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Principal-Agent Contracts under the Threat of Insurance

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[1] <fweinsch@udesa.edu.ar> Vito Dumas 284 (1644) Victoria -Provincia de Buenos Aires- Argentina. Phone (54-11)4725-7041, Fax (54-11)4725-7010. A previous version of this paper has circulated with the title "The Threat of Insurance. On the Robusness of Principal-Agent Models". We received valuable comments from an anonymous referee, as well as from Federico Echenique, Bryan Ellickson, Hugo Hopenhayn, Hernán Ianello, David Levine, Alejandro Manelli, David Perez-Castrillo, Jorge Streb and Bill Zame, and from participants at various seminars. We received very valuable suggestions and excellent research assistance from Ignacio Esponda.

Abstract

The traditional principal-agent model assumes that the principal offers an exclusive contract to the agent. This paper shows that the standard results are not robust to the introduction of additional contracting opportunities for the agent. We analyze equilibria of an extended game with the presence of additional players who might trade risk away from the agent. The contract offered by the principal in order to elicit high effort is steeper than in the standard model. In some settings, the agent accepts this contract and then unwinds part of those incentives through additional trades. (This seems consistent with some findings in the literature on managerial compensation). For some settings and parameter values, suboptimal effort is implemented in equilibrium, the principal is worse off, and total welfare is lower. These findings may call for a revision of some previous theoretical and applied conclusions. In designing compensation schemes, attention should be paid to outside opportunities, even when they are productively unrelated. Some results such as "the Informativeness Principle" might need to be reformulated to consider the observability of signals by the principal relative to their observability by other potential traders.

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KEYWORDS: Principal-Agent, Moral Hazard, Insurance, Common agency, Non-exclusive contracts, Managerial compensation.

1 Introduction.

1.1 Motivation

Most of agency theory proceeds under the implicit assumption that the relationship between principal and agent can be isolated from other trading opportunities.[2] In particular, there is the implicit assumption that the consumption vector of the agent across states of nature is the one stipulated in the contract with the principal. This requires that, for technological or legal reasons, the agent is signing an exclusive contract with the agent.

That might seem an innocuous assumption at first sight. For instance, a CEO spends her entire day working for the firm, so it seems unlikely that conflicts could arise from competition with other firms for her efforts. Enforcing exclusivity seems easy: the board simply controls that the CEO does not work for other firms. (A similar argument could be made for the case of a professional sports player). As a result, competition over efforts is not a problem, and studying the problem in isolation seems the proper assumption.

However, it seems demanding to assume that the principal is able to control the agent's consumption vector. Recall that in the traditional model the principal can give incentives to a risk-averse agent only at the cost of exposing her to some risk. But this opens the door for an outside trade in which the agent might reduce her risk exposure. As a matter of fact, the standard principal-agent contract predicted by the literature gives the agent the minimum amount of risk necessary to provide incentives; if the agent was able just to marginally reduce her risk exposure, the standard incentive contract would be in trouble. There are different ways in which the agent could alter the consumption lottery induced by the contract with the principal, and hence alter her willingness to exert high levels of effort. Additional income would suffice to affect her marginal risk aversion (except for specific preferences). Saving and borrowing would have the same effect in a dynamic principal-agent model.[3] More to the point of our modelling

[2]See for instance the textbooks by Salanié (1997), by Macho-Stadler and Pérez Castrillo (1997), and by Laffont and Martimort (2002), and the surveys by Gibbons (1996) and by Prendergast (1999). There is a small but burgeoning literature that relaxes the (often implicit) assumption of exclusive contracts. Even though our focus is different than the one in most of that literature, our paper makes some contributions on that margin, which we describe in more detail later.

[3]Chiappori, Macho, Rey and Salanié (1994) address the last two issues. They show that the availability of credit could affect the implementability of some incentive contracts,

below, agents might have explicit trading opportunities allowing them to get rid of some of the risk provided by the principal's contract.

For brevity, from now on we will often refer to these outside trading opportunities as "insurance," and to the new traders (which we will assume to be risk-neutral) as "insurers." As clear in the previous examples we are not thinking literally about an insurance market, but since the main function of these potential trades is to take risk away from the agent, they play an "insurance" role.

Such opportunities are indeed quite common in some of the archetypal applications of incentive contracting, such as executive compensation and professional sports. In both examples there are outside (financial or betting) markets in which, in principle, some or all of the risk of the agency contract can be unwind. In the case of executive compensation, virtually all of the sensitivity of pay to corporate performance for the typical US CEO is attributable to his or her holdings of company stocks and stock options (Hall and Leibman, 1998, Hall and Murphy, 2000).[4] Even though there are restrictions on the ability of the CEO to unwind such contract through going short on the company's shares, there is empirical evidence showing that such diversification does indeed occur (Ofek and Yermack, 2000, Bebchuk, Fried and Walker, 2002). For instance, Ofek and Yermack (2000) find that (for managers who own more shares than the number of annual options awarded) for every 1000 new options awarded, an executive sells 684 shares of stock. This finding is presented by the authors as somewhat puzzling or contradictory with the standard theory. In some of the specifications of the model in this paper we do find that such empirical observations might be perfectly consistent with optimal contracting between principal and agent, taking into account the fact that the agent has later trading opportunities. When the principal recognizes those trading opportunities, he might adjust his contract accordingly, either not providing incentives that would disappear in later trades, or providing incentives different from those he would provide in the absence of outside trading opportunities. (Both things happen in our model, for different specifications and parameter values.)

except in cases such as constant absolute risk aversion (CARA) with monetary cost of effort – in that case income effects wash away.

[4]According to a thorough recent survey (Lafontaine and Slade, 2001), executive compensation packages provide a rich laboratory in which to test the insurance/incentive aspects of contract theory, precisely the focus on our modelling here. See also Murphy (1999).

Also, under some specifications of our model, the principal is not hurt by the additional trading opportunities, so that our findings might also help to understand another empirical puzzle in executive compensation (Bebchuk et al, 2002, p. 6): sometimes managers' have substantial freedom to undo the financial incentives provided to them by their compensation arrangements. Bebchuk et al (2002) present several of these unwinding practices as evidence against the optimal contracting approach to managerial compensation. Whether the optimal contracting approach or alternatives such as "managerial power" are better at explaining specific features of executive compensation is ultimately an empirical question; yet our paper makes some contribution to that discussion in showing that some of these observed practices are not necessarily inconsistent with optimal contracting with outside trading opportunities.

1.2 Brief sketch of the model and results

In this paper we investigate to what extent the results from the standard principal-agent model are robust to the possible presence of outside trading opportunities. We focus on the shape and characteristics of the contract signed by the principal and the agent, on the level of effort provided in equilibrium (i.e., on the effects on incentives), as well as on the distribution of the surplus of the relationship.[5]

We work out the case with two levels of effort and a continuum of outcomes. Recall that in that case, the first best allocation of effort is obtained in case of observable effort, and a second-best solution (adding an incentive constraint to the basic participation constraint) is attained under noncontractible effort. In this paper we examines what happens if there are additional risk-neutral players ("insurers") with whom the agent can contract. The principal continues to act as a Stackelberg leader - the other insurers move sequentially after him in the various timings explored. We present a third "constraint" to the design problem, a generalized non-insurability condition, under which the contract offered by the principal for the imple-

[5]This focus on the productive relationship between the principal and the agent, which relates to the empirical focus on managerial (and related) incentive contracts, is a feature that distinguishes our contribution from some papers such as those of Kahn and Mookherjee (1998) and Bisin and Guaitoli (1999), who focus on aggregate behavior and welfare implications in markets that could be more naturally interpreted as insurance or financial markets. More on this below.

mentation of high effort is robust to the introduction of a third risk-neutral player.[6]

Using that non-insurability condition, it is immediate to check that the standard "second-best" contract is not robust to the introduction of further trading opportunities. That is due to the fact that the risk born by the agent in the second-best contract creates a surplus for an agent-insurer relationship.

After showing that initial non-robustness result, we characterize equilibria of an extended principal - agent -insurer(s) game under different settings. These settings differ in two main dimensions: the number of insurers and the sequence of play. We vary the number of (potential) insurers all the way from one to free entry. (In practice, we deal with three cases: one insurer, a finite number N>1 of insurers, and free entry). We study two broad categories of sequential settings: sequential offering and sequential contracting. In the case of sequential offering, the agent receives all offers (contracts) and then decides which of them, if any, to accept. In the case of sequential contracting the agent signs the original contract with the principal first, and only then do the new contractual opportunities become available, having to decide whether to sign each of them before the following one becomes available. Our different settings allow us to study incentive contracting under different environments that give the agent different "outside insurance" opportunities.

One important result is that, for some model specifications, low effort is implemented in equilibrium for some "economies" (parameter values) in which the standard principal-agent model would implement high effort. This happens when the "new" cost of implementing high effort is such that the principal decides not to implement high effort. Whenever high effort is indeed implemented, the contract offered by the principal is steeper than the one from the basic model (i.e. steeper than the "second-best" contract).

That steepness comes in two different forms under different extensive-form specifications. In some cases the contract is steeper because the principal offers a scheme that reduces the expected payment when low effort is exerted.[7] In that case, the agent would receive an interim payoff lower than

[6] This third condition can be interpreted as a stronger incentive compatibility constraint for the agent, reflecting the fact that the presence of further insurance increases the benefits from low effort. Alternatively, the non-insurability condition can be seen as expressing the fact that the profits from taking the agent to low effort are non-positive. This condition is quite general in that it does not depend on the particular extensive form use to model the "competition" between the principal and the insurers.

[7] Intuitively, this is achieved by lowering payments in the event of low output (profits).

her reservation utility, but is restored to that utility level by an insurance contract that improves her payoff in bad states of the world. In those cases the expected payoff from low effort is so low that the insurer would have to put money from his own pocket in order to take the agent to her reservation utility under low effort. Also, in those cases the cost of implementing high effort for the principal is the same as in the second best, so that the principal is not hurt.

In other cases, the principal offers contracts that give the agent higher expected payment than the second best when the agent exerts high effort.[8] These contracts have higher implementation costs from the point of view of the principal. (Sometimes they would be so costly that the principal decides not to provide incentives, and the economy switches to low effort). We call those contracts third-best contracts since they incorporate a third constraint, a non-insurability condition to prevent later contracts from inducing low effort, into the planning problem.[9]

One of the key aspects of the description of the environment that leads to these different results is the role played by the "last contract". Compare the case with one insurer versus the case of free entry under the assumption of sequential offering. In the former, the insurer complements the (steeper) contract offered by the principal with a zero profit insurance contract, and takes her back to the second-best. (The same happens with the last insurer in the case of finite N>1.) Such equilibrium collapses in the case of free entry of insurers. The threat of further insurance will prevent any player from offering a contract to the agent that (if last contract) will take her to the second best. The equilibrium based on the "last contract" can also collapse even without free entry, in the case of sequential contracting (when the agent has to sign first the contract from the principal) if the insurer has the bargaining power in this second relationship. In that case the agent would refuse to sign any interim contract that leaves her below her reservation utility.

1.3 Related literature

Our paper is related to several previous contributions that enrich the basic moral-hazard principal agent framework. Perhaps the unifying theme of these

[8] Intuitively, this is achieved by increasing the payments associated to high output (profits).

