C.I.R.P.É.E

Centre Interuniversitaire sur le Risque,
les Politiques Économiques et l'Emploi

Cahier de recherche/Working Paper **09-01**

Peer Pressure, Incentives, and Gender: an Experimental Analysis of Motivation in the Workplace

Charles Bellemare
Patrick Lepage
Bruce Shearer

Janvier/January 2009

Bellemare : Département d'économique, Université Laval, CIRPÉE and IZA
cbellemare@ecn.ulaval.ca
Lepage : Département d'économique, Université Laval
plepage@ecn.ulaval.ca
Shearer : Département d'économique, Université Laval, CIRPÉE and IZA
bruce.shearer@ecn.ulaval.ca

We thank two anonymous referees as well as participants at the IZA Behavioral Economics Workshop in Bonn for helpful comments and suggestions. Research Support from the Social Sciences and Humanities Council of Canada (SSHRC) is gratefully acknowledged. We also thank Alexander Beaulieu-Shearer and Philippe Antoine Beaulieu-Shearer for their assistance in translating the experimental instructions.

Abstract:
We present results from a real-effort experiment, simulating actual work-place conditions, comparing the productivity of workers under fixed wages and piece rates. Workers, who were paid to enter data, were exposed to different degrees of peer pressure under both payment systems. The peer pressure was generated in the form of private information about the productivity of their peers. We have two main results. First, we find no level of peer pressure for which the productivity of either male or female workers is significantly higher than productivity without peer pressure. Second, we find that very low and very high levels of peer pressure can significantly decrease productivity (particularly for men paid fixed wages). These results are consistent with models of conformism and self-motivation.

Keywords: Peer effects, Fixed wages, Piece rates, Gender

JEL Classification: M52, C91

1 Introduction

The economic study of personnel policies and work-place productivity has traditionally concentrated on monetary incentive mechanisms. Theorists have studied the ability of piece-rate contracts (eg. Stiglitz, 1975), tournaments (eg. Lazear and Rosen, 1981), and termination contracts (eg. MacLeod and Malcomson, 1989) to induce productive behaviour on the part of workers.[1] Recently, however, economists have become increasingly interested in how workers modify their behaviour in the presence of information on the productivity of other workers (eg. Kandel and Lazear, 1992). If workers respond to peer effects, a firm can hope to raise the productivity of its workers by making publicly available information about worker productivity without having to relate pay to individual or group productivity. Experiments have proven to be particularly useful for empirical work in this area, allowing researchers to exogenously vary elements that would be difficult to observe in a real firm (eg. Falk and Ichino, 2006).[2] The exogenous manipulation of peer effects circumvents several identification problems which complicate the measurement of peer effects using naturally occurring data (Manski, 1993).

In this paper, we use experimental methods to analyse the effects of peer pressure on worker performance. During the experiment, male and female workers were paid to enter data on computer terminals. Performance was measured on the basis of the amount of data entered (controlling for quality). The experiment was completed in four treatments, varying the compensation system and the amount of peer pressure that each worker was subject to. Workers in the first and second treatments were paid, respectively, under fixed wages and piece rates, both in the absence of peer pressure. Workers in the third and fourth treatments were paid, respectively, under fixed wages and piece rates and were exposed to peer pressure. Peer pressure was generated by providing each worker with private information about the realized productivity of another worker in a past experimental session, under the same compensation system. Since productivity varied across individuals, different workers were exposed to differing intensities of pressure. This design ensures that peer pressure is heterogeneously and exogenously distributed across subjects. This allows the estimation of the effect of peer pressure intensity on productivity under both payment systems.

[1] There is now a good deal of evidence showing that workers do respond to monetary incentives; see Paarsch and Shearer (1999, 2000) and Lazear (2000) for studies using field data and Shearer (2004) for a field experiment.

[2] A notable exception is Mas and Moretti (2006).

We use the data arising from the experiment to consider three issues related to the effectiveness of peer pressure. First, we analyze whether peer pressure is equally as effective as a motivational tool when workers are paid piece rates as when they are paid fixed wages. Recent evidence suggests that peer pressure can increase productivity when workers are paid a fixed wage (Falk and Ichino, 2006; Mas and Moretti, 2006). However, it is not well understood whether peer pressure can be an effective tool to raise productivity in workplaces where workers receive explicit financial incentives to perform. One potential reason is that if the marginal cost of effort is increasing, high effort levels associated with monetary incentives will imply lower responses to peer pressure. Another reason is that peer pressure may simply be more conspicuous for workers under fixed wages than those under piece-rates.

Second, we empirically measure the effect of peer pressure intensity on the productivity of workers under fixed wages and piece rates. In Falk and Ichino (2006), peer pressure was generated by having pairs of subjects work simultaneously and together. Our experiment, by posting a signal of peer productivity, allows us to measure the intensity of peer pressure. Consequently, we are able to investigate, not only the average effect of peer pressure, but also detect non-linearities in the relationship between peer pressure intensity and productivity. Nonlinearities can result from diminishing or increasing returns to peer pressure. They can also result from the will to conform to the low or high productivity of others (see Bernheim (1994)). Nonlinearities are also predicted by theories of self-assessment developed in social psychology. These theories raise the possibility that providing workers with feedback on their individual level of competence can have both positive and negative effects on productivity. For example, Deci (1975) notes that a person's self-motivation will increase with feelings of competence, and decrease with feelings of incompetence. In the case of peer pressure, workers can infer their own level of competence from signals about the productivity of other workers. A low signal may increase the feelings of competence and result in productivity increases, whereas a very high signal may decrease feelings of competence and result in productivity decreases.

Finally, we consider interactions between gender and peer pressure. We systematically analyze the effects of peer pressure intensity on the productivity of women and men, working under differing levels of explicit incentives and peer pressure. Gender gaps in earnings and the lower promotion rates of women within the firm are well documented.[3] Such differences

[3]In the Harvard Business Review, it was reported that in 2003 women made up more than half the managerial

have traditionally been attributed to easily observable differences in abilities, or difficult-to-measure employer discrimination. An alternative explanation is that men and women may differ in terms of unobservable abilities which are correlated with social position attainment within the firm, such as their behaviour under competitive pressures. Recently, Gneezy and Rustichini (2004) found that within an environment absent incentives, peer pressure significantly affected the performance of male children while having no affect on the performance of female children.[4] Our experiment allows us to investigate whether these results are robust to changes in the motivational environment and to characterize the interactions between peer pressure, incentives, and gender in the workplace.

We find that there exists no level of peer pressure in our experiment for which the productivity of either men or women is significantly higher than without peer pressure. On the contrary, we find that very low and very high levels of pressure can significantly decrease the productivity of men paid fixed wages. We argue that the productivity decrease associated with low levels of peer pressure is consistent with a simple model of conformism. On the other hand, conformism considerations cannot explain the productivity decrease associated with high levels of peer pressure. There, we argue that the decrease is consistent with theories of self-motivation.

The rest of the paper is organized as follows. The next section presents the experimental design. Section 3 presents a simple theoretical model of peer pressure and incentives. In section 4, we present and analyze the data. Section 5 presents our conclusions.

2 Experimental design

The experiment took place at the laboratory of the Center for Interuniversity Research and Analysis on Organizations (CIRANO). Participants were recruited via the CIRANO's list of participants to previous experiments. The email invitation solicited participants for a session

and professional labour pool, but held only one percent of chief executive positions in Fortune 500 companies.

[4]Gender differences in the presence of incentives have also been found. Angrist and Levy (2009) find that women respond significantly to cash incentives in education investments while men do not. Gneezy, Niederle, and Rustichini (2003) find that men increase significantly their effort in tournaments but women do not. Moreover, men and women are equally productive under piece-rates. Paarsch and Shearer (2007) found no evidence that men and women responded differently to piece-rate incentives within a tree-planting firm.

of work lasting 40 minutes. The invitation email also informed participants that they would receive a 10$ show up fee on the day of the work session. They were further informed that, depending on the quality of their work, they would receive an additional payment for their work which would be mailed to them in the week following their participation. More details about the quality control procedures were given prior to each work session.

The experiment followed a 2 by 2 design, consisting of four treatments. Prior to each treatment, instructions explaining the task to be performed and the payment system were distributed and read aloud. The task consisted of entering scorecards of professional golfers into a database. Workers were informed that the data they entered would be used by university researchers to conduct their own research. Scorecards were obtained from the web site of the Professional Golfers Association of America (www.pgatour.com). All scorecards consisted of four rounds of golf for a given golfer, with each round consisting of 18 holes.[5]

Each participant was assigned to a work desk consisting of a computer and a data binder containing the scorecards to be entered into the database. Each page of each binder contained the scorecard of a professional golfer. Figure 2 presents a sample scorecard. Each golfer is identified by an ID number located in the top left corner of the page. Each column contains the scores on each of the 18 holes in a round of golf. A brief presentation showed the participants how to enter data into the database. In order to facilitate data entry, the entry screen mimicked the scorecards. Figure 3 presents a snapshot of the entry screen. We note that the golfer ID number and rounds of golf are positioned in a similar way on both the scorecards and the entry screen. The entry screen contained two additional components not present on the scorecard sheets. First, the cell "# Rnd de départ" contained the number of rounds of golf already present in the database at the beginning of the work session. This number remained fixed throughout the work session. As will be made clear below, this was the cell used to generate peer pressure. Workers could keep track of their own productivity by looking at the cell "Votre # Rnd entrées" which contained the number of rounds of golf they had entered since the beginning of the work session. After workers finished entering a scorecard, the entry screen would be refreshed and the number of rounds of golf entered ("Votre # Rnd entrées") would be incremented by 4.

The four experimental treatments captured different work environments, differing accord-

[5]We did not use the scorecards for golfers who failed to make the cut since this would imply that only two rounds of golf would be observed.

ing to the payment system and the amount of peer pressure generated. Participants in a particular treatment were given information about their own work environment and were unaware that workers in other sessions worked under different environments. Since the productivity data from the treatments without peer pressure were used to generate peer pressure, we conducted the treatments without peer pressure first. In treatment FW-NoPP (fixed wage payment and no peer pressure), participants received a fixed payment of $10 for their work (in addition to the $10 show-up fee) and received no information about the productivity of other participants. In treatment PR-NoPP (piece-rate payment and no peer pressure), participants were paid $0.10 for each round of golf entered (in addition to the $10 show-up fee) and received no information about the productivity of other participants. In both treatments, each participant started entering data in a new database. As a result, the cell "# Rnd de départ," containing the number of rounds of golf in the database at the beginning of the work session, was set to 0 – there was no peer pressure for participants during these treatments.[6]

The other two treatments, FW-PP (fixed wage payment with peer pressure) and PR-PP (piece-rate payment with peer pressure), were carried out in identical fashion except that peer pressure was added in an exogenous manner. Each participant in the FW-PP treatment entered data into a database randomly chosen from the pool of participants in the FW-NoPP treatment conducted earlier. As a result, the cell "# Rnd de départ" contained the number of rounds of golf entered by another participant paid under a fixed wage system; each participant could therefore observe both his/her current productivity (in the cell "Votre # Rnd entrées") and the total productivity of one of his/her peers.[7] Because the productivity of participants in the FW-NoPP varied, the number appearing in the cell "# Rnd de départ" varied across workers in the FW-PP treatment. This ensured that workers in the FW-PP treatment were exposed to differing intensities of peer pressure.[8] Peer pressure was introduced in an similar way during the piece rate payment system, having participants in the PR-PP treatment enter data into a database of a randomly chosen participant in the PR-NoPP treatment.

Before participants began entering data, the quality-control system was described; this was

[6]Participants in these treatments were told that they were the first to enter data into their data base.

[7]Participants in the peer-pressure treatments were made aware of the cell "# Rnd de départ" and told what the number in it represented.

[8]Our experimental design can also be seen as providing workers with reference points. Setting reference levels based on the productivity of peers can also be interpreted as a form of peer pressure.

the same for all treatments. It consisted of randomly drawing 20% of the rounds entered by a worker and counting the number of rounds entered with errors. If less than 20% of the rounds selected for the control contained errors, the participant would receive his/her payment for all data entered. If more than 20% of the rounds selected for the control contained errors, no payment would be received for the data entered.[9]

After exactly 40 minutes of work, a bell rang signaling the end of the work session. Participants collected their 10$ show-up fee before leaving the room. In the week following the experiment, the quality control check was performed, and the payment (if applicable), along with a description of the results of the quality control, was mailed to each participant.

3 Model

In this section we develop a simple theoretical model of effort decisions under piece rates and fixed wages that accounts for the effects of peer pressure and self motivation. We ignore quality decisions on the part of the worker. We consider worker utility to be a (separable) function of earnings, effort and peer pressure; ie, $U(W,E) = W - C(E) - 0.5\beta_i(E-P)^2$. Here, W represents individual earnings, $C(E)$ represents the cost of effort and P represents the level of peer pressure (or the signal of peer productivity). $\beta_i(E-P)^2$ represents a loss function, capturing the cost to the worker of differing from his/her peer signal, and $\beta_i > 0$ is a parameter capturing sensitivity to peer pressure.

The theoretical concept of self-motivation implies that effort is supplied independently of monetary rewards so that workers will supply effort under fixed wages. To capture this in an empirically tractable manner, we specify a cost of effort function of the form

$$(1) \quad C(E) = \kappa_i \frac{\gamma_i}{(\gamma_i+1)} E^{\frac{(\gamma_i+1)}{\gamma_i}} - \eta_i E, \quad \kappa_i > 0, \gamma_i > 0, \eta_i > 0.$$

where κ_i denotes an individual productivity parameter and γ_i denotes a parameter capturing the curvature of the cost of effort function. Note, since the marginal cost of effort is negative at zero effort, individuals will supply positive effort levels under a fixed wage. We interpret η_i to be a self-motivation parameter in our model. All parameters $(\beta, \gamma, \kappa, \eta)$ are subscripted with i to denote that they can vary across workers.

[9] The worker would still receive the $10 show-up fee.

Since there is no inherent risk in typing golf scores (little affects productivity beyond worker actions), we take output to be worker effort; ie, $Y = E$. Earnings are given by

$$(2) \qquad W = \begin{cases} rY & \text{if payment by piece rates} \\ \omega & \text{if payment by fixed wages.} \end{cases}$$

Let I_{pr} be a function indicating that the worker was paid piece rates and I_s be a function indicating that the worker received a peer-pressure signal. Optimal output choice, denoted $y^* = e^*$, then satisfies the equation

$$(3) \qquad rI_{pr} - \kappa_i e^{*\frac{1}{\gamma_i}} + \eta_i - \beta_i(e^* - P)I_s = 0.$$

Notice that $\eta_i > 0$ is a necessary condition for positive output under fixed wages in the absence of peer pressure. Since explicit financial incentives are equal to zero, a worker only supplies positive effort if he/she has some level of self-motivation to work.[10] The model, while not giving rise to closed form solutions, does provide a number of empirical predictions. Taking the total derivative of (3) gives

$$(4) \qquad \left[\frac{\kappa_i}{\gamma_i} e^{*\frac{(1-\gamma_i)}{\gamma_i}} + \beta_i I_s\right] de = I_{pr}dr + d\eta_i + I_s\beta_i dP.$$

1. Workers react positively to increases in the piece rate:
$$\frac{\partial e^*}{\partial r} = \left[\frac{\kappa_i}{\gamma_i} e^{*\frac{(1-\gamma_i)}{\gamma_i}} + \beta_i I_s\right]^{-1} > 0.$$
2. Workers react positively to peer pressure:
$$\frac{\partial e^*}{\partial P} = \beta_i \left[\frac{\kappa_i}{\gamma_i} e^{*\frac{(1-\gamma_i)}{\gamma_i}} + \beta_i\right]^{-1} > 0.$$
3. The effects of peer pressure diminish with the level of explicit incentives if $\gamma_i < 1$:[11]
$$\frac{\partial^2 e^*}{\partial r \partial P} = -\beta_i \left[\frac{\kappa_i}{\gamma_i} e^{*\frac{(1-\gamma_i)}{\gamma_i}} + \beta_i\right]^{-2} \frac{\kappa_i}{\gamma_i^2}(1-\gamma)e^{*\frac{(1-2\gamma_i)}{\gamma_i}} \frac{\partial e^*}{\partial r} < 0.$$

   This implies that the effects of peer pressure on productivity caused by changes in self-motivation are greater in magnitude when workers are paid fixed wages than when

[10] Second-order-sufficient conditions for optimal effort are given by: $\kappa_i > 0, \gamma_i > 0, \beta_i > 0$.

[11] Paarsch and Shearer (2007) estimate γ_i to be equal to 0.39 using data from a field experiment.

workers are paid piece-rates. The condition $\gamma_i < 1$ corresponds to $C'''(e) > 0$, or greater than quadratic costs. Intuitively, workers exert more effort in response to increases in explicit financial incentives. By increasing their effort, workers also increase their marginal cost of effort, making it more costly for them to respond to peer pressure. This is one motivation for the conjecture that explicit financial incentives may crowd out the effects of peer pressure on productivity.

4. Effort in the presence of a peer-pressure signal of zero, denoted $e^*(P = 0)$, is lower than is effort in the absence of peer pressure, denoted $\tilde{e}$. To see this, let

   (5) $\psi(e) = \kappa_i e^{\frac{1}{\gamma_i}} + \beta_i e - I_{pr} r - \eta_i$

   and note that $\psi\left(e^*(P = 0)\right) = 0$. In the absence of a signal, $\tilde{e}$ solves

   (6) $\kappa_i \tilde{e}^{1/\gamma_i} = I_{pr} r + \eta_i.$

   Evaluating $\psi(e)$ at $\tilde{e}$ then gives

   (7) $\psi(\tilde{e}) = \kappa_i \tilde{e}^{\frac{1}{\gamma_i}} + \beta \tilde{e} - I_{pr} r - \eta_i > 0$

   from (6). What is more,

   (8) $\psi'(e) = \frac{\kappa_i}{\gamma_i} e^{\frac{1-\gamma_i}{\gamma_i}} + \beta_i > 0 \quad \forall e > 0.$

   It therefore follows that $e^*(P = 0) < \tilde{e}$.

4 Empirical Results

4.1 Aggregate results

Table 1 presents descriptive statistics of productivity, quality of work, age and gender for all four treatments. Because of our randomized experimental design, the average age of our workers (27.45) and the proportions of women and men are similar across treatments.[12] We find that workers entered an average of 85.33 rounds[13] when paid a fixed wage without peer pressure. Because workers knew they were hired for a single day of work, we rule out the possibility

[12] The age of our participants ranges from 19 to 59.

[13] This represents gross productivity, without regard for quality.

that this level of productivity reflects concerns for future employment. As a result, we interpret productivity in the fixed wage treatment without peer pressure as evidence of considerable self-motivation. Surprisingly, we find that the average productivity of workers paid a fixed wage and exposed to peer pressure is 82.20 rounds of golf, slightly lower than the average productivity of workers without peer pressure.

The incentive effects of using piece-rates are present both with and without peer-pressure. We find that workers entered an average of 107.18 rounds without peer pressure, an increase of 25.6% relative to the fixed wage treatment without peer pressure. Similarly, an average of 114.05 rounds were entered in the piece-rate treatment with peer pressure, an increase of 38.7% relative to the average productivity in the fixed wage treatment with peer pressure.[14]

Figure 1 presents the distributions of the number of rounds entered containing mistakes for the four treatments. We find similar distributions of mistakes with and without peer pressure, given a payment system. Across payment systems, workers are more likely to make a mistake when paid a piece-rate rather than when paid a fixed wage.

4.2 Regression results

Productivity

We measure productivity y_i as the total number of rounds of golf entered without mistakes.[15] The mistakes are analyzed separately below. We first estimate the following model of the natural logarithm of productivity

$$\text{(9)} \quad \ln(y_i) = \beta_0 + \beta_1 PR_i + \beta_2 PP_i + \beta_3 p_{-i,i} + \beta_4 p^2_{-i,i} + \varepsilon_i$$

where PR_i denotes a binary variable taking a value of 1 when participant i is paid a piece-rate, and 0 otherwise. Similarly, PP_i denotes a binary variable taking a value of 1 when participant i is taking part in a treatment with peer pressure, and 0 otherwise. The effect of peer pressure

[14] These results are in line with existing empirical evidence from observational studies and field experiments which find that productivity increases when workers are paid piece-rates rather than fixed wages (Lazear, 2000; Paarsch and Shearer, 2000; Shearer, 2004)

[15] By excluding mistakes, we overcome the problems of having to infer the productive value of rounds entered with various degrees of mistakes.

intensity is captured by including a linear and quadratic term in $p_{-i,i}$, representing the signal that participant i received about the productivity of a randomly matched participant $-i$. Recall from Section 2 that this signal corresponds to the gross productivity of the matched participant. The quadratic term in $p_{-i,i}$ was added to capture possible non-linearities between the level of peer pressure and productivity. Finally, ε_i is a random component assumed to satisfy the conditional median restriction $\mathbf{Med}(\varepsilon_i|PR_i, PP_i, p_{-i,i}) = 0$. This gives rise to a median regression model. Quantile restrictions are typically weaker than the more traditional conditional mean restrictions of the OLS estimator. Furthermore, median regressions are known to be robust outliers (See Koenker (2005)).[16]

Our theoretical model developed in Section 3 implies a number of restrictions on the parameters of (9). Result 1 suggests that workers will react positively to piece rates, implying that $\beta_1 > 0$. Result 2 suggests that workers will react positively to peer pressure, implying that $\beta_3 + 2\beta_4 p_{-i,i} > 0$.[17] Result 4 suggests effort in the presence of a very low peer-pressure signal is lower than is effort in the absence of peer pressure, implying that $\beta_2 < 0$.

We first estimated 9 combining data for men and women. We then ran regressions for men and women separately. Our results are presented in Table (2) under the columns "FW and PR". We find that workers supplied significantly more effort when paid a piece-rate relative to a fixed wage, consistent Result 1. All other variables are insignificant. Separate regressions for men and women produced similar results.

Peer pressure and mode of compensation

The regression model in (9) imposes the restriction that the effect of peer pressure on productivity is the same under both payments systems. More generally, the effect of peer pressure may depend on the compensation system. As shown in Section 3, our theoretical model predicts that the effect of peer pressure on productivity under fixed wages will be different than the corresponding effect under piece-rates (if $\gamma \neq 1$). To investigate this, we estimated (9) separately for the piece-rate and fixed-wage treatments.[18] Results for the fixed-wage and piece-rate

[16]OLS estimates of our model parameters are qualitatively similar to those presented in this section but are associated with substantially larger standard errors. A table of results is available upon request.

[17]Result 3, suggesting that the effect of peer pressure should be smaller under piece rates, is not testable in this specification. We expand our specification in the next section to consider this.

[18]We omit the variable PR_i from these regressions as its effect is no longer identified.

treatments are presented in Table 2 under the columns "FW only" and "PR only" respectively.

We first discuss results using all participants (combining men and women). Under piece-rates, we find that the dummy variable PP_i and the linear term in $p_{-i,i}$ are both insignificant at conventional levels. The quadratic term in $p_{-i,i}$ is positive and marginally significant at the 10% level, suggesting that peer pressure has some positive effect on productivity, consistent with Result 2.[19] Under fixed wages we find that the dummy variable PP_i has a negative and significant effect on productivity. This is consistent with Result 4 of the model of conformism set forth in Section 3. In particular, participants who receive low signals about the productivity of their matched participant are significantly less productive than participants who receive no signal about the productivity of others. The level of peer pressure, captured by the variable $p_{-i,i}$, also plays a significant role under fixed wages. We find that the linear term is positive while the quadratic term is negative, suggesting a concave relationship. These results are broadly consistent with Result 2 – the increases in peer pressure have a positive effect on productivity, at least over some range.

These results are qualitatively similar to those obtained when we run separate regressions for men and women under fixed wages. In particular, the binary variable PP_i is negative and significant for men and women, although the magnitude of the effect appears greater for men. The effect of peer pressure intensity and productivity is also concave for both men and women.[20]

In line with results obtained combining all participants, we find that the behaviour of men and women under fixed wages differs significantly from their behaviour under piece rates. Contrary to the fixed-wage case, the binary variable PP_i is not significant, for either men or women, under piece rates. This implies that men and women are only willing to reduce their effort to conform to the low effort of another worker when there are no financial consequences of doing so. Finally, contrary to the fixed-wage case, the linear and quadratic variables of peer-pressure intensity $p_{-i,i}$ are both individually insignificant for men and women under piece rates. However, it bears mention that the linear and quadratic variables are jointly significant

[19]The linear and quadratic variables in $p_{-i,i}$ are jointly significant at the 10% level (p-value = 0.0811).

[20]We also estimated models controlling for the effect of age. To proceed, we interacted the treatment variable PP and the linear and quadratic variables of peer pressure intensity with age. We find that our results are robust to this control but are generally insignificant due to the small number of degrees of freedom.

for men (p-value = 0.001) but not for women (p-value = 0.889).

To better understand the interaction of peer pressure and the mode of compensation, we plot, in Figure 4, the predicted logarithm of productivity of men (top two graphs) and women (bottom two graphs) under fixed wages (first column of graphs) and piece rates (second column of graphs). We include in each graph the predicted productivity of workers in the absence of peer pressure (ie. flat lines). The response curves of men and women under piece rates are both negatively sloped, with a slightly steeper curve for men. Clearly, increases in peer pressure are not predicted to have any beneficial effect on the productivity of workers under piece rates.

The response curve of women under fixed wages is substantially flatter that that of men, suggesting that women respond less to peer pressure than do men. Men are predicted to react negatively to either very low and very high peer-pressure signals relative to a moderate signal.

Again these results are broadly consistent with our model, at least for low levels of peer pressure. As discussed above, the response to low peer pressure signals can be explained by our model of conformism (Result 4). What is more, the reaction to increases in peer pressure is stronger under fixed wages than under piece rates (Result 3). It is also clear, however, that our model does not explain the negative reactions of workers at high levels of peer pressure. A possible explanation for this effect is provided by theories of self-assessment and motivation (see Deci (1975)). There it is argued that a person's self-motivation can decrease with feelings of incompetence. Hence, a high signal about the productivity of another worker may decrease feelings of competence and result in the productivity decreases which are captured in our experiment. Such an effect appears to be more important for men than women.

Finally, Figure 4 highlights the limited effect of peer pressure on productivity within our experiment. There was no level of peer pressure in the experiment for which the productivity of either men or women was significantly higher than without any pressure. In contrast, our results suggest that peer pressure can significantly decrease productivity (particularly for men) when the productivity signal is either very low or very high.

Quality

Figure 1 presents the distribution of the number of rounds entered with mistakes in each of the four treatments. We find that, both with and without peer pressure, the proportions of subjects not making any mistakes was higher when workers were paid a fixed wage than when they were paid a piece rate. This pattern is consistent with workers substituting quantity for quality under piece rates (see Stiglitz (1975), Lazear (1986) for theoretical discussions of this issue and Paarsch and Shearer (2000) for an empirical treatment within an actual firm).

To investigate systematically the relationship between quality of the work, incentives, and gender, let N be the number of workers in the experiment, and $y_{bi} \in \{0, 1, ..\}$ denote the number of mistakes of worker i, where $i = 1, 2, ..., N$. We assume that y_{bi} follows a negative binomial distribution whose first two moments are assumed to satisfy

$$\begin{aligned} \mathbf{E}\left(y_{bi}|\mathbf{x}_i\right) &= \exp(\mathbf{x}_i'\boldsymbol{\alpha}) \\ \mathbf{V}\left(y_{bi}|\mathbf{x}_i\right) &= \left(1 + \theta \exp(\mathbf{x}_i'\boldsymbol{\alpha})\right) \exp(\mathbf{x}_i'\boldsymbol{\alpha}) \end{aligned}$$

such that $\theta \geq 0$. This parameterization allows the conditional variance to exceed the conditional mean, a phenomena known as overdispersion and which is frequently observed in count data models (see Cameron and Trivedi 1998). A special case is the Poisson distribution (with $\theta = 0$), characterized by equidispersion (the conditional variance equals the conditional mean). Estimation of α and θ was performed by Maximum Likelihood.

The model was estimated first by combining data of men and women participants. We next estimated separate models for men and women participants.[21] Results of these regressions appear under the column label "Quality" in Table 2.

Looking first at the combined results, we find that the number of mistakes is significantly higher under piece rates than under fixed wages. This is consistent with the observations made earlier in Figure 1. The number of mistakes significantly decreases when workers receive a very low peer pressure signal. Moreover, the relationship between the number of mistakes and the level of peer pressure is significantly concave.

Looking at men only, we find that working under piece rates significantly increases the number of mistakes made. Moreover, there is a weak negative effect of the variable PP, hinting that men may make less mistakes when receiving a low signal about the productivity of another worker. Finally, we find that none of the peer pressure variables significantly affect the quality

[21] A log-likelihood ratio test easily rejects the null hypothesis that the coefficients in the men and women regressions are the same (χ^2_8 = 29.128, p-value = 0.0003).

of the work of women. Moreover, we cannot reject the hypothesis that women working under piece rates make the same number of mistakes than women working under fixed wages.

5 Conclusions

We have presented results from a real effort experiment where the payment system and the intensity of peer pressure were both varied exogenously among workers. Our experimental design allowed us to estimate the effect of peer pressure intensity on the productivity of men and women workers under both fixed wages and piece rates.

To interpret our findings, we presented a simple model of conformism. Our model builds on two key elements. First, we assume that workers have heterogeneous predispositions to work in the absence of incentives. Second, workers have heterogeneous needs to supply a level of effort which conforms with the effort level of another worker. These considerations, interacted with the presence of explicit incentives, produce clear predictions which were tested using our experimental data.

Our main results were the following. First, we found that the productivity of women was not strongly affected by the level of peer pressure when paid either a fixed wage or a piece rate. The productivity of men on the other hand was significantly affected by peer pressure, both under fixed wages and to a lesser extent under piece rates. Under fixed wages, we found a significant non-linear relationship between the productivity of men and the level of peer pressure they face. In particular, we found that men significantly reduce their productivity when given a very low signal about the productivity of another worker. This response is consistent with the model of conformism presented in Section 3, where it was argued that workers have an incentive to reduce the distance between their effort and that of another worker. On the other hand, high levels of peer pressure were found to have a significant negative effect on productivity, an effect which is inconsistent with our model of conformism. We have argued that the latter decline in productivity is broadly consistent with theories of self-motivation, according to which too much peer pressure can decrease a worker's own feelings of competence, and thus his self-motivation and productivity. Moreover, conformism and self-motivation considerations appear to be muted when male workers are paid piece rates. Indeed, we found a small (although significant) negative effect of peer pressure on productivity which contrasts with the effect of peer pressure under fixed wages. Overall, these results suggest that our simple model of conformism, while being able to predict many responses to peer pressure, should be generalized to better predict responses under very high levels of peer pressure.

While we find that the level of peer pressure can affect productivity, there is little to suggest that the level of productivity will be higher in the presence of peer pressure than in its absence. These results suggest that peer pressure has a limited range of effectiveness as an incentive-policy tool and can in some cases (eg. men under fixed wages) lead to significant productivity decreases.

Finally, our results demonstrate the usefulness of experimental methods for analyzing motivational models by generating random variation in (unobservable) forcing variables. Peer effects are difficult to measure in real firms. The work of Falk and Ichino (2006) as well as that of Gneezy and Rustichini (2004) demonstrated that it can be generated in laboratory (like) environments. Here, we have generated exogenous variation in peer pressure, allowing us to uncover nonlinearities in its effect on productivity. The random matching of workers ensures that every worker has a positive probability of being matched with a worker of higher or lower ability.

	FW-NoPP			PR-NoPP			FW-PP			PR-PP		
	All	Men	Women	All	Men	Women	All	Men	Women	All	Men	Women
Rounds entered	85.333	87.600	83.272	107.179	105.818	108.941	82.200	76.210	87.619	114.051	123.157	105.400
	(37.902)	(44.351)	(31.872)	(36.982)	(38.062)	(36.620)	(41.567)	(51.922)	(29.635)	(42.191)	(46.867)	(36.297)
Rounds with mistakes	2.404	3.300	1.591	5.436	6.868	3.588	1.725	1.000	2.381	3.333	4.947	1.800
	(5.296)	(7.498)	(1.563)	(12.711)	(16.674)	(3.519)	(2.241)	(1.291)	(2.711)	(4.163)	(5.328)	(1.642)
Age	27.428	28.800	26.181	27.307	29.454	24.529	27.95	27.421	28.428	27.102	27.157	27.050
	(7.444)	(8.888)	(5.771)	(8.189)	(9.231)	(5.734)	(8.317)	(6.256)	(9.958)	(6.832)	(6.414)	(7.373)
Female	0.523	-	-	0.436	-	-	0.525	-	-	0.513	-	-
	(0.505)			(0.502)			(0.505)			(0.506)		
Earnings $	10	10	10	10.71	10.582	10.894	10	10	10	11.40	12.315	10.540
	-			(3.698)	(3.806)	(3.620)	-			(4.219)	(4.687)	(3.629)
Number of workers	42	20	22	39	22	17	40	19	21	39	19	20

Table 1: Descriptive statistics for the four treatments: fixed wage with (FW-PP) and without (FW-NoPP) peer pressure, and piece-rate wage with (PR-PP) and without (PR-NoPP) peer pressure. Within each treatment statistics are provided for all workers, men workers, and female workers. Standard deviations in parenthesis.

	All participants				Men				Women			
	FW and PR	FW only	PR only	Quality	FW and PR	FW only	PR only	Quality	FW and PR	FW only	PR only	Quality
Constant	4.331***	4.331***	4.553***	0.957***	4.277**	4.331***	4.488***	1.058***	4.344***	4.344***	4.634***	0.763***
	(0.073)	(0.084)	(0.083)	(0.183)	(0.095)	(0.181)	(0.103)	(0.277)	(0.091)	(0.089)	(0.196)	(0.206)
PR	0.281***	-	-	0.663***	0.281**	-	-	0.993***	0.221**	-	-	0.249
	(0.089)			(0.217)	(0.114)			(0.357)	(0.110)			(0.238)
PP	-0.050	-0.694**	0.616	-2.387**	0.263	-2.737***	1.195	-3.591*	0.314	-0.768**	0.377	-1.057
	(0.334)	(0.338)	(0.515)	(1.077)	(0.425)	(0.554)	(0.922)	(1.864)	(0.411)	(0.298)	(0.993)	(1.105)
$p_{-i,i}$	0.003	0.019**	-0.010	0.040**	-0.005	0.077***	-0.016	0.058	-0.002	0.025***	-0.005	0.019
	(0.006)	(0.008)	(0.008)	(0.020)	(0.007)	(0.015)	(0.012)	(0.037)	(0.008)	(0.007)	(0.018)	(0.021)
$p^2_{-i,i}/1000$	-0.014	-0.112**	0.048*	-0.182**	0.031	-0.496***	0.066	-0.269	0.001	-0.142***	0.014	-0.093
	(0.027)	(0.045)	(0.027)	(0.093)	(0.023)	(0.101)	(0.041)	(0.175)	(0.037)	(0.039)	(0.074)	(0.095)
θ				1.296***				1.685***				0.600***
				(0.192)				(0.333)				(0.177)
Nobs	160	82	78	160	80	39	41		80	43	37	

Table 2: Productivity and quality regressions for men and women. θ denotes the overdispersion parameter of the negative binomial distribution. Standard errors in parenthesis. ′**′,′*′ denote significance respectively at the 5% and 10% level.

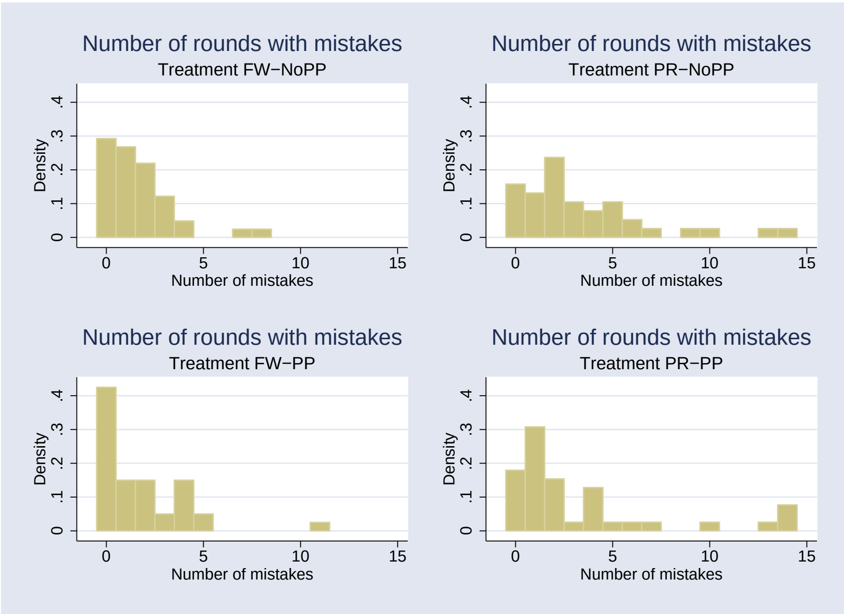
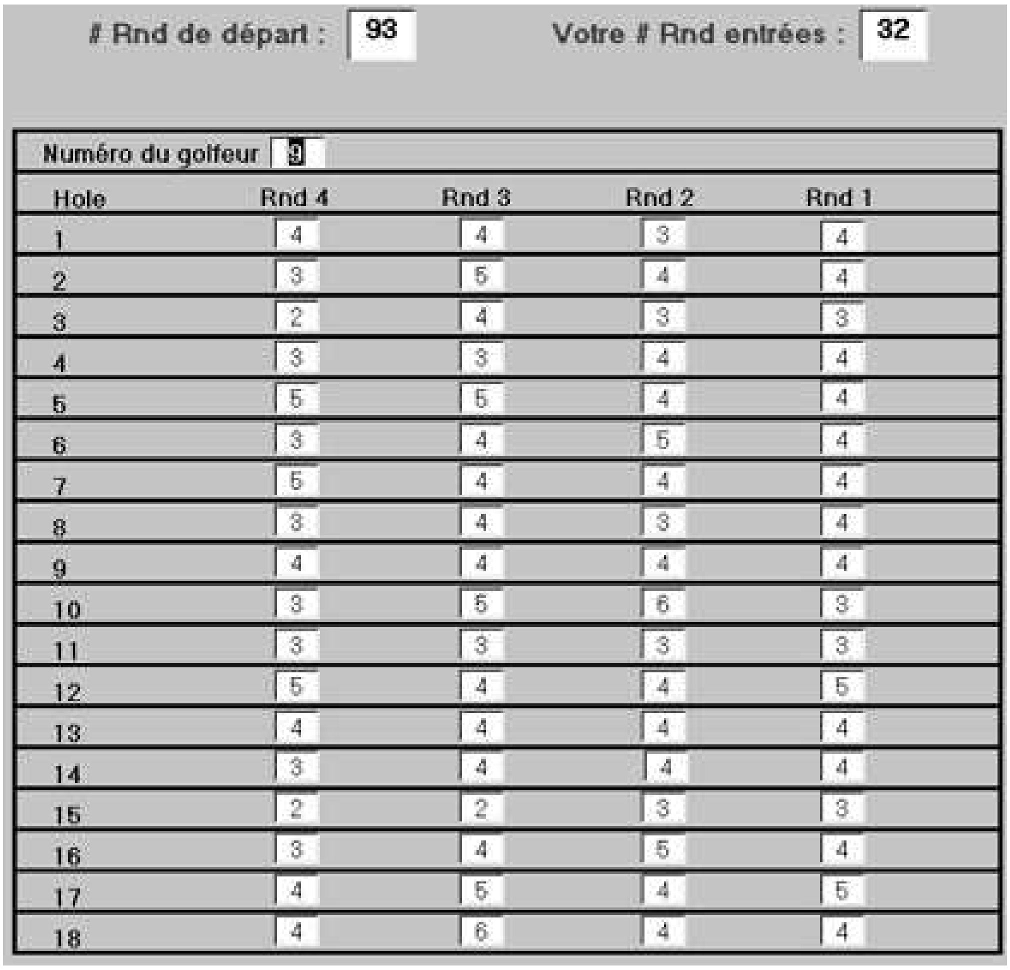


Figure 1: Number of rounds of golf entered with mistakes across the four treatments.

Numéro du golfeur : 23				
Trou	Rnd 4	Rnd 3	Rnd 2	Rnd 1
1	5	4	3	4
2	4	4	4	3
3	3	3	2	4
4	4	4	4	4
5	3	4	5	4
6	5	4	5	5
7	4	4	4	4
8	2	3	3	3
9	4	5	3	4
10	4	4	4	4
11	3	4	3	3
12	4	4	5	7
13	4	4	4	3
14	4	5	4	4
15	3	3	3	3
16	4	4	5	4
17	4	5	4	4
18	4	5	5	4

Figure 2: Sample scorecard taken from a worker's booklet.



\# Rnd de départ : 93   Votre # Rnd entrées : 32

Numéro du golfeur 9

Hole	Rnd 4	Rnd 3	Rnd 2	Rnd 1
1	4	4	3	4
2	3	5	4	4
3	2	4	3	3
4	3	3	4	4
5	5	5	4	4
6	3	4	5	4
7	5	4	4	4
8	3	4	3	4
9	4	4	4	4
10	3	5	6	3
11	3	3	3	3
12	5	4	4	5
13	4	4	4	4
14	3	4	4	4
15	2	2	3	3
16	3	4	5	4
17	4	5	4	5
18	4	6	4	4

Figure 3: Snapshot of the data entry screen.

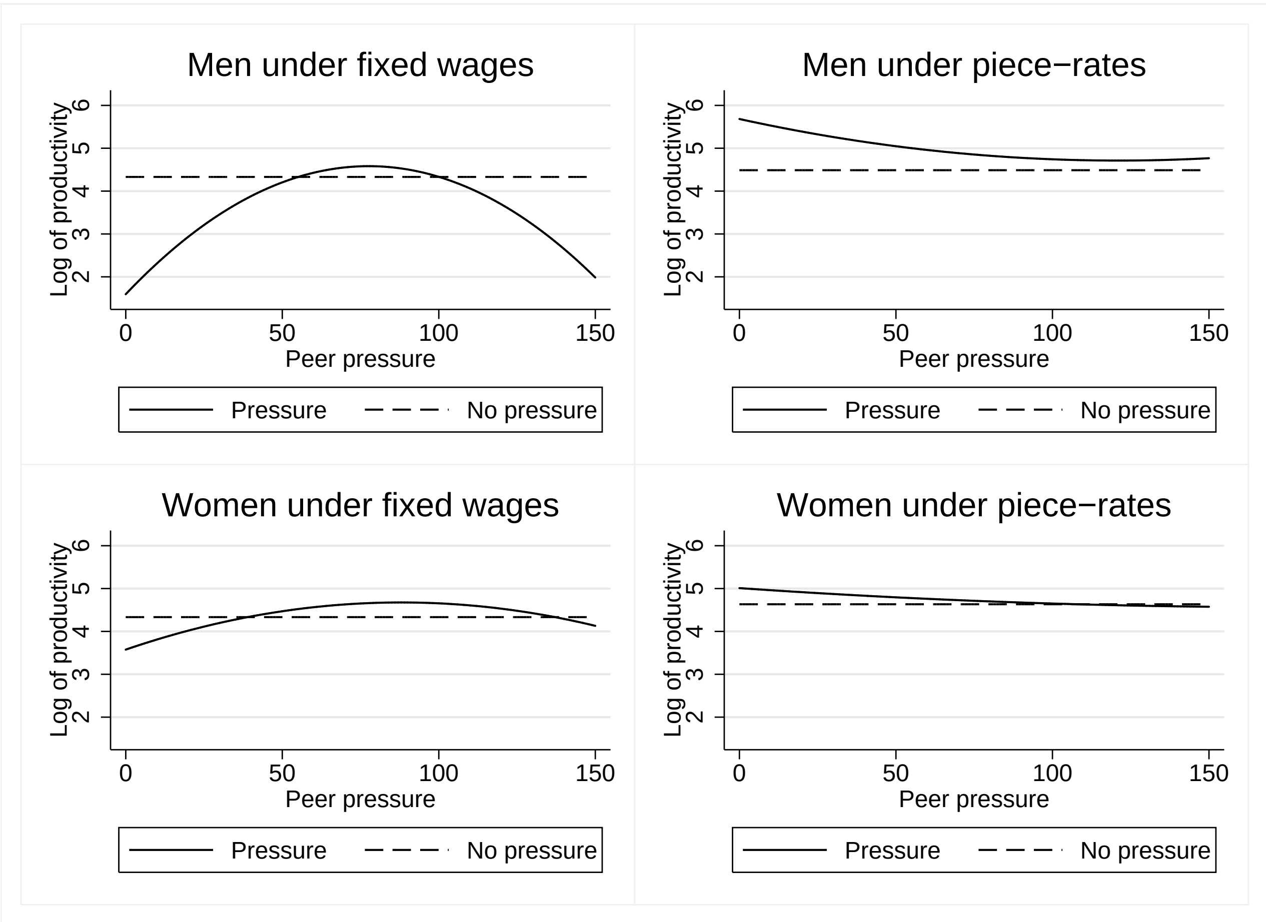


Figure 4: Predicted log productivity of men and women under fixed wages and piece rates.

References

ANGRIST, J., AND V. LAVY (2009): "Performance in competitive Environments: Gender Differences," *forthcoming, American Economic Review*.

BERNHEIM, B. D. (1994): "A Theory of Conformity," *Journal of Political Economy*, 102, 841–877.

CAMERON, A. C., AND P. TRIVEDI (1998): *Regression analysis of count data*. Econometric Society Monographs, Cambridge University Press.

DECI, E. (1975): *Intrinsic Motivation*. Plenum Press, New-York.

FALK, A., AND A. ICHINO (2006): "Clean Evidence on Peer Effects," *Journal of Labor Economics*, 24, 39–57.

GNEEZY, U., M. NIEDERLE, AND A. RUSTICHINI (2003): "Performance in competitive Environments: Gender Differences," *Quarterly Journal of Economics*, 45, 347–368.

GNEEZY, U., AND A. RUSTICHINI (2004): "Gender and Competition at a Young Age," *American Economic Review Papers and Proceedings*, 94, 377–381.

KANDEL, E., AND E. LAZEAR (1992): "Peer Pressure and Partnerships," *Journal of Political Economy*, 100, 801–817.

KOENKER, R. (2005): *Quantile Regression*. Cambridge University Press, Cambridge, U.K.

LAZEAR, E. (1986): "Salaries and Piece Rates," *Journal of Business*, 59, 405–431.

——— (2000): "Performance Pay and Productivity," *American Economic Review*, 90, 1346–1361.

LAZEAR, E., AND S. ROSEN (1981): "Rank-Order Tournaments as Optimum Labor Contracts," *Journal of Political Economy*, 89, 841–864.

MACLEOD, W. B., AND J. M. MALCOMSON (2000): "Implicit Contracts, Incentive Compatibility, and Involuntary Unemployment," *Econometrica*, 57, 447–480.

MANSKI, C. (1993): "Identification of Endogeneous Social Effects: The Reflection Problem," *Review of Economic Studies*, 60, 531–542.

MAS, A., AND E. MORETTI (2006): "Peers at Work," *forthcoming, American Economic Review*.

PAARSCH, H., AND B. SHEARER (1999): "The Response of Worker Effort to Piece Rates: Evidence from the British Columbia Tree-Planting Industry," *Journal of Human Resources*, 34, 643–667.

——— (2000): "Piece Rates, Fixed Wages and Incentive Effects: Evidence from Payroll Data," *International Economic Review*, 41, 59–92.

——— (2007): "Do Women React Differently to Incentives: Evidence from Experimental Data and Payroll Records," *European Economic Review*, 51, 1682–1707.

SHEARER, B. (2004): "Piece Rates, Fixed Wages and Incentives: Evidence from a Field Experiment," *Review of Economic Studies*, 71, 513–534.

STIGLITZ, J. (1975): "Incentives, Risk, and Information: Notes Towards a Theory of Hierarchy," *Bell Journal of Economics*, 6, 552–579.