $\underline{t}_F \geq 0$.

Using the notation $\phi = \psi'^{\,-1}$, it comes

$$U_{BR}^{LL,\ with\ R} \geq \underset{e\ \in\ [0,1]}{Max}\, U_{A,\{I,R\}} = e * \bar{t}_I + (1 - e) * \underline{p} - \psi(e) \Leftrightarrow \underline{t}_F + R(\phi(\bar{t}_I - \underline{t}_F - \underline{p})) \geq R(\phi(\bar{t}_I - \underline{p})). \tag{33}$$

Let suppose $t_F \leq 0$**.** If $\underline{t}_F \leq 0$, then $\bar{t}_I - \underline{t}_F - \underline{p} > \bar{t}_I - \underline{p} > 0$. As $R(\phi(x))$ is continuous and differentiable on $[\bar{t}_I - \underline{p}\,, \bar{t}_I - \underline{t}_F - \underline{p}\,]$, according to the Mean-Value theorem (31), there exists a number c in $[\bar{t}_I - \underline{p}\,, \bar{t}_I - \underline{t}_F - \underline{p}\,]$ such that

$$\begin{aligned}
(33) \quad &\Leftrightarrow \quad R(\phi([\bar{t}_I - \underline{t}_F - \underline{p}])) - R(\phi([\bar{t}_I - \underline{p}])) = R'(\phi(c)) * \left([\bar{t}_I - \underline{t}_F - \underline{p}] - [\bar{t}_I - \underline{p}]\right) \\
&\Leftrightarrow \quad R(\phi([\bar{t}_I - \underline{p}])) - R(\phi([\bar{t}_I - \underline{t}_F - \underline{p}])) = R'(\phi(c)) * \underline{t}_F
\end{aligned} \tag{34}$$

Using lemma (12), $\underline{t}_F \leq 0$, and the fact that $R(\phi(x)$ is increasing since (12), (34) entails:

$$R(\phi([\bar{t}_I - \underline{p}])) - R(\phi([\bar{t}_I - \underline{t}_F - \underline{p}])) \geq \underline{t}_F \Leftrightarrow \underline{t}_F + R(\phi([\bar{t}_I - \underline{t}_F - \underline{p}])) \leq R(\phi([\bar{t}_I - \underline{p}])) \tag{35}$$

This later inequation is in contradiction with (33). Thus $\underline{t}_F \leq 0$ does not satisfy the firm's participation constraint.

Let suppose $t_F \geq 0$**.** If $t_F \geq 0$, then $0 < \bar{t}_I - \underline{t}_F - \underline{p} < \bar{t}_I - \underline{p}$. As $R(\phi(x))$ is continuous and differentiable on $[\bar{t}_I - \underline{t}_F - \underline{p}\,,\, \bar{t}_I - \underline{p}]$, according to the Mean-Value theorem (31), there exists a number c in $[\bar{t}_I - \underline{t}_F - \underline{p}\,,\, \bar{t}_I - \underline{p}]$ such that

$$\begin{aligned} (33) \quad &\Leftrightarrow \quad R(\phi([\bar{t}_I - \underline{p}])) - R(\phi([\bar{t}_I - \underline{t}_F - \underline{p}])) = R'(\phi(c)) * \left([\bar{t}_I - \underline{p}] - [\bar{t}_I - \underline{t}_F - \underline{p}]\right) \\ &\Leftrightarrow \quad R(\phi([\bar{t}_I - \underline{p}])) - R(\phi([\bar{t}_I - \underline{t}_F - \underline{p}])) = R'(\phi(c)) * \underline{t}_F \end{aligned} \tag{36}$$

Using lemma (12), $\underline{t}_F \geq 0$, and the fact that $R(\phi(x)$ is increasing since (12), (34) entails:

$$R(\phi([\bar{t}_I - \underline{p}])) - R(\phi([\bar{t}_I - \underline{t}_F - \underline{p}])) \leq \underline{t}_F \Leftrightarrow \underline{t}_F + R(\phi([\bar{t}_I - \underline{t}_F - \underline{p}])) \geq R(\phi([\bar{t}_I - \underline{p}])) \tag{37}$$