[9] A similar terminology has been used in the related papers by Kahn and Mookherjee (1998) and Bisin and Guaitoli (1999).

diverse contributions is the introduction of what me might generically call "additional trading opportunities". These additional opportunities (further moves in the extensive form game) come in different forms. In Fudenberg and Tirole (1990) the new trading opportunity is a renegotiation with the principal, after the agent has chosen the level of effort. In Chiappori et al (1994), the agent has the ability of making intertemporal trades via saving and borrowing, in a way that plays a similar role to our intra-temporal trading across states of the world via insurance. There are also a number of papers dealing with non-exclusive contracting in moral hazard situations. Our paper shares some formal similarities with these latter papers, even though their focus is different. Most of them are not concerned with productive relationships between principal and agent, since they consider insurance or financial markets. We provide below a synthetic account of some of the main connections between that literature and our contribution here.

Fudenberg and Tirole (1990) study a situation in which the original contract can be renegotiated after the agent chooses the level of effort, but before output levels are realized. The traditional contract is not robust, since once effort is undertaken, the principal would rather offer full insurance to the agent. Foreseeing this, the agent would choose low effort in the first place. The equilibrium with renegotiation involves mixed strategies. The optimal contract may give the agent a positive rent. One key difference with our set up is their timing assumption in which some contracts are signed after effort, transforming the original moral hazard problem into an adverse selection one.[10] Other aspects of the setup are equivalent: the second incarnation of the principal, "the renegotiator", is analogous to our insurer; and their renegotiation proofness requirement plays a similar role than our non-insurability constraint.

The model of Chiappori et al (1994) introduces the dynamic dimension of repeated moral hazard. Some of our results based on intra-temporal trade across states (insurance) resemble some of their results based on intertemporal financial opportunities. In their paper, the availability of credit could affect the implementability of some incentive contracts.

The literature on moral hazard with non-exclusive contracts starts with a sequence of papers by Arnott and Stiglitz (now collected in Arnott and

[10] In our paper, since the agent did not choose effort yet, it is a new moral hazard problem where the distribution of "output" is given by the payments coming out of the principal's contract.

Stiglitz, 1993) and Hellwig (1983), and has been recently advanced by Kahn and Mookherjee (1998) and Bisin and Guaitoli (1999).[11] This previous literature deals with homogeneous "principals", none of which has a productive technology, and concentrates on what we call "the aggregate contract." In our paper there is a principal who has a productive technology and employs the services of the agent, (while the other players can only provide insurance).[12] We focus on that primary contract, and on how the productive relationship changes with the presence of these outside opportunities. Substantively, our paper is better suited to study applications of incentive contracts to employment relationships, franchising, and the like; while those other papers are better suited to study insurance markets, financial markets, and the like.

KM study the effects of nonexclusive credit or insurance contracts in moral hazard economies with hidden action. They study the effects of nonexclusive credit or insurance contracts from multiple risk-neutral firms with sequential entry. They find that competition between firms can induce a reduction in customers' effort, and that the lack of coordination among insurers may affect the cost of implementation even without affecting effort levels. One of the settings of our model can be seen as an extension of their work in which their first insurer is replaced by a productive principal, with a different bargaining protocol.

BG analyze a case where "intermediaries" design and offer contracts simultaneously. They show, as we do, that the optimal action is not implemented in equilibrium for some economies. They also show that whenever the equilibrium contracts implement the optimal action, intermediaries make positive profits and equilibrium allocations are inefficient.[13]

[11] We refer to those contributions as AS, H, KM and BG respectively. See also Bisin and Rampini (2002).

[12] Our contribution is also related to the case of "common agency", a scenario in which there are several productive principals that simoultaneously attempt to influence the actions of one agent. (The pioneer paper in this literature is Berheim and Whinston, 1986). Our model can be read as a common agency situation in which there is only one dimension of effort, and only one of the principals cares about that action. It turns out that our main point, the negative externality of insurance, is a feature present also in the traditional moral hazard common-agency models, on top of the externality coming from competition for effort. This intuition is mentioned in passing by Dixit (2002) and by Tommasi and Weinschelbaum (2003), who also provide further references.

[13] Contractual externalities in a sequential banking setting are studied by Bizer and de Marzo (1992). A bank cannot prevent a borrower from getting a loan at another bank. The terms of this new contract will not reflect the devaluation of existing debt. As a

We compare now a little more closely our modelling choices and results with those of the previous non-exclusive contracting literature. While the papers by AS, H and BG model simultaneous-move games, our paper presents a number of sequential games, as do KM. None of our specifications coincides exactly with the one of KM. While they analyze only the case of sequential contracting where the agent has all the bargaining power, in all our settings we give the principal the bargaining power in the productive relationship, as standard in the principal-agent literature (and probably as empirically more relevant in several employment and franchising relationships).[14] While all those previous papers study the case of free entry, we compare the case with free entry with cases with a finite number of insurers. One of our contributions is to show that with a given finite number of "principals," the extensive form game has an effect on the region of parameters which admit enforceability of high effort.

Given our different focus, our main results with regards to the contract between the productive principal and the agent, are not present in any of those previous papers. Regarding the characteristics of the aggregate contract, there are cases in which the threat of insurance eliminates incentives. But unlike some older analyses of non-exclusive contracting,[15] incentives are not always eliminated in KM, in BG, or in our paper; as a matter of fact, sometimes they are accentuated via steeper aggregate contracts. (The third-best contract gives more intense incentives than the second-best contract).

In our setting, and in several of the papers on non-exclusive contracting we just reviewed, the introduction of new players has (weakly) negative implications for surplus in the original relationship. This contrasts with other scenarios in which the introduction of new players can be beneficial for the principal. Those scenarios require that the new players have better information than the principal. Itoh (1993) considers a framework with one principal and two agents. When the agents can monitor each other efforts' perfectly, the principal is better off. In a small introductory section Itoh establishes that if each agent does not have an informational advantage over the principal with respect to the other agent's actions, then side contracting cannot make

result, interest rates are higher and welfare is lower due to the fact that banks have to operate under a "no further borrowing" constraint, which plays a similar role than the non-insurability constraint in our paper. See also Bisin and Rampini (2002).

[14] Although not necessarily in all of them. See Bebchuk et al (2002) for a view in which top managers design their own contracts.

[15] See Pauly (1974), Helpman and Laffont (1975), Kletzer (1984).

the principal better off.[16] In this paper we work out the exact welfare implications under different settings for side contracting with players that share the same information than the principal, finding under what conditions the principal is strictly worse off.

Arnott and Stiglitz (1991) is another paper that highlights the role of informational assumptions in multi-contract situations. They study how a client's access to informal markets, such as family-provided insurance, affects formal markets and welfare. If the family observes effort, peer monitoring increases welfare. But if they only observe output, the role of family interactions is that of providing mutual risk-sharing, and the economy is worse off as the formal sector must deal with these additional contractual constraints.

These considerations on the role of information bring to mind the "intermediate" case of imperfect observability of effort via signals other than output. According to the informativeness principle, any signal that gives information about the agent's effort is valuable (Holmstrom, 1979, Shavell, 1979, and Grossman and Hart, 1983). Our model suggests that the usefulness of including different indicators in an incentive contract might depend not only on their observability by the principal, but also on their observability by other actors who might engage in side contracting with the agent. For instance, if costly (and imperfect) monitoring of effort was possible, firms may find more advantageous to use indicators of effort that are relatively less easy to observe by outsiders.[17]

Comparing the predictions of canonical principal-agent models with actual practices, in a series of provocative papers Prendergast has been challenging the standard prediction of a negative trade-off between risk and incentives (Prendergast 1999, 2000, 2002a, 2002b). Prendergast reviews the extant empirical literature and concludes that it is far from conclusive, and that in fact there are several instances in which the correlation seems to go the wrong way, with riskier activities being associated with more incentives. The gist of his explanation consists in enriching the basic principal agent model to allow for other factors affecting contract selection, and figuring out motives why those other factors might be correlated with measures of risk or uncertainty of different activities.[18] At some level, our paper also enriches

[16] See also Holmstrom and Milgrom (1990), Varian (1990) and Dana (1993).

[17] Although observability by third parties (the court) is a requirement for verifiability. Yet, the non-verifiable indicators can be part of an implicit contract enforced through reputation.

[18] For wider discussion of contract selection and ommitted variable biases, see Chiappori

the description of the environment by introducing outside trading opportunities. From an empirical perspective, it might be worth pondering whether the availability of those opportunities might in itself correlate with the riskiness of the environment. The examples from managerial compensation packages and from professional sports suggest that might indeed be the case.

1.4 The organization of the paper

In Section 2 we show non-robustness of the traditional second-best equilibrium. In Section 3 we present some preliminary results which are valid across all the different extensive form games that we analyze in the rest of the paper. As explained above, we have essentially three specifications for the number of insurers (1, N, ∞), and three specifications of the sequencing of play (sequential offering, sequential contracting with the agent having bargaining power vis a vis the insurers, and sequential contracting with the insurers having bargaining power). It turns out that the cases with 1 insurer and with a finite number of insurers are very similar; and that the presence of free entry (i.e., absence of a last potential insurer) dominates issues of sequencing. The organization of the paper follows to some extent the format of these results. In Section 4 we characterize equilibria in a game of sequential offering with a finite number of insurers. In Section 5 we consider the case of free entry. In Section 6 we analyze the case of sequential contracting under alternative bargaining assumptions. We conclude, in Section 7 with a summary of results, welfare and empirical implications, and possible extensions.

2 Non-Robustness of the Standard Results

2.1 The Standard Case

We consider the traditional principal-agent problem where a principal wishes to hire an agent. Their interests are opposed since the agent bears a cost from effort while the principal is benefited from the agent's effort. There is asymmetric information (effort is not contractible). Assume the possible outcomes, given the agent's effort, are distributed in the set $\Pi \subset \mathbb{R}$ with density $f(\pi/e) > 0$ for all $\pi \in \Pi$ and for all e. To keep the framework

and Salanie (2002) and Lafontaine and Slade (2001).

simple, we assume that there are only two levels of effort, $e \in \{e_l, e_h\}$, low and high effort respectively. The principal's gross benefits under high effort are greater than under low effort, $\int \pi f(\pi/e_h)d\pi > \int \pi f(\pi/e_l)d\pi$.

The agent maximizes expected utility [19]

$$U_a(w(\pi), e) = \int v(w(\pi))f(\pi/e)d\pi - g(e),$$

where the cost of high effort is strictly greater than the cost of low effort, i.e. $g(e_h) > g(e_l)$. Additionally, we assume $v' > 0$ and $v'' < 0$, so that the agent is strictly risk averse.

The sequence of the game is the following. The principal offers a contract w_p to the agent. The agent accepts or rejects the contract. Rejection gives the agent reservation utility $\overline{u}$. Upon acceptance, the agent must decide on the level of effort. Given the level of effort, payoffs are realized according to the density $f(\pi/e)$. The solution concept is subgame perfect equilibrium (SPE).

Following Grossman and Hart (1983), the problem of the principal can be decomposed in two steps. First, he finds the optimal incentive scheme for each level of effort; then he selects the optimal level of effort.

Once step 1 is solved, step 2 is trivial: the principal compares profits from implementing low and high effort and decides which level, if any, to implement. We therefore concentrate on part 1 of the problem.

The optimal incentive scheme for implementing e must solve

$$Min_{w(\pi)} \int w(\pi) f(\pi|e)\, d\pi$$

s.t.

$$\int v(w(\pi)) f(\pi|e)\, d\pi - g(e) \geqslant \overline{u} \tag{PC}$$

$$e \text{ solves } Max_{\tilde{e}} \int v(w(\pi)) f(\pi|\tilde{e})\, d\pi - g(\tilde{e}), \tag{IC}$$

where PC is the participation constraint and IC is the incentive (compatibility) constraint.

