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Abstract
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Keywords
obesity, behavioral economics, incentives, weight loss, intrinsic motivation

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Do Financial Incentives Reduce Intrinsic Motivation for Weight Loss?: Evidence from Two Tests of Crowding Out

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ABSTRACT

Financial incentives have been used successfully to promote health behaviors, however they may be counterproductive if they "crowd out" pre-existing intrinsic motivation and lead to a decrease in performance once incentives are removed to a level lower than had they never been introduced. We provide new evidence that incentives do not crowd out intrinsic motivation in the case of weight loss. We measure motivation via a survey administered before and after the introduction of financial incentives in two weight loss field experiments and find no evidence that intrinsic motivation fell among participants receiving incentives compared to control participants who do not receive incentives.

Keywords: Obesity; Behavioral economics; Incentives; Weight loss; Intrinsic motivation.
JEL Classifications: D03, D04, D8, I1, C93

1. Introduction

While financial incentives for good performance have not traditionally been used in domains such as personal health, policy makers are increasingly interested in approaches that introduce such incentives. In health care, incentives have now been used successfully in a number of field experiments testing programs to promote weight loss, smoking cessation, drug abstinence, and medication adherence (Volpp et al., 2008a; Volpp et al., 2009; Silverman et al., 1996; Silverman et al., 1999; Donatelle et al., 2004; Heil et al., 2008; Higgins et al., 1993; Higgins et al., 1994; Higgins et al., 2000; Volpp et al., 2008b). These demonstrations have potentially important policy implications, building a case for using financial incentives to shift individuals towards making better health-related choices, with benefits for both the individuals involved and society at large.

The idea of using financial incentives for health is not, however, without potential concerns. One of these is the possibility, suggested by a long line of research in psychology (Deci, Koestner, and Ryan, 1999; Deci and Ryan, 1985; see also Gneezy, Meier, and Rey-Biel, 2011)[1], that such financial incentives might crowd out intrinsic motivation. To the extent that introducing incentives crowds out some form of pre-existing intrinsic motivation, this might lead to a decline in effort once incentives are removed to a lower level than if incentives had never been introduced. Indeed, if the long-run decrease in effort more than offsets the short-term gains, an intervention featuring temporary incentives could on net be counterproductive.

[1] Recently, behavioral economists have studied the impact of incentives on intrinsic motivation, but the main focus has been on whether incentives crowd out pro-social motives, such as willingness to contribute to charities, donate blood, or agree to local siting of unwanted projects (Kunreuther and Kleindorfer, 1986; Frey and Oberholzer-Gee, 1997; Frey and Goette, 1999; Gneezy and Rustichini, 2000a and 200b; Ariely, Benabou and Tirole, 2003; Bracha, and Meier, 2009). While this is a very important topic, and the studies provide convincing evidence that incentives may crowd out pro-social motives, it is a quite different context and may reflect a different type of intrinsic motivation than that which may underlie behaviors that affect one's own health in contexts like weight loss.

While the issue of incentives and intrinsic motivation in health has been identified as an important topic for research (e.g., Shaw, 2007; Halpern et al., 2009; Marteu et al., 2009), there is little empirical evidence on the direct effects of financial incentives on motivation in the context of health behavior. Existing research on crowding out may not be generalizable to the context of personal health behaviors for several reasons. Most of the evidence in psychology on the crowding out hypothesis comes from laboratory studies involving tasks such as puzzle solving or drawing pictures, with subject pools consisting of college students and young children (for a review, see Deci, Koestner, and Ryan, 1999). It is unclear whether such results generalize to the domain of health and to adults who are likely to have strong prior intrinsic motivation to overcome health problems. That is, the strength or robustness of intrinsic motivation in the domain of personal health might be different than in domains where it has typically been explored to this point (for more discussion of motivation in health setting versus previous evidence from psychology, see Promberger and Marteau, 2013).

There is so far little in the way of "smoking gun" evidence of crowding out in field studies on incentives and health; behavior often exhibits a trend back towards baseline levels after incentives are removed (John et al., 2011; Sutherland, Christianson, and Leatherman, 2008), but this likely reflects lack of sustainability of interventions post-intervention and is not by itself evidence of crowding out. None of the incentive studies we are aware of demonstrate that behavior falls below baseline post-intervention, which would indicate crowding out (for an overview, see Promberger and Marteau, 2013). At least two studies have even found evidence that incentives may "crowd in" motivation. For example, Charness and Gneezy (2009) found that college students who were paid to attend the gym continued to have higher attendance rates than control even after incentives were removed, potentially due to habit formation, and Volpp et

al. (2009) found that participants who previously received incentives for smoking cessation maintained higher quit rates than control arm participants 15-months post-incentives.[2]

Our study provides new evidence on whether or not financial incentives affect intrinsic motivation, focusing on the case of weight loss. Our approach involves measuring intrinsic motivation in the field using a survey tool developed by psychologists to measure crowding out as described above (Ryan and Connell, 1989). There are some advantages of such an approach; while crowding out might take a relatively long time to manifest in terms of behavior and thus empirical evidence based on an outcome such as weight might be missed in the limited time window of a follow-up period, the impact on motivation itself should happen more quickly. A decrease in motivation should in principle manifest already during the intervention itself, as well as being apparent during the period immediately post-intervention. A survey-based approach is thus a useful complement to previous studies that only observed behavior (which is also observed here). We know of only one previous study that has measured the effect of incentives on motivation levels in a health-related setting; Ledgerwood and Petry (2006) use a different survey tool to measure motivation in the context of a substance use program and find no difference in motivation levels among those who had previously received incentives to change substance use and a control group three months after the incentives were removed, suggesting that financial incentives did not crowd out intrinsic motivation.

The ideal data for studying the impact of incentives on direct measures of intrinsic motivation for weight loss would involve experiments conducted in the field with multiple measures of motivation for each participant over time, across different types of incentive interventions and different populations. We conducted two such field experiments, with different

[2] Acland and Levy (2010) replicated these results, but found that behavior dropped off when students left for winter break (see also Royer, Stehr, and Sydnor, 2012).

populations and different types of incentives, and we measure intrinsic motivation at baseline and then two subsequent times for each person: at the end of the active phase of the intervention and three-months post-intervention. Our field experiments take place within the context of workplace wellness programs, which also makes the results relevant for assessing potential impacts of incentives for health-related behaviors adopted by employers.

Our main finding is that incentives have no systematic impact on intrinsic motivation for weight loss. This is generally true across different types of incentives, and across both of the different field experiments and study populations. Participants reported high levels of intrinsic motivation initially, and there was essentially no change during the six-month intervention period or the three-month follow-up period. These results are reproduced for sub-populations of interest, such as those differing in terms of initial levels of motivation and initial weight, as well as those who earned relatively more vs. less money through financial incentives. We also devote considerable attention to ensuring that these results are robust to corrections for censoring and missing data.

2. Experimental design

We used data from two randomized controlled trials of workplace weight loss programs to evaluate the relationship between motivation, incentives, and weight loss. Both studies offered substantial financial rewards for meeting weight loss goals to overweight individuals over six months, followed by a three-month no-incentive follow-up period. In both studies, we measured intrinsic and extrinsic motivation at baseline, at the end of the incentives period (six months), and at the end of the follow-up period (nine months). This allowed us to gather consistent

measures of motivation across two studies which offered different incentive schemes for achieving the same weight loss goal (losing one pound per week for 24 weeks) and to see how these measures of motivation changed over time for participants in the incentive arms versus control and whether they differed across incentive schemes.

2.1. Theoretical framework

Why might incentives affect intrinsic motivation, from a theoretical perspective? There are multiple explanations for crowding out in psychology, but in their seminal economic model of intrinsic motivation Benabou and Tirole (2003) identify a key element in common for many of the different explanations: that introducing incentives signals something about task value or difficulty. In their model, a principal can choose whether or not to offer incentives to an agent based on some private information the principal may have about the difficulty of the task, and/or the social or individual value of the task. The agent has imperfect knowledge about task difficulty or value. Accordingly, the agent can potentially take the introduction of incentives as a negative signal about task difficulty; the fact that the principal thinks incentives are needed must mean that the task is relatively difficult. In this case, the negative signal regarding the task could lead to reduced intrinsic motivation. Once incentives are removed, then, this reduced motivation could result in a drop in task-related performance.

The signaling framework makes clear, however, that the introduction of incentives could alternatively be taken as a signal that the task is very valuable or important, which could potentially enhance motivation of the agent. It is also possible, of course, that incentives do not affect motivation, for example if agents have sufficiently strong beliefs about the value of the task to themselves and society. This opens up the possibility for context to matter, since the same

incentive might be interpreted in different ways in different contexts. In the context of our experiments, we can test specifically whether the introduction of incentives reduces, enhances, or leaves unchanged the intrinsic motivation of individuals regarding weight loss.

2.2. Study 1: Individual versus group rewards for weight loss

"Study 1" tested the effectiveness of two novel financial incentive designs on weight loss among 105 employees at the Children's Hospital of Philadelphia with a body mass index of 30-40 kilograms per meter squared. Employees were given the goal of losing one pound per week for 24 weeks and randomly assigned to a monthly weigh-in control group or one of two financial incentive groups. Control arm participants were reminded to attend monthly weigh-ins at their workplace scale and, following their weigh-in, were informed of whether or not they had met their weight loss goal for the month. Participants in the "individual" incentive arm were given the same information as control arm participants, but were also told that they could receive $100 per month for being at or below their monthly target weight. Participants in the "group" arm also received the same information as control arm participants. In addition, each "group" arm participant was put into an (anonymous) group with four other participants and told that at the end of each month, $500 would be split among those members of the group who had met their weight loss goal (i.e., if two participants out of five achieved their goal, each would receive $250; if all five met their goal, each would receive $100). The key behavioral finding from this study was that participants in the group arm met more weight loss goals and lost more weight than control and individual arm participants during the intervention period, and maintained greater weight loss than the control arm (but not the individual reward arm) in a 12 week follow-up period (Kullgren et al., 2013a). Notably, at the end of the follow-up period, participants in

both intervention arms had equal or lower weights compared both to control participants and to their own baseline weights, indicating that there is no behavioral evidence of crowding out, at least within the three-month time horizon of the follow-up period.

2.3. Study 2: Employer matching of deposit contracts for weight loss

"Study 2" tested three different types of deposit contract incentive designs among 132 employees at Horizon Blue Cross Blue Shield in Newark, New Jersey. As in study 1, every participant in study 2 was given a 24-pound weight loss goal for the 24-week intervention period. Participants in study 2 were randomly assigned to a control arm or one of three arms with deposit contracts with varying levels of employer matching (matching was tested as a means of increasing take-up of deposit contracts). In the "no match" deposit contract arm, participants were given the chance to deposit between $1 and $3 per day (up to $84) into an individual account (deposits were not mandatory). The money was then refunded at the end of the month for every day in that month that an individual weighed in and was at or below their target weight for that day. In the 1:1 match group, participants were again given the chance to deposit between $1 and $3 per day (up to $84) into an individual account, and whatever they deposited was matched 1:1 by their employer as an additional incentive. The final arm used a 2:1 match for participants' deposit contracts.

Results from study 2 showed no significant differences in take-up of, or overall participation in, deposit contracts across the three arms, however weighing frequencies were higher in the deposit contract arms than in the control arm, and, after 24 weeks, participants in the 1:1 match arm lost significantly more weight than participants in the control arm (participants in the no match and 2:1 match arms did not have significantly different weight loss than in the

control arm). After 36 weeks, participants in the no match arm were the only group with significantly lower weight, on average, than at baseline (Kullgren et al., 2013b). As in the first weight loss study described, the study reveals no behavioral evidence of crowding out based on measured weight.

2.4. Measuring motivation: The Treatment Self-Regulation Questionnaire

In both studies, we used the Treatment Self-Regulation Questionnaire (TSRQ) to measure intrinsic motivation for weight loss at baseline (zero), six months (at the conclusion of the active phase of the intervention), and nine months (three months following cessation of the active phase of the intervention). The TSRQ was developed in the psychology literature as a means of eliciting individuals' reasons for engaging in certain behaviors, and was initially used to assess intrinsic and extrinsic motivation for participating in academic and pro-social activities among children (Ryan and Connell, 1989). It has since been validated across a number of settings and health behaviors (Levesque et al., 2007) and was first used in relation to health-related behaviors by Williams et al. (1996). Most studies that have used the TSRQ have focused on linking intrinsic motivation to outcome realization with a particular focus on the use of baseline motivation measures (particularly intrinsic motivation) to predict "success" in an intervention or treatment.[3] Previous studies have typically not, however, considered changes in intrinsic motivation over time (i.e., before and after a behavior change program), or how motivation changes due to other components of the program such as incentives.

[3] For example, Williams et al. (1996) found that weight loss program participants who were intrinsically motivated to lose weight attended sessions more regularly, and ultimately lost more weight by the end of the 23-month follow-up period. Intrinsic motivation has also been associated with better (self-reported) adherence to longer-term medications (Williams et al., 1998), lower levels of hemoglobin A1c in a study of dieting and exercise among diabetics (Williams, Freedman, and Deci, 1998), and smoking abstinence (Williams et al., 2002).

The TSRQ is a 15-question multiple-choice questionnaire; items are responses to the stem, "the reason I would lose weight is." Responses reflect intrinsic (autonomous) motivation for the behavior change [e.g., "Because I feel that I want to take responsibility for my own health"] or sources of more controlled, extrinsic motivation [e.g., "Because I feel pressure from others to do so"], or are amotivational [e.g., "I don't really know"]. Each response is answered on a likert scale ranging from 1 (not at all true) to 7 (very true). Typically, the responses on the intrinsic motivation items are averaged to form an intrinsic motivation "score" for the target behavior and the responses on the extrinsic items are averaged to form the extrinsic motivation "score" for the target behavior. In those studies where amotivation has also been assessed, the amotivated responses are also averaged. These three subscale scores can be used separately and/or a "Relative Autonomous Motivation Index" can be formed by subtracting the average for the controlled reasons from the average for the autonomous reasons.[4] We test for differential changes in these motivation scores over time by study arm. In the presence of crowding out, we would expect to see a relatively greater decrease in intrinsic motivation in financial incentive arms than in the control arms.

3. Empirical results: The effect of incentives on intrinsic motivation for weight loss

3.1. Empirical strategy and statistical tests

We use non-parametric statistical tests (Wilcoxon rank-sum/Wilcoxon-Mann-Whitney tests for independent samples and Wilcoxon signed-rank tests for paired samples) to test changes in intrinsic motivation over time due to small sample size concerns and the non-normality of our intrinsic motivation measure (heavily skewed to the right). Where appropriate, we use

[4] For details on scoring, see Levesque et al. (2007) and http://www.selfdeterminationtheory.org/questionnaires.

conservative bonferroni adjustment for multiple comparisons to conserve the overall Type I error rate (e.g., to compare any of the incentive arms to the control group in a study).

We focus on three key tests, first in aggregate (section C below) and then among several sub-populations of interest (section D). First, we test the change in intrinsic motivation over time *within each control and incentive condition* in each study (e.g., change in intrinsic motivation for those in the individual rewards group between 0 and 6 months in study 1; significant changes of this type are shown in figures) [test 1]. Second, we test the difference in the *change* in intrinsic motivation over time *between incentive arms and control arms*; to do this, we construct 0-6, 6-9, and 0-9 month differences and test these differences across arms using Wilcoxon rank-sum tests and correcting for multiple comparisons as appropriate (for example, correcting for two simultaneous tests to test the 0-6 month change in any incentive arm versus control in study 1 where there were two incentive arms) [test 2]. Third, we test the difference in the change in intrinsic motivation over time *among incentive arms* within each study, using a similar procedure as described above [test 3]. Test 2 is the key test of crowding out of intrinsic motivation by financial incentives as it assesses differential changes in intrinsic motivation over time in incentive versus control arms.

3.2. Baseline intrinsic motivation among voluntary participants

Before presenting evidence on crowding out, we first verify that randomization was successful in generating similar baseline levels of intrinsic motivation across incentive and control conditions. Table 1 reports average baseline values for the intrinsic motivation component of the TSRQ measure. There is only one difference across arms that is significant at the 5% level, between incentive arm 3 (2:1 match group) and the control group in study 2

(difference 0.384, p-value 0.026). Otherwise baseline intrinsic motivation scores are not significantly different across the arms in each study.

Table 1: Mean intrinsic motivation by arm at baseline

	Mean score (standard deviation) [incentive type]	
ARM	**Study 1**	**Study 2**
Control	5.995 (1.356)	6.789 (0.388)
Incentive arm 1	6.487 (0.607) [Individual rewards]	6.618 (0.543) [No match]
Incentive arm 2	6.449 (0.741) [Group rewards]	6.538 (0.567) [1:1 match]
Incentive arm 3	N/A	6.405 (0.663) [2:1 match]

Note: difference in baseline intrinsic motivation between control and incentive arm 3 is significant at the 5% level (p-value 0.0257), however once adjusted for multiple comparisons it is no longer significant.

The baseline measures are also informative in that they show that initial levels of intrinsic motivation were high: motivation scores can range from 1 to 7, and mean baseline scores in both studies were uniformly above 6. These high levels indicate that the weight loss patients in our study considered themselves highly intrinsically motivated to lose weight, shedding some light on the strength of intrinsic motivation for this and similar health behaviors. There is also a technical implication of the high initial values, which is that floor effects pose no difficulty for our key research question; given that initial scores are high, there is plenty of "room" for financial incentives to reduce intrinsic motivation through crowding out should this effect be present.

3.3. Crowding out in aggregate

To see whether external incentives are associated with crowding out of intrinsic motivation for weight loss, we show changes in intrinsic motivation over time, by arm (Figure 1). Crowding out of intrinsic motivation by incentives would be illustrated by a decline over time in motivation in the incentive arms that is greater than any downward trend in motivation for the control groups. The results in Figure 1 show little evidence of crowding out. First, in study 1, there is no statistically significant decline over time within any of the control or incentive conditions for any time horizon (e.g., between baseline and six months). In study 2, there are significant declines in intrinsic motivation in the 2:1 match arm and the control arm between 0 and 9 months, however given that there are no differential declines in incentive arms versus control, this suggests that there is no evidence of crowding out due to incentives [test 1].

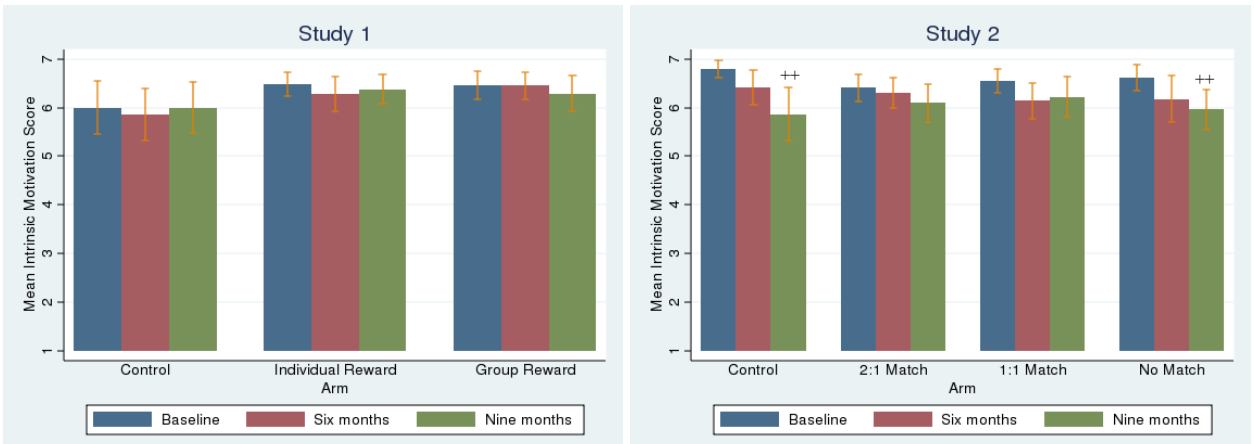

Fig. 1. Average intrinsic motivation by arm. Error bars show two standard errors, **indicates a change from 0 – 6 months that is significant at the 5% level, and ++indicates a change from 0 – 9 months that is significant at the 5% level.

We test specifically for crowding out by testing for differential changes in intrinsic motivation over time between incentive arms and control [test 2]. Table 2 shows p-values for this

test of changes in intrinsic motivation between incentive and control arms, as well as changes in intrinsic motivation over time within arms [test 1] and comparing any of the incentive arms to other incentive arms in each study (e.g., 2:1 match versus 1:1 match in study 2) [test 3]. There are no statistically significant differences either in the change in intrinsic motivation over time, comparing any of the incentive arms to the respective control group, or comparing any of the incentive arms to other incentive arms in each study. The overall conclusion, replicated across both studies, is that financial incentives do not appear to lead to a drop in intrinsic motivation for weight loss; this finding appears to be robust to various types of financial incentives (i.e., cash rewards and deposit contracts).

Table 2: P-values for tests of changes in intrinsic motivation over time

		0-6 month change	6-9 month change	0-9 month change
Study 1	*Within-arm changes:*			
	Individual rewards	0.2722	0.1575	0.202
	Group rewards	0.836	0.3614	0.4446
	Control	0.1836	0.606	0.9783
	Across-arm changes:			
	Control vs. Individual rewards	0.7018	0.9451	0.7164
	Control vs. Group rewards	0.1397	0.1896	0.4967
	Individual vs. Group rewards	0.3626	0.0938	0.7014
Study 2	*Within-arm changes:*			
	2:1 match	0.2988	0.2684	0.1526
	1:1 match	0.0239	0.693	0.1137
	No match	0.0599	0.1809	0.0033**
	Control	0.0191	0.0294	0.0018**
	Across-arm changes:			
	Control vs. No match	0.8838	0.299	0.4913
	Control vs. 1:1 match	0.899	0.0361	0.0811
	Control vs. 2:1 match	0.3461	0.1618	0.0494
	No match vs. 1:1 match	0.9882	0.1713	0.1709
	No match vs. 2:1 match	0.285	0.6771	0.176
	1:1 match vs. 2:1 match	0.2836	0.3058	0.1

Note: Wilcoxon rank-sum/Wilcoxon-Mann-Whitney tests for independent samples and Wilcoxon signed-rank tests for paired samples used. Bonferroni adjustment for multiple comparisons used to test statistical significance of changes given multiple hypothesis tests. ** indicates significance at the 5% level after adjustment.

We also have measures of some sources of extrinsic motivation, and thus can investigate whether the incentives affect these types of extrinsic motivation. For example, if participating in

a weight loss initiative with financial incentives in a workplace setting makes participants feel pressure from those implementing the program (in particular, their employers), this could affect extrinsic motivation levels. (Alternatively, if incentives simply offer a financial nudge but do not exert any type of social or other pressure, extrinsic motivation would likely not be significantly affected.) Figure 2a shows average extrinsic motivation by arm over time for each study. We also show measures of the "Relative Autonomous Motivation Index," which is formed by subtracting extrinsic motivation from intrinsic motivation (see section 2.4, above) in Figure 2b. There are no significant changes within or across arms over time in either of these two measures.

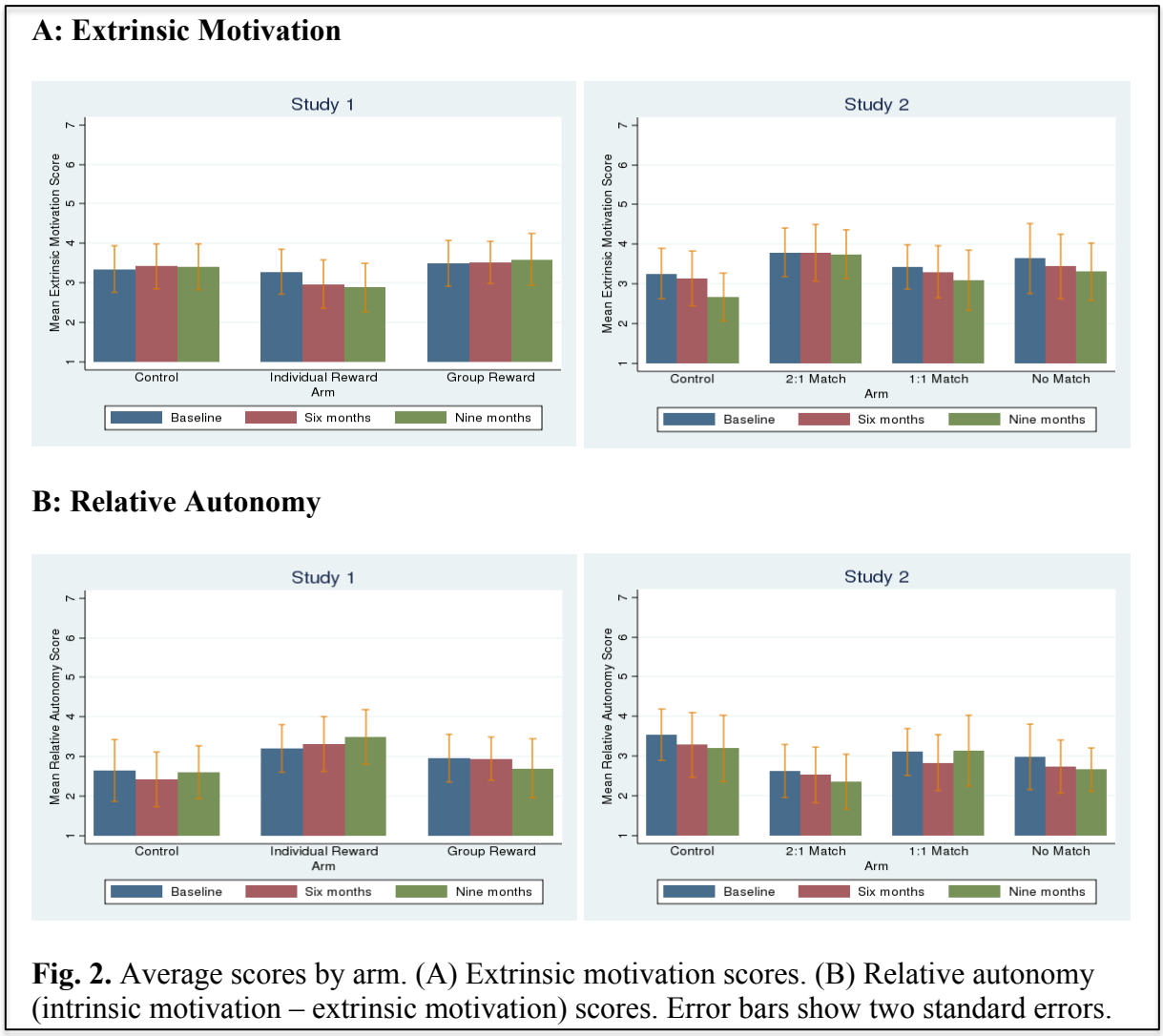

Fig. 2. Average scores by arm. (A) Extrinsic motivation scores. (B) Relative autonomy (intrinsic motivation – extrinsic motivation) scores. Error bars show two standard errors.

One potential concern is that censoring could prevent us from observing crowding out even if it occurs. A non-trivial fraction of our participant population rates themselves at the maximum value of 7 on the TSRQ scale at baseline. Thus, we may be concerned that the true intrinsic motivation level for some of these individuals lies above 7, but our scale is unable to capture this (their motivation levels are censored). For these individuals, then, we might miss crowding out that occurs in a range of motivation above the maximum scale value of 7. We can check, however, whether there is any evidence of crowding out among the remaining proportion of individuals who state an initial motivation level that is below the maximum, and thus are not subject to censoring; between 55% and 59% of the sample in each study has baseline intrinsic motivation below 7. As shown in Figure 3, the changes in intrinsic motivation over time are small in magnitude and far from significant in this sub-sample. Thus, there is also little evidence of crowding out among the restricted sample for which censoring problems do not apply, and we conclude that the lack of crowding out cannot be explained simply by censoring.

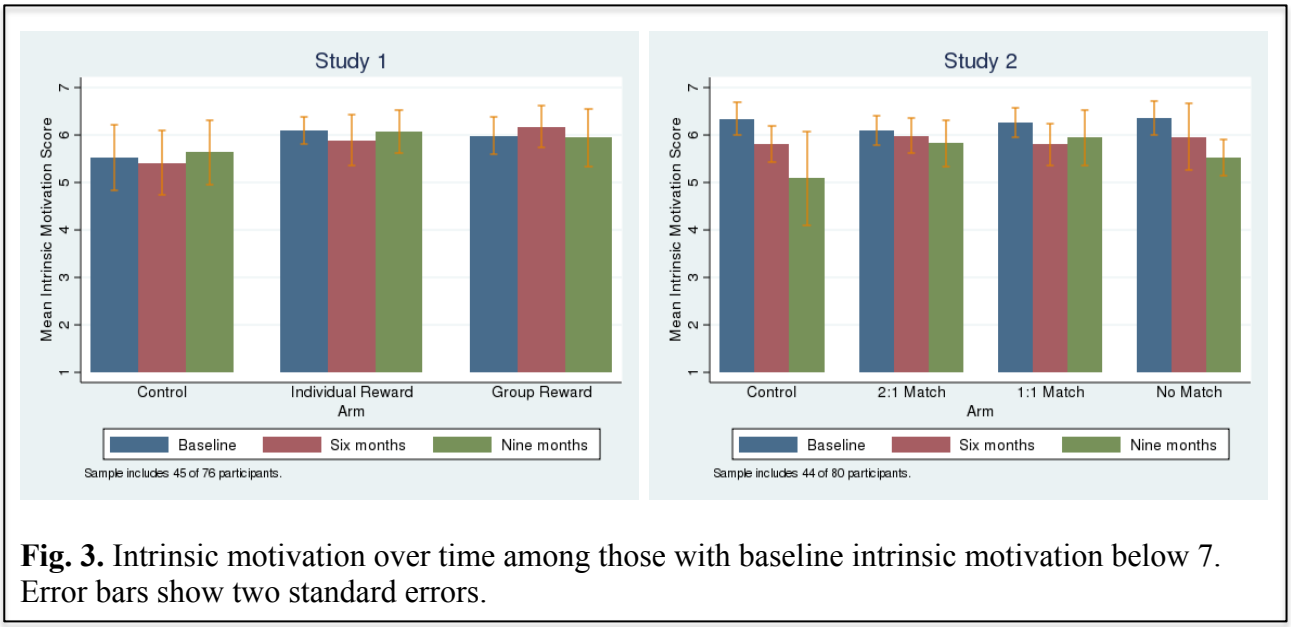

Fig. 3. Intrinsic motivation over time among those with baseline intrinsic motivation below 7. Error bars show two standard errors.

3.3. Crowding out in sub-populations

We find no crowding out effects in the aggregate study populations, however there is the potential for heterogeneity in crowding out effects across participants.[5] Crowding out might affect participants with relatively higher baseline weight differently than those with relatively lower baseline weight. In addition, experiences in the program might be associated with differential effects on intrinsic motivation. In particular, it might be that crowding out of intrinsic motivation is more likely if a participant receives greater financial rewards. Below we look at changes in intrinsic motivation among two sub-populations of interest: those with initial weight above versus below the median weight for that study and those who earned more versus less from incentives during the intervention.

Baseline weight. Median baseline weight was 209.2 pounds and 208.2 pounds in study 1 and 2, respectively. Figure 4 shows changes in average intrinsic motivation over time for those below and above median baseline weight in each study. There are no significant changes in intrinsic motivation in either baseline weight group (above versus below median baseline weight) in study 1. In study 2, there is evidence that intrinsic motivation fell over time within both categories of participants, consistent with declines in the aggregate study 2 population shown in Figure 1. There is no evidence of differential changes in intrinsic motivation over time between baseline weight categories in either study (i.e., the change in intrinsic motivation between baseline and 6 months, 6 and 9 months, and baseline and 9 months, is statistically the same for the below median weight group and the above median weight group in each study).

[5] For example, Charness and Gneezy (2009) find that their results are driven by the sub-group of individuals who were new gym-goers versus those who had been members before the study.

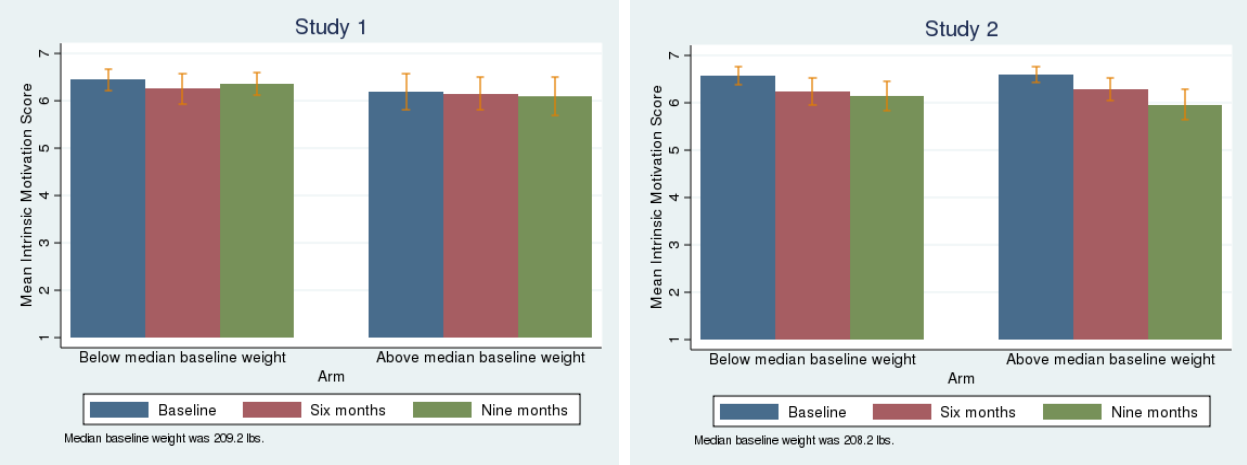

Fig. 4. Intrinsic motivation over time by baseline weight. Error bars show two standard errors.

Financial Rewards. If financial incentives crowd out intrinsic motivation, we might expect that those who earned more in incentives would be more likely to experience any crowd out or to experience relatively more crowd out.[6] Figure 5 shows mean intrinsic motivation at baseline, 6 months, and 9 months by earning status for incentive-arm participants who earned more than the median amount of money during the intervention period versus those who lost less than the median amount in study 1 (left) and for those who lost versus gained money during the intervention period (conditional on making a deposit) in study 2 (left).

In study 1, we divide incentive-arm participants into those who earned above versus below the median earnings within each incentive arm (e.g., participants in the individual rewards arm who earned more or less than the median earnings within the individual arm). To maintain sample sizes, we pool those in the two incentive arms who earned above the median earnings in their respective arm and those who earned below the median. In the individual rewards arm, the median earning level was $100; 19 of 35 participants (54%) had positive (versus zero) earnings,

[6] Though note that there is the potential for reverse causality, i.e., that those who experience decreases in intrinsic motivation are less likely to meet weight loss goals and therefore less likely to earn financial rewards; thus, analysis of the interaction between financial rewards earned and intrinsic motivation within this study is correlational only.

ranging from $100 to $600. Median earning in the group arm was higher, $350, and 28 of the 34 participants (82%) had positive earnings, ranging from $125 to $1,917. In study 2, we divide incentive arm participants into those who earned positive versus negative amounts overall. We choose this division because take-up of deposit contracts was very low; only 22 participants out of 80 made deposits and either earned or lost money. Of the 22 participants who made deposits, only eight earned positive total rewards over the intervention period (ranging from $4 to $807, mean $296.13) and 14 lost money (ranging from -$5 to -$142, mean -$41.57). All participants in the no match group who made a deposit (five participants) lost money.

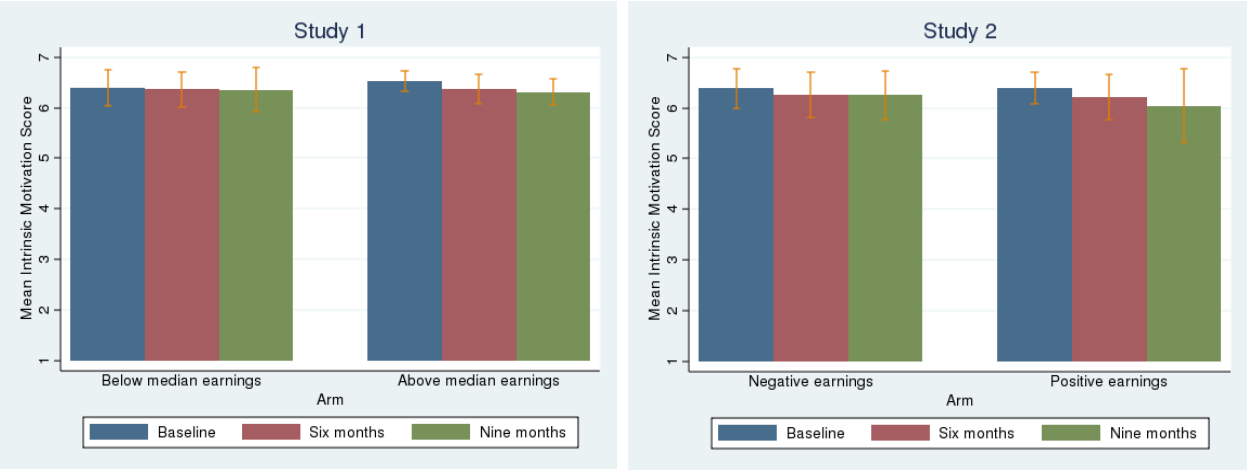

Fig. 5. Changes in intrinsic motivation over time by arm and level of earnings. Error bars show two standard errors.

Figure 5 shows that there is no evidence of significant changes in intrinsic motivation within earning category over time or across categories over time (e.g., the change in intrinsic motivation between baseline and six months is not statistically different between the positive and negative earners in study 2). Though we are limited by small sample sizes, these results provide further suggestive evidence in support of our main finding of no crowding out of intrinsic motivation by financial incentives.

3.4. Sensitivity analyses of missing data

In the results reported thus far, our sample included only those participants with non-missing intrinsic motivation scores at baseline, 6, and 9 months, resulting in sample sizes of 76 and 80 in study 1 and 2, respectively. We drop 28 participants with incomplete intrinsic motivation data from study 1 (about one-quarter of participants in each arm) and 52 participants from study 2 (ranging from 30-48% of participants per arm). In all, about one-third of participants in each arm has missing data (and is therefore dropped); the missing rate across incentive and non-incentive arms is largely similar in both studies.[7]

The characteristics of these omitted participants suggest that there are no systematic differences in baseline intrinsic motivation between participants who completed and did not complete subsequent questionnaires. In study 1, participants with subsequent missing data had an average baseline motivation of 6.312 [standard deviation (sd) 0.969] compared to a baseline level of 6.476 [sd 0.633] among those who completed follow-up (p-value 0.576); in study 2, participants with subsequent missing data had an average baseline motivation of 6.577 [sd 0.564] compared to a baseline level of 6.314 [sd 0.970] among those who completed later surveys of motivation (p-value 0.401). The populations also do not differ with regards to baseline weight or self-reported health status, or self-reported income level, education, and race.

There is evidence, however, that participants with missing data were less likely to have a weight recorded at 6 months and 9 months, though it is important to view these numbers in the context of missing weight data, which is relatively low at approximately 17% averaged across

[7] In study 1, 10 of 35 participants in the individual reward arm had missing motivation data (10/35), compared to 8 of 34 participants in the group reward arm, and 10 of 35 participants in the control arm. In study 2, the missing rates were: 10/33 in the 2:1 match arm, 12/33 in the 1:1 match arm, 16/33 in the no match arm, and 14/33 in the control arm.

both studies at 6 months and 12% at 9 months. In study 1, 61% of participants with missing motivation data had missing weight measurements at the end of the intervention period, compared to 12% of participants with complete motivation data (p-value 0.000); 43% of participants with missing subsequent motivation data had missing weight measurements at the end of the follow-up period, compared to zero participants who completed later motivation surveys. Patterns in study 2 were similar. Participants with missing motivation data were more likely to have missing weight measurements at 6 months (25% of participants) and 9 months (29%) compared to those with no missing data (0% and 1.3% missing weight measures at 6 and 9 months, respectively, p-value 0.0001). In study 1, we also find that on average among incentive arm participants, those who had missing motivation data met fewer monthly weight targets than those who did not have missing data (1.056 versus 2.059 among in-sample participants, p-value 0.0318) and actually gained weight between baseline and the end of the follow-up period (2.113 pounds on average) compared to those with full motivation data who lost an average of 4.397 pounds over this time period (p-value 0.047). In study 2, there were no significant differences between the in-sample and dropped populations in terms of weight loss over time.

Overall, these results suggest that those with missing intrinsic motivation data may have been more likely to drop out of the study, resulting in missing weight measurements and, in study 1, fewer weight loss goals met over the course of the study. It is impossible to know the direction of causality between missing motivation data and missing weight measurements in this case; if dropping out is an indicator of reduced intrinsic motivation, however, we may miss this decline in our survey measures and this may bias our results. Generally, our findings suggest that those who were dropped from the analysis sample were relatively reflective of the larger group in terms of baseline characteristics, including motivation, and relatively evenly distributed across

intervention and control arms, mitigating this issue to a certain extent.[8] Furthermore, among those who do not have missing data, there is essentially zero change in intrinsic motivation. Thus, if intrinsic motivation is crowded out, it has to be in such a way that it is entirely confined to the group with missing data. We conducted two sensitivity analyses to examine the implications of missing data and, in particular, the potential that participants with missing weight data may have also had reduced intrinsic motivation.

First, we compared changes in motivation over time between those who were missing any motivation measure (e.g., missing the 9-month motivation measure but not the 6-month measure) and those who had complete data. If missing data was an indicator of reduced motivation and drop-out, we would expect that participants missing some data experienced greater declines in intrinsic motivation over time than those with complete data. We find no significant differences in the change in intrinsic motivation from baseline to 6 months among those missing the 9-month motivation measure compared to those with complete data (p-value 0.451 and 0.673 in studies 1 and 2, respectively) and no significant differences in the change in intrinsic motivation from baseline to 9 months among those missing the 6-month motivation measure compared to those with complete data (p-value 0.988 and 0.476 in studies 1 and 2, respectively).

Second, we redo the analyses presented in sections C and D above assuming that those with missing motivation data have a decline in intrinsic motivation that is equal to the mean change in the 10% of the sample with the biggest motivation decrease (rather than dropping these participants from our sample). This is a strong assumption since approximately one-third of our data were dropped due to missing motivation and using this method we assign this third a relatively large decrease in intrinsic motivation over time. When we use this method there are

[8] There are no significant differences across arms (in particular, between incentive and control arms) in measures that would suggest that the participant dropped out (missing weights at 6 and 9 months and whether or not the participant weighed in at all in month 6).

several cases in which we now find significant decreases in intrinsic motivation decreases over time *within* a given arm (e.g., between 0 and 9 months in the control arm in study 1, between 0 and 6 months in all arms of study 2). Even with this strong assumption, however, there is still no evidence of the differential decreases in intrinsic motivation over time in *incentive vs. control arms* that would indicate crowding out. The results of these sensitivity analyses strengthen our conclusion that financial incentives do not appear to crowd out intrinsic motivation for weight loss in our setting.

4. Discussion

We have presented evidence that providing monetary incentives for achieving weight loss goals does not crowd out intrinsic motivation for weight loss. We directly measured intrinsic motivation over time in two randomized controlled trials of financial incentives for weight loss and find that individuals who enrolled in voluntary workplace weight loss programs were highly motivated at baseline and that incentives did not crowd out this intrinsic motivation whether they were designed as deposit contracts or cash rewards. In addition, we find no difference in effect across sub-populations of particular interest, including those who won more or less money through incentives.

This lack of crowd out is consistent with behavioral evidence of the long-run effects of incentives seen in the field. To our knowledge there is no behavioral evidence that indicates crowding out from field studies on health behavior; that is, no study has actually observed a decline in performance below baseline after removal of incentives, which would be a direct sign of crowding out. In addition, there are a number of incentive studies that even find some

prolonged beneficial effects, consistent with "crowding in" or habit formation (Charness & Gneezy, 2009; Acland & Levy, 2010; Volpp et al, 2009; Price et al, 2013). This finding is relevant for the debate on whether financial incentives can be an effective component of policy interventions designed to foster better individual health outcomes, and improved public health. It is also important in light of the rapid adoption of financial incentives by employers; in 2013 over 80% of large employers will be using some type of incentive to foster employee health (Towers Watson/NBGH, 2012). Up to this point, there has been little evidence on the efficacy of such incentives in a workplace setting, particularly in terms of potential long-term effects on motivation.

The main limitation of this paper is a rate of missing data on motivation scores that is higher among participants who also have missing weight data, suggesting that they were unsuccessful in losing weight and/or dropped out of the study. The proportion of this missing weight data, however, is relatively low (17% at 6 months and 12% at 9 months averaged across both studies), and there is no difference in the rate of missing weight data between incentive and control arm participants, limiting the degree to which this could bias the results. We conduct two sensitivity analyses focused on missing data, including assuming that those with missing motivation scores have substantial drops in motivation over time, and find that our main result of no crowding out holds even with this strong assumption.

A second potential concern is that we do not have wide baseline heterogeneity in motivation scores, suggesting that the survey tool we use to measure motivation, the TSRQ, may have some limitations in settings such as ours (in particular, among a population that volunteers to participate in a behavior change program). While the uniformly high baseline levels of intrinsic motivation leave "room to fall," and thus make it more likely that we could detect

crowding out should it exist, the lack of heterogeneity in these measures makes it difficult to establish any links between intrinsic (or extrinsic) motivation and actual behavior (e.g., baseline intrinsic motivation associated with higher weight loss in a weight loss program as seen in Williams et al., 1996). We measure motivation using the TSRQ because it has been widely used in the field of psychology to study intrinsic motivation and, in particular, crowding out of intrinsic motivation by financial incentives. Future work should experiment with new and different types of scales to capture behavior and motivation among this type of population, as well as in populations whose baseline motivation is likely to be lower, and across a variety of health care settings. In addition, we studied two forms of financial incentives (deposit contracts and group and individual cash rewards) but future research should test motivation in the presence of other types of incentive designs with the goal of providing further insights into the implications of financial incentives and incentive design for intrinsic motivation and long-run behavior maintenance.

The results of this paper are informative for policy debates over whether financial incentives are likely to be counter-productive in domains like health. Our results indicate that incentives need not reduce intrinsic motivation, at least in the context of health, and that we ought to be cautious in generalizing crowding out results from pro-social behaviors or activities such as puzzles to personal health behaviors among adults. Further, our findings highlight the value of future research on decision-making under incentives, outside of the lab and across different types of incentives and populations, to improve understanding of when crowding out may happen and when it tends not to happen. Given the lack of motivational crowding out, policy interventions featuring time-limited incentives and short-term effects are likely to be cost-effective as long as the short-term gains outweigh the costs of incentives.

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