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Conflicting Tasks and Moral Hazard: Theory and Experimental Evidence*

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Abstract
We study a multi-task principal-agent problem in which tasks can be in direct conflict with each other. In theory, it is difficult to induce a single agent to exert efforts in two conflicting tasks, because effort in one task decreases the success probability of the other task. We have conducted an experiment in which we find strong support for the relevance of this incentive problem. In the presence of conflict, subjects choose two efforts significantly less often when both tasks are assigned to a single agent than when there are two agents each in charge of one task.

Keywords: moral hazard; conflicting tasks; experiment
JEL Classification: D86; C90; M54

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1 Introduction

In real-world agency problems, it is often the case that principals have to delegate not just one but several tasks. In this paper we focus on situations in which two different tasks to be delegated may be in direct conflict with each other; i.e., providing effort in one task may have a negative side effect on the success probability of the other task.[1] In such situations, job design becomes a major issue. In particular, it might be the case that implementing effort in both tasks may be facilitated by hiring two different agents each in charge of one task instead of letting one agent be responsible for both tasks. In the present paper we investigate these incentive problems in a theoretical model and provide first experimental evidence that also in the laboratory, where fairness and reciprocity considerations matter, agents are indeed reluctant to perform different tasks when they are in conflict with each other.

To fix ideas, consider a merchant (principal) who wants to sell two products which may be imperfect substitutes. The merchant may hire either one or two sales representatives (agents) who can exert effort to promote the products. The effort decisions are assumed to be non-contractible, but the wages can depend on which products are sold. The agents are risk-neutral and have no wealth, so that the wages must be non-negative. There are no technological (dis-)economies of scope, so that in the absence of incentive problems, the principal would be indifferent between hiring one or two agents.

Suppose first that the merchant has only one sales representative in charge of both products. If the products are imperfect substitutes, then promotion effort in one task increases the probability of sale of the promoted product, but at the same time it lowers the probability of sale of the other product (i.e., there is conflict between the tasks). In contrast, if there is no relation between the products, promotion of one product has no effect on the probability of sale of the other product. We consider a symmetric situation such that in theory, when the products are unrelated (so that there is no conflict), the

[1] Examples of conflicting tasks abound in the real world. For instance, franchise companies that decide to open a new branch store in close proximity to their existing stores have to investigate carefully to which extent the opening of the new store will affect sales in the existing stores and whether overall company sales will increase. Moreover, when producers of consumer goods have related and competing products in their portfolio, they always have to consider that an advertising campaign for one product may cannibalize the sales levels of their related products.

principal induces either effort in both tasks or no effort at all. However, when there is conflict between the tasks, then it may be optimal for the principal to induce the agent to invest effort in only one task. Intuitively, if there is conflict between the two tasks, a single sales representative is very reluctant to exert effort in both tasks, because he knows that promotion effort does not only increase the probability of sale of the promoted product, but at the same time it also lowers the probability of sale of the other product he is supposed to sell. This makes it very expensive for the principal to induce two efforts.

Suppose next that there are two (identical) sales representatives, each of them responsible for promoting one product. Due to symmetry, in theory the principal induces either effort in both tasks or no effort at all, regardless of whether or not there is conflict.

In general, if there is conflict, it depends on the parameter constellation whether the principal's expected profit is larger with one or with two agents. Yet, if there is no conflict, then the principal's expected profit is unambiguously larger when only one agent is in charge of both tasks. Intuitively, when the tasks are not in conflict with each other, the rent that the principal leaves to the agent to motivate him to work on one task can also be used to motivate him to work on the other task.

In order to find an answer to our research question whether the theoretical incentive problem of inducing a single agent to simultaneously exert efforts in conflicting tasks is empirically relevant, we conducted a laboratory experiment with 474 subjects. There are two treatments with conflict; one where the principal has only a single agent and another one where she has two agents. We have chosen a parameter constellation such that according to standard theory, a merchant who has only one sales representative would induce him to invest effort in only one task, while a merchant with two sales representatives would induce each one to promote his respective product. Moreover, there are two treatments without conflict, one with a single agent and another one with two agents. The theoretical prediction for our parameter constellation is that in the absence of conflict, a merchant would always induce two efforts, regardless of whether she has only one or two sales representatives to perform these tasks.

One central finding of our experiment is that in the one-agent treatment with conflict, two efforts are chosen significantly less often than in the other three treatments. Hence, our experimental data provides strong support for the empirical relevance of the theoretically predicted incentive problem to motivate a single agent to provide efforts in conflicting tasks. However, even in the presence of conflict, a relevant fraction of agents still exerts two efforts. This happens mostly when a principal's wage offer is very generous. Thus, fairness and reciprocity may mitigate the incentive problem. Moreover, in contrast to the theoretical prediction, in the presence of conflict, the principals' average profit is slightly larger in the one-agent treatment than in the two-agent treatment. Two facts contribute to this result. First, the fraction of two efforts in the one-agent treatment with conflict is larger than theoretically predicted, and second, in the two-agent treatment, in sum the principal offers the agents more than in the one-agent treatment. Yet, with regard to the no-conflict treatments, we find significant support for the theoretical prediction that the principals' profits are larger in the case of one agent than in the case of two agents.

Since the seminal work of Holmström and Milgrom (1991), multi-task principal-agent problems have played a prominent role in the contract theoretic literature.[2] However, most of these papers have focused on effort substitution and the trade-off between insurance and incentives when agents are risk-averse. More recently, many authors have studied moral hazard models with risk-neutral but wealth-constrained agents.[3] In the latter framework, several authors have shown that a principal can save agency costs if she lets one agent be in charge of several tasks (see e.g. Hirao, 1993, Che and Yoo, 2001, Laux, 2001, and Mylovanov and Schmitz, 2008).[4] The potential benefits of separating tasks in sequential agency problems have been discussed by Hirao (1993), Schmitz (2005), and Khalil, Kim, and Shin (2006). The fact that conflicts between different tasks may explain why they are delegated to different agents ("advocates") has first been studied by Dewatripont and Tirole (1999). They analyze the optimality of organizing the judicial system in an incomplete contracting framework. The present paper is most closely related to a complete contracting variant of their model which is discussed in Bolton and Dewatripont (2005, Section 6.2.2). To the best of our knowledge, only a

[2]For surveys, see e.g. Dewatripont, Jewitt, and Tirole (2000), Laffont and Martimort (2002, ch. 5), and Bolton and Dewatripont (2005, ch. 6).

[3]See e.g. Innes (1990), Pitchford (1998), and Tirole (2001).

[4]See also Dana (1993) and Gilbert and Riordan (1995) who have found related results in other frameworks.

few experiments on multi-task principal-agent problems have been conducted so far. In particular, Fehr and Schmidt (2004) study a problem where one task is contractible and they focus on the pros and cons of piece-rate versus bonus contracts. Brüggen and Moers (2007) investigate the role of financial and social incentives in multi-task settings where agents choose an effort level and an effort allocation.

The remainder of the paper is organized as follows. The theoretical model which is based on Bolton and Dewatripont (2005) is analyzed in Section 2 and serves as a motivation for our experimental study. The experimental design is introduced in Section 3 and qualitative hypotheses are derived in Section 4. The experimental results are presented and discussed in Sections 5 and 6. Finally, concluding remarks follow in Section 7. All proofs are relegated to Appendix A.

2 The theoretical framework

Consider a principal who wants to sell a single unit of a product 1 and a single unit of a product 2. The sales level for a given product $i \in \{1,2\}$ is denoted by $q_i \in \{0,1\}$. If product i is sold, the principal obtains revenue $R > 0$. We consider two different scenarios. In the first scenario the principal employs a single agent to sell products 1 and 2, while she employs two agents in the other scenario. All parties are risk-neutral. An agent has no wealth and his reservation utility is zero. If there is only a single agent, he can exert effort $a_i \in \{0,1\}$ to promote product $i \in \{1,2\}$. In case that there are two agents, agent A can promote product 1 and agent B can promote product 2; i.e., A chooses $a_1 \in \{0,1\}$ and B chooses $a_2 \in \{0,1\}$. The effort levels are non-contractible.

Effort to promote product i *increases* the probability of sale of product i but (weakly) *lowers* the probability of sale of product $j \neq i$. In other words, there may be a direct conflict between the effort tasks when the products are imperfect substitutes. Formally, let the probability of sale of product i be given by $\Pr(q_i = 1) = \alpha + \rho a_i - \gamma a_j$. The base rate of sale of product i is $\alpha > 0$. If product i is promoted (i.e., $a_i = 1$), the probability of sale of product i increases by $\rho > 0$. If the other product $j \neq i$ is promoted (i.e., $a_j = 1$) and the products are imperfect substitutes, the probability of sale of product i decreases by $\gamma > 0$. When the products are unrelated ($\gamma = 0$), effort to promote one product has no effect on the probability of sale of the other product.

Throughout we assume that $\gamma \leq \alpha \leq 1-\rho$ to ensure that $0 \leq \alpha+\rho a_i-\gamma a_j \leq 1$ for any combinations of effort decisions a_1 and a_2. An agent has to incur effort costs ψ if he promotes a product i. Hence, product i generates an expected net surplus of $(\alpha + \rho a_i - \gamma a_j)R - a_i\psi$. Due to the symmetry of the model it is either efficient to promote both or no products. We assume $(\rho - \gamma) > \psi/R$ such that $(\alpha+\rho-\gamma)R- \psi > \alpha R$ which implies that the expected total surplus is maximized when both products are promoted (i.e., $a_1 = a_2 = 1$). Hence, if effort were verifiable, the principal would always implement two efforts. Yet, since in our setup effort is not contractible, to induce an agent to exert effort the principal can offer a wage scheme $w_{q_1q_2} := w(q_1, q_2)$ that is contingent only on which products have been sold.

One-agent scenario

Given that the principal has only one agent, she has to decide whether to induce promotion effort in both tasks, in only one task, or in no task.

Let us first consider the case where the principal wishes to induce effort in both tasks. The principal's problem is to minimize the expected compensation $E\left[w_{q_1q_2} \mid a_1 = a_2 = 1\right]$ she has to pay to her agent subject to the constraints $w_{q_1q_2} \geq 0$,

$$E\left[w_{q_1q_2} \mid a_1 = a_2 = 1\right] - 2\psi \geq E\left[w_{q_1q_2} \mid a_1 = 1, a_2 = 0\right] - \psi, \tag{IC 1}$$

$$E\left[w_{q_1q_2} \mid a_1 = a_2 = 1\right] - 2\psi \geq E\left[w_{q_1q_2} \mid a_1 = 0, a_2 = 1\right] - \psi, \tag{IC 2}$$

$$E\left[w_{q_1q_2} \mid a_1 = a_2 = 1\right] - 2\psi \geq E\left[w_{q_1q_2} \mid a_1 = a_2 = 0\right], \tag{IC 3}$$

$$E\left[w_{q_1q_2} \mid a_1 = a_2 = 1\right] - 2\psi \geq 0. \tag{PC}$$

The first two incentive compatibility constraints ensure that the agent prefers exerting two efforts to exerting only one effort and the third one ensures that the agent prefers exerting two efforts to exerting no effort. The last constraint ensures that the agent participates.

Lemma 1 *Suppose the principal wants to induce $a_1 = a_2 = 1$. Then she sets $w_{11} = \frac{2\psi}{(\alpha+\rho-\gamma)^2-\alpha^2}$ and $w_{10} = w_{01} = w_{00} = 0$. Given this wage scheme, the principal's expected profit is $\Pi_{hh} = (\alpha + \rho - \gamma)^2(2R - w_{11}) + 2(\alpha + \rho - \gamma)(1 - \alpha - \rho + \gamma)R$.*

Suppose next the principal wants to induce effort in only one task. Let us assume w.l.o.g. that the principal wants to induce effort with regard to product 1; i.e., the principal wishes to implement $a_1 = 1, a_2 = 0$. In this case the principal's problem is to minimize $E\left[w_{q_1q_2} \mid a_1 = 1, a_2 = 0\right]$ subject to the constraints $w_{q_1q_2} \geq 0$,

$$E\left[w_{q_1q_2} \mid a_1 = 1, a_2 = 0\right] - \psi \geq E\left[w_{q_1q_2} \mid a_1 = a_2 = 1\right] - 2\psi, \tag{IC 1}$$

$$E\left[w_{q_1q_2} \mid a_1 = 1, a_2 = 0\right] - \psi \geq E\left[w_{q_1q_2} \mid a_1 = 0, a_2 = 1\right] - \psi, \tag{IC 2}$$

$$E\left[w_{q_1q_2} \mid a_1 = 1, a_2 = 0\right] - \psi \geq E\left[w_{q_1q_2} \mid a_1 = a_2 = 0\right], \tag{IC 3}$$

$$E\left[w_{q_1q_2} \mid a_1 = 1, a_2 = 0\right] - \psi \geq 0. \tag{PC}$$

Lemma 2 *Suppose the principal wants to induce $a_1 = 1$ and $a_2 = 0$.*[5] *Then it is optimal for her to set $w_{10} = \frac{\psi}{\alpha\gamma+\rho(1-\alpha+\gamma)}$ and $w_{11} = w_{01} = w_{00} = 0$. Given this wage scheme, the principal's expected profit is $\Pi_{hl} = (\alpha+\rho)(\alpha-\gamma)2R + (\alpha+\rho)(1-\alpha+\gamma)(R-w_{10}) + (1-\alpha-\rho)(\alpha-\gamma)R$.*

Observe that if there is conflict and the principal wants the agent to promote product 1 only, then it is strictly optimal to pay the agent no wage in case that also product 2 is sold. The reason is that effort in task 1 reduces the probability of sale of product 2 and hence the sale of this product can be seen as a signal that the agent may not have promoted product 1. In contrast, if there is no conflict, a wage scheme with $w_{11} = 0$ is not the only solution. This is because then the sale of product 2 provides no signal for the effort level in task 1. Therefore, a positive wage w_{11} can be optimal as long as it does not induce the agent to promote product 2 as well. Specifically, it is easy to show that if $\gamma = 0$, then any wage scheme $0 \leq w_{11} \leq \frac{1+\rho}{\rho(\alpha+\rho)}\psi, w_{10} \geq 0, w_{01} = w_{00} = 0$ which satisfies $\alpha w_{11} + (1-\alpha)w_{10} = \frac{\psi}{\rho}$ is optimal.

Finally the principal could induce no effort at all. It is immediate to see that for this case the optimal wage scheme is simply given by $w_{11} = w_{10} = w_{01} = w_{00} = 0$. Then the principal's expected profit is $\Pi_{ll} = 2\alpha R$.

The preceding discussion immediately implies the following result.

Proposition 1 *(i) If $R > \frac{\psi(\alpha+\rho-\gamma)^2}{[(\alpha+\rho-\gamma)^2-\alpha^2](\rho-\gamma)}$ and $R > \frac{2\psi(\alpha+\rho-\gamma)^2}{[(\alpha+\rho-\gamma)^2-\alpha^2](\rho-\gamma)} - \frac{(\alpha+\rho)(1-\alpha+\gamma)\psi}{[\alpha\gamma+\rho(1-\alpha+\gamma)](\rho-\gamma)}$, then the principal induces effort in both tasks.*

[5] Note that due to the symmetry of the problem the principal's expected profit is the same if she implements $a_1 = 0$ and $a_2 = 1$.

(ii) If $\frac{(\alpha+\rho)(1-\alpha+\gamma)\psi}{[\alpha\gamma+\rho(1-\alpha+\gamma)](\rho-\gamma)} < R < \frac{2\psi(\alpha+\rho-\gamma)^2}{[(\alpha+\rho-\gamma)^2-\alpha^2](\rho-\gamma)} - \frac{(\alpha+\rho)(1-\alpha+\gamma)\psi}{[\alpha\gamma+\rho(1-\alpha+\gamma)](\rho-\gamma)}$, *then the principal induces effort in only one task.*

(iii) Otherwise the principal induces no effort.

It is obvious that the principal will induce promotion for both products if the return is sufficiently large. However for intermediate values of R, if there is conflict, the principal may prefer to induce effort in only one task. The reason is as follows. If the adverse effects of promotion efforts increase, the sale of two products provides weaker evidence that the agent has chosen to exert effort in both tasks, while the sale of only one product provides stronger evidence that the agent has exerted effort to promote this product. As a consequence, if the conflict between tasks increases, it becomes more expensive for the principal to induce the agent to promote both products, while it becomes less expensive to implement effort in only one task.

In contrast, if γ is sufficiently small (in particular, if there is no conflict), the principal will never implement effort in only one task; i.e., the condition in part (ii) cannot be satisfied.

Two-agent scenario

Given that the principal can employ two agents, she has to decide whether to induce both agents to exert effort, whether to provide only one agent with incentives or whether she prefers to induce no efforts at all. The principal will now offer a wage schedule $w^k_{q_1q_2} := w^k(q_1, q_2)$ with $k \in \{A, B\}$ to the agents. This means she will offer each agent one wage for each possible combination of q_1 and q_2.

Let us first assume the principal wishes to induce agent A to exert effort to promote product 1 and agent B to exert effort to promote product 2. The principal's problem is to minimize the sum of the expected compensation $E\left[w^A_{q_1q_2} + w^B_{q_1q_2} \mid a_1 = a_2 = 1\right]$ she has to pay to the agents subject to the constraints $w^k_{q_1q_2} \geq 0$,

$$E\left[w^A_{q_1q_2} \mid a_1 = a_2 = 1\right] - \psi \geq E\left[w^A_{q_1q_2} \mid a_1 = 0, a_2 = 1\right], \tag{IC A}$$

$$E\left[w^B_{q_1q_2} \mid a_1 = a_2 = 1\right] - \psi \geq E\left[w^B_{q_1q_2} \mid a_1 = 1, a_2 = 0\right], \tag{IC B}$$

$$E\left[w^A_{q_1q_2} \mid a_1 = a_2 = 1\right] - \psi \geq 0, \tag{PC A}$$

$$E\left[w^B_{q_1q_2} \mid a_1 = a_2 = 1\right] - \psi \geq 0. \tag{PC B}$$

The two incentive compatibility constraints ensure that each agent prefers to exert effort to promote his product and the participation constraints ensure that both agents will accept the offered wage scheme.

Lemma 3 *Suppose the principal wants to induce* $a_1 = a_2 = 1$. *Then she sets* $w_{10}^A = w_{01}^B = \frac{\psi}{(\alpha+\rho-\gamma)(1-\alpha-\rho+\gamma)-(\alpha-\gamma)(1-\alpha-\rho)}$ *and* $w_{11}^k = w_{00}^k = w_{01}^A = w_{10}^B = 0$. *Given this wage scheme, the principal's expected profit is* $\Pi_{hh}^{AB} = (\alpha+\rho-\gamma)^2 2R + 2(\alpha+\rho-\gamma)(1-\alpha-\rho+\gamma)(R - w_{10}^A)$.

