Contracting with altruistic agents under moral hazard

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Abstract

In principal-agent settings with moral hazard, the fact that agents are altruistic vis-à-vis third parties —e.g. their family— modifies incentive costs. We derive sufficient conditions for the principal to benefit from altruism. They bear on how altruism affects the agent's marginal rate of substitution between monetary transfers and effort. We then characterize the optimal contracts allowing to screen agents under asymmetric information on their degree of altruism for additive separable utilities.

When two agents who are altruistic with respect to each other participate in a contractual relationship with two different principals, the outcomes in the two hierarchies become linked as in a common agency game. With public information on contracts and outcomes, and sequential contracting, the first principal cannot induce effort in equilibrium.

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1 Introduction

The theory of incentives usually consider agents in isolation from their environment, as if they were the only individuals affected by the contract. The environment of the agent may nevertheless play an important role. For instance, if a good sold to an agent is resold or duplicated, the

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optimal pricing becomes more complex.[1] Contrary to situations in which agents trade with each other to take advantage of arbitrage possibilities[2], we consider here that the utility of the agent involved in the contract *directly* depends on the welfare of the other agents, through altruism.

Little attention has been devoted to the indirect consequences for relatives, friends, members of some group, etc., of the participation of the agent in a contract. This paper focuses on the impact of the familial or affective situation of individuals on their contractual relationships with outsiders, and more particularly in moral hazard settings.

It is a regularity of empirical studies on labor economics that married workers are better paid than unmarried ones, *ceteris paribus.* The following results may provide an explanation for this fact, when married status is taken as a signal on one's degree of altruism for some third party (husband/wife). Wage differentials may then reflect the impact of altruism on the willingness of employees to undertake costly activities, or 'effort', in order to better perform their tasks.

To better see how altruism with respect to members of the family —interpreted in a large sense— may change the results from well-known models, let us briefly consider the theory of nutrition-based efficiency wages (Stiglitz, 1981). It applies to very poor regions, in which all revenues are used for food consumption, and under-nutrition prevents employees from working at full efficiency. Employers may choose to pay workers a higher wage than the subsistence level in order that they get a larger food intake, and therefore be more productive than if they nearly starve. But if increases in wages are spent on food for children, for instance, instead of on more food for the worker, his wage becomes unrelated to his physical fitness. The theory then breaks down: Employers should anticipate this and prefer to pay parent-workers no more than the subsistence wage. The predictions completely change since one may now observe higher wages for single individuals than for individuals in charge of a family; being without a family may even become a criteria for being hired.

[1] Laffont (2001) analyzes the problem of pricing for a public good when multiple consumption cannot be prevented (as for softwares or CDs that can be duplicated at a very low cost) and decisions within the group of potential users are taken according to majority voting. Bakas, Brynjolfson et Lichtman (1999) focus on the optimal tariff for information goods, that are shared by several individuals. Last, Jeon et Menicucci (2002) analyze how consumers may collude to react to second-degree price discrimination.

[2] See for instance Schroyen (2002) on individual taxation and the way it determines specialization within the household, when household members bargain with each other.

Another example is given by lending contracts: When there is moral hazard in the choice of the riskiness of a project, the fact that the borrower takes into account the utility of other individuals is relevant, since it will in general change his degree of risk aversion.

Brief outline We will focus here on a moral hazard setting in which the worker's utility depends on the utility of another individual, to which he can transfer resources. The objective is to describe how a principal (an employer) will adjust contracts so as to take this altruism into account, even though it concerns a third party. We derive conditions under which the principal benefits from the agent's altruism for such third parties, for a general functional form. The sufficient conditions obtained bear on the way in which altruism affects the marginal rate of substitution between money and effort. In particular, the principal always benefits from altruism when it increases the marginal value of monetary rewards for the agent, whatever the effect on his reservation utility. It is the case for separable utility functions for instance.

Assuming additive separability of the utility function, we characterize the contracts allowing to screen between altruistic and selfish agents under asymmetric information. An altruistic agent is less paid, and has therefore an incentive to understate his degree of altruism. The problem is a particular one with type-dependent reservation utilities, but where the shape of the utility function is also modified when the reservation utility changes. As a result, the optimal contract is quite specific. It may be stochastic (the selfish agent may receive a contract with a probability strictly less than one), especially when the degree of altruism of the more altruistic agent is high.

We also show that if the principal delegates two independent tasks to two agents, she prefers to contract with two independent agents, rather with agents who care for each other, assuming that their desutility of effort does not change. The fact that altruistic agents share their resources would indeed prevent her from designing wages so that each agent is rewarded as a function of his own performance only. When several principals contract sequentially and when there is public information on contracts and outcomes, one principal can benefit from insuring her agent from the variations in incomes due to the other contractual relationship. But this destroys incentives in the other hierarchy. This striking result particularly highlights the importance of taking into account the effects of altruism on incentives.

Related literature The literature dealing with related issues is extremely large but it does not exactly answer the questions we are interested in. Most papers study an altruistic principal 'contracting' with the individual (often selfish) for whom she cares. This paper adopts a different perspective, by focusing on the optimal contract for a selfish principal contracting with an agent whose altruism exclusively concerns some third party.

Becker (1974, 1975)'s Rotten-Kid theorem and Buchanan (1975)'s analysis of the Samaritan's dilemma, show that even selfish children may prefer to maximize the total welfare of the household when the family head is altruistic.[3] The subsequent literature has mainly considered the negative effect of gifts by altruistic individuals on the incentives of selfish receivers[4]. Gatti (2000) and Villanueva (2001) are two examples of this approach: In a model with uncertainty and moral hazard, they show how altruistic parents commit to under-insure their selfish children so as to induce effort from them. Villanueva, in addition, uses data from the 1988 wave of the US PSID (Panel Statistics of Income Dynamics) Data to calibrate and test his model. He finds that asymmetric information seems to explain parental transfers.[5]

Fernandes (2000) provides an interesting explanation for the numerous empirical studies that reject the hypothesis of altruism between household members. The tests used rely generally on the result that, under altruism, the allocation of consumption across household members should be independent form the distribution of resources. Yet, if one introduces an endogeneity of the resources, this result no longer holds. Fernandes considers endogenous labor: When effort is unobservable, consumption has to depend on the resources earned, for incentive purposes. This explanation seems to be consistent with the results from existing empirical tests. The employer is taken to be passive, and the focus is on the response from the household to potential internal incentive problems.

[3]Barro shows that altruism reinforces the Ricardian equivalence principle: Inter-generational transfers by the Government are countered by private inter-generational transfers, so that consumption becomes independent of this type of Government policies.

[4]See for instance Blanchet and Fleurbaey (2002)'s survey on altruism and the design of social insurance, or Laferrère and Wolff (2002) on microeconomic models of families. The main problem consists in preventing the agent from choosing socially dominated actions because of the perspective of gifts or insurance.

[5]One should note nevertheless that data on such transfers is quite rough since it only concerns the existence or not of transfers. Their size cannot be reliably estimated.

In contrast, we study here the effect of the altruism of an agent vis-à-vis a third party, and the way in which the principal can take advantage of it, even though she is not involved in the relationship between the agent and this third party.[6]

A major effect of altruism from the agent is that it changes the degree of risk aversion of the agent, once transfers to his spouse/children/etc. are taken into account. The link between risk aversion and the cost of incentives therefore matters for the determination of the benefits and costs of altruism for the principal.

When the agent is risk neutral, and not protected by limited liability, the cost of inducing effort is null. As soon as the worker is risk averse, on the other hand, incentive costs arise. Yet the relationship between risk aversion and incentive costs is more complex than it may appear from this observation. Grossman and Hart (1983) show that an increase in risk aversion increases the cost of inducing effort, but for specific utility functions, with two possible outcomes and a finite set of actions. Jullien, Salanié and Salanié (2001) demonstrate that the link between risk aversion and the power of incentives is quite complex, and non monotonic in a parameter of risk aversion. In order to isolate the effect of risk aversion, they use utility functions that are such that the marginal rate of substitution (MRS) between money and effort remains unchanged when one increases the parameter of risk aversion.

These results are not directly useful for our study: We are actually interested in the consequences of the degree of altruism on the MRS. Comparing different degrees of altruism will make us compare utility functions for which, not only the degree of risk aversion, but also the MRS between money and effort differs. This will be a crucial effect of altruism.

The remaining of the paper is organized as follows. Section 2 describes a simple moral hazard model, and Section 3 shows how incentives are affected by the fact that the agent derives a utility from the well-being of another individual and allocates resources to his/her welfare. Section 4

[6] An exception to the lack of analysis of the principal's best response is the article by Rotemberg (1994). It addresses the issue of whether an employer can benefit from altruism between workers. The problem differs nevertheless from the one we are interested in since this 'altruism' stems from the interdependence between workers' tasks and is endogenously chosen by the principal, when he decides to pay workers according to joint output, and not only according to the performance in their own task.

then considers how the principal may select agents according to their degree of altruism. Section 5 briefly shows how multi-agent problems change when the agents care for each other. Sequential multi-principal issues with public outcomes are introduced in Section 6. Section 7 concludes.

2 A simple moral hazard model with altruism

2.1 The household

Consider two individuals, A and B. A is altruistic and cares for B, and may participate in some contract offered by a principal.

The utility of agent A is taken to be separable between effort and monetary rewards. The utility obtained from monetary reward t depends on the utility level of the other individual, u^B. It is represented by a von Neumann-Morgenstern function $u^A(t, u^B)$. Function $u^A(.,.)$ is concave in its first argument and increasing in both arguments. We do not specify the sign of $u^A_{12}(t, u^B)$: Altruism may increase or decrease the marginal utility from monetary rewards.

The utility of member B will be represented by the von Neumann-Morgenstern concave utility function $u^B(.)$. We will not consider altruism on B's part as long as B remains passive, in order to clarify the exposition. A simple example of altruism by both individuals is given in subsection 2.3. In addition, Section 5 introduces symmetric altruism between A and B.

2.2 The moral hazard game

A principal delegates the implementation of some project to agent A. The project can either be successful and yield a high return $S > 0$, or fail and yield 0. This outcome is verifiable.

Effort is discrete (0 or 1). If agent A exerts a high effort, $e = 1$, he incurs a private desutility of effort ψ and the probability that the project be successful is p_1. If he shirks on the other hand, and exerts effort $e = 0$ only, he incurs no desutility but the probability of success falls to $p_0 < p_1$. Effort is not observable by the principal. It is known, on the other hand, by the other member of the household. Expected total utility for agent A is $\mathbf{E}_e u^A(t, u^B) - \psi e$.