[19] Thus, his utility function is $u_a(w, e) = v(w) - g(e)$. We assume that $v(0) - g(e_l) < \overline{u}$; namely, that the agent will not work for free.

Let $\phi \equiv v^{-1}(\cdot)$. The minimum cost of implementing e_l is achieved by offering $w_p = \phi\left[g(e_l) + \overline{u}\right] > 0$, a flat wage that makes the agent just indifferent between accepting and rejecting the contract.

The cost-minimizing contract that implements e_h is the solution to the two binding constraints PC and IC, and to the first order condition

$$\frac{1}{v'(w(\pi))} = \lambda + \gamma\left[1 - \frac{f(\pi/e_l)}{f(\pi/e_h)}\right],$$

where $\lambda > 0$ and $\gamma > 0$ are the Lagrange multipliers of PC and IC, respectively. This is known as the second-best solution, w^{2nd}, and it is unique given our assumptions (Mas-Colell et al, 1995).

Given $g(e_h) > g(e_l)$ and the fact that the agent is risk averse, it is straightforward to show that

$$\int w^{2nd}(\pi) f(\pi/e_h) d\pi > \phi\left[g(e_l) + \overline{u}\right] > 0; \tag{1}$$

that is, the cost of implementing e_h is strictly greater than the cost of implementing e_l. Denote these minimum costs by $c^{2nd}(e_h)$ and $c^{2nd}(e_l)$, respectively.[20]

2.2 Non-robustness

The traditional principal-agent model implicitly assumes that either the agent has an "exclusivity" contract or that there is no other player who can provide her with insurance and has the same informational structure that the principal has. The next proposition motivates the discussion that follows, by showing that standard results are not robust to the introduction of this third player.[21]

Lemma 1 *The principal's contract, w_p, intended to implement high effort is robust to a third risk neutral player if and only if the following General Non-Insurability Constraint holds:*[22]

$$\psi \geq v\left(\int w_p(\pi) f(\pi/e_l) d\pi\right) - g(e_l), \tag{GNIC}$$

[20] Given the optimal incentive scheme for each level of effort (step 1) , the principal now chooses the level of effort that maximizes his benefits, $\int \pi f(\pi/e) d\pi - c^{2nd}(e)$ (step 2).

[21] We assume risk neutrality for simplicity; the spirit of our main results will hold if this third player is risk averse.

[22] GNIC is a condition such that a third risk-neutral player has no incentive to take the agent to low effort by offering her full insurance.

where $\psi = \max\left\{\overline{u}, \int v(w_p(\pi)) f(\pi/e_h) d\pi - g(e_h)\right\}.$

The intuition is simple: when an insurer is present, the agent's utility under low effort is no longer given by the traditional equation, but now takes the form of the RHS of GNIC. Then the above expression simply requires that choosing low effort is not the (only) best alternative. Notice that we could also think of GNIC as a New Incentive Compatibility constraint, where the presence of an insurer changes (increases) the agent's benefits from low effort. A formal proof of the lemma is provided below.

Notice that by introducing ψ we have left open the possibility that the principal might leave the agent above her reservation utility. This is something that might happen in the presence of insurers. Notice however that when the principal's contract for high effort does not offer the agent more than her reservation utility, then $\psi = \overline{u}$, and the constraint is replaced by

$$\overline{u} \geq v\left(\int w_p(\pi) f(\pi/e_l) d\pi\right) - g(e_l). \tag{NIC}$$

The above condition, which we refer to as the Non-Insurability Constraint, will play a crucial role in the settings where the principal can manage to overcome the presence of insurers at no additional cost. Notice that NIC is indeed a sufficient condition for robustness, as NIC implies GNIC. When $\psi = \overline{u}$, NIC is equivalent to GNIC, hence it is also necessary (Lemma 1).

Proof. Notice first that ψ is what the agent gets from doing something other than low effort, so that the insurer must offer her at least ψ to induce low effort.

To prove sufficiency notice that the insurer's optimal contract (w_I) giving incentives for low effort is

$$w_I(\pi) = \phi[\psi + g(e_l)] - w_p(\pi),$$

so that the aggregate contract is a flat wage. Integrating we see that the insurer's expected profits are

$$-\int w_I(\pi) f(\pi/e_l) d\pi = \int w_p(\pi) f(\pi/e_l) d\pi - \phi[\psi + g(e_l)].$$

GNIC implies that profits from taking the agent to low effort are less than or equal to zero. This can be seen by rewriting GNIC as

$$\int w_p(\pi) f(\pi/e_l) d\pi \leq \phi[\psi + g(e_l)] \tag{2}$$

To establish necessity, we will prove that if GNIC does not hold then there are incentives to insure the agent.

Notice that if GNIC does not hold, then

$$v\left(\int w_p\left(\pi\right) f(\pi/e_l)d\pi\right) - g(e_l) > \psi$$

Then, there exists a ρ such that

$$v\left(\int w_p\left(\pi\right) f(\pi/e_l)d\pi - \rho\right) - g(e_l) = \psi$$

If the insurer pays $\int w_p\left(\pi\right) f(\pi/e_l)d\pi - \rho - w_p\left(\pi^0\right)$ when the profits are π^0 the insurer will get an expected profit of ρ (the risk premium) and the agent will accept the contract. ■

The intuition is also clear from equation (2), which is simply a restatement of GNIC. The principal must pay less than what the agent requires to make low effort, so that anyone wishing to take the agent to low effort is forced to put money from his own pocket. An outside player uninterested in the agent's effort would surely not do so.

We now show our non-robustness result.

Theorem 1 *The second-best contract is not robust to the presence of a third, risk-neutral, player.*

Proof. The second best contract satisfies PC (and IC) with equality. As a result, we have $\psi = \overline{u}$. Therefore, NIC is a necessary (and sufficient) condition for robustness. We now show that the second best contract does not satisfy NIC. From PC and IC one obtains

$$\int v(w^{2nd}\left(\pi\right))f\left(\pi|e_l\right)d\pi = \overline{u} + g(e_l).$$

By Jensen's inequality we get

$$v\left(\int w^{2nd}\left(\pi\right) f\left(\pi|e_l\right)d\pi\right) > \overline{u} + g(e_l).$$

This violates NIC. ■

We have seen that, when the principal wants to implement high effort, results are not robust to the threat of insurance. This is not the case when the principal wants to implement low effort. This is because the traditional optimal contract is a flat wage, so that new players have nothing further to offer to the agent.[23]

There are settings where implementation of high effort will cost the principal more than the second-best cost. When this happens, two things might occur. If the principal's gross benefits from high effort are large enough he will still prefer to pay the higher cost. But when the opposite occurs, the principal will implement low effort when it would have otherwise implemented high effort.

In the rest of the paper we study the characteristics of the principal's contract. We pay special attention to the conditions under which the implementation of high effort is indeed costlier for the principal when we allow for the existence of these risk-neutral players which we call, from now on, the "insurers".

3 Preliminary Results

Before characterizing equilibria for some specific settings, we provide some useful results that generalize to all of our settings. In all the settings: the players move sequentially rather than simultaneously, the principal moves first, and the insurers and the principal have the same information (in particular, they can all observe and contract on outcomes, but not on efforts).

Throughout the paper, we denote by $w_j(\pi)$ the contract offered by party j (either the principal, an insurer, or, as in Section 6.1, the agent). This is taken to be the amount that the agent receives (pays, if negative) when the output is π.

Let $I = \{1, 2, ..., N\}$ denote the set of insurers (where N is infinity in the free entry case). Then our set of players is given by $\{p\} \cup I \cup \{a\}$, where p and a stand for the principal and the agent, respectively.

We say a player (other than the agent) is *active* if he signs a contract $w \neq 0$ with the agent. Denote the set of active players by A.

[23] When the principal wants to implement low effort in the presence of insurers, there are also other equilibria. However, they share some of the properties with the flat-wage equilibrium, as we will briefly comment in the next section. In particular the expected payment made by the principal is the same.

Let $\Pi_i(e)$, $i \in I$, stand for insurer i's benefits from implementing e,[24] and let

$$w_A(\pi) = \sum_{i \in A} w_i(\pi)$$

represent the aggregate contract.

Lemma 2 *A subgame perfect equilibrium of our game is characterized by the following properties:*

1. *The aggregate cost of implementing effort e is at least as great as the cost in the traditional principal-agent problem.*
2. *The principal is never better off than in the traditional problem.*
3. *In any case where the agent chooses e_l or e_h, the principal is always an active player.*

Proof.

1. Part 1 says that it is not possible for our aggregate player (the principal and the insurers) to do better. Suppose the contrary. But then the principal could mimic such an aggregate contract in the traditional principal-agent problem and pay less to implement e than the minimum found in Section 2. We know this is not true.
2. From Part 1, we know that $\int w_A(\pi) f(\pi/e) d\pi = \int w_p(\pi) f(\pi/e) d\pi - \sum_{i \in I} \Pi_i(e) \geq c^{2nd}(e)$. If the principal were better off, at least one insurer would be making negative profits. This is not possible in equilibrium.
3. Notice that, ex-ante, insurers are not interested in the agents's effort. This implies that, by themselves, they can never offer a profitable contract that gives an agent incentives to choose e. The principal must be active in every such case. Formally, we know from equation (1) that the aggregate cost of implementing e is greater than zero, so that

[24] We say a principal or an insurer "implements e" if he makes an offer (maximizing profits taking into account both past offers and the best responses of players moving next) such that the agent accepts his contract (and possibly others) and chooses effort e.

$\int w_A(\pi)f(\pi/e)d\pi = \int w_p(\pi)f(\pi/e)d\pi - \sum_{i\in I}\Pi_i(e) > 0$. If the principal is not active, then $\int w_p(\pi)f(\pi/e) = 0$, and at least one insurer makes negative profits, which is not possible in equilibrium.

■

Lemma 2 simply says that the introduction of these new players can add nothing to our previous economy. If our insurers had an informational advantage over the principal, such that they could observe the agent's level of effort, then the principal could be better off, as in Itoh (1993) and Arnott and Stiglitz (1991). We will comment in the conclusions how this alternative assumption might alter our results.

The fact that the principal is always an active player in our set-up is quite relevant given our applied focus on managerial (or more generally, labor) contracts, and one of the features that distinguishes our contribution from those of other recent papers on non-exclusive contracting. In the rest of the paper we characterize in more detail the principal's contract under different scenarios of non-exclusive contracting.

4 Sequential Offering

4.1 The one-insurer case

In this subsection we consider the implementation of high effort in a setting in which 1) the principal offers a non-exclusive contract w_p; 2) an insurer observes w_p and offers a contract w_1; 3) the agent considers which contracts (if any) to accept, and chooses the level of effort; 4) payoffs are realized. We denote this setting by PIA, which gives the order in which each player moves.

From Lemma 2 we know that

$$\int w_p(\pi)f(\pi/e_h)d\pi \geq \int w^{2nd}(\pi)f(\pi/e_h)d\pi. \qquad (3)$$

We also know, from Lemma 1, that the principal's contract for implementing high effort must satisfy GNIC. If that is the case, then the insurer can either stay out or implement high effort. We will show that the latter is the equilibrium action, induced by the first move of the principal.