Observe that if there is conflict, then the principal pays an agent a positive wage if and only if the agent was successful in selling his product while the other agent failed. The reason is that in the case of conflict, the failure of an agent to sell his product can be seen as an indication that the other agent has promoted his product, since promotion decreases the probability of sale of the competing agent's product. In contrast, if there is no conflict, a wage scheme with $w_{11}^k = 0$ is not the only one that can be optimal. This is because in the case of no conflict, the success or failure of one agent indicates nothing about the other agent's effort decision. In particular, if $\gamma = 0$, then any wage scheme with $w_{00}^k = w_{01}^A = w_{10}^B = 0$ such that $(1-\alpha-\rho)w_{10}^A + (\alpha+\rho)w_{11}^A = \frac{\psi}{\rho}$ and $(1-\alpha-\rho)w_{01}^B + (\alpha+\rho)w_{11}^B = \frac{\psi}{\rho}$ is optimal.

Suppose next the principal wants to induce effort in only one task. Let us assume w.l.o.g. that the principal wants to induce effort with regard to product 1; i.e., the principal wishes to implement $a_1 = 1, a_2 = 0$. It is obvious that in this case the principal will set $w_{q_1q_2}^B = 0$ for all possible combinations of q_1 and q_2 such that agent B will not exert effort. Hence, the principal's problem is to minimize $E\left[w_{q_1q_2}^A \mid a_1 = 1, a_2 = 0\right]$ subject to the constraints $w_{q_1q_2}^A \geq 0$,

$$E\left[w_{q_1q_2}^A \mid a_1 = 1, a_2 = 0\right] - \psi \geq E\left[w_{q_1q_2}^A \mid a_1 = a_2 = 0\right], \qquad \text{(IC A)}$$

$$E\left[w_{q_1q_2}^A \mid a_1 = 1, a_2 = 0\right] - \psi \geq 0. \qquad \text{(PC A)}$$

Lemma 4 *Suppose the principal wants to induce* $a_1 = 1$ *and* $a_2 = 0$. *Then it is optimal for her to set* $w_{10}^A = \frac{\psi}{\alpha\gamma+\rho(1-\alpha+\gamma)}$ *and* $w_{11}^A = w_{01}^A = w_{00}^A = w_{q_1q_2}^B = 0$. *Given this wage scheme, the principal's expected profit is* $\Pi_{hl}^{AB} = (\alpha+\rho)(\alpha-\gamma)2R + (\alpha+\rho)(1-\alpha+\gamma)(R - w_{10}^A) + (1-\alpha-\rho)(\alpha-\gamma)R$.

Also with two agents the principal could induce no efforts at all and as in the one-agent case this yields an expected profit of $\Pi_{ll}^{AB} = 2\alpha R$.

It is now straightforward to show that the following result holds.

Proposition 2 *(i) If* $R > \frac{\psi(\alpha+\rho-\gamma)(1-\alpha-\rho+\gamma)}{[\rho(1-\alpha-\rho)+\gamma(\alpha+\rho-\gamma)](\rho-\gamma)}$*, then the principal induces effort in both tasks.*

(ii) Otherwise the principal induces no effort.

Note that if the principal has two agents, then she will never induce only one agent to exert effort. This is obvious in the absence of conflict, because then there is no interaction between the agents, and hence she induces both agents to choose the effort level that she would implement if there were only one agent in charge of one task. If there is conflict, consider a situation where the principal prefers inducing only one effort to inducing no efforts. In such a situation, the principal can always increase her profit further by inducing two efforts. The reason is that if only one agent is induced to exert effort, then even if he deviates, the probability of sale of his product is still relatively large, which makes it expensive for the principal to induce effort. In contrast, if both agents are induced to exert effort, then if an agent chooses low effort, the probability of sale of his product is small due to the adverse effect of the other agent's promotion effort, which makes it less expensive for the principal to induce effort.

Proposition 1 and Proposition 2 imply the following result.

Proposition 3 *There exists a unique* $\hat{\gamma} \in (0, \min\{\alpha, \rho\})$ *such that* $\Pi_{hh}(\hat{\gamma}) = \Pi_{hh}^{AB}(\hat{\gamma})$.

(i) Consider the case $\gamma \leq \hat{\gamma}$*. If* $R > \frac{\psi(\alpha+\rho-\gamma)^2}{[(\alpha+\rho-\gamma)^2-\alpha^2](\rho-\gamma)}$*, then it is optimal for the principal to have one agent and to induce effort in both tasks.*

(ii) Next consider $\gamma > \hat{\gamma}$*. If* $R > \frac{\psi(\alpha+\rho-\gamma)(1-\alpha-\rho+\gamma)}{[\rho(1-\alpha-\rho)+\gamma(\alpha+\rho-\gamma)](\rho-\gamma)}$*, then it is optimal for the principal to have two agents and to induce effort in both tasks.*

(iii) Otherwise it is optimal to induce no efforts and it makes no difference whether the principal has one or two agents.

Observe that if the conflict between the tasks is weak ($\gamma \leq \hat{\gamma}$), then the principal prefers to employ one agent, provided that the return R is sufficiently large such that she wants to induce effort in both tasks.[6] This observation generalizes the well-known result that in the absence of conflict, a principal who wants to delegate several tasks may prefer to assign them to a single

[6] Note that it is never optimal to hire only one agent and implement only one effort, since this yields the same expected profit as hiring two agents and implementing only one effort, which cannot be optimal according to Proposition 2.

agent, because this gives her the possibility to save rents. Specifically, if there are two agents each in charge of one task, then even when there is only one success, the principal has to leave a rent to the successful agent. In contrast, if there is only one agent in charge of both tasks, the principal has to leave a rent to the agent only if he was successful in both tasks.

Now consider the case where the conflict is strong ($\gamma > \hat{\gamma}$). In this case, inducing two efforts is less expensive for the principal when she hires two agents. Intuitively, consider the limiting case where γ approaches α, so that if only one product is promoted, the probability of sale of the other product approaches zero. This means that in the two-agent case, an agent will almost never sell his product if he shirks, provided that the other agent exerts effort. Hence, the agents' rents tend to zero. In contrast, in the one-agent case, when the agent exerts no effort at all, both products will still be sold with probability α^2. This implies that the principal has to deter the agent from doing so by leaving him a non-negligible rent.

3 Design

Our experiment consists of four different treatments. Each treatment was run in four sessions. Each session had 30 participants, except for one session with 28 subjects and one session with 26 subjects (due to no-shows). No subject was allowed to participate in more than one session. In total, 474 subjects participated in the experiment. All subjects were students of the University of Cologne from a wide variety of fields of study. The computerized experiment was programmed and conducted with z-Tree (Fischbacher, 2007) and subjects were recruited using ORSEE (Greiner, 2004). A session lasted between 30 and 40 minutes. Subjects were paid on average 11.03€.[7]

In order to give subjects a monetary incentive to take their decisions seriously and to ensure a large number of independent observations, each session consisted of only one round; i.e., there were no repetitions and this was known to the subjects. In each session there were subjects in the role of principals (merchants) and other subjects in the role of agents (sales representatives). Each principal could sell one single unit of a product 1 and one single unit of a product 2 via a single agent in the one-agent treatments and via two agents

[7]The average payment includes the show-up fee which was 4€.

in the two-agent treatments. If a product was sold, the principal obtained a revenue of $R = 15$€. All interactions were anonymous; i.e., the participants did not know the identity of the subject(s) they were playing with. At the beginning of each session, written instructions were handed out to the subjects. Then they were given 20 minutes to read the instructions and afterwards all participants had to answer some questions to check that they had understood the instructions.

One-agent treatments

In each session, half of the participants are randomly assigned to the role of principals and the others to the role of agents. Each principal is randomly matched with one agent. There are two stages. In the first stage, each principal offers her agent a wage scheme that can be contingent on which products the agent has sold. In particular, the principal sets w_{11}, w_{10} and w_{01}. For w_{11} the principal could choose any number between 0 and 30, while for w_{10} and w_{01}, any numbers between 0 and 15 could be chosen.[8] Since the principal obtains no revenue in the case that no product is sold, the wage w_{00} is set to zero. In the second stage each agent learns the wage scheme his principal has set. Then the agent can exert promotion effort for each of the two products. In particular, the agent can decide whether to promote no product, only one product, or both products. If the agent promotes a product, he has to incur promotion costs $\psi = 2$€. The principal cannot observe the effort decision of her agent. The effect of promotion effort is as follows. If no product is promoted, then each product is sold with a probability of $\alpha = 0.4$. If only one product is promoted, the probability of sale of this product increases by $\rho = 0.5$, while the probability of sale of the other product decreases by γ. If both products are promoted, then each product is sold with probability $\alpha + \rho - \gamma = 0.9 - \gamma$. There is one treatment with $\gamma = 0.3$, which implies that there is conflict between the two promotion tasks. In another treatment we have $\gamma = 0$, such that there is no conflict between the two tasks. Once the agent has taken the effort decisions with regard to both tasks, the probabilities of sale of the two products are fixed. According to these probabilities the computer decides

[8]All wages could be specified with up to one decimal place. In the experiment, to avoid unlimited losses, the feasible wage offers had to be bounded from above. The stated upper bounds are the ones that arise naturally if also the principal is subject to limited liability. It is easy to show that given the parameter constellations in the experiment, the principal's limited liability constraint will never affect the equilibrium payoffs obtained in Section 2.

randomly, whether no, exactly one, or both products are sold. Depending on the wage scheme and on which products are sold, the principal's profit is $15€(q_1 + q_2) - w_{q_1 q_2}$. The agent's profit is given by $w_{q_1 q_2} - 2€(a_1 + a_2)$ and it depends on the wage scheme, on the number of products sold and on the effort decisions regarding both tasks.

Two-agent treatments

In each session, one third of the participants are randomly assigned to the role of principals, another third of the participants are randomly assigned to the role of agents A, and the others are assigned to the role of agents B. Each principal is randomly matched with one agent A and one agent B. The principal pays both agents according to a wage scheme that can be contingent on which products have been sold.

There are two stages. In the first stage, each principal offers her agents A and B a wage scheme that can be contingent on which products are sold. In particular, each principal sets non-negative wages w^A_{11}, w^A_{10}, and w^A_{01} for agent A and w^B_{11}, w^B_{10}, and w^B_{01} for agent B. For the same reasons as explained above, the wages w^A_{00} and w^B_{00} are set to zero, while $w^A_{11} + w^B_{11}$ (resp., $w^A_{10} + w^B_{10}$ and $w^A_{01} + w^B_{01}$) had to be weakly smaller than 30 (resp., 15). In the second stage, each agent learns the wage scheme which the principal has designed. In particular, each agent does not only learn his wage scheme, but he also learns the other agent's wage scheme. Then agent A can decide whether or not to promote product 1 and agent B can decide whether or not to promote product 2. Each agent has to incur promotion costs $\psi = 2€$ if he decides to promote his product. The effect of promotion effort is exactly as in the one-agent treatments. There are again two treatments, one with conflict (where $\gamma = 0.3$) and another one without conflict ($\gamma = 0$). When both agents have taken their effort decision, the probabilities of sale of the two products are fixed. According to these probabilities the computer decides randomly, whether no, exactly one, or both products are sold. Depending on the wage scheme and on how many products have been sold, the principal's profit is $15€(q_1 + q_2) - w^A_{q_1 q_2} - w^B_{q_1 q_2}$. The agents' profits $w^A_{q_1 q_2} - 2€a_1$ and $w^B_{q_1 q_2} - 2€a_2$ depend on the wage scheme, on the number of products that have been sold, and on their respective effort decision.

4 Qualitative hypotheses

One agent - Conflict ($\gamma = 0.3$)

According to Proposition 1 and Lemma 2, under standard theory assumptions, the agent would be induced to exert only one effort. He would get a wage of 3.51€ if only the product he is supposed to promote is sold, and zero otherwise. As a result, the expected wage payment would be 2.84€ and the principal's expected profit would be $\Pi_{hl} \approx 12.16$€. With regard to their structures, we did not expect the wage schemes observed in the experiment to be very close to the theoretical prediction. Taking into consideration the results from many previous experiments,[9] we anticipated that in the laboratory, principals will leave the agents more of the surplus than what in theory would be necessary to induce effort. Specifically, we expected that in our experiment, the principals would set the wages such that an agent obtains a substantial fraction of the revenue if at least one product is sold.[10] This implies that an agent who has exerted effort would not make a loss if at least one product is sold. Yet, we thought that even these more generous wage offers would not induce the majority of agents to exert two efforts. The reason is that agents may be very reluctant to exert two costly efforts because of the adverse effect that effort in one task has on the success probability of the other task. Hence, we hypothesized that indeed many agents would exert only one effort and that there would also be a non-negligible fraction of agents exerting no effort at all.

One agent - No conflict ($\gamma = 0$)

As we can see from Proposition 1 and Lemma 1, according to theory the agent would be induced to exert two efforts. The theoretically predicted wage scheme is such that he would get a wage of 6.15€ if both products are sold and nothing otherwise, leading to an expected wage payment of 4.98€ and to an expected profit of $\Pi_{hh} \approx 22.02$€ for the principal. For similar reasons as explained above, we expected the wage offers in the experiment to be larger than in theory. In the absence of conflict, exerting effort in one task has no adverse effect on the agent's prospects to be successful in the other task. This means, provided that an offer is generous, the probability to sell both products

[9]For recent surveys on fairness and other-regarding preferences in experiments, see e.g. Camerer (2003) and Fehr and Schmidt (2006).

[10]See also Keser and Willinger (2007) who investigate how principals set wages when confronted with a moral hazard problem.

and thus to obtain a relevant share of the revenue of 30€ becomes very likely if the agent exerts two efforts. Hence, in this treatment we actually hypothesized the wage offers to be very effective in inducing two efforts.

Two agents - Conflict ($\gamma = 0.3$)
According to Proposition 2 and Lemma 3, the theoretical prediction is that both agents would be induced to exert effort. Moreover, an agent would get a wage of 8.70€ whenever only his product is sold and zero otherwise, such that the expected wage payment is 4.17€ and the principal's expected profit is $\Pi_{hh}^{AB} \approx 13.83$€. While we thought again that the wages in the laboratory would be larger, we hypothesized that in line with theory, the vast majority of agents would indeed exert effort. The reason is that in this treatment, the agents might be very inclined to exert effort, since it increases the probability of sale of their own product, while the adverse side effect has an impact only on the probability of sale of the other agent's product. Moreover, if an agent believes that the other agent will exert effort, then his own probability of success would be very low if he shirked.

Two agents - No conflict ($\gamma = 0$)
As we can see from Proposition 2 and Lemma 3, according to theory, both agents will exert effort. Any wage scheme with $w_{00}^k = w_{01}^A = w_{10}^B = 0$€ such that $0.1w_{10}^A + 0.9w_{11}^A = 4$€ and $0.1w_{01}^B + 0.9w_{11}^B = 4$€ would be optimal, yielding an expected wage payment of 7.20€. The principal's expected profit would be $\Pi_{hh}^{AB} \approx 19.80$€. We expected again that in the experiment the offered wages would be larger and that most agents would indeed exert effort. If an offer is generous, the agent's prospect to get a relevant fraction of the revenue increases considerably if he exerts effort.

The preceding discussion leads us to the following qualitative hypotheses.

Hypothesis 1. In the one-agent treatment with conflict, the relative frequency of two efforts will be much lower than in the other three treatments.

Hypothesis 2. (i) In the absence of conflict, the principals' average profit will be larger in the one-agent treatment than in the two-agent treatment. (ii) If there is conflict, the principals' average profit will be larger in the two-agent treatment than in the one-agent treatment.

5 Data analysis

5.1 Experimental results

Figure 1 shows the frequencies of zero, one, and two efforts per treatment.[11] The figure concisely illustrates the central finding of our experiment. It is striking that in the one-agent treatment with conflict, two efforts were chosen considerably less often than in the other three treatments. Note that in the other three treatments, two efforts were chosen in the vast majority of the cases, while zero efforts were hardly ever observed. In contrast, in the one-agent case with conflict, two efforts were chosen less often than one effort, and zero efforts were observed in quite a relevant number of cases.

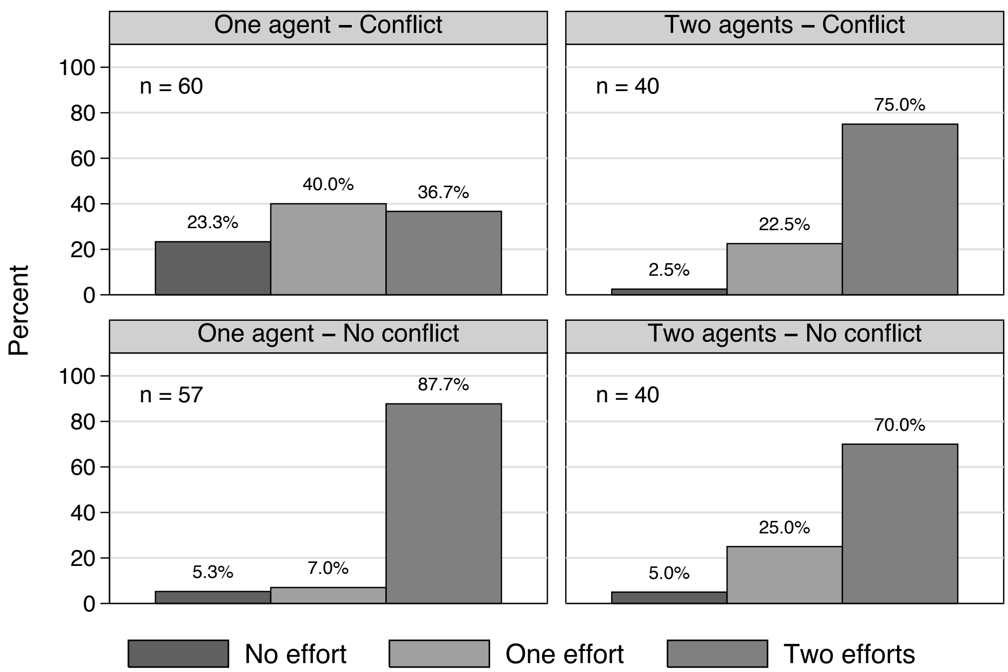

Figure 1. Effort levels per treatment (n denotes the number of principal-agent(s) groups per treatment). In the two-agent treatments, 86.3% (resp., 82.5%) of the agents exerted effort if there was conflict (resp., no conflict).

[11]In the one-agent treatments, the average numbers of efforts are 1.13 (conflict) and 1.81 (no conflict). In the two-agent treatments, the average numbers of efforts are 1.73 (conflict) and 1.65 (no conflict).

	Percentage of two efforts		p-value
One agent - Conflict vs. Two agents - Conflict	36.7%	75%	0.000
One agent - Conflict vs. One agent - No conflict	36.7%	87.7%	0.000
One agent - Conflict vs. Two agents - No conflict	36.7%	70%	0.002
One agent - No conflict vs. Two agents - Conflict	87.7%	75%	0.174
Two agents - Conflict vs. Two agents - No conflict	75%	70%	0.803
One agent - No conflict vs. Two agents - No conflict	87.7%	70%	0.039

Table 1. Significance levels for pairwise comparisons of the shares of two efforts between the treatments. The table reports p-values according to two-sided Fisher exact tests.

As can be seen in Table 1, it is highly significant that in the one-agent treatment with conflict, two efforts were chosen less often than in the other treatments, which provides strong support for Hypothesis 1.