The timing of the game is the following:

1. The principal offers a contract specifying a transfer $\bar{t}$ in case of success and $\underline{t}$ in case of failure[7].

2. Agent A chooses whether to participate in the contract.

3. If the contract offer has been accepted, agent A exerts some level of effort e.

4. The uncertainty over the outcome realizes and agent A is paid according to this outcome. He then transfers some amount x to B.

2.3 Exploiting altruism: An illustration

Let us move away from the main model, in this subsection only, to illustrate how altruism can affect the allocation of effort and resources. The illustration we suggest here turns out to be a simple variation on the 'Prodigal Son'[8]. Consider a benevolent 'Father', who maximizes the sum of the welfare of his two children, A and B, putting equal weight on both. Their welfare depends on the amount of effort[9] (in housework, farm work, education) that both produce, e_A and e_B. The characteristics of that effort are as before: Effort can take two values, 0 and 1, and effort 1 costs a desutility $\psi > 0$.

As long as the children are young enough, the father has authority on them and can require a certain amount of effort to be undertaken. Contrary to the following sections, incentive and participation do not matter here. The father allocates a limited amount R to the children (transfers t_A and $t_B = R - t_A$).

Each child's utility function exhibits altruism for the other in an additive separable way:

$$\begin{aligned} U^A &\equiv u(t_A, e_A + e_B) + \alpha U^B - \psi e_A, \\ U^B &\equiv u(t_B, e_A + e_B) + \beta U^A - \psi e_B, \end{aligned}$$

[7]This is the best the principal can do.

[8]In the Biblical story, a hard-working, caring son remained with his parents while his prodigal brother went away spending all the money he could find. The surprise in the story is that the father welcomes the prodigal son on his return with open hands, literally killing the fat calf for him, something he never did for the caring son ...

[9]Effort is not necessary here to obtain that one child will obtain larger transfers than the other, but we want to emphasize that effort may be less costly to provide when the agent is more altruistic.

with $\alpha > 0$ and $\beta > 0$. We assume that child A is more altruistic than child B: $\alpha > \beta$. The utility functions can be rewritten as

$$\begin{aligned} U^A &= \frac{u(t_A, e_A + e_B) + \alpha u(R - t_A, e_A + e_B) - \psi(e_A + \alpha e_B)}{1 - \alpha\beta}, \\ U^B &= \frac{u(R - t_A, e_A + e_B) + \beta u(t_A, e_A + e_B) - \psi(e_B + \beta e_A)}{1 - \alpha\beta}. \end{aligned}$$

Equalization of the marginal utilities of the two children is thus not equivalent to equal treatment. If it is preferable to exert effort in only one task, A will be asked to exert it, not B.

Moreover, whatever the effort levels required from each child, the transfers received by A and B will be determined by $\frac{u_1(t_A, e_A+e_B)}{u_1(R-t_A, e_A+e_B)} = \frac{1+\alpha}{1+\beta} > 1$. Hence, $t_A < t_B$. Due to the separability of the utility functions in the desutility of effort and the absence of any participation and incentive compatibility constraints, this sharing rule does not compensate one agent for exerting more effort than the other.

Note that the cost of the desutility of his own effort increases for each agent, since the other suffers from it, to an extent determined by his parameter of altruism. Yet, with the separable form we use here, the increase in the weight of effort is identical to the increase in the weight of the other components of the utility of the individual, his own monetary revenues and the utility from one's brother, so the weight of the cost of effort *relative* to the benefits of money remains unchanged: The marginal rate of substitution between monetary rewards and own effort for one brother is not affected by the degree to which this brother is altruistic.

The next sections are concerned with the impact of altruism on optimal contracts when the principal has to ensure participation and to give incentives to effort. We first describe the benchmark case in which altruism plays no role, before turning, in Section 3, to contracting with an altruistic agent.

2.4 The benchmark of an 'individualistic' agent

Let us briefly describe the outcome when agent A is the only member in his household — or does not care for anyone else. The utility function of the agent is $u^A(t, 0)$, strictly concave in

t. Let us normalize $u^A(0,0)$ to zero.[10]. The setting is then the one of Holmström and Tirole (1997) in its simplest version.

If the principal does not wish to induce a high effort level, she just satisfies the participation constraint of the agent. She will fully insure him (here, $\bar{t} = \underline{t} = 0$).

Assume on the other hand that the principal wants to induce a high effort ($e = 1$) from the agent. The incentive compatibility constraint to be met is the following:

$$p_1 u^A(\bar{t}, 0) + (1 - p_1) u^A(\underline{t}, 0) - \psi \geq p_0 u^A(\bar{t}, 0) + (1 - p_0) u^A(\underline{t}, 0),$$

which can also be written as

$$(p_1 - p_0)(u^A(\bar{t}, 0) - u^A(\underline{t}, 0)) \geq \psi.$$

The difference between the utility levels obtained by the agent in case of success and in case of failure must be large enough, so that the increased probability of getting a high transfer, instead of a low one, compensates for the cost of effort.

The optimal transfers from the point of view of the Principal, $\bar{t}^i$ and $\underline{t}^i$, are obtained by having the incentive compatibility and participation constraints binding:

$$\begin{aligned} u^A(\underline{t}^i, 0) &= \frac{-p_0 \psi}{p_1 - p_0} \\ u^A(\bar{t}^i, 0) &= \frac{(1 - p_0)\psi}{p_1 - p_0}. \end{aligned}$$

The cost of giving incentives to the agent is crucially linked to his degree of risk aversion. A risk-premium has to be given up to a risk averse agent in order to compensate him for the variability in his pay-off needed to induce effort. The principal ultimately bears this risk premium.

The expected welfare of the principal is, when she prefers to induce effort:

$$p_1 S - p_1 \bar{t}^i - (1 - p_1)\underline{t}^i.$$

As soon as the agent is strictly risk averse, this level is lower than the first best level, $p_1 R - \psi$ —which corresponds to the case of verifiability of effort e.

[10]Note that this normalization does not imply strong restrictions on the way in which altruism affects welfare since $u^B(0)$ may not equal zero, and $u^A(t, u^B(0)) \neq u^A(t, 0)$ in general.

3 Altruism and the cost of providing incentives

Let us now consider an 'altruistic' agent A who cares for the utility level obtained by B and transfers some amount x to B. We assume in this section that the resources that B may have are non transferable.

3.1 The sharing rule

In order to determine the optimal incentive contract from the point of view of the principal, we first need to compute the reaction of individual A to monetary incentives, and in particular how A will share his wage with individual B.

Agent A will choose the amount x transferred to B so as to maximize his own utility, subject to the constraint that x has to be positive. The first order condition of the unconstrained maximization program yields the sharing rule (SR):

$$u_1^A(t-x, u^B(x)) = u^{B\prime}(x) u_2^A(t-x, u^B(x)) \quad (SR).$$

Denoting $\hat{x}(t)$ the solution to the unconstrained program, the actual solution is $x(t) \equiv \max\{0, \hat{x}(t)\}$. We will omit the argument when there is no risk of confusion.

The marginal utility of individual B is equalized to the marginal cost for agent A of the transfer to B, weighted by the marginal utility that A derives from an increase in B's welfare. As could be expected, the larger this last term $(u_2^A(t-x, u^B(x)))$, the higher the intra-household transfer x (since $u_1^A(.,.)$ is decreasing).

One can show that $\frac{dx}{dt} \geq 0$: The larger the wage received by A, the larger the amount he transfers to B.

Let us denote by $\tilde{u}(t)$ the utility derived by individual A from a transfer t when the subsequent optimal sharing rule is taken into account:

$$\tilde{u}(t) = \max_x u^A(t-x, u^B(x)).$$

This function is important since it is the one the principal should use to compute the actual utility obtained by the agent when accepting the contract and choosing his effort level.

One can notice that we always have $\tilde{u}(t) \geq u^A(t, u^B(0))$, whatever the value of wage t. The possibility of transferring resources to B increases the utility derived by A from a given monetary wage. It is as if the agent had access to two different technologies to 'produce well-being', one corresponding to spending directly on oneself, and the other using individual B as an intermediary.[11]

3.2 The optimal incentive contract with altruism

A principal that anticipates this sharing of resources and the resulting increase in utility from which agent A benefits will offer a contract specifying transfers $(\bar{t}^a, \underline{t}^a)$ in case of success and failure, respectively, so as to have both the incentive compatibility and participation constraints binding —since the problem is still separable in the desutility of effort, ψ. These constraints are similar to the ones for an individualistic agent except that the utility function of agent A has to be replaced by $\tilde{u}(.)$.

Altruism changes utility levels for a given couple (t, e), and in particular the reservation utility: The reservation utility of an altruistic agent is $u^A(0, u^B(0))$, which may be larger or lower than $u^A(0, 0) = 0$. It will be positive when the sheer existence of B increases the welfare of A, but negative on the other hand, if A suffers from the lack of resources of B —in other words, being a family may help you through bad times, but you may also find poverty and hunger more difficult to bear if your family is also suffering from them.

If the existence of individual B increases the utility of agent A even when no transfer is received $(u^A(0, u^B(0)) > 0)$, the latter will be less willing to accept contracts. On the other hand, a negative utility level of the other agent when no transfer occurs, $u^A(0, u^B(0)) < 0$, makes agent A willing to accept contracts that give only a negative expected utility level. In other words, if agent A suffers more from lack of resources on behalf of B than on his own, his participation constraint will be less demanding than when he is individualistic. He will obtain a lower utility level, but this does not imply that the minimum transfers he must receive are also lower (the utility function considered being different).

[11]For instance, if $u^B(0) \geq 0$, then $\tilde{u}(t) \geq u^A(t, u^B(0)) \geq u^A(t, 0)$: An altruistic individual is necessarily happier than an individualistic one when receiving the same transfer.

A second effect of altruism is that it affects the relative substitution between money and effort, and therefore the cost for the principal of inducing a given effort level.