Thus (33) is always satisfied if $\underline{t}_F \geq 0$. Consequently,

$$U_{A\_BR}^{LL,\, with\ R} \geq \underset{e\,\in\,[0,1]}{Max}\, U_{A,\{I,R\}} \Leftrightarrow \underline{t}_F \geq 0 \tag{38}$$

5.3.2 Firm's program

Optimal induced effort is obtained by taking the FOC of the program of the Firm maximizing its expected payoff $(1-e) * (\underline{S}_F - \underline{t}_F)$, given others' optimal transfers $\bar{t}_I$ and $\underline{p}$, when the Agent responds optimally to incitations (16). We shall verify ex-post the firm's participation constraint (23).

$$\begin{aligned} (P'_F): \quad & \underset{\{e,\, \underline{t}_F\}}{Max}\, U_F^{with\ R} = (1-e) * (\underline{S}_F - \underline{t}_F) \\ subject\ to\ (16): \quad & \bar{t}_I - \underline{t}_F - \underline{p} = \psi'(e) \end{aligned} \tag{39}$$

By substitution, it comes

$$\underset{e}{Max} \quad V_F^{with\ R} = (1-e) * \left(\underline{S}_F - \bar{t}_I + \underline{p} + \psi'(e)\right) \tag{40}$$

This program has to be concave in order to use the first order approach.

$$\frac{\partial V_F^{with\ R}}{\partial e^2} = (1-e) * \psi'''(e) - 2\psi''(e) \leq 0 \Leftrightarrow \psi''(e) \geq \frac{1-e}{2}\psi'''(e) \tag{41}$$

We must therefore verify that equilibrium effort satisfies $\psi''(e) \geq \frac{1-e}{2}\psi'''(e)$.

In such cases, the FOC implies

$$\underline{S}_F - \bar{t}_I + \underline{p} = -\psi'(e) + (1-e) * \psi''(e) \tag{42}$$

as long as the participation constraint is satisfied ($\underline{t}_F^* \geq 0 \Leftrightarrow \underline{S}_F \geq (1-e^*) * \psi''(e^*)$) and the program is concave in e ($\psi''(e^*) \geq \frac{1-e^*}{2}\psi'''(e^*)$). Whereas the latter condition is easily satisfied, the former one determines whether the firm will or not give incentives to the agent to support overvaluation..

Finally, by injecting FOC in (16), we get the firm'optimal transfert.

$$\underline{t}_F^* = \underline{S}_F - (1-e^*).\psi''(e^*) \text{ as long as } \underline{t}_F \geq 0, \text{ 0 otherwise (not active at equilibrium).} \tag{43}$$

Remark 13 *The fact that ψ must simultaneously verify Inada conditions (more specially $\lim_{e\to 1}\psi'(e) = +\infty$), and the Firm's SOC, limits the number of potential functions. We observe however that $\lim_{e\to 1}\frac{1-e}{2} = 0$, facilitating $\psi''(e) \geq \frac{1-e}{2}\psi'''(e)$ for e sufficiently high. For instance, the function $\psi(e) = -e*ln(1-e)$ meets all conditions required in this paper.*

By dropping Inada conditions at $e = 1$, and focussing on inner solution, we enlarge noticeably the domain of potential functions and we allow more particularly quadratic cost functions.

5.4 Regulator's program

5.4.1 Program

$$\underset{\{e,\, \underline{p}\}}{Max} \; U_R = (1-e) * \left[\underline{S}_R - \rho(\underline{p})\right] \tag{44}$$

subject to :

$$\begin{cases} (IC_A^{with\ R}): & \bar{t}_I - \underline{t}_F - \psi'(e) = \underline{p} \\ (IR_A^{LL,with\ R}): & V_R = (1-e) * \underline{S}_R - (1-e) * \rho(\bar{t}_I - \underline{t}_F - \psi'(e)) \geq -K \end{cases} \tag{45}$$

We shall verify ($IR_A^{LL,with\ R}$) ex-post. After substitution of ($IC_A^{with\ R}$) for $\underline{p}$ in U_R according to the first order approach, we determine the optimal level of effort as regard the Regulator's preferences by the FOC:

$$V'_R = \frac{\partial V_R}{\partial e} = 0 \Leftrightarrow -\underline{S}_R + \rho(\bar{t}_I - \underline{t}_F - \psi'(e)) + (1-e) * \psi''(e) * \rho'(\bar{t}_I - \underline{t}_F - \psi'(e)) = 0. \tag{46}$$