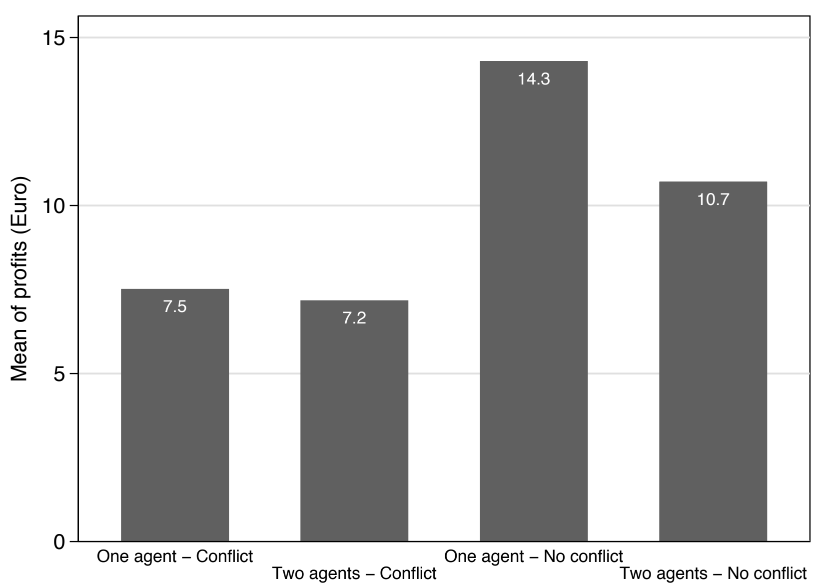

Figure 2. The principals' average profits. Recall that the theoretically predicted expected profits are 12.16€, 13.83€, 22.02€, and 19.80€, respectively.

The principals' average profits in the four treatments are shown in Figure 2. Observe that in the absence of conflict, the principals' average profit was notably larger if they had only one agent instead of two. The difference is highly significant (see Table 2). In line with Hypothesis 2(i), this finding provides empirical support for the well-known result that if there is no conflict, then delegation of several tasks to a single agent is profitable, since it gives the principal the possibility to save agency costs. Next observe that, contrary to the theoretical prediction, in the treatments with conflict the principals' average profit was slightly larger if only one agent instead of two was assigned to them. The difference is not statistically significant, though. Note also that the theoretically predicted difference between the expected profits is very small, which made it quite difficult to find support for Hypothesis 2(ii).

Finally, the average wage payments that were made to the agents in the four treatments are displayed in Table 3. As anticipated, the average payments were larger than the expected wage payments according to standard theory. Yet, the relative order of the magnitudes is exactly as predicted by theory. In particular, the average wage payment in the one-agent treatment with conflict is the smallest one, which is in line with the fact that the average number of efforts and thus also the average number of products a principal sold were smallest in this treatment.

	Principals' average profit (in €)		p-value	n_1	n_2	U
One agent - Conflict vs. Two agents - Conflict	7.50	7.20	0.713	60	40	1147.5
One agent - Conflict vs. One agent - No conflict	7.50	14.30	0.000	60	57	503
One agent - Conflict vs. Two agents - No conflict	7.50	10.70	0.006	60	40	813
One agent - No conflict vs. Two agents - Conflict	14.30	7.20	0.000	57	40	270
Two agents - Conflict vs. Two agents - No conflict	7.20	10.70	0.007	40	40	518.5
One agent - No conflict vs. Two agents - No conflict	14.30	10.70	0.000	57	40	629.5

Table 2. Significance levels for pairwise comparisons of the principals' profits between the treatments. The table reports p-values according to two-sided Mann-Whitney-U tests.

	One agent - Conflict	Two agents - Conflict	One agent - No conflict	Two agents - No conflict
Average wage payment	7.20	8.60	11.80	12.90
Theoretical prediction	2.84	4.17	4.98	7.20

Table 3. Average wage payments in Euro.

5.2 Individual wage offers and resulting efforts

One-agent treatments

First of all, it is noteworthy that nearly all wage offers are symmetric.[12] Let us now have a closer look at the symmetric wage offers which for both treatments are illustrated in Figure 3. For each offer, the figure also shows the resulting effort choices and the optimal effort choice according to standard theory. The three principles of contract design identified by Keser and Willinger (2000, 2007) are very useful to give an excellent description of the observed wage offers in our experiment. In both treatments, the wage for an agent is always strictly larger when he sells two products than when he sells only one product. This means that principals apply the principle of appropriateness which requires that the payment in case of a high gain is not lower than the payment in case of a low gain. Moreover, most of the principals offer wage schemes that ensure non-negative payoffs to the agent in case that at least one product is sold. For our experiment, this principle of loss avoidance means that principals are reluctant to make wage offers smaller than 4€.[13] In the treatment with (without) conflict, 85.7% (79.2%) of the wage offers are such that w_{10}, w_{01}, and w_{11} are (weakly) larger than 4€. Finally, nearly all wages offers are such that the profit of the principal equals at least 50% of the net surplus. For our experiment, this requires w_{10} and w_{01} to be smaller than 9.50€ and w_{11}

[12] In the treatment with conflict, only 4 out of 60 offers were asymmetric, and in the treatment without conflict, 4 out of 57 offers were asymmetric. Specifically, the wage offers (w_{10}, w_{01}, w_{11}) were $(8.5, 0, 0)$, $(8.5, 6.5, 18.5)$, $(13, 6, 6)$, and $(4, 2, 9)$ in the treatment with conflict, and $(9, 5, 13)$, $(7, 8, 14)$, $(10, 12, 29)$, and $(4, 7.5, 7.5)$ in the treatment without conflict.

[13] Observe that principals were not able to fully insure agents against losses, since w_{00} was set equal to 0€. Note, however, that this design is natural for our experiment, since in case that no product is sold, the principal obtains no revenue which she could share with the agent.

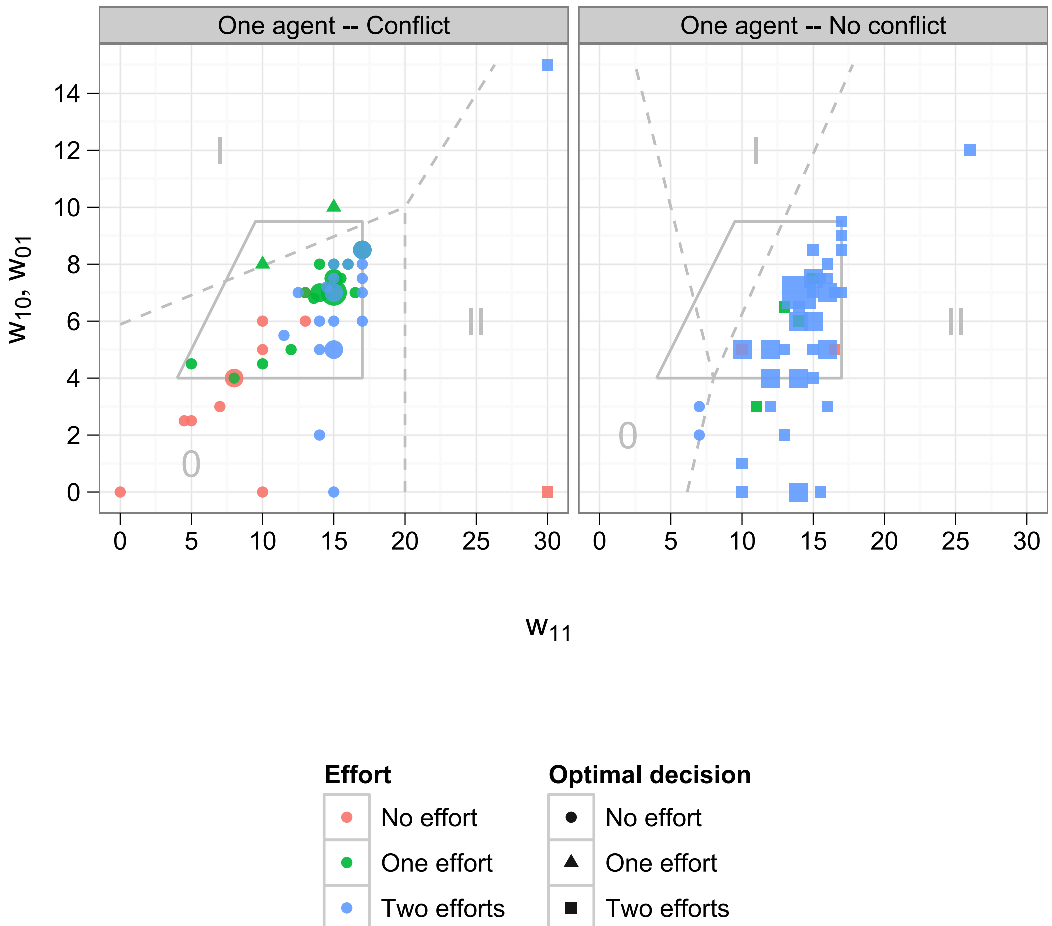

Figure 3. Symmetric wage schemes and resulting effort decisions in the one-agent treatments. The actually observed effort decisions are indicated by different colors, while the theoretically optimal effort decisions for given wage offers are indicated by different symbols. The size of the symbols represents the number of observations. The solid line indicates the fair-offers area. The dashed lines divide the panels into three parts where 0, I, or II efforts are optimal given symmetric offers.

to be smaller than 17€.[14] In the treatment with (without) conflict, 94.6% (98.1%) of the wage offers are in line with this principle of sharing power. The figure illustrates that the combination of these three principles characterizes a relatively small subset of all possible wage schemes. It is remarkable that in the treatment with (without) conflict, 82.1% (77.4%) of the symmetric wage schemes satisfy all three principles and thus belong to this small subset of possible wage schemes. In the wording of Keser and Willinger (2000), we will refer to this subset of offers as the "fair-offers area."

Now consider the treatment with conflict. Figure 3 makes it obvious that if principals intended to make offers in the fair-offers area, then (according to standard contract-theoretic reasoning) it was hardly possible to induce one effort and it was even impossible to induce two efforts. Indeed, taking into account all offers in the fair-offers area, no effort was the best response in 45 out of 46 cases.[15] However, contrary to standard-theoretic reasoning, only six of these 45 agents exerted no effort at all, while 21 agents exerted one effort and 18 agents exerted even two efforts. Hence, we observe that principals make generous wage offers that theoretically do not generate incentives to exert effort, but the vast majority of agents responds to such offers with one or even two efforts. Given offers in the fair-offers area, agents might actually decide to exert effort because they do not risk making a loss and they regard the offer as generous since in case of success, they receive a relevant share of the net surplus. Agents might thus reciprocate the principals' generous offers by effort levels above the theoretical predictions.[16] It is also interesting to compare offers in the fair-offers area that led to one effort with those that led to two efforts. Strikingly, when two efforts were chosen, the difference between w_{11} and $w_{10} = w_{01}$ is 8.74€, while it is only 6.60€ when one effort was chosen ($p = 0.001$, $U = 94$, $n_1 = 20$, $n_2 = 22$, two-sided Mann-Whitney-U test). It seems that the stronger principals rewarded the sale of two products compared to the sale of one product, the more inclined were agents to choose two efforts.

[14]In case one product is sold, the net surplus is minimally 11€ such that the principal does not want to leave more than 5.50€ + 4€ to the agent. Similarly, the principal offers not more than $(30€-4€)/2 + 4€$ when two products are sold.

[15]There was only one offer for which it was the agent's best response to exert one effort. Indeed, in this case the agent exerted one effort.

[16]Although the agents did not face fixed wages, note that the situation is related to the gift exchange settings studied by Akerlof (1982) and Fehr, Kirchsteiger, and Riedl (1993).

To sum up, in the fair-offers area, agents rewarded the principals for relatively generous offers by exerting one or even two efforts, while the few low wage offers outside of the fair-offers area were reciprocated with no effort.

Next consider the treatment with one agent and no conflict. Figure 3 illustrates that all 41 offers in the fair-offers area (77.4% of all 57 offers) were such that it would have been the agent's best response to exert two efforts. Indeed, 36 out of 41 agents that received an offer belonging to the fair-offers area decided to exert two efforts. This result is robust also when we take into account all 57 offers. It was then optimal to exert two efforts in 54 cases, and 48 agents actually decided to do so. In this treatment, it was relatively easy to make offers that belong to the fair-offers area and at the same time create incentives to exert two efforts. The analysis of our data shows that indeed, in the absence of conflict, the majority of principals made such generous and also incentive-compatible offers. The fact that the vast majority of agents exerted two efforts is not very surprising. As can be seen in Table 4 in Appendix B, in the absence of conflict, exerting two efforts led to an appreciable profit with a probability of 81% while the probability of making a loss was only 1%. Hence, the majority of agents seemed to perceive this strategy as promising and almost riskless and preferred it to other strategies.

Two-agent treatments

Again we observe that nearly all wage offers are symmetric.[17] Let us first explain Figure 4 which shows the symmetric wage offers. Generally, a wage scheme consists of six single wages but since the figure is restricted to symmetric offers, a wage offer is fully characterized by only three wages $w_{11} := w^A_{11} = w^B_{11}$, $w_1 := w^A_{10} = w^B_{01}$, and $w_0 := w^A_{01} = w^B_{10}$. A pair (w_{11}, w_1) appears in a darker shade while each corresponding pair (w_{11}, w_0) is plotted in a lighter shade; so each single wage scheme is represented by two points in the figure. Furthermore, a single offer is shown as a circle if – according to standard theory – both agents had a dominant strategy to exert effort, while it is shown as a triangle if both agents had a dominant strategy not to exert effort. Cases in which agents had no dominant strategy (indicated by a square) are observed very rarely. The figure illustrates that for exerting effort to be a dominant

[17] While in the treatment without conflict all wage offers are symmetric, there are four asymmetric wage offers in the treatment with conflict, namely, the asymmetric offers $(w^A_{10}, w^A_{01}, w^A_{11}, w^B_{01}, w^B_{10}, w^B_{11})$ are $(1, 1.5, 2, 1.5, 1, 2)$, $(5, 4, 10, 6, 4, 10)$, $(4, 2, 7, 4, 0, 7)$, and $(0, 0, 0, 5, 0, 5)$.

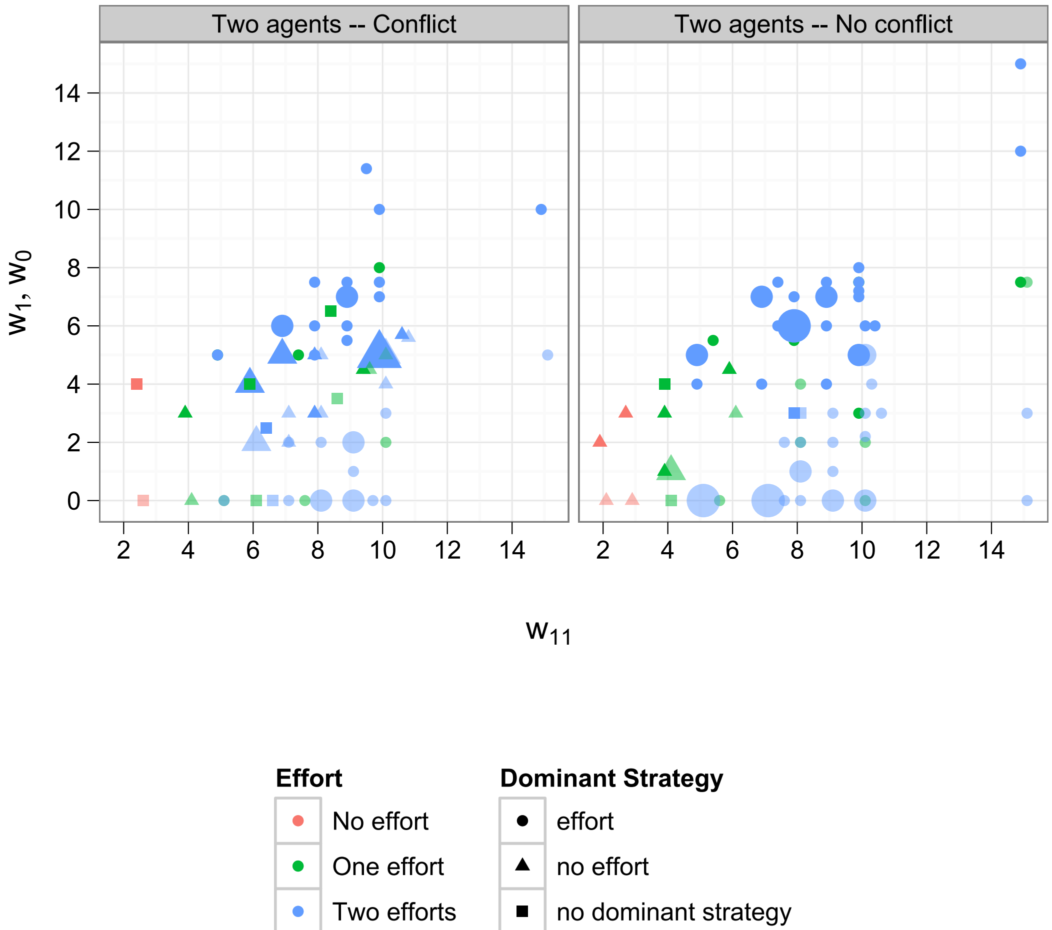

Figure 4. Symmetric wage schemes and resulting effort decisions in the two-agent treatments. Symmetric offers are fully characterized by three wages $w_{11} := w^A_{11} = w^B_{11}$, $w_1 := w^A_{10} = w^B_{01}$, and $w_0 := w^A_{01} = w^B_{10}$. A pair (w_{11}, w_1) appears in a darker shade (shifted 0.1 units to the left) while each corresponding pair (w_{11}, w_0) is plotted in a lighter shade (shifted 0.1 units to the right), so each single offer is represented by two points. The actually observed effort decisions are indicated by different colors, while the theoretically optimal effort decisions for given wage offers are indicated by different symbols. The size of the symbols represents the number of observations.

strategy, the difference between w_1 and w_0 had to be relatively large.[18]

Let us now analyze the symmetric wage offers in the treatment with conflict. The principals made wage offers such that for 52.8% of the agent pairs, it was a dominant strategy to exert effort, while for 36.1%, it was a dominant strategy not to exert effort. The remaining 11.1% of offers were such that there existed no dominant strategy. How did the agents react to these offers? The large majority of agents exerted effort regardless of whether this was a dominant strategy or not. Specifically, 35 out of 38 agents with the dominant strategy to exert effort actually promoted their product.[19] Moreover, when it was the optimal strategy not to provide effort, 23 out of 26 agents still decided to promote their product.[20] How may the agents' behavior be explained? Observe that wage offers for which exerting effort was a dominant strategy were characterized by w_0 being very small or 0€. Hence, an agent facing such an offer may have been very reluctant not to exert effort if he feared that the other agent might exert effort. The reason is that if an agent exerts no effort, the probability of sale of the own product becomes very small (10%, see Table 5 in Appendix B) given that the other agent exerts effort. Hence, with a probability of 90%, the shirking agent's gain would be 0€ or very small. In contrast, exerting effort might be considered an attractive strategy since the probability of selling the own product and thereby making a reasonable profit increases regardless of the other agent's decision. Next observe that nearly all wage offers for which not exerting effort was a dominant strategy were characterized by w_0 equal to 2€ or even larger. This observation may help to explain why most of the agents exerted effort even if the dominant strategy was not to exert effort. By promoting their product, agents could reciprocate these generous wage offers that insured them against making losses and at the same time, they further increased their chance to obtain a reasonable share of the revenue.