The optimal contract from the point of view of the principal can be computed exactly as in the individualistic case, but using $\tilde{u}(.)$ to represent the preferences of the agent. To induce effort at the lowest cost, the principal solves the following problem:

$$\begin{array}{lll} \max\limits_{(\underline{t},\bar{t})} & p_1 S - [p_1\bar{t} + (1-p_1)\underline{t}] & \\ \text{s.t.} & p_1\tilde{u}(\bar{t}) + (1-p_1)\tilde{u}(\underline{t}) - \psi \geq \tilde{u}(0) & (IR)^a \\ & (p_1 - p_0)(\tilde{u}(\bar{t}) - \tilde{u}(\underline{t})) - \psi \geq 0 & (IC)^a. \end{array}$$

Both constraints are binding in equilibrium, and the optimal transfers $\underline{t}^a$ and $\bar{t}^a$ are characterized by:

$$\begin{aligned} \tilde{u}(\underline{t}^a) &= \frac{-p_0\psi}{p_1 - p_0} + \tilde{u}(0) \\ \tilde{u}(\bar{t}^a) &= \frac{(1-p_0)\psi}{p_1 - p_0} + \tilde{u}(0). \end{aligned}$$

a - The impact of the degree of altruism

In order to assess the impact of more or less altruism, let us consider the following family of functions: $u^A(t, \alpha u^B)$, where $\alpha > 0$ is a measure of the degree to which individual A cares for B. This form allows to isolate the effect of an increase in the weight associated with the welfare of individual B. We need to isolate it from the interdependence in $u^A(.,.)$ between resources and the utility derived from the utility of B. This necessity will become clear in the next Proposition.

It is straightforward that the intra-household transfer $x(t)$ is an increasing function of α. The method used to compare the cost for the principal of contracting with an agent of degree of altruism α rather than $\alpha' > \alpha$ is given in Appendix A.1.2. Let us denote by $\bar{t}$ and $\bar{t}'$ the transfers in case of success for a degree of altruism α and α' respectively. $\underline{t}$ and $\underline{t}'$ will denote the same transfers in case of failure.

The sign of $\underline{t}' - \underline{t}$ is that of $-\int_0^{\underline{t}} \frac{\partial u_1^A(y - x(y), \hat{\alpha} u^B(x(y)))}{\partial \alpha} dy$. Moreover, $\frac{\partial u_1^A(y - x(y), \alpha u^B(x(y)))}{\partial \alpha} = u^B(x(y)) u_{12}^A(y - x(y), \alpha u^B(x(y)))$. The same result can be obtained for the transfer in the good state of nature, $\bar{t}$. Although the sharing rule gives some information on $x(t)$, it does not enable us to determine the sign of $u_{12}^A(y - x(y), \alpha u^B(x(y)))$ (see appendix A.1).

If $u^A_{12}(.,.)$ is a positive function, the principal is always better off dealing with a more altruistic agent (in the sense of a higher parameter α): A higher α then indeed corresponds to a larger increase in the marginal utility from monetary transfers for the agent, making effort less costly to induce.

Proposition 1 *The principal is better off when contracting with a more altruistic agent if the following two inequalities are satisfied (condition $(\mathcal{A}_1)$):*

$$
\begin{aligned}
\int_0^{\underline{t}} u^B(x(y))u^A_{12}(y - x(y), \alpha u^B(x(y)))dy &\geq 0 \\
\int_0^{\bar{t}} u^B(x(y))u^A_{12}(y - x(y), \alpha u^B(x(y)))dy &\geq 0.
\end{aligned}
$$

A more stringent sufficient condition for the transfers paid by the principal to decrease with altruism is that altruism increases the marginal utility from monetary transfers:

$$u^B u^A_{12}(y, u^B) \geq 0 \text{ for all } (y, u^B).$$

If $u^B(0) \geq 0$, then $u^B(x) \geq 0$ for all $x \geq 0$. Then, $u^A_{12}(y, u^B(x)) \geq 0$ is a sufficient condition. For a positive $u^B(0)$, an altruistic agent is necessarily happier than an individualistic one receiving the same transfer. An increase in the marginal utility from transfers when altruism increases (a positive cross derivative $u^A_{12}(.,.)$) means that the marginal rate of substitution between money and effort decreases when the agent is more altruistic. Hence the result on the principal's welfare. It should be noted that it also means that the two components of the agent's utility function are complements, which we can interpret as less risk aversion, in a situation similar to consumption of multiple goods.

The sign of this cross derivative cannot be posited *a priori*. Indeed, a negative sign means that the richer the agent becomes, the more selfish he becomes, a situation that cannot be ruled out. On the other hand, a positive sign can also be justified: An individual who is extremely poor will be more focused on his own survival, and may care relatively more for the resources he keeps than when he is richer —and 'can afford' to care more for others.[12]

[12]Notice that the fact that the marginal utility of money for the agent is decreasing implies only that a richer agent will give more to individual B: $x(t)$ increases with t. But this is independent from the sign of the cross derivative $u^A_{12}(.,.)$.

The conditions given above are sufficient but not necessary, since they implies that the transfers for a more altruistic agent are lower than for a less altruistic one for *both* outcomes, while it would be enough that their expectation be lower, for the principal to benefit from altruism.

b - Altruism versus individualism

Let us now compare the cost of inducing effort for an altruistic agent, and for a fully individualistic one. The methodology is the same as above (the detail is in Appendix A.1.2.). We obtain

$$\int_0^{\underline{t}^a} [u_1^A(y - x(y), u^B(x(y))) - u_1^A(y, 0)]dy + \int_{\underline{t}^a}^{\underline{t}^i} u_1^A(y, 0)dy = 0$$
$$\int_0^{\bar{t}^a} [u_1^A(y - x(y), u^B(x(y))) - u_1^A(y, 0)]dy + \int_{\bar{t}^a}^{\bar{t}^i} u_1^A(y, 0)dy = 0.$$

A sufficient condition for the principal to prefer dealing with an altruistic rather than an individualistic agent is the following:

$$\begin{aligned}\int_0^{\underline{t}^a} [u_1^A(y - x(y), u^B(x(y))) - u_1^A(y, 0)]dy &\geq 0\\ \int_0^{\bar{t}^a} [u_1^A(y - x(y), u^B(x(y))) - u_1^A(y)]dy &\geq 0.\end{aligned}$$

More stringent sufficient conditions are given below.

Proposition 2 *The principal is better off when contracting with an altruistic agent, rather than an individualistic one, when*

$$u_1^A(y - x(y), u^B(x(y))) \geq u_1^A(y, 0) \quad \textit{on} \quad [0, \bar{t}^a].$$

It is also guaranteed by: $u^B(0) \geq 0$ *and* $u_{12}^A(y, u^B(x))$ *positive for* $(y, x) \in \Re_+^2$.

The intuition is simple and parallels the one for the previous Proposition: The fact that individual A is altruistic modifies his marginal rate of substitution between money and effort. When $u_1^A(y - x(y), u^B(x(y))) \geq u_1^A(y, 0)$, the existence of individual B increases the marginal utility from transfer for A (as when $u_{12}^A(.,.)$ is positive), and giving monetary incentives to incur the desutility of effort becomes less costly for the principal.

Note that the effect of altruism on the principal's welfare is very simple to compute when the utility functions $\tilde{u}(.)$ and $u^A(.,0)$ cross only once. The principal benefits from altruism when $u^A(.,.)$ crosses $u^A(.,0)$ from *below* for some transfer t_0 lower than $\underline{t}$. Obviously the transfers $\underline{t}$ and $\bar{t}$ are endogenous. But in some cases, t_0 is far outside the relevant range of transfers, so this result may still be useful.

3.3 Additive separability

It is obvious that if $u^A_{12}(y,v) = 0$ for all (y,v), then condition $(\mathcal{A}_1)$ is satisfied. The utility of individual B then only plays a 'level effect' for agent A and will not affect directly the trade-off between money and effort. But since the agent transfers some of her monetary rewards to B, the marginal utility derived from the transfer becomes higher. Let us consider this case in more detail.

Let us assume here that the utility function of agent A, $u^A(.,.)$ is perfectly separable in its two arguments: $u^A_{12}(t,u^B) = 0$ for all (t,u^B). We consider the following separable function:

$$u^A(t,u^B) \equiv h(t) + \alpha u^B,$$

where $h(t) \equiv u^A(t,0)$, α is a strictly positive parameter measuring the degree to which individual A cares for the welfare of B.

The optimal amount $x(t)$ transferred from A to B given a transfer t paid by the principal satisfies the following condition:

$$u^{A\prime}(t-x) = \alpha u^{B\prime}(x).$$

The minimal level of utility that the principal must offer to induce participation in the contract is now $\tilde{u}(0) = \alpha u^B(0)$. Solving the problem faced by the principal yields the transfers she will offer, characterized by:

$$\begin{aligned} \tilde{u}(\underline{t}^a) &= \alpha u^B(0) - \tfrac{p_0\psi}{p_1-p_0} &= \alpha u^B(0) + h(\underline{t}^i) \\ \tilde{u}(\bar{t}^a) &= \alpha u^B(0) + \tfrac{(1-p_0)\psi}{p_1-p_0} &= \alpha u^B(0) + h(\bar{t}^i). \end{aligned}$$

One can immediately check the following result:

Proposition 3 *The principal is always better off dealing with a more altruistic agent when altruism intervenes in a separable way.*

The transfers in both states are decreasing in α. By definition, $\tilde{u}(\underline{t}^a) = \alpha u^B(0) + h(\underline{t}^i) \leq \tilde{u}(\underline{t}^i)$, hence $\underline{t}^a < \underline{t}^i$. The same reasoning yields $\overline{t}^a < \overline{t}^i$.

The fact that A cares for the welfare of B and chooses the optimal amount transferred between them implies that A always derives a (weakly) higher utility level from the same transfer as a less altruistic agent. The principal always has the incentive and participation constraints binding whatever the degree of altruism of her agent, and the transfer to offer to obtain this result is the smaller, the more altruistic the agent is. It is striking that this result does not depend on the shape of the utility function of agent B, nor on the reservation level $u^B(0)$, nor on the degree of risk aversion induced by caring for the other. This comes from the fact that A is risk neutral vis-à-vis B's utility, so that altruism always decreases risk for A, due to the sharing effect. This insurance property guarantees that an altruistic agent is better off than an individualistic one for a given schedule of transfers.

3.4 The case of a risk neutral agent

Until now, we have assumed that A was strictly risk averse. The principal takes thus advantage of both the intrinsic utility coming from the welfare of the other individual, and the insurance properties of exchange within the household. Let us now assume that A is risk-neutral with respect both to transfers and to the utility level of B.