If the insurer were to stay out, the combination of the non-insurability constraint with the participation constraint will lead to a cost to induce high effort which is higher than the second best, leaving the principal worse off.

The other possibility (the one that will be chosen in equilibrium) is for the principal to offer a contract such that the insurer is willing to participate and take the agent to high effort. In order to implement e_h the insurer will offer the contract such that the aggregate contract is the second-best contract:

$$w_1(\pi) = w^{2nd}(\pi) - w_p(\pi),$$

The expected benefits to the insurer from implementing e_h are therefore

$$\begin{aligned} \Pi_1(e_h) &= -\int w_1(\pi) f(\pi/e_h) d\pi \\ &= \int w_p(\pi) f(\pi/e_h) d\pi - \int w^{2nd}(\pi) f(\pi/e_h) d\pi. \end{aligned}$$

Expression (3) implies that $\Pi_1(e_h) \geq 0$, so an insurer will have incentives to take the agent to high effort (and he will not have incentives to take her to low effort given that the contract satisfies GNIC). The principal's least costly way of implementing e_h is by setting w_p such that $\Pi_1(e_h) = 0$. We show next that this is possible, so that it is a property shared by any SPE of this game.

From the zero profit condition the contract must satisfy

$$\int w_p(\pi) f(\pi/e_h) d\pi = \int w^{2nd}(\pi) f(\pi/e_h) d\pi \ ; \tag{SBEC}$$

that is, the principal is paying the same expected cost as in the traditional problem. (SBEC stands for Second-Best Expected Cost).

Lemma 3 *If the principal's contract satisfies SBEC, then $\psi = \overline{u}$ (and therefore GNIC becomes NIC).*

Proof. Assume that $\psi \neq \overline{u}$, so that $\int v(w_p(\pi)) f(\pi/e_h) d\pi - g(e_h) > \overline{u}$. We show that in that case the principal's contract cannot satisfy SBEC. If the principal's contract satisfies IC, then costs must be higher than second best costs, so that SBEC cannot be true. Suppose the principal's contract does not satisfy IC. But then an insurer must take the agent to high effort, offering a contract such that $w_p(\pi) + w_1(\pi)$ satisfies IC. The cost of this aggregate contract must be higher than SBEC, since the insurer cannot leave the agent below ψ. If the principal's contract satisfied SBEC, then the insurer would be making negative profits. ■

We are therefore looking for a contract that satisfies both SBEC and NIC:

$$\begin{aligned} \int w_p(\pi) f(\pi/e_h) d\pi &= \int w^{2nd}(\pi) f(\pi/e_h) d\pi \\ &> \phi\left[g(e_l) + \overline{u}\right] \geq \int w_p(\pi) f(\pi/e_l) d\pi, \end{aligned} \tag{4}$$

where the equality is SBEC, the first inequality follows from equation (1) and the second inequality follows from a version of NIC where ϕ is applied to both sides.[25]

Equation (4) has a nice interpretation. Compared to the second-best contract, the principal offers higher payments in the "good" states and lower payments in the "bad" ones in such a way that average compensation is the same when the agent makes high effort, but lower when she makes low effort. Therefore, the principal is offering a riskier contract to the agent but still paying the cost of the second-best contract.[26] Since this alternative is less costly than preempting the insurer's entry, this is the option chosen in equilibrium, as mentioned before.

We therefore have the following result:

Proposition 1 *In the setting PIA, the principal's cost of implementing high effort is identical to the traditional second-best cost. Furthermore, equilibria where high effort is implemented are characterized by the following properties:*

(i) The principal offers a contract $w_p(\pi)$ that satisfies both SBEC and NIC. The contract is riskier than the second best contract.

(ii) The insurer takes the agent to the second-best contract, $w_A(\pi) = w^{2nd}(\pi)$, and makes zero profits.

(iii) The agent accepts both contracts, chooses e_h and makes her reservation level of utility $\overline{u}$.

Three points should be noticed. First, greater risk to the agent implies that the principal's contract, by itself, leaves the agent under her reservation utility $\overline{u}$. Call this the agent's interim utility.[27]

[25] It is easy to see that existence is guaranteed.

[26] The contract is riskier since the agent is being paid the same expected wage, but receiving lower utility than in the second best. Indeed, the interim payoff is below her reservation utility.

[27] We will see later that when the principal cannot leave the agent below her reservation utility, then he is worse off.

Second, there are multiple optimal contracts because many contracts satisfy *(i)* in Proposition 1. This multiplicity appears because the principal can expose the agent to different amounts of risk. That is, while there is an upper bound to the agent's interim utility (which is SBEC and NIC with equality), there is no lower bound. Of course, we can assume that lower bound if we introduce limited liability. In that case, we get a bounded range of possible contracts.[28]

Third, the insurer is given the incentives necessary to insure the agent and take her to the second-best aggregate contract and, consequently, to her reservation utility $\overline{u}$.

The intuition is simple. Knowing that an insurer has incentives to reduce any risk the agent might take and eventually give her incentives to choose e_l, the principal offers a riskier contract such that the insurer is just willing to participate and insure the agent up to the second-best contract. As a result, the principal manages to pay the traditional second-best cost, even in the presence of an insurer.

Given that results also remain the same for the case of e_l,[29] the resulting equilibria of this extended game shares some of the properties of the traditional equilibria. The principal still pays the second-best cost to implement high effort, the agent makes her reservation level of utility, and the insurer makes zero profits. What differs is the principal's optimal contract, which is now steeper. However, the aggregate contract is still the second-best contract.

So far there have been no fundamental changes to the aggregate contract. Moreover, the expected payment made by the principal does not change, neither do the parameter values under which the principal implements high effort. Nevertheless, in this case the contract offered by the principal will be riskier than the one without the presence of an insurer. From Lemma 2 we know that, given our informational assumption, the principal cannot be better off. We have just seen a particular setting under which the principal is not worse off either. In the remainder of the paper we study other extensive

[28] Of course, the introduction of limited liability can jeopardize existence. Notice also that uniqueness of the contract can also be achieved by assuming that the insurer has a slight degree of risk aversion.

[29] To be precise, the principal's cost of implementing e_l remains the same, but there are now multiple optimal contracts that implement e_l. There are some contracts that give the agent somewhat greater risk, but cost $c^{2nd}(e_l)$, and the insurer will afterwards insure the agent and take her to the flat wage $\phi\left[g(e_l)+\overline{u}\right]$.

form specifications of non-exclusive contracting, and we find that there are some cases in which the "threat of insurance" actually hurts the principal (implementation of high effort costs more).

We extend the model in two dimensions: 1) increasing the number of insurers both to a finite number and to its limiting case, free entry; and 2) considering alternative time sequences.

4.2 N insurers

In the last subsection we found that with one insurer the principal can implement the high level of effort at the same cost as before, by offering a contract that is "steeper" than the second-best contract. We now show that this result generalizes to a finite number of insurers.

We extend the setting of the previous section to the case where N insurers offer contracts to the agent, and the agent finally decides which of the N+1 contracts to accept, and which level of effort to exert. We denote this setting by PII...IA.

The straightforward extension to the finite case is stated in the next proposition in order to emphasize the role played by the last insurer. The proof, together with some details specific to our multi-insurers setting, are presented in the Appendix.

Proposition 2 *In the setting PII...IA, the principal's cost of implementing high effort is identical to the traditional second-best cost. Furthermore, equilibria where high effort is implemented are characterized by the following properties:*[30]

(i) The principal offers a contract $w_p(\pi)$ *that satisfies SBEC and NIC. The contract is riskier than the second best contract.*

(ii) $k \in \{0, 1, ..., N-1\}$ *insurers are active, make zero profits and offer contracts such that each subset of insurers satisfy NIC. (See the Appendix for details)*

[30] Again, we have multiple equilibria. But now there is a second source of multiplicity: equilibrium is consistent with any number of active insurers (as long as the last insurer is active). There is a simple way to get rid of the second source. If the agent bears a small cost $\varepsilon > 0$ from contracting with each insurer, then we have uniqueness in the sense that the agent will accept contracts only from the last insurer. Of course, there is still multiplicity from the first source.

(iii) The last insurer (insurer N) is always active, makes zero profits, and takes the agent to the second-best contract, $w_A(\pi) = w^{2nd}(\pi)$.

(iv) The agent accepts the aggregate contract, chooses e_h *and makes her reservation level of utility* $\overline{u}$.

Proof: see the Appendix.

It is apparent from Proposition 2 that a key player in the result is the last insurer. He is responsible for taking the agent to the second-best aggregate contract. Of course, he is able to do so because he knows there is no next insurer willing to take the agent to an aggregate flat wage. In the traditional principal agent problem the principal possesses the technology that makes the agent's effort valuable, as well as the power to control her consumption vector. In the case here the agent's consumption vector is under the control of the last insurer, but the timing of the game gives the principal the ability to "appropriate" the rents generated by this power. With free-entry of insurers, there is no last insurer, and consequently no one willing to take the agent to the second best, since nobody has the power to control the agent's consumption vector. As we will see next, in that case the threat of insurance does hurt the principal, and does affect more substantively the equilibrium contract(s).

5 Free entry

In this section we extend the previous setting to the case where there is free entry of insurers. Insurers continue to make their offers sequentially, but now there is no last insurer. To avoid the problem of infinity of offers, we assume that a) the agent can stop the game at any time;[31] b) the agent gets an utility of $-\infty$ if she negotiates an infinite number of contracts.

Results from the finite case can be interpreted as follows. The principal and the N insurers can be seen as an aggregate player facing a single agent. $>$From Lemma 2, part 1, the aggregate cost of implementing a given level of effort is greater than or equal to the traditional cost, without the presence of insurers. It turns out that, given his first-mover advantage, the principal can

[31] The agent, however, cannot commit to stop the game at a certain time.

still pay that lower bound cost in order to implement high effort. With free-entry, it will still be true that the principal pays the lower bound aggregate cost of implementing e_h. However, this cost now differs from the second-best cost.

Recall that the aggregate contract is

$$w_A(\pi) = \sum_{i \in A} w_i(\pi),$$

where A is the set of active players. What is the equilibrium aggregate cost of implementing high effort? In the finite case, it was simply the second-best cost; that is, the solution to the problem of minimizing cost subject to PC and IC. But now, we know that such a contract cannot implement high effort: a new insurer will take the agent to low effort. As a result, the optimal aggregate contract (i.e. the one that yields the minimum aggregate cost of implementing high effort) is the solution to the following third-best problem:

$$\max - \int w_A(\pi) f(\pi/e_h) d\pi$$

subject to

$$\int v(w_A(\pi)) f(\pi/e_h) d\pi - g(e_h) \geq \overline{u} \tag{PC}$$

$$\int v(w_A(\pi)) f(\pi/e_h) d\pi - g(e_h) \geq \int v(w_A(\pi)) f(\pi/e_l) d\pi - g(e_l) \tag{IC}$$

$$\psi \geq v\left(\int w_A(\pi) f(\pi/e_l) d\pi\right) - g(e_l), \tag{GNIC}$$

where the new constraint, GNIC, follows from Lemma 1. Recall that

$$\psi = \max \left\{ \overline{u}, \int v(w_A(\pi)) f(\pi/e_h) d\pi - g(e_h) \right\}.$$

Call the cost minimizing contract the third best, and denote it by $w^{3rd}(\pi)$. It is an immediate result that the third best contract costs more than the second best contract.