Taking a look at the treatment without conflict, wage offers were such

[18] This becomes apparent by the fact that the vertical distance between the dark and light circles (indicating a dominant strategy to exert effort) is relatively large, while the vertical distance between the dark and light triangles (indicating a dominant strategy not to exert effort) is relatively small.

[19] This led to two efforts in 84.2% and to one effort in 15.8% of the principal-agent triads.

[20] This led to two efforts in 76.9% and to one effort in 23.1% of the principal-agent triads. With regard to the eight agents that had no dominant strategy, we observe four agents that promoted their product.

that 82.5% of the agent pairs had the dominant strategy to promote their product, 12.5% had the dominant strategy not to promote their product, and the remaining 5% had no dominant strategy. A telling number of 60 agents (out of 66) with a dominant strategy to provide effort actually promoted their product. There were only ten agents with a dominant strategy not to promote their product, and seven of them decided not to exert effort. Also in this treatment, the decision to exert effort seemed to be an attractive strategy, because it promised a reasonable profit, the probability of a loss was very small, and the agents could again reward the principal for making fair wage offers.[21]

6 Discussion

In theoretical principal-agent models, inducing a single agent to invest effort in two conflicting tasks is difficult for the principal, because the agent anticipates that exerting effort in one task directly undermines the probability of success regarding the other task. This has led us to formulate Hypothesis 1 according to which in the one-agent treatment with conflict, the relative frequency of two efforts should be much lower than in the other treatments. Indeed, our experimental results provide strong support for this hypothesis: in the one-agent treatment with conflict, only 36.7% of the agents chose two efforts while in all other treatments, two efforts were observed in at least 70% of the cases. This shows that the theoretically predicted incentive problem is of high relevance in the laboratory. Nevertheless, a relevant share of agents decides to exert two efforts even in the presence of conflict. Our analysis in Section 5.2 has shown that agents that chose two efforts were those who were offered very generous wage schemes. While offers that led to two efforts were mostly very generous offers in the fair-offers area, they did not satisfy the incentive constraints for choosing two efforts. This means that in the experiment, agents often reciprocated generous offers by exerting two efforts although their best reply according to the incentive constraints would have been different. To sum up, incentive problems due to conflicting tasks are also prevalent in the lab,

[21] As can be seen in Figure 4, in this treatment w_0 is more often equal to zero than in the treatment with conflict. This might be due to the fact that in the absence of conflict, an agent's probability of not selling his product was very small when he exerted effort.

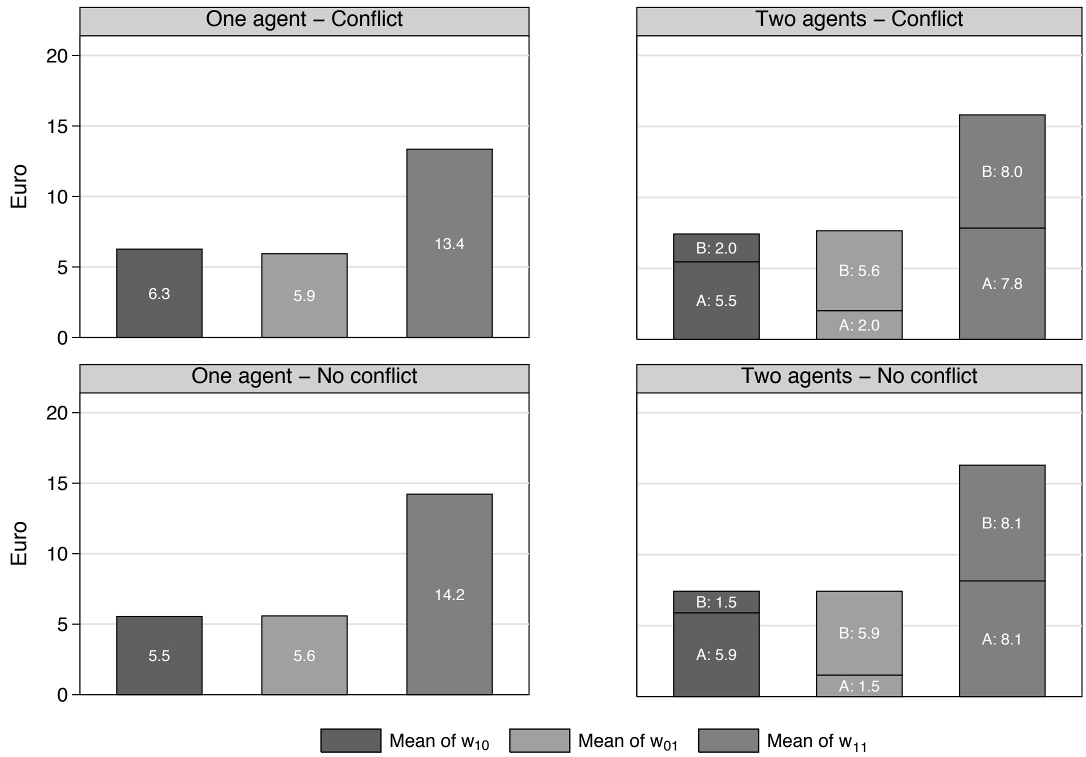

Figure 5. Average wage offers. In the two-agent treatments, the mean of w_{10} consists of the sum of the means of w_{10}^A and w_{10}^B, the mean of w_{01} consists of the sum of the means of w_{01}^A and w_{01}^B and the mean of w_{11} consists of the sum of the means of w_{11}^A and w_{11}^B.

but the strength of this problem seems to be weaker when principals try to trigger reciprocity by very fair and generous offers.

The observation that in the lab, the incentive problem seems not to be as strong as in theory can help to explain why we cannot find support for Hypothesis 2(ii). For our parameter constellation, theory predicts that in the presence of conflict, the principal's expected profit is larger when she employs two agents instead of one. The fact that this result is not supported by our data can be attributed to two reasons. Given the parameter constellation of our experiment and conflicting tasks, in theory the principal will never induce two efforts with one agent, while in the experiment, two efforts are observed in 36.7% of the cases. Moreover, as illustrated in Figure 5, when two agents are assigned to the principal, in sum she pays the agents more and thus gives up a larger share of the total surplus.[22] In fact, when there are two agents, due to fairness considerations the principal tends to give up considerably more than half of the net surplus while if she has only one agent, she tends to keep at least half of the net surplus for herself. These two facts may explain why in contrast to the theoretical prediction, in the treatments with conflict the principal is better off with one agent than with two agents.

7 Concluding remarks

While multi-task principal-agent models have attracted considerable attention by contract theorists in recent years, there is scarce experimental evidence on the problems involved. In this paper we focus on incentive problems that arise when tasks are in direct conflict with each other. In theory, inducing a single agent to invest effort in two conflicting tasks is difficult for the principal, because the agent anticipates that exerting effort in one task directly undermines the probability of success regarding the other task.

Our experimental results provide strong support for the relevance of this incentive problem. Subjects in the experiment were indeed reluctant to invest simultaneously in two different tasks that are in conflict with each other. While efforts in both conflicting tasks were observed significantly more often when the tasks were assigned to two different agents, some principals even succeeded in inducing a single agent to exert efforts in both tasks by making very generous wage offers. In contrast, if the tasks were unrelated, two efforts were observed in the vast majority of cases, regardless of whether a single agent or two different agents were in charge of the tasks.

It might be a promising avenue for future research to conduct experiments in which principals can choose how many agents they want to employ to perform different tasks that may be in conflict with each other. It would then be interesting to see whether agents perceive a principal's choice to employ two agents when the tasks are conflicting as an unfriendly act. An agent may

[22]Note that in the two-agent treatments, for any state of nature (one or two products sold), the sum of the wages offered to the agents is on average larger than the respective wage offered to a single agent. The differences are statistically significant on the 5% level according to one-sided Mann-Whitney-U tests.

be demotivated if he knows that the principal intentionally employs another agent whose effort frustrates his own effort. Moreover, it would be interesting to investigate whether our results remain robust when agents face real effort tasks.[23]

[23]Note that Brüggen and Strobel (2007) investigate experimentally real effort and chosen effort where participants choose increasingly costly effort levels. They find that the results support equivalence between real and chosen effort.

Appendix A

Proof of Lemma 1

First observe that given that the wages cannot be negative, the agent's participation constraint is redundant as it is implied by (IC 3). It is immediate to verify that given the symmetry of the problem, it is optimal for the principal to set $w_{10} = w_{01} = w_1$. Then it is straightforward to show that w_{00} must be equal to zero. Thus, the reduced problem is to minimize $E\left[w_{q_1 q_2} \mid a_1 = a_2 = 1\right] = (\alpha+\rho-\gamma)^2 w_{11} + 2(\alpha+\rho-\gamma)(1-\alpha-\rho+\gamma)w_1$ subject to the constraints $w_{11} \geq 0, w_1 \geq 0$,

$$\begin{aligned}&(\alpha+\rho-\gamma)^2 w_{11} + 2(\alpha+\rho-\gamma)(1-\alpha-\rho+\gamma)w_1 - 2\psi \geq \\ &(\alpha+\rho)(\alpha-\gamma)w_{11} + (\alpha+\rho)(1-\alpha+\gamma)w_1 + \\ &(\alpha-\gamma)(1-\alpha-\rho)w_1 - \psi,\end{aligned} \tag{IC 1}$$

$$\begin{aligned}&(\alpha+\rho-\gamma)^2 w_{11} + 2(\alpha+\rho-\gamma)(1-\alpha-\rho+\gamma)w_1 - 2\psi \geq \\ &\alpha^2 w_{11} + 2\alpha(1-\alpha)w_1.\end{aligned} \tag{IC 3}$$

Now it is easy to see that $w_1 = 0$ is optimal. To show this, consider a wage scheme $w_{11}, w_1 > 0$. Then the LHS of the two incentive constraints are unchanged if we change this wage scheme such that $\Delta w_1 = -\Delta w_{11} \frac{\alpha+\rho-\gamma}{2(1-\alpha-\rho+\gamma)} < 0$. But now the RHS of both incentive constraints are relaxed which enables the principal to reduce the expected compensation by reducing w_1. She can do so until $w_1 = 0$. Then it turns out that (IC 3) is binding which implies $w_{11} = \frac{2\psi}{(\alpha+\rho-\gamma)^2-\alpha^2}$. ■

Proof of Lemma 2

In analogy to Lemma 1, it turns out that the participation constraint is redundant and that $w_{00} = 0$ is optimal. In what follows, we can ignore (IC 2). Let us verify that $w_{01} = 0$ is optimal. Consider a wage scheme with $w_{11}, w_{10}, w_{01} > 0$. If we change this wage scheme such that $\Delta w_{01} = -\Delta w_{10} \frac{(\alpha+\rho)(1-\alpha+\gamma)}{(1-\alpha-\rho)(\alpha-\gamma)} < 0$, the LHS of the two remaining incentive constraints are unchanged, while both RHS are relaxed. So the principal can increase her expected profit by lowering w_{01} until $w_{01} = 0$. In the same way it is straightforward to show that it is optimal to set $w_{11} = 0$. To see this, consider a wage scheme with $w_{11} > 0, w_{10}$. Then the LHS of the two incentive constraints remain unchanged if we change this wage scheme such that $\Delta w_{11} = -\Delta w_{10} \frac{1-\alpha+\gamma}{\alpha-\gamma} < 0$. Given this new wage scheme, the RHS of the two incentive constraints are relaxed which implies that the principal can increase her expected profit by lowering w_{11}. She can do so until $w_{11} = 0$. It is then immediate to see that the claimed solution satisfies all the constraints. ■

Proof of Lemma 3

Observe that given the wages cannot be negative, each agent's participation constraint is redundant as it is implied by the agent's incentive compatibility constraint. It is straightforward to show that $w_{00}^A = w_{00}^B = 0$. Moreover it is immediate to verify that given the symmetry of the problem, we can solve the problem for one agent and the other agent will receive the same incentive scheme; i.e., $w_{11}^A = w_{11}^B$, $w_{10}^A = w_{01}^B$, and $w_{01}^A = w_{10}^B$. Let us w.l.o.g. derive the optimal incentive scheme for agent A. The reduced problem is to minimize $(\alpha+\rho-\gamma)^2 w_{11}^A + (\alpha+\rho-\gamma)(1-\alpha-\rho+\gamma)(w_{10}^A + w_{01}^A)$ subject to $w_{q_1 q_2}^A \geq 0$ and

$$\begin{aligned}&(\alpha+\rho-\gamma)^2 w_{11}^A + (\alpha+\rho-\gamma)(1-\alpha-\rho+\gamma)(w_{10}^A + w_{01}^A) - \psi \geq \\ &(\alpha-\gamma)(\alpha+\rho) w_{11}^A + (\alpha-\gamma)(1-\alpha-\rho) w_{10}^A + (\alpha+\rho)(1-\alpha+\gamma) w_{01}^A.\end{aligned} \tag{IC A}$$

It is immediate to verify that in the optimal incentive scheme $w_{01}^A = 0$ must hold. To see this consider a wage scheme $w_{11}^A, w_{10}^A, w_{01}^A > 0$. The LHS of the incentive constraint remains unchanged if we change this wage scheme in the following way: $\Delta w_{01}^A = -\Delta w_{10}^A < 0$. But this relaxes the RHS of the incentive constraint and hence enables us to lower the expected compensation by reducing w_{01}^A until $w_{01}^A = 0$. In the next step we can show that $w_{11}^A = 0$ is optimal. To see this consider a wage scheme $w_{11}^A > 0, w_{10}^A$. The LHS of the incentive constraint remains unchanged if we change this wage scheme such that $\Delta w_{11}^A = -\Delta w_{10}^A \frac{1-\alpha-\rho+\gamma}{\alpha+\rho-\gamma} < 0$. This relaxes the RHS of the incentive constraint and thus makes it possible to lower the expected compensation by reducing w_{11}^A. This can be done until $w_{11}^A = 0$. Then the result follows immediately. ■

Proof of Lemma 4

In analogy to Lemma 3, the participation constraint is redundant and $w_{00}^A = 0$. To verify that $w_{01}^A = 0$ is optimal, consider a wage scheme with $w_{11}^A, w_{10}^A, w_{01}^A > 0$. If we change this wage scheme such that $\Delta w_{01}^A = -\Delta w_{10}^A \frac{(\alpha+\rho)(1-\alpha+\gamma)}{(1-\alpha-\rho)(\alpha-\gamma)} < 0$, the LHS of the incentive constraint remains unchanged, while the RHS of the incentive constraint is relaxed. So the principal can increase her expected profit by lowering w_{01}^A until $w_{01}^A = 0$. Next, let us show that $w_{11}^A = 0$. To see this, consider a wage scheme with $w_{11}^A > 0, w_{10}^A$. The LHS of the incentive constraint remains unchanged if we change this wage scheme such that $\Delta w_{11}^A = -\Delta w_{10}^A \frac{1-\alpha+\gamma}{\alpha-\gamma} < 0$. Given this new wage scheme, the RHS of the incentive constraint is relaxed which means that the principal can increase her expected profit by lowering w_{11}^A. She can do so until $w_{11}^A = 0$. The lemma follows immediately. ■

Proof of Proposition 2

We have to show that it cannot be optimal for the principal to induce only one effort. To show this, assume the contrary. This means the two conditions $\Pi_{hl}^{AB} > \Pi_{hh}^{AB}$ and $\Pi_{hl}^{AB} > \Pi_{ll}^{AB}$ must be satisfied. The former condition can be rewritten as $R < \frac{2\psi(\alpha+\rho-\gamma)(1-\alpha-\rho+\gamma)}{[(\alpha+\rho-\gamma)(1-\alpha-\rho+\gamma)-(\alpha-\gamma)(1-\alpha-\rho)](\rho-\gamma)} - \frac{\psi(\alpha+\rho)(1-\alpha+\gamma)}{[\alpha\gamma+\rho(1-\alpha+\gamma)](\rho-\gamma)}$ and the latter can be rewritten as $R > \frac{\psi(\alpha+\rho)(1-\alpha+\gamma)}{[\alpha\gamma+\rho(1-\alpha+\gamma)](\rho-\gamma)}$. This implies that the RHS of the former condition must be larger than the RHS of the latter, which is equivalent to $(1-\alpha)^2 + \alpha^2 + \alpha(\rho-\gamma) + (1-\alpha-\rho)\gamma < (1-\alpha)\rho$. But this inequality cannot hold under our assumptions. Hence, the two conditions $\Pi_{hl}^{AB} > \Pi_{hh}^{AB}$ and $\Pi_{hl}^{AB} > \Pi_{ll}^{AB}$ cannot be satisfied simultaneously. Then the proposition follows immediately. ■

Proof of Proposition 3

If the principal implements $a_i = 1$ and $a_{j\neq i} = 0$ in the one-agent scenario, then she would prefer to have two agents and to implement $a_1 = a_2 = 1$. To see this, suppose it is optimal for the principal to implement $a_i = 1$ and $a_{j\neq i} = 0$ in the one-agent scenario. Then $\Pi_{hl} > \Pi_{ll}$ holds. But this means that in the two-agent scenario $\Pi_{hl}^{AB} > \Pi_{ll}^{AB}$ must be satisfied, since $\Pi_{hl} = \Pi_{hl}^{AB}$ and $\Pi_{ll} = \Pi_{ll}^{AB}$. But we know from Proposition 2 that if $\Pi_{hl}^{AB} > \Pi_{ll}^{AB}$, then $\Pi_{hh}^{AB} > \Pi_{hl}^{AB} = \Pi_{hl}$.

It remains to be shown that there exists a unique $\hat{\gamma} \in (0, \min\{\alpha, \rho\})$ such that $\Pi_{hh}(\hat{\gamma}) = \Pi_{hh}^{AB}(\hat{\gamma})$. Observe that $\Pi_{hh} - \Pi_{hh}^{AB} > 0$ if $\gamma = 0$ and $\Pi_{hh} - \Pi_{hh}^{AB} < 0$ if $\gamma = \min\{\alpha, \rho\}$. Moreover, the condition $\Pi_{hh} - \Pi_{hh}^{AB} > 0$ is equivalent to $f(\cdot) := \gamma(3\alpha\rho + \rho^2 + \alpha^2 - \rho - 2\alpha) + \gamma^2(1-\alpha-\rho) + \rho\alpha - \rho\alpha^2 - \rho^2\alpha > 0$. The derivative of $f(\cdot)$ with respect to γ is given by $\frac{df(\cdot)}{d\gamma} = (2\gamma - \alpha - \rho)(1 - \alpha - \rho) - (1-\rho)\alpha < 0$. Hence, a simple intermediate value argument implies that there exists a unique $\hat{\gamma} \in (0, \min\{\alpha, \rho\})$ such that $\Pi_{hh}(\hat{\gamma}) = \Pi_{hh}^{AB}(\hat{\gamma})$. The remainder of the proposition follows immediately from Proposition 1 and Proposition 2. ■

Appendix B

	No effort	Effort in task 1	Effort in task 2	Efforts in both tasks
No product sold	36%	6%	6%	1%
Only product A sold	24%	54%	4%	9%
Only product B sold	24%	4%	54%	9%
Both products sold	16%	36%	36%	81%

Table 4. Probabilities of sale in the no-conflict treatments.