This is equivalent to risk neutrality with respect to transfers, and altruism intervening in an additively separable way: $u^A(t, u^B) = at + \alpha u^B$, with $a > 0$, $\alpha > 0$. Assuming $\alpha > 0$, agent A will perfectly insure B by providing a constant transfer $\hat{x}$ such that $u^{B\prime}(\hat{x}) = \frac{a}{\alpha}$, provided $-a\hat{x} + \alpha u^B(\hat{x}) \geq u^B(0)$. We will assume that this condition is satisfied (otherwise, no transfer takes place, and the analysis is straightforward). The incentive compatibility constraint is given by $(p_1 - p_0)a(\overline{t} - \underline{t}) \geq \psi$ and is independent from the degree of altruism of the agent. Altruism affects exclusively the participation constraint: $a[p_1\overline{t}^a + (1-p_1)\underline{t}^a - \hat{x}] - \psi + \alpha(u^B(\hat{x}) - u^B(0)) \geq 0$. The derivative of the left hand-side with respect to α is $u^B(\hat{x}) - u^B(0)$, which is positive: The participation constraint becomes easier to satisfy with more altruism. The principal therefore benefits from more altruism.

If a limited liability constraint states that transfers have to be above some level y, the analysis depends on whether it is more stringent than the participation constraint. If it is the case, the principal becomes indifferent as to the degree of altruism of her agent, since the relevant constraints, the incentive compatibility constraint and the limited liability one are therefore independent from the degree of altruism.

4 Altruism and the selection of agents by employers

From the previous results, we know that the principal benefits from dealing with a more altruistic agent, when altruism intervenes in an additive separable way. The question of the selection of agents thus naturally arises. If the principal knows the type of agent she faces, she can offer a different contract to altruistic and individualistic agents, and these contracts are the ones defined above. If she cannot observe the type of the agent, these contracts may not lead to an efficient self-selection of agents.

We will focus on the case of additive separability. This guarantees that the principal benefits from contracting with a more altruistic agent, under complete information on the agent's degree of altruism. A 'natural ordering' of agents arise, under complete information, from the point of view of the principal. The agent can either be 'altruistic', with probability $\nu \in]0,1[$ (his parameter of altruism is $\overline{\alpha} \equiv \alpha$) or 'individualistic', with probability $1-\nu$ (his parameter of altruism is then $\underline{\alpha} \equiv 0 < \alpha$).

4.1 The screening problem

Under perfect information on the agent's type, the more altruistic agent receives a lower transfer than the less altruistic one. An altruistic agent has therefore incentives, under asymmetric information, to mimic an individualistic one (the more altruistic agent is the 'good' type). For more clarity, we will denote in this section by $\overline{t}^k_{FI}$ and $\underline{t}^k_{FI}$ the transfers given to an agent of type k, $k = a, i$, under full information on his type (these are the transfers defined in 2.4. for an individualistic type, i, and in 2. for an altruistic type, a).

Since the principal cannot distort quantities (there is only one contract to be signed), it is logical to consider stochastic contracts, in addition to pooling and exclusion of one type. The principal can indeed use contracts, in which the agent first makes a report on his type, and then obtains the contract corresponding to his report with some pre-specified probability, that we will denote by ρ^k, $k = a, i$.

The principal must thus choose the probability that each type obtains a contract, ρ^i and ρ^a for an individualistic and an altruistic type respectively, the transfers in the contract for an altruistic agent, $\bar{t}^a$ and $\underline{t}^a$, and the transfers for an individualistic agent, $\bar{t}^i$ and $\underline{t}^i$. She must satisfy participation constraints, and incentive compatibility constraints to guarantee that the agent will exert a high effort, and that he will truthfully reveal his type. The principal's general program can be written as:

$$\max_{\rho^i,\rho^a,\bar{t}^a,\underline{t}^a,\bar{t}^i,\underline{t}^i} \quad (\rho^a\nu + \rho^i(1-\nu))p_1 S - \nu\rho^a[p_1\bar{t}^a + (1-p_1)\underline{t}^a] - (1-\nu)\rho^i[p_1\bar{t}^i + (1-p_1)\underline{t}^i]$$

$$\text{s.t.} \qquad p_1 h(\bar{t}^i) + (1-p_1)h(\underline{t}^i) - \psi \geq 0 \quad (IR)^i$$

$$p_1\tilde{u}(\bar{t}^a) + (1-p_1)\tilde{u}(\underline{t}^a) - \psi \geq \tilde{u}(0) \quad (IR)^a$$

$$(p_1 - p_0)[h(\bar{t}^i) - h(\underline{t}^i)] - \psi \geq 0 \quad (IC)^i_e$$

$$(p_1 - p_0)[\tilde{u}(\bar{t}^a) - \tilde{u}(\underline{t}^a)] - \psi \geq 0 \quad (IC)^a_e$$

$$\rho^i[p_1 h(\bar{t}^i) + (1-p_1)h(\underline{t}^i) - \psi] \geq \rho^a[p_1 h(\bar{t}^a) + (1-p_1)h(\underline{t}^a) - \psi] \quad (IC)^i_R$$

$$\rho^a[p_1\tilde{u}(\bar{t}^a) + (1-p_1)\tilde{u}(\underline{t}^a) - \psi] \geq \rho^i[p_1\tilde{u}(\bar{t}^i) + (1-p_1)\tilde{u}(\underline{t}^i) - \psi] \quad (IC)^a_R$$

$$\rho^i[p_1 h(\bar{t}^i) + (1-p_1)h(\underline{t}^i) - \psi] \geq \rho^a[p_0 h(\bar{t}^a) + (1-p_0)h(\underline{t}^a)] \quad (IC)^i_{\{R,e\}}$$

$$\rho^a[p_1\tilde{u}(\bar{t}^a) + (1-p_1)\tilde{u}(\underline{t}^a) - \psi] \geq \rho^i[p_0\tilde{u}(\bar{t}^i) + (1-p_0)\tilde{u}(\underline{t}^i)] \quad (IC)^a_{\{R,e\}}.$$

We show in the appendix that constraints $(IC)^i_{\{R,e\}}$ and $(IC)^a_{\{R,e\}}$ are implied by the other constraints, and that incentive constraints relative to effort have to be binding.

In this problem, the minimum gap between transfers in case of success and transfers in case of failure is thus determined by incentive compatibility constraints with respect to effort. The level of transfers, on the other hand, must satisfy, not only participation constraints, but also incentive compatibility constraints with respect to truthful revelation of the degree of altruism. We can now focus on this revelation issue.

One should note that the welfare of the principal is linear in the probability that a type obtains a contract. Hence, the solution will be 'bang-bang' with respect to these probabilities. We first compute the solution for deterministic contracts. This highlights the possible benefits of reducing one of these probabilities. We then turn to the possibility of using stochastic contracts.

4.2 Deterministic contracts

Let us first consider that the contract offered by the principal is deterministic and entails full participation of both types. We do not consider exclusion for the moment. Stochastic contracts will indeed offer a better way of reducing rents than fully excluding one type, as we will see in the next subsection.

The adverse selection problem faced by the principal entails type-dependent reservation utilities: The altruistic agent has a higher reservation utility than the individualistic one, when $\tilde{u}(0) = \alpha u^B(0)$ is strictly larger than zero. We need to compare this reservation utility to the information rent an altruistic agent can get by mimicking an individualistic one, in order to know whether the participation constraint is more stringent than the incentive compatibility constraint with respect to revelation.

Let us denote by Δ^i the benefit for an altruistic agent of mimicking an individualistic one. We have:

$$\Delta^i = p_1\tilde{u}(\bar{t}^i_{FI}) + (1-p_1)\tilde{u}(\underline{t}^i_{FI}) - \psi > 0.$$

Low reservation utility of the altruistic type

As long as $\alpha u^B(0)$ is lower than Δ^i, the participation constraint of an individualistic type, $(IR)^i$, and the revelation constraint for an altruistic type, $(IC)^a_R$ are binding in equilibrium. The individualistic type obtains a null expected utility, while the altruistic type obtains an information rent exactly equal to what he would obtain by mimicking the individualistic one: $p_1\tilde{u}(\bar{t}^a) + (1-p_1)\tilde{u}(\underline{t}^a) - \psi = \Delta^i = p_1\tilde{u}(\bar{t}^i_{FI}) + (1-p_1)\tilde{u}(\underline{t}^i_{FI}) - \psi$.

The transfers for the altruistic type are therefore higher than under complete information, contrary to the transfers for the individualistic agent. In order to lessen the incentive of the altruistic agent to lie on his type, the principal would like to decrease the transfers received by the individualistic agent below their full information level. But this is obviously not feasible, since these transfers were the minimum levels that were compatible with the participation and effort incentive compatibility constraint of the individualistic agent. The principal is therefore not able to play on them to decrease the information rent of the altruistic agent. This observation justifies considering stochastic contracts.

One has to check that the individualistic type still finds it unattractive to mimic the altruistic one, now that the altruistic one obtains transfers that are higher than the full information ones. All constraints are satisfied with $\bar{t}^a = \bar{t}^i_{FI}$ and $\underline{t}^a = \underline{t}^i_{FI}$. This implies that the principal cannot actually benefit from screening agents: She has to give the same transfers to both types of agents.

High reservation utility of the altruistic type

Let us consider now that $\alpha u^B(0)$ is higher than Δ^i. The participation constraints are then binding for both types. The revelation incentive compatibility constraints are not relevant here. This implies that the transfers are identical to the ones the principal would have chosen under full information on the agent's type.

Remember that the altruistic type always obtain lower transfers, under full information, than the individualistic one ($\Delta^a \leq 0$). The individualistic type therefore never has to incentive to mimic him when $\alpha u^B(0)$ is high[13].

Result 1 *Assume $\alpha u^B(0) \geq \Delta^i$. The principal can separate the two types with a deterministic contract offering the full information transfers for each type.*

4.3 Stochastic contracts

Decreasing the probability with which the altruistic type receives a contract, ρ^i, may then be a way of making it less attractive for the altruistic type to pass himself as individualistic, in the case in which revelation incentive compatibility constraints matter ($\alpha u^B(0) < \Delta^i$). We focus on this case in what follows.

By choosing a value of ρ^i below one, the principal reduced the expected benefit, for an altruistic agent, of mimicking an individualistic one, to $\rho^i \Delta^i$. There is no value in decreasing

[13]From the definition of $\tilde{u}(.)$, $p_1\tilde{u}(\bar{t}^a_{FI})+(1-p_1)\tilde{u}(\underline{t}^a_{FI}) = \alpha u^B(0) \geq p_1[h(\bar{t}^a_{FI})+\alpha u^B(0)]+(1-p_1)[h(\underline{t}^a_{FI})+\alpha u^B(0)]$. Hence, $p_1 h(\bar{t}^a_{FI}) + (1-p_1)h(\underline{t}^a_{FI}) \leq 0$.

it below $\alpha u^B(0)$, since the level of the expected transfers for the altruistic type would then be determined by this participation constraint. Since the objective of the principal is linear in ρ^i, it is thus better either to have $\rho^i = 1$, or to have ρ^i such that the revelation incentive compatibility constraint of the altruistic agent becomes no more costly than his participation constraint: $\rho^i = \frac{\alpha u^B(0)}{\Delta^i}$.