To be concave in e, the Regulator's program must satisfy the following CSO condition:

$$V''_R = \frac{\partial^2 V_R}{\partial e^2} \leq 0 \Leftrightarrow -2 * \psi''(e) * \rho'(\bar{t}_I - \underline{t}_F - \psi'(e))$$
$$+ (1-e) * \left[\psi'''(e) * \rho'(\bar{t}_I - \underline{t}_F - \psi'(e)) - \psi''(e)^2 * \rho''(\bar{t}_I - \underline{t}_F - \psi'(e))\right] \leq 0$$

The Regulator's program is concave if and only if

$$\psi''(e) < \frac{1-e}{2} * \left[\psi'''(e) - \psi''(e)^2 * \frac{\rho''(\bar{t}_I - \underline{t}_F - \psi'(e))}{\rho'(\bar{t}_I - \underline{t}_F - \psi'(e))}\right] \tag{47}$$

5.4.2 Illustration

For tractability reasons, we propose to use *infra* the quadratic cost $\rho :]-\infty, 0] \to]0, +\infty]$, $\underline{p} \to \frac{d\underline{p}^2}{2}$, with $d > 0$, to describe regulation costs. As a result, the couples $(\underline{p}, e^*)$ satisfying the Regulator's FOC are described by the following second-order polynom in $\underline{p}$:

$$\underline{p}^2 + 2(1-e).\psi''(e).p - \frac{S_R}{d} = 0.$$

Let determine the sign of the determinant, i.e. the sign of $\Delta(e) = (1-e)^2 * \psi''(e)^2 + \frac{2S_R}{d}$.

By hypothesis, $\frac{2S_R}{d} \leq 0$. Moreover, by posing $f(e) = (1-e)^2 * \psi''(e)^2$, we get $f'(e) = (1-e).\psi''(e) * \left[-\psi''(e) + (1-e).\psi'''(e)\right]$. By assuming that, $\forall e \in [0,1]$, ψ verifies $-\psi''(e) + (1-e).\psi'''(e) \geq 0$ and $\lim_{e \to 1^-} -\psi''(e) + (1-e).\psi'''(e) = +\infty$, we get, $\forall e \in [0,1]$, $f(e) \geq 0$, since $f(0) = 0$, and $f'(e) \geq 0$. Moreover, since $\frac{2S_R}{d} \leq 0$ and $\lim_{e \to 1^-} -\psi''(e) + (1-e).\psi'''(e) = +\infty$ entailing $\lim_{e \to 1^-} f(e) = +\infty$, $\exists!\ e_{\min}$ solving $\Delta(e) = (1-e_{\min})^2 * \psi''(e_{\min})^2 + \frac{2S_R}{d} = 0$. Because of $\frac{2S_R}{d} \leq 0$, it is straightforward that $e_{\min}$ increases with the social cost of overvaluation ($\searrow \underline{S_R}$) and decreases with the regulation implementing cost ($\nearrow d$). Thus, $\forall e > e_{\min}$, $\Delta(e) > 0$ and we find both following real roots:

$$\underline{p} = -(1-e) * \psi''(e) \pm \sqrt{(1-e)^2 * \psi''(e)^2 + \frac{2S_R}{d}}$$

Let write $\underline{p}_1 = -(1-e) * \psi''(e) + \sqrt{(1-e)^2 * \psi''(e)^2 + \frac{2S_R}{d}}$ and $\underline{p}_2 = -(1-e) * \psi''(e) - \sqrt{(1-e)^2 * \psi''(e)^2 + \frac{2S_R}{d}}$.

By noticing that $\lim_{e \to 1^-} \underline{p}_1 = 0$, $\lim_{e \to 1^-} \underline{p}_2 = -\infty$, $e \geq e_{\min} \geq 0$ and $\underline{p}(e_{\min}) = -(1-e) * \psi''(e) < 0$, we get the general shape of the optimal relation between $\underline{p}$ and e[12].