	No effort	Effort in task 1	Effort in task 2	Efforts in both tasks
No product sold	36%	9%	9%	16%
Only product A sold	24%	81%	1%	24%
Only product B sold	24%	1%	81%	24%
Both products sold	16%	9%	9%	36%

Table 5. Probabilities of sale in the conflict treatments.

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Supplementary material

The following instructions and comprehension questions were handed out to the participants in the treatment with one agent and conflict ($\gamma = 0.3$):

Experimental instructions

In this experiment, you can earn money. Your payoff depends on your decisions and on other participants' decisions.

During the whole experiment communication is not allowed. If you have a question, please raise your hand out of the cabin. All decisions are anonymous; i.e., no participant ever learns the identity of a person who has made a particular decision. The payment is conducted anonymously, too; i.e., no participant learns what the payoff of another participant is.

In this experiment, you will either be a merchant or a sales representative with equal probability. Each merchant is matched with exactly one sales representative. As soon as the experiment starts, you will learn whether you have been assigned to the role of a merchant or to the role of a sales representative.

The merchant can sell exactly one unit of a product A and exactly one unit of a product B via his sales representative. Product A and product B are similar. The merchant receives a revenue of 15 Euro for each product sold. He can pay his sales representative a wage depending on the number of products sold.
(Suppose that the costs the merchant had to incur when purchasing the products are not relevant in this experiment. Furthermore, the merchant does not have to bear any stockkeeping costs if product A or product B is not sold.)

The sales representative can promote each product A and B individually. If the sales representative does not promote any product, the probability of sale of each product is 40%. If the sales representative promotes a product, the probability of sale of this product increases by 50 percentage points while the probability of sale of the other product decreases by 30 percentage points. The sales representative can either *promote no product*, or *promote exactly one product*, or *promote both products.* Depending on the number of products promoted, the probabilities of sale read as follows:

- If the sales representative does not promote any product, then each product will be sold with a probability of 40%.
- If the sales representative promotes *only* product A, then product A will be sold with a probability of 40% + 50% = 90%, and product B will be sold with a probability of 40% - 30% = 10%.
- If the sales representative promotes *only* product B, then product B will be sold with a probability of 40% + 50% = 90%, and product A will be sold with a probability of 40% - 30% = 10%.
- If the sales representative promotes both products, then product A and product B will be sold with a probability of 40% + 50% - 30% = 60% each.

As the products are similar, promotion for one product does not only have a positive effect on the probability of sale of the promoted product, but it has also a negative effect on the probability of sale of the other product.

	No promotion for product B	Promotion for product B
No promotion for product A	40%, 40%	10%, 90%
Promotion for product A	90%, 10%	60%, 60%

In each cell, the first number denotes the probability of sale of product A, while the second number denotes the probability of sale of product B.

If the sales representative promotes a product, he has to incur promotion costs of 2 Euro; i.e. promoting both products causes promotion costs *PC* = 2 Euro + 2 Euro = 4 Euro, while promoting one product causes promotion costs *PC* = 2 Euro. If he promotes no product, he has to incur no promotion costs (*PC* = 0).

The merchant cannot observe whether his sales representative decides to promote a product or not. Thus, the merchant cannot condition his wage offer on the sales representative's promotion decision but only on the number of products sold.

In detail, the experiment proceeds as follows:

The experiment consists of only a single period.
This period consists of two stages.

Stage 1 – Merchant decides on wage offers

The merchant offers his sales representative wages depending on the number of products sold. There are four possible cases. For each case, the merchant can specify one wage:

1. Neither product A nor product B are sold → wage w_{00}
2. Only product A but not product B is sold → wage w_{10}
3. Only product B but not product A is sold → wage w_{01}
4. Both products A and B are sold → wage w_{11}

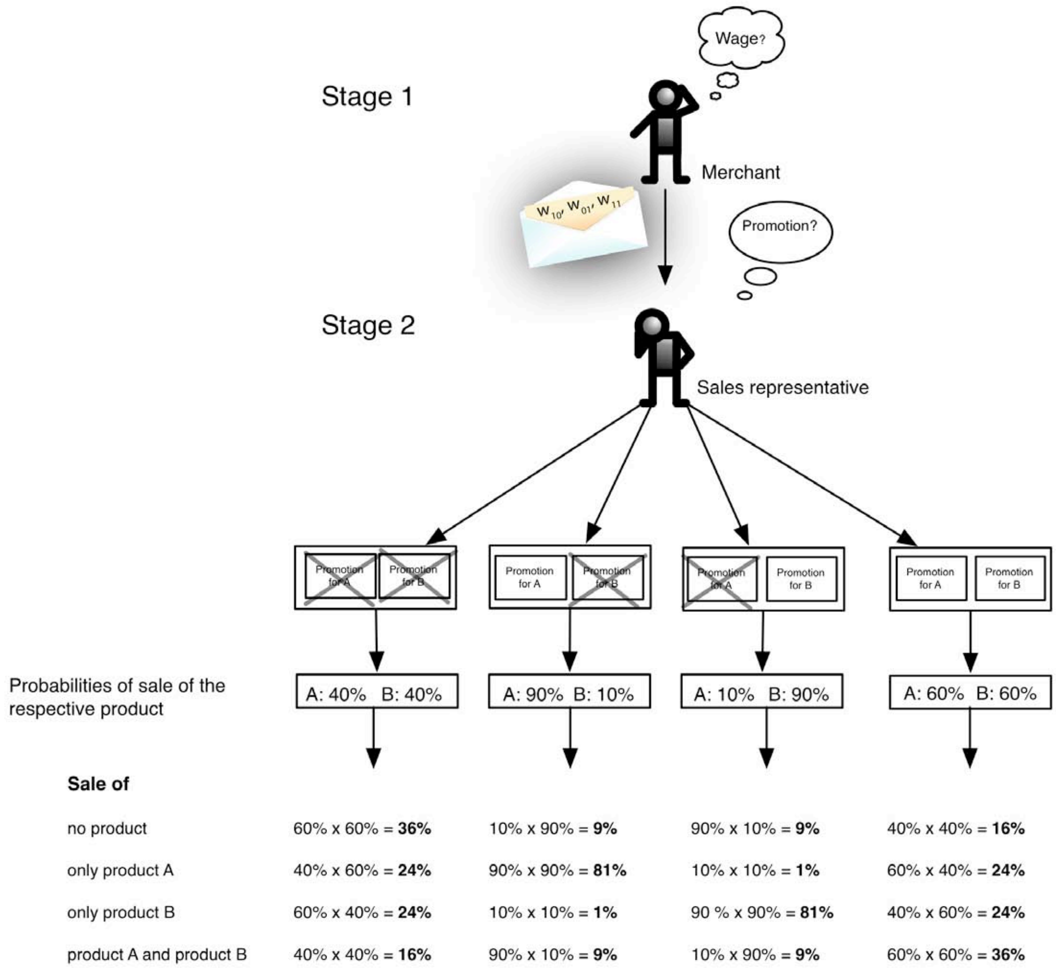
As the merchant obtains no revenue in case 1, the wage w_{00} is fixed at 0 Euro. In the cases 2, 3, and 4, the merchant has to set the wages w_{10}, w_{01}, and w_{11} (see Figure 1 on the last page). (All wages can be specified with up to one decimal place. Please use points instead of commas as decimal separators.)

Stage 2 – Sales representative decides on promotion

The sales representative learns his merchant's wage offers $w_{00} = 0$, w_{10}, w_{01}, and w_{11}. **He can decide whether to promote no product, only product A, only product B, or whether to promote both products A and B** (see Figure 2 on the last page).

Once the sales representative has decided on his promotion effort, the probabilities of sale of the products are determined (as described above). According to these probabilities, the computer decides randomly whether *no*, *exactly one*, or *both products* are sold.

Diagram of the experiment:



The profits are as follows:

Sale of	**merchant's profit**	**sales rep.'s profit**
no product	$0 - w_{00} = 0$	$w_{00} - PC = 0 - PC$
only product A	$15 - w_{10}$	$w_{10} - PC$
only product B	$15 - w_{01}$	$w_{01} - PC$
product A and product B	$30 - w_{11}$	$w_{11} - PC$

Your payoff:
In addition to the (possibly negative) profit realized in the experiment you get 4 Euro and the resulting amount is paid out to you in cash.

Figure 1: Stage 1 – Merchant decides on wage offers

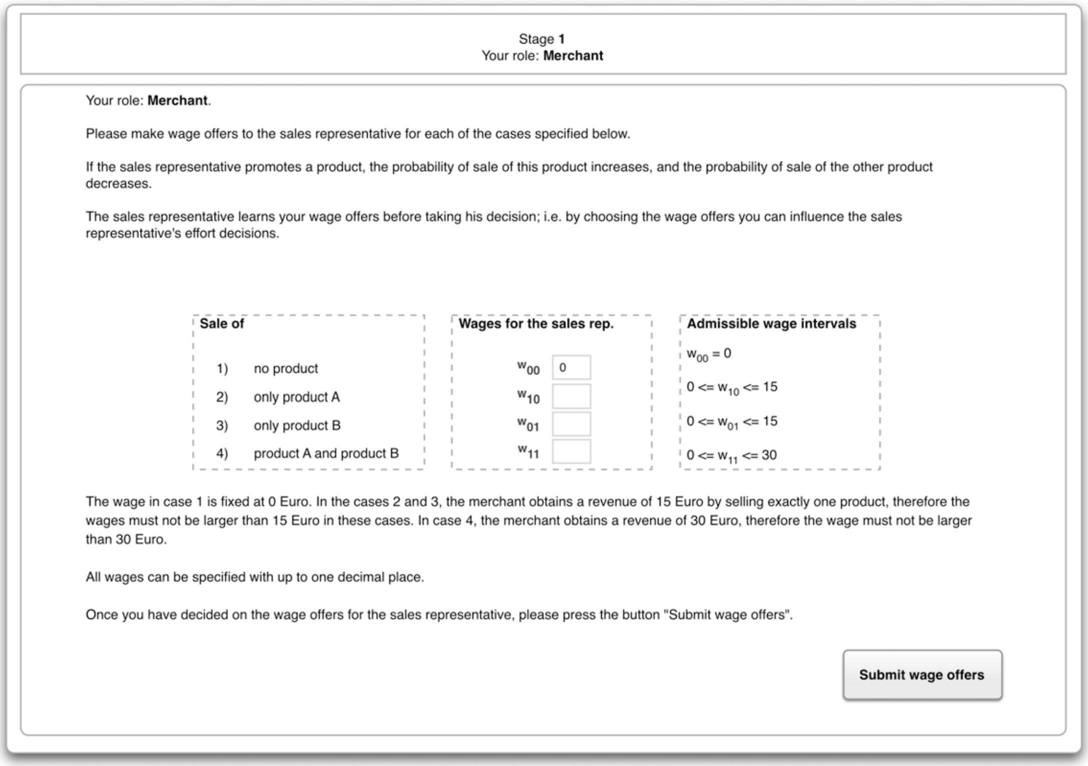
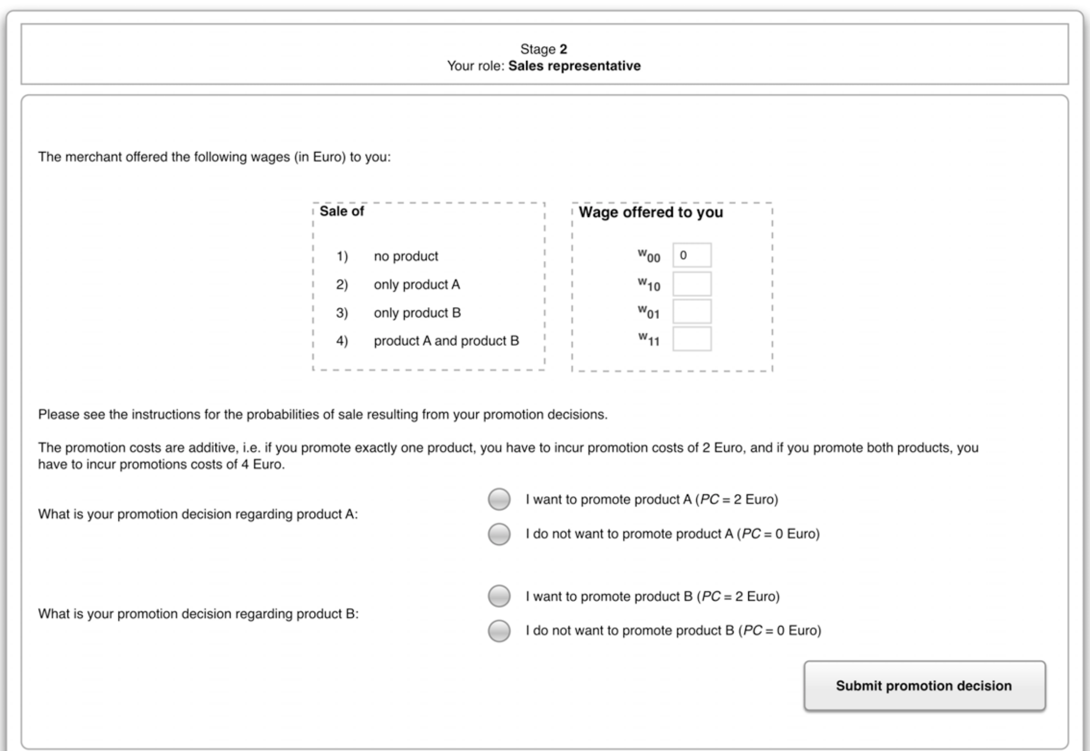


Figure 2: Stage 2 – Sales representative decides on promotion effort



Comprehension questions

Question 1:
Which of the following statements is true:

1. Promoting a product increases the probability of sale of this product and decreases the probability of sale of the other product.
2. Promoting a product increases the probability of sale of this product and increases the probability of sale of the other product.
3. Promoting a product decreases the probability of sale of this product and increases the probability of sale of the other product.
4. Promoting a product increases the probability of sale of this product and has no effect on the probability of sale of the other product.

Question 2:
Which of the following statements is true:

1. The merchant offers his sales representative exactly one wage.
2. The merchant can offer his sales representative different wages depending on the number of products sold.
3. The sales representative can demand a wage from the merchant.

Question 3:
Which of the following statements is true:

1. Suppose you are the sales representative. Once you have decided on your promotion effort, you know exactly how many products will be sold.
2. Suppose you are the sales representative. Once you have decided on your promotion effort, the probabilities of sale depend on the magnitude of the wages.
3. Suppose you are the sales representative. Once you have decided on your promotion effort, you know the probabilites of sale of both products.

Question 4:
Which of the following statements is true:

1. The merchant can condition his wages on whether the sales representative has promoted the products.
2. The merchant can offer wages conditional on the number of products sold.
3. The merchant can offer wages conditional on the probabilities of sale of the products.
4. The sales representative sets the wages.

Question 5:
Which of the following statements is true:

1. Wage w_{10} is paid if no product is sold.
2. Wage w_{10} is paid if only product A but not product B is sold.
3. Wage w_{10} is paid if both products are sold.
4. Wage w_{10} is paid if only product B but not product A is sold.

Question 6:
What is the probability that only product B is sold when the sales representative promotes only product A?

Question 7:
What is the probability that wage w_{10} is paid when the sales representative promotes both products?

The following instructions and comprehension questions were handed out to the participants in the treatment with one agent and without conflict ($\gamma = 0$):

Experimental instructions

In this experiment, you can earn money. Your payoff depends on your decisions and on other participants' decisions.

During the whole experiment communication is not allowed. If you have a question, please raise your hand out of the cabin. All decisions are anonymous; i.e., no participant ever learns the identity of a person who has made a particular decision. The payment is conducted anonymously, too; i.e., no participant learns what the payoff of another participant is.

In this experiment, you will either be a merchant or a sales representative with equal probability. Each merchant is matched with exactly one sales representative. As soon as the experiment starts, you will learn whether you have been assigned to the role of a merchant or to the role of a sales representative.

The merchant can sell exactly one unit of a product A and exactly one unit of a product B via his sales representative. The merchant receives a revenue of 15 Euro for each product sold. He can pay his sales representative a wage depending on the number of products sold. (Suppose that the costs the merchant had to incur when purchasing the products are not relevant in this experiment. Furthermore, the merchant does not have to bear any stockkeeping costs if product A or product B is not sold.)

The sales representative can promote each product A and B individually. If the sales representative does not promote any product, the probability of sale of each product is 40%. If the sales representative promotes a product, the probability of sale of this product increases by 50 percentage points. The sales representative can either *promote no product*, or *promote exactly one product*, or *promote both products.* Depending on the number of products promoted, the probabilities of sale read as follows:

- If the sales representative does not promote any product, then each product will be sold with a probability of 40%.
- If the sales representative promotes *only* product A, then product A will be sold with a probability of 40% + 50% = 90%, while product B still will be sold with a probability of 40%.
- If the sales representative promotes *only* product B, then product B will be sold with a probability of 40% + 50% = 90%, while product A still will be sold with a probability of 40%.
- If the sales representative promotes both products, then product A and product B will be sold with a probability of 40% + 50% = 90% each.

	Probability of sale of the product
No promotion for a product	40%
Promotion for a product	90%

If a sales representative promotes a product, he has to incur promotion costs of 2 Euro, i.e. promoting both products causes promotion costs *PC* = 2 Euro + 2 Euro = 4 Euro, while promoting one product causes promotion costs *PC* = 2 Euro. If he promotes no product, he has to incur no promotion costs (*PC* = 0).

The merchant cannot observe whether his sales representative decides to promote a product or not. Thus, the merchant cannot condition his wage offer on the sales representative's promotion decision but only on the number of products sold.

In detail, the experiment proceeds as follows:

The experiment consists of only a single period.
This period consists of two stages.