The cost of using such stochastic contracts, and decreasing the probability that a type obtains a contract, is that the principal looses a beneficial transaction with some probability. The expected cost, $\mathcal{C}$, of decreasing ρ^i to $\frac{\alpha u^B(0)}{\Delta^i}$ is

$$\mathcal{C} \equiv \Big(1 - \frac{\alpha u^B(0)}{\Delta^i}\Big)(1-\nu)[p_1 S - (p_1 \bar{t}^i_{FI} + (1-p_1)\underline{t}^i_{FI})].$$

One should note that this cost is decreasing in the degree of altruism, α, and in the probability that the agent be altruistic, ν.

This cost has to be compared to the expected benefit, $\mathcal{B}$ of decreasing the altruistic agent's rent: The expected utility of the altruistic agent is decreased by $\Delta^i - u^B(0)$, and the transfers he receives are now the full information transfers for an altruistic type, $(\bar{t}^a_{FI}, \underline{t}^a_{FI})$, instead of the full information transfers for an individualistic one, $(\bar{t}^i_{FI}, \underline{t}^i_{FI})$. The benefit of choosing $\rho^i = \frac{\alpha u^B(0)}{\Delta^i}$ is therefore

$$\mathcal{B} \equiv \nu[p_1(\bar{t}^i_{FI} - \bar{t}^a_{FI}) + (1-p_1)(\underline{t}^i_{FI} - \underline{t}^a_{FI})].$$

The expected benefit is increasing in ν, and in the difference between the full information transfers for an individualistic and an altruistic type —which is itself increasing in the degree of altruism, α.

To summarize,

Proposition 4 • *Assume $\alpha u^B(0) \leq \Delta^i$. When $\mathcal{B} < \mathcal{C}$, the optimal contract is deterministic and entails pooling: Transfers are $(\bar{t}^i_{FI}, \underline{t}^i_{FI})$ for both types.*

When $\mathcal{B} \geq \mathcal{C}$, on the other hand, the optimal contract is stochastic: The principal will offer the individualistic type transfers $(\bar{t}^i_{FI}, \underline{t}^i_{FI})$ together with a probability of getting a contract equal to $\frac{\alpha u^B(0)}{\Delta^i}$; the altruistic type then receives transfers $(\bar{t}^a_{FI}, \underline{t}^a_{FI})$, and obtains a contract with certainty.

The principal is more likely to prefer a stochastic contract when the degree of altruism of the altruistic type, α, and when the probability of this type, ν, increase.

- *Assume now that $\alpha u^B(0) > \Delta^i$. Then the principal can offer the full information transfers and perfectly screen the two types of agents.*

5 Contracting with several members from the same household

May it be beneficial for the principal to hire two individuals who care for each other —for instance the members of the same household— to execute two independent tasks, rather than have them done by two independent individuals, also altruistic but vis-à-vis an unknown third person? When both members are hired by the same principal in order to execute independent tasks, if monetary rewards are transferable, the utility of each agent will *de facto* depend not only on the outcome on his task, but also on the outcome for the task performed by the second agent.

The framework is the same as in Section 2, except that the principal may now implement two projects, that are independent from one another (success in one is not related to success in the other) and have the same characteristics. We focus moreover on additive separable utility functions, i.e. on a situation in which the principal benefits from altruism when he contracts with one agent only.

a - Hiring independent altruistic workers

Let us first consider the case of two independent and identical workers, who each care for some third party. To facilitate comparisons, we assume that they care in a separable way for a third party, who has the same utility function for money as their own, $h(.)$, and with $\alpha = 1$ (the workers care as much for the utility of the 'significant' other as for their own). Then, each worker will share equally his monetary reward with the person he cares for, obtaining from a transfer t a utility of $2h(\frac{t}{2})$ (which is larger than $h(t)$ from the concavity of $h(.)$).

The principal offers two independent contracts, similar to the ones described in Section 3, and obtains an expected welfare of

$$W^{Ind.} \equiv 2p_1S - p_1h^{-1}\Big(\frac{(1-p_0)\psi}{2(p_1-p_0)}\Big) - (1-p_1)h^{-1}\Big(\frac{-p_0\psi}{2(p_1-p_0)}\Big).$$

b - Hiring altruistic members from the same household

Assume now that the two workers care for one another. Then, their utility will depend not only on the wages paid by the principal but also on the way in which they share them. Wages are then split evenly within the household, given our assumptions on the utility function.

Hence, a reward scheme that is robust to intra-household transfers necessarily gives the same wage to both agents in each state of nature, where the state of nature is defined by the outcome for both projects —and not for one project only, as in the case of independent agents. When one agent is successful and not the other, it is useless to give them different wages, since redistribution will occur anyway. Since in addition the two tasks are perfectly symmetric, the principal will *de facto* offer three different wages to each agent: $\bar{t}$ when both projects succeed, $\hat{t}$ when only one succeeds, and $\underline{t}$ when both fail. Since the two agents receive the same wage in all states of nature, there is no longer room for insurance in equilibrium.

For such a sharing of resources between agents to occur without destroying effort incentives, it is necessary that the expected wage of an insured agent when he exerts effort be higher than when he does not. The following constraint must therefore be satisfied:

$$(p_1-p_0)[p_1(h(\bar{t})-h(\hat{t}))+(1-p_1)(h(\hat{t})-h(\underline{t}))] \geq \psi.$$

The principal faces a problem similar to multi-tasking with a single agent.[14]

It is optimal in this situation to offer a high reward only when both projects succeed, and to give the same low wage when at least one project has failed, regardless of the outcome for the other project. In this case, the incentive compatibility constraint stated above becomes:

$$(p_1^2-p_0^2)(h(\bar{t})-h(\underline{t})) \geq \psi.$$

[14]Notice that in a general setting, the principal is restricted in the instruments she can use, since she is not able to discriminate between the two states of nature in which only one project succeeds. Here however, this does not constitute a true restriction due to the symmetry of the tasks and utility functions. The principal suffers additional costs if she is even more restricted: Consider for a moment an institutional constraint that prevents employers from making the wages of one employee depend on the outcome of a task in which he has no responsibility. Then necessarily, $\hat{t} = \frac{\bar{t}+\underline{t}}{2}$, an additional, and costly, restriction.

The optimal contract entails the following transfers:

$$\begin{aligned}
\hat{t} &= \underline{t} \\
h(\underline{t}) &= \frac{-p_0^2}{p_1^2 - p_0^2}\psi \\
h(\bar{t}) &= \frac{1 - p_0^2}{p_1^2 - p_0^2}\psi.
\end{aligned}$$

c - Individualistic agents insuring each other

Let us consider the case of two individualistic agents who are able to insure each other, under Nash bargaining with equal bargaining power. If they decide to insure each other, they will equalize their marginal utility in each possible state of nature by sharing equally the sum of their wages. Since the principal can anticipate this sharing and controls all the resources shared, we can, without loss of generality, restrict attention to mechanisms that induce no transfer between agents.

The remaining of the analysis is identical to the case of agents who are altruistic vis-à-vis one another.

With additive separability of the utility function, the insurance effect is independent from the intrinsic utility derived from the existence of the other individual. The optimal contract with insurance, which is also the optimal contract with agents from the same household, actually involves no transfer between agents, and was therefore available to the principal when contracting with independent agents unable to insure each other. Since it was not optimal, it necessarily yields a lower welfare to the principal than the optimal contract without insurance.

d - The choice of agents by the principal

Proposition 5 *Even if tasks are independent, a principal who contracts with two agents who care for each other will not be able to make the reward of a given individual depend on his performance only. The optimal contract entails the same transfers as if the two agents were not altruistic vis-à-vis one another, but were insuring each other.*
Moreover, the principal will always (weakly) prefer to contract with independent agents rather than with altruistic agents from the same household.

A principal would therefore prefer his workers not to become friends, in this particular setting[15], since they would then insure each other for altruistic reasons.

There exists a *discontinuity* between different degrees of altruism: No altruism at all between the two agents is preferred, since then no transfer sharing occurs —unless they can insure each other— but if they are altruistic, and even for a parameter α very close to zero, inducing effort is less costly when altruism increases, as for a single agent. This can easily be understood by noticing that the case of altruistic agents from the same household is formally similar to multitasking for a single agent.

A parallel result is the one obtained by Bandiera et al. (2004): Their empirical study shows that absolute (e.g., piece-rate) incentives yields a productivity 50% higher at least than relative incentives (where wages depend on others' performance). Workers indeed seem to internalize the negative effect of their own productivity on others' wages, and the more so when a larger proportion of their co-workers are close friends. Friendship can be associated to altruism, but without resource transfers in the case considered.

In practice, it is likely that the desutility of effort changes when the task is performed in the same location as the individual the agent cares for. One could assume that the desutility of effort for each worker decreases when he works together with his/her 'significant other', or more generally with friends. Assume that it then takes value $\hat{\psi} < \psi$. The effect of a lower desutility of effort — relaxing the participation and incentive constraints — could then offset the insurance effect described above.

Notice that here, agents obtain the same expected utility, zero, whatever the identity of their co-worker. But this result is incomplete. In order to rigorously analyze the difference in welfare from the point of view of an agent, and not only of the principal, we would need to compare the expected utility when both individuals work from the same principal to their utility when they work for different principals. We cannot directly use the previous results on independent workers, since it is implicitly assumed in the case of independent workers that the individual for whom each agent cares, does not undertake any risky activity. Comparing the two cases would

[15]This would obviously not be true if cooperation between workers mattered, or if the desutility of effort depended on the type of relationships with one's co-workers.

introduce a bias, since contracting with the same principal would necessarily imply an increase in risk, compared to having one agent in a non risky activity.

The next section is an attempt at providing a better understanding of the situation in which each of the two individuals who care for each other is engaged in a risky contractual activity.

6 Strategic behavior of multiple employers

Let us assume that each of the two individuals who are altruistic with respect to each other — e.g. each member of the household— is employed by a different principal, principal P^A for agent A and P^B for agent B. Even if the tasks, a and b, are completely independent, the structure of the problem becomes similar to common agency with moral hazard, since the transfer given by one principal affects the utility level obtained by the agent of the other principal. Altruism creates an indirect externality between the two principals.