Proposition 3 *The minimum aggregate cost of implementing e_h with sequential free entry of insurers is strictly greater than the cost of implementing e_h without insurers or with a finite number of insurers; that is*

$$\int w^{3rd}(\pi) f(\pi/e_h) d\pi > \int w^{2nd}(\pi) f(\pi/e_h) d\pi.$$

Proof. Relative to the second best problem, there is an additional constraint, implying that $\int w^{3rd}(\pi)f(\pi/e_h)d\pi \geqslant \int w^{2nd}(\pi)f(\pi/e_h)d\pi$. The strict inequality comes from the fact that the solution to the second best problem does not satisfy the new restriction, GNIC. ■

Given the sequential nature of the game and following the analysis from the finite case, it is easy to show that the principal can implement high effort by paying the minimum possible cost; in this case, the third-best cost. One possibility is for the principal to offer the third-best contract, so that no insurer participates. Another possibility is for the principal to offer a contract satisfying third-best expected cost ,

$$\int w_p(\pi)f(\pi/e_h)d\pi = \int w^{3rd}(\pi)f(\pi/e_h)d\pi, \tag{TBEC}$$

and GNIC, but with $w_p(\pi) \neq w^{3rd}(\pi)$. In this case the principal's contract gives the agent higher risk than the third-best contract, and leaves her under her reservation utility. An insurer (or many insurers) will take the agent to the third-best aggregate contract. Thus, we continue to have multiple equilibria.

The following proposition characterizes the equilibrium in the free entry case.

Proposition 4 *In a setting with Free Entry, the principal's cost of implementing e_h is equal to the third-best cost, which is greater than the traditional second best cost. Furthermore, equilibria where high effort is implemented are characterized by the following properties:*

(i) The principal offers a contract $w_p(\pi)$ that satisfies TBEC and GNIC. The contract is riskier than the second best contract.

(ii) If $w_p(\pi) = w^{3rd}(\pi)$, no insurers are active. If $w_p(\pi) \neq w^{3rd}(\pi)$, any number of finite insurers are active,[32] *make zero profits, and offer contracts such that each subset of insurers satisfy GNIC.* [33]

(iii) The equilibrium aggregate contract satisfies $w_A(\pi) = w^{3rd}(\pi)$.

(iv) The agent accepts that aggregate contract, stops the game, chooses e_h and makes, at least, her reservation utility level, $\overline{u}$.

Notice that we have used the more general constraint, GNIC; simply because we have not yet specified whether the optimal contract for implementing high effort might leave the agent above her reservation utility.

[32] Again, we can get rid of this multiplicity with a small cost of contracting.

[33] The requirement that a subset of insurers satisfy GNIC is identical to the requirement formally stated in the proof of proposition 2, except that NIC is now replaced by GNIC.

5.1 Characterization of the Third-Best Contract

Next we provide a characterization of the third best contract under a particular assumption over the utility function. In particular, we show a sufficient condition on the utility function such that the principal leaves the agent at her reservation utility (so that NIC is the relevant constraint).[34]

We first show that IC is a redundant constraint.

Lemma 4 *Given strict risk aversion, constraint GNIC and PC imply that IC is satisfied with strict inequality.*

Proof. Using the fact that v is a strictly concave function, Jensen's inequality implies that

$$\int v(w_A(\pi))f(\pi/e_l)d\pi < v\left(\int w_A(\pi)f(\pi/e_l)d\pi\right). \tag{5}$$

General NIC implies that

$$\int v(w_A(\pi))f(\pi/e_l)d\pi - g(e_l) < \psi.$$

The result follows from PC and the definition of ψ. ■

Lemma 4 allows us to rewrite the third-best problem in the following way:

$$\max_{w_A(\pi)} - \int w_A(\pi)f(\pi/e_h)d\pi$$

subject to

$$\int v(w_A(\pi))f(\pi/e_h)d\pi - g(e_h) \geq \overline{u} \tag{PC}$$

$$\int v(w_A(\pi))f(\pi/e_h)d\pi) - g(e_h) \geq v\left(\int w_A(\pi)f(\pi/e_l)d\pi\right) - g(e_l), \tag{GNIC'}$$

Constraint GNIC' can be seen as a modified incentive constraint, given that the presence of insurance has increased utility from low effort.

As in the traditional problem, it is easy to see that the incentive constraint GNIC' is binding. If that was not the case, then the optimal contract would be a flat wage satisfying PC. But this does not satisfy GNIC'.

Could the cost minimizing contract leave the agent above her reservation utility? The following proposition shows that this cannot be the case if we assume non-decreasing absolute risk aversion.

[34]We also conjecture, in the next footnote, a condition under which the principal might decide to leave the agent above her reservation utility (so that GNIC is the relevant constraint).

Proposition 5 *Assume the agent has non-decreasing absolute risk aversion. Then the third-best aggregate contract leaves her exactly at her reservation utility level, $\overline{u}$. Furthermore, the optimal contract $w^{3rd}(\pi)$ is fully characterized by solution to constraints PC and GNIC' binding, and to the following first-order condition*

$$\frac{1}{v'(w^{3rd}(\pi))} = \frac{\lambda}{1+\delta\frac{f(\pi/e_l)}{f(\pi/e_h)}}, \qquad \textit{(FOC)}$$

where $\lambda > 0$ and $\delta > 0$ are the usual Lagrange multipliers.

Proof. See the appendix.

The only incentive the principal could have to pay the agent more than her reservation utility is to reduce the risk premium. But when the agent has non-decreasing absolute risk aversion, increasing the utility of the agent will not reduce the risk premium.[35] From now on we assume the agent has non-decreasing absolute risk aversion, so that she is always left at her reservation utility.

Proposition 5 characterizes the third-best contract under the assumption of non-decreasing absolute risk aversion. It is easy to verify that a property valid in the traditional problem holds for the third-best contract as well: the optimal third-best rewarding scheme is increasing in π under the assumption that the monotone likelihood ratio property holds.

We close this section with a comparison between the finite and the free entry case. The aggregate contract in the finite case, similar to the standard results, is the second-best contract. The aggregate contract in the free entry case is a third-best contract; this has different implications for welfare and (for some parameter values) for equilibrium actions.

However, in both the case with finite number of insurers and in the case of free entry there are similarities with regard to the principal's contract. In both cases the "labor" contract is steeper than in the standard case. Under free entry the contract's variance is amplified by increasing the reward to high effort. This, as we have noticed, involves a greater cost. On the other hand, the principal's optimal contract when the number of insurers is finite pays the same to high effort but decreases the expected payoff of undertaking

[35]It seems possible that when the agent absolute risk aversion is strongly decreasing, the principal could reduce the cost by giving the agent more than her reservation utility, but we do not have an example where this happens.

low effort. The variance is also increased. Therefore, incentives are enhanced in both cases. The difference is that in one case the reward to high effort increases, while in the other the reward to low effort decreases.

6 Sequential Contracting

Up to now we have modeled situations in which the agent faces a full set of offers before making a final decision. We called such set up "sequential offering."[36] In this section we focus on the case in which, after signing the contract with the principal (and before exerting effort), the agent can engage in additional contracts. We consider two scenarios, one in which the bargaining power in the potential later trades resides in the hands of the agent (she makes the offer) (6.1), and another one in which the bargaining power is in the hands of the insurers (6.2). It turns out that the results when the agent has the bargaining power in the later contracts are virtually identical to those of sequential offering. The results when the insurers have bargaining power deviate further from the standard case. As before, we deal first with the case of one insurer, then with the case of any finite number of insurers, and finally with the free entry case.

6.1 The agent has the bargaining power in later trades

We consider a sequential setting where: 1) The principal offers a non-exclusive contract $w_p(\pi)$; 2) the agent decides whether to accept or reject the contract; 3) the agent offers a contract $w_a(\pi)$ to the insurer; 4) the insurer either accepts or rejects the contract; 5) the agent chooses the level of effort; 6) payoffs are realized. We denote this setting by PAAI. It turns out that the results are identical to the ones from the sequential offering case, (in which the agent was the last to play.)

The principal offers a contract satisfying SBEC and NIC, which by itself gives the agent a utility under her reservation level. Now the agent makes an offer $w_a(\pi)$ to the insurer. In principle, this contract could be offered with the intention of making high or low effort.

[36] Stole (1997), in characterizing different common-agency situations, calls a similar set up "delegated common agency." (Recall that in common agency there are productive relationships with several principals.)

Notice that the most the agent can get is $\overline{u}$. This is because if the agent gets more than $\overline{u}$, it must be at the expense of an insurer making negative profits. In the case of high effort, the agent gets $\overline{u}$ by offering a contract such that $w_a(\pi) = w^{2nd}(\pi) - w_p(\pi)$. Integrating and using SBEC we get $\int w_a(\pi) f(\pi/e_h) d\pi = 0$; that is, the insurer makes zero profits and is indifferent between accepting this contract or not.

It is easy to see that the agent will not choose low effort. In order to do so she should ask the insurer for a contract $w_p(\pi) + w_a(\pi) = \phi\left[g(e_l) + \overline{u}\right]$. But the insurer would never accept this contract, because the principal's contract satisfies NIC and so the insurer would make negative profits. Therefore we have an equilibrium where the principal offers a contract satisfying SBEC and NIC, and the insurer takes the agent to the second best.[37]

Consider the extension of the above setting to the case with N insurers, where the agent makes an offer to a second insurer, who can either accept or reject it, and so on, until the last insurer is reached.[38] Once again, it is easy to show that no insurer except the last would accept to take the agent to the second-best aggregate contract. Results are almost identical to the timing PI...IA, as summarized in Proposition 2. There is a slight difference in Part *(ii)* of the Proposition as a result that now the contracts are not only offered sequentially but are also being signed sequentially. As a result, we do not need all subsets of *offered* contracts (except the last insurer's contract) to satisfy NIC, as we did in the proof of Proposition 2. That condition must now hold only for each subset of contracts that have been *signed*, for all stages of the game (except the last).

In the free entry version of this timing we still have the third best. This is simply because no insurer will accept the agent's insurance proposal since she cannot commit to not making any further proposals to other insurers.[39]

[37] Once again we have multiple optimal contracts; comments from Section 4 are also valid here.

[38] What is important is that the agent has all the bargaining power in the last agent-insurer relationship.

[39] To be precise, Proposition 4 needs a slight modification. In part *(ii)*, even if the principal offers the third best contract, $w^p(\pi) = w^{3rd}(\pi)$, any number of insurers may be active. These insurers might continually give and take risk away from the agent. These contracts are, of course, completely uninteresting.

6.2 The insurers have the bargaining power in later trades

We now consider a timing where the insurers are given all the bargaining power vis a vis the agent. We start by analyzing the case of $N = 1$, in which: 1) The principal offers a non-exclusive contract $w_p(\pi)$; 2) the agent decides whether to accept the contract; 3) the insurer offers the agent the contract $w_I(\pi)$; 4) the agent either accepts or rejects the contract; 5) the agent chooses the level of effort; 6) payoffs are realized. We denote this setting by PAIA.

Proposition 6 *In the setting PAIA, the principal's cost of implementing high effort is greater than the second-best cost but smaller than the third-best cost. Furthermore, equilibria where high effort is implemented are characterized by the following properties:*

(i) The principal offers a contract $w_p(\pi)$ that is riskier than the second best contract but less risky than the third best.

(ii) The insurer takes the agent to the second-best contract, $w_A(\pi) = w^{2nd}(\pi)$, and makes positive profits.