<u>Stage 1 – Merchant decides on wage offers</u>

The merchant offers his sales representative wages depending on the number of products sold. There are four possible cases. For each case, the merchant can specify one wage:

1. Neither product A nor product B are sold → wage w_{00}
2. Only product A but not product B is sold → wage w_{10}
3. Only product B but not product A is sold → wage w_{01}
4. Both products A and B are sold → wage w_{11}

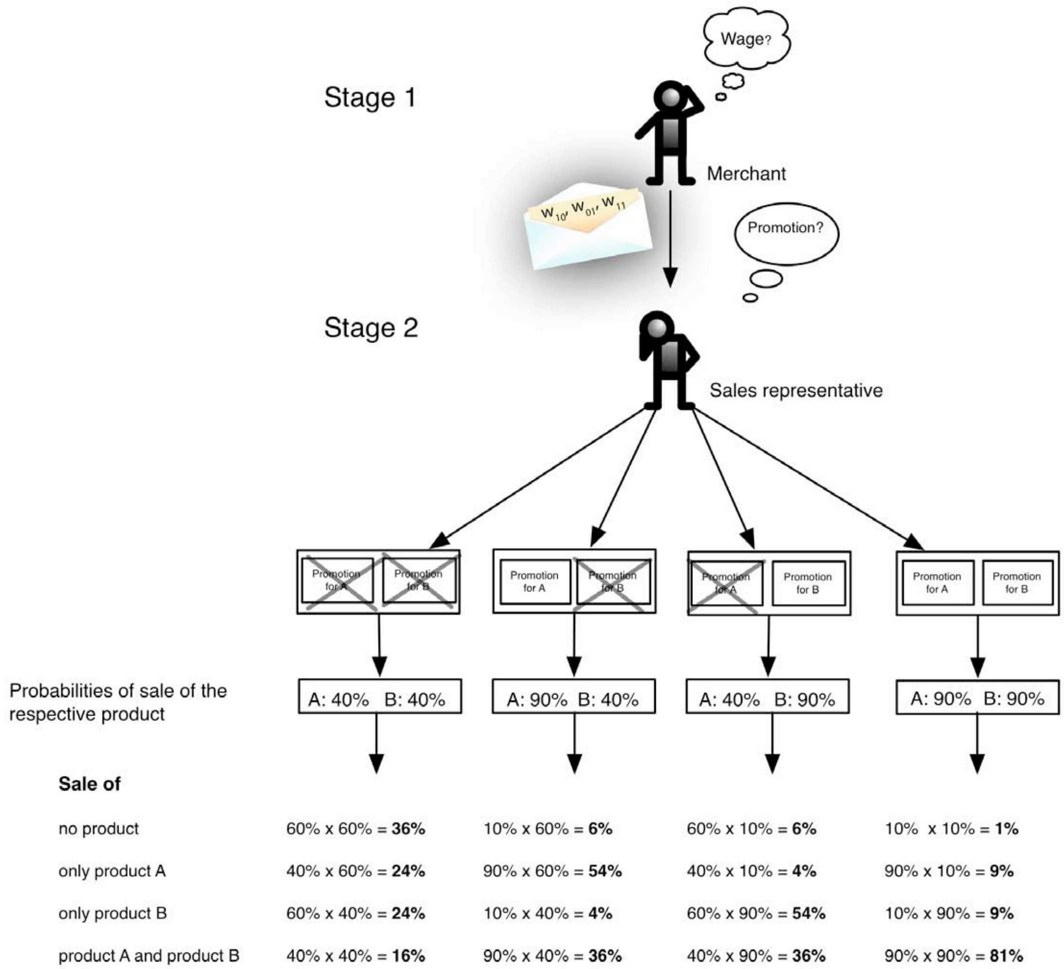
As the merchant obtains no revenue in case 1, the wage w_{00} is fixed at 0 Euro. In the cases 2, 3, and 4, the merchant has to set the wages w_{10}, w_{01}, and w_{11} (see Figure 1 on the last page). (All wages can be specified with up to one decimal place. Please use points instead of commas as decimal separators.)

<u>Stage 2 – Sales representative decides on promotion</u>

The sales representative learns his merchant's wage offers $w_{00} = 0$, w_{10}, w_{01}, and w_{11}. **He can decide whether to promote no product, only product A, only product B, or whether to promote both products A and B** (see Figure 2 on the last page).

Once the sales representative has decided on his promotion effort, the probabilities of sale of the products are determined (as described above). According to these probabilities, the computer decides randomly whether *no*, *exactly one*, or *both products* are sold.

Diagram of the experiment:



The profits are specified as follows:

Sale of	**merchant's profit**	**sales rep.'s profit**
no product	$0 - w_{00} = 0$	$w_{00} - PC = 0 - PC$
only product A	$15 - w_{10}$	$w_{10} - PC$
only product B	$15 - w_{01}$	$w_{01} - PC$
product A and product B	$30 - w_{11}$	$w_{11} - PC$

Your payoff:
In addition to the (possibly negative) profit realized in the experiment you get 4 Euro and the resulting amount is paid out to you in cash.

Figure 1: Stage 1 – Merchant decides on wage offers

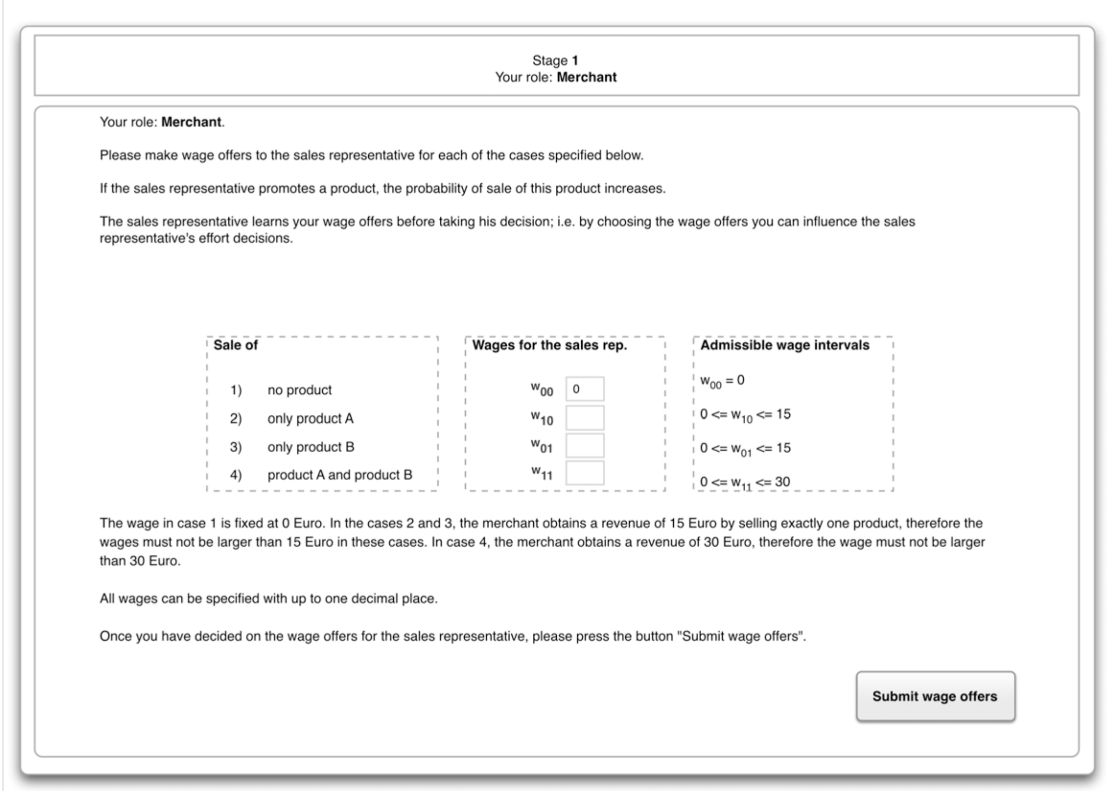
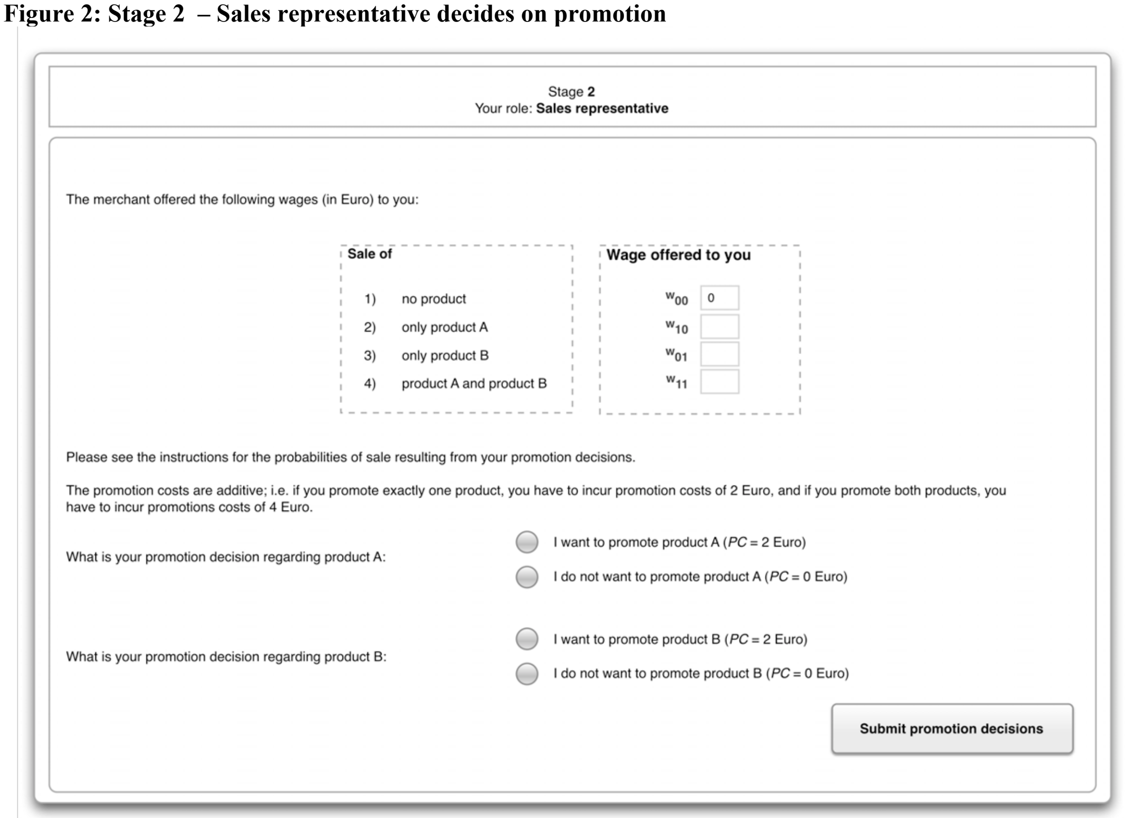


Figure 2: Stage 2 – Sales representative decides on promotion



Comprehension questions

Question 1:
Which of the following statements is true:

1. Promoting a product increases the probability of sale of this product.
2. Promoting a product decreases the probability of sale of this product.
3. Promoting a product has no effect on the probability of sale of this product.

Question 2:
Which of the following statements is true:

1. The merchant offers his sales representative exactly one wage.
2. The merchant can offer his sales representative different wages depending on the number of products sold.
3. The sales representative can demand a wage from the merchant.

Question 3:
Which of the following statements is true.

1. Suppose you are the sales representative. Once you have decided on your promotion effort, you know exactly how many products will be sold.
2. Suppose you are the sales representative. Once you have decided on your promotion effort, the probabilities of sale depend on the magnitude of the wages.
3. Suppose you are the sales representative. Once you have decided on your promotion effort, you know the probabilities of sale.

Question 4:
Which of the following statements is true:

1. The merchant can condition his wages on whether the sales representative has promoted the products.
2. The merchant can offer wages conditional on the number of products sold.
3. The merchant can offer wages conditional on the probabilities of sale of the products.
4. The sales representative sets the wages.

Question 5:
Which of the following statements is true:

1. Wage w_{10} is paid if no product is sold.
2. Wage w_{10} is paid if only product A but not product B is sold.
3. Wage w_{10} is paid if both products are sold.
4. Wage w_{10} is paid if only product B but not product A is sold.

Question 6:
What is the probability that only product B is sold when the sales representative promotes only product A?

Question 7:
What is the probability that wage w_{10} is paid when the sales representative promotes both products?

The following instructions and comprehension questions were handed out to the participants in the treatment with two agents and conflict ($\gamma = 0.3$):

Experimental instructions

In this experiment, you can earn money. Your payoff depends on your decisions and on other participants' decisions.

During the whole experiment communication is not allowed. If you have a question, please raise your hand out of the cabin. All decisions are anonymous; i.e., no participant ever learns the identity of a person who has made a particular decision. The payment is conducted anonymously, too; i.e., no participant learns what the payoff of another participant is.

In this experiment, you will either be a merchant with a probability of one-third or a sales representative with a probability of two-thirds. Every merchant is matched with two sales representatives (sales representative A and sales representative B). As soon as the experiment starts, you will learn whether you have been assigned to the role of a merchant or to the role of a sales representative.

The merchant can sell exactly one unit of a product A via sales representative A and exactly one unit of a product B via sales representative B. Product A and product B are similar. The merchant receives a revenue of 15 Euro for each product sold. He can pay his sales representatives wages depending on the number of products sold.
(Suppose that the costs the merchant had to incur when purchasing the products are not relevant in this experiment. Furthermore, the merchant does not have to bear any stockkeeping costs if product A or product B is not sold.)

Each sales representative (sales representative A and sales representative B, respectively) can decide whether he wants to promote his product (product A and product B, respectively). If no sales representative promotes his product, the probability of sale of each product is 40%. If a sales representative promotes his product, the probability of sale of his product increases by 50 percentage points while the probability of sale of the other sales representative's product decreases by 30 percentage points. Each sales representative can decide whether to promote his product or not. The resulting probabilities of sale depend on whether *no sales representative*, *one sales representative*, or *both sales representatives* promote their respective product:

- If no sales representative promotes his product, then each product will be sold with a probability of 40%.
- If sales representative A promotes his product and sales representative B does not promote his product, then product A will be sold with a probability of 40% + 50% = 90%, and product B will be sold with a probability of 40% - 30% = 10%.
- If sales representative B promotes his product and sales representative A does not promote his product, then product B will be sold with a probability of 40% + 50% = 90%, and product A will be sold with a probability of 40% - 30% = 10%.
- If both sales representatives promote their respective product, then product A and product B will be sold with a probability of 40% + 50% - 30% = 60% each.

As the products are similar, promotion effort for one product does not only have a positive effect on the probability of sale of the promoted product, but it has also a negative effect on the probability of sale of the other product.

		Sales representative B	
		does not promote product B	promotes product B
Sales representative A	does not promote product A	40%, 40%	10%, 90%
	promotes product A	90%, 10%	60%, 60%

In each cell, the first number denotes the probability of sale of product A, while the second number denotes the probability of sale of product B.

If a sales representative promotes his product, he has to incur promotion costs *PC* = 2 Euro. If a sales representative does not promote his product, he does not have to incur promotion costs (*PC* = 0 Euro).

The merchant cannot observe whether his sales representatives decide to promote their products or not. Thus, the merchant cannot condition his wage offers on the sales representatives' promotion decisions but only on the number of products sold. A sales representative also cannot observe the promotion decision of the other sales representative.

In detail, the experiment proceeds as follows:

The experiment consists of only a single period.
This period consists of two stages.

Stage 1 – Merchant decides on wage offers

The merchant offers his sales representatives wages depending on the number of products sold. There are four possible cases. For each case, the merchant can specify one wage:

1. neither product A nor product B are sold
   → wage w_{00}^A for sales representative A and w_{00}^B for sales representative B
2. only product A but not product B is sold
   → wage w_{10}^A for sales representative A and w_{10}^B for sales representative B
3. only product B but not product A is sold
   → wage w_{01}^A for sales representative A and w_{01}^B for sales representative B
4. both products A and B are sold
   → wage w_{11}^A for sales representative A and w_{11}^B for sales representative B

As the merchant obtains no revenue in case 1, the wages w_{00}^A and w_{00}^B are fixed at 0 Euro. In the cases 2, 3, and 4, the merchant has to set the wages w_{10}^A and w_{10}^B, w_{01}^A and w_{01}^B, w_{11}^A and w_{11}^B for his sales representatives A and B (see Figure 1 on the last page).
(All wages can be specified with up to one decimal place. Please use points instead of commas as decimal separators.)

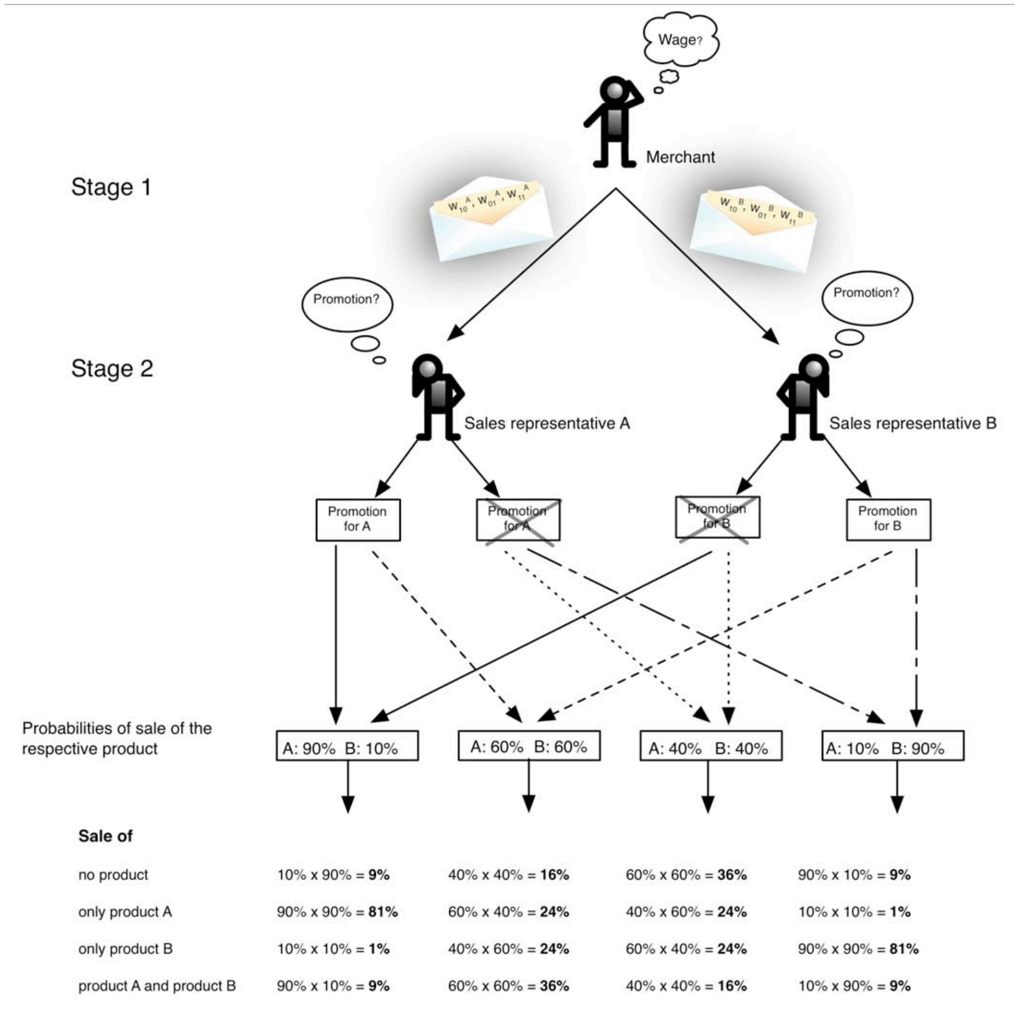
Stage 2 – Sales representatives A and B decide on promotion

The sales representatives A and B learn every wage offer the merchant has made in stage 1. Thus, a sales representative knows the wages he may receive as well as the wages that the merchant may pay to the other sales representative.