We consider here a 'Stackelberg' game in which one employer, say principal P^B, acts first, and cannot condition transfers on the outcome in the other hierarchy. The timing[16] is the following:

1. Principal P^B offers a contract to agent B, who then accepts or refuses it.
2. Principal P^A then offers a contract to A, who can also choose to accept or refuse it.
3. If an agent has accepted a contract, he fulfills his obligations.
4. The outcome for task b is observed, and B is paid by P^B.
5. The outcome for task a is observed, A is paid by P^A, and the total payment is shared by A and B.

We assume that agent B must be paid before agent A, so that P^B cannot use contracts contingent on A's wage.

The contract concerns the same type of stochastic production as before, with discrete unobservable effort levels, 0 or 1, and respective desutilities of effort 0 and $\psi > 0$. The projects are

[16]Since the contract offered by P^B is accepted or refused before principal P^A' contract offer is known, P^B cannot take advantage of the subsequent relationship between agent A and P^A in his dealings with B.

independent and identically distributed, each yielding a verifiable benefit of S in case of success to the principal, and 0 otherwise.

To simplify the analysis, we assume that altruism appears in an additive separable way and that both agents have the same degree of altruism, $\alpha = 1$. This implies equal sharing of total resources by the two agents.

One should note that the situation is identical to a common agency game with a single, non altruistic agent, whose utility function would be $U(t^A, t^B) = 2u(\frac{t^A+t^B}{2})$.

The results depend strongly on whether each principal can observe the contract offered by the other principal and the outcome of the corresponding task. We will focus on the case of public outcomes — the case of private outcomes is sketched in Appendix A.4.

6.1 The second-stage contract

Let us assume for the moment that principal P^A prefers to induce effort from the agent (the other case is straightforward).

If agent B has refused the contract offered by principal P^B, the problem is a standard principal-agent problem for principal P^A, except that a transfer t_A yields utility $2u(\frac{t_A}{2})$ to the agent[17]. The reservation utility of the agent is $2u(0) = 0$. The optimal contract gives a null expected utility to agents A and B.

If on the other hand, B has accepted the contract offered to him, principal P^A takes as given the distribution of his earnings.

Principal P^a can observe and contract on the outcome of the task performed on behalf of the other principal. She should offer four different transfers, t^A_{ab} when both tasks succeed, t^A_a when only task a succeeds, similarly t^A_b when only b succeeds, and t^A_0 when both tasks fail (we will denote the transfer paid by principal P^B as $\bar{t}^B$ when tasks b succeeds, and $\underline{t}^B$ when it fails).

In a general framework, separating between four states of nature when two states are sufficient to obtain a sufficient statistic on the agent's effort has no value for incentive purposes: Since the tasks are independent, making the transfer of an agent depend on an unrelated factor increases in general the risk the agent bears, and therefore also the incentive costs. Here, however, principal

[17]Since $u(.)$ is strictly concave, $2u(\frac{x}{2}) > u(x)$.

P^A can use transfers that are differentiated according to the four states of nature so as to *insure* the agents against income shocks that do not depend from his effort. This is costless to the risk-neutral principal, and allows to obtain effort at a lower cost. Principal P^A has thus incentives to set transfers so that the agent's utility depend only on success in task A: $t^A_{ab}+\bar{t}^B = t^A_a+\underline{t}^B \equiv \overline{T}^A$ and $t^A_b + \bar{t}^B = t^A_0 + \underline{t}^B \equiv \underline{T}^A$. Using the incentive and compatibility constraints of agent A, one obtains $h(\frac{\overline{T}^A}{2}) = \frac{1-p_0}{p_1-p_0}\psi$ and $h(\frac{\underline{T}^A}{2}) = \frac{-p_0}{p_1-p_0}\psi$. The expected welfare of principal P^A is $p_1 S - [p_1\overline{T}^A + (1-p_1)\underline{T}^A] + [p_1\bar{t}^B + (1-p_1)\underline{t}^B]$, and increases with the transfers given by principal P^B.

Thus, there exists a strong conflict of interests between the two principals (even though there is no direct externality between them) since insurance by the second employer destroys the incentives to exert effort for the agent the first employer, P^B, contracts with. The first mover is here at a disadvantage.[18]

6.2 The first-stage contract

Principal P^B cannot induce effort, and will therefore offer a fixed transfer of 0 to her agent. Principal P^A then does not need to consider whether task b succeeds or not, and simply offers the standard contract[19] with two different transfers only, $\bar{t}_A$ and $\underline{t}_A$, such that $2u(\frac{\bar{t}_A}{2}) = \frac{1-p_0}{p_1-p_0}\psi$ and $2u(\frac{\underline{t}_A}{2}) = \frac{p_0}{p_1-p_0}\psi$.

Although the transfers received by agent A depend ex post only on the outcome in task a, the simple possibility for P^A to differentiate transfers according to more states, and therefore to counter the incentive scheme designed by the other principal, makes it impossible for P^B to induce effort.

Proposition 6 *When contracts and outcomes are public, in a situation of sequential contracting with either a common agent or agents who are altruistic vis-à-vis each other, the principal who acts as a follower may find it optimal to insure her agent with respect to variations in the wage*

[18]Note that this would not be true if the first mover was able to condition wages on the wage paid by the second principal to the other individual. in this case, we would be back to a situation of simultaneous contracting, as first examined, under moral hazard and complete information, by Bernheim and Whinston (1986).

[19]It would not, obviously, be an equilibrium if the game was simultaneous.

of the other agent. The principal who acts as Stackelberg leader then cannot induce effort in equilibrium.

This is a striking effect of altruism, since it differs completely from the outcome one would have in a game without altruism. Recognizing the role of the environment of the agent is here essential.

7 Conclusion

This paper has shown how a principal may benefit or lose from altruism when contracting with given agents, and how she may select agents under asymmetric information so as to maximize her welfare.

A large number of issues remains to be studied. First, it may be that the cost of effort is also affected by altruism. This may lead to less stark results for the case of additive separability. Considering a different desutility of effort seems particularly relevant in the case in which two altruistic agents contract with the same principal: They may enjoy working in the same area, for instance. It would also be useful to study the framework of the last two Sections with a non separable utility function. The case of multiple principals is obviously of importance, and much work is necessary to obtain clear insights in more complex situations than the Stackelberg game with public outcomes studied here.

Interesting applications of these theoretical results concern governmental programs. A major problem for Governments trying to establish development programs, in poverty reduction, education, health or fertility for instance, is their cost, due to imperfect adjustment of the monetary incentive to individuals' situations. Taking into account the altruism of members of the same household vis-à-vis one another might enable to decrease these monetary incentives while retaining their desirable properties.

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Appendix

A.1. The optimal incentive contract with altruism

A.1.1. The sharing rule

The first order condition of the maximization program that determines the amount transferred by A to B is:

$$-u_1^A(t-x,\alpha u^B(x))+\alpha u^{B'}(x)u_2^A(t-x,u^B(x))=0.$$

Since this relation has to be satisfied for any interior solution $x(t)$, we can differentiate it with respect to the first argument of the utility function of individual A, which gives:

$$\begin{aligned}&-u_{11}^A(t-x,\alpha u^B(x))+\alpha u^{B'}(x)u_{21}^A(t-x,\alpha u^B(x))\\&+\frac{dx}{dt}\Big[u_{11}^A(t-x,\alpha u^B(x))-2\alpha u^{B'}(x)u_{12}^A(t-x,\alpha u^B(x))+\alpha^2 u^{B''}(x)u_2^A(t-x,\alpha u^B(x))\\&+(\alpha u^{B'}(x))^2u_{22}^A(t-x,\alpha u^B(x))\Big]=0.\end{aligned}$$

From this, we obtain $\frac{dx}{dt}\geq 0$.

The second order condition[20] states that:

$$\begin{aligned}&u_{11}^A(t-x,\alpha u^B(x))-2\alpha u^{B'}(x)u_{12}^A(t-x,\alpha u^B(x))+\alpha^2u^{B''}(x)u_2^A(t-x,\alpha u^B(x))\\&+(\alpha u^{B'}(x))^2u_{22}^A(t-x,\alpha u^B(x))\leq 0,\end{aligned}$$

but this is not enough to determine the sign of $u_{12}^A(t-x,\alpha u^B(x))$ for the optimal sharing of resources.

A.1.2. The impact of the degree of altruism

More or less altruistic agents Let us compare the cost for the principal of contracting with an agent of degree of altruism α rather than $\alpha'>\alpha$.

First, using $'$ to denote the transfers corresponding to α', the optimal contracts entail:

$$\begin{aligned}u^A(\underline{t}-\underline{x},\alpha u^B(\underline{x}))-u^A(0,\alpha u^B(0))&=u^A(\underline{t}'-\underline{x}',\alpha' u^B(\underline{x}'))-u^A(0,\alpha' u^B(0))\\u^A(\overline{t}-\overline{x},\alpha u^B(\overline{x}))-u^A(0,\alpha u^B(0))&=u^A(\overline{t}'-\overline{x}',\alpha' u^B(\overline{x}'))-u^A(0,\alpha' u^B(0)).\end{aligned}$$

[20] The second order condition is satisfied under our assumptions on the concavity of utility functions.

Using for instance the first equality, and rewriting it as an integral, yields:

$$\int_0^{\underline{t}}[u_1^A(y-x(y),\alpha u^B(x(y)))-u_1^A(y-x'(y),\alpha' u^B(x'(y)))]dy=\int_{\underline{t}}^{\underline{t}'}u_1^A(y-x'(y),\alpha' u^B(x'(y)))dy.$$

The right-hand side is of the sign of $\underline{t}'-\underline{t}$. Determining the sign of the left-hand side therefore enables to find out if the principal prefers to contract with a more or less altruistic agent.

Using the envelope theorem, the equality becomes

$$\int_0^{\underline{t}}\int_{\alpha'}^{\alpha}\frac{\partial u_1^A(y-x(y),\hat{\alpha}u^B(x(y)))}{\partial\alpha}d\hat{\alpha}dy=\int_{\underline{t}}^{\underline{t}'}u_1^A(y-x'(y),\alpha' u^B(x'(y)))dy.$$

Hence, $\underline{t}'-\underline{t}$ is of the sign of $-\int_0^{\underline{t}}\frac{\partial u_1^A(y-x(y),\hat{\alpha}u^B(x(y)))}{\partial\alpha}dy$. Moreover, $\frac{\partial u_1^A(y-x(y),\alpha u^B(x(y)))}{\partial\alpha}=u^B(x(y))u_{12}^A(y-x(y),\alpha u^B(x(y)))$. The same result can be obtained for the transfer in the good state of nature, $\bar{t}$.