(iii) The agent accepts both contracts, chooses e_h and makes her reservation level of utility $\overline{u}$.

Proof. The principal would like, once again, to offer SBEC and NIC, but this gives the agent less than $\overline{u}$. Then the insurer, who has all the bargaining power, would leave the agent at this lower utility. The agent will never accept the principal's contract in the first place. Therefore, the principal now faces three constraints: 1) give the agent the reservation level of utility 2) give the agent the incentives to exert high effort; and 3) give the the insurer the incentives to implement high effort. Hence the problem becomes

$$\max_{w_p(\pi)} - \int w_p(\pi) f(\pi/e_h) d\pi$$

subject to

$$\int v(w_p(\pi)) f(\pi/e_h) d\pi - g(e_h) \geq \overline{u} \tag{PC}$$

$$\int v(w_p(\pi)) f(\pi/e_h) d\pi - g(e_h) \geq \int v(w_p(\pi)) f(\pi/e_l) d\pi - g(e_l) \tag{IC}$$

$$\int \left(w_p(\pi) - w^{2nd}(\pi)\right) f(\pi/e_h)d\pi \geq \int w_p(\pi)f(\pi/e_l)d\pi - \phi\left[g(e_l) + \overline{u}\right] \quad (6)$$

Equation (6) means that the insurer's profit implementing low effort should be non greater than implementing high effort. Notice that $w_p(\pi) = w^{2nd}(\pi)$ does not satisfy the constraint (6) hence the cost must be greater than SBEC. $w_p(\pi) = w^{3rd}(\pi)$ is feasible since it fulfills equation (6) and (IC) with strict inequality, but that would call for a flat wage (since the only non-negative multiplier would be that of PC). But a flat wage would not (IC) nor (6). Hence, we know that the principal's expected cost must be between the second and the third best. Since the agent is always in her reservation utility, a higher cost is associated with a riskier contract.

Given this contract, the insurer offers to take the extra risk away from the agent and makes positive profits. This is done by offering $w_I(\pi) = w_p(\pi) - w^{2nd}(\pi)$, so that integrating we get

$\Pi_1(e_h) = -\int w_I(\pi)f(\pi/e_l)d\pi = \int \left(w_p(\pi) - w^{2nd}(\pi)\right) f(\pi/e_h)d\pi > 0$

■

In this case, the insurer appropriates some rents from being able to control the agent's consumption vector. Hence, the insurer's bargaining power does hurt the principal in this case. But the principal is able to capture more than in the free entry case because his first mover advantage allows him to catch some of the surplus that is generated because there is somebody who is able to take the agent to the second best.

When there are N insurers, once again, only the last insurer takes her to the second-best aggregate contract and he makes positive profits. However in this case the cost of the principal is increasing in the quantity of insurers (but never higher than the third best cost), and all the insurers make positive profits (see the Appendix).

Notice also that under this particular sequence, free entry leads to a unique equilibrium: the principal's contract is always the third-best contract. The reason is that any contract satisfying TBEC and NIC, but different from the third-best contract, would leave the agent below her reservation utility.

7 Conclusion

7.1 Summary of Results

In this paper we have studied how the presence of outside trading opportunities ("the threat of insurance") affects contracting in moral-hazard agency relationships. We build from a standard moral hazard model with two effort levels and a continuum of performance levels. In the benchmark situation, the agent can only contract with the principal, and there is a cost-minimizing (second-best) contract that implements the high effort level, as in Holmstrom (1979) and all the subsequent literature. We examine what happens if, besides the principal, there is a multiplicity of risk-neutral insurers with whom the agent can contract. The principal continues to act as a Stackelberg leader in the sense that the other insurers sequentially move after him in the various timings explored.

A necessary and sufficient generalized non-insurability condition is given under which a contract offered by the principal and intended to implement high effort by the agent is robust to the introduction of a third risk-neutral player. It can be interpreted as a stronger incentive compatibility constraint for the agent, reflecting the fact that the presence of a further insurer increases the benefits from low effort. Alternatively, the non-insurability condition can be seen as expressing the fact that the profits from taking the agent to low effort are less than or equal to zero. This condition is quite general in that it does not depend on the particular extensive form used to model the "competition" between the principal and the insurers. Using this condition, it is immediate to check that the standard second-best contract is not robust to the introduction of a further trade opportunity.

After showing the non-robustness of the standard contract, we characterize the equilibria of an extended game with different settings in terms of the number of players and in terms of the sequence of play. We found that the principal can sometimes manage to overcome the threat of insurance by offering steeper (more intense) rewarding schemes. However, under some specifications the implementation of high effort becomes more costly to the principal, and for some parameter values so costly that he just lets the agent provide low effort. Table 1 presents a more detailed comparison of our results across specifications.

<Insert Table 1 around here>

The first three rows present three different sequences for the case in which the number of insurers is finite. The fourth row presents the free entry case. For brevity, the table presents results applying the necessary refinements to induce uniqueness in each case. The refinement essentially consists on adding a small cost to writing contracts, which eliminates superfluous contracts. (We will make a brief caveat for the case of free entry below). The first five columns refer to (contracts, cost, etc., for) the implementation of high effort; while the last two columns refer to effort and welfare more generally.

The first two cases (sequential offering, and sequential contracting with the agent making the offer in the insurance contract) give results closer to those of the standard case. The main differences are in the set of contracts entered in equilibrium. The contract from the principal provides steeper incentives, by providing lower expected payments in the case of low effort. This contract by itself would put the agent below her reservation utility, but the reservation level of utility is restored by a contract with an insurer. The other features of these scenarios coincide with those of the standard principal agent model: the cost of implementing high effort is the second-best cost, the aggregate contract that the agent faces is still the second-best contract, the same effort levels are implemented across parameter values, and total welfare is the same, with insurers making zero profits.

It is in the other two cases (two bottom rows) where the results differ more substantially from the standard case. In the case in which the bargaining power in the insurance relationship is in the hands of the insurer, it is no longer possible to give the agent an interim utility below her reservation utility, and the principal is forced to pay a higher cost to implement high effort. He provides a steeper contract with expected cost greater than the second best.[40] This prevents him from forcing a "zero profit" condition onto the insurers, who make positive profits.

In the case of free entry, with the threat of further insurance, the principal is forced to offer a (higher cost) third-best contract. This contract is also steeper than the second best one, although in this case because of higher payments associated to higher outcomes. In both of these last two cases, given higher implementation costs of high effort, there will be parameter values for which the equilibrium level of effort chosen by the principal in his

[40] This cost as well as the steepness of the contract are increasing in the number of insurers. This is because the minimun level of risk that a player can give to the agent, while avoiding that the following players take her to low effort, is increasing in the quantity of insurers left.

design problem will be lower than in the standard case, and incentives "will be eliminated." Figure 1 compares the equilibrium levels of effort exerted in the different cases. The horizontal axis measures the difference in expected profits to the principal under high versus low effort. $w^{2nd}(\pi)-\phi\left[g(e_l)+\overline{u}\right]$, low effort is chosen in equilibrium in all setups. To the right of $w^{3nd}(\pi)-\phi\left[g(e_l)+\overline{u}\right]$, high effort is chosen in equilibrium in all set ups. In the region in between those two values, the effective threat of insurance moves the economy from high to low effort for the case of free entry, while for the case of PAIA the region for which effort switches from high to low effort is smaller but increasing in the number of insurers.

<Insert Figure1 around here>

Notice that in Table 1 we restricted the free entry model to deliver a unique equilibrium in which no insurer is active (via imposing a contracting cost). Without such costs there would be equilibria with active insurers (and steeper principal's contracts). Even more realistically, if the principal has some imperfect information on some parameter of the agent's problem (say, on the cost of effort) we would have a situation in which the principal offers a contract even steeper than the third best, and then the agent buys some insurance. We consider this a possibly realistic case, since it would be consistent with the empirical evidence cited in the introduction about managers unwinding part of their incentives through the stock market (a case that might approximate our "free-entry" assumption).

Looking at total welfare or surplus (the last column in Table 1), it does not change from the standard case in the first two cases, while it decreases in the third and even more so in the fourth case. There are two sources of inefficiency, one is the change in equilibrium effort from high to low for some parameter values in case three, and for an even wider set of parameters in the case of free entry. In this last case there is a further source of inefficiency. Since the insurers do not appropriate any of the principal's higher costs of implementing high effort, there is an efficiency loss due to this higher implementation cost. It is therefore in the case of free entry where the economy suffers the greatest welfare loss.

7.2 Empirical Implications

We try to distill now some implications from our model. Some of these implications might be thought of as recommendations for those designing incentive contracts. For instance, we make the point that, in designing compensation schemes, attention should be paid to outside opportunities even if they seem productively unrelated. Complementarily, if we assume that the world might already work as predicted by optimal contracting theory, some of these implications are falsifiable empirical implications from our model.

A given specification of a model can be taken as a good potential approximation to reality, and then one can derive empirical implications from comparative statics on the parameters of that model. Some such exercises, building from the basic moral-hazard agency model, are nicely surveyed in Chiappori and Salanié (2002) and in Lafontaine and Slade (2001). Additionally, one might play around with the specification of the model, and make predictions across specifications. That is closer to what we do here. We postulate that the type of outside trading opportunities (or "the threat of insurance") that we emphasize here might be of more relevance in some empirical environments (industries, job types, legal environments), and then we can postulate that our implications (as opposed to those of the standard model) are more likely in such environments. Furthermore, one can combine these two approximations to deriving empirical predictions, and suggest that the implications for the dependence of contracts on parameters of the empirical environment might indeed be reversed in our model vis a vis the standard case.

The "threat of insurance" (or non-exclusivity of contracts) might be an issue in some environments, while it might be totally absent in others. The threat of insurance may not be a problem either because the risk in question is not insurable (technologically, or because of the absence of the relevant markets) or because, being insurable, further contracting can be forbidden in a legally enforceable manner. This in turn might relate to the overall institutional and legal capability of a given country, or to the observability and verifiability of the additional contracts, which might vary across markets or across activities.

For instance, the standard agency model predicts a negative correlation between risk and incentives. One way of operationalizing "incentives" is by the presence of contracts for performance. But, it might be the case that other reasons influencing the decision whether to use incentive contracts might correlate with the amount of risk in the environment. Take for instance the example in Prendergast (2002a). If one were to make predictions about compensation using the standard trade-off, one would expect to see more pay for performance for international managers operating in Canada (low-risk environment) than in Armenia (high-risk environment) since the managers' performance (how good her decisions were) can be measured more precisely in Canada. The evidence points in exactly the opposite direction. Prendergast develops a number of reasons why omitted variables can be causing the correlation to go against the standard theory (heterogeneity in aversion to risk being an obvious one). From the analysis in this paper we can add another possible reason: stock markets and other financial markets for trading across states of the economic world are a lot more developed in Canada than in Armenia. A manager operating in Canada might more easily unwind her incentives in those markets than one operating in Armenia. And our model predicts that in environments where it is easier to trade risk away, we should observe fewer contracts for performance.

More generally, we predict that:[41]

1) In cases in which it is easier to trade risk away, contracts for performance will be less common, and effort (and hence output) will be lower on average.

2) When performance contracts are indeed used, they will tend to be steeper. (This extra steepness comes from lowering the expected payoff to low effort in rows 1 and 2 of Table 1, and from increasing the expected payoff to high effort in rows 3 and 4).

3) We might observe agents facing (steep) contracts for performance from their principals, and then partially unwinding those incentives through further trades. (This seems consistent with the findings in Ofek and Yermack, 2000.)