As the Regulator does not profit financially from the penalty, but indirectly through its impact on the equilibrium effort, and that implementing a penalty is costly, the Regulator chooses $\underline{p}$ according to $\underline{p}_1(e)$, since $\forall e > e_{\min}$, $0 > \underline{p}_1(e) > \underline{p}_2(e)$. We also notice that using $\underline{p}_1(e)$ to determine the equilibrium effort faciliates the satisfaction of the Regulator's CSO ($\psi''(e) \leq \frac{1-e}{2} * \left[\psi'''(e) - \psi''(e)^2 * \frac{1}{\underline{p}}\right]$ with $\rho(\underline{p})$ quadratic). Indeed,

[12] The equilibrium effort naturally results from all principals' incitations.

as $0 > \underline{p}_1(e) > \underline{p}_2(e)$, then $-\frac{1}{\underline{p}_1(e)} > -\frac{1}{\underline{p}_2(e)}$ and $\frac{1-e}{2} * \left[\psi'''(e) - \psi''(e)^2 * \frac{1}{\underline{p}_2}\right] \leq \frac{1-e}{2} * \left[\psi'''(e) - \psi''(e)^2 * \frac{1}{\underline{p}_1}\right]$.

5.5 Proof of Proposition 2

If a parfect Nash equilibrium exists, it solves simultenously all Principals' FOC, given the Common Agent Incentive Constraint:

$$\begin{cases} FOC_I^{with\ R}: & \bar{t}_I = \bar{S}_I - e\psi''(e_R^*) \\ FOC_F^{with\ R}: & \underline{t}_F = \max\left[\underline{S}_F - (1-e).\psi''(e_R^*), 0\right] \\ FOC_R^{with\ R}: & -\underline{S}_R + \rho(\underline{p}) + (1-e).\psi''(e).\rho'(\underline{p}) = 0 \end{cases}$$
$$given \quad FOC_A^{with\ R}: \qquad \bar{t}_I - \underline{t}_F - \underline{p} = \psi'(e)$$

By substitution, we get:

$$\begin{aligned} g(e_R^*) = & -\underline{S}_R + \rho(\bar{S}_I - e_R^*\psi''(e_R^*) - \max\left[\underline{S}_F - (1-e_R^*).\psi''(e_R^*), 0\right] - \psi'(e_R^*)) \\ & + (1-e_R^*).\psi''(e_R^*).\rho'(\bar{S}_I - e_R^*\psi''(e_R^*) - \max\left[\underline{S}_F - (1-e_R^*).\psi''(e_R^*), 0\right] - \psi'(e_R^*)) = 0 \end{aligned}$$

Can we found $e_R^* \in [0,1]$ solving $g(e_R^*) = 0$ and satisfying simultaneously the second order conditions and the agent's individual rationality constraint?

5.5.1 First, we determine necessary conditions such as $\exists!\ e_R^* \mid g(e_R^*) = 0$, with $g(e_R^*)$ the previous piecewise function.

$$\begin{aligned} g'(e_R^*) &= \frac{\partial g(e_R^*)}{\partial e^*} = \rho'(f(e_R^*)) * \left[f'(e_R^*) + (1-e_R^*).\psi'''(e_R^*) - \psi''(e_R^*)\right] + \rho''(f(e_R^*)) * f'(e_R^*) * (1-e_R^*).\psi''(e_R^*) \\ \text{with} \quad f(e_R^*) &= \bar{S}_I - e_R^*\psi''(e_R^*) - \max\left[\underline{S}_F - (1-e_R^*).\psi''(e_R^*), 0\right] - \psi'(e_R^*) \end{aligned}$$

We emphasize that $f(e_R^*)$ is the penalty that the regulator has to implement so that the common agent plays e_R^* as the rational investor's and the rational firm's payoffs are $\bar{S}_I$ and $\underline{S}_F$.

Let note $e_{threshold}$ the effort solving $\underline{S}_F - (1 - e_{threshold}).\psi''(e_{threshold}) = 0$.