Altruistic versus individualistic agents In order to compare the cost of dealing with an altruistic agent with the cost of dealing with a totally individualistic agent, we use the same methodology as above:

The optimal contract that induces effort with altruism can be expressed as a function of the transfers paid to an individualistic agent:

$$\tilde{u}(\underline{t}^a)=u^A(0,u^B(0))+u^A(\underline{t}^i,0)$$
$$\tilde{u}(\bar{t}^a)=u^A(0,u^B(0))+u^A(\bar{t}^i,0)$$

This yields $\int_0^{\underline{t}^a}\tilde{u}'(y)dy=\int_0^{\underline{t}^i}u_1^A(y,0)dy$ and $\int_0^{\bar{t}^a}\tilde{u}'(y)dy=\int_0^{\bar{t}^i}u_1^A\prime(y,0)dy$. Since $\tilde{u}'(y)=u_1^A(y-x(y),u^B(x(y)))$ (using the envelope theorem), we obtain

$$\int_0^{\underline{t}^a}[u_1^A(y-x(y),u^B(x(y)))-u_1^A(y,0)]dy-\int_{\underline{t}^a}^{\underline{t}^i}u_1^A(y,0)dy=0$$
$$\int_0^{\bar{t}^a}[u_1^A(y-x(y),u^B(x(y)))-u_1^A(y,0)]dy-\int_{\bar{t}^a}^{\bar{t}^i}u_1^A(y,0)dy=0.$$

Hence the following sufficient condition for the principal to prefer dealing with an altruistic rather than an individualistic agent:

$$\int_0^{\underline{t}^a}[u_1^A(y-x(y),u^B(x(y)))-u_1^A(y,0)]dy \geq 0$$
$$\int_0^{\bar{t}^a}[uu_1^A(y-x(y),u^B(x(y)))-u_1^A(y,0)]dy \geq 0.$$

If $x(\underline{t}^a)$ is an interior solution ($x(\underline{t}^a) > 0$), then from the sharing rule, $u_1^A(\underline{t}^a - x(\underline{t}^a), u^B(x(\underline{t}^a)) = u_2^A(\underline{t}^a - x(\underline{t}^a), u^B(x(\underline{t}^a))u^{B\prime}(x(\underline{t}^a))$. On the other hand, since an individualistic agent will never transfer resources to B, we must have $u_1^A(t, 0) \geq u_2^A(t, 0)u^{B\prime}(0)$. Hence the sufficient condition given in the text implies, for an interior solution, $u_2^A(\underline{t}^a - x(\underline{t}^a), u^B(x(\underline{t}^a))u^{B\prime}(x(\underline{t}^a)) \geq u_2^A(t, 0)u^{B\prime}(0)$.

For an interior solution and a concave function $u^B(.)$, $u^{B\prime}(x(\underline{t}^a)) \leq u^{B\prime}(0)$, so that the previous condition can only be satisfied if $u_2^A(\underline{t}^a - x(\underline{t}^a), u^B(x(\underline{t}^a))$ is sufficiently larger than $u_2^A(t, 0)$.

A.2. Altruism and the selection of agents by employers

We consider below the case in which $\alpha u^B(0)$ is lower than Δ^i.

Let us denote by $U^a \equiv p_1\tilde{u}(\bar{t}^a) + (1 - p_1)\tilde{u}(\underline{t}^a) - \psi$ and $U^i \equiv p_1 h(\bar{t}^i) + (1 - p_1)h(\underline{t}^i) - \psi$ the expected utility obtained by each type when truthfully revealing his type and exerting effort.

The principal's program can be rewritten as:

$$\max_{\rho, \bar{t}^a, \underline{t}^a, \bar{t}^i, \underline{t}^i} \quad (\nu + \rho(1 - \nu))p_1 S - \nu[p_1\bar{t}^a + (1 - p_1)\underline{t}^a] - \rho(1 - \nu)[p_1\bar{t}^i + (1 - p_1)\underline{t}^i]$$

s.t.

$$U^i \geq 0 \quad (IR)^i$$

$$U^a \geq \alpha u^B(0) \quad (IR)^a$$

$$(p_1 - p_0)[h(\bar{t}^i) - h(\underline{t}^i)] - \psi \geq 0 \quad (IC)_e^i$$

$$(p_1 - p_0)[\tilde{u}(\bar{t}^a) - \tilde{u}(\underline{t}^a)] - \psi \geq 0 \quad (IC)_e^a$$

$$\rho U^i \geq U^a - p_1[\tilde{u}(\bar{t}^a) - h(\bar{t}^a)] + (1 - p_1)[\tilde{u}(\underline{t}^a) - h(\underline{t}^a)] \quad (IC)_R^i$$

$$U^a \geq \rho[U^i + p_1(\tilde{u}(\bar{t}^i) - h(\bar{t}^i)) + (1 - p_1)(\tilde{u}(\underline{t}^i) - h(\underline{t}^i))] \quad (IC)_R^a$$

$$\rho U^i \geq U^a - [p_1\tilde{u}(\bar{t}^a) - p_0 h(\bar{t}^a)] - [(1 - p_1)\tilde{u}(\underline{t}^a) - (1 - p_0)h(\underline{t}^a] + \psi \quad (IC)_{\{R,e\}}^i$$

$$U^a \geq \rho[U^i + p_0\tilde{u}(\bar{t}^i) - p_1 h(\bar{t}^i) + (1 - p_0)\tilde{u}(\underline{t}^i) - (1 - p_1)h(\underline{t}^i) + \psi] \quad (IC)_{\{R,e\}}^a.$$

One can show that the last two constraints are implied by the incentive compatibility constraints regarding effort only. Indeed, using $(IC)_e^a$ in $(IC)_{\{R,e\}}^i$ reduces it to

$$\rho U^i \geq U^a - p_0[\tilde{u}(\bar{t}^a) - h(\bar{t}^a)] - (1 - p_0)[\tilde{u}(\underline{t}^a) - h(\underline{t}^a)],$$

which is implied by $(IC)_R^i$.

And $(IC)^i_e$ and $(IC)^a_R$ imply $(IC)^a_{\{R,e\}}$ provided that $(IC)^a_e$ be binding in equilibrium: Constraint $(IC)^a_{\{R,e\}}$ can be rewritten as

$$\begin{aligned}(p_1 - p_0)[\tilde{u}(\overline{t}^i) - \tilde{u}(\underline{t}^i) - \tilde{u}(\overline{t}^a) + \tilde{u}(\underline{t}^a) &\geq 0 \\ \Leftrightarrow \quad [\tilde{u}(\overline{t}^i) - \tilde{u}(\underline{t}^i)] - [\tilde{u}(\overline{t}^a) - \tilde{u}(\underline{t}^a)] &\geq 0,\end{aligned}$$

which is equivalent to $[\tilde{u}(\overline{t}^i) - \tilde{u}(\underline{t}^i)] - [h(\overline{t}^i) - h(\underline{t}^i)] \geq 0$ when both $(IC)^i_e$ and $(IC)^a_e$ are binding. In the case we are considering, we have $\tilde{u}'(x) \geq h'(x)$ for all x. The inequality is therefore satisfied.

Since $(IC)^a_e$ will be binding in equilibrium, as is shown in the next paragraph, we can neglect the last constraint, $(IC)^a_{\{R,e\}}$.

Constraint $(IC)^a_R$ has to be binding in equilibrium (it is more demanding than the participation constraint, due to the assumption that $\Delta^i > \alpha u^B(0)$, and cannot be slack since it would be costly without reducing the cost of the other constraints). We can therefore express transfers $\overline{t}^a$ and $\underline{t}^a$ as functions of ρ, $\overline{t}^i$ and $\underline{t}^i$. These three parameters determine the expected value of the transfer of the altruistic type, but not the allocation of this expected value according to the state. This can be obtained by minimizing the cost for the principal of giving this expected value: If there was no incentive compatibility constraint $(IC)^a_e$, the principal would choose $\overline{t}^a = \underline{t}^a$. The incentive compatibility constraint with respect to effort must therefore be binding for the altruistic type.

We use the fact that the participation constraint of the individualistic type also has to be binding for an optimal contract, and the fact that the constraints are binding $(IC)^a_e$ and $(IC)^a_R$ to compute these transfers. Combining the following two equations,

$$p_1\tilde{u}(\overline{t}^a) + (1-p_1)\tilde{u}(\underline{t}^a) = \rho[p_1\tilde{u}(\overline{t}^i) + (1-p_1)\tilde{u}(\underline{t}^i) - \psi] \qquad (IC)^a_R$$

$$(p_1 - p_0)[\tilde{u}(\overline{t}^a) - \tilde{u}(\underline{t}^a)] = \psi \qquad (IC)^a_e,$$

yields a characterization of the transfers offered to an altruistic individual:

$$\begin{aligned}\tilde{u}(\overline{t}^a(\rho, \overline{t}^i, \underline{t}^i)) &= \rho[p_1\tilde{u}(\overline{t}^i) + (1-p_1)\tilde{u}(\underline{t}^i)] - \Big(\rho + \frac{p_1}{p_1 - p_0}\Big)\psi, \\ \tilde{u}(\underline{t}^a(\rho, \overline{t}^i, \underline{t}^i)) &= \rho[p_1\tilde{u}(\overline{t}^i) + (1-p_1)\tilde{u}(\underline{t}^i)] - \Big(\rho - \frac{p_0}{p_1 - p_0}\Big)\psi.\end{aligned}$$

The program of the principal can be rewritten as:

$$\begin{aligned}
\max_{\{\rho,\overline{t}^i,\underline{t}^i\}} \quad & [\nu+\rho(1-\nu)]p_1 S - \nu[p_1\tilde{u}^{-1}(\overline{t}^a(\rho,\overline{t}^i,\underline{t}^i)) + (1-p_1)\tilde{u}^{-1}(\underline{t}^a(\rho,\overline{t}^i,\underline{t}^i))] \\
& -\rho(1-\nu)[p_1\overline{t}^i + (1-p_1)\underline{t}^i] \\
\text{s.t.} \quad & (p_1-p_0)[h(\overline{t}^i) - h(\underline{t}^i)] \geq \psi \quad (IC)^i_e.
\end{aligned}$$