Some additional predictions might be obtained, although they would require further theoretical analysis, extending our analysis - for instance by endogeneizing some contractual restrictions, or enriching the set of variables over which there might be observation, monitoring, etc. (i.e., interacting with other relevant pieces of agency theory, such as the informativeness principle, monitoring, yardstick competition, etc.). We conjecture that:

4) We might observe a tendency to utilize compensation instruments that are more difficult to "trade away" (this might relate to the tendency to use "discretional" promotions or other rewards for performance that are not directly monetary).[42]

[41] For brevity, we do not push here specific predictions across the different specifications (sequencing, bargaining protocol, number of players) of our model and focus, rather, on some generic predictions of all specifications.

[42] See for instance Baron and Kreps (1999), Murphy (1999), and Gibbons and Waldman

5) The tendency to observe exclusivity clauses (or other trading restrictions) will depend on the ex ante incentives of the principal and the agent to use such commitment technology if available. It will be more demanding in situations in which the lost surplus due to insurance is higher.

6) The tendency to use different indicators in performance contracts will depend not only on their observability by the principal (positively) but also on their observability by outside parties (negatively).

7) This might also influence the form taken by monitoring effort inside organizations

7.3 Extensions

Some possible extensions have already been hinted throughout the paper. We list here a few additional exercises which might deliver interesting insights.[43]

One possible extension would be to work with a simultaneous setting in which everybody offers contracts at the same time, or a semi-simultaneous setting in which all insurers simultaneously offer contracts after the principal. This might generate different results, since the notion of last player was crucial for part of the analysis. One might conjecture that when the insurers make the offers simultaneously and there is limited liability, the second-best solution would be implementable only if the quantity of insurers is small enough.[44]

Alternatively, the appearance of new contractual opportunities might not be an event known with certainty by the principal or the agent. One can model a sequential setting in which the appearance of an insurer occurs with an interior probability. Notice that we already know the results when that probability is zero (the standard case), and when it is one (this paper). Preliminary computations suggest that, even in the cases where the second best is

(1999).

[43]Of course there is the possibly straightforward, but certainly tedious, extension to multiple effort levels. In that case we would have a non-insurability condition for each effort level above the lowest one. The model might also be extended to the continuous case, where several technical details will appear; all in the spirit of the traditional model's extension to continuous effort.

[44]This could also be thought as an extension of the Arnott-Stiglitz, Hellwig papers. A principal will offer a contract knowing that after him the agent will face the insurance market studied by them. So the principal will provide a contract that is the lottery with which the agent arrives to the insurance market.

implementable with insurers present for sure, it might not be implementable when the existence of insurers is uncertain. The intuition is that in these cases the uncertainty about the presence of insurers precludes an agent from accepting a principal's contract that leaves her below her reservation utility.

As mentioned already, the standard principal-agent problem might also be non robust to other contracts by the agent even if those contracts are not related to the output of this productive relationship: for instance other contracts that generate income for the agent and affect her risk aversion at the margin. It could be interesting to model how different realistic specifications of such a situation affect the original contract.

It also might be interesting to explore the interaction between the timing assumption in Fudenberg and Tirole (1990), in which some (re)contracting occurs after effort, with the presence of additional traders that we model here. Similarly, one could embed our multi-player setup in a repeated moral hazard context like the one in Chiappori et al (1994), adding intertemporal trading opportunities to the opportunities of further trade across states that we emphasize.

In this paper we have emphasized the negative effects of insurance opportunities. Itoh (1993) and Arnott and Stiglitz (1991) have shown that when these "third players" have perfect information – i.e., they observe effort – welfare improves. It would be quite interesting to interact the different settings developed in our paper, with different degrees of informational advantage by the insurers.

Also, as stated before, this paper might lead to a sort of "qualification" of the Informativeness Principle. Briefly, such a principle states that any signal that gives information about the agent's level of effort has positive value and (if costless) should be included in the reward scheme. Our results suggest that the value of information might depend also on the observability (and contractibility) by other potential contractual partners. This intuition would require a multi-signal extension of our work.[45]

More generally, outside opportunities should be taken into account when designing incentive schemes. We have shown that this is true even when those outside opportunities are seemingly unrelated. This might require the revision of some additional previous results in the applied literature on incentives.

[45]Note that here, as in the basic model of the standard case, "output" is the only signal of effort.

8 Appendix:

Proof of Proposition 2

To prove Proposition 2 notice that Lemma 2 implies that

$$\int w_A(\pi) f(\pi/e_h) d\pi \geq c^{2nd}(e_h)$$

or

$$\int w_p(\pi) f(\pi/e_h) d\pi - \sum_{i=1}^{N} \Pi_i(e) \geq c^{2nd}(e_h). \tag{7}$$

Consider the case where the principal offers a contract with second-best expected cost, as in (SBEC). Insurers can respond by implementing e_h, e_l or staying out. Assume for the moment that the best response for insurer 1 is to implement e_h, and that he chooses to play that best response. Then from equation (7) profits must be zero, and profits from deviating to e_l must be less than or equal to zero. Now insurer 2 will take as given

$$\begin{aligned}\int [w_p(\pi) + w_1(\pi)] f(\pi/e_h) d\pi &= c^{2nd}(e_h) - \Pi_1(e_h) \\ &= c^{2nd}(e_h) - 0 \\ &= c^{2nd}(e_h),\end{aligned}$$

Insurer 2 simply faces the same situation as insurer 1, so his best response must again include e_h. All we need to check is that insurers have no incentives to deviate to e_l.

From Lemma 1 and a trivial generalization of the results from the one insurer case (i.e. lemma 3), insurer one will have no incentives to take the agent to low effort if and only if NIC holds. So again the principal can offer a contract satisfying SBEC and NIC and incur the same cost to make the agent implement high effort.

The remaining insurers, except for the last insurer, are themselves subject to NIC. This means that none of them can take the agent to the second-best aggregate contract (if they did, they would make negative profits because the next insurer would take the agent to low effort). Therefore, they must satisfy a notion of aggregate NIC that we define below.

Let $O_h = \{p, 1, 2, ..., h-1\}$, $h = 1, ..., N$, represent the set of players that have already made their offers by the time it is the turn of insurer h to move, where p is the principal. Let $\wp(O_h)$ denote the set whose elements are all the subsets of O_h; that is, the power set. We then require that NIC is satisfied for all subset of players $X_h \in \wp(O_h)$, for all $h = 1, ..., N$. To state this formally, let W_{X_h} stand for the contract made up of players in the subset X_h,

$$W_{X_h} = \sum_{i \in X_h} w_i(\pi).$$

Then the equilibrium contracts $(w_p, w_1, ..., w_N)$ must satisfy $v\left(\int W_{X_h}(\pi) f(\pi/e_l) d\pi\right) - g(e_l) \leq \overline{u}$ for all $X_h \in \wp(O_h)$, for all $h = 1, ..., N$.

Notice also that the equilibrium aggregate contract up to insurer N-1 gives the agent a utility that is below her reservation utility. The agent will accept to put the high level of effort only in the case the last insurer takes her to the second best aggregate contract. ■

Proof of Proposition 5

i) Our first step is to show that non-decreasing absolute risk aversion implies that under the optimal solution, constraint PC is binding. Let w^* be an optimal solution with PC non-binding. Define $\widehat{w}(\pi) = w^*(\pi) - \varepsilon$ for all π, for $\varepsilon > 0$ small enough so that PC holds. It is straightforward to see that costs are lower under $\widehat{w}$. Next, we show that constraint GNIC' remains satisfied with this new contract (and hence that w^* cannot be an optimal solution.)

To see this, use the definition of risk premium to rewrite the agent's utility under high effort as $v\left(\int w^*(\pi) f(\pi/e_h) d\pi - \rho(w^*(\pi))\right) - g(e_h)$. Use this new definition to rewrite GNIC'. We must show that

$$\begin{aligned} & v\left(\int w^*(\pi) f(\pi/e_h) d\pi - \rho(w^*(\pi))\right) - \\ & v\left(\int w^*(\pi) f(\pi/e_h) d\pi - \rho(\widehat{w}(\pi)) - \varepsilon\right) \\ \leq \; & v\left(\int w^*(\pi) f(\pi/e_l) d\pi\right) - v\left(\int w^*(\pi) f(\pi/e_l) d\pi - \varepsilon\right). \end{aligned}$$

Nondecreasing absolute risk aversion implies that $\rho(w^*(\pi)) \geq \rho(\widehat{w}(\pi))$. Therefore,

$$\begin{aligned} & v\left(\int w^*(\pi) f(\pi/e_h) d\pi - \rho(w^*(\pi))\right) - \\ & v\left(\int w^*(\pi) f(\pi/e_h) d\pi - \rho(\widehat{w}(\pi)) - \varepsilon\right) \end{aligned}$$

$$\begin{aligned} &\leq v\left(\int w^*(\pi)f(\pi/e_h)d\pi - \rho(w^*(\pi))\right) - \\ &\quad v\left(\int w^*(\pi)f(\pi/e_h)d\pi - \rho(w^*(\pi)) - \varepsilon\right) \\ &< v\left(\int w^*(\pi)f(\pi/e_l)d\pi\right) - v\left(\int w^*(\pi)f(\pi/e_l)d\pi - \varepsilon\right). \end{aligned}$$

The first inequality follows directly from nondecreasing absolute risk aversion. The second inequality holds due to the strict concavity of v. To see the latter, let $A = \int w^*(\pi)f(\pi/e_h)d\pi - \rho(w^*(\pi))$ and $B = \int w^*(\pi)f(\pi/e_l)d\pi$. Notice that as w^* satisfies GNIC', then $A > B$. Strict concavity of v implies that $v(A) - v(A-\varepsilon) < v(B) - v(B-\varepsilon)$ for $\varepsilon > 0$.

ii) Our next step is to use the fact that the solution will be such that $\psi = \overline{u}$ to rewrite the third-best problem as

$$\max_{w_A(\pi)} - \int w_A(\pi)f(\pi/e_h)d\pi$$

subject to

$$\int v(w_A(\pi))f(\pi/e_h)d\pi - g(e_h) = \overline{u} \tag{PC}$$

$$\overline{u} \leq v\left(\int w_A(\pi)f(\pi/e_l)d\pi\right) - g(e_l) \tag{NIC}$$

Rewriting NIC as in equation 2 in the text and applying the standard trick of defining $x(\pi) \equiv v(w_A(\pi))$ so that $w_A(\pi) = \phi(x(\pi))$ (see Grossman and Hart (1983)), the problem becomes

$$\max_{x(\pi)} - \int \phi(x(\pi))f(\pi/e_h)d\pi$$

subject to

$$\int x(\pi)f(\pi/e_h)d\pi - g(e_h) = \overline{u} \tag{PCt}$$

$$\int \phi(x(\pi))f(\pi/e_l)d\pi \leq \phi\left[g(e_l) + \overline{u}\right]. \tag{NICt}$$

To apply the Kuhn-Tucker Theorem, notice that the objective function is strictly concave and that the constraint set is convex. To see the latter let PCt and NICt hold for x and y. We need to show that both equations also hold for $z = \alpha x + (1-\alpha)y$. That the first holds is trivial since it is linear. That the second holds follows from the strict convexity of ϕ:

$$\begin{aligned} & \int \phi\left[\alpha x(\pi) + (1-\alpha)y(\pi)\right] f(\pi/e_l) \\ < & \int \alpha\phi\left(x(\pi)\right) + (1-\alpha)\phi(y(\pi))\, f(\pi/e_l) \\ \leq & \ \phi\left[g(e_l) + \overline{u}\right]. \end{aligned}$$

As a result, the first order conditions are both necessary and sufficient for a global optimum. The FOC are:

$$\frac{1}{v'(w^{3rd}(\pi))} = \frac{\lambda}{1+\delta\frac{f(\pi/e_l)}{f(\pi/e_h)}}, \tag{FOC}$$

where λ and $\delta \geq 0$ are the Lagrange multipliers associated to PCt and NICt respectively.