Each sales representative then can decide whether to promote his product or not (see Figure 2 on the last page).

Once the sales representatives have decided on their promotion effort, the probabilities of sale of the products are determined (as described above). According to these probabilities, the computer decides randomly whether *no*, *exactly one*, or *both products* are sold.

Diagram of the experiment:

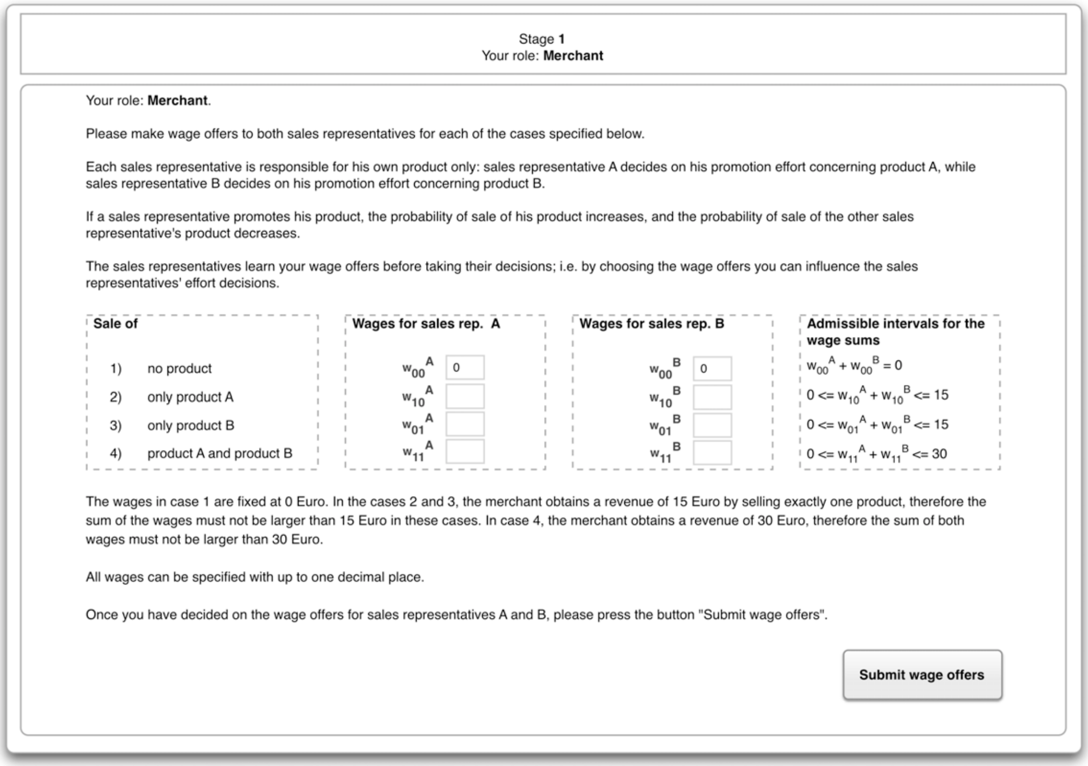


The profits are as follows:

Sale of	**merchant's profit**	**sales rep. A's profit**	**sales rep. B's profit**
no product	$0 - w_{00}^{A} - w_{00}^{B} = 0$	$w_{00}^{A} - PC = 0 - PC$	$w_{00}^{B} - PC = 0 - PC$
only product A	$15 - w_{10}^{A} - w_{10}^{B}$	$w_{10}^{A} - PC$	$w_{10}^{B} - PC$
only product B	$15 - w_{01}^{A} - w_{01}^{B}$	$w_{01}^{A} - PC$	$w_{01}^{B} - PC$
product A and product B	$30 - w_{11}^{A} - w_{11}^{B}$	$w_{11}^{A} - PC$	$w_{11}^{B} - PC$

Your payoff:
In addition to the (possibly negative) profit realized in the experiment you get 4 Euro and the resulting amount is paid out to you in cash.

Figure 1: Stage 1 – Merchant decides on wage offers



Stage **1**
Your role: **Merchant**

Your role: **Merchant**.

Please make wage offers to both sales representatives for each of the cases specified below.

Each sales representative is responsible for his own product only: sales representative A decides on his promotion effort concerning product A, while sales representative B decides on his promotion effort concerning product B.

If a sales representative promotes his product, the probability of sale of his product increases, and the probability of sale of the other sales representative's product decreases.

The sales representatives learn your wage offers before taking their decisions; i.e. by choosing the wage offers you can influence the sales representatives' effort decisions.

Sale of	Wages for sales rep. A	Wages for sales rep. B	Admissible intervals for the wage sums
1) no product	w_{00}^A 0	w_{00}^B 0	$w_{00}^A + w_{00}^B = 0$
2) only product A	w_{10}^A	w_{10}^B	$0 <= w_{10}^A + w_{10}^B <= 15$
3) only product B	w_{01}^A	w_{01}^B	$0 <= w_{01}^A + w_{01}^B <= 15$
4) product A and product B	w_{11}^A	w_{11}^B	$0 <= w_{11}^A + w_{11}^B <= 30$

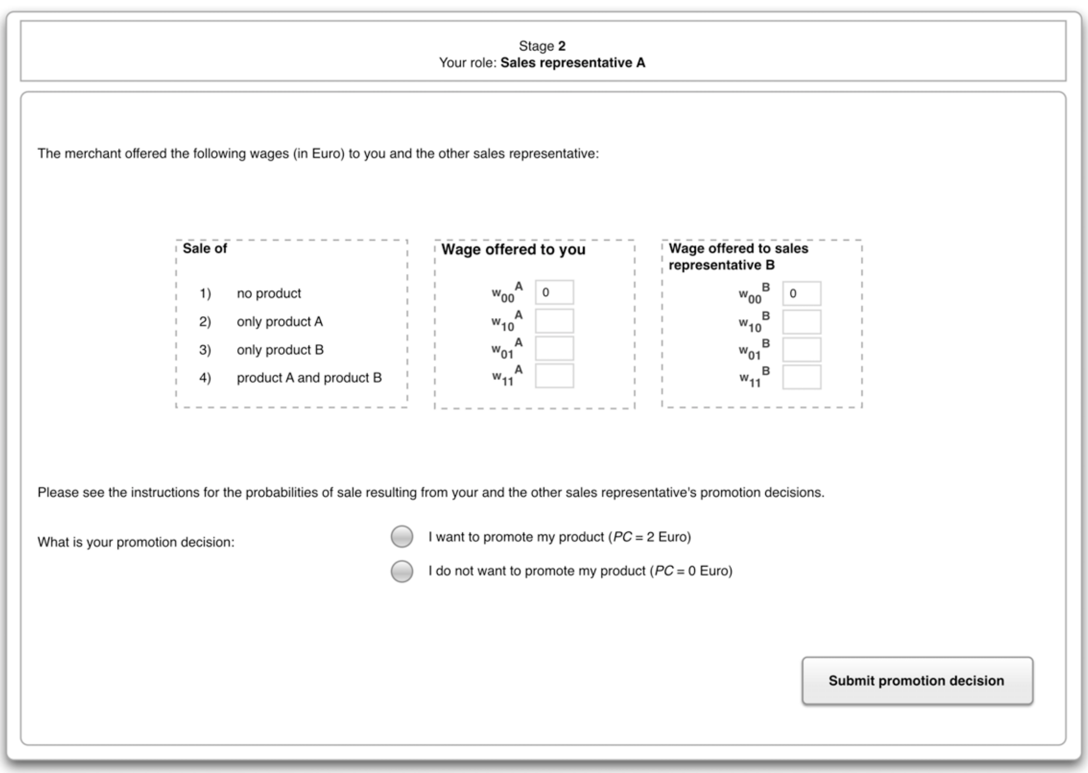
The wages in case 1 are fixed at 0 Euro. In the cases 2 and 3, the merchant obtains a revenue of 15 Euro by selling exactly one product, therefore the sum of the wages must not be larger than 15 Euro in these cases. In case 4, the merchant obtains a revenue of 30 Euro, therefore the sum of both wages must not be larger than 30 Euro.

All wages can be specified with up to one decimal place.

Once you have decided on the wage offers for sales representatives A and B, please press the button "Submit wage offers".

Submit wage offers

Figure 2: Stage 2 – Sales representatives A and B decide on promotion



Stage **2**
Your role: **Sales representative A**

The merchant offered the following wages (in Euro) to you and the other sales representative:

Sale of	Wage offered to you	Wage offered to sales representative B
1) no product	w_{00}^A 0	w_{00}^B 0
2) only product A	w_{10}^A	w_{10}^B
3) only product B	w_{01}^A	w_{01}^B
4) product A and product B	w_{11}^A	w_{11}^B

Please see the instructions for the probabilities of sale resulting from your and the other sales representative's promotion decisions.

What is your promotion decision:
- I want to promote my product (*PC* = 2 Euro)
- I do not want to promote my product (*PC* = 0 Euro)

Submit promotion decision

Comprehension questions

Question 1:
Which of the following statements is true:

1. Promoting a product increases the probability of sale of this product and decreases the probability of sale of the other product.
2. Promoting a product increases the probability of sale of this product and increases the probability of sale of the other product.
3. Promoting a product decreases the probability of sale of this product and increases the probability of sale of the other product.
4. Promoting a product increases the probability of sale of this product and has no effect on the probability of sale of the other product.

Question 2:
Which of the following statements is true:

1. The merchant offers his sales representatives exactly one wage.
2. The merchant can offer his sales representatives different wages depending on the number of products sold.
3. The sales representatives can demand a wage from the merchant.

Question 3:
Which of the following statements is true:

1. Suppose you are a sales representative. Once you have decided on your promotion effort, you know exactly how many products will be sold.
2. Suppose you are a sales representative. Once you have decided on your promotion effort, the probabilities of sale depend on the magnitude of the wages.
3. Suppose you are a sales representative. Once you have decided on your promotion effort, the probabilities of sale depend on the promotion effort decision of the other sales representative.

Question 4:
Which of the following statements is true:

1. The merchant can condition his wages on whether the sales representatives have promoted the products.
2. The merchant can offer wages conditional on the number of products sold.
3. The merchant can offer wages conditional on the probabilities of sale of the products.
4. The sales representatives set the wages.

Question 5:
Which of the following statements is true:

1. Wage w_{10}^{A} is paid if no product is sold.
2. Wage w_{10}^{A} is paid to sales representative A if only product A but not product B is sold.
3. Wage w_{10}^{A} is paid to sales representative B if both products are sold.
4. Wage w_{10}^{A} is paid to sales representative B if only product B but not product A is sold.

Question 6:
What is the probability that only product B is sold when sales representative A promotes product A but sales representative B does not promote product B?

Question 7:
What is the probability that wage w_{10}^{A} is paid if both sales representatives promote their respective product?

The following instructions and comprehension questions were handed out to the participants in the treatment with two agents and without conflict ($\gamma = 0$):

Experimental instructions

In this experiment, you can earn money. Your payoff depends on your decisions and on other participants' decisions.

During the whole experiment communication is not allowed. If you have a question, please raise your hand out of the cabin. All decisions are anonymous; i.e., no participant ever learns the identity of a person who has made a particular decision. The payment is conducted anonymously, too; i.e., no participant learns what the payoff of another participant is.

In this experiment, you will either be a merchant with a probability of one-third or a sales representative with a probability of two-thirds. Every merchant is matched with two sales representatives (sales representative A and sales representative B). As soon as the experiment starts, you will learn whether you have been assigned to the role of a merchant or to the role of a sales representative.

The merchant can sell exactly one unit of a product A via sales representative A and exactly one unit of a product B via sales representative B. The merchant receives a revenue of 15 Euro for each product sold. He can pay his sales representatives wages depending on the number of products sold.
(Suppose that the costs the merchant had to incur when purchasing the products are not relevant in this experiment. Furthermore, the merchant does not have to bear any stockkeeping costs if product A or product B is not sold.)

Each sales representative (sales representative A and sales representative B, respectively) can decide whether he wants to promote his product (product A and product B, respectively). If no sales representative promotes his product, the probability of sale of each product is 40%. If a sales representative promotes his product, the probability of sale of his product increases by 50 percentage points. Each sales representative can decide whether to promote his product or not. The resulting probabilities of sale depend on whether *no sales representative*, *one sales representative*, or *both sales representatives* promote their respective product.

- If no sales representative promotes his product, then each product will be sold with a probability of 40%.
- If sales representative A promotes his product and sales representative B does not promote his product, then product A will be sold with a probability of 40% + 50% = 90%, and product B still will be sold with a probability of 40%.
- If sales representative B promotes his product and sales representative A does not promote his product, then product B will be sold with a probability of 40% + 50% = 90%, and product A still will be sold with a probability of 40%.
- If both sales representatives promote their respective product, then product A and product B will be sold with a probability of 40% + 50% = 90% each.

Sales representative A	Probability of sale of product A
does not promote product A	40%
promotes product A	90%

Sales representative B	Probability of sale of product B
does not promote product B	40%
promotes product B	90%

If a sales representative promotes his product, he has to incur promotion costs *PC* = 2 Euro. If a sales representative does not promote his product, he does not have to incur promotion costs (*PC* = 0 Euro).

The merchant cannot observe whether his sales representatives decide to promote their products or not. Thus, the merchant cannot condition his wage offers on the sales representatives' promotion decisions but only on the number of products sold. A sales representative also cannot observe the promotion decision of the other sales representative.

In detail, the experiment proceeds as follows:

The experiment consists of only a single period.
This period consists of two stages.

Stage 1 – Merchant decides on wage offers

The merchant offers his sales representatives wages depending on the number of products sold. There are four possible cases. For each case, the merchant can specify one wage:

1. neither product A nor product B are sold
   → wage w_{00}^{A} for sales representative A and w_{00}^{B} for sales representative B
2. only product A but not product B is sold
   → wage w_{10}^{A} for sales representative A and w_{10}^{B} for sales representative B
3. only product B but not product A is sold
   → wage w_{01}^{A} for sales representative A and w_{01}^{B} for sales representative B
4. both products A and B are sold
   → wage w_{11}^{A} for sales representative A and w_{11}^{B} for sales representative B

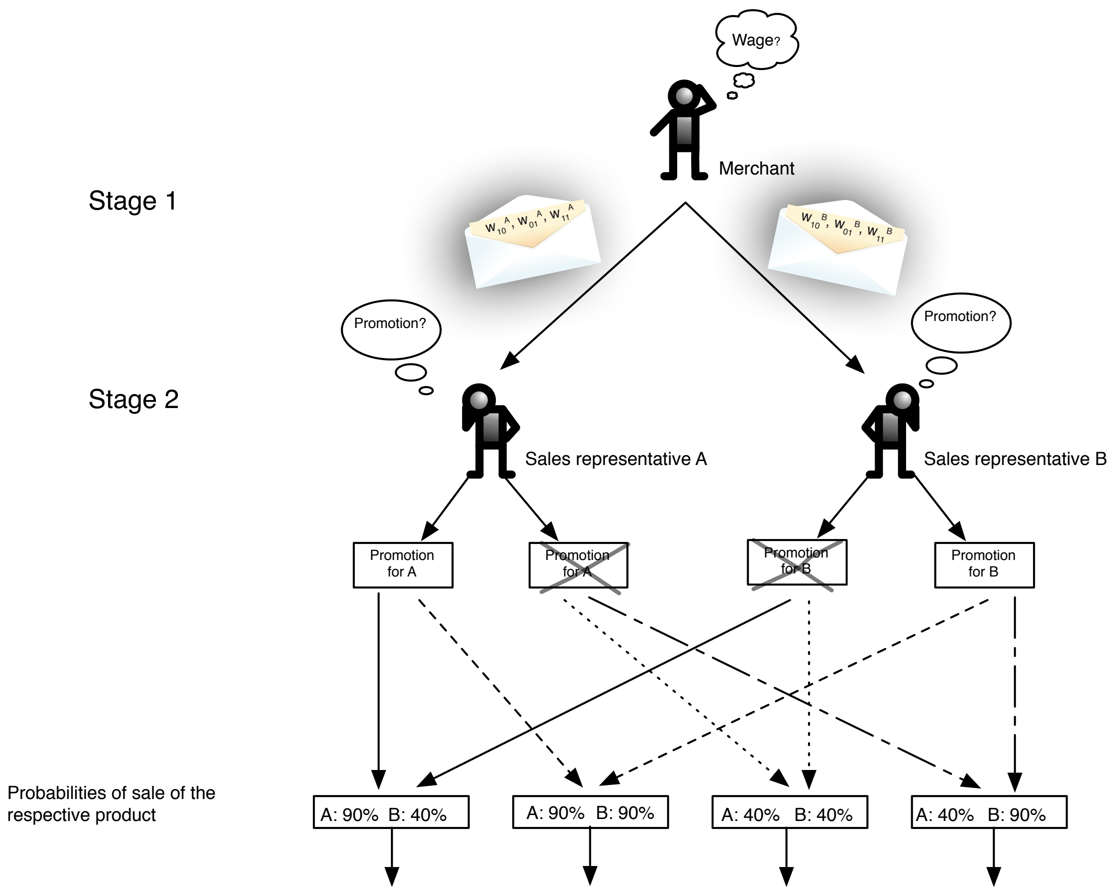
As the merchant obtains no revenue in case 1, the wages w_{00}^{A} and w_{00}^{B} are fixed at 0 Euro. In the cases 2, 3, and 4, the merchant has to set the wages w_{10}^{A} and w_{10}^{B}, w_{01}^{A} and w_{01}^{B}, w_{11}^{A} and w_{11}^{B} for his sales representatives A and B (see Figure 1 on the last page).
(All wages can be specified with up to one decimal place. Please use points instead of commas as decimal separators.)

Stage 2 – Sales representatives A and B decide on promotion

The sales representatives A and B learn every wage offer the merchant has made in stage 1. Thus, a sales representative knows the wages he may receive as well as the wages that the merchant may pay to the other sales representative.
Each sales representative then can decide whether to promote his product or not (see Figure 2 on the last page).

Once the sales representatives have decided on their promotion effort, the probabilities of sale of the products are determined (as described above). According to these probabilities, the computer decides randomly whether *no*, *exactly one*, or *both products* are sold.

Diagram of the experiment:



Sale of				
no product	10% x 60% = **6%**	10% x 10% = **1%**	60% x 60% = **36%**	60% x 10% = **6%**
only product A	90% x 60% = **54%**	90% x 10% = **9%**	40% x 60% = **24%**	40% x 10% = **4%**
only product B	10% x 40% = **4%**	10% x 90% = **9%**	60% x 40% = **24%**	60% x 90% = **54%**
product A and product B	90% x 40% = **36%**	90% x 90% = **81%**	40% x 40% = **16%**	40% x 90% = **36%**

The profits are as follows:

Sale of	**merchant's profit**	**sales rep. A's profit**	**sales rep. B's profit**
no product	$0 - w_{00}^{A} - w_{00}^{B} = 0$	$w_{00}^{A} - PC = 0 - PC$	$w_{00}^{B} - PC = 0 - PC$
only product A	$15 - w_{10}^{A} - w_{10}^{B}$	$w_{10}^{A} - PC$	$w_{10}^{B} - PC$
only product B	$15 - w_{01}^{A} - w_{01}^{B}$	$w_{01}^{A} - PC$	$w_{01}^{B} - PC$
product A and product B	$30 - w_{11}^{A} - w_{11}^{B}$	$w_{11}^{A} - PC$	$w_{11}^{B} - PC$

Your payoff:
In addition to the (possibly negative) profit realized in the experiment you get 4 Euro and the resulting amount is paid out to you in cash.