Case 1 If $e_R^* > e_{threshold}$, then $\underline{S}_F - (1-e_R^*).\psi''(e_R^*) \leq 0$ and $\max\left[\underline{S}_F - (1-e_R^*).\psi''(e_R^*), 0\right] = 0$. Consequently:

$$f(e_R^*) = f^{\ +}(e_R^*) = \bar{S}_I - e_R^*\psi''(e_R^*) - \psi'(e_R^*) \quad \text{and} \quad f'(e_R^*) = f^{\ +\ \prime}(e_R^*) = -e_R^*\psi'''(e_R^*) - 2\psi''(e_R^*).$$

$$
\begin{aligned}
\forall e_R^* &> e_{threshold}, \\
f^{\ +}(e_R^*) &\leq 0 \quad if \quad \bar{S}_I \leq e_R^* \psi''(e_R^*) + \psi'(e_R^*) \quad \text{and} \quad \lim_{e \to 1^-} f^{\ +}(e_R^*) = -\infty \\
f^{\ +\prime}(e_R^*) &\leq 0 \quad \text{and} \quad \lim_{e \to 1^-} f^{\ +\prime}(e_R^*) = -\infty
\end{aligned}
$$

Compact form:

$$
\begin{aligned}
g^+(e_R^*) &= -\underline{S}_R + \rho\left(f^{\ +}(e_R^*)\right) + (1 - e_R^*).\psi^{''}(e_R^*).\rho'\left(f^{\ +}(e_R^*)\right) = 0. \\
g^{+\prime}(e_R^*) &= \frac{\partial g^+(e_R^*)}{\partial e^*} = \begin{array}{l} \rho'(f^{\ +}(e_R^*)) * \left[(1 - 2e^*).\psi'''(e_R^*) - 3\psi''(e_R^*)\right] \\ \quad + \rho''(f^{\ +}(e_R^*)) * \left[-2\psi''(e_R^*) - e_R^*\psi'''(e_R^*)\right] * (1 - e_R^*).\psi''(e_R^*) \end{array}
\end{aligned}
$$

Developped form:

$$
\begin{aligned}
g^+(e_R^*) &= -\underline{S}_R + \rho(\bar{S}_I - e_R^*\psi''(e_R^*) - \psi'(e_R^*)) + (1 - e_R^*).\psi^{''}(e_R^*).\rho'(\bar{S}_I - e_R^*\psi''(e_R^*) - \psi'(e_R^*)) = 0. \\
g^{+\prime}(e_R^*) &= \frac{\partial g^+(e_R^*)}{\partial e^*} = \begin{array}{l} \rho'(\bar{S}_I - e_R^*\psi''(e_R^*) - \psi'(e_R^*)) * \left[(1 - 2e^*)\psi'''(e_R^*) - 3\psi''(e_R^*)\right] \\ \quad + \rho''(\bar{S}_I - e_R^*\psi''(e_R^*) - \psi'(e_R^*)) * \left[-2\psi''(e_R^*) - e_R^*\psi'''(e_R^*)\right] * (1 - e_R^*).\psi''(e_R^*) \end{array}
\end{aligned}
$$

Assuming $\rho : \underline{p} \to \frac{d\underline{p}^2}{2}$, it comes:

$$
\begin{aligned}
g^+(e_R^*) &= -\underline{S}_R + \frac{d}{2}\left[\bar{S}_I - e_R^*\psi''(e_R^*) - \psi'(e_R^*)\right]^2 + (1 - e_R^*).\psi^{''}(e_R^*) * d.\left[\bar{S}_I - e_R^*\psi''(e_R^*) - \psi'(e_R^*)\right] = 0. \\
g^{+\prime}(e_R^*) &= \frac{\partial g^+(e_R^*)}{\partial e^*} = \begin{array}{l} d * \left[\bar{S}_I - e_R^*\psi''(e_R^*) - \psi'(e_R^*)\right] * \left[(1 - 2e^*)\psi'''(e_R^*) - 3\psi''(e_R^*)\right] \\ \quad + d * \left[-2\psi''(e_R^*) - e_R^*\psi'''(e_R^*)\right] * (1 - e_R^*).\psi''(e_R^*) \end{array}
\end{aligned}
$$