Notice that we must have $\delta > 0$, if it were $\delta = 0$ then the solution would be a flat wage, and this does not satisfy NICt. Given that $\delta > 0$ and $v' > 0$ (and finite!), then we must also have $\lambda > 0$. This proves the desired result. ■

Sequential contracting, N>1 insurers make offers

First notice that the principal is not able to implement high effort with the contract that he uses when there is just one insurer. This is because the insurer that plays after him cannot offer the second best contract, so he will receive less surplus implementing high effort than taking the agent to low effort.

Let define W^n as the aggregate contract signed by the agent with the principal and the insurers $1, 2, ...n$.

If high effort is implemented we know that

$$\int w_p(\pi) f(\pi/e_h) d\pi \geq \int W^1(\pi) f(\pi/e_h) d\pi \geq ... \geq \int W^N(\pi) f(\pi/e_h) d\pi$$

Otherwise one of the insurers would be making negative profits, and this is not possible in equilibrium.

The problem that the principal will solve is

$$\max_{w_p} -\int w_p(\pi) f(\pi/e_h) d\pi$$

subject to

$$\int v(w_p(\pi)) f(\pi/e_h) d\pi - g(e_h) \geq \overline{u} \tag{PC}$$

$$\int v(w_p(\pi))f(\pi/e_h)d\pi - g(e_h) \geq \int v(w_p(\pi))f(\pi/e_l)d\pi - g(e_l) \qquad \text{(IC)}$$

$$\int \left(w_p(\pi) - W^1(\pi)\right) f(\pi/e_h)d\pi \geq \int w_p(\pi)f(\pi/e_l)d\pi - \phi\left[g(e_l) + \overline{u}\right] \quad (8)$$

The participation constraint must be binding, otherwise the principal can reduce the wage in all states by the same amount ε and both (IC) and equation (8) will still hold, since it will not change the incentives of the first insurer.

The first insurer will solve the following problem

$$\max_{W^1(\pi)-w_p(\pi)} - \int \left(W^1(\pi) - w_p(\pi)\right) f(\pi/e_h)d\pi$$

subject to

$$\int v(W^1(\pi))f(\pi/e_h)d\pi - g(e_h) \geq \overline{u} \qquad \text{(PC)}$$

$$\int v(W^1(\pi))f(\pi/e_h)d\pi - g(e_h) \geq \int v(W^1(\pi))f(\pi/e_l)d\pi - g(e_l) \qquad \text{(IC)}$$

$$\int \left(W^1(\pi) - W^2(\pi)\right) f(\pi/e_h)d\pi \geq \int W^1(\pi)f(\pi/e_l)d\pi - \phi\left[g(e_l) + \overline{u}\right] \text{(9a)}$$

As in the principal's problem, we know that (PC) must be binding. Since this is true for every insurer, none will give the agent a utility higher than $\overline{u}$. In general the participation constraint for insurer n that is

$$\int v(W^n(\pi))f(\pi/e_h)d\pi \geq \int v(W^{(n-1)}(\pi))f(\pi/e_h)d\pi$$

can be rewritten as follows

$$\int v(W^n(\pi))f(\pi/e_h)d\pi - g(e_h) \geq \overline{u}$$

In general, insurer n will solve the following problem

$$\max_{W^n(\pi)-W^{(n-1)}(\pi)} - \int \left(W^n(\pi) - W^{(n-1)}(\pi)\right) f(\pi/e_h)d\pi$$

subject to

$$\int v(W^n(\pi))f(\pi/e_h)d\pi - g(e_h) \geq \overline{u} \qquad \text{(PC)}$$

$$\int v(W^n(\pi))f(\pi/e_h)d\pi - g(e_h) \geq \int v(W^n(\pi))f(\pi/e_l)d\pi - g(e_l) \qquad \text{(IC)}$$

$$\int \left(W^n(\pi) - W^{(n+1)}(\pi)\right) f(\pi/e_h)d\pi \geq \int W^n(\pi)f(\pi/e_l)d\pi - \phi\left[g(e_l) + \overline{u}\right] (10)$$

That is, he has to be sure that a) the agent accepts the contract, b) the agent has incentives to exert high effort, and c) the next insurer has no incentives to take the agent to low effort.

Notice that if

$$\int W^{(n+1)}(\pi)f(\pi/e_h)d\pi < \int w^{3rd}(\pi)(\pi)f(\pi/e_h)d\pi,$$

there is no $W^n(\pi)$ such that $\int \left(W^n(\pi) - W^{(n+1)}(\pi)\right) f(\pi/e_h)d\pi \leq 0$ and satisfies (10), (IC) and (PC). While, with $W^n(\pi) = w^{3rd}(\pi)$ the (PC) holds and both (IC) and (10) are fulfilled with inequality. Once more we know that this cannot happen in equilibrium. So the solution has to be such that

$$\int W^{n+1}(\pi)f(\pi/e_h)d\pi < \int W^n(\pi)f(\pi/e_h)d\pi < \int w^{3rd}(\pi)(\pi)f(\pi/e_h)d\pi \quad (11)$$

From inequality (11) with the fact that the last insurer is able to offer the second best contract, i.e., $W^N(\pi) = w^{2nd}(\pi)$, we know that every insurer makes positive profits. In particular the contract $W^N(\pi)$, $W^{N-1}(\pi)$, etc. are independent of the number of insurers. So the cost that the principal has to pay is increasing in the number of insurers. The idea is that the principal is giving a risky contract and the insurers are taking some of this risk away. The minimum level of risk that each player can give is increasing in the quantity of insurers left. Of course, neither the principal, nor any insurer will ever need to give a contract riskier than the third best.

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SETTING	Principal's contract	Principal's cost	Aggregate contract	Insurance contract?	Insurers' profits	Allocation of effort (Fig. 1)	Total Welfare
Sequential Offering (PIA)	Steeper than 2^{nd} best	2^{nd} best	Last insurer takes to 2^{nd} best	Yes (1)	Zero	As in standard case	Same as in standard case
Sequential Contracting Agent makes offer (PAAI)	Steeper than 2^{nd} best	2^{nd} best	Last insurer takes to 2^{nd} best	Yes (1)	Zero	As in standard case	Same as in standard case
Sequential Contracting Insurer makes offer (PAIA)	Steepness in between 2^{nd} and 3^{rd} best. (increasing in N)	Between 2^{nd} and 3^{rd} best (increasing in N)	Last insurer takes to 2^{nd} best	Yes (N)	Every insurer makes positive profits	Lower. For some economies move from high to low effort	Lower (because sometimes lower effort)
Free Entry	3^{rd} best	3^{rd} best	3^{rd} best	No	Zero	Even Lower. For even more economies move to low effort	Even Lower (lower effort + higher cost of high effort)

Table 1. Summary of results

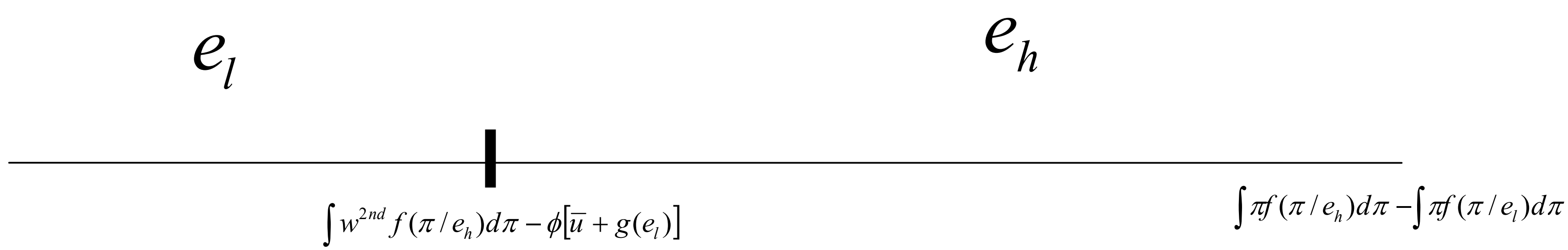

Figure 1A. Effort implemented in equilibrium: standard case, PIA, PAAI.

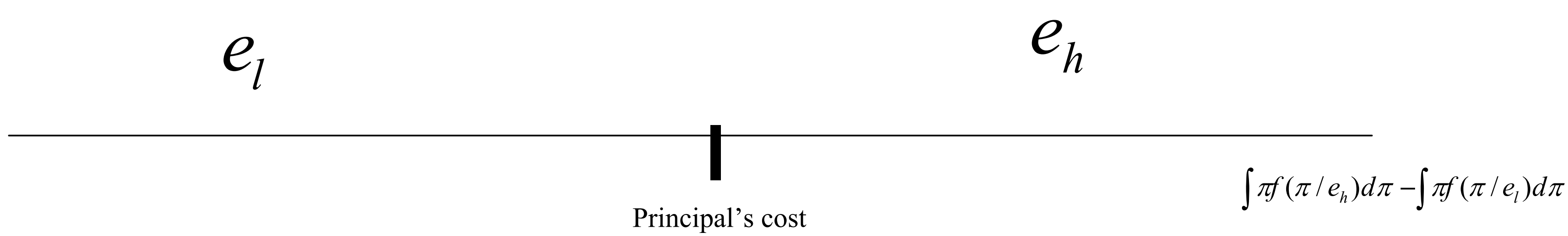

Figure 1B. Effort implemented in equilibrium: PAIA.

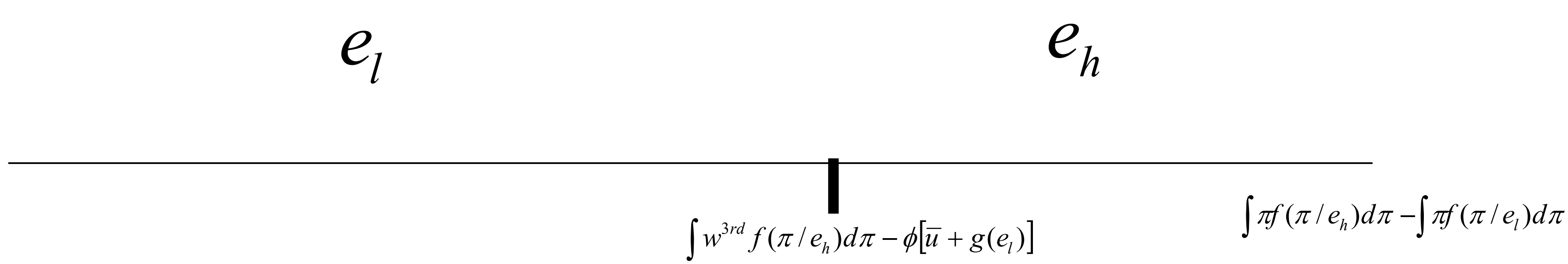

Figure 1C. Effort implemented in equilibrium: Free Entry.