Figure 1: Stage 1 – Merchant decides on wage offers

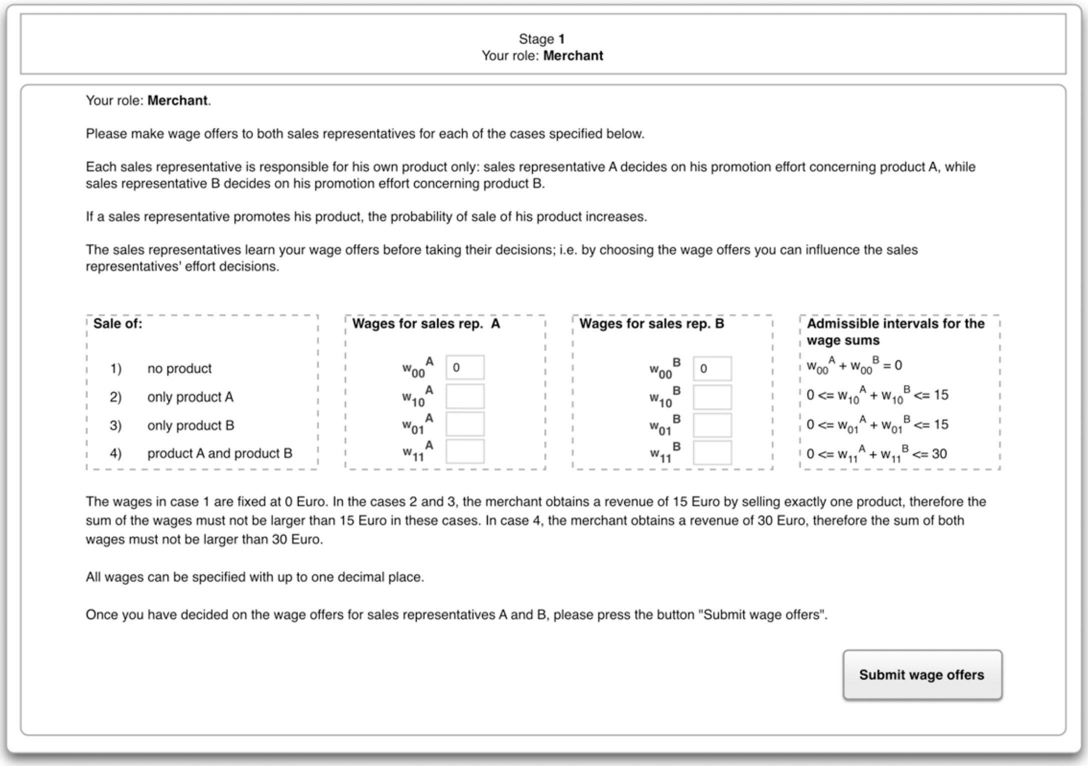
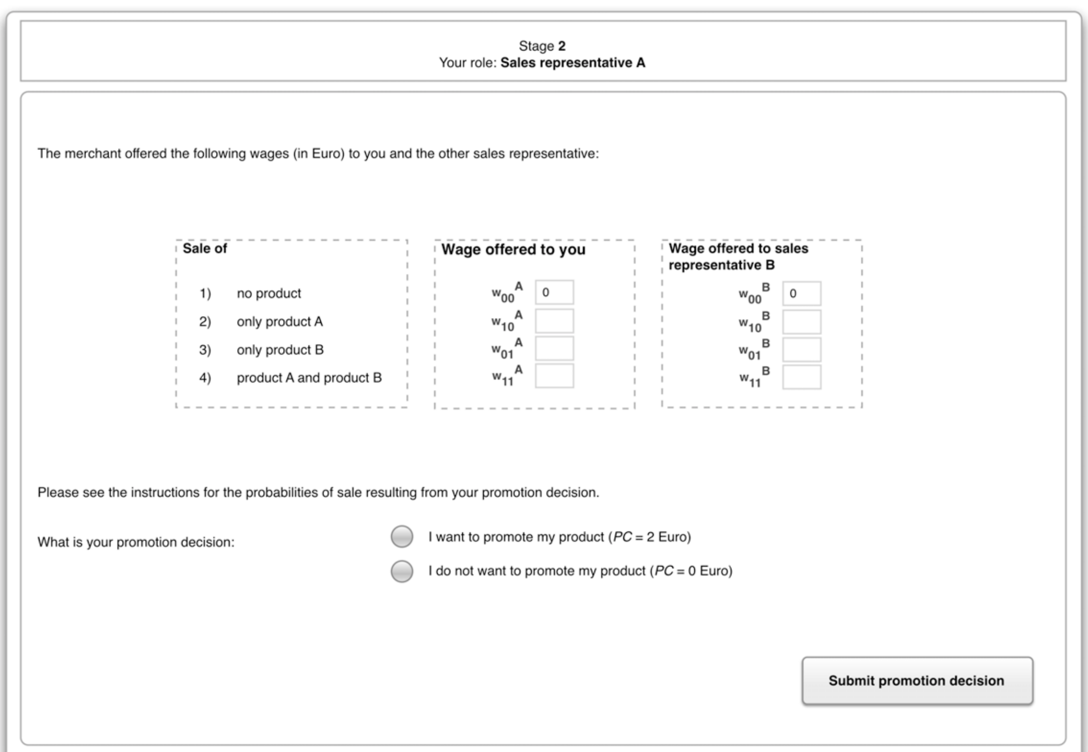


Figure 2: Stage 2 – Sales representatives A and B decide on promotion



Comprehension questions

Question 1:
Which of the following statements is true:
1. Promoting a product increases the probability of sale of this product.
2. Promoting a product decreases the probability of sale of this product.
3. Promoting a product has no effect on the probability of sale of this product.

Question 2:
Which of the following statements is true:

1. The merchant offers his sales representatives exactly one wage.
2. The merchant can offer his sales representatives different wages depending on the number of products sold.
3. The sales representatives can demand a wage from the merchant.

Question 3:
Which of the following statements is true:

1. Suppose you are a sales representative. Once you have decided on your promotion effort, your product will be sold with certainty.
2. Suppose you are a sales representative. Once you have decided on your promotion effort, the probabilities of sale depend on the magnitude of the wages.
3. Suppose you are a sales representative. Once you have decided on your promotion effort, you know the probability of sale of your product.

Question 4:
Which of the following statements is true:

1. The merchant can condition his wages on whether the sales representatives have promoted the products.
2. The merchant can offer wages conditional on the number of products sold.
3. The merchant can offer wages conditional on the probabilities of sale of the products.
4. The sales representatives set the wages.

Question 5:
Which of the following statements is true:

1. Wage w_{10}^{A} is paid if no product is sold.
2. Wage w_{10}^{A} is paid to sales representative A if only product A but not product B is sold.
3. Wage w_{10}^{A} is paid to sales representative B if both products are sold.
4. Wage w_{10}^{A} is paid to sales representative B if only product B but not product A is sold.

Question 6:
What is the probability that only product B is sold when sales representative A promotes product A but sales representative B does not promote product B?

Question 7:
What is the probability that wage w_{10}^{A} is paid if both sales representatives promote their respective product?

One agent - Conflict

w10	w01	w11	Effort	Optimal decision
0.0	0.0	0.0	0	0
8.5	0.0	0.0	0	1
2.5	2.5	4.5	0	0
2.5	2.5	5.0	0	0
3.0	3.0	7.0	0	0
4.0	4.0	8.0	0	0
4.0	4.0	8.0	0	0
4.0	2.0	9.0	0	0
0.0	0.0	10.0	0	0
5.0	5.0	10.0	0	0
6.0	6.0	10.0	0	0
6.0	6.0	13.0	0	0
7.0	7.0	13.0	0	0
0.0	0.0	30.0	0	2
4.5	4.5	5.0	1	0
13.0	6.0	6.0	1	1
4.0	4.0	8.0	1	0
4.5	4.5	10.0	1	0
8.0	8.0	10.0	1	1
5.0	5.0	12.0	1	0
7.0	7.0	13.0	1	0
6.8	6.8	13.6	1	0
7.0	7.0	14.0	1	0
7.0	7.0	14.0	1	0
8.0	8.0	14.0	1	0
7.0	7.0	15.0	1	0
7.0	7.0	15.0	1	0
7.0	7.0	15.0	1	0
7.5	7.5	15.0	1	0
7.5	7.5	15.0	1	0
8.0	8.0	15.0	1	0
10.0	10.0	15.0	1	1
7.5	7.5	15.5	1	0
8.0	8.0	16.0	1	0
7.0	7.0	16.5	1	0
8.5	8.5	17.0	1	0
8.5	8.5	17.0	1	0
8.5	6.5	18.5	1	1
5.5	5.5	11.5	2	0
7.0	7.0	12.5	2	0
2.0	2.0	14.0	2	0
5.0	5.0	14.0	2	0
6.0	6.0	14.0	2	0
7.2	7.2	14.5	2	0
0.0	0.0	15.0	2	0
5.0	5.0	15.0	2	0
5.0	5.0	15.0	2	0
6.0	6.0	15.0	2	0
7.0	7.0	15.0	2	0
7.0	7.0	15.0	2	0
7.5	7.5	15.0	2	0
8.0	8.0	15.0	2	0
8.0	8.0	16.0	2	0
6.0	6.0	17.0	2	0
7.0	7.0	17.0	2	0
7.5	7.5	17.0	2	0
8.0	8.0	17.0	2	0
8.5	8.5	17.0	2	0
8.5	8.5	17.0	2	0
15.0	15.0	30.0	2	2

One agent - No conflict				
w10	w01	w11	Effort	Optimal decision
4.0	7.5	7.5	0	1
5.0	5.0	10.0	0	2
5.0	5.0	16.5	0	2
3.0	3.0	11.0	1	2
6.5	6.5	13.0	1	2
6.0	6.0	14.0	1	2
7.5	7.5	15.0	1	2
2.0	2.0	7.0	2	0
3.0	3.0	7.0	2	0
0.0	0.0	10.0	2	2
1.0	1.0	10.0	2	2
5.0	5.0	10.0	2	2
5.0	5.0	10.0	2	2
3.0	3.0	12.0	2	2
4.0	4.0	12.0	2	2
4.0	4.0	12.0	2	2
5.0	5.0	12.0	2	2
5.0	5.0	12.0	2	2
2.0	2.0	13.0	2	2
5.0	5.0	13.0	2	2
9.0	5.0	13.0	2	2
0.0	0.0	14.0	2	2
0.0	0.0	14.0	2	2
4.0	4.0	14.0	2	2
4.0	4.0	14.0	2	2
6.0	6.0	14.0	2	2
6.0	6.0	14.0	2	2
6.5	6.5	14.0	2	2
7.0	7.0	14.0	2	2
7.0	7.0	14.0	2	2
7.0	7.0	14.0	2	2
7.0	8.0	14.0	2	2
7.0	7.0	14.0	2	2
4.0	4.0	15.0	2	2
5.0	5.0	15.0	2	2
6.0	6.0	15.0	2	2
6.0	6.0	15.0	2	2
7.0	7.0	15.0	2	2
7.5	7.5	15.0	2	2
7.5	7.5	15.0	2	2
8.5	8.5	15.0	2	2
0.0	0.0	15.5	2	2
7.5	7.5	15.5	2	2
3.0	3.0	16.0	2	2
5.0	5.0	16.0	2	2
5.0	5.0	16.0	2	2
7.0	7.0	16.0	2	2
7.0	7.0	16.0	2	2
7.5	7.5	16.0	2	2
8.0	8.0	16.0	2	2
7.0	7.0	16.5	2	2
7.0	7.0	17.0	2	2
8.5	8.5	17.0	2	2
9.0	9.0	17.0	2	2
9.5	9.5	17.0	2	2
12.0	12.0	26.0	2	2
10.0	12.0	29.0	2	2

Two agents - Conflict

w10A	w01A	w11A	w10B	w01B	w11B	Effort	dominant strategy agent A	dominant strategy agent B
4.0	0.0	2.5	0.0	4.0	2.5	0	no dominant strategy	no dominant strategy
0.0	0.0	0.0	0.0	5.0	5.0	1	no effort	effort
3.0	0.0	4.0	0.0	3.0	4.0	1	no effort	no effort
5.0	0.0	5.0	0.0	5.0	5.0	1	effort	effort
4.0	0.0	6.0	0.0	4.0	6.0	1	no dominant strategy	no dominant strategy
5.0	0.0	7.5	0.0	5.0	7.5	1	effort	effort
6.5	3.5	8.5	3.5	6.5	8.5	1	no dominant strategy	no dominant strategy
4.5	4.5	9.5	4.5	4.5	9.5	1	no effort	no effort
5.0	5.0	10.0	5.0	5.0	10.0	1	no effort	no effort
8.0	2.0	10.0	2.0	8.0	10.0	1	effort	effort
1.0	1.5	2.0	1.0	1.5	2.0	2	no effort	no effort
5.0	0.0	5.0	0.0	5.0	5.0	2	effort	effort
4.0	2.0	6.0	2.0	4.0	6.0	2	no effort	no effort
4.0	2.0	6.0	2.0	4.0	6.0	2	no effort	no effort
2.5	0.0	6.5	0.0	2.5	6.5	2	no dominant strategy	no dominant strategy
4.0	2.0	7.0	0.0	4.0	7.0	2	no effort	no dominant strategy
5.0	3.0	7.0	3.0	5.0	7.0	2	no effort	no effort
5.0	2.0	7.0	2.0	5.0	7.0	2	no effort	no effort
6.0	0.0	7.0	0.0	6.0	7.0	2	effort	effort
6.0	2.0	7.0	2.0	6.0	7.0	2	effort	effort
3.0	3.0	8.0	3.0	3.0	8.0	2	no effort	no effort
5.0	5.0	8.0	5.0	5.0	8.0	2	no effort	no effort
5.0	0.0	8.0	0.0	5.0	8.0	2	effort	effort
6.0	2.0	8.0	2.0	6.0	8.0	2	effort	effort
7.5	0.0	8.0	0.0	7.5	8.0	2	effort	effort
5.5	1.0	9.0	1.0	5.5	9.0	2	effort	effort
6.0	0.0	9.0	0.0	6.0	9.0	2	effort	effort
7.0	2.0	9.0	2.0	7.0	9.0	2	effort	effort
7.0	2.0	9.0	2.0	7.0	9.0	2	effort	effort
7.5	0.0	9.0	0.0	7.5	9.0	2	effort	effort
11.4	0.0	9.6	0.0	11.4	9.6	2	effort	effort
5.0	4.0	10.0	4.0	6.0	10.0	2	no effort	no effort
5.0	5.0	10.0	5.0	5.0	10.0	2	no effort	no effort
5.0	5.0	10.0	5.0	5.0	10.0	2	no effort	no effort
5.0	4.0	10.0	4.0	5.0	10.0	2	no effort	no effort
7.0	3.0	10.0	3.0	7.0	10.0	2	effort	effort
7.5	0.0	10.0	0.0	7.5	10.0	2	effort	effort
10.0	5.0	10.0	5.0	10.0	10.0	2	effort	effort
5.7	5.6	10.7	5.6	5.7	10.7	2	no effort	no effort
10.0	5.0	15.0	5.0	10.0	15.0	2	effort	effort

Two agents - No conflict

w10A	w01A	w11A	w10B	w01B	w11B	Effort	dominant strategy agent A	dominant strategy agent B
2.0	0.0	2.0	0.0	2.0	2.0	0	no effort	no effort
3.0	0.0	2.8	0.0	3.0	2.8	0	no effort	no effort
1.0	1.0	4.0	1.0	1.0	4.0	1	no effort	no effort
3.0	1.0	4.0	1.0	3.0	4.0	1	no effort	no effort
4.0	0.0	4.0	0.0	4.0	4.0	1	no dominant strategy	no dominant strategy
5.5	0.0	5.5	0.0	5.5	5.5	1	effort	effort
4.5	3.0	6.0	3.0	4.5	6.0	1	no effort	no effort
5.5	2.0	8.0	2.0	5.5	8.0	1	effort	effort
6.0	4.0	8.0	4.0	6.0	8.0	1	effort	effort
3.0	2.0	10.0	2.0	3.0	10.0	1	effort	effort
7.5	0.0	10.0	0.0	7.5	10.0	1	effort	effort
7.5	7.5	15.0	7.5	7.5	15.0	1	effort	effort
4.0	0.0	5.0	0.0	4.0	5.0	2	effort	effort
5.0	0.0	5.0	0.0	5.0	5.0	2	effort	effort
5.0	0.0	5.0	0.0	5.0	5.0	2	effort	effort
4.0	0.0	7.0	0.0	4.0	7.0	2	effort	effort
7.0	0.0	7.0	0.0	7.0	7.0	2	effort	effort
7.0	0.0	7.0	0.0	7.0	7.0	2	effort	effort
6.0	0.0	7.5	0.0	6.0	7.5	2	effort	effort
7.5	2.0	7.5	2.0	7.5	7.5	2	effort	effort
3.0	3.0	8.0	3.0	3.0	8.0	2	no dominant strategy	no dominant strategy
6.0	0.0	8.0	0.0	6.0	8.0	2	effort	effort
6.0	1.0	8.0	1.0	6.0	8.0	2	effort	effort
6.0	2.0	8.0	2.0	6.0	8.0	2	effort	effort
7.0	1.0	8.0	1.0	7.0	8.0	2	effort	effort
4.0	0.0	9.0	0.0	4.0	9.0	2	effort	effort
6.0	2.0	9.0	2.0	6.0	9.0	2	effort	effort
7.0	3.0	9.0	3.0	7.0	9.0	2	effort	effort
7.0	0.0	9.0	0.0	7.0	9.0	2	effort	effort
7.5	1.0	9.0	1.0	7.5	9.0	2	effort	effort
5.0	5.0	10.0	5.0	5.0	10.0	2	effort	effort
5.0	5.0	10.0	5.0	5.0	10.0	2	effort	effort
7.0	3.0	10.0	3.0	7.0	10.0	2	effort	effort
7.2	2.2	10.0	2.2	7.2	10.0	2	effort	effort
7.5	0.0	10.0	0.0	7.5	10.0	2	effort	effort
8.0	0.0	10.0	0.0	8.0	10.0	2	effort	effort
6.0	4.0	10.2	4.0	6.0	10.2	2	effort	effort
6.0	3.0	10.5	3.0	6.0	10.5	2	effort	effort
12.0	3.0	15.0	3.0	12.0	15.0	2	effort	effort
15.0	0.0	15.0	0.0	15.0	15.0	2	effort	effort