Case 2 If $e_R^* < e_{threshold}$, then $\underline{S}_F - (1 - e_R^*).\psi''(e_R^*) > 0$, and $\max\left[\underline{S}_F - (1 - e_R^*).\psi''(e_R^*), 0\right] = \underline{S}_F - (1 - e_R^*).\psi''(e_R^*)$. Consequently:

$$
\begin{aligned}
f(e_R^*) &= f^{\ -}(e_R^*) = \bar{S}_I - \underline{S}_F + (1 - 2e^*)\psi''(e_R^*) - \psi'(e_R^*) \\
\text{and} \quad f'(e_R^*) &= f^{-\prime}(e_R^*) = (1 - 2e^*)\psi'''(e_R^*) - 3\psi''(e_R^*).
\end{aligned}
$$

$$\forall e_R^* \in [0, e_{threshold}],$$

$$f^-(0) = \bar{S}_I - \underline{S}_F + \psi''(0) \quad \text{with } f^-(0) \leq 0 \text{ if } \bar{S}_I + \psi''(0) \leq \underline{S}_F \text{ (high firm's payoff)}$$

$$f^{-\prime}(e_R^*) \text{ potentially increasing when } e \text{ small, certainly decreasing for } e > \frac{1}{2}$$

Compact form:

$$\begin{aligned} g^-(e_R^*) = &- \underline{S}_R + \rho(\bar{S}_I - \underline{S}_F + (1-2e^*)\,\psi''(e_R^*) - \psi'(e_R^*)) \\ &+ (1-e_R^*).\psi''(e_R^*).\rho'(\bar{S}_I - \underline{S}_F + (1-2e^*)\,\psi''(e_R^*) - \psi'(e_R^*)) = 0 \end{aligned}$$

$$\begin{aligned} g^{-\prime}(e_R^*) = \tfrac{\partial g^-(e_R^*)}{\partial e^*} = \; & \rho'(f^-(e_R^*)) * \left[(2-3e^*)\psi'''(e_R^*) - 4\psi''(e_R^*)\right] \\ & + \rho''(f^-(e_R^*)) * \left[-3\psi''(e_R^*) + (1-2e^*)\,\psi'''(e_R^*)\right] * (1-e_R^*).\psi''(e_R^*) \end{aligned}$$

Developped form:

$$\begin{aligned} g^-(e_R^*) = &- \underline{S}_R + \rho(\bar{S}_I - \underline{S}_F + (1-2e^*)\,\psi''(e_R^*) - \psi'(e_R^*)) \\ &+ (1-e_R^*).\psi''(e_R^*).\rho'(\bar{S}_I - \underline{S}_F + (1-2e^*)\,\psi''(e_R^*) - \psi'(e_R^*)) = 0 \end{aligned}$$

$$\begin{aligned} g^{-\prime}(e_R^*) = \tfrac{\partial g^-(e_R^*)}{\partial e^*} = \; & \rho'(\bar{S}_I - \underline{S}_F + (1-2e^*)\,\psi''(e_R^*) - \psi'(e_R^*)) * \left[(2-3e^*)\psi'''(e_R^*) - 4\psi''(e_R^*)\right] \\ & + \rho''(\bar{S}_I - \underline{S}_F + (1-2e^*)\,\psi''(e_R^*) - \psi'(e_R^*)) * \left[-3\psi''(e_R^*) + (1-2e^*)\,\psi'''(e_R^*)\right] * (1-e_R^*).\psi''(e_R^*) \end{aligned}$$

Assuming $\rho : \underline{p} \rightarrow \frac{d\underline{p}^2}{2}$, it comes:

$$\begin{aligned} g^-(e_R^*) = &- \underline{S}_R + \frac{d}{2}\left[\bar{S}_I - \underline{S}_F + (1-2e^*)\,\psi''(e_R^*) - \psi'(e_R^*)\right]^2 \\ &+ (1-e_R^*).\psi''(e_R^*) * d.\left[\bar{S}_I - \underline{S}_F + (1-2e^*)\,\psi''(e_R^*) - \psi'(e_R^*)\right] = 0 \end{aligned}$$

$$\begin{aligned} g^{-\prime}(e_R^*) = \tfrac{\partial g^-(e_R^*)}{\partial e^*} = \; & d * \left[\bar{S}_I - \underline{S}_F + (1-2e^*)\,\psi''(e_R^*) - \psi'(e_R^*)\right] * \left[(2-3e^*)\psi'''(e_R^*) - 4\psi''(e_R^*)\right] \\ & + d * \left[-3\psi''(e_R^*) + (1-2e^*)\,\psi'''(e_R^*)\right] * (1-e_R^*).\psi''(e_R^*) \end{aligned}$$

Continuity and differentiability in $e_{threshold}$. Since $e_{threshold}$ is defined as solving $\underline{S}_F - (1-e_{threshold}).\psi''(e_{threshold}) = 0$, $g^-(e_{threshold}) = g^+(e_{threshold})$ and as $\frac{\partial\left[\underline{S}_F - (1-e).\psi''(e)\right]}{\partial e}(e_{threshold}) = \frac{\partial 0}{\partial e} = 0$, we get $g^{-\prime}(e_{threshold}) = g^{+\prime}(e_{threshold})$. Consequently, $g(e)$ is continuous and differentiable on $[0,1]$.

