Loss contracts do not increase group effort (but gender does)*

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Abstract

In this paper we study the effects that loss contracts – prepayments that can be clawed back later – have on group coordination when there is strategic uncertainty. To do so, we compare the choices made by experimental subjects in a minimum effort game. In control sessions incentives are formulated as a classical gain contract, while in treatment sessions incentives are framed as an isomorphic loss contract. Our results show that loss contracts result in a decrease of both the effort and the coordination of participants. However, these results depend strongly on the gender composition of groups; those groups with a higher proportion of females are better at coordinating and do so for higher efforts. Such differences in behavior result in strong welfare effects.

Keywords strategic uncertainty, loss aversion, coordination, contract design, framing, experiment

JEL Classification C91 · D84 · G11 · G41

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1 Introduction

Coordination lies at the center of most organizational settings. In those contexts, the decision of any single member can impact the entire business process of the firm. This is apparent in assembly lines or just-in-time inventory systems, but also applies to other less obvious settings such as an advertising company with a shirking graphic designer or a restaurant with an especially slow waiter.

In such organizational settings, having all subjects coordinate on a high effort can be complicated as individuals face a trade-off: while exerting more effort might result in higher productivity, such efforts might be wasted if someone else along the chain (the weakest link) is not keeping up to speed. One way to mitigate this coordination failure is to increase the monetary benefits from coordination (Brandts and Cooper, 2006). Yet, this measure is expensive. A recent, popular and cost-effective suggestion to increase effort is the use of so-called loss contracts (e.g., Hossain and List, 2012). In a loss contract, individuals are prepaid and then clawed back if certain productivity targets are unmet.

The intuition for the application of loss contracts rests on the presence loss aversion: since losses loom larger than gains, loss averse individuals will work harder to avoid the loss of a dollar than to gain an additional dollar (e.g., Hossain and List, 2012; Imas et al., 2016; De Quidt, 2017). However, this intuition is based on the assumption that higher levels of effort guarantee a higher payoff or reduce the probability of a claw-back. This might hold for some individual decision-making situations, but is not realistic in many setups that require groups to coordinate. In a situation with strategic uncertainty – for example, when productivity relies on the "weakest link" – the interaction between loss and risk aversion might backfire and induce individuals to exert lower effort. The reason is that, if losses loom larger than gains, then the uncertainty of outcome-related losses might also loom larger than the potential gains, pushing individuals towards low effort "risk minimizing" strategies (Pierce et al., 2020).[1]

Against this background, we study how loss contracts affect the coordinated efforts within groups when there is strategic uncertainty. To do so, we design a between-

[1]Pierce et al. (2020) present a principal-agent problem where agents face a set of effort strategies that cannot be ordered on a first-order stochastic dominance criteria, trading off lower profits for higher security (as happens in a minimum effort game). In this setting, whenever loss aversion is large enough, loss contracts will have perverse effects and drive individuals to reduce their effort to mitigate their exposure to (large) losses.

subject experiment in which subjects play multiple rounds of the "minimum effort game" (Van Huyck et al., 1990), also known as the "weakest link" game (e.g., Engelmann and Normann, 2010; Knez and Camerer, 1994; Riedl et al., 2016). As in a production chain, in this setup, the payoff of each subject depends on her own effort and the lowest effort of all members of the group. To study the effects of loss contracts, we set up two treatments, a control group with a "classic" *gain contract* and a treatments group with an isomorphic payoff function that is framed as a *loss contract*. Because the only difference between both treatments is the way in which the payoffs are presented, any change in the behavior of subjects can be attributed to the *framing* of the payoff function.

The results show that loss contracts result in lower group productivity, with groups exerting a lower minimum effort than in sessions with gain contracts. Furthermore, we observe that loss contracts worsen coordination among group members which is reflected in a higher variance of the effort choices within the groups. This higher variance translates into a substantial amount of wasted efforts and therefore in lower welfare across its members. Interestingly, our results show strong gender effects, as groups with a larger proportion of females achieve higher minimum effort levels, do so in a more coordinated way, and achieve higher welfare levels.