We denote by μ the Lagrange multiplier of $(IC)^i_e$ and $\mathcal{L}$ the corresponding Lagrangean. Replacing the rent obtained by an altruistic agent by its expression as a function of ρ, $\overline{t}^i$ and $\underline{t}^i$, the derivatives of the Lagrangean are:

$$\begin{aligned}
\frac{\partial \mathcal{L}}{\partial \overline{t}^i} &= \rho p_1\Big[-(1-\nu)p_1 + \nu\tilde{u}'(\overline{t}^i)\Big[p_1\frac{\tilde{u}'(\overline{t}^a)}{(\tilde{u}(\overline{t}^a))^2} + (1-p_1)\frac{\tilde{u}'(\underline{t}^a)}{(\tilde{u}(\underline{t}^a))^2}\Big]\Big] + \mu(p_1-p_0)h'(\overline{t}^i) \\
\frac{\partial \mathcal{L}}{\partial \underline{t}^i} &= \rho(1-p_1)\Big[-(1-\nu) + \nu\tilde{u}'(\underline{t}^i)\Big[p_1\frac{\tilde{u}'(\overline{t}^a)}{(\tilde{u}(\overline{t}^a))^2} + (1-p_1)\frac{\tilde{u}'(\underline{t}^a)}{(\tilde{u}(\underline{t}^a))^2}\Big]\Big] - \mu(p_1-p_0)h'(\underline{t}^i) \\
\frac{\partial \mathcal{L}}{\partial \rho} &= (1-\nu)[p_1 S - p_1\overline{t}^i - (1-p_1)\underline{t}^i] \\
& \quad -\nu[p_1\tilde{u}(\overline{t}^i) + (1-p_1)\tilde{u}(\underline{t}^i) - \psi]\Big[p_1\frac{\tilde{u}'(\overline{t}^a)}{(\tilde{u}(\overline{t}^a))^2} + (1-p_1)\frac{\tilde{u}'(\underline{t}^a)}{(\tilde{u}(\underline{t}^a))^2}\Big].
\end{aligned}$$

The last derivative shows that the solution in the probability ρ is bang-bang. Depending on its sign, ρ will be either $\frac{\alpha u^B(0)}{\Delta^i}$ or 1.

When the individualistic type is excluded with some probability ($\rho = \frac{\alpha u^B(0)}{\Delta^i} < 1$), the contract offered to the altruistic one is identical to the contract that it would receive if there were no imperfect information (or no individualistic type), since incentive compatibility for revelation does not matter any longer.

When both type participate ($\rho = 1$), the problem that arises is determining whether the effort incentive compatibility constraint $(IC)^i_e$ is binding. Assume it is not, so that $\mu = 0$. Then the two first equations imply:

$$\begin{aligned}
1-\nu &= \nu\tilde{u}'(\overline{t}^i)\Big[p_1\frac{\tilde{u}'(\overline{t}^a)}{(\tilde{u}(\overline{t}^a))^2} + (1-p_1)\frac{\tilde{u}'(\underline{t}^a)}{(\tilde{u}(\underline{t}^a))^2}\Big] \\
1-\nu &= \nu\tilde{u}'(\underline{t}^i)\Big[p_1\frac{\tilde{u}'(\overline{t}^a)}{(\tilde{u}(\overline{t}^a))^2} + (1-p_1)\frac{\tilde{u}'(\underline{t}^a)}{(\tilde{u}(\underline{t}^a))^2}\Big],
\end{aligned}$$

that is $\underline{t}^i = \overline{t}^i$, which does not satisfy the effort incentive compatibility constraint. $(IC)^i_e$ must therefore be binding.

A.3. Contracting with two altruistic agents

The optimal contract for a household

We can restrict attention to contracts such that agents do not need to redistribute transfers, i.e. contracts specifying the same payment to both agents in each state of nature. Denoting $\bar{t}$ the wage when both tasks succeed, $\hat{t}$ when one task only succeeds and $\underline{t}$ when both fail, we can rewrite the program of the principal as follows:

$$\begin{aligned}
\max_{\bar{t},\hat{t},\underline{t}} \quad & 2[p_1^2 S - p_1^2\bar{t} - 2p_1(1-p_1)\hat{t} - (1-p_1)^2\underline{t}] \\
\text{s.t.} \quad & 2[p_1^2 h(\bar{t}) + 2p_1(1-p_1)h(\hat{t}) + (1-p_1)^2 h(\underline{t})] \geq 2\psi \quad (IR) \\
& 2(p_1-p_0)[p_1(h(\bar{t})-h(\hat{t})) + (1-p_1)(h(\hat{t})-h(\underline{t}))] \geq \psi \quad (IC)^1 \\
& 2(p_1-p_0)[(p_1+p_0)(h(\bar{t})-h(\hat{t})) + (1-p_1+1-p_0)(h(\hat{t})-h(\underline{t}))] \geq 2\psi \quad (IC)^2,
\end{aligned}$$

where $(IC)^1$ and $(IC)^2$ are the incentive compatibility constraints preventing the agents from shirking in one and both tasks respectively.

To decrease the cost of incentives, the principal will set $\hat{t} = \underline{t}$. The two incentive compatibility constraints $(IC)^1$ and $(IC)^2$ become respectively $h(\bar{t}) - h(\underline{t}) \geq \frac{\psi}{2p_1(p_1-p_0)}$ and $h(\bar{t}) - h(\underline{t}) \geq \frac{\psi}{(p_1+p_0)(p_1-p_0)}$. Since $2p_1 > p_1 + p_0$, the second constraint is more stringent than the first. The optimal contract is therefore simply obtained by having (IR) and $(IC)^2$ binding, with $\hat{t} = \underline{t}$.

A.4. Multiple principals and private outcomes

The case of public outcomes has been studied in the text. The following briefly show the contracts that arise when outcomes are private.

* *The contract offered by the follower*

If principal P^A cannot observe the outcome of the task performed by agent B for the other principal, she cannot do better than offer some transfer $\bar{t}_A$ in case of success and $\underline{t}_A$ in case of failure. The incentive compatibility constraint that she has to satisfy is:

$$2(p_1-p_0)\Big[\mathbf{E}_{t_B} u\Big(\frac{\bar{t}_A + t_B}{2}\Big) - \mathbf{E}_{t_B} u\Big(\frac{\underline{t}_A + t_B}{2}\Big)\Big] \geq \psi \quad (IC)^A.$$

The reservation utility of agent A also depends on the contract accepted by B. The participation constraint is thus:

$$2p_1\mathbf{E}_{t_B}u(\frac{\bar{t}_A+t_B}{2})+2(1-p_1)\mathbf{E}_{t_B}u(\frac{\underline{t}_A+t_B}{2})\geq\psi+2\mathbf{E}_{t_B}u(\frac{t_B}{2})\quad (IR)^A.$$

In equilibrium, principal P^A has both constraints binding and offers transfers $\underline{t}_A$ and $\bar{t}_A$ that are functions of the distribution of t_B and satisfy:

$$\mathbf{E}_{t_B}u(\frac{\bar{t}_A+t_B}{2})=\frac{1-p_0}{2(p_1-p_0)}\psi$$
$$\mathbf{E}_{t_B}u(\frac{\underline{t}_A+t_B}{2})=\frac{-p_0}{2(p_1-p_0)}\psi.$$

As could be expected, both transfers are decreasing in the expected transfer from principal P^B.

* *The contract offered by the leader*

Let us denote by $\underline{t}_A(\bar{t}_B,\underline{t}_B)$ and $\bar{t}_A(\bar{t}_B,\underline{t}_B)$ the payment schemes that are solution to the second stage of the game.

The incentive compatibility constraint and the participation constraint faced by the first principal are:

$$\begin{aligned}&2(p_1-p_0)\{p_1\Big[u\Big(\tfrac{\bar{t}_A(\bar{t}_B,\underline{t}_B)+\bar{t}_B}{2}\Big)-u\Big(\tfrac{\bar{t}_A(\bar{t}_B,\underline{t}_B)+\underline{t}_B}{2}\Big)\Big]\\&+(1-p_1)\Big[u\Big(\tfrac{\underline{t}_A(\bar{t}_B,\underline{t}_B)+\bar{t}_B}{2}\Big)-u\Big(\tfrac{\underline{t}_A(\bar{t}_B,\underline{t}_B)+\underline{t}_B}{2}\Big)\Big]\}\geq\psi\qquad (IC)^B\\&2\{(p_1)^2u\Big(\tfrac{\bar{t}_A(\bar{t}_B,\underline{t}_B)+\bar{t}_B}{2}\Big)+p_1(1-p_1)\Big[u\Big(\tfrac{\underline{t}_A(\bar{t}_B,\underline{t}_B)+\bar{t}_B}{2}\Big)+u\Big(\tfrac{\bar{t}_A(\bar{t}_B,\underline{t}_B)+\underline{t}_B}{2}\Big)\Big]\\&+(1-p_1)^2u\Big(\tfrac{\underline{t}_A(\bar{t}_B,\underline{t}_B)+\underline{t}_B}{2}\Big)\}\geq\psi\qquad (IR)^B.\end{aligned}$$

The optimal contract has the standard shape:

$$p_1u\Big(\frac{\bar{t}_A(\bar{t}_B,\underline{t}_B)+\bar{t}_B}{2}\Big)+(1-p_1)u\Big(\frac{\underline{t}_A(\bar{t}_B,\underline{t}_B)+\bar{t}_B}{2}\Big)=\frac{1-p_0}{2(p_1-p_0)}\psi$$
$$p_1u\Big(\frac{\bar{t}_A(\bar{t}_B,\underline{t}_B)+\underline{t}_B}{2}\Big)+(1-p_1)u\Big(\frac{\underline{t}_A(\bar{t}_B,\underline{t}_B)+\underline{t}_B}{2}\Big)=\frac{-p_0}{2(p_1-p_0)}\psi.$$

By decreasing the wages she offers, principal P^B can force P^A to increase her own. She will therefore choose the smallest transfers for which principal P^A is still willing to offer a contract.

Contrary to the case of public outcomes, the Stackelberg leader of the game has an advantage here.

We also need to check whether principal P^B prefers P^A to induce effort or not. If P^A does not wish to induce effort, she is willing to pay up to p_0S as a constant transfer to obtain participation by the agent, assuming this agent to be the only one that can execute the task. In the second case, the expected transfer $p_1\bar{t}_A(\bar{t}_B, \underline{t}_B) + (1 - p_1)\underline{t}_A(\bar{t}_B, \underline{t}_B)$ must be lower or equal to $p_1 S$, or she prefers not to contract. But since the household bears more risk when both principals induce effort than when only the first one does, the fact that expected transfers are higher in the first case is not enough to guarantee that principal P^B is better off in this situation. This issue is complex and will not be resolved here, with the general utility function we have chosen.