Existence of a root We assume $\rho()$ is such that $-\underline{S}_R + \rho(\bar{S}_I - \underline{S}_F + \psi''(0)) \geq -\psi^{''}(0).\rho'(\bar{S}_I - \underline{S}_F + \psi''(0))$, so that:

$$g^-(0) = -\underline{S}_R + \rho(\bar{S}_I - \underline{S}_F + \psi''(0)) + \psi^{''}(0).\rho'(\bar{S}_I - \underline{S}_F + \psi''(0)) \geq 0$$

We also assume that

$$\lim_{e \to 1^-} g^+(e_R^*) = -\underline{S}_R + \rho(\bar{S}_I - e_R^*\psi''(e_R^*) - \psi'(e_R^*)) + (1 - e_R^*).\psi^{''}(e_R^*).\rho'(\bar{S}_I - e_R^*\psi''(e_R^*) - \psi'(e_R^*)) = -\infty$$

We then need the following lemma:

Lemma 14 *If $f(t)$ is defined, increasing and positive on $[c, 1^-]$, with $f(c)$ finite and $\lim_{t \to 1^-} f(t) = +\infty$, then $\lim_{t \to 1^-} \ln f(t) = +\infty$.*
Consequently:

$$\lim_{t \to 1^-} \ln f(t) = +\infty \quad \Rightarrow \quad \lim_{x \to 1^-} [\ln f(t)]_c^x = +\infty \quad \Rightarrow \quad \lim_{x \to 1^-} \int_c^x \frac{f'(t)}{f(t)} dt = +\infty$$

If $\int_c^x \frac{f'(t)}{f(t)} dt$ is divergent and tends to $+\infty$ as x tends to 1^-, then $\frac{f'(t)}{f(t)}$ is also divergent and tends to $+\infty$ as t tends to 1^-. Consequently, $\forall t$ sufficiently high in $[c, 1^-]$, $f'(t) > f(t)$.

Given our assumptions on $\rho()$ and $\psi()$, and notably the relative growth properties of ψ given Inada condition when $e \to 1$ (c.f. previous lemma), continuity and differentiability of $g(e_R^*)$ on $[0, 1]$, and properties of $g'(e_R^*)$ on $[0, 1]$, we get:

$g(e_R^*)$ is continuous and differentiable on $[0, 1[$

$g^-(0) \geq 0$

$\lim_{e_R^* \to 1^-} g^+(e_R^*) = -\infty$

$g'(e_R^*)$ is potentially positive for e small, then negative and tends to $-\infty$

Consequently, $\exists!\ e_R^* \in [0, 1] \mid g^+(e_R^*) = 0$.

5.5.2 Second, we demonstrate that the presence of a regulator induced a more intense effort ($e_R^* \geq e^*$)

We remind that e^* and e_R^* are defined as solving $f(e^*) = 0$ and $g(e_R^*) = 0$. According to previous results, we find out simple conditions such as e^* and e_R^* are unique. We shall now prove by contradiction that $e_R^* < e^*$ is impossible, implying that $e_R^* \geq e^*$.

If $e_R^* < e^*$, then $f(\ e_R^*) \geq 0$, and $g(e_R^*) = -\underline{S}_R + \rho(f(e_R^*)) + (1 - e_R^*)\,.\psi^{''}\,(e_R^*)\,.\rho'(f(e_R^*)) > 0$ since $\forall \underline{p} \geq 0$, $\rho'\left(\underline{p}\right) \geq 0$.by assumption and other rhs terms are positive. To resume

$$e_R^* < e^* \Rightarrow g(e_R^*) > 0 \text{ with } e_R^* \mid g(e_R^*) = 0 : \quad \textit{contradiction}$$

As we know that e^* and e_R^* are unique and that $e_R^* < e^*$ is impossible, then $e_R^* \geq e^*$.

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