Our study contributes to the literature on the effects of negatively framed incentives. While this literature is rich in the effect of loss contracts on individual worker effort (e.g., DellaVigna and Pope, 2018; Imas et al., 2016; Pierce et al., 2020), to the best of our knowledge, only few papers have studied the effects that such contracts have on group coordination. Hossain and List (2012) study the effects of loss contracts on group productivity in a field experiment and show that loss contracts have strong effects on group productivity. However, in their experiment there is no strategic uncertainty.[2] In the lab, Cachon and Camerer (1996) study *loss avoidance* and forward induction (implicit communication about the subjects expectations) as an equilibrium selection refinement in median and minimum effort games. Hamman et al. (2007) study the effect of imposing a penalty or bonus conditional on specified outcomes while Brandts and Cooper (2006) look at the effect that a reduction in previous bonus payments has on coordination. However, all of these laboratory experiments have different focuses and with several behavioral aspects at

[2] As explained in page five of the article, a subset of groups worked around belt lines with a speed that the group could alter, or around guide rails with a fixed speed. It is not clear if strategic uncertainty existed in the two remaining groups (G3 and G4), but the results for these groups are mixed.

play cannot determine the isolated effects of negatively framed incentives on group coordination. Our contribution is, therefore, to study the isolated effects of negatively framed incentives on group coordination and performance in a controlled laboratory environment with strategic uncertainty.

The paper is organized as follows. Section 2 presents our experimental design. Section 3 presents the experiment's results which are discussed in Section 4. Finally, Section 5 concludes.

2 Experimental Design

We design a between-subjects experiment with two treatments: gain contract and loss contract. In both cases subjects are divided into groups of six and simultaneously decide how much effort to exert in each given round. Subjects' payoffs are decreasing in their own effort and increasing in the minimum effort chosen across all subjects in the group. Formally,

$$\Pi(e_i, e_{min}) = a[\min_{i \in n}(e_i)] - be_i + C, \tag{1}$$

where e_i is the effort of subject i, e_{min} is the minimum effort across all subjects n in the group, a and b are parameters such that $a - b > 0$, and C is a constant to avoid negative payoffs. The parametrization follows Van Huyck et al. (1990), with $a = 20$ points, $b = 10$ points, and $C = 60$ points. The exchange rate at the end of the experiment is of € 1 for every 70 points. This exchange rate is comparable to Engelmann and Normann (2010) and Leng et al. (2018).

Our treatment comes in through the framing of the payoffs. In the gain contract treatment, subjects are presented with the payoffs resulting from equation (1), as depicted in the left panel of Table 1. The vertical axis of the payoff table denotes the effort choice of an individual subject i. The horizontal axis denotes the smallest effort level chosen by all group members of subject i's group. In the loss contract treatment, subjects are endowed with 140 points before each round and presented with the right panel of Table 1. Importantly, this second table does not represent final payoffs of a subject, but the outcomes of all subjects' joint actions. To calculate the payoffs for each set of actions, subjects need to subtract the resulting outcome from their per-round endowment of 140

	Gain Contract						
	Minimum Choice Within Group						
	7	**6**	**5**	**4**	**3**	**2**	**1**
7	130	110	90	70	50	30	10
6		120	100	80	60	40	20
5			110	90	70	50	30
4				100	80	60	40
3					90	70	50
2						80	60
1							70

	Loss Contract						
	Minimum Choice Within Group						
	7	**6**	**5**	**4**	**3**	**2**	**1**
7	-10	-30	-50	-70	-90	-110	-130
6		-20	-40	-60	-80	-100	-120
5			-30	-50	-70	-90	-110
4				-40	-60	-80	-100
3					-50	-70	-90
2						-60	-80
1							-70

Table 1: Payoff tables presented to subjects. In both cases, rows represent own effort, columns minimum effort of the group. In the left panel is the control treatment where subjects see their final payoff in points. The right panel shows the treatment table. In this case, subjects get the points subtracted from their initial endowment (140) and not final payoffs.

points.[3] This is made clear in the instructions. In both treatments, subjects had several practice rounds to get acquainted with the interface and payoff structure of the game.

Note that in both tables the values presented are either all positive or all negative. We choose this modeling device to avoid the creation of any focal points which potentially attract subjects' attention and bias their behavior.[4]

The game is played for ten consecutive rounds, maintaining the same group composition. After each round, subjects receive feedback about the minimum effort of the group and the resulting payoff. After the ten rounds, we elicit several personality traits from our subjects. First, we measure cognitive ability using the CRT (Frederick, 2005), CRT2 (Thomson and Oppenheimer, 2016) and eCRT (Toplak et al., 2014) questions. Second, we elicit subjects' risk-, ambiguity-, and loss aversion through a modification of the multiple price lists used in Rubin et al. (2017). Finally, subjects answer the short version of the Big Five personality traits suggested by Rammstedt and John (2007) and state their gender.

[3]The interface included a calculator in case any subject needed it.

[4]Cachon and Camerer (1996) show that in minimum effort games with negative and non-negative outcomes, the latter act as focal points. Consequently, subjects avoid losses by ignoring all strategies which result in negative outcomes. Showing only positive or only negative entries allow us to exclude such *loss avoidance* as potential equilibrium selection principle.

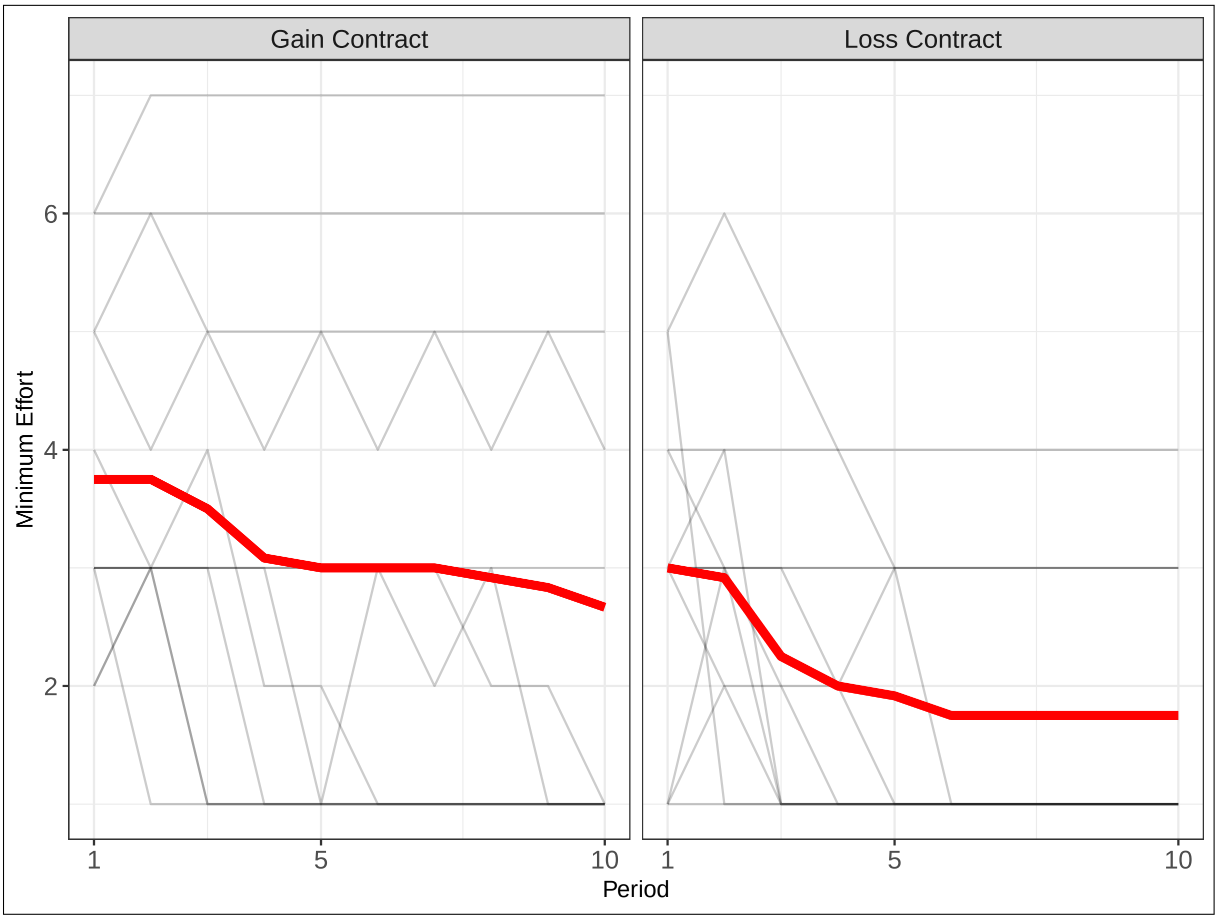


Figure 1: Summary of all choices across treatments. For both treatments, in grey the minimum strategy played in each group and in red the mean of such minimum strategies.

3 Results

The experiment was run at the Experimental Economics Laboratory of the Technische Universität Berlin. In total we had eight sessions, four with gain contracts and four with loss contracts. In each session we randomly divided subjects into three groups of 6 subjects for a total of 144 subjects across all sessions. Sessions lasted less than one hour with average earnings of € 12.74. All subjects were recruited through ORSEE (Greiner, 2015) and the experiment was programmed and conducted using z-Tree (Fischbacher, 2007).

Figure 1 summarizes the results across all sessions and groups. In it, we present the minimum choice of each group in each period (grey lines) and the mean minimum choice across groups in each period (red line). Contrary to the hypothesis of Hossain and List (2012), Figure 1 shows that a loss contract reduces the average minimum effort of groups. While a Mann-Whitney U test detects no significant effect between the treatments for initial period decisions (p-value=0.325), there seem to be some differences in the last period (p-value = 0.082).

The differences between treatments become more apparent once we look at the data in a more disaggregate way. In Table 2 we use a random effects model with the per group minimum effort for each period as the dependent variable. In all cases we control for the ratio of females per group ($female\_ratio$) as well as the average value of different personality traits (e.g., $avg\_risk\_aversion$ is the mean value of the risk aversion across all subjects of a group). The results show that a loss contract has a *negative effect* on the minimum effort of each group. This effect is significant at the 5% level and is consistent with the drop in effort which we observe in Figure 1. Therefore, we conclude that a loss contract brings down the coordinated effort of groups.

Result 1: A loss contract results in a lower minimum effort of groups.

Another result from Table 2 is that the gender composition of groups has a strong effect on the minimum effort. This statistically and economic significant effect stands out from all other other group characteristics, with the exception of extraversion which has a negative effect on the minimum effort of groups.

3.1 Coordination

In this section we analyze how loss contracts affect the coordination of subjects within groups. To do so, in Table 3 we study the variance of the individual effort levels within each group. In Columns (1) to (3) we regress the variance of all effort choices, across all rounds, for each group (*varagg* in Table 3) on a set of controls using OLS. Again, the main control variables are the ratio of females per group ($female\_ratio$), and the average value of the different personality traits. In Columns (4) to (6) we use a random effects model where the dependent variable is the variance within each group for *each period* while controlling for the composition of each group. The results are very similar for both models: a loss contract results in higher variance in the effort choices of subjects within groups.

	(1)	(2)
	periodmineffort	periodmineffort
loss contract	-1.151*	-1.272**
	(0.691)	(0.640)
female_ratio	2.644**	3.857***
	(1.163)	(1.163)
avg_risk_aversion	-0.279	-0.595*
	(0.274)	(0.317)
avg_loss_aversion	-0.175	-0.342
	(0.202)	(0.259)
avg_ambiguity_aversion	0.00392	-0.0640
	(0.303)	(0.400)
avg_CRT	0.255	0.290
	(0.182)	(0.206)
avg_extraversion		-0.561**
		(0.271)
avg_conscientiousness		0.139
		(0.513)
avg_agreeableness		0.579
		(0.693)
avg_neuroticism		0.188
		(0.539)
avg_openness		0.244
		(0.372)
constant	4.325	4.579
	(3.143)	(5.593)
N	240	240

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 2: Random effects GLS. All standard errors are clustered at the group level.

Result 2: A loss contract results in less coordination (larger variance) of effort choices within groups.

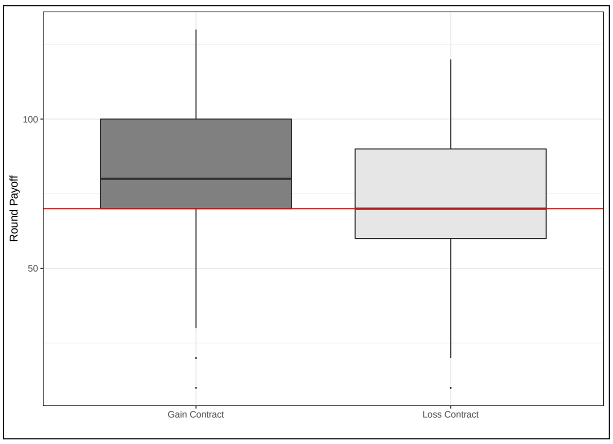
Again, the composition of groups has a strong influence on how they behave; those groups with a higher share of females pick much less dispersed effort levels and have a lower effort variance.

3.2 Welfare Effects

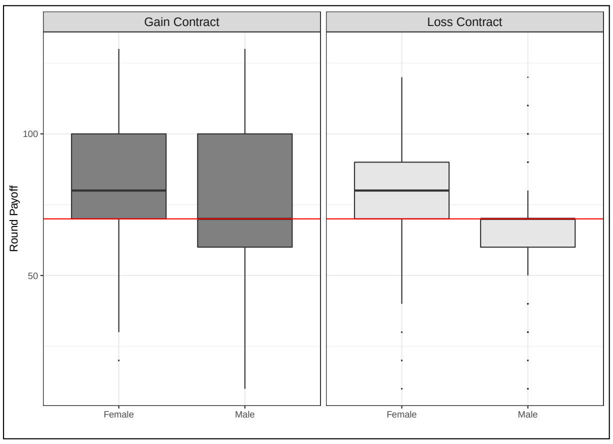
To study the impact that a loss contract has on the welfare of subjects, we will consider the payoffs of our subjects as their "welfare." In this way, subject i's welfare in period t depends of two things: the minimum effort exerted by the group of subject i at period t ($mineffort_{g,t}$) and the individual effort choice of subject i at period t ($effort_{i,t}$). According to this definition, welfare is maximal at the payoff-dominant equilibrium (i.e. effort level 7) where the wasted effort of all group members is zero. Define *wasted effort* of each subject i at period t as,

$$waste_{i,t} = effort_{i,t} - mineffort_{g,t}, \tag{2}$$

where $waste_{i,t}$ captures the amount of effort that is lost for each individual in each round. Notice that $waste_{i,t}$ can only take positive values, with a minimum of zero whenever a subject is exerting the minimum effort of the group.



(a) Payoffs Across Treatments



(b) Payoffs Across Treatments and Gender

Figure 2: Payoffs for Each Period. In the left panel we present the boxplots for the payments across treatments. In the right panel we disaggregate the data by treatment and gender.

	OLS			Random Effects GLS		
	(1)	(2)	(3)	(4)	(5)	(6)
	varagg	varagg	varagg	varaggt	varaggt	varaggt
loss contract	1.127	1.430*	2.533***	0.587	0.686*	0.986***
	(0.715)	(0.758)	(0.790)	(0.428)	(0.410)	(0.230)
female_ratio	-3.082**	-2.188	-7.088**	-1.351*	-0.538	-3.024***
	(1.459)	(1.792)	(2.369)	(0.809)	(0.932)	(0.595)
avg_risk_aversion		-0.461	0.211		-0.422*	0.0845
		(0.508)	(0.568)		(0.230)	(0.173)
avg_loss_aversion		0.455*	0.244		0.242*	0.305**
		(0.237)	(0.308)		(0.127)	(0.122)
avg_ambiguity_aversion		0.440	0.760		0.198	0.240
		(0.475)	(0.485)		(0.194)	(0.175)
avg_CRT		-0.311	-0.237		-0.249***	-0.198**
		(0.214)	(0.228)		(0.0868)	(0.0815)
avg_extraversion			1.095*			0.932***
			(0.568)			(0.159)
avg_conscientiousness			-1.584**			-0.534**
			(0.629)			(0.250)
avg_agreeableness			-0.294			-0.455*
			(0.628)			(0.270)
avg_neuroticism			0.445			0.0243
			(0.491)			(0.259)
avg_openness			-0.191			-0.0792
			(0.469)			(0.181)
constant	3.556***	0.828	-1.011	1.973***	2.745	-1.092
	(0.743)	(3.758)	(6.188)	(0.442)	(2.038)	(2.357)
N	24	24	24	240	240	240

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 3: Analysis of the aggregate variance in effort choices using OLS and random effects GLS. All standard errors are clustered at the group level.

In the left panel of Figure 2 we plot the per-period payoff (i.e., the individual welfare) of all subjects across both treatments. The figure shows that the median per-period payoff is higher under gain contracts than under loss contracts. In fact, the median payoff across all periods under loss contracts is 70 experimental units, which is exactly equal to the payoff of the risk-dominant equilibrium (i.e., effort level 1).[5,6] We mark this payoff of 70 experimental units with a horizontal red line in Figure 2. In the right panel of Figure 2 we see the effect of gender on payoffs, with the median payoff for females being higher under both gain and loss contracts.

In Table 4 we present two random effects models. In the first one (left panel) we study how the framing of contracts and the personality traits of subjects affect individual payoffs. In the second one (the right panel) we study the effects of contract framing and of group composition on payoffs and wasted effort. Overall, both models confirm our result from above that a loss contract is detrimental to subjects' payoffs. This is especially significant once we control for group characteristics rather than individual ones. The influence of gender on welfare also becomes evident in Table 4. Gender only has a small impact on payoffs when we look at the individual characteristics of subjects. However, at the group level the ratio of females plays an important role in determining the payoffs of subjects.[7]

Result 3: A loss contract results in lower welfare.

4 Comments on the Gender Effects

We did not design the experiment to study the the different effects of loss contracts on gender, so our data is limited if we want to analyze such effects. Yet, the results are strong enough to justify taking a closer look at the data.

[5]There are other combinations by which a subject might get 70 experimental units. Yet, exerting the minimum effort is the only way a subject can guarantee these 70 experimental units.

[6]Figure 4 in the appendix compares the payoffs of subjects for each period. Note that the median average payoff under loss contracts is 70 experimental units in each single period, while it is greater than 70 in most periods under gain contracts. Another interesting feature of Figure 4 is how the variance in payoffs seems to decrease as the experiment advances under loss contracts, but not under gain contracts.

[7]More surprising is the strong effect that the ratio of extroverted subjects has on payoffs. We have no explanation for such a result.

Individual Characteristics

	(1)	(2)
	ind_payoff	ind_waste
loss contract	-12.58*	0.210
	(7.408)	(0.182)
female	8.374*	-0.281*
	(4.581)	(0.166)
risk_aversion	0.204	-0.0184
	(0.531)	(0.0209)
ambiguity_aversion	0.00524	-0.00181
	(0.391)	(0.0185)
loss_aversion	-0.166	-0.00857
	(0.404)	(0.0151)
CRT	0.812	-0.0283
	(0.653)	(0.0173)
openness	-0.173	0.00331
	(0.721)	(0.0297)
neuroticism	-0.538	0.0414
	(1.454)	(0.0545)
agreeableness	-0.760	0.0755**
	(1.260)	(0.0378)
conscientiousness	0.144	-0.0376
	(1.271)	(0.0410)
extraversion	-0.210	0.0368
	(0.753)	(0.0295)
constant	82.14***	0.822
	(22.20)	(0.636)
N	1440	1440

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Group Characteristics

	(1)	(2)	(3)	(4)
	ind_payoff	ind_waste	mean_payoff	mean_waste
loss contract	-15.71**	0.299**	-15.71**	0.299**
	(7.277)	(0.142)	(7.422)	(0.145)
female_ratio	49.12***	-1.055**	49.12***	-1.055**
	(13.86)	(0.449)	(14.14)	(0.457)
avg_risk_averion	-5.675	-0.0271	-5.675	-0.0271
	(3.852)	(0.127)	(3.929)	(0.129)
avg_ambiguity_aversion	-1.498	0.0858	-1.498	0.0858
	(4.567)	(0.109)	(4.658)	(0.111)
avg_loss_aversion	-4.497	0.107	-4.497	0.107
	(3.068)	(0.0699)	(3.129)	(0.0713)
avg_CRT	3.630	-0.0734	3.630	-0.0734
	(2.396)	(0.0515)	(2.444)	(0.0526)
avg_openness	2.760	-0.0324	2.760	-0.0324
	(4.494)	(0.104)	(4.583)	(0.106)
avg_neuroticism	1.349	0.0528	1.349	0.0528
	(6.526)	(0.153)	(6.656)	(0.156)
avg_agreeableness	6.424	-0.0632	6.424	-0.0632
	(8.124)	(0.155)	(8.286)	(0.158)
avg_conscientiousness	3.224	-0.184	3.224	-0.184
	(6.220)	(0.154)	(6.344)	(0.157)
avg_extraversion	-8.973***	0.336***	-8.973***	0.336***
	(3.274)	(0.0972)	(3.339)	(0.0991)
constant	109.0	-0.316	109.0	-0.316
	(66.53)	(1.424)	(67.85)	(1.453)
N	1440	1440	240	240

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 4: Random effects GLS. All standard errors are clustered at the group level.

Our results show that groups with more females coordinate on higher effort levels (Table 2) and produce less wasted effort (Table 4). The consequence of these higher levels of coordination is a higher average payoff for those groups with a higher ratio of females (Table 4).

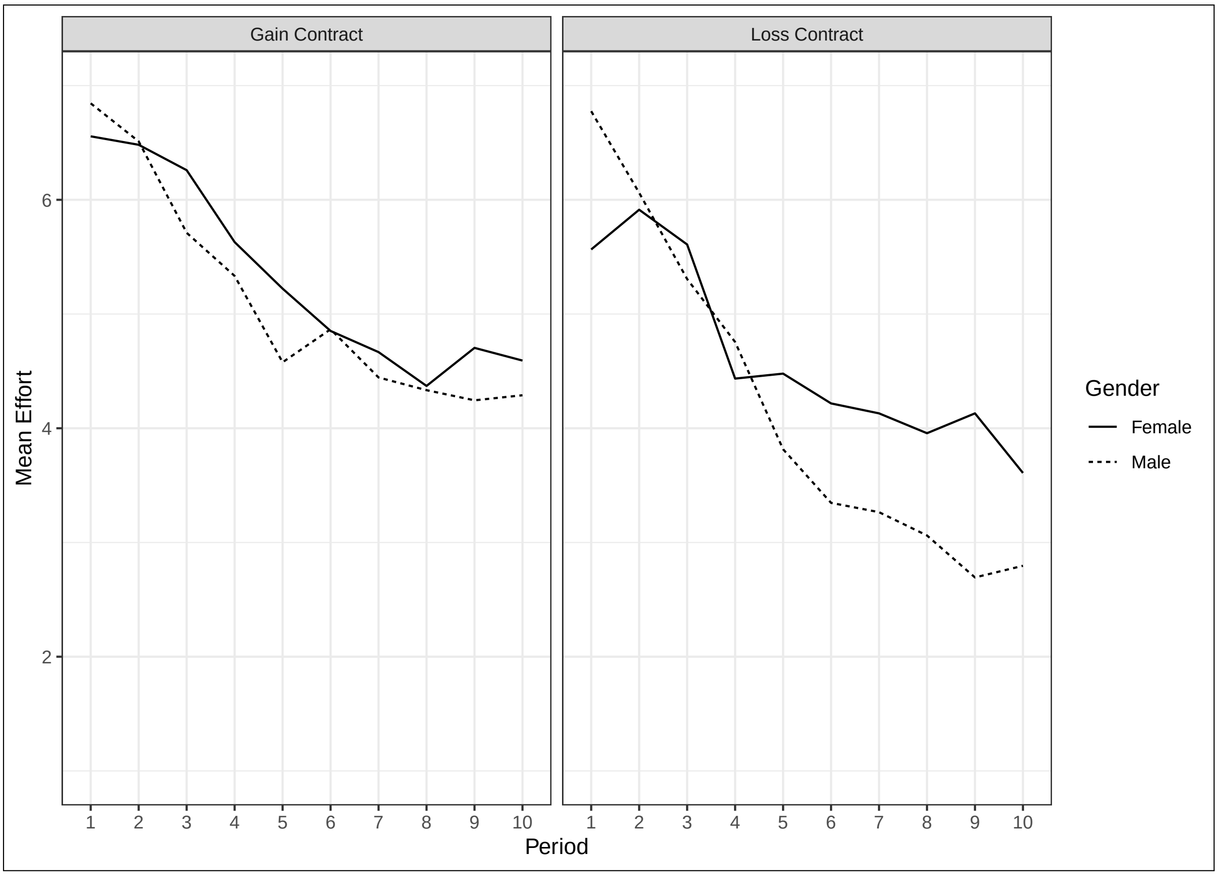


Figure 3: Mean effort decisions by gender and treatment. The left panel shows the mean effort decision of all females per round (solid line) and the mean effort decisions of all males per round (dashed line) for gain contracts. The right panel shows the same for loss contracts.

In Figure 3 we plot the average choices of males and females in each period for both treatments. From the figure it appears that most of the gender differences come from the loss contract treatment. A series of Mann-Whitney tests confirm this. We cannot reject that females and males exert the same level of effort both at the beginning or at the end of the session (p-value= 0.342 and p-value= 0.534, respectively) under a gain contracts. However, under a loss contract we find strong differences in the effort choices between gender, both at the beginning and at the end of the session (Mann-Whitney p-value=0.007 and p-value=0.002, respectively).[8]

[8]If we look at the payoffs and wasted efforts across treatments, we find that for the last period

Our finding from the gain contract treatment that there are no gender differences are in line with the existing literature on gender effects in coordination games with strategic complements (e.g., Dufwenberg and Gneezy, 2005; Heinemann et al., 2009; Engelmann and Normann, 2010; Di Girolamo and Drouvelis, 2015). However, the differences we observe under loss contracts seem to indicate that this might not be a generalizable result. Unfortunately, our data is not adequate to go beyond these initial indications of gender effects under loss contracts.[9] Yet, we do believe that our data points to some interesting effects and we plan on studying them in the future.

5 Conclusion

Coordination lies at the center of most organizational settings. The timing and quality of many production chains depend on the coordinated efforts of all of its members, from sophisticated just-in-time inventory systems to co-authored scientific research papers, we all depend crucially on the "weakest link" of the chain.

One way that has been suggested to increase effort in the workplace is to present incentives in the form of loss contracts. In such contracts, workers are paid a bonus beforehand which they need to pay back later if the required productivity threshold is not met. The literature studying such loss contracts at the individual level is large (e.g., Hossain and List, 2012; DellaVigna and Pope, 2018; De Quidt, 2017) and, while inconclusive, points towards loss contracts increasing worker productivity. However, in all of these cases, workers know that an increase in effort is associated with a lower probability of losing the bonus. This might not resemble many organizational settings that require coordination in sophisticated environments with diffuse responsibilities. In this context, the presence of strategic uncertainty might push individuals to low effort strategies to reduce their "exposure" to potential losses.

We recreate such an environment in the lab using the highly stylized minimum effort game (Van Huyck et al., 1990). Our results show that, if anything, loss contracts reduces the minimum effort of groups. Such reduction in effort has strong welfare effects as groups

there are no differences across gender under gain contracts (Mann-Whitney p-value= and p-value=0.342, respectively), but there are some under Loss Contracts (Mann-Whitney p-value=0.012 for payoffs and p-value=0.907).

[9]For example, the number of groups composed only by males in control is 1 while in treatment it is 3, while no group is composed only by females.

are not only less "productive," but effort levels are more heterogeneous, resulting in higher levels of "wasted efforts," and therefore in lower individual welfare.

These results run contrary to the conjecture that loss contracts will results in higher worker effort (e.g., Brooks et al., 2012; Hossain and List, 2012; Fryer Jr et al., 2012; Hong et al., 2015; DellaVigna and Pope, 2018, among others) and complement those of Pierce et al. (2020) who show (both theoretically and empirically) that loss contracts can backfire in some settings with uncertainty as workers might pursue lower productivity strategies that help them decrease their exposure to losses.

Additionally, we find strong gender effects. Groups with a larger proportion of females achieve higher minimum effort levels, do so in a more coordinated way, and achieve higher welfare levels. Yet, these results seem to be driven mostly by gender differences in the loss contract sessions. Hence, the evidence from the existing literature that gender does not show any effects in coordination games with strategic complements (e.g., Dufwenberg and Gneezy, 2005; Heinemann et al., 2009; Engelmann and Normann, 2010; Di Girolamo and Drouvelis, 2015) does not seem to generalize to loss contracts.

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A Extra Figures

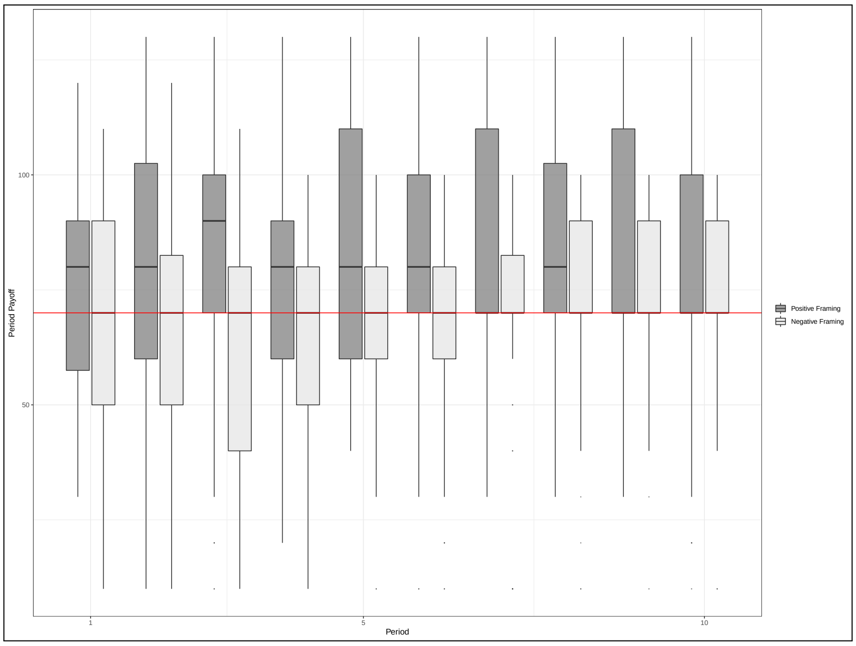

Figure 4: Payoff comparison. Boxplots comparing the payoff (vertical axis) of subjects across periods (horizontal axis) for each treatment. The horizontal red line marks the payoff for a subject exerting minimum effort.