TEAM INCENTIVES: EVIDENCE FROM A FIRM LEVEL EXPERIMENT

Oriana Bandiera
London School of Economics
and Political Science

Iwan Barankay
The Wharton School,
University of Pennsylvania

Imran Rasul
University College London

Abstract
Many organizations rely on teamwork, and yet field evidence on the impacts of team-based incentives remains scarce. Compared to individual incentives, team incentives can affect productivity by changing both workers' effort and team composition. We present evidence from a field experiment designed to evaluate the impact of rank incentives and tournaments on the productivity and composition of teams. Strengthening incentives, either through rankings or tournaments, makes workers more likely to form teams with others of similar ability instead of with their friends. Introducing rank incentives however reduces average productivity by 14%, whereas introducing a tournament increases it by 24%. Both effects are heterogeneous: rank incentives only reduce the productivity of teams at the bottom of the productivity distribution, and monetary prize tournaments only increase the productivity of teams at the top. We interpret these results through a theoretical framework that makes precise when the provision of team-based incentives crowds out the productivity-enhancing effect of social connections under team production. (JEL: D23, J33, M52)

1. Introduction

Team organization is pervasive in the workplace. The latest nationally representative survey for US establishments reveals that 52% of firms use teamwork, while the corresponding survey for British establishments shows that in 47% of firms more

The editor in charge of this paper was Stefano DellaVigna.

Acknowledgments: Financial support from the ESRC is gratefully acknowledged. We thank Philippe Aghion, Pierre Azoulay, George Baker, Roland Benabou, Peter Cappelli, Giacomo De Giorgi, Robert Gibbons, Christopher Ksoll, Claire Leaver, Thomas Lemieux, Bentley MacLeod, James Malcolmson, Joao Montalvao Machado, Muriel Niederle, Paul Oyer, Canice Prendergast, Daniel Rogger, Betsey Stevenson, Justin Wolfers, and seminar participants at Bergen, Columbia, Edinburgh, Erasmus, Harvard/MIT, IZA, LSE, Oxford, Sabanci, San Diego, Stanford, Wharton, the editor, and three anonymous referees for valuable suggestions. We thank all those involved in providing the data. This paper has been screened to ensure no confidential information is revealed. All errors remain our own.

E-mail: o.bandiera@lse.ac.uk (Bandiera); barankay@wharton.upenn.edu (Barankay); i.rasul@ucl.ac.uk (Rasul)

Journal of the European Economic Association October 2013 11(5):1079–1114

DOI: 10.1111/jeea.12028

than 90% of the workforce is organized in teams.[1] According to evidence cited by Lazear and Shaw (2007) the incidence of teamwork has been increasing over time. For instance, the share of large firms with workers in self-managed teams rose from 27% to 78% between 1987 and 1996. Finally, a survey of Fortune 1000 companies reveals that among large firms, 70% used some form of team incentives (Ledford Jr, Lawler III, and Mohrman, 1995).

In contrast to their empirical prevalence in the workplace, the academic literature on teams and team-based incentives remains relatively scarce. This lacuna needs addressing because the large literature on *individual* incentives provides limited guidance to understanding the effect of *team* incentives. Indeed, the margins along which individuals and teams can respond to incentives differ, as team incentives affect both worker effort and team composition. This is particularly relevant in the light of potential free-riding problems that plague team production. If workers can freely choose team members, then they might opt to form teams with others they are socially connected to, and such teams might be better able to mitigate free-riding within teams. In consequence, the provision of high-powered team incentives can backfire in terms of productivity if they strengthen incentives for individual workers to assortatively match by ability into teams, rather than form teams with workers they are socially connected to, and thus exacerbate free-riding within some teams. Given the very heterogenous effects this has across teams of different compositions—as highlighted theoretically and empirically in our analysis—this provision of high-powered incentives can lead to a reduction in overall productivity and leave the firm worse off.

This paper presents evidence from a field experiment designed to evaluate the effect of different incentive schemes on firm performance when the workforce is organized in teams. We analyze three commonly used schemes: piece rates, rank incentives, and tournaments. As in most organizations that use teams, in our study team composition is endogenous. We assess how each incentive scheme affects the composition of teams, and we decompose the total effect of each incentive type on team productivity into that caused by changes in team composition, and that caused by changes in effort holding constant team composition. While it is not feasible to compare individual and team incentives in this setting, our study provides evidence on the effect of incentive power on team composition, which is the key dimension along which individual and team incentives differ, as well as the heterogeneous effects of incentives across teams of different compositions.

The firm we study is a leading soft fruit producer in the United Kingdom. The field experiment was designed and implemented in collaboration with the firm's CEO during the 2005 harvest season and concludes a series of experiments run in the same

1. The National Employer Survey (1994) covers all US manufacturing and nonmanufacturing establishments with 20 or more employees, except agriculture and government establishments. Available at http://www.census.gov/econ/overview/mu2400.html, accessed on 18 May 2011. The Workplace Employment Relations Survey (2004) is a representative survey of establishments in Great Britain with five or more employees, with the exception of agriculture, forestry and fishing: mining and quarrying and overseas organizations. Available at http://www.wers2004.info/wers2004/wers2004.php, accessed on 18 May 2011.

context to shed light on the interaction of social connections and monetary incentives in the workplace (Bandiera, Barankay, and Rasul, 2005, 2007, 2009).[2] The experiment alters the work environment for those at the lowest level of the hierarchy while holding constant the compensation schemes at other tiers. Workers are organized into teams of five, and their main task is to pick fruit from fields on different sites. When workers arrive to the farm they are assigned to a team by the general manager for their first week. Thereafter workers are free to choose their own team members at a *team exchange* that takes place every week. A team is formed only if all its members agree. Hence in this setting workers have two choice variables: how much effort to exert into picking, and team composition.

Two forces drive team formation in our setting: workers' ability and social connections. Individual earnings increase with the ability of team members, and teams can form only if all members agree. These features push towards an equilibrium where workers match assortatively by ability, as high-ability workers are better off by forming teams among themselves. On the other hand, workers might prefer to form teams with friends because they enjoy the nonpecuniary benefits of doing so (Hamilton, Nickerson, and Owan, 2003) or because friends are more able to co-operate in this context (Bandiera, Barankay, and Rasul, 2005) thus limiting free-riding within teams. Hence the existence of social connections between workers might be beneficial for the firm.

The experiment generates exogenously timed variation in the trade-off between sorting into teams by ability versus sorting by social connections in the following way. At the beginning of the season, teams were paid piece rates based on their aggregate productivity. Halfway through the season we provided, in addition to team piece rates, rank incentives to workers by posting daily histograms of each team's productivity. Rank incentives make precise the absolute productivity of each team, and their ranking relative to all other teams. If workers have concerns for their social status the provision of such rank incentives would change the composition of teams that form in equilibrium. Halfway through the remaining part of the season we introduced a tournament, namely added a monetary prize for the most productive team each week to the provision of rank incentives and team piece rates. If workers payoffs increase in their earned income, the provision of such tournaments would also change the composition of teams that form.

Ours is not a randomized controlled trial, namely we do not randomly assign teams to treatment and control groups at the same point in time. The choice of within-worker experimental design is dictated by the fact that workers can easily observe and react to

2. Our previous experiments show that workers and managers in this firm internalize the effect of their actions on colleagues they are socially connected to; and that increasing the strength of monetary incentives diminishes the responsiveness to social connections (Bandiera et al. 2005, 2009). In both cases strengthening monetary incentives unambiguously increased productivity because these earlier experiments took place in a setting where social connections were potentially detrimental to the firm's productivity. Our previous experiments left unanswered the question of whether incentives crowd out the effect of social connections when these are beneficial for the firm, as might be the case under team production.

the incentives offered to their colleagues, so that the comparison of contemporaneously assigned treatment and control groups would yield biased treatment effect estimates.

The choice of incentive schemes is guided by rank incentives and tournaments being widely used to provide incentives in organizations, and yet field evidence on their effects is scarce.[3] Theory highlights how rank incentives can affect productivity if individuals have status concerns (Moldovanu, Sela, and Shi, 2007; Besley and Ghatak, 2008), and a small empirical literature shows that providing information on rankings without prizes impacts productivity when individuals work independently (Barankay, 2010; Delfgaauw et al., 2009; Clark, Masclet, and Villeval, 2010; Blanes i Vidal and Nossol, 2011; Kosfeld and Neckermann, 2011). To the best of our knowledge, ours is the first field experiment designed to evaluate the effect of rank incentives on team composition and productivity in a real workplace. In our context, rank incentives might be particularly effective because, as teams are paid piece rates, rankings effectively provide information on relative earnings and this is a key determinant of happiness (Layard, 2006; Kahneman et al., 2006).

Comparing rank incentives and tournaments in the same setting is particularly useful because whenever tournaments are in place, workers *inevitably* receive some rank incentives. Our research design allows us to separately identify the effect of rank incentives from the effect of monetary prizes. As the provision of rank incentives is almost costless, measuring its contribution to the overall tournament effect can lead to considerable cost savings if most of the positive effect of tournaments on productivity is actually due to worker responses to rank incentives.

We develop a theoretical framework to illustrate that rank incentives and tournaments affect the marginal return to effort, hence determine how workers optimally sort into teams, and the effort they exert within the team. Both channels affect productivity. The theoretical framework makes precise how incentive power affects the trade-off each worker faces between matching with colleagues of similar ability or colleagues he is socially connected to.

As is intuitive, we show that a sufficiently large increase in incentive power makes high-ability workers want to leave their friends and match with colleagues of similar ability, and this affects both the average productivity of teams and the dispersion of productivity across teams. More subtly, we show that the dispersion unambiguously increases while the effect on average productivity is ambiguous. On the one hand, the change in team composition reduces average productivity because the firm no longer harnesses the benefit of team members being socially connected, namely that workers are less likely to free-ride on their friends' efforts. On the other hand, average productivity will rise overall if the gains from increased effort induced by the rise in the strength of incentives more than offset the losses due to the increase in free-riding.

3. The empirical evidence on tournament theory either tests whether a particular compensation scheme has a tournament structure (Rosen, 1986; Gibbons and Murphy, 1990; Eriksson, 1999; Bognanno, 2001), or whether individual behavior changes with tournament features in a way consistent with theory, using data either from experimental settings (Bull, Schotter, and Weigelt, 1987; Nalbantian and Schotter, 1997), personnel data (Knoeber and Thurman, 1994; Eriksson, 1999; Bognanno, 2001), or sports (Ehrenberg and Bognanno, 1990).

Our key results are as follows. First, the introduction of rank incentives and of monetary prizes lead to significant changes in team composition. Relative to the team piece rate regime in place at the start of the study period, the share of team members connected by social ties is lower and team members' ability levels are more similar after the introduction of rank incentives, and after the introduction of tournaments.

Second, rank incentives and prizes have opposite effects on average productivity. Relative to the piece rate regime, the introduction of rank incentives reduces average team productivity by 14%. Relative to rank incentives, the introduction of tournaments significantly increases productivity by 24%. The reduction in average productivity when rank incentives are provided is consistent with workers being better off sorting into teams on the basis of ability rather than friendship, and the firm being worse off because it no longer harnesses the ability of socially connected workers to ameliorate free-riding within the team. Hence the endogenous formation of teams under rank incentives reduces the firm's productivity overall. In contrast, the tournament regime is sufficiently high-powered that the increase in worker's effort more than offsets any increase in free-riding within teams. Hence the firm's productivity rises.

Third, the dispersion of productivity increases under both regimes because both effects are heterogeneous, as indicated by the theoretical framework. Quantile regression results show that the introduction of rank incentives reduces the productivity of teams at the bottom of the conditional productivity distribution compared to when only team piece rates are in place, while it has no effect on teams above the 40th percentile. In contrast, the introduction of tournaments increases the productivity of teams at the top of the conditional productivity distribution compared to rank incentives, while it has no effect on teams below the 30th percentile. Taken together, this implies that, compared to piece rates, tournaments significantly reduce productivity for teams below the first decile and significantly increase productivity for teams above the median.

Fourth, we use information on the productivity of teams that remain intact after the change in incentives to evaluate the effect of rank incentives and tournaments on effort, holding constant team composition. We find that rank incentives do not affect team productivity, suggesting that the documented negative effect of rank incentives is primarily due to the endogenous changes in team composition rather than changes in behavior of the select sample of teams that remain intact. In contrast, the tournament increases team productivity by 25% for teams that choose to remain intact, suggesting that tournaments affect firm performance through both the endogenous changes in team composition and changes in behavior within the same team.

Finally, qualitative evidence from a worker survey we conducted reveals that relative to the piece rate regime, during the tournament regime significantly fewer workers report pushing their team members to work hard or giving team members instructions. This is consistent with workers having fewer social connections with their team members under the tournament regime, so that peer pressure within the team becomes less effective.

The paper is organized as follows. Section 2 describes our setting and field experiment. Section 3 presents a stylized model of how the formation of teams and effort within teams are affected by team incentives. Section 4 provides evidence on the impact of rank incentives and tournaments on team composition. Section 5 estimates the effects of each incentive scheme on average team productivity, the dispersion of productivity across teams, the productivity of teams that remain intact across incentive schemes, and provides descriptive evidence on how interactions among team members change with each incentive scheme. Section 6 concludes by discussing the generalizability of our results to other settings. Proofs and robustness checks are in the Online Appendix.

2. The Context and Field Experiment

2.1. Organization of Production

The firm we study is a leading soft fruit producer in the United Kingdom. The field experiment was designed and implemented in collaboration with the CEO of the firm during the 2005 harvest season. The firm hierarchy has three tiers below the CEO: a general manager, field managers, and workers. The general manager is a permanent employee of the firm, whereas field managers and workers are hired seasonally from Eastern Europe and live and work on the farm site.[4]

The main task of the bottom tier workers is to pick fruit from fields located on two farm sites. Within a field, plants are organized in parallel rows, and these are covered by plastic sheets, which form tunnels containing five rows each. The architecture of tunnels is such that workers can observe all other pickers in the same field. A team of five workers is assigned to each tunnel, and each worker picks on her individual row. Teams typically pick fruit on two fields per day and they pick the same fruit type throughout the week. Teams are present on a given field for the number of hours it takes to pick all the available fruit. Throughout the experiment teams are always paid a piece rate for each kilogram of fruit picked by the team, and each member receives an equal share of the total team pay.

On any given field, there are around 30 pickers in six teams. Teams are equally divided between field managers, and their task is to monitor the quality of fruit picking and to organize the field logistics for the teams they are responsible for. The quality of picking is monitored along three dimensions—that all ripe fruit is picked, that fruit or plants are undamaged, and that fruit is correctly classified by size. The field managers are responsible for logistics such as the movement of fruit from the field to the packing plant.

4. To be recruited, individuals must be full-time university students, and be returning to the same university in the Fall. Workers are not typically hired from the local labor market and very few workers are hired for two consecutive seasons. The work permit of workers allows them to work on other UK farms subject to the approval of the permit agency. Their outside option to employment at the farm is therefore to return home or to move to another farm during the season. Workers typically stay on the farm for between three and six months—the median stay is 139 days. No workers are observed deciding to leave before the date they are due to leave.

In this setting the production technology is such that there are no complementarities among team members. As each worker picks on her own row, her productivity is independent of the efforts of other team members. Nor is there much scope for task specialization unlike in other team settings (Hamilton, Nickerson, and Owan, 2003). Nevertheless, establishing teams has three key advantages: it saves administrative time because daily computations of productivity and pay are done for teams rather than individuals; it saves management time because the allocation of workers to rows is delegated to the teams rather than field managers; it allows the firm to harness workers' social preferences to boost firm productivity. In Bandiera, Barankay, and Rasul (2005), we found that in this context workers internalize the effects of their effort on colleagues they are socially connected to, and that, therefore, incentive schemes where the individual worker generates a positive externality on his colleagues are likely to be more effective than schemes without such externalities.

Workers and field managers do not choose which fields they work on. At the start of each day they are assigned to a field by a general manager. The order in which fields are picked is predetermined at the start of the season, and depends on the exact fruit varieties across fields and the years in which they were planted. The general manager establishes the piece rate for teams on each field at the beginning of each day each field is picked, based on his assessment of field conditions. Workers who do not pick fruit are typically assigned to other tasks such as planting, weeding, packing fruit, or the construction of field tunnels.[5]

2.2. *Teams*

In this setting, workers choose how much effort to expend in picking and the team composition. When workers first arrive at the farm they are assigned to a team by the general manager for their first week. Thereafter workers are free to choose their own team members. Teams are formed weekly at the *team exchange*, which takes place at the end of each pay week. Workers can either go to the exchange to register an agreed team, namely a group of five workers who want to be part of the same team for the following week, or use the team exchange to coordinate with other workers who do not already belong to a team, and form a new team. Two rules govern the exchange. First, a team can form if and only if all five members agree to it. Second, workers who are unable to form a team by the end of the team exchange are not allowed to work for the week. This provided strong incentives for teams to form at the exchange, prevented workers strategically choosing not to form a team, and provided workers with strong effort incentives during the work week to ensure their team members did not want

5. The piece rate is the same for all teams on a given field-day. This piece rate is announced to workers before they start picking, and cannot be revised ex post. If a team's productivity is so low that they earn an hourly equivalent less than the legally prescribed minimum wage, they are paid a one-off supplement to ensure they reach the minimum wage. When they first arrive on the farm, workers are informed that they will be sent home if they consistently need to be paid this supplement. We observe less than 1% of team-field-day observations where workers are paid the supplement.

them to leave the team at the next team exchange. Indeed, we never observed workers being unable to form a team at the exchange.[6]

The comparison of team demands from the team exchange records and actual team composition from personnel records show that workers were indeed assigned to their proposed teams. However, it does happen that a given worker does not pick with all the four colleagues he formed a team with at the exchange, and the unconditional probability that a given worker is observed working alongside a colleague he demanded at the team exchange is 0.76. The discrepancy is due to the fact that occasionally a team can be temporarily reduced from size five to four either because a worker is sick, or is assigned to some other task that needs completing urgently. Reassuringly we find that the discrepancy between actual and desired teams is orthogonal to the incentive regime, suggesting management faithfully implemented worker demands from the team exchange throughout the season, irrespective of whether rank incentives or prizes were in place. These and related issues are discussed further in the Online Appendix.

Two factors drive team composition in this setting. First, as in nearly any setting where workers are organized in teams and pay is a positive function of aggregate team productivity, all workers prefer to match with high-ability colleagues. Other things equal, we would therefore expect workers to sort into teams with others of similar ability. Second, workers might prefer to form teams with colleagues they are socially connected to, both because they derive utility from their presence and because socially connected workers might be more able to co-operate, or provide more credible rewards and punishments to each other, and hence overcome the free-rider problem that plagues team production. In Bandiera, Barankay, and Rasul (2005) we provide evidence that during an earlier season workers in the same setting were more able to co-operate whenever they worked alongside their friends. To the extent that workers do not form friendships on the basis of ability, workers then face a trade-off from the benefits of assortatively matching with others on ability and matching into teams on the basis of friendship.[7]

2.3. The Field Experiment

The experiment was designed to generate exogenously timed variation in the trade-off between sorting into teams by ability versus sorting by social connections. The experiment was structured in three stages. From the start of the peak picking season in June teams were paid piece rates based on the average productivity of their members. We refer to this as the control period. Starting on 4 August, in addition to the piece

6. From our worker survey (i) 85% of workers report understanding how the team exchange worked; (ii) 90% of workers report a preference for the team exchange over management fixing teams each week.

7. Two points are of note. First, the way in which agents match depends crucially on the properties of agent's payoff functions—supermodularity in ability induces positive matching, while submodularity induces negative matching (Kremer, 1993; Newman and Legros, 2002). The former case better represents the worker's payoff structure in our setting. Second, Bandiera, Barankay, and Rasul (2009) provide additional evidence in this setting that the ability of individuals is uncorrelated within pairs of workers that report each other as friends.

rates scheme, we also provided daily rank incentives on team performance. Starting on 2 September we added a weekly monetary prize for the most productive team on each site. During the experiment sixteen weekly team exchanges took place—eight during the control period and four during each experimental treatment.

The research design is within-subject so that workers and teams earlier in the season form the control group. We do not randomly assign different treatments to different groups of workers at the same moment in time because in this context, information spillovers between teams are unavoidable and likely to invalidate the identification of causal effects if those in the control group react to not having been assigned to any given treatment. Given our research design, the main identification concern is that the estimated treatment effects capture changes that would have occurred for natural reasons at the same time as the introduction of the treatments. Reassuringly, the analysis of productivity data from the three previous years shows that while daily productivity fluctuates throughout the season, no systematic changes occur on 4 August and 2 September, the dates on which we introduced rank incentives and prizes in the 2005 season. We later show further evidence to rule out that time-varying unobservables generate a spurious correlation between the treatments and productivity.

To avoid confounding the effects of each treatment with some other factors, the compensation schemes of field managers and the general manager were left unchanged throughout the season. Field managers were always paid a fixed wage and a performance bonus based on aggregate productivity, and the general manager—a permanent employee—was paid a fixed wage throughout. Moreover, to avoid anticipation effects, neither change was announced to workers or field managers beforehand.

2.3.1. Rank Incentives. During the rank incentive treatment, data on each team's daily productivity was publicly posted at the campsite where workers reside. A simple histogram illustrated: (i) the absolute level of productivity of each team; (ii) the productivity ranking across teams; (iii) the productivity differentials between teams. At the end of the work week and prior to the team exchange, the same information was presented ranking productivities for the whole week. To guarantee comparability, separate rankings were posted by type of fruit picked and farm site, to net out exogenous differences in productivity across farm sites and fruit types.

Although the name of the workers in each team were listed on the histogram, their individual productivity is *not* measured and hence not reported. This shuts down an important channel through which rank incentives can affect team composition, namely by providing information on the ability of all potential matches. In this setting, workers can estimate their colleagues' ability as each worker is clearly visible to others, and others' productivity can be gauged by the speed at which they move. Moreover, as rank incentives were introduced two months after the start of the peak picking season, workers had many opportunities to form estimates of colleagues' ability.

Rank incentives provide a public and precise comparison of teams' productivities. As teams are paid piece rates, the rankings also provide precise information on relative earnings. Rank incentives can therefore affect effort and team composition if individuals have concerns for their relative position or status, as assumed in some models (Moldovanu, Sela, and Shi, 2007; Besley and Ghatak, 2008), and supported by research in psychology (Kluger and DeNisi, 1996), neuroscience (Fliessbach et al., 2007), and on the determinants of happiness (Layard, 2006; Kahneman et al., 2006).

2.3.2. Tournament. During the tournament treatment management paid a weekly monetary prize to the most productive team, in addition to rank incentives and the team piece rate. The prize was awarded to the most productive team on each of the two farm sites and each of the two fruit types. The actual prize amount was held fixed throughout. Its value corresponds to 5% of average team weekly earnings during the tournament regime if we assume that the prize could only have been won by a team when they are observed to do so, or corresponds to 22% of average team weekly earnings if the same team had won the prize each week. The true expected monetary value of the prize to any given team lies between these bounds. Regardless of how workers perceive their likelihood to win, the prize was paid in pounds sterling and likely to be spent in Eastern Europe, so the PPP-adjusted value was significant.

3. Theoretical Framework

3.1. Set-up

We develop a stylized model to illustrate the effect of increasing incentive power when workers choose both effort and team composition. The framework makes precise the conditions under which workers face a trade-off between matching by ability and matching by friendship, and provides testable predictions on how team incentives affect the average productivity of teams, and the dispersion of productivity across teams. To focus on the effects that can be identified in the empirical analysis, we make several simplifying assumptions.

We first assume that worker i produces output $y_i = \theta_i e_i$ where θ_i measures worker i's ability and e_i is the effort she devotes to fruit picking. Effort entails disutility $\frac{1}{2}e_i^2$ and we normalize the hours worked to one so that effort and productivity are equivalent. Second, we assume that there are two pairs of friends and hence four workers in total. Two of the workers are of low ability θ_L and two are of high ability $\theta_H > \theta_L$. Importantly, we assume that workers' ability is common knowledge. This assumption is motivated by our empirical setting where workers can easily observe individual abilities. Third, we assume that teams can only be of size two and earnings are shared equally among team members. In an extension we show that results are robust to allowing team members to make transfers between teams, and to allowing friends to be better able to make transfers.

Fourth, we assume that working alongside a friend provides a nonpecuniary benefit $s > 0$, and that friends have social preferences so that worker i places some positive weight on the earnings of his teammate j, π_{ij}, if i and j are friends. Such social preferences can be a consequence of altruism or might reflect that friends are better able to sustain co-operation than nonfriends. For our purposes, the motives behind social preferences are irrelevant as in both cases workers partially internalize the externality their effort imposes on their team member when the member is a friend.

Fifth, we assume that productivity y yields utility py, where p is a comprehensive measure of incentive power. It captures piece rates, the effect of rank incentives and the effect of monetary prizes on the returns to effort. Hence relative to a scenario in which teams are paid a piece rate, the introduction of rank incentives and tournaments can be represented through a potential change in p. The provision of public rankings is equivalent to an increase in incentive power if individuals care about their relative position or status in the workplace. Of course, whether this concern is sufficiently strong to affect real outcomes in this setting is an empirical question.

It is important to stress that the main purpose of the theoretical framework is to illustrate the effect of incentives on the trade-off between matching by friendship and by ability, and its effect on team composition and productivity, and to then guide our empirical analysis. Modeling the richness of the tournament structure goes beyond the purposes of our simple setup. Finally, while we illustrate all results with respect to an increase in p, we do not make any assumptions regarding the relative strength of piece rates, rank incentives, and tournaments. Plausibly, as prizes are offered on top of rank incentives, p should be highest in the tournament treatment, but again this is ultimately an empirical question.

3.2. Analysis

The utility of worker i who forms a team with worker j is

$$U_{ij} = \frac{p(1+\pi_{ij})}{2}(\theta_i e_i + \theta_j e_j) - \frac{1}{2}e_i^2 + s_{ij}, \tag{1}$$

where $\pi_{ij} \in [0, 1]$ is the weight worker i places on the earnings of worker j in her team. $\pi_{ij} > 0$ and $s_{ij} = s > 0$ if i and j are friends, and $\pi_{ij} = s_{ij} = 0$ otherwise.[8] Holding constant team composition, the first-order condition for effort is

$$e_i^* = \frac{p(1+\pi)}{2}\theta_i. \tag{2}$$

The existence of friendship ties in the team effectively boosts the incentive power p as each worker internalizes the effect her effort has on her team member. To analyze team composition we focus on coalition-proof Nash equilibria (Bernheim, Peleg, and Whinston, 1987) where (i) all workers form teams and (ii) teams are stable in the sense that no worker is better off by leaving his team and forming a new one with whoever

8. For ease of exposition we assume that individuals place no weight on the earnings of their friends if they are not in the same team and $\pi_{ij} = \pi$ for all friendship pairs i and j in the same team. This is in line with the case in which $\pi > 0$ represents friends' ability to co-operate rather than altruism. The results in what follows hold if we also allow for individuals to place some weight on friend's earnings regardless of whether they are in the same team.

is willing to do so. Our choice of equilibrium concept is driven by the two key features of our setting, namely that workers must form teams to be able to work and that a team can form only if all workers agree to be part of it. Our first results makes precise the conditions under which workers face a trade-off between matching by ability or by friendship, and, if so, how the trade-off depends on the power of incentives.

RESULT 1 (Team Composition). *If friends are of different abilities, the ability differential is not too low, and workers' social preferences (π) are not too strong, there exists a threshold level of incentives $\hat{p}$, such that when incentives are sufficiently strong ($p > \hat{p}$) workers match by ability, whereas when they are weak ($p < \hat{p}$), they match by friendship.*

Intuitively, if friends are of the *same* ability level, the only stable equilibrium is the one in which the high-ability pair forms one team and the low-ability pair forms the other. Indeed, the high-ability workers have nothing to gain by leaving their high-ability friend and matching with a low-ability worker. Consequently, the low-ability workers have no incentive to break their team either, because they would not be able to match with anybody else.

If friends are of *different* abilities, then low-ability workers again face no trade-off, namely their utility is always higher when matching with their high-ability friend rather than the other low-ability worker. To understand how workers actually sort into teams, we need to compare whether the utility of high-ability workers is higher by forming a team with their low-ability friend or with the other high-ability worker. High ability workers always prefer to match with their friend if they place a large weight on their friends' earnings (π high) or if the ability of their friends is similar to theirs ($\frac{\theta_L}{\theta_H}$ high). If not, the utility differential between matching by ability and matching by friendship will depend on the strength of incentives, p.

Utility (1) depends on earnings and the benefits of socializing with friends, s. Other things equal, utility increases in the ability of the team member through the effect this has on earnings. An increase in incentive power effectively increases the relative weight of earnings in the utility function and hence increases the likelihood that high-ability workers prefer to work together rather than with their low-ability friends.[9] Increasing incentive power can therefore affect both team composition and effort within the team as described by the next result.

RESULT 2 (Team Productivity). *An increase in incentive power that leaves team composition unchanged unambiguously increases productivity. An increase in incentive power that makes workers leave their friends to match by ability has the following effects: (a) average productivity increases if and only if $p_1 > p_0(1 + \pi)$; (b) productivity dispersion unambiguously increases; (c) if average productivity*

9. As shown in the proof, the threshold level $\hat{p}$ is increasing in π,s, and θ_L/θ_H, so workers are more likely to match by friendship rather than ability if friends internalize the within-team externality to a greater extent, if the socializing benefit of working with friends is higher, and if the difference in ability between the workers is less pronounced.

increases, the productivity of the most productive team increases and the productivity of the least productive team might increase or decrease; (d) if average productivity decreases, the productivity of the least productive team decreases and the productivity of the most productive team might increase or decrease.

The effect of incentives on productivity when team composition is unchanged follows directly from differentiating the first-order condition (2) with respect to p, holding all else equal. This is a standard effort effect. The intuition for part (a) is that when team members are friends, each of them places a positive weight π on the earnings of the other, hence effectively behaves as if the weight on earnings were $p(1+\pi)$. When team members are not friends, this effect disappears and the weight on earnings is p. Thus when p increases from $p_0 < \hat{p}$ to $p_1 > \hat{p}$ (so that team composition changes), the effort of each worker might increase or decrease, depending on whether p_1 is sufficiently large to compensate for the fact that workers now fail to internalize the effect of their effort on the earnings of team members. It is important to note that this is individually rational: when p increases from $p_0 < \hat{p}$ to $p_1 > \hat{p}$ the high-ability worker is better off leaving his friend and matching with an equally able colleague. This increases their earnings but at the expense of average productivity, which is of course detrimental to the firm. Hence the provision of more high-powered incentives can leave the firm worse off in terms of average productivity.

Part (b) is due to the fact that when matching by friendship, teams had equal productivity, whereas when matching by ability, the team composed of the two high-ability workers has higher productivity than the team made of the two low-ability workers. Importantly, the intuition for the result holds in a more general setting where all workers are of heterogeneous ability and the initial productivity dispersion is positive.

Parts (c) and (d) follow from the fact that, for a given level of effort, the productivity of the most productive team is higher and the productivity of the least productive team is lower when workers match by ability, as the most productive team will have two high-ability members and the least productive will have two low-ability members. It then follows that when the increase in incentive power is strong enough to increase individual effort ($p_1 > p_0(1+\pi)$), the productivity of the top team must increase as both effects have the same sign, whereas the productivity of the bottom team might decrease if the increase in effort is not strong enough to compensate for the fact that both members are now of low ability. Vice versa, when the increase in incentive power is not strong enough so that individual effort decreases ($p_1 < p_0(1+\pi)$), both effects go in the same direction for the bottom team and its productivity unambiguously decreases, whereas the productivity of the top team might increase if the fall in effort is not large enough to compensate for the fact that both members are now of high ability.

In summary, the model makes precise how changes in the strength of team incentives, as defined by an increased return to effort, affects productivity through the standard change in effort but also through changes in team composition. Importantly, the model highlights that the provision of incentives, as modeled though an increase in the returns to effort, can reduce average productivity in such team-based settings, and exploiting social connections among workers is beneficial to the firm because they reduce free-riding in teams. In the Online Appendix we provide an extension of the model where we allow for monetary transfers between friends. We show that if feasible transfers are low enough, we still obtain the finding that there exists a threshold of incentive power such that for all incentives above the threshold workers prefer to match by ability.

4. Team Composition

Guided by the theoretical framework, our empirical analysis is organized as follows. Motivated by Result 1, this section tests whether the introduction of rank incentives and prizes changes the way workers sort into teams. The next section then identifies the impact on average productivity and tests whether this is heterogeneous across the ability distribution of teams as illustrated by Result 2. Throughout, the composition of the overall workforce is constant because workers face a high cost of quitting the firm as their outside option is to return home or to move to another farm that their work permit allows. In addition, our time frame is too short for new workers to join the farm in response to the introduction of rank incentives or tournaments.[10]

4.1. Friendship and Ability

To test whether the introduction of rank incentives and monetary prize tournaments affect team composition, we first need to measure friendship ties and worker ability. To measure social ties we use a survey we administered to workers to collect information on each workers' social network of friends on the farm. We asked workers to name up to seven friends in the workplace, and for each friendship, whether it formed in the workplace or pre-existed in their home country. We then define worker i to be socially tied to worker j, if i reports j to be his friend. We find that 85% of surveyed workers report having at least one friend in the workplace, the median worker reports four co-workers as friends and the majority of friendships are newly formed in the workplace.[11]

10. The histogram of arrival and departure times in Figure 1(a) shows that the majority of workers arrive before the provision of rank incentives and leave at the end of the season, coinciding with the end of our study, in the first week of October. Only 10% of workers leave before the end of our sample.

11. To provide evidence that workers credibly report the identity of their friends, we collected information along four dimensions of social interaction for each reported friendship—going to the supermarket together, eating together, lending/borrowing money, and talking about problems. Although workers were not asked to rank their friends, we find that, as in previous survey years, workers report first the friend with whom they interact most frequently, followed by the second reported friend, and so on. Moreover, although workers may have more than seven friends in the firm, the strength of the social ties between workers—measured either by forms of social interaction or the probability the relationship is reciprocal—is highest for the friends who are mentioned first. This implies that we capture the strongest friendship bonds in the workplace.

To measure individual ability, we exploit the fact that all workers in the sample are observed picking with several teams over time. We then estimate the following panel data specification for worker w in team i on field f and day t:

$$y_{ift} = \beta I_t + \gamma P_t + \delta X_{wft} + \eta Z_{ft} + \theta t + \lambda_f + \sum_{w \in W_{ft}} \sigma_w S_{wift} + u_{ift}, \tag{3}$$

where y_{ift} is the log productivity of team i on field f and day t, and I_t and P_t are dummies for when the rank incentive and tournament regimes are in place respectively. To isolate the effects of interest from natural trends in productivity we control for the following time varying determinants of productivity: (i) the workers picking experience X_{wft}, defined as the cumulative number of field-days the individual has been picking fruit, as there are likely to be positive returns to picking experience; (ii) the field life cycle Z_{ft}, defined as the nth day the field is picked divided by the total number of days the field is picked over the season, to capture any within-field time trend in productivity; and, (iii) an aggregate linear time trend t, to capture learning by management. Field fixed effects λ_f account for unobserved and permanent differences in productivity across fields. W_{ft} is the set of workers on field-day ft, and S_{wift} is a dummy variable equal to one if worker w is part of team i on field-day ft. The disturbance term u_{ift} is clustered at the field-day level because of common productivity shocks that all teams face as field conditions change.

We therefore measure a worker's ability as her conditional productivity, namely the $\widehat{\sigma}_w$ coefficient on the worker dummy, S_{wift}. The only restriction we place to estimate $\widehat{\sigma}_w$ is that worker w must have picked for at least six field-days through the season. Four points are of note. First, there is considerable heterogeneity in worker ability: the worker at the 75th percentile of the ability distribution is 46% more productive than the worker at the 25th percentile. Second, this measure of ability is based on the productivity of teams that a worker has been part of. If there is heterogeneity in ability within a team, the reversion to the mean that $\widehat{\sigma}_w$ is subject to will imply the distribution of $\widehat{\sigma}_w$ is compressed relative to the true distribution of worker ability.[12]

Third, to check whether our measure of ability is informative, we defined another ability measure based on information on workers' pay preferences from the survey. In particular, workers were asked to report whether they would prefer to be paid fixed time wages, individual piece rates, or team piece rates. A workers' pay preference is a function of the workers' own perception of their ability, as higher-ability workers are more likely to benefit from individual piece rates, all else equal. Other things equal, two workers who have similar pay preferences should therefore be of similar ability if they are similarly risk averse. In line with this, we find that the absolute difference in ability in any given worker pair $|\widehat{\sigma}_w - \widehat{\sigma}_{w'}|$ averaged over all feasible pairs of workers

12. The measures of ability are therefore estimated for all the workers used in our main analysis as all these workers switch teams at least once. It is because of this compression of the estimated worker ability distribution that we do not estimate equation (3) using only productivity data from the control regime. Doing so would mechanically lead to teams appearing to be more homogeneous in terms of ability in the control regime.

is significantly smaller, at the 1% significance level, when the pair report having the same pay preferences.

Finally, we find that in this setting, workers' ability is not correlated with friendship ties so that workers face a real trade-off between forming teams with their friends or colleagues of similar ability. For example, the coefficient of variation of $\widehat{\sigma}_w$ among friends averaged over all friendship networks is 0.20. This is not significantly different to the coefficient of variation of $\widehat{\sigma}_w$ among all workers, 0.16, so that friendship ties and ability are not much correlated. This result is also in line with our earlier findings on ability in this workplace being uncorrelated to the formation of friendship ties among co-workers both unconditionally, and conditional on other similarities in worker characteristics (Bandiera, Barankay, and Rasul, 2009).

4.2. Descriptive Evidence

Panel A of Table 1 reports the average number of friendship links in teams that form under each incentive regime. The mean share of friendship ties 0.21, 0.13, and 0.12 in teams formed during the piece rate, rank incentive, and tournament regimes, respectively. These values imply that the average team of five people formed during the control regime had two pairs of workers linked by friendship ties, whereas the average team of five people formed during the rank incentive or tournament regime only had one pair. The difference between the means between control and either of the two treatment regimes is precisely estimated, and the Kolmogorov–Smirnov test also rejects the null of equality of the distribution functions shown in Figure 1(a). In contrast, neither the means nor the distributions differ between the rank incentive and tournament regimes.

Figure 1(b) plots the kernel density of the mean ability of team members. As the pool of workers available to pick in the three regimes is unchanged, mean ability does not differ across regimes. The figure however illustrates that the introduction of rank incentives and prizes is associated with an increase in the dispersion of ability between teams, which is consistent with an increase in positive assortative matching, as very low and very high ability teams are more likely to form during the rank incentive and prize treatments, compared to the control regime. As Panel A of Table 1 shows, the average coefficient of variation of ability of team members is 0.14 for teams formed during the piece rate regime, and 0.11 for teams formed during the rank incentive and tournament regimes. The p-value of the null hypothesis of equality between control and rank incentives is 0.02, and between rank incentives and prizes is 0.87.[13]

Figure 2(a) plots the average friendship share by week of team formation. Figure 2(b) reports the average coefficient of variation of ability of team members

13. Results are qualitatively similar if we use pay preferences as a measure of ability. The share of teams whose members have the same pay preference (wage or piece rate) is 0.60 in the control period and increases to 0.64 and 0.68 in the rank and tournament periods, respectively. As pay preferences exhibit much less variation than estimated ability (68% of sample workers prefer fixed wages), the differences are less precisely estimated. The p-values of the test of equality of means are 0.33, 0.28, and 0.07 between control versus rank, rank versus tournament, and control versus tournament, respectively.

TABLE 1. Time series descriptives on composition and productivity by regime.

	Control Regime	Rank Incentives Regime	Tournament Regime	H0: Control = Rank Incentives	H0: Rank Incentives = Tournament	H0: Control = Tournament
Panel A: Team composition by regime						
Share of Friendship Links	.215	.137	.123	[.000]	[.381]	[.000]
	(.159)	(.144)	(.009)			
Team Members' Ability: Coefficient of Variation	.136	.109	.108	[.017]	[.874]	[.001]
	(.102)	(.070)	(.079)			
Panel B: Team productivity by regime						
Average productivity (kg/hr)	9.13	6.31	8.37	[.000]	[.000]	[.091]
	(2.05)	(1.58)	(1.78)			
Productivity dispersion	.318	.479	.529	[.004]	[.497]	[.000]
	(.206)	(.258)	(.281)			

Notes: The share of friendship links is computed as the number of worker pairs linked by a friendship tie over the total number of worker pairs that could be linked by a friendship tie. Team members ‘ ability equals the coefficient on the individual team member dummy in a regression of log team productivity on log worker's picking experience, the log of the field life cycle plus one, a linear time trend, and field fixed effects. This is done for all workers that are observed picking on at least six field days in each of the regimes. The sample is restricted to the teams for which we can compute the ability measure for at least 80% of the members. This restriction holds for 80% of the sample teams. The daily average productivity is computed as the weighted average of field-day worker productivity. The dispersion is computed as the weighted average of the field-day interquartile range (the difference between the productivity of the team at the 75th percentile and the productivity of the team at the 25th percentile) divided by field-day productivity. In both cases weights are defined as the number of field man-hours worked on the field-day as a share of the total number of man-hours worked on the farm that day. The sample covers 109 days from June 1st to October 6th. Of these, 54 are in the control regime, 24 in the feedback regime and 30 in the monetary prize regime. The table reports the means and standard deviations of the series in the three regimes, together with the p-values of the test of equality of the means.

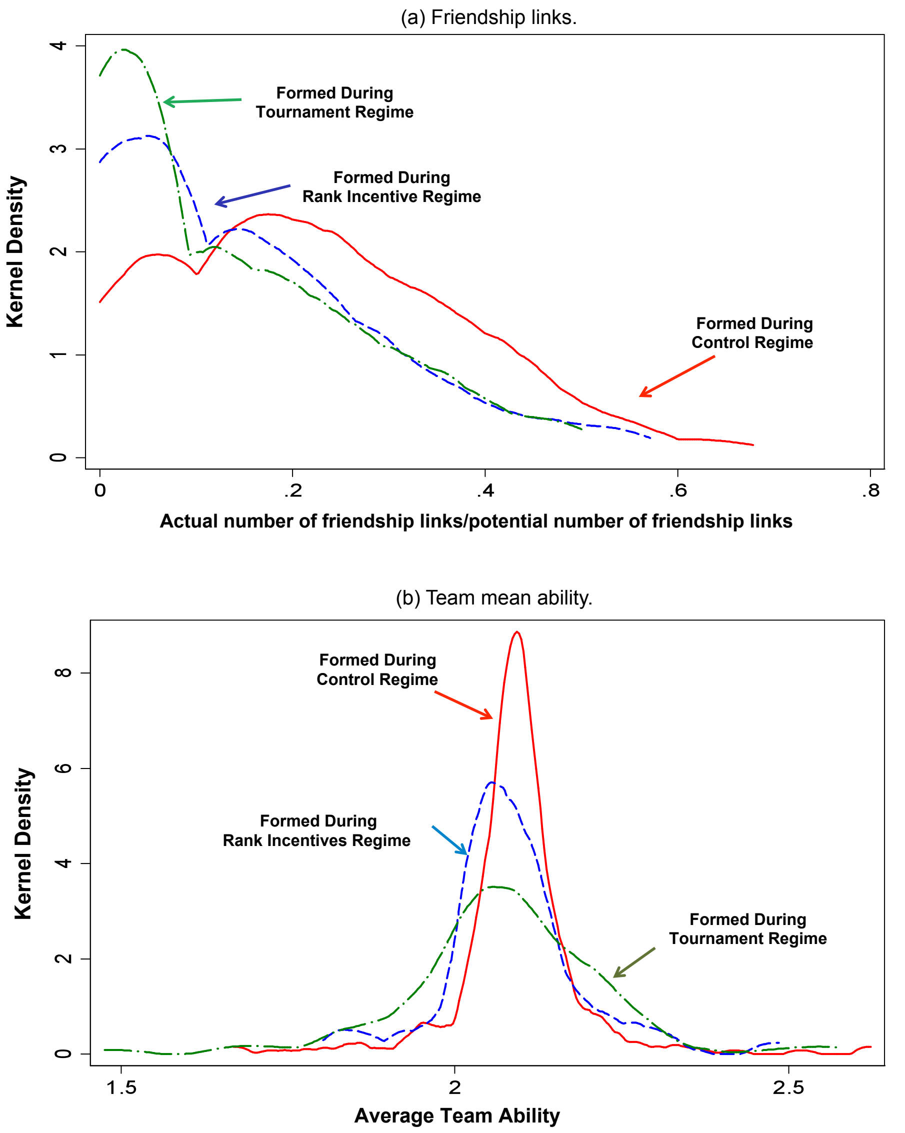

FIGURE 1. Team composition by incentive regime. Figure 1(a) shows kernel density estimates of the share of friendship links in team that first formed during the control regime, first formed during the rank incentive regime, and first formed during the tournament regime. There are 351, 126, and 211 such teams, respectively. The share of friendship links is computed as the number of worker pairs linked by a friendship tie over the total number of worker pairs that could be linked by a friendship tie. Figure 1(b) shows kernel density estimates of the average ability of teams that first formed during the control regime, first formed during the rank incentive regime, and first formed during the tournament regime. Team average ability is computed as the mean of the ability of individual team members. This is computed as the coefficient on the individual team member dummy in a regression of log team productivity on log worker's picking experience, the log of the field life cycle plus one, a linear time trend, and field fixed effects. This is done for all workers that are observed picking on at least six field days in each of the regimes. The sample in both panels is restricted to the teams for which we can compute the ability measure for at least 80% of the members. This restriction holds for 80% of the sample teams.

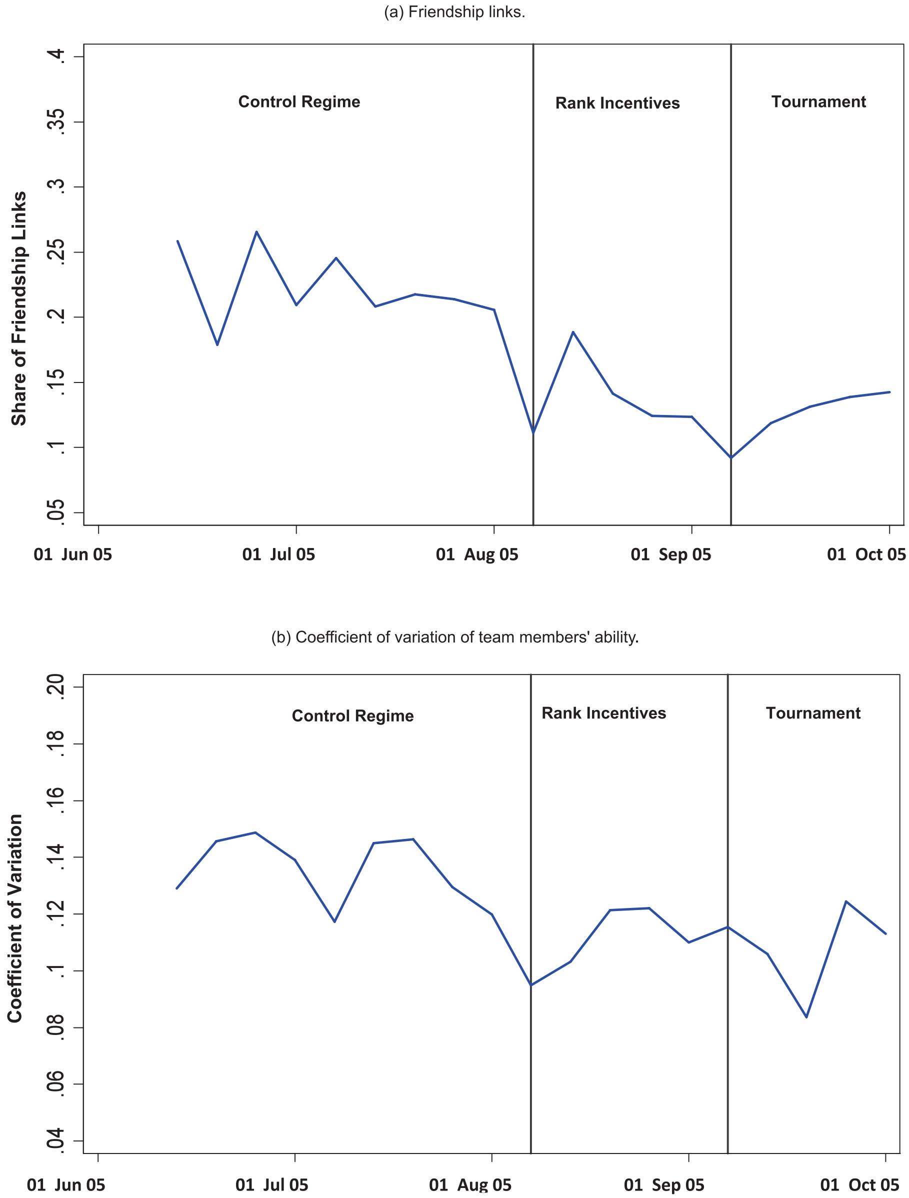

FIGURE 2. Team composition by week. Figure 2(a) shows the average share of friendship links in team that first formed in each of week at the team exchange. The share of friendship links is computed as the number of worker pairs linked by a friendship tie over the total number of worker pairs that could be linked by a friendship tie. Figure 2(b) shows the average coefficient of variation of team members' ability in team that first formed in each week. Individual ability is computed as the coefficient on the individual team member dummy in a regression of log team productivity on log worker's picking experience, the log of the field life cycle plus one, a linear time trend, and field fixed effects. This is done for all workers that are observed picking on at least six field-days in each of the regimes. The sample in both panels is restricted to the teams for which we can compute the ability measure for at least 80% of the members. This restriction holds for 80% of the sample teams.

by week of team formation. These time series replicate the patterns presented in Figure 1 and Table 1.

Mapping these results back to the theoretical framework, the data suggest that the provision of rank incentives and monetary prizes both increase the strength of incentives, as measured by increasing the returns to effort, p. In line with Result 1, this increase is sufficiently large to cause workers to sort *less* by friendship ties, and to match assortatively by ability. Denoting the strength of incentives under the piece rate, rank incentive, and tournament regimes as p_0, p_Z, and p_T respectively, these documented changes are therefore consistent with p_T and p_Z both being greater than the threshold value $\hat{p}$, which determines whether workers assortatively match by ability or by friendship, and in turn, $\hat{p}$ being greater than p_0. The fact that p_T and p_Z are both greater than the threshold $\hat{p}$ is consistent with there being no additional changes in worker sorting when moving from the rank incentive regime to the tournament regime.

4.3. Team Regressions

To present formal evidence on the effect of the introduction of rank incentives and monetary prizes on team composition, we estimate the following specification:

$$c_i = \alpha T1_i + \beta T2_i + \kappa_i, \tag{4}$$

where c_i is a measure of composition of team i—either the share of friendship ties or the coefficient of variation of ability of the individual team members. $T1_i = 1$ if team i was formed during the rank incentive regime and 0 otherwise. $T2_i = 1$ if team i was formed during the tournament regime, namely when both rank incentives and prizes were offered, and 0 otherwise. The coefficients α and β thus measure the difference in team composition between the piece rate regime, and the rank incentive and tournament regimes, respectively. As the pool of available workers is fixed over time, and teams can form at every weekly team exchange, we cluster κ_i by the week of formation, to account for the fact that our measures of composition are not independent across teams formed during the same team exchange.

Column (1) of Table 2 shows that compared to teams formed during the piece rate regime, the share of friendship ties in teams formed during the rank incentive regime is 7% lower, and in teams formed during the tournament regime is 8% lower. These are statistically significant changes and correspond to 36% and 42% of the mean level of the dependent variable during the piece rate regime. Column (4) shows that compared to teams formed during the piece rate regime, the coefficient of variation of ability of the individual team members is 2% lower, which corresponds to 16% of the mean level of the dependent variable during the piece rate regime.

In Columns (1) and (4), while both coefficients are statistically different from zero, they are not significantly different from each other, as shown by the p-values at the foot of Table 2.

TABLE 2. Team composition–team level regressions.

Robust standard errors in parentheses clustered by week

	Share of Friendship Links			Team Members' Ability: Coefficient of Variation		
Dependent Variable:	(1)	(2)	(3)	(4)	(5)	(6)
Team formed under rank incentives regime	–.066***	–.074***		–.022***	–.018**	
	(.010)	(.013)		(.006)	(.008)	
Team formed under tournament regime	–.078***	–.086***		–.023***	–.020**	
	(.012)	(.015)		(.007)	(.008)	
Team formed under second half of control regime		–.017	–.017		.007	.007
		(.016)	(.016)		(.007)	(.007)
Team formed under first half of rank incentives regime			–.064**			–.013
			(.024)			(.013)
Team formed under second half of rank incentives regime			–.082***			–.023***
			(.012)			(.007)
Team formed under first half of tournament regime			–.101***			–.020***
			(.015)			(.005)
Team formed under second half of tournament regime			–.072***			–.019
			(.011)			(.014)
P-value Test 1: Rank incentives = Tournament	[.424]	[.424]		[.840]	[.840]	
P-value Test 2: Second half control = rank incentives		[.000]	[.043]		[.001]	[.086]
P-value Test 3: First half = Second half-rank incentives			[.481]			[.506]
P-value Test 4: First half = Second half-tournament			[.018]			[.961]
Adjusted R-squared	.080	.081	.083	.019	.019	.016
Observations	656	656	656	594	594	594

Notes: *** denotes significance at 1%, ** at 5%, and * at 10%. The unit of observation is team i. The sample includes all teams that form from June 1st until October 1st for whom friendship links and ability measures can be constructed for. The dependent variable in Columns 1 to 3 is the share of friendship links in the team. This is computed as the number of worker pairs linked by a friendship tie over the total number of worker pairs that could be linked by a friendship tie. Individual ability is computed as the coefficient on the individual team member dummy in a regression of log team productivity on log worker's picking experience, the log of the field life cycle plus one, a linear time trend, and field fixed effects. This is done for all workers that are observed picking on at least six field days in each of the regimes. The coefficient of variation in worker ability on any given team can then be constructed, and this is the dependent variable in Columns 4 to 6. We limit the sample to teams for who 80% of their members have either of these measures defined.

While both the introduction of rank incentives and prize is exogenous to other firm practices, the different regimes are in place at different points in time; thus α and β might be biased by the fact that team composition naturally changes with time. For instance, friendship links might break as time passes, so that it might look as if the share of friends in a team has decreased, whereas in effect old links have been replaced by new links that we do not measure. The remaining columns in Table 2 augment (4) to provide evidence to address this class of concerns. To begin with we test whether the changes in team composition pre-date the introduction of rank incentives. To do so, we divide the piece rate period into two four-week periods and test whether teams formed during the first and second half differ. Columns (2) and (5) show the results for friendship and ability, respectively. In both cases the coefficient on the dummy variable that indicates whether a team is formed during the second half of the control period is close to zero and precisely estimated. In both cases we can reject the null hypothesis that teams formed during the second half of the piece rate regime and during the rank incentive regime are of similar composition with p-values well below 1%. This casts doubts on the relevance of time-varying unobservables that are correlated with team composition. For instance, if the decline in the share of friends were due to the fact that our measure of friendship worsens with time, we would expect a smooth decline, rather than a sudden drop after the introduction of rank incentives.

Next, we show that team composition changes discontinuously after the introduction of rank incentives and stays constant thereafter. To do so, columns (3) and (6) divide the rank incentive and tournament regimes in two periods of equal length. Comparison of the coefficients for teams formed in the two subperiods within each regime shows that in most cases teams formed during the two subperiods have similar composition. These findings are in line with rank incentives not revealing additional information on individual worker abilities. Indeed, if that were the case, we could expect the effect of rank incentives to increase over time, as workers have more observations to infer individual ability from the reported team productivity data. The fact that team composition changes discontinuously after the introduction of rank incentives and stays constant thereafter suggests instead that the results are driven by factors that change discontinuously with the introduction of rank incentives, such as status concerns.[14] Overall, the evidence indicates that relative to when teams are paid piece rates, additionally introducing rank incentives and prizes affects team composition. Both changes are in line with the assumption that the introduction of rank incentives and prizes both strengthen incentives and increase the returns for high-ability workers to match with one another, as made precise in Result 1 of the model.

14. A related concern is that team composition might be a function of how long an individual has spent on the farm, rather than calendar time per se. This would again be the case if workers gradually learn co-workers' ability, so that workers are better able to match by ability the longer they have been on the farm, even in the absence of rank incentives or monetary prizes. To assess the relevance of this concern, we augment (4) by controlling for the team members average number of days at the farm when the team was first formed. We find that the coefficients of interest remain negative, of similar magnitude, and precisely estimated when we control for the team members' average time in the workplace.

5. Team Productivity

5.1. Descriptive Evidence

The firm's personnel records contain information on each team's productivity on every field-day they pick fruit. Productivity is defined as the kilograms of fruit picked per hour and is recorded electronically with little measurement error. Productivity is therefore comparable across teams at any given moment in time, and comparable within the same team over time. We focus on fruit picking operations for the main type of fruit during the 2005 peak picking season from 1 June until 6 October. To eliminate variation due to differences in the composition of fields between the control and treatment periods, we restrict the sample to fields that were in operation for at least one week under each of the control, rank incentive, and tournament regimes. The final sample contains 2,914 observations at the team-field-day level, covering 407 teams, 15 fields, and 109 days. The piece rate regime is in place for 40% of the field-days, the rank incentive regime for 24%, and the tournament regime for the remaining 36%.[15]

Figure 3(a) shows the time series for productivity, calculated as the weighted average of productivity on all fields picked on a given day, where the weights are the share of man-hours employed in each. This shows that average productivity drops with the provision of rank incentives on team performances, and rises with the introduction of the monetary prize tournaments. The average productivity levels during each regime and a test of the null hypothesis of equality are reported in Panel B of Table 1. This shows that, unconditionally, the provision of rank incentives reduces productivity by 31%, and the introduction of a monetary prize for the best team increases the productivity of the average team by 36%. In both cases the null hypothesis of equal means can be rejected at conventional levels. Although productivity rises moving from the rank incentive treatment to the tournament treatment, compared to the control regime, productivity in the tournament regime remains 8% lower, a significant difference at the 10% level.

The theoretical framework makes clear that team incentives affect the *dispersion* of productivity, as well as its mean value. Figure 3(b) plots the time series of the productivity dispersion between teams in the same field-day. The measure is the weighted mean of the field-day interquartile range normalized by average field-day productivity, for all fields picked on a given day. As before, we weight each field-day observation by its share of man-hours. Figure 3(b) shows that both the introduction of rank incentives and the introduction of prizes increase the dispersion in productivity relative to the control regime. Panel B of Table 1 reports the average dispersion levels during each regime. This indicates that the provision of rank incentives significantly increases dispersion by 50% relative to its value during the control regime when only team piece rates are in place. The dispersion in productivity increases by a further 10% in the tournament regime but this difference is not significant.

15. Recall that a team can be temporarily reduced from size five to four either because a worker is sick, or is assigned to some other task that needs completing urgently. This scenario represents two teams in our data. The average five-member team works together for 26 field-days.

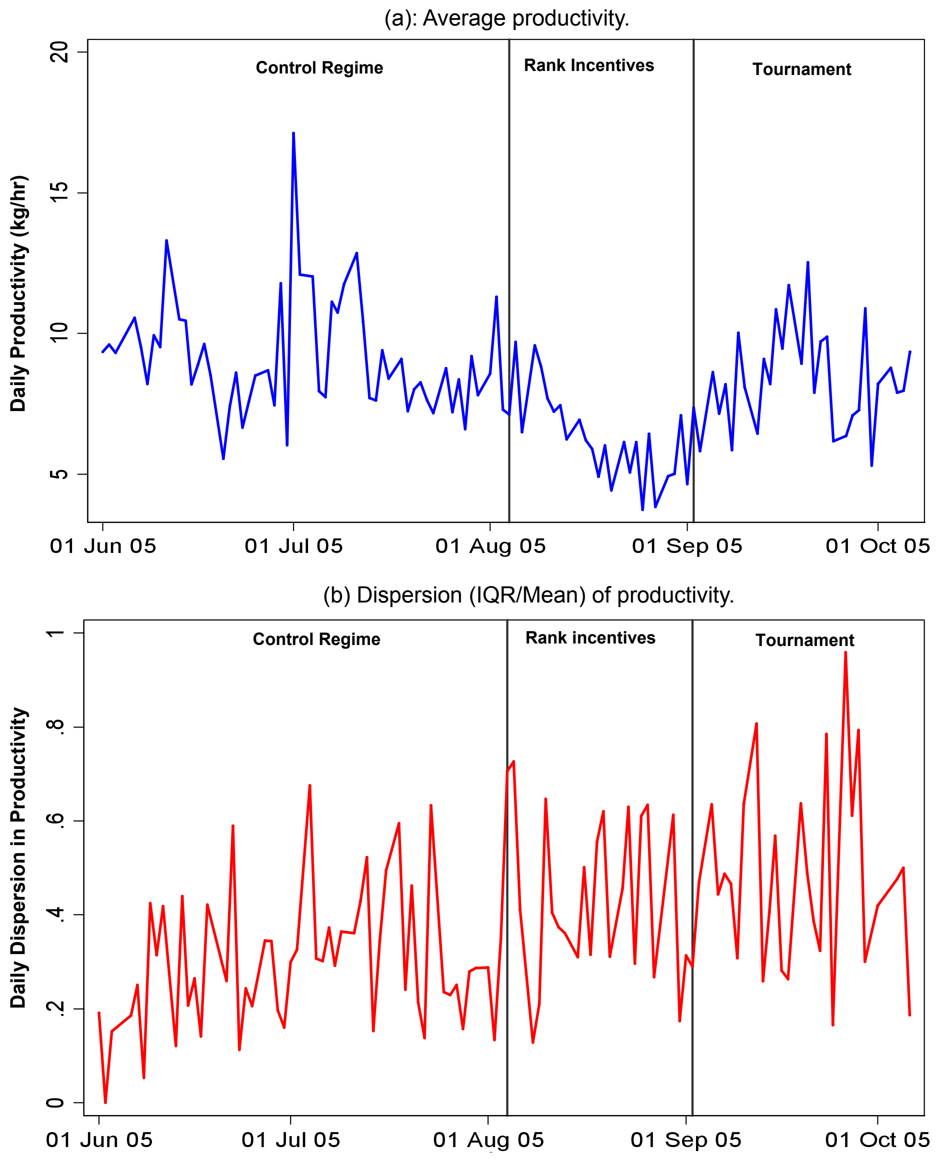

FIGURE 3. Productivity. The panels show the time series for the average and dispersion of worker productivity on each day. The daily average productivity is computed as the weighted average of field-day worker productivity. The dispersion is computed as the weighted average of the field-day interquartile range (the difference between the productivity of the team at the 75th percentile and the productivity of the team at the 25th percentile) divided by average field-day productivity. In both cases weights are defined as the number of field man-hours worked on the field-day as a share of the total number of man-hours worked on the farm that day. The sample covers 109 days from 1 June to 6 October. Of these, 54 days are in the control regime, 24 in the rank incentive regime, and 30 in the tournament regime.

While the introduction of rank incentives and tournaments is timed to be exogenous to other changes in firm behavior, the three regimes are in place at different points of the season and so productivity within each regime will be correlated with other time-varying determinants of productivity. Hence any natural downward trend in productivity in the fields we focus on might lead us to overestimate any negative effect of rank incentives, and underestimate any positive effect of tournaments relative to the control regime of piece rates alone. Figures 4(a) and (b) show the time series of average productivity and dispersion in the same farm, one year earlier, when no change in incentives was introduced. The 2004 season can be therefore used as a counterfactual for what would have happened in 2005, but for two caveats. First, in 2004 the workforce was not organized in teams, so the data in Figure 4 refer to individual productivity. Second, the 2004 season started and ended earlier, so the two time series are only both available until mid-September. Figure 4(a) shows that in the previous 2004 season there was no natural trend in productivity and that, most importantly, productivity does not appear to change at the same time as rank incentives and tournaments were introduced in 2005. Figure 4(b) shows that, instead, dispersion naturally *decreases* over the course of the 2004 season. Hence the observed *increase* in 2005 under the rank incentive and tournament regimes occurs despite the natural downward trend suggested by the data from the previous season.

5.2. Average Productivity

To shed light on the mechanisms behind the aggregate time series patterns described in Figure 3, we estimate the effect of rank incentives and tournaments on productivity at the team-field-day level using the following panel data model, controlling for time varying determinants of productivity:

$$y_{ift} = \beta R_t + \gamma T_t + \lambda_f + \delta X_{ift} + \eta Z_{ft} + \theta t + u_{ift}, \tag{5}$$

where y_{ift} is the log productivity of team i on field f and day t, R_t is an indicator variable that is equal to one after the introduction of rank incentives, and T_t is an indicator variable that is equal to one after the introduction of the tournament regime. The coefficients of interest are β, which measures the impact of rank incentives on productivity relative to the control period, and γ, which measures the effect of the tournament regime relative to the provision of rank incentives. Relative to the control period, introducing the tournament, that is rankings plus prizes, the percentage change in productivity is $[(1+\beta)(1+\gamma)-1]$.[16]

To isolate the effects of interest from natural trends in productivity we control for the following time-varying determinants of productivity: team members' average picking experience X_{ift}, the field life cycle Z_{ft}, and an aggregate linear time trend

16. Denoting productivity in the control period by y_c, productivity in the rank incentive regime is equal to $(1+\beta)y_c$ and in the prize regime $(1+\gamma)(1+\beta)y_c$. The percentage change is thus equal to $(1+\gamma)(1+\beta)-1$.

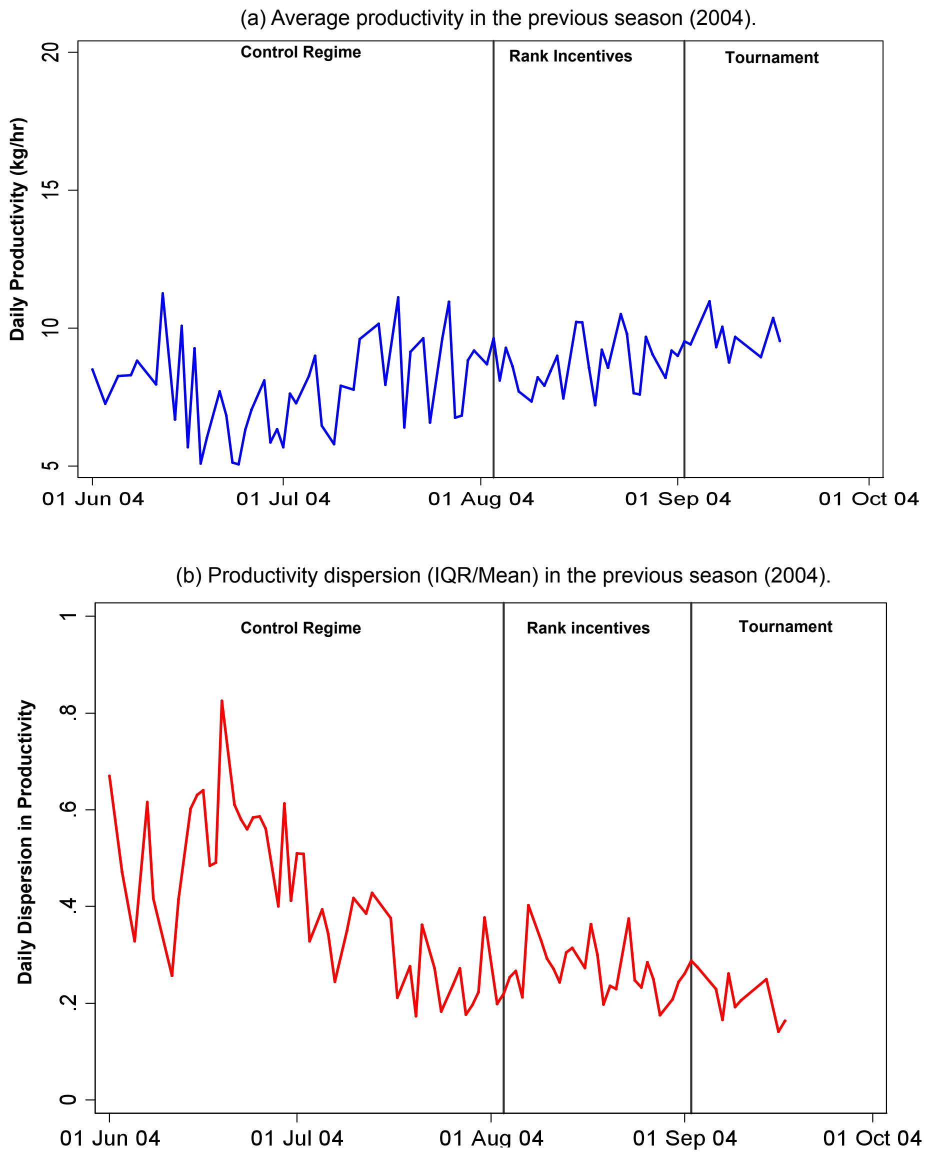

FIGURE 4. Productivity in the previous season (2004). The figures show the time series for the average and dispersion of worker productivity on each day in 2004. The daily average productivity is computed as the weighted average of field-day worker productivity. The dispersion is computed as the weighted average of the field-day interquartile range (the difference between the productivity of the team at the 75th percentile and the productivity of the team at the 25th percentile) divided by average field-day productivity. In both cases weights are defined as the number of field man-hours worked on the field-day as a share of the total number of man-hours worked on the farm that day. The sample covers 82 days from 1 June to 17 September 2004. Of these, 47 days are in the control regime, 25 in the rank incentive regime, and 10 in the tournament regime.

t, to capture learning by management. Field fixed effects λ_f account for unobserved and permanent differences in productivity across fields. Finally, the disturbance term u_{ift} is clustered by week level because team composition cannot be changed during the week, hence all productivity observations belonging to the same team during the same week are likely to be correlated.[17]

Table 3 reports the results. Column 1 shows that the introduction of rank incentives and tournaments have an effect on productivity over and above natural changes due to the time-varying factors controlled for in equation (5). Relative to the piece rate regime, average team productivity is 15% lower under the rank incentive regime. Relative to the rank incentive regime, average productivity is 24% higher during the tournament regime. The fact that β and γ have opposite signs, so that productivity declines and then increases over time, helps rule out that the results are due to unobservables that cause productivity to monotonically increase or decrease throughout the season. Table A.2 in the Online Appendix presents a series of more flexible time specifications to address further concerns related to time trends in productivity.

Column 2 tests for anticipation effects by additionally controlling for two indicator variables set to one during the week preceding the introduction of rank incentives and prizes respectively in equation (5). The result shows that neither effect is present before the introduction of the treatments—rather, both coefficients have the opposite signs, suggesting that neither treatment is capturing a naturally occurring trend.

The overall effect of tournament relative to piece rates in column 1 is 0.061 with a standard error of 0.127 while in column 2 it is 0.038 with a standard error of 0.146. Thus, adding a tournament to team piece rates in this setting has *no* effect on average productivity, as the positive effect of prizes is offset by the negative effect of rank incentives. This implies that of the three team incentive schemes considered, piece rates yield the highest average productivity for the firm.[18]

Mapping these results back to the model, we denote the strength of incentives under the control, rank incentive, and tournament regimes as p_0, p_Z, and p_T respectively. The documented average effects in Table 3 are therefore consistent with $p_T > p_0(1+\pi) > p_Z$. Following on from Result 2, the data suggest that while the tournament unambiguously increases the returns to effort, the incentive power of

17. Clustering by field-day to take into account field-day conditions that affect all teams on that field-day yields similar standard errors. Clustering at the team-week level and AR(1) models yield smaller standard errors.

18. We can benchmark the magnitude of the estimated productivity effects against other studies and compared to other determinants of productivity in this setting. While, to the best of our knowledge, no field study compares tournaments to other incentive schemes, Nalbantian and Schotter (1997) find that in the laboratory average effort increases by 66% when moving from team piece rates to a tournament between two teams—of fixed composition—with one prize. Freeman and Gelber (2010) find that average effort increases by 50% when moving from team piece rates to a tournament between six teams with five prizes and by 26% when there is only one prize, again with fixed team compositions. The latter is in line with our estimated prize effect but much larger than our estimated tournament effect. Our findings can be reconciled with these by noting that in the field the positive effect of prizes is cancelled by the negative effect of rank incentives through changes team composition, whereas in the laboratory team composition is fixed. As composition does not change going from the rank incentive treatment to the prize treatment, the prize effect is comparable to the tournament effect estimated in the laboratory.

TABLE 3. The effect on rank incentives and monetary prizes on team productivity, team-field-day level.

Dependent Variable = Log of team's productivity on the field-day (kilograms/hour)
Standard errors in parentheses, clustered by week

	Panel Estimates: All Teams		Quantile Estimates: All Teams					Fixed Effect Estimates: Unchanged Teams	
	(1) Baseline	(2) Pre-trend	(3a) 10th	(3b) 25th	(3c) 50th	(3d) 75th	(3e) 90th	(4) Teams Together for 3 Regimes	(5) Teams Together for 2 Regimes
Rank Incentives Regime	–.147	–.218***	–.340***	–.135**	–.012	–.052	–.029	.048	–.092
	(.101)	(.057)	(.125)	(.064)	(.035)	(.035)	(.045)	(.125)	(.068)
Tournament Regime	.244***	.328***	.021	.025	.312***	.388***	.461***	.250**	.212**
	(.071)	(.078)	(.110)	(.077)	(.041)	(.033)	(.051)	(.097)	(.082)
Week preceding rank incentives		.154**							
		(.042)							
Week preceding tournament		–.075							
		(.058)							
Rank Incentives effects equal: 10th and 25th quantiles			[.066]						
Prize effects equal: 10th and 25th quantiles			[.971]						
Rank Incentives effects equal: 25th and 50th quantiles				[.031]					
Prize effects equal: 25th and 50th quantiles				[.000]					
Rank Incentives effects equal: 50th and 75th quantiles					[.251]				
Prize effects equal: 50th and 75th quantiles					[.040]				
Rank Incentives effects equal: 75th and 90th quantiles						[.533]			
Prize effects equal: 75th and 90th quantiles						[.090]			
Field fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Additional controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Team fixed effects	No	No	No	No	No	No	No	Yes	Yes
Adjusted R-squared	.313	.312	–					.461	.408
Number of team-field-day observations	2914	2914	2914	2914	2914	2914	2914	349	893

Notes: *** denotes significance at 1%, ** at 5%, and * at 10%. All continuous variables are in logarithms. The additional controls are the log of average team picking experience, the log of the field life cycle plus one, a linear time trend, and field fixed effects. The field life cycle is defined as the nth day the field is picked divided by the total number of days the field is picked over the season. In Column 2, the week preceding rank incentives variable is a dummy equal to one in the week prior to the introduction of rank incentives, and zero otherwise. The week preceding tournament variable is analogously defined. Simultaneous quantile regression estimates are reported in Columns 3a to 3e, with bootstrapped standard errors based on 500 replications. Standard errors are clustered at the week level in Columns 1, 2, 4 and 5. The sample in Column 4 is restricted to teams that are observed in all three regimes. The sample in Column 5 is restricted to teams that are observed in at least two of the three regimes.

rank incentives is sufficiently strong to induce teams to be less likely to form along friendship lines, so $p_Z > \widehat{p}$, but is not sufficiently strong to offset the increase in free-riding within new teams made up of members with weaker social ties among themselves. The theoretical framework makes precise the effects on the dispersion of productivity and heterogeneous effects by team productivity that are consistent with the case $p_T > p_0(1+\pi) > p_Z$. We now turn to testing these predictions.

5.3. Dispersion of Productivity

The evidence so far indicates that the introduction of rank incentives reduces productivity while adding prizes increases it. The model developed makes precise that in this case the effect of rank incentives and tournaments are heterogeneous across the productivity distribution and that, to be consistent with the average productivity results, rank incentives must decrease the productivity of the bottom teams, whereas tournaments must increase the productivity of the top teams. To check for this, we use quantile regression methods to estimate the conditional distribution of log productivity at different quantiles θ:

$$Quant_\theta(y_{ift}|.) = \beta_\theta R_t + \gamma_\theta T_t + \varphi_{\theta f}\lambda_f + \delta_\theta X_{ift} + \lambda_\theