Goal Setting and Monetary Incentives:

When Large Stakes Are Not Enough.

Joaquín Gómez-Miñambres, Brice Corgnet and Roberto Hernán-Gonzalez*

This Draft: November, 2012

Abstract

The aim of this paper is to test the effectiveness of wage-irrelevant goal setting policies in a laboratory environment. In our design, managers can assign a goal to their workers by setting a certain level of performance on the work task. To establish our theoretical conjectures we develop a model where assigned goals act as reference points to workers' intrinsic motivation, creating a sense of gain when attained and a sense of loss when not attained. Consistent with our theoretical framework, we find evidence that managers set goals that are challenging but attainable for an average-ability worker. Workers respond to these goals by increasing effort, performance and by decreasing on-the-job leisure activities with respect to the no-goal setting baseline. We study the interaction between goal setting and monetary rewards by considering different values for the monetary incentives involved in completing the task. Interestingly, we find that goal setting is especially effective when monetary incentives are strong. These results suggest that goal setting may foster workers' intrinsic motivation and increase their level of performance beyond what is achieved using solely monetary incentives.

KEYWORDS: Intrinsic motivation, incentives, goal-setting, reference dependent preferences, virtual organizations.

JEL CODES: C92, D23, M54.

* Joaquín Gómez-Miñambres: Chapman University, Economic Science Institute. One University Drive, Orange, California 92866. Email: minambre(at)chapman.edu. Brice Corgnet: Chapman University, George L. Argyros School of Business and Economics. One University Drive, Orange, California 92866.Email: corgnet(at)chapman.edu. Roberto Hernán-Gonzalez: Universidad de Granada, Department of Economic Theory and Economic History. Campus de la Cartuja, 18011, Granada, Spain.

1. INTRODUCTION

1.1. Work Motivation and Goal Setting

Motivating workers has always been a crucial aspect of labor relationships. Traditionally, the principal-agent paradigm has emphasized the importance of monetary incentives (i.e., wages and the threat of being fired) as the most effective way to induce workers to exert effort (see Laffont and Martimort (2002) or Bolton and Dewatripont (2005) for reviews). These theories emphasize the role of *extrinsic motivation* by which people engage in an activity for monetary rewards while disregarding *intrinsic motivation* by which people engage in an activity for their own sake. Psychologists (Deci (1971, 1975)) and behavioral economists (Frey and Jegen (2001)) have pointed out the relevance of intrinsic motivation and its relationship with extrinsic (i.e., monetary) incentives. Intrinsic motivation is viewed by these authors as an idiosyncratic characteristic of workers that can be undermined by the presence of extrinsic incentives generating the so-called "motivation crowding-out effect" (see Gneezy et al. (2011) for review).

The previous approach leaves a relevant open question: Can we foster workers' intrinsic motivation so as to increase their level of performance? Many psychologists provide a positive answer to this question by arguing that wage-irrelevant (i.e., nonbinding) performance goals enhance employees' motivation and work performance (Locke and Latham (2002)). According to the *goal-setting* literature, workers respond to non-monetary symbolic goals because their attainment engenders intrinsic satisfaction and a sense of accomplishment. The effectiveness of goal setting has been reported consistently in the experimental literature in psychology. Locke and Latham (2002) provide an exhaustive literature review of the topic and find that goals increase performance in more than 90% of the studies.

In this paper, we propose to test the effectiveness of goal setting policies and assess their interaction with monetary incentives in an incentivized controlled laboratory setting. Our experimental methodology enables us to control for confounding factors that may have interfered in the empirical evaluation of goal setting policies such as corporate culture, explicit

and implicit incentives and supervision policies. To that end, we consider a laboratory environment which reproduces several features of field environments while keeping control over the decision environment (Corgnet et al. (2011)). Our experimental approach to the analysis of goal-setting is novel in many ways. First, in contrast with existing experiments, we consider the interplay between goal setting and monetary incentives. Second, in our setting, goals are endogenously determined by participants who were assigned the role of managers rather than selected randomly or assigned arbitrarily by the experimenter (Latham and Locke (1979), Winter and Latham (1996)). This was intended to mimic actual managerial practices. Third, our laboratory environment was characterized by the use of long, repetitive and effortful work tasks which differ substantially from those usually considered by psychologists such as assembling tinker toys or listing objects uses (Locke et al. (1981), Mento et al. (1992)) which may already induce a certain level of intrinsic motivation. Fourth, we allow subjects to undertake a real leisure activity (Internet browsing) instead of working on the task. Our intention is not only to reproduce a relevant feature of real-world organizations but also to ensure that our results are not driven by a lack of alternative activities in the laboratory. This issue has been described as the *active participation hypothesis* (Lei, Noussair and Plott (2001)). Finally, we consider a multi-period setting which allows us to evaluate the effectiveness of goal setting over time in a context in which fatigue is likely to set in.

To establish our theoretical conjectures we develop a principal-agent (manager-worker) model where the worker's motivation to exert effort is twofold. First, as in standard models, the worker responds to *extrinsic* incentives which are captured by the magnitude of the monetary reward. Second, workers are *intrinsically motivated* to exert effort and attain the goals which are set by their managers. We model workers' intrinsic motivation as a goal-dependent intrinsic utility function in line with prospect theory (Kahneman and Tversky (1979)). Our theoretical framework is an extension of Wu et al. (2008). In this paper the authors examine the agent's response to exogenously given goals under prospect theory preferences and in the absence of extrinsic incentives. In our model, we deviate from the previous analysis by considering the case in which the principal is in charge of setting goals. In addition, our model introduces extrinsic incentives with the aim of studying the interaction between

monetary incentives and workers' responses to goals. Note that in order to avoid gift-exchange effects by which managers can increase workers' effort by inducing positive reciprocity from workers, we consider the case in which monetary incentives are outside the control of managers (Fehr et al. (1993) and Fehr et al. (1997)).

Our experiment consists of two treatments which will be referred to as *Baseline* and *Goal Setting*. In the goal setting treatment, managers were able to set wage-irrelevant goals for workers while no such option was available in the *Baseline*. Comparing the two treatments, we find that goal setting increases workers' performance. We also observe that goals increase workers' dedication to the work task increasing effort and decreasing the time spent browsing the internet. The effectiveness of goals is closely related to the fact that managers set goals that are challenging but yet attainable by an average-ability worker, which is consistent with our theoretical conjectures. As a result, the effect of goal setting varied across workers' ability levels. In particular, low-ability workers for whom goals were likely to be challenging increased their performance by 40% in the goal setting treatment with respect to the baseline while high-ability workers achieved the same level of performance across treatments.

Interestingly, we observe that the effectiveness of goal setting decreases over time as workers' fatigue kicks in. The short-lived effects of goal setting suggest certain limitations for the use of goal setting policies in repetitive tasks in which people achieve their maximum level of performance in a short period of time. Nevertheless, we report good news about the effectiveness of goal setting as we show that its effectiveness is magnified rather than undermined by the use of high monetary incentives. Indeed, the effect of goal setting on workers' performance appears to be stronger with high monetary incentives. We propose two possible interpretations of this result. First, consistent with our theoretical results, we find that high monetary incentives promote higher goals which magnify workers' motivation and performance. Second, we show that goals tend to eradicate the excessively prudent behaviors of workers facing large stakes. These results suggest that the effectiveness of goal setting which has been reported in the psychology literature is robust to the more general case of work environments where monetary incentives prevail.

1.2. Literature Review

The idea that specific, attainable and nonbinding goals affect workers' motivation has received considerable attention in the psychology literature (Latham (2000) and Locke and Latham (1996, 2002) for reviews).[1] The first finding of this literature is that specific and difficult (but perceived as attainable) goals lead to greater performance than vague and easy goals. Second, workers are more motivated or more committed to attain goals when they perceive their goal as being relevant and difficult to attain. Finally, goals are shown to increase workers' persistence to exert effort. These results suggest that goal setting may be effective in fostering a worker's intrinsic motivation. Our study complements this previous research by studying an environment in which nonbinding goals and monetary incentives coexist. As we shall show, goals not only boost workers' intrinsic motivation but they also mediate the relationship between intrinsic and extrinsic incentives, generating a "crowding-in" effect of large stakes on workers' intrinsic motivation to work.

In Economics, the concept of intrinsic motivation has been closely linked to the idea of "motivation crowding-out" (Frey and Jegen (2001)). Workers' intrinsic motivation has been introduced into economic models in which monetary rewards were shown to crowd out intrinsic motives to work (e.g., Benabou and Tirole (2003)). Gneezy and Rustichini (2000) provide evidence of "motivation crowding-out" in a controlled laboratory environment. The authors find that, although performance increases with significant monetary compensation, small monetary incentives may actually undermine performance compared to a situation with no compensation at all. Recently, Ariely et al. (2009) and Pokorny (2008) provide experimental evidence that very high monetary rewards can also decrease performance. This evidence sheds light on the non-monotonic relationship between monetary incentives and performance. This is not only the case that low rewards can be worse off than no rewards at all but very high rewards may also have a detrimental effect on workers' motivation. Interestingly, we confirm

[1] The goal setting literature is certainly vast, according to Latham (2000): *"…the theory has been shown to predict, influence, and explain the behavior of over 40,000 people in numerous countries (e.g., Australia, Canada, the Caribbean, England, Germany, Israel, Japan, and the United States), in both laboratory and field settings, involving at least 88 different tasks in occupations that included logging, word processing, engineering, and teaching in a university."*

this result in our baseline design without goal setting in which we observe that performance levels tend to be lower in the presence of either low or high monetary incentives compared with average incentives levels. However, this pattern of incentives effects disappears in the goal setting treatment in which neither small nor large stakes undermine workers' performance.

To our knowledge our paper is the first work that assesses the effect of assigned goals and monetary incentives on workers' performance. From a theoretical standpoint, our paper relates to the Economics and Management literature including the work of Wu et al. (2008) who study workers' response to goals in the context in which goals are exogenously given and in the absence of extrinsic incentives based.[2] Wu et al. (2008) find that performance increases with goals which are attainable but may decrease otherwise. Gómez-Miñambres (2012) studies a principal-agent model where agents derive utility from attaining nonbinding goals. In this setting, the principal is willing to use goal setting policies as a tool to increase agents' intrinsic motivation to work. Agents have private information about their own personal standards that determine whether a goal is challenging and rewarding to them. It is shown that assigned goals and performance increase with agents' standards. Likewise, some theoretical papers (e.g., Kock and Nafziger (2011), Hsiaw (2012)) have considered the effects of personal (i.e., self-set) goals in attenuating self-control problems. At the empirical level, in a recent paper, Goerg and Kube (2012) consider the impact of setting personal goals in a field experiment where participants have to reallocate books on shelves of a large library. The authors consider a standard piece rate compensation treatment as a baseline. They compare this baseline with several other treatments: A purely nonbinding personal goal, a binding personal goal for which the compensation increases with the goal if it is attained while no money is received otherwise, and two standard bonus contracts. The authors show that the highest increase in performance levels is achieved when workers are allowed to set personal goals even if goals do not entail monetary consequences. Also, the bonus contract only increases performance with respect to the piece rate baseline when the goal is challenging.

[2] The authors consider the utility function which was proposed by Heath et al. (1999) who considered the goal as a reference point. In that respect, goals tend to alter the psychological value of monetary outcomes in a way which is consistent with prospect theory.

The paper proceeds as follows. Section 2, presents the experimental environment while the theoretical framework and the hypotheses are derived in Section 3. Results are exposed in Section 4 and Section 5 provides concluding remarks.

2. EXPERIMENTAL DESIGN

2.1. Virtual Organization with Real Effort and Real Leisure

The core of our methodology is the design of a computerized platform that reproduces several features of real-world work environments. We develop a framework in which subjects can undertake a real-effort task while having access to Internet at any point in time during the experiment. The experimental environment is described in detail below.

2.1.1 Organizational Roles

We consider organizations with two types of subjects referred to as B (worker) and C (manager). Each period, subjects in a session were randomly assigned to one of these two roles so that one worker was matched with only one manager. During a period, workers could dedicate their time to either completing the *work task* or *browsing the web* while managers could only browse the Internet. At the beginning of each period, managers could set a *goal* for the worker's production level on the *work task*. An experimental session consisted of 8 periods of 10 minutes each.

2.1.2 The Work Task

We consider a real-effort task that is particularly long, laborious and effortful compared to previous real-effort experiments that have reported the use of counting tasks (Dohmen and Falk (2011), Eriksson, Poulsen and Villeval (2009), Niederle and Vesterlund (2007)).[3] In

[3] Different variations of this task have been used by Bartling, Fehr, Maréchal and Schunk (2009) and Dohmen and Falk (2010), Abeler et al. (2011). A counting task that consisted of summing up the number of zeros in a table randomly filled with ones and zeros was also used in Falk and Huffman (2007). A long typing task was used in

particular, subjects were asked to sum up matrices of 36 numbers comprised between 0 and 5 for 1 hour and 20 minutes. Note that participants were not allowed to use a pen, scratch paper or calculator. This rule amplified the level of effort subjects had to exert in order to complete tables correctly. Our *work task* is designed to reduce as much as possible the intrinsic motivation derived from the task itself rather than from goals. As a result, we expect to identify signs of fatigue and boredom during the experiment. An example of the *work task* is shown in Figure 1.[4]

							Sum Row:
	0.00	3.00	4.00	3.00	0.00	4.00	14.00
	0.00	4.00	0.00	0.00	0.00	1.00	5.00
	3.00	5.00	0.00	0.00	1.00	4.00	13.00
	3.00	1.00	1.00	5.00	5.00	1.00	16.00
	2.00	1.00	5.00	4.00	4.00	4.00	20.00
	5.00	3.00	4.00	5.00	1.00	4.00	22.00
Sum Column:	13.00	17.00	14.00	17.00	11.00	18.00	90.00

FIGURE 1.- Example of table summation for the *work task*.

Before providing the final sum of all numbers in the table in the yellow cell, participants had to fill the sum of each column. Filling in these cells did not directly generate earnings but could help subjects compute the final sum. Only the final answer was rewarded although intermediate sums of all columns were required but did not generate payoffs. The value of a correct table was selected randomly at the beginning of each period in the following set of values: 10 cents, 80 cents or 150 cents. No pecuniary penalties were enforced for incorrect answers.[5] Therefore, monetary incentives varied across periods allowing us to study the interplay between goals and monetary stakes. In order to eliminate possible confounding with a gift-exchange game (as commonly found in the literature), total earnings were split equally

Dickinson's (1999) experiment for which subjects had to come during four days for a two-hour experiment. Falk and Ichino (2006) used a four-hour mailing task in their field experiment on peer effects.

[4] Before providing the final sum of all numbers in the table in the yellow cell, participants had to fill the sum of each column. Filling in these cells did not directly generate earnings but could help subjects compute the final sum. Only the final answer was rewarded although intermediate sums of all columns were required but did not generate payoffs.

[5] This was decided so as to be able to define goals on the basis of the number of tables completed correctly rather than defining goals on the basis of the monetary value of workers' production. This difference is relevant given that workers may face different monetary incentives making it more difficult for managers to set goals. Note that there still exists an opportunity cost for completing a table incorrectly.

between the worker and the manager at the end of each period and were displayed in the history panel located at the bottom of subjects' screens.

2.1.3 Internet Browsing

At any point during the experiment, workers could switch from the *work task* to the leisure activity that consisted of browsing the Internet. Each activity was undertaken separately, in a different screen. To switch from one activity to another subjects simply had to click on the corresponding option of the action menu displayed on their screen (see Figure 2). Participants were informed that their use of the Internet was strictly confidential and could not be recorded. Internet browsing and the *work task* were undertaken on different screens so that subjects could not complete tables while being on the Internet. Switching back and forth between the Internet browser and the *work task* was quick and easy. Subjects who returned to the Internet screen after working on the task were automatically directed to the last web page they visited. Subjects were free to consult their email or visit any web page.[6] The Internet browser was embedded in the software (see Figure 2) so that the experimenter could keep record of the switching times between activities as well as the exact amount of time subjects spent on each activity.

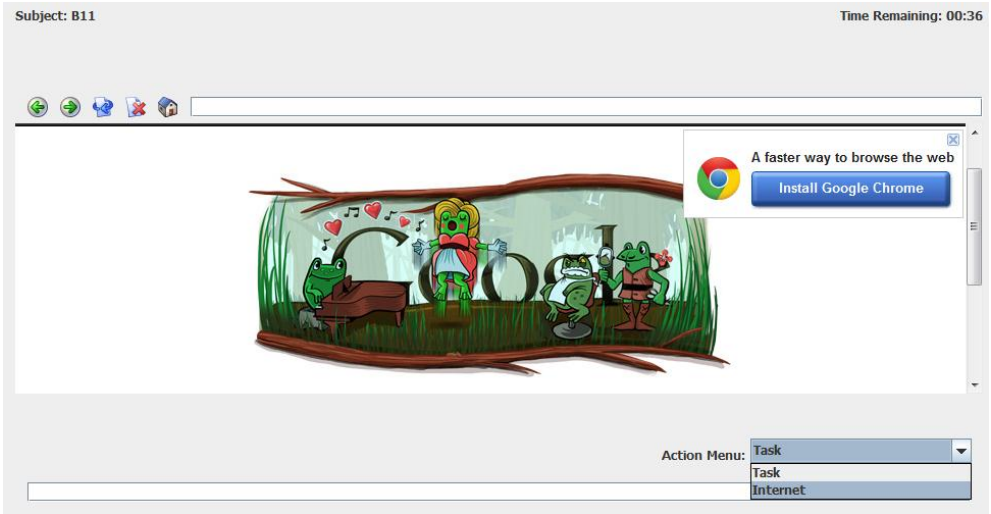

FIGURE 2.- Embedded Internet screen.

[6] Subjects were expected to follow the norms set by the university regarding the use of Internet on campus.

The introduction of Internet in our virtual organizations is motivated by the widespread use of Internet at the workplace. According to a 2005 study by *American Online* and *Salary.com*, employees spend about 26% of their time on activities unrelated to their work (Malachowski (2005)).[7] Almost half of this time actually corresponds to Internet usage.[8] An appealing feature of Internet as an alternative to the *work task* is the wide range of activities that can be completed online. Indeed, a large number of people are likely to derive utility from Internet access as they will be able to browse Web pages that best correspond to their favorite hobbies. The consideration of leisure-related issues in the experimental literature was introduced in the analysis of labor supply by Dickinson (1999). Falk and Huffman (2007) also introduced the possibility for subjects to quit the experiment when analyzing minimum wages and workfare in the laboratory.[9]

2.1.4 Goal Setting

A crucial feature of our experiment is the introduction of nonbinding goals assigned by managers to their worker. This feature will allow us to assess the effect of goal setting on workers' effort and performance (Locke and Latham (2002)).

At the beginning of each period and after learning the value of monetary rewards for completing the *work task* (either 10 cents, 80 cents or 150 cents), managers could set a goal for their workers. The goal stated the number of correct tables to be completed by a worker during the period. Workers knew from the instructions that the goal set by their manager did not entail monetary consequences so that producing more or less tables than the goal neither generates rewards nor induces penalties. Note that the manager could decide not to set a goal in which case the label *"no goal"* would appear on the screen. After managers made their decision regarding the goal, workers were informed about their goal as well as the monetary

[7] "Wasted Time At Work Costing Companies Billions", San Francisco Chronicle, July 11, 2005, discussing the findings of the AOL/Salary.com study:
http://www.sfgate.com/cgi-bin/article.cgi?f=/g/a/2005/07/11/wastingtime.TMP

[8] Similar estimates are provided in a 2005 study by *Web@Work*.
http://edition.cnn.com/2005/BUSINESS/05/19/web.work/index.html

[9] Two related studies (Charness, Masclet and Villeval (2010), Eriksson, Poulsen and Villeval (2009)) have also introduced on-the-job leisure activities in experimental environments by giving subjects access to magazines. However, the leisure activity was not embedded in the computerized platform.

incentives associated with completing the *work task* correctly. At any moment during the experiment subjects had access to their past performance levels and earnings.

2.2. Treatments and procedures

We conducted two treatments (see Table 1). In the goal setting treatment, managers could set wage-irrelevant goal*s* for workers at the beginning of each period while no such option was available for the *baseline*.

TABLE 1

SUMMARY OF THE TREATMENTS

Treatment	Description	Number of sessions (subjects) [observations]
Baseline (B)	Worker's production is split equally between the worker and the manager.	4 (46) [368]
Goal Setting (GS)	The manager sets a *wage-irrelevant goal* for the worker. Worker's production is split equally between the worker and the manager.	4 (46) [368]

Our subject pool consisted of students from a major U.S University. The experiments took place in March and April 2012. In total, 92 subjects participated in the experiment, divided in 8 sessions. We ran four sessions for the Baseline treatment (B), and four sessions for the Goal Setting treatment (GS). Each session consisted of 8 periods in which subjects were randomly matched to either the role of worker or manager. As a result, we collected a total of 736 observations.

The experiment was computerized using the software *Virtual Organizations* developed by *CYDeveloper LLC* (Corgnet et al. (2011)). All of the interaction was anonymous. The instructions were displayed on subjects' computer screens. Subjects had exactly 20 minutes to read the instructions. A 20-minute timer was shown on the laboratory screen. Three minutes before the end of the instructions period, a monitor announced the time remaining and handed out a

printed copy of the summary of the instructions. None of the participants asked for extra time to read the instructions. At the end of the 20-minute instruction round, the instructions file was closed, and the experiment started. The interaction between the experimenter and the participants was negligible.[10]

At the end of the experiment, subjects were paid their earnings in cash. Individual earnings at the end of the experiment were computed as the sum of the earnings in the *8* periods. Participants in the baseline treatments earned on average $33.88, while participants in the goal setting treatment earned on average $34.99. This includes a $7.00 show-up fee. Experimental sessions lasted on average two hours.

3. THEORETICAL FRAMEWORK

In this section, we develop a principal-agent model with goal-dependent preferences so as to derive a set of conjectures for our experiments.

3.1. The Model

We build on a model according to which wage-irrelevant goals affect the intrinsic value of workers' production in a way that is consistent with prospect theory (Kahneman & Tversky (1979)). We consider a principal-agent model with one risk neutral manager (principal) and one worker (agent). Worker's production (y) is defined as follows: $y=\theta e$, where e is the time that the worker dedicates to productive activities and θ is the worker's ability. There are two types of workers indexed by $i\epsilon\{L,H\}$, where L stands for low-ability worker (θ_L) and H for high-ability worker (θ_H) where $\theta_H > \theta_L > 0$. Managers do not observe workers' ability level but know the proportion $p\epsilon[0,1]$ of high-ability workers in the population. The worker is endowed with a total amount of time, normalized to 1, which can be dedicated to either productive ($e_i \geq 0$) or leisure activities ($l_i \geq 0$). Hence $e_i + l_i = 1$ for all $i\epsilon\{L,H\}$. We consider a standard increasing and convex

[10] In the majority of sessions, no questions were asked during the experiment.

disutility of effort function: $c(e_i) = \frac{{e_i}^2}{2}$. We denote by $\Omega_i = Ay_i > 0$ the monetary value of worker's production where A denotes the value of each unit of production generated by the worker, which is assumed to be exogenous. The manager and the worker share total production equally. Therefore, if we denote by $\alpha = \frac{A}{2}$, we can define $w_i = \alpha\theta_i e_i$ as the monetary outcome received by each of them given a worker's ability level $i \epsilon \{L,H\}$.

The worker is assumed to be both extrinsically and intrinsically motivated. The *extrinsic utility function* of the worker coincides with the monetary incentives (w_i):

$$V_E(y_i, \alpha) = w_i$$

In addition, the worker derives intrinsic utility from achieving the goals set by the manager. We define the worker's intrinsic utility function so that it is consistent with the properties of the value function in prospect theory (Kahneman & Tversky (1979)). More specifically, the reference point is assumed to be the goal (g) which is set by the manager.[11] The *intrinsic utility function* is defined as follows and illustrated in Figure 3:

$$V_I(y_i, g, \lambda) = \begin{cases} (y_i - g)^{\frac{1}{2}} & \text{if } y_i > g, \\ -\lambda\left(-(y_i - g)\right)^{\frac{1}{2}} & \text{if } y_i \leq g. \end{cases}$$

Thus, the goal (g) acts as a reference point that alters the intrinsic utility of the worker dividing the space of outcomes into gains, when the goal is attained, and losses, when the goal is not attained. Note that function $V_I(.)$ satisfies the standard prospect theory properties of loss aversion and diminishing sensitivity, where $\lambda > 1$ is the coefficient of loss aversion.

[11] See Heath et al. (1999) for a discussion of such a value function. An alternative goal-dependent intrinsic utility is considered by Gómez-Miñambres (2012). Most of the qualitative results of our model are robust to both specifications.

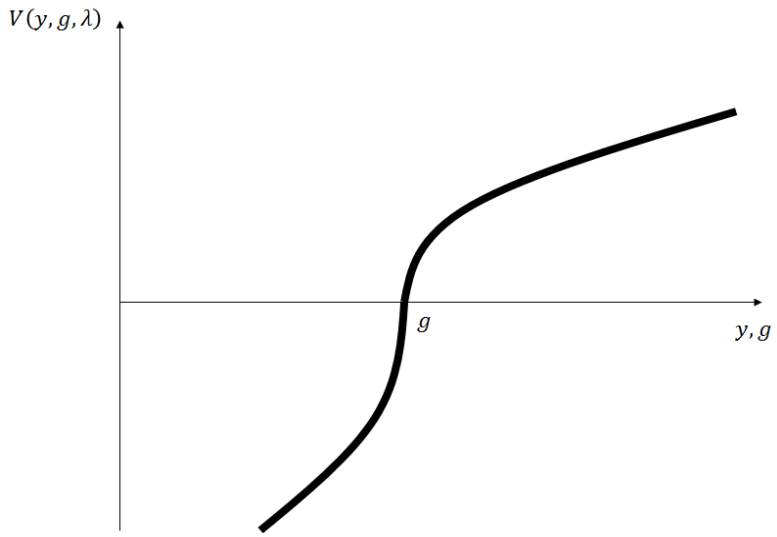

FIGURE 3.- The goal-dependent intrinsic utility: $V(y_i, g, \lambda)$.

We denote by $u(y_i, g, \lambda, \alpha)$ the sum of extrinsic and intrinsic motivation:

$$u(y_i, g, \lambda, \alpha) = V_E(y_i, \alpha) + V_I(y_i, g, \lambda) = \begin{cases} w_i + (y_i - g)^{\frac{1}{2}} & \text{if } y_i > g, \\ w_i - \lambda\left(-(y_i - g)\right)^{\frac{1}{2}} & \text{if } y_i \leq g, \end{cases}$$

and assume that the overall utility of the worker takes the general separable form:

$$U(y_i, g, \lambda, \alpha) = u(y_i, g, \lambda, \alpha) - c(e_i)$$

Although managers are not in charge of setting monetary incentives they can assign goals that affect workers' intrinsic motivation. The manager's utility only depends on worker's production and the exogenously given monetary incentives:

$$\Pi(y_i, \alpha) = \alpha y_i.$$

Therefore, in our framework, the manager's unique objective is to set the goal that maximizes the worker's production.[12] In particular, given a goal (g) the worker's optimal effort (e_i) is characterized by the following first order conditions:

$$\alpha\theta_i + \frac{\theta_i}{2}(\theta_i e_i - g)^{-\frac{1}{2}} = e_i \quad \text{if } \theta_i e_i > g, \tag{1}$$

[12] Note that if the managers were in charge of setting monetary incentives, they would also want to maximize the workers' intrinsic utility in order to pay lower wages (see Gómez-Miñambres (2012)).

$$\alpha\theta_i + \lambda\frac{\theta_i}{2}(g - \theta_i e_i)^{-\frac{1}{2}} = e_i \quad \text{if } \theta_i e_i \leq g \tag{2}$$

The left-hand side of equations (1) and (2) is the marginal utility of effort ($\frac{du}{de}$) while the right-hand side represents the marginal cost of effort ($\frac{dc}{de}$).

We assume that $\alpha\theta_H<1$ so that in the standard model without intrinsic motivation ($V_I(y_i, g, \lambda) = 0$) it is never optimal to exert the maximum possible effort.[13,14]

Our first result describes several properties of the optimal level of effort for a given goal, which will be useful in our subsequent analysis.

Lemma 1. Using equations (1) and (2) we obtain the following properties:

(i) Given a goal (g), effort increases with monetary incentives (α).

(ii) $\frac{d^2U}{de_i dg} > 0\ (< 0)$ if and only if y_i>g (<g). Thus, $\frac{de_i}{dg} > 0\ (< 0)$ if and only if y_i>g (<g).

Property (i) is a standard result which follows from the fact that effort and incentives are complements with respect to the extrinsic utility function, i.e. $\frac{d^2V_E}{de_i d\alpha} = \theta_i > 0$.[15] An important implication of Property (ii) is that performance increases with the difficulty of the goal if the goal is attainable so that goal and effort are complements. However, workers' performance decreases with goal difficulty if the goal is not attainable so that goal and effort are substitutes in that case.[16] Therefore, Property (ii) ensures that worker´s performance is higher when the

[13] For $\alpha\theta_H>1$ the maximum level of effort (e=1) will would be automatically achieved, at least for the high type which renders our theoretical framework less appealing. This assumption is made for the sake of exposition and it does not affect our qualitative results.

[14] Note that the convexity of the intrinsic utility function for losses implies that solutions are not unique in general. Following Wu et al. (2008), we assume that among the multiple possible equilibria that may arise when the individual is unable to attain the goal, the individual picks the one with the lowest level of production (which entails the lowest level of effort). This is a technical assumption that greatly simplifies our analysis but does not affect our qualitative results. Moreover, this assumption implies that at the optimal effort characterized by equations (1) and (2), $\frac{d^2U}{d^2e_i} < 0$, so second order conditions are automatically satisfied.

[15] Note that our model does not allow for the existence of a negative income effect when the increment in worker's income as a consequence of higher monetary incentives could lead to lower performance. This effect can be captured with more general specifications of the extrinsic utility, such as a CES function.

[16] This property of goals has also been proven by Wu et al. (2008) in a model with no monetary incentives.

assigned goal is difficult but attainable than in the absence of goals. It also implies that a challenging but attainable goal works better than either too easy or too difficult goals. These properties will help us to interpret our equilibrium results; in particular note that property (ii) implies that a goal may have very different effects for workers with different levels of ability. A challenging goal can be a good tool to increase performance of a high ability worker, but, at the same time, can undermine production of a low ability worker.

In Lemma 1 we have described important properties of the optimal level of worker's effort for a given goal. In the subsequent analysis, we determine the optimal value of the goal which is the one that maximizes workers' production levels. We start by describing the solution for the case of *perfect information* in which managers know the worker's level of ability with certainty (i.e., pϵ{0,1}), so that they can design personalized goals (g_i) to motivate workers with different ability levels.

Proposition 1. (*Perfect Information*) If the manager knows the worker's level of ability, the optimal personalized goals are as follows:

$$g_i^{PI} = \alpha\theta_i^2 + 3\left(\frac{\lambda\theta_i^2}{4}\right)^{2/3},$$

where PI stands for Perfect Information and iϵ{L,H}.

In equilibrium both types of workers attain the goal so that $y_i^{PI} > g_i^{PI}$,[17] where y_i^{PI} is given by the solution to the following equation:

$$\alpha\theta_i + \frac{\theta_i}{2}\left(y_i^{PI} - g_i^{PI}\right)^{-1/2} = \frac{y_i^{PI}}{\theta_i}.$$

We illustrate the equilibrium for the case of perfect information in Figure 4. We plot marginal benefits and marginal costs of effort as a function of worker´s performance (y_i) for a given goal

[17] Note that under our assumptions, $\alpha\theta_i<1$, and hence first order conditions (1) and (2) cannot be satisfied if $y_i = g$.

g. The solid curve represents the marginal utility of effort ($\frac{du}{de}$) which includes monetary rewards and intrinsic utility while the dash line represents the marginal cost of effort ($\frac{dc}{de}$).

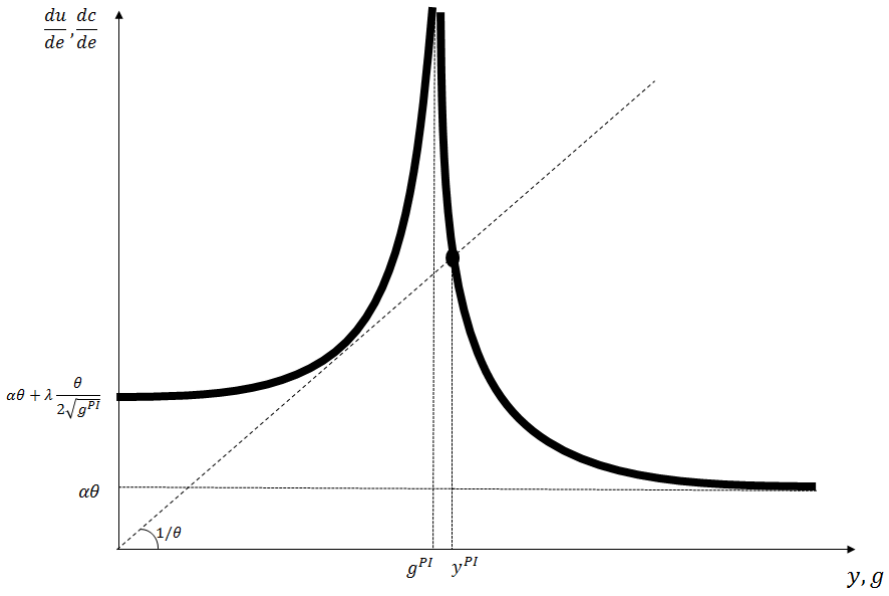

FIGURE 4.- Values for goals and production levels in the perfect information equilibrium.

When the level of ability of the worker is known, the optimal strategy for managers is to assign a goal which is equal to the maximum level of production that can be attained by a worker given his or her ability level. These challenging goals are such that they maximize the level of effort of workers. Graphically, the equilibrium goal under perfect information will be the maximum goal that leads to an intersection of the marginal cost line for which that $y_i^{PI} > g_i^{PI}$ so that the worker derives intrinsic utility from working ($V_I(y_i, g, \lambda) > 0$).

As we can see in Figure 5, deviating from g_i^{PI} is not profitable to the manager. On the one hand, setting a goal higher than g_i^{PI} (g_i^H) would imply that the worker does not attain the goal so that production would decrease ($y_i|g_i^H < y_i^{PI}$). On the other hand, if the manager sets a goal that is easier than g_i^{PI} (g_i^L) we know from Lemma 1 (ii) that the worker's level of performance would also be lower ($y_i|g_i^H < y_i^{PI}$), as goals and effort are complements when the goal is attainable (right panel of Figure 5).

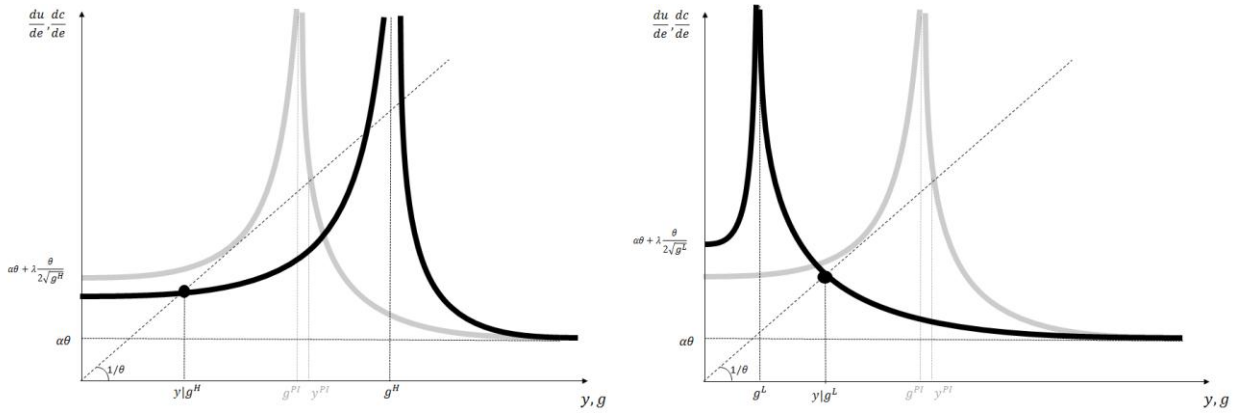

FIGURE 5.- Values for goals and production levels for the case in which the manager sets a goal which is easier than the equilibrium goal, $g^L < g^{PI}$, (left panel) and for the case in which the manager sets a goal which is more difficult than the equilibrium goal, $g^H > g^{PI}$, (right panel).

It is worth stressing that $\frac{dg_i^{PI}}{d\alpha} > 0$ which implies that the maximum goal that a worker can attain in equilibrium increases with extrinsic incentives. As a result, under perfect information, goals are expected to rise with the magnitude of monetary incentives. This implies that monetary incentives may affect workers' intrinsic motivation by promoting challenging but attainable goals. Since attainable goals and worker's effort are complements (see Lemma 1), an interesting implication of this result is that goal setting is more effective in increasing performance in the presence of high monetary rewards. As we shall see, this result is robust to the case of imperfect information (see Corollary 1 below).

Now we proceed to describe the general model for the case in which managers are uncertain about workers' ability levels (i.e., pϵ(0,1)). In that case, managers will set a single goal (g^*) for both types of workers. Note that managers will not set a goal which is lower than the goal they would set for a low-ability worker under perfect information (g_L^{PI}) or which is higher than the goal they would set for a high-ability worker (g_H^{PI}) under perfect information so that, in equilibrium, $g^* \epsilon [g_L^{PI}, g_H^{PI}]$. As a result, both types of workers will be able to achieve the goal in equilibrium if and only if $g^* = g_L^{PI}$. Otherwise, the goal will only be achieved by high-ability workers in equilibrium. Applying Lemma 1 (ii), we know that both types of workers will produce more with goal g_L^{PI}, which is attained by both types of workers, than with any lower goal, i.e.,

$y_i|g_L^{PI} > y_i|g$ for all $g < g_L^{PI}$. As a result, in equilibrium, performance is expected to be higher with goal setting than in the absence of goals because $g^* > 0$ as long as $g_L^{PI}>0$.

In the next proposition we summarize the main result of our model with imperfect information.

Proposition 2 *(Imperfect Information: Goal setting*). Given parameters {α, λ, p, θ_H} there exists a threshold $\hat{\theta}$ such that:

$$\begin{cases} g^* = g_L^{PI} & \text{if and only if} \quad \theta_L \geq \hat{\theta}, \\ g^* \in (g_L^{PI}, g_H^{PI}] & \text{if and only if} \quad \theta_L < \hat{\theta}. \end{cases}$$

Proposition 2 captures the tradeoff faced by the manager between raising the goal to increase the high-ability worker's performance and keeping the goal low enough to maximize the low-ability worker's performance. Note that if both types of workers do not significantly differ in terms of ability levels, the manager could offer a goal which is attainable by both low- and high- ability workers. However, if ability levels differ substantially, the manager will set a goal which can only be attained by high-ability workers.

In Figure 6, we represent the equilibrium solution for $g^* = g_L^{PI}$ on the left panel and for $g^* \in (g_L^{PI}, g_H^{PI}]$ on the right panel. We plot in grey (black) the marginal utility and the marginal cost of increasing performance for the high- (low-) ability worker.

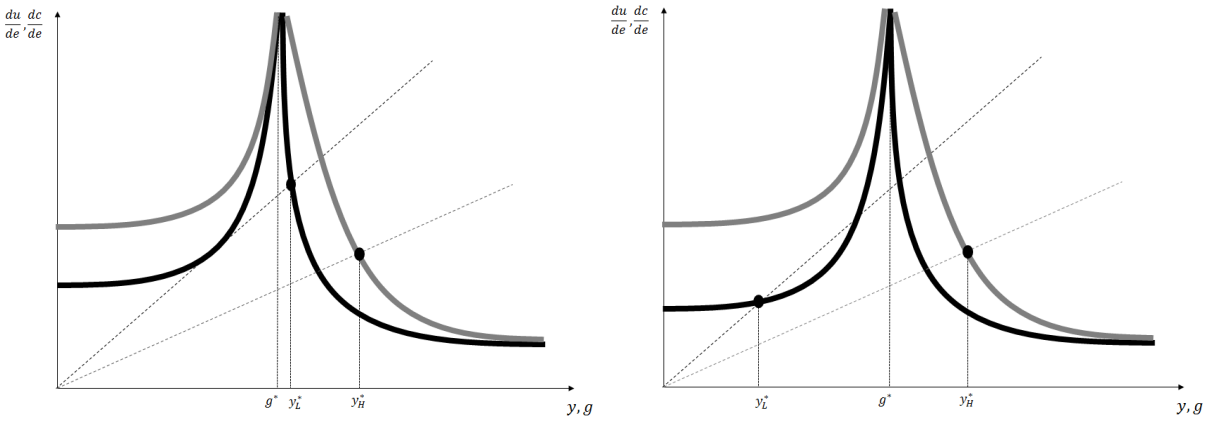

FIGURE 6.- Equilibrium production with high-ability (blue) and low-ability (red) workers for $g^* = g_L^{PI}$ on the left panel and $g^* \in (g_L^{PI}, g_H^{PI}]$ on the right panel.

To finish the model section we point out the relationship between goal setting and monetary incentives. In Corollary 1 we show, as in the case of imperfect information, that equilibrium goals and monetary incentives are complements.

Corollary 1 *(Imperfect Information: Goal setting and monetary incentives)*. In equilibrium, the goal increases with monetary incentives, i.e., $\frac{dg^*}{d\alpha} \geq 0$.

The intuition for Corollary 1 is described as follows. Given the level of monetary incentives (α), a marginal increment in the equilibrium goal (g^*) would decrease the performance of the low ability worker (y_L^*) while increasing the performance of the high ability worker (y_H^*) (see Lemma 1 (ii)). If monetary incentives increase the performance of both types of workers will also increase (Lemma 1 (i)). Then, the manager could take advantage of this situation by raising the goal above g* so that the performance of the low ability workers is the same as before the increase in monetary incentives (y_L^*) while the performance of the high ability worker increases. As a result, the equilibrium goal increases with monetary incentives.

In sum, high monetary incentives can foster workers' motivation in two ways. On the one hand, it has a direct positive effect on performance as it increases extrinsic motivation to work. On the other hand, it allows the manager's to set higher goals, which further increases performance through its effect on workers' intrinsic motivation.

3.2. Theoretical conjectures

Based on the previous analysis, we state the following conjectures regarding the impact of wage-irrelevant goals on production levels and effort which will be measured as the time workers dedicate to the *work task*.

First, we expect production and effort levels to be higher in the goal-setting treatment than in the baseline. Following our model, we know that whenever workers are intrinsically motivated to attain goals, managers will use goal setting policies to increase the workers' level of effort which will translate in an increase in production levels.

Hypothesis 1 (Production Levels and Work Dedication)

We expect work dedication and production levels to be greater in the goal setting treatment than in the baseline.

We also conjecture that the manager will set goals which are moderately difficult, that is, which are challenging for an average ability worker (see Proposition 2).[18] In our setting, this means that goals will tend to be too easy for high-ability workers while being too difficult for low-ability workers. In our model, we have also put forward an interesting interaction effect between monetary incentives and goals according to which higher extrinsic incentives should lead to higher goals and performance levels (see Corollary 1).

Hypothesis 2 (Goal Setting and Incentives)

(i) *We expect managers to set goals which are challenging for an average ability worker.*

(ii) *We expect goals to be larger when monetary incentives are high.*

(iii) *We expect monetary incentives and goals to be complements so that the positive effect of goals on workers' performance is most pronounced when incentives are high.*

4. RESULTS

We start the results section by comparing workers' production levels across treatments while focusing on workers' effort and Internet usage in Section 3.2. We study the interaction between goal setting and monetary incentives in Section 3.3. We analyze managers' decisions to set goals in more detail in Section 3.4.

[18] As a result, if managers had access to information about workers' ability levels (for instance by having access to past performances) they could set personalized goals which would be more effective than generic goals. In that sense, our experimental design can be seen as a conservative test for the effect of nonbinding goals on workers' performance.

3.1. Goal setting and workers' performance

We begin the analysis by studying production levels in the *work task* across treatments. We define production as the total number of correct tables completed by workers. In Table 2, we present descriptive statistics regarding workers' production levels on the *work task* in both the baseline and the goal setting treatment. For the goal setting treatment, we present separately the descriptive statistics for those subjects who were assigned a goal (left column) and for those who were not assigned a goal (right column).

TABLE 2
WORKERS' TOTAL PRODUCTION ON THE *WORK TASK*

	Total Production Baseline	Total Production Goal setting	
		Goals	No goals
Mean	9.49	10.93	6.87
Standard Deviation	5.13	4.46	5.10
Observations	184	160	24

We find that production levels were on average 15.2% higher under the goal setting treatment than under the baseline when restricting our analysis to those workers who were assigned a goal in the goal setting treatment. Interestingly, workers' performance in the goal setting treatment was very different whether a subject had or had not been assigned a goal. In particular, the average production of workers who did not receive a goal was 37.1% lower than the average production of workers who received a goal. This result stresses that failing to provide goals to workers in an environment in which they are expected to do so may undermine motivation as it can be perceived as a lack of interest in a worker's task. In the management literature, caring about workers' tasks has been recognized as a fundamental dimension of leadership (e.g. Goffee and Jones, 2000).

We study the statistical significance of our results by conducting a regression analysis assessing the effect of goal setting on workers' production. To that end, we use a panel data Poisson regression with random effects (Table 3). We control for workers' ability levels by using an ability dummy independent variable which takes value 1 if a subject is classified as a high-ability subject and value 0 otherwise. We classify subjects as either high- or low- ability workers

depending on whether they completed their first table correctly or incorrectly. We rely on previous research showing the positive relationship between first table performance and subsequent production (Corgnet et al., 2011).[19] According to this criterion, the proportion of subjects who are characterized as high-ability subjects is equal to 55.9% for the whole sample and equal to 52.1% and 59.7% for the baseline and goal setting treatments, respectively. Note that using proportion tests we do not find significant differences in the proportion of high-ability subjects across treatments (p-value = 0.2985). In our experiments, the average production level following the completion of the first table was 68.1% higher for the subjects who answered the first table correctly (12.1) than for the subjects who answered the first table incorrectly (7.2) (Mann-Whitney-Wilcoxon test, $p<0.001$). Our regression results are robust to the use of two alternative measures of workers' ability. In particular, we considered as alternative ability measures the absolute and the relative performance of a given subject in a previous experiment in which participants had to undertake a similar summation task in groups of ten workers (Corgnet et al. 2011). Relative performance was assessed by classifying subjects according to their rank in a given experimental session. More specifically, we pooled the top three performers of each experimental session in the high-rank category and the bottom three performers in the low-rank category. Subjects that did not belong to either one of these two categories were grouped together and referred to as middle ranks.

In our regression analysis, we also include a "No Goal" Dummy independent variable which takes value 1 if a manager decided not to set any goal to the worker in the goal setting treatment.

[19] Also, in an independent study, we invited subjects to participate in a one-hour survey in which subjects had to answer questions related to demographics, personality traits and arithmetic skills. Subjects' summation skills were measured in an incentivized exercise similar to the *work task* in the current experimental design. Given that all 296 subjects recruited for the survey participated in earlier experiments similar to the one described in the current paper, we were able to regress their score on the arithmetic test conducted during the survey with their performance on the first table they completed. The p-value for the coefficient test was equal to 0.024.

TABLE 3

POISSON REGRESSION WITH RANDOM EFFECTS FOR INDIVIDUAL PRODUCTION MEASURED AS THE NUMBER OF CORRECTLY COMPLETED TABLES[20]

	Coefficients
Intercept	2.445***
Ability	0.506***
Treatment Dummy (takes value 1 for goal setting and value 0 for the baseline)	0.129*
No Goal Dummy	-0.376***
Number of observations	n = 368
and Log likelihood	-1091.999, Prob > χ^2 = 0.000

Note: Statistically significant coefficients with p-values < 0.10 are marked *, p-values < 0.05 are marked **, and p-values < 0.01 are marked ***.

We confirm that goal setting affects workers' performance positively. First, workers who were not assigned a goal by their manager in the goal setting treatment performed significantly worse than those who were assigned a goal (p-value < 0.001). Second, workers performed better in the goal setting treatment than in the baseline, although this differences was only marginally significant (p-value = 0.07).

In a debriefing questionnaire which was completed at the end of the experiment, we asked participants to report how they felt had they produced more or less than the goal set by their manager. In line with our regression results, a large proportion of participants (83%) reported that attaining goals made them feel good. Moreover, most of the participants (64%) felt bad when not attaining the goal set by the manager. These results support the idea that workers value nonbinding goals, and that the goal acts as a reference point for workers' intrinsic motivation in line with our theoretical model.

In order to shed light on the magnitude of goal setting effects on workers' performance we study the time dynamics of workers' production levels for both the baseline and the goal

[20] The performance on the first table is excluded from the analysis.

setting treatment. In Table 4, we provide descriptive statistics for production levels analyzing the first (periods 1 to 4) and the second part (periods 5 to 8) of the experiment separately.

TABLE 4

DYNAMICS OF WORKERS' PRODUCTION ON THE *WORK TASK*

	Production Baseline		Production Goal setting	
	First half of the experiment	Second half of the experiment	First half of the experiment	Second half of the experiment
Mean	8.63	10.35	10.26	10.53
Standard Deviation	4.97	5.70	4.78	4.72
Observations	184	184	184	184

We observe that in the first half of the experiment, production levels in the goal setting treatment were on average 18.9% higher than in the baseline treatment while goal setting outperforms the baseline by only 1.7% in the second half of the experiment. We show in the statistical analysis in Table 5 that the positive effect of goal setting is significant in the first part of the experiment while being negligible in the second part.

TABLE 5

POISSON REGRESSION WITH RANDOM EFFECTS FOR INDIVIDUAL PRODUCTION FOR THE FIRST AND SECOND HALF OF THE EXPERIMENT

	First half of the experiment (Periods 1 to 4) Coefficients	Second half of the experiment (Periods 5 to 8) Coefficients
Intercept	2.374***	2.515***
Ability	0.551***	0.480***
Treatment Dummy	0.191**	0.045
No Goal Dummy	-0.410***	-0.246
Number of observations	n = 184	n = 184
and Log likelihood	-550.805, Prob > χ^2 = 0.000	-553.674, Prob > χ^2 = 0.042

Note: Statistically significant coefficients with p-values < 0.10 are marked *, p-values < 0.05 are marked **, and p-values < 0.01 are marked ***.

In order to understand these results, one should take into account that most subjects reached their highest level of performance by the end of the first half of the experiment after which improvements were difficult to obtain. This is a consequence of the limited amount of learning involved in the summation task used in the current experiment. In the baseline (goal setting) treatment, 51.0% (48.8%) of the subjects achieved their maximum performance level in period 2, and 89.9% (86.1%) of the subjects achieved their maximum level of performance by period 4. As a result, there may be little room for improvements in the goal setting treatment in the second part of the experiment.

In order to assess possible differences in the quality of the workers' output across treatments, we define the accuracy variable as being the ratio between the number of tables which were completed correctly and the total number of tables which were completed. We find that accuracy levels are not significantly different between the goal setting (84.7%) and the baseline treatments (86.1%) (see Table A.1 in the appendix).

We summarize our results regarding the effect of goal setting on workers' performance as follows.

RESULT 1 (Production and Accuracy)

i) Workers' production levels were significantly greater in the goal setting treatment than in the baseline treatment. This effect was significant in the first half of the experiment while being negligible in the second half.

ii) Setting no goal in the goal setting treatment had a significantly negative effect on workers' production. This effect was highly significant in the first half of the experiment while being negligible in the second half.

iii) Goal setting did not increase the quality of workers' production. Accuracy levels were comparable across treatments.

3.2. Goal setting and workers' effort levels

In this section, we assess the effect of goal setting on workers' effort which can be measured by the amount of time they spent working on the task and by the number of tables they completed. We define work dedication as the proportion of available time that workers spent on the *work task* rather than on the Internet. We represent workers' *work dedication* as well as the number of tables they completed across treatments in Figures 7 and 8, respectively.

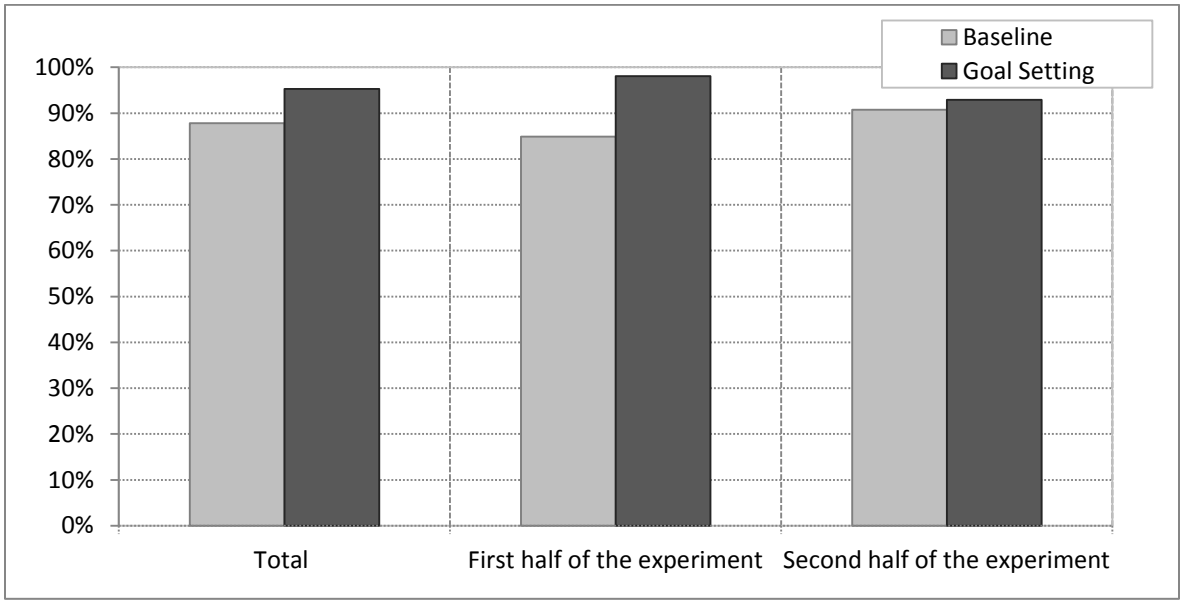

FIGURE 7.- Dynamics of *work dedication* across treatments.

We observe that work dedication is higher in the goal setting treatment (95.1%) compared with the baseline (87.8%) while this difference is more pronounced in the first part of the experiment (98.1% vs. 84.9%) than in the second part of the experiment (92.9% vs. 90.7%). Consistently, we see that the number of completed tables was 13.0% higher in the goal setting treatment than in the baseline. This difference was also greater in the first part of the experiment (21.6%) than in the second part (5.1%). We test these differences by conducting a regression analysis for work dedication (Table 6) and for the number of completed tables (Table 7). The coefficient of the dummy variable for treatment GS is positive and significant in the first

part of the experiment for both variables. This difference vanishes in the second half of the experiment (corresponding coefficients are then no significant).

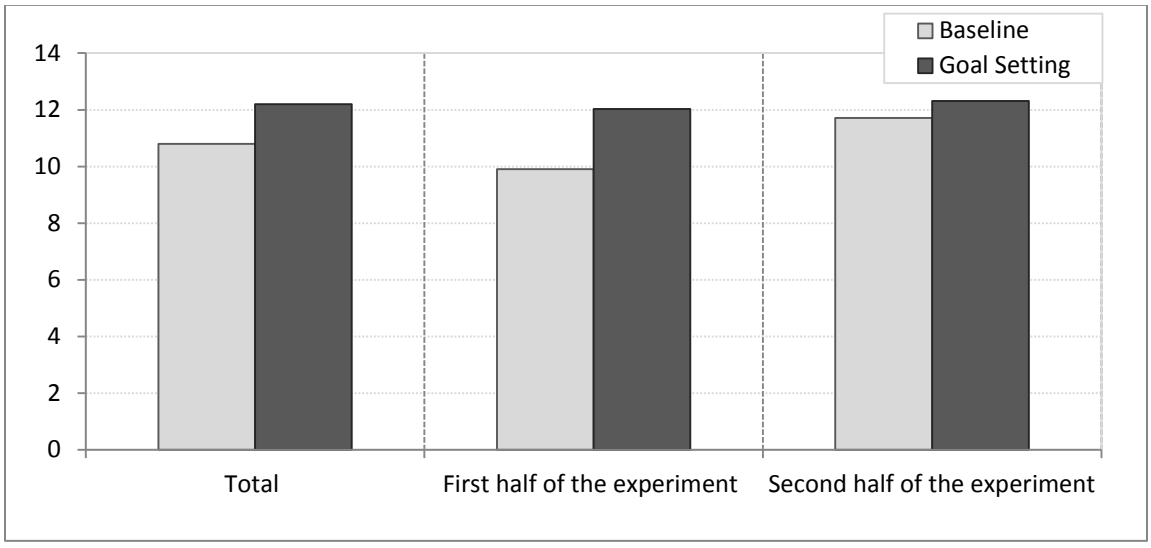

FIGURE 8.- Average number of completed tables by workers across treatments.

TABLE 6

TOBIT REGRESSION WITH RANDOM EFFECTS FOR WORK DEDICATION

	All periods Coefficients	First half of the experiment (Periods 1 to 4) Coefficients	Second half of the experiment (Periods 5 to 8) Coefficients
Intercept	2.011***	0.898***	0.919***
Ability	0.488**	0.144***	0.064***
Treatment Dummy	0.389**	0.110***	0.019
No Goal Dummy	-0.797***	-0.281***	0.043
Number of observations	*n* = 368	*n* = 184	*n* = 184
and Log likelihood	-213.228 Prob > χ^2 = 0.000	-54.405 Prob > χ^2 = 0.000	-21.737 Prob > χ^2 = 0.347

Note: Statistically significant coefficients with p-values < 0.10 are marked *, p-values < 0.05 are marked **, and p-values < 0.01 are marked ***.

TABLE 7

POISSON REGRESSION WITH RANDOM EFFECTS FOR THE NUMBER OF COMPLETED TABLES

	All periods Coefficients	First half of the experiment (Periods 1 to 4) Coefficients	Second half of the experiment (Periods 5 to 8) Coefficients
Intercept	2.556***	2.489***	2.618***
Ability	0.434***	0.478***	0.399***
Treatment Dummy	0.150**	0.222***	0.066
No Goal Dummy	-0.364***	-0.447***	-0.163
Number of observations	*n* = 368	*n* = 184	*n* = 184
and Log likelihood	-1142.367 Prob > χ^2 = 0.000	-578.464 Prob > χ^2 = 0.000	-578.190 Prob > χ^2 = 0.000

Note: Statistically significant coefficients with p-values < 0.10 are marked *, p-values < 0.05 are marked **, and p-values < 0.01 are marked ***.

We summarize our results as follows.

RESULT 2 (Effort and work dedication)

i) Work dedication was significantly larger in the goal setting treatment than in the baseline. This effect was highly significant in the first half of the experiment while being negligible in the second half.

ii) The number of completed tables was significantly greater in the goal setting treatment than in the baseline. This effect was significant in the first half of the experiment while being negligible in the second half.

iii) Setting no goal in the goal setting treatment had a significantly negative effect on work dedication and on the number of completed tables. This effect was highly significant in the first half of the experiment while being negligible in the second half.

3.3. Goal setting and monetary incentives

In our experimental design, monetary incentives were assigned on a random basis at the beginning of each period. Regardless of the treatment, the monetary reward for completing one table correctly was either 10, 80 or 150 cents. In this section, we study the effect of monetary incentives on workers' production levels and effort as well as the interaction between monetary incentives and goal setting. It is worth noting how significant the differences in incentives are. Indeed, an average-performance worker who only receives low incentives for the duration of the experiment would generate an average earning of $4 compared to $60 in the case of high incentives. The value of average incentives (80¢) was selected so that a subject who only worked under this incentives scheme would earn an average of $32 which corresponds to the average payment for a 2 hours and a half experiment at the laboratory in which the study was conducted.

First, we report that monetary incentives affect production levels in a non-monotonic way in line with Ariely et al. (2009) and Pokorny (2008). In the baseline treatment, production levels were 20.1% greater under average incentives (10.51) compared to low incentives (8.75) while production was 13.9% lower under high monetary incentives (9.05) compared with average incentives. This pattern of production levels suggests the presence of an adverse effect of high monetary incentives. This adverse effect of high monetary incentives has also been reported by other authors (see Ariely et al. (2009) and Pokorny (2008)). Ariely et al. (2009) account for this effect by the excessive arousal and preoccupation produced by the presence of large stakes ("chocking under pressure") that can lead to a decrement in performance.

In relation with the previous argument, the current study shows that agents tend to exhibit excessive prudence in the presence of high incentives. In particular, we report that in the baseline treatment agents spent more time on average completing tables under high incentives (67.2 seconds) than under average (60.7 seconds) and low incentives (60.0 seconds) (see Appendix A, Table A.2 for statistical analysis).[21] At the same time, the level of accuracy of the agent's work was not higher under high incentives (84.9%) than in the case of average (88.7%) and low incentives (84.3%) suggesting that workers were excessively prudent when facing high stakes. In the goal setting treatment, agents spent the same amount of time to complete a table whether incentives were high (49.7 seconds) or not (49.6 seconds). Under goal setting, agents appeared to be more active and complete significantly more tables regardless of the magnitude of the incentives. Consequently, the excessive cautiousness identified in the baseline treatment in the presence of high stakes disappeared with goal setting. In the goal setting treatment, production levels under high incentives (11.2) were larger than under average incentives (10.8) although this difference was not significant.

We study the effect of monetary incentives across treatments in Table 8. We conduct Poisson regressions with random effects as we did in our previous analysis. We assess incentives effects for both treatments separately. We report the coefficient and p-values for the dummy variables capturing incentives effects. The average (high) incentives dummy variable takes value 1 if a worker is assigned average (high) incentives in a given period and zero otherwise.

[21] Also, the average amount of time spent to complete a correct table was significantly higher under high incentives (88.3 seconds) than under low (57.0 seconds) and average incentives (77.2 seconds) in the baseline while it was not the case for the goal setting treatment (61.3, 57.1 and 60.4 seconds for low, average and high incentives, respectively).

TABLE 8

POISSON REGRESSION WITH RANDOM EFFECTS FOR PRODUCTION

		All periods	First half of the experiment	Second half of the experiment
Baseline	Average incentives	0.168***	0.430***	0.162*
	High incentives	0.124*	0.259**	0.269**
	Test equality of coefficients (p-value)	0.475	0.075*	0.296
Goal setting	Average incentives	0.177**	0.127	0.247**
	High incentives	0.175**	0.051	0.279**
	Test equality of coefficients (p-value)	0.971	0.436	0.733

Note: Statistically significant coefficients with p-values < 0.10 are marked *, p-values < 0.05 are marked **, and p-values < 0.01 are marked ***.

Not surprisingly, average and high incentives significantly outperformed low incentives in both treatments. Note that the effect of high incentives is more pronounced in the goal setting treatment than in the baseline. Interestingly, we find that average incentives (10.6) outperformed high incentives (8.1) in the first part of the baseline experiment by more than 30.9% while this effect is absent in the goal setting treatment. These results suggest that the effect of goal setting is more important when incentives are high. We confirm this conjecture by conducting additional regressions (see Tables A.3, A.4, and A.5). We find a significant effect of goal setting on workers' performance and effort for high incentives, and to a lesser extent for low incentives. These positive effects tend to be mostly significant in the first part of the experiment while disappearing in the second part (see Figure 9).

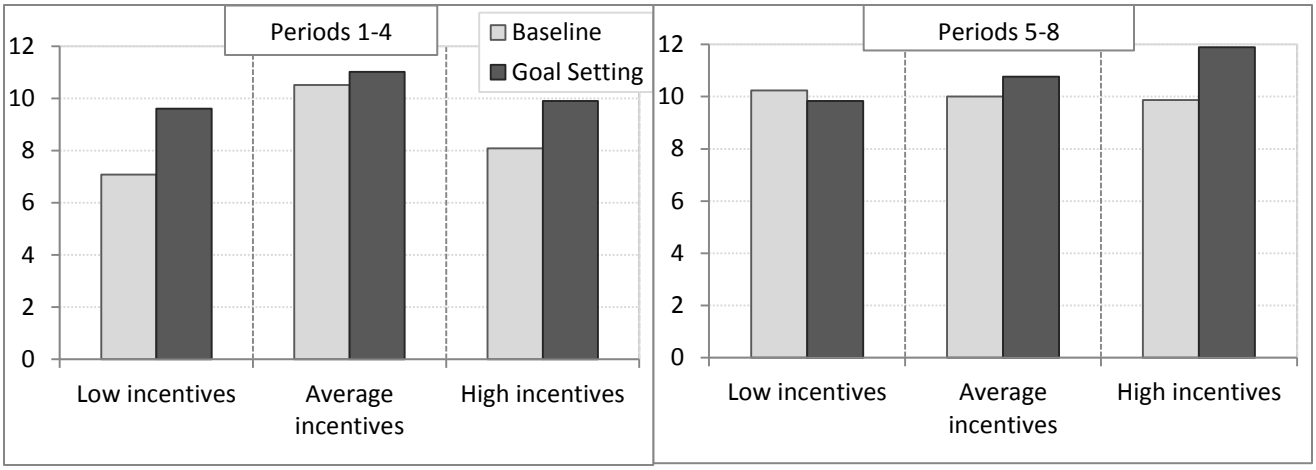

FIGURE 9.- Average production levels across treatments and incentives for the first half of the experiment on the left panel and for the second half on the right panel.

We conduct Poisson regressions with random effects to assess goal setting effects for low, average and high incentives, separately. In Table 9, we report the coefficient for the treatment dummy variable. [22]

TABLE 9

POISSON REGRESSION WITH RANDOM EFFECTS FOR PRODUCTION IN THE GOAL SETTING TREATMENT

	All periods	First half of the experiment	Second half of the experiment
Low incentives	0.073	0.419**	-0.049
Average incentives	0.080	0.086	0.019
High incentives	0.164**	0.243**	0.070

Note: Statistically significant coefficients with p-values < 0.10 are marked *, p-values < 0.05 are marked **, and p-values < 0.01 are marked ***.

[22] See Appendix A for the same analysis for production accuracy (Table A.6) and for workers' effort (Tables A.7 and A.8).

Overall, workers' production levels were significantly greater in the goal setting treatment than in the baseline treatment only for the case of high monetary incentives. This effect was highly significant in the first half of the experiment while being negligible in the second half. The goal setting treatment also outperformed the baseline for low incentives in the first half of the experiment. This was not the case in the second half of the experiment.

We summarize our findings regarding the effects of goals and incentives on workers' production levels as follows.

RESULT 3 (Production: Goals and Incentives)

i) Incentives effects were observed in both treatments as average and high incentives outperformed low incentives.

ii) We find evidence of an adverse effect of high monetary incentives in the baseline treatment which faded away under goal setting. Indeed, in the first half of the experiment, high incentives underperformed average incentives in the baseline treatment while this was not the case under goal setting.

iii) Workers' production levels were significantly greater in the goal setting treatment than in the baseline treatment under high monetary incentives. This effect was highly significant in the first half of the experiment while being negligible in the second half.

iv) The goal setting treatment also outperformed the baseline for low incentives in the first half of the experiment. This was not the case in the second half of the experiment.

3.4. An analysis of goal selection

In the goal setting treatment, average production was equal to 10.4 tables while the average goal was set at 11.4 tables. The goals were on average challenging although they were not

significantly greater than average production levels.[23] Agents attained their assigned goal in 57.7% of the cases suggesting again that goals were challenging but yet accessible.

Managers used their own experience on the *work task* in order to set their goal to workers. The correlation between the average goal set by a principal and his or her average level of performance during the experiment is positive and significant (p-value = 0.0476). Also, we observe that goals increase significantly over time as is shown by regressing goals with respect to a period trend. The average goal was equal to 9.0 in the first period and 11.8 in the last period.[24] This positive trend in goals follows from the fact that average production also increased over time which was 8.7 in the first period and 11.3 in the last period (see Figure A.1 in Appendix A).[25]

In line with the previous results, we find that a significant proportion of participants (39%) reported in the debriefing questionnaire they set goals which they considered challenging but yet attainable for an average ability worker. Also, 25% of the participants mentioned that they set goals to be equal to their own maximum attainable performance. Similarly, 15% of the participants mentioned that their goal was based on their own past performance.

It is interesting to note that the average goal was not challenging for a high-ability worker. Indeed, the average production level for a high-ability worker in the baseline was 12.4 which was well-above the average goal. High-ability workers attained their goals in 69.0% of the cases. High-ability workers in the goal setting treatment did not outperform high-ability workers in the baseline. In fact, they produced slightly less on average in the goal setting treatment (12.2) than in the baseline (12.4). The average goal was much more challenging for low-ability workers who attained their goal only 42.1% of the cases. Low-ability workers produced an average of 6.2 in the baseline compared with an average production of 8.7 in the goal setting treatment.[26]

[23] The p-value for the corresponding t-test (rank sum test) is equal to 0.318 (0.494).

[24] We use a Tobit regression for goals and report that the p-value associated with the trend coefficient is equal to 0.019.

[25] We use a Tobit regression for production and report that the p-value associated with the trend coefficient is equal to 0.029.

[26] We confirm these results by conducting the Poisson regressions, similar to the analysis presented in Table 3, for each subset of subjects with the same ability level. We find that the effect of goal setting was highly significant for low-ability workers (p-value = 0.006) while not being significant for high-ability workers (p-value=0.829).

Interestingly, we find that goal setting not only allows low-ability subjects to increase their production levels but also to improve their relative standings. To do so, we classified subjects according to their rank in a given set of experiments. More specifically, we pooled the top 30% performers in the high-rank category (Rank 1) and the bottom 30% in the low-rank category (Rank 3). Subjects that did not belong to either one of these two categories were grouped together and referred to as middle ranks (Rank 2). We then compared the rank of a given subject in the current study and in a previous study in which participants had to undertake a similar summation task in groups of ten workers (Corgnet et al. 2011) (see Table 10).

TABLE 10

PERCENTAGE OF SUBJECTS ACROSS PERFORMANCE RANKS
IN CURRENT (COLUMNS) AND PREVIOUS STUDIES (ROWS)

	Current Rank 1		Current Rank 2		Current Rank 3	
	Goal Setting	Baseline	Goal Setting	Baseline	Goal Setting	Baseline
Previous Rank 1	40.0%	52.4%	38.3%	32.1%	18.8%	11.9%
Previous Rank 2	41.8%	35.71%	34.6%	32.1%	25.0%	36.6%
Previous Rank 3	48.2%	19.7%	27.2%	35.9%	26.8%	43.7%

Interestingly, we report that almost half of the low rank producers were able to improve their relative standings to the top rank in the goal setting treatment compared with only 19.7% in the baseline (proportion test, p-value <0.001). Also, subjects who had a low rank in the previous study are more likely to remain in the low rank category in the baseline (43.7%) than under goal setting (26.8%) (proportion test, p-value = 0.046). This is not the case for average and high ranks (proportion tests, p-value = 0.765 and 0.225, respectively).

Finally, we find that goals were significantly greater under high incentives (11.9) than under either average (10.0) or low incentives (10.1).[27] This result, which is consistent with our theoretical conjectures (Hypothesis 2iii), helps us to understand why goal setting is especially effective under high monetary incentives.

RESULT 4 (GOAL SELECTION)

i) Managers set goals which were challenging for an average-ability worker. Also, managers increased the difficulty of the goal over time so as to respond to the increase in workers' production levels. Managers used information regarding their own performance on the task to set their goals.

ii) Goals were less challenging for high-ability workers than for low-ability workers. This is consistent with the fact that goal setting was highly effective for low-ability workers while being ineffective for high-ability workers.

iii) Goals were greater for high monetary incentives than for low and average incentives.

5. CONCLUSIONS

The purpose of this paper was to test the effectiveness of wage-irrelevant goal setting policies in the laboratory. Our experimental design allowed us to incorporate several crucial features of firms such as real-effort tasks, access to leisure activities (Internet browsing) as well as various levels of monetary incentives. Although goals were only symbolic as they did not entail any monetary consequences, we found that they significantly increased both production levels and effort. These results suggest that the intuitive appeal of goal setting which has been reported at length in the psychology literature is robust to the more general case of work environments in

[27] We use a Tobit regression with goals as the dependent variable and report that the p-value associated with the dummy coefficient for high incentives was less than 0.001. Using the same methodology, no significant differences were identified between low and average incentives.

which monetary incentives prevail. However, it is worth stressing that the positive effect of goal setting was mostly significant in the first part of the experiment. The short-lived effects of goal setting suggest certain limitations for the use of such policies in repetitive tasks. Indeed, the stimulating effect of goal setting is likely to vanish for jobs for which continuous improvement is not possible.

On the positive side, we find that the effectiveness of goal setting is magnified rather than undermined by the use of high monetary incentives. The effect of goal setting on workers' performance was stronger with high monetary incentives because it eliminated the excessively prudent behaviors of workers facing large stakes. The complementarity between monetary incentives and goals which was highlighted in our theoretical model follows from the fact that high monetary incentives promote higher goals which in turn increase motivation and performance. The fact that wage-irrelevant goals are particularly effective when combined with high monetary incentives contributes to the understanding of the literature documenting the crowding-out effect of high incentives on workers' intrinsic motivation (See Gneezy et al. (2011) for review). In particular, we show that the negative effect of large stakes on performance (Ariely et al. (2009) and Pokorny (2008)) may vanish once we introduce goal setting. This suggests that management tools which enhance workers' intrinsic motivation like goal setting may help alleviate the crowding-out effect of high monetary incentives. More generally speaking, our results suggest that managers should develop practices which boost intrinsic motivation (Herzberg, 1987) in combination with the setting of monetary incentives. This implies that managers not only should rely on both intrinsic and extrinsic incentives but should design these incentives schemes in coordination. This finding is particularly relevant in light of the Behavioral Economics literature which postulates that economic and psychological phenomena should not be studied in isolation.

In addition, the current design also allowed us to study the managers' selection of goals. In particular, we observed that managers set goals that were challenging but yet attainable by an average-ability worker. In line with the complementarity argument between goals and

incentives, we found that average goals were significantly greater under high monetary incentives than under average and low incentives.

Finally, we want to highlight that the interplay between monetary incentives and goal setting is also relevant to the study of optimal contracting in a principal-agent model in which the agent is intrinsically motivated (Bénabou and Tirole (2003) and Murdock (2002)). On the one hand, the principal is willing to set goals so as to maximize the agents' intrinsic motivation and reduce the wage bill, as result (see Gómez-Miñambres (2012)). On the other hand, the complementarity between monetary rewards and goals implies an additional positive effect of goals setting which may motivate the use of goals even in environments in which doing so is highly expensive.

5. REFERENCES

Abeler, J., A. Falk, L. Goette, and D. Huffman (2011): "Reference Points and Effort Provision," *American Economic Review* 101(2), 470–492.

Ariely, D., U. Gneezy, G. Lowenstein and N. Mazar (2009): "Large Stakes and Big Mistakes," *Review of Economic Studies* 76, 451-469.

Bartling, B., E. Fehr, M. A. Maréchal, and D. Schunk (2009): "Egalitarianism and Competitiveness," *American Economic Review: Papers & Proceedings*, 99(2), 93–98.

Baumeister, R. F (1984): "Chocking Under Preassure: Self-Consciousness and Paradoxical Effects of Incentives on Skillful Performance", *Journal of Personality and Social Psychology*, 46, 610-620.

Bénabou, R., and J. Tirole (2003): "Intrinsic and Extrinsic Motivation," *Review of Economics Studies*, 70, 489-520.

Bolton, P. and M. Dewatripont (2005): Contract Theory. MIT Press, Cambridge, MA.

Charness, G., D. Masclet, and M. C. Villeval (2010): "Competitive Preferences and Status as an Incentive: Experimental Evidence," IZA Discussion Paper 5034, Bonn, and GATE WP 10-16. halshs-00497974.

Corgnet, B., R. Hernan-Gonzalez, S. Rassenti (2011): "Real Effort, Real Leisure and Real-time Supervision: Incentives and Peer Pressure in Virtual Organizations", *Working Papers 11-05* Chapman University Economic Science Institute.

Deci, E. L. (1971): "Effects of Externally Mediated Rewards on Intrinsic Motivation," *Journal of Personality and Social Psychology*, 18(1), 105-115.

Deci, E. L. (1975): Intrinsic Motivation. New-York: Plenum Press.

Dickinson, D. (1999): "An Experimental Examination of Labor Supply and Work Intensities," *Journal of Labor Economics*, 17, 638-670.

Dohmen, T., and A. Falk (2010): "You Get What You Pay For: Incentives and Selection in the Education System," *The Economic Journal*, 120 (546), 256-271.

Dohmen, T., and A. Falk (2011): "Performance Pay and Multi-Dimensional Sorting: Productivity, Preferences and Gender," *American Economic Review*, 101 (2), 556-590.

Eriksson, T., A. Poulsen, and M. C. Villeval (2009): “Feedback and Incentives: Experimental Evidence,” *Labour Economics*, 16 (6), 679-688.

Falk, A., D. Huffman, and B. MacLeod (2011): “Institutions and contract and enforcement,” Discussion Paper No. 361, GESY.

Fehr, E., S. Gächter, G. Kirchsteiger (1997): “Reciprocity as a contract enforcement device: Experimental evidence,” *Econometrica* 65, 833-860.

Fehr, E. G. Kirchsteiger, A. Riedl (1993): “Does fairness prevent market clearing? An experimental investigation,” *The Quarterly Journal of Economics* 108, 437-59.

Frey, B. S. and R. Jegen, (2001): “Motivation Crowding Theory,” *Journal of Economic Surveys*, Wiley Blackwell, vol. 15(5), pages 589-611.

Gneezy, U., S. Meier and P. Rey-Biel (2011): “When and Why Incentives (Don’t) Work to Modify Behavior,” *Journal of Economic Perspectives*, 25(4), 191-210.

Gneezy, U. and A. Rustichini (2000): “Pay Enough or Don’t Pay at all,” *Quarterly Journal of Economics*, 115, 791-810.

Goerg, S. J. and S. Kube (2012): “Goals (th)at Work,” mimeo.

Goffee, R., and G. Jones (2000): “Why Should Anyone Be Led by You?,” *Harvard Business Review,* 78(5):62-70.

Gómez-Miñambres, J. (2012): “Motivation through Goal Setting,” *Journal of Economic Psychology,* 33(6), 1223-1239.

Heath, C., R. P. Larrick, and G. Wu. (1999): “Goals as Reference Points,” *Cognitive Psychology*, 38, 79-109.

Herzberg, F. (1987): “One more time: How do you motivate employees?,” *Harvard Business Review*, 65(5), 109-120.

Hsiaw, A. (2012): “Goal-Setting and Self-Control,” *Journal of Economic Theory* (forthcoming).

Kahneman, D., and A. Tversky (1979): "Prospect Theory: An Analysis of Decision under Risk," *Econometrica*, 48, 263-291.

Kock, A. K., and J. Nafziger (2011): “Self-Regulation through Goal Setting,” *The Scandinavian Journal of Economics*, 113, 212-227.

Laffont, J. J., and D. Martimort (2002): The theory of incentives: The principal-agent model. Princeton University Press: Princeton, N.J.; Oxford.

Latham, G. P. (2000): Motivate Employee Performance through Goal-Setting. In E. A. Locke (Ed.), The Blackwell Handbook of Principles of Organizational Behavior (pp. 107-119). Malden: Blackwell Publishers.

Latham, G. P. and E. A. Locke (1979): "Goal Setting: A Motivational Technique that Works," *Organizational Dynamics*, 8, 68-80.

Lei, V., Noussair, C., and C. Plott (2001) "Nonspeculative Bubbles in Experimental Asset Markets: Lack of Common Knowledge of Rationality vs. Actual Irrationality," *Econometrica*, 69, 831-59.

Locke, E. A. (1996): "Motivation through Conscious Goal Setting. Applied & Preventive Psychology," 5, 117-124.

Locke, E. A., and G. P. Latham (2002): "Building a Practically Useful Theory of Goal Setting and Task Motivation," *American Psychologist*, 57, 705-717.

Locke, E. A., N. Karyll, L. Shaw, M. Saari, and G. P. Latham. (1981): "Goal Setting and Task Performance: 1969-1980," *Psychological Bulletin*, 90, 125-1252.

Malachowski, D. (2005): "Wasted Time at Work Costing Companies Billions," *San Francisco Chronicle*, July 11.

http://www.sfgate.com/cgi-bin/article.cgi?f=/g/a/2005/07/11/wastingtime.TMP

Mento, A. J., Klein, H. J., and E. A. Locke (1992): "Relationship of Goal Level to Valence and Instrumentality," *Journal of Applied Psychology*, 77, 395-405.

Murdock, K. (2002): "Intrinsic Motivation and Optimal Incentive Contracts," *RAND Journal of Economics*, 33, 650-671.

Niederle, M., and L. Vesterlund (2007): "Do Women Shy Away from Competition? Do Men Compete Too Much?," *The Quarterly Journal of Economics*, 3(8), 1067-1101.

Pokorny, K. (2008): "Pay-But Do Not Pay Too Much. An Experimental Study on the Impact of Incentives," *Journal of Economic Behavior and Organization*, 66, 251-264.

Winter, D., and G.P. Latham (1996): "The effect of learning versus outcome goals on a simple versus a complex task," *Group and Organization Management*, 21, 236-250.

Wu, G., C. Heath, and R. Larrick (2008): "A Prospect Theory Model of Goal Behavior," *mimeo* University of Chicago.

Zizzo, D. (2010): "Experimenter Demand Effects in Economic Experiments," *Experimental Economics*, 13(1), 75-98.

APPENDIX A

TABLE A.1

POISSON REGRESSION WITH RANDOM EFFECTS FOR ACCURACY

	All periods Coefficients	First half of the experiment (Periods 1 to 4) Coefficients	Second half of the experiment (Periods 5 to 8) Coefficients
Intercept	0.932***	0.911***	0.951***
Ability	0.085***	0.076***	0.093***
Treatment Dummy	-0.033	-0.021	-0.044
No Goal Dummy	-0.001	-0.006	-0.015
Number of observations	*n* = 346	*n* = 168	*n* = 178
and Log likelihood	-22.818 Prob > χ^2 = 0.004	5.874 Prob > χ^2 = 0.063	--26.324 Prob > χ^2 = 0.050

Note: Statistically significant coefficients with p-values < 0.10 are marked *, p-values < 0.05 are marked **, and p-values < 0.01 are marked ***.

In the next regression, we study the effect of high stakes on the amount of time workers need to complete a correct table. We display the coefficient and p-value of the independent variable High incentives which is a dummy variable that takes value 1 if an agent faces high incentives and value 0 otherwise.

TABLE A.2

RESULTS FOR TOBIT REGRESSION WITH RANDOM EFFECTS FOR THE AMOUNT OF TIME TO COMPLETE A CORRECT TABLE AND FOR [ACCURACY]

			All periods	First half of the experiment	Second half of the experiment
Baseline	High incentives	AMOUNT OF TIME PER CORRECT TABLE	13.716	37.552**	-6.608
		ACCURACY	[-0.028]	[-0.006]	[-0.036]
Goal setting	High incentives	AMOUNT OF TIME PER CORRECT TABLE	5.137	1.493	-1.448
		ACCURACY	[0.012]	[-0.002]	[0.023]

Note: Statistically significant coefficients with p-values < 0.10 are marked *, p-values < 0.05 are marked **, and p-values < 0.01 are marked ***.

TABLE A.3

RESULTS FOR TOBIT REGRESSION WITH RANDOM EFFECTS FOR ACCURACY

		All periods	First half of the experiment	Second half of the experiment
Baseline	Average incentives	0.047	0.077	0.026
	High incentives	0.017	0.051	-0.002
	Test equality of coefficients (p-value)	0.327	0.582	0.441
Goal setting	Average incentives	-0.005 (0.85)	-0.010	-0.019
	High incentives	0.007	-0.006	0.008
	Test equality of coefficients (p-value)	0.667	0.869	0.524

Note: Statistically significant coefficients with p-values < 0.10 are marked *, p-values < 0.05 are marked **, and p-values < 0.01 are marked ***.

TABLE A.4

RESULTS FOR TOBIT REGRESSION WITH RANDOM EFFECTS FOR WORK DEDICATION

		All periods	First half of the experiment	Second half of the experiment
Baseline	Average incentives	0.208***	0.223***	0.217***
	High incentives	0.224***	0.244***	0.272***
	Test equality of coefficients (p-value)	0.748	0.774	0.450
Goal setting	Average incentives	0.096**	0.026	0.182**
	High incentives	0.124***	0.060	0.196***
	Test equality of coefficients (p-value)	0.549	0.644	0.796

Note: Statistically significant coefficients with p-values < 0.10 are marked *, p-values < 0.05 are marked **, and p-values < 0.01 are marked ***.

TABLE A.5

RESULTS FOR TOBIT REGRESSION WITH RANDOM EFFECTS FOR TOTAL NUMBER OF TABLES COMPLETED

		All periods	First half of the experiment	Second half of the experiment
Baseline	Average incentives	0.176***	0.414***	0.171*
	High incentives	0.179**	0.325***	0.310***
	Test equality of coefficients (p-value)	0.949	0.333	0.149

	Average incentives	0.147***	0.089	0.232***
Goal setting	High incentives	0.157***	0.078	0.279**
	Test equality of coefficients (p-value)	0.854	0.899	0.585

Note: Statistically significant coefficients with p-values < 0.10 are marked *, p-values < 0.05 are marked **, and p-values < 0.01 are marked ***.

TABLE A.6

POISSON REGRESSION WITH RANDOM EFFECTS FOR ACCURACY

	All periods	First half of the experiment	Second half of the experiment
Low incentives	-0.003	0.051	-0.043
Average incentives	-0.065**	-0.065**	-0.078
High incentives	-0.005	0.009	-0.012

Note: Statistically significant coefficients with p-values < 0.10 are marked *, p-values < 0.05 are marked **, and p-values < 0.01 are marked ***.

TABLE A.7

POISSON REGRESSION WITH RANDOM EFFECTS FOR WORK DEDICATION IN THE GOAL SETTING TREATMENT

	All periods	First half of the experiment	Second half of the experiment
Low incentives	0.136	0.284*	0.111
Average incentives	0.404	0.597***	0.072
High incentives	0.152*	0.172	0.022

Note: Statistically significant coefficients with p-values < 0.10 are marked *, p-values < 0.05 are marked **, and p-values < 0.01 are marked ***.

TABLE A.8

POISSON REGRESSION WITH RANDOM EFFECTS FOR TOTAL NUMBER OF TABLES COMPLETED IN THE GOAL SETTING TREATMENT

	All periods	First half of the experiment	Second half of the experiment
Low incentives	0.074	0.559**	-0.037
Average incentives	0.116	0.116	0.056
High incentives	0.151*	0.027**	0.077

Note: Statistically significant coefficients with p-values < 0.10 are marked *, p-values < 0.05 are marked **, and p-values < 0.01 are marked ***.

In the next graph, we observe that managers respond to changes in production levels by adjusting their goals upwards or downwards. The increase in average production levels until period 5 is associated with a corresponding increase in average goals. The decrease in average production levels at the end of the experiment, which may be due to boredom and fatigue (Corgnet et al. (2011)), is followed by a decrease in average goals.

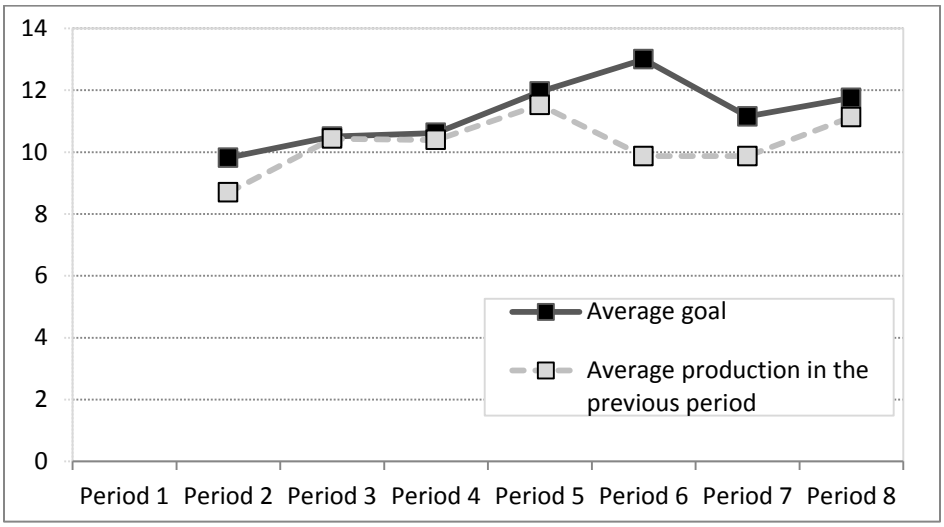

FIGURE A.1- Average goals and average production levels of managers in the previous period (if available).

APPENDIX B

Theoretical Framework: PROOFS

Proof of Lemma 1

It follows directly from FOC (1) and (2).

Q.E.D.

Proof of Proposition 1

Taking into account that $y_i=\theta_i e_i$, and that the manager assigns personalized goals with perfect information, we can rewrite FOC (1) and (2) as:

$$\alpha\theta_i + \frac{\theta_i}{2}(y_i - g_i)^{-\frac{1}{2}} = \frac{y_i}{\theta_i} \quad \text{if } y_i \geq g_i, \tag{B1}$$

$$\alpha\theta_i + \lambda\frac{\theta_i}{2}(g_i - y_i)^{-\frac{1}{2}} = \frac{y_i}{\theta_i} \quad \text{if } y_i < g_i. \tag{B2}$$

The manager's objective is to get the maximum effort from both types of workers. Applying Lemma 1 (ii) we know that effort increases with the goal if the worker attains it but decreases with the goal otherwise. Therefore, the optimal goals are the maximum goal that each type is able to attain.

Let us define by $\hat{g}_i$ the minimum goal that the individual would fail to attain and by $\hat{y}_i$ the corresponding production (see Figure B.1). Graphically:

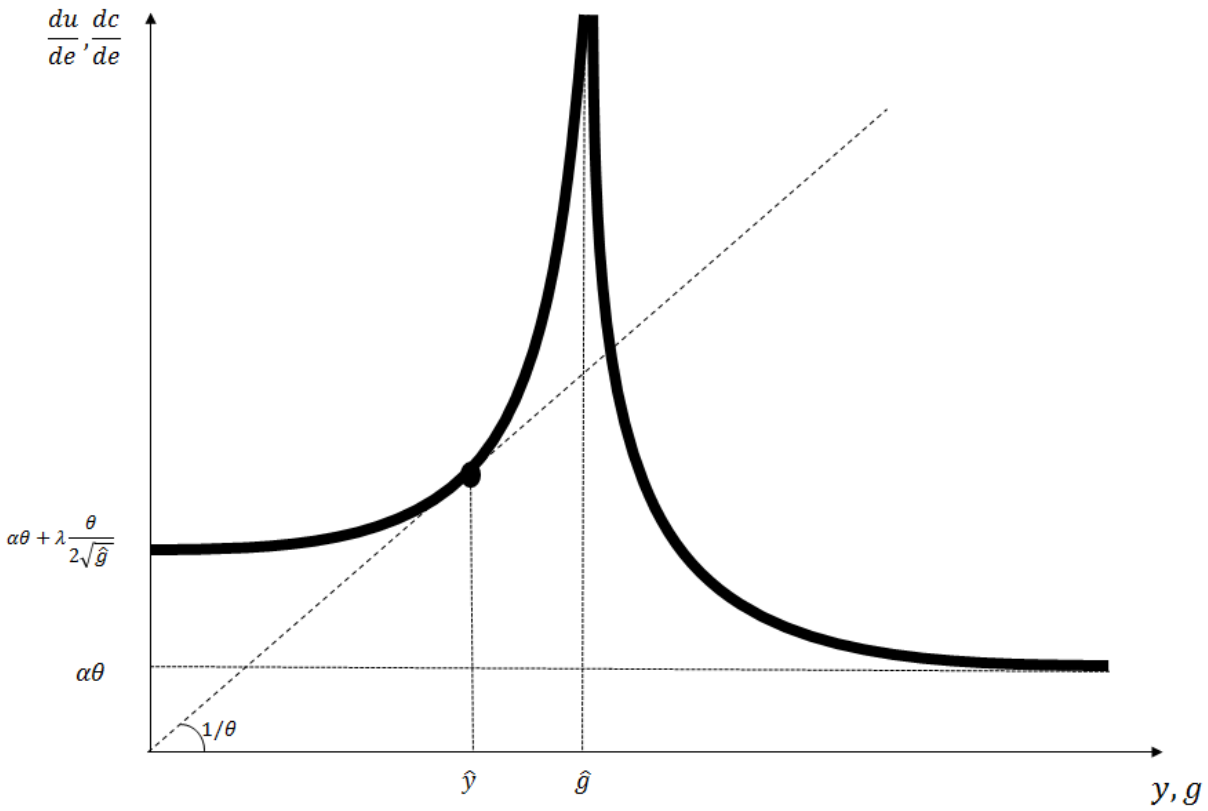

FIGURE B.1- Plot of $\hat{g}_i$ and $\hat{y}_i$.

Note that $(\hat{g}_i - \hat{y}_i)$ can be obtained by differentiating both sides of equation (B2) with respect to y_i:

$$\frac{\theta_i}{4} = \frac{1}{\theta_i}\lambda(\hat{g}_i - \hat{y}_i)^{-3/2},$$

$$\hat{g}_i - \hat{y}_i = \left(\frac{\theta_i^2}{4}\lambda\right)^{2/3}. \tag{B3}$$

By manipulating FOC (B2) we obtain:

$$g_i - y_i = \left(\frac{\lambda\theta_i^2}{2(y_i - \alpha\theta_i)}\right)^2. \tag{B4}$$

Therefore, we can use (B3) and (B4) to get:

$$\hat{y}_i = \left\{y : \left(\frac{\lambda\theta_i^2}{2(y - \alpha\theta_i)}\right)^2 = \left(\frac{\theta_i^2}{4}\lambda\right)^{2/3}\right\}.$$

Hence,

$$\hat{y}_i = \frac{\left(2\lambda\theta_i^2\right)^{2/3}}{2} + \alpha\theta_i^2, \tag{B5}$$

and,

$$\hat{g}_i = \alpha\theta_i^2 + 3\left(\frac{\lambda\theta_i^2}{4}\right)^{2/3}.$$

Note that by definition of $\hat{g}_i$, for any $\varepsilon > 0$, $g_i = \hat{g}_i - \varepsilon$ implies $y_i > g_i$. Therefore, the goal that maximizes worker i's performance is obtained by taking $\varepsilon \to 0$. So, in equilibrium

$$g_i^{PI} = \alpha\theta_i^2 + 3\left(\frac{\lambda\theta_i^2}{4}\right)^{2/3}.$$

Finally, y_i^{PI} is obtained by substituting g_i^{PI} in FOC (B1). So the result follows.

Q.E.D.

Proof of Proposition 2 (Sketch)

First we provide a sufficient condition for both types of workers to achieve the goal in equilibrium.

Lemma A1. If $g_L^{PI} \geq \theta_H - \left(\frac{\theta_H}{2(1-\alpha\theta_H)}\right)^2$ then $g^* = g_L^{PI}$ and $e_L^* \leq e_H^* = 1$.

Where e_L^* is given by the solution of the following equation:

$$\alpha\theta_L + \frac{\theta_L}{2}\left(\theta e_L^* - g_L^{PI}\right)^{-1/2} = e_L^*.$$

Proof of Lemma A1

The high type's production when exerting the maximum effort (e_H=1) is y_H=θ_H. Manipulating FOC (A1) we get

$$y_H - g = \left(\frac{\theta_H^2}{2(y_H - \alpha\theta_H)}\right)^2$$

Hence if $y_H=\theta_H$ then $g = \theta_H - \left(\frac{\theta_H^2}{2(y_H-\alpha\theta_H)}\right)^2$. Therefore, $e_H^*=1$ for all $g \geq \theta_H - \left(\frac{\theta_H^2}{2(y_H-\alpha\theta_H)}\right)^2$.

If $g^* = g_L^{PI}$ both types achieve the goal in equilibrium. Note that a slightly more difficult goal implies that the low ability type does not achieve the goal which lowers his production but high type production would increase as we know from Lemma 1 (ii). However, if $g^* = g_L^{PI} \geq \theta_H - \left(\frac{\theta_H^2}{2(y_H-\alpha\theta_H)}\right)^2$, we have a corner solution where the high type exerts the maximum possible effort, so the manager has not incentives to increase the goal beyond g_L^{PI}.

Q.E.D.

Let's assume that $g_L^{PI} < \theta_H - \left(\frac{\theta_H}{2(1-\alpha\theta_H)}\right)^2$. By Lemma A1 we know that in this case $e_H^* < 1$.

Using Lemma 1 (ii) we know that when $\theta_L < \theta_H$ the manager faces the following trade-off: by increasing the goal, $g^* \in (g_L^{PI}, g_H^{PI}]$, he can increase the production of the high type but at the cost of decreasing production of the low type. Clearly, if $\theta_L \to \theta_H$, $g^* = g_L^{PI} \to g_H^{PI}$ and both types attains the goal in equilibrium. Similarly, if $\theta_L \to 0$, $g^* \to g_H^{PI}$ and only the high type attains the goal in equilibrium. Therefore, there exists a threshold, $\hat{\theta}$, up to which $g^* = g_L^{PI}$. This threshold for θ_L depends on the other parameters of the model {α, λ, p, θ_H}. In Figure B.2 we plot the equilibrium goal as a function of the low type ability.

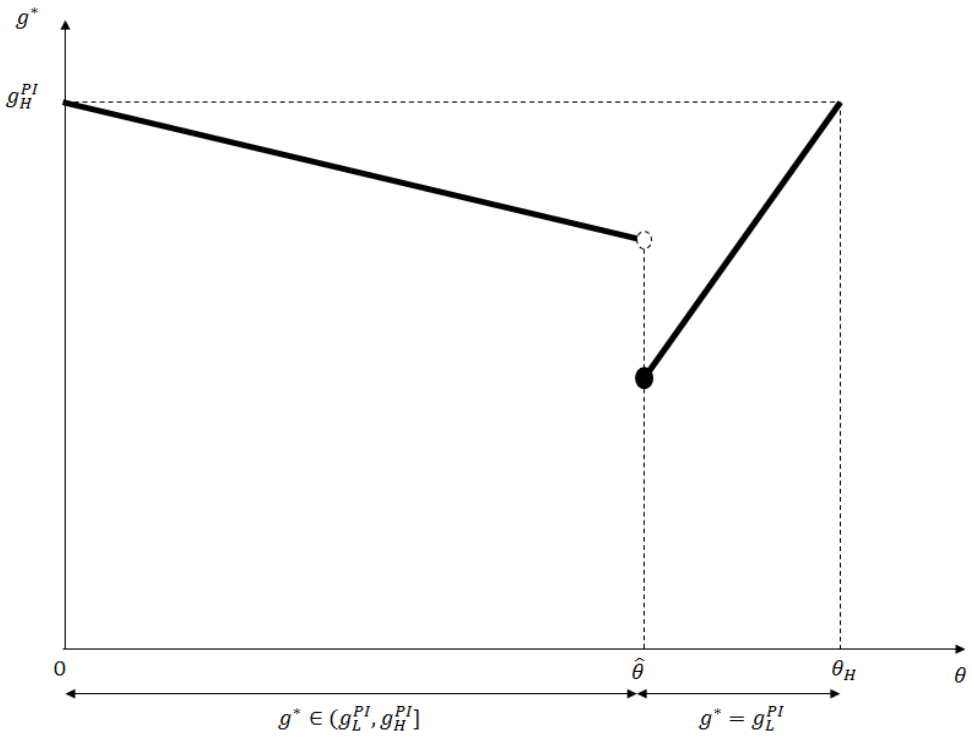

FIGURE B.2- The equilibrium goal g^*.

On the one hand, $\theta_L \in [\hat{\theta}, \theta_H]$ implies $g^* = g_L^{PI}$ and hence the goal increases with θ_L because, as we have shown in Proposition 1, $\frac{dg_L^{PI}}{d\theta_L} > 0$. On the other hand, $\theta_L \in [0, \hat{\theta})$ implies $g^* \in (g_L^{PI}, g_H^{PI}]$ so $y_L^* < g^* < y_H^*$. In the last case, g^* decreases with θ_L because, as θ_L decreases, the low type is less important for the manager and he focuses more on increasing high type's production increasing the goal. The jump in the equilibrium goals that we can observe in Figure B.2, comes from the fact that if $g = g_L^{PI} - \varepsilon$, for an $\varepsilon \to 0$, then y_H marginally increases while y_L jumps from y_L^{PI} to $\hat{y}_L < y_L^{PI}$, where $\hat{y}_L$ is the production associated with the minimum goal that the individual would fail to attain, and it was defined in the proof of Proposition 1 (See equation B5).

Q.E.D.

Proof of Corollary 1

First note that if $g^* = g_L^{PI}$ or $g^* = g_H^{PI}$, the result follows straightforwardly from the definition of g_i^{PI} in Proposition 1.

If $g^* \in (g_L^{PI}, g_H^{PI})$, the high ability worker (θ_H) attains the goal while the low ability worker (θ_L) fails. Let us consider a level of monetary incentives α_1 that induces the equilibrium goal $g^*|\alpha_1$ and the corresponding level of efforts $e_L|\alpha_1$ and $e_H|\alpha_1$ satisfying first order conditions (1) and (2):

$$\alpha_1\theta_H - e_H|\alpha_1 + \frac{\theta_H}{2}(\theta_H e_H|\alpha_1 - g^*|\alpha_1)^{-\frac{1}{2}} = 0,$$

$$\alpha_1\theta_L - e_L|\alpha_1 + \lambda\frac{\theta_L}{2}(g^*|\alpha_1 - \theta_L e_L|\alpha_1)^{-\frac{1}{2}} = 0.$$

Now let us consider a higher level of monetary incentives $\alpha_2 > \alpha_1$. It follows from Lemma 1(i) that, given goal $g^*|\alpha_1$, performance of both worker types will increase with α_2. Since a goal higher than g^* would increase performance of the high type but decrease performance of the low type (Lemma 1(ii)), we can define the goal $\tilde{g} > g^*|\alpha_1$ such that performance of the low type would be the same as the equilibrium performance with monetary incentives α_1:

$$\alpha_2\theta_L - e_L|\alpha_1 + \lambda\frac{\theta_L}{2}(\tilde{g} - \theta_L e_L|\alpha_1)^{-\frac{1}{2}} = 0.$$

Therefore, note that goal $\tilde{g}$ promotes performance of the high type while it does not undermine performance of the low type. Thus, under α_2, $\tilde{g} > g^*|\alpha_1$ induces higher performance than $g^*|\alpha_1$ so it is preferred by the manager.

Q.E.D.

Economic Science Institute Working Papers

2012

12-23 Clots-Figueras, I., Hernán González, R., and Kujal, P. Asymmetry and Deception in the Investment Game.

12-22 Dechenaux, E., Kovenock, D. and Sheremeta, R. A Survey of Experimental Research on Contests, All-Pay Auctions and Tournaments.

12-21 Rubin, J. and Sheremeta, R. Principal-Agent Settings with Random Shocks.

12-20 Gómez-Miñambres, J. and Schniter, E. Menu-Dependent Emotions and Self-Control.

12-19 Schniter, E., Sheremeta, R., and Sznycer, D. Building and Rebuilding Trust with Promises and Apologies.

12-18 Shields, T. and Xin, B. Higher-order Beliefs in Simple Trading Models.

12-17 Pfeiffer, G. and Shields, T. Performance-Based Compensation and Firm Value: Experimental evidence.

12-16 Kimbrough, E. and Sheremeta, R. Why Can't We Be Friends? Entitlements, bargaining, and conflict.

12-15 Mago, S., Savikhin, A., and Sheremeta, R. Facing Your Opponents: Social identification and information feedback in contests.

12-14 McCarter, M., Kopelman, S., Turk, T. and Ybarra, C. Too Many Cooks Spoil the Broth: How the tragedy of the anticommons emerges in organizations.

12-13 Chowdhury, S., Sheremeta, R. and Turocy, T. Overdissipation and Convergence in Rent-seeking Experiments: Cost structure and prize allocation rules.

12-12 Bodsky, R., Donato, D., James, K. and Porter, D. Experimental Evidence on the Properties of the California's Cap and Trade Price Containment Reserve.

12-11 Branas-Garza, P., Espin, A. and Exadaktylos, F. Students, Volunteers and Subjects: Experiments on social preferences.

12-10 Klose, B. and Kovenock, D. Extremism Drives Out Moderation.

12-09 Buchanan, J. and Wilson, B. An Experiment on Protecting Intellectual Property.

12-08 Buchanan, J., Gjerstad, S. and Porter, D. Information Effects in Multi-Unit Dutch Auctions.

12-07 Price, C. and Sheremeta, R. Endowment Origin, Demographic Effects and Individual Preferences in Contests.

12-06 Magoa, S. and Sheremeta, R. Multi-Battle Contests: An experimental study.

12-05 Sheremeta, R. and Shields, T. Do Liars Believe? Beliefs and Other-Regarding Preferences in Sender-Receiver Games.

12-04 Sheremeta, R., Masters, W. and Cason. T. Winner-Take-All and Proportional-Prize Contests: Theory and experimental results.

12-03 Buchanan, J., Gjerstad, S. and Smith, V. There's No Place Like Home.

12-02 Corgnet, B. and Rodriguez-Lara, I. Are you a Good Employee or Simply a Good Guy? Influence Costs and Contract Design.

12-01 Kimbrough, E. and Sheremeta, R. Side-Payments and the Costs of Conflict.

2011

11-20 Cason, T., Savikhin, A. and Sheremeta, R. Behavioral Spillovers in Coordination Games.

11-19 Munro, D. and Rassenti, S. Combinatorial Clock Auctions: Price direction and performance.

11-18 Schniter, E., Sheremeta, R., and Sznycer, D. Restoring Damaged Trust with Promises, Atonement and Apology.

11-17 Brañas-Garza, P., and Proestakis, A. Self-discrimination: A field experiment on obesity.

11-16 Brañas-Garza, P., Bucheli, M., Paz Espinosa, M., and García-Muñoz, T. Moral Cleansing and Moral Licenses: Experimental evidence.

11-15 Caginalp, G., Porter, D., and Hao, L. Asset Market Reactions to News: An experimental study.

11-14 Benito, J., Branas-Garz, P., Penelope Hernandez, P., and Sanchis Llopis, J. Strategic Behavior in Schelling Dynamics: A new result and experimental evidence.

11-13 Chui, M., Porter, D., Rassenti, S. and Smith, V. The Effect of Bidding Information in Ascending Auctions.

11-12 Schniter, E., Sheremeta, R. and Shields, T. Conflicted Minds: Recalibrational emotions following trust-based interaction.

11-11 Pedro Rey-Biel, P., Sheremeta, R. and Uler, N. (Bad) Luck or (Lack of) Effort?: Comparing social sharing norms between US and Europe.

11-10 Deck, C., Porter, D., and Smith, V. Double Bubbles in Assets Markets with Multiple Generations.

11-09 Kimbrough, E., Sheremeta, R., and Shields, T. Resolving Conflicts by a Random Device.

11-08 Brañas-Garza, P., García-Muñoz, T., and Hernan, R. Cognitive effort in the Beauty Contest Game.

11-07 Grether, D., Porter, D., and Shum, M. Intimidation or Impatience? Jump Bidding in On-line Ascending Automobile Auctions.

11-06 Rietz, T., Schniter, E., Sheremeta, R., and Shields, T. Trust, Reciprocity and Rules.

11-05 Corgnet, B., Hernan-Gonzalez, R., and Rassenti, S. Real Effort, Real Leisure and Real-time Supervision: Incentives and peer pressure in virtual organizations.

11-04 Corgnet, B. and Hernán-González R. Don't Ask Me If You Will Not Listen: The dilemma of participative decision making.

11-03 Rietz, T., Sheremeta, R., Shields, T., and Smith, V. Transparency, Efficiency and the Distribution of Economic Welfare in Pass-Through Investment Trust Games.

11-02 Corgnet, B., Kujal, P. and Porter, D. The Effect of Reliability, Content and Timing of Public Announcements on Asset Trading Behavior.

11-01 Corgnet, B., Kujal, P. and Porter, D. Reaction to Public Information in Markets: How much does ambiguity matter?

2010

10-23 Sheremeta, R. Perfect-Substitutes, Best-Shot, and Weakest-Link Contests between Groups.

10-22 Mago, S., Sheremeta, R., and Yates, A. Best-of-Three Contests: Experimental evidence.

10-21 Kimbrough, E. and Sheremeta, R. Make Him an Offer He Can't Refuse: Avoiding conflicts through side payments.

10-20 Savikhim, A. and Sheremeta, R. Visibility of Contributions and Cost of Inflation: An experiment on public goods.

10-19 Sheremeta, R. and Shields, T. Do Investors Trust or Simply Gamble?

10-18 Deck, C. and Sheremeta, R. Fight or Flight? Defending Against Sequential Attacks in the Game of Siege.

10-17 Deck, C., Lin, S. and Porter, D. Affecting Policy by Manipulating Prediction Markets: Experimental evidence.

10-16 Deck, C. and Kimbrough, E. Can Markets Save Lives? An Experimental Investigation of a Market for Organ Donations.

10-15 Deck, C., Lee, J. and Reyes, J. Personality and the Consistency of Risk Taking Behavior: Experimental evidence.

10-14 Deck, C. and Nikiforakis, N. Perfect and Imperfect Real-Time Monitoring in a Minimum-Effort Game.

10-13 Deck, C. and Gu, J. Price Increasing Competition? Experimental Evidence.

10-12 Kovenock, D., Roberson, B., and Sheremeta, R. The Attack and Defense of Weakest-Link Networks.

10-11 Wilson, B., Jaworski, T., Schurter, K. and Smyth, A. An Experimental Economic History of Whalers' Rules of Capture.

10-10 DeScioli, P. and Wilson, B. Mine and Thine: The territorial foundations of human property.

10-09 Cason, T., Masters, W. and Sheremeta, R. Entry into Winner-Take-All and Proportional-Prize Contests: An experimental study.

10-08 Savikhin, A. and Sheremeta, R. Simultaneous Decision-Making in Competitive and Cooperative Environments.

10-07 Chowdhury, S. and Sheremeta, R. A generalized Tullock contest.

10-06 Chowdhury, S. and Sheremeta, R. The Equivalence of Contests.

10-05 Shields, T. Do Analysts Tell the Truth? Do Shareholders Listen? An Experimental Study of Analysts' Forecasts and Shareholder Reaction.

10-04 Lin, S. and Rassenti, S. Are Under- and Over-reaction the Same Matter? A Price Inertia based Account.

10-03 Lin, S. Gradual Information Diffusion and Asset Price Momentum.

10-02 Gjerstad, S. and Smith, V. Household Expenditure Cycles and Economic Cycles, 1920 – 2010.

10-01 Dickhaut, J., Lin, S., Porter, D. and Smith, V. Durability, Re-trading and Market Performance.

2009

09-11 Hazlett, T., Porter, D., and Smith, V. Radio Spectrum and the Disruptive Clarity OF Ronald Coase.

09-10 Sheremeta, R. Expenditures and Information Disclosure in Two-Stage Political Contests.

09-09 Sheremeta, R. and Zhang, J. Can Groups Solve the Problem of Over-Bidding in Contests?

09-08 Sheremeta, R. and Zhang, J. Multi-Level Trust Game with "Insider" Communication.

09-07 Price, C. and Sheremeta, R. Endowment Effects in Contests.

09-06 Cason, T., Savikhin, A. and Sheremeta, R. Cooperation Spillovers in Coordination Games.

09-05 Sheremeta, R. Contest Design: An experimental investigation.

09-04 Sheremeta, R. Experimental Comparison of Multi-Stage and One-Stage Contests.

09-03 Smith, A., Skarbek, D., and Wilson, B. Anarchy, Groups, and Conflict: An experiment on the emergence of protective associations.

09-02 Jaworski, T. and Wilson, B. Go West Young Man: Self-selection and endogenous property rights.

09-01 Gjerstad, S. Housing Market Price Tier Movements in an Expansion and Collapse.

2008

08-09 Dickhaut, J., Houser, D., Aimone, J., Tila, D. and Johnson, C. High Stakes Behavior with Low Payoffs: Inducing preferences with Holt-Laury gambles.

08-08 Stecher, J., Shields, T. and Dickhaut, J. Generating Ambiguity in the Laboratory.

08-07 Stecher, J., Lunawat, R., Pronin, K. and Dickhaut, J. Decision Making and Trade without Probabilities.

08-06 Dickhaut, J., Lungu, O., Smith, V., Xin, B. and Rustichini, A. A Neuronal Mechanism of Choice.

08-05 Anctil, R., Dickhaut, J., Johnson, K., and Kanodia, C. Does Information Transparency Decrease Coordination Failure?

08-04 Tila, D. and Porter, D. Group Prediction in Information Markets With and Without Trading Information and Price Manipulation Incentives.

08-03 Thomas, C. and Wilson, B. Horizontal Product Differentiation in Auctions and Multilateral Negotiations.

08-02 Oprea, R., Wilson, B. and Zillante, A. War of Attrition: Evidence from a laboratory experiment on market exit.

08-01 Oprea, R., Porter, D., Hibbert, C., Hanson, R. and Tila, D. Can Manipulators Mislead Prediction Market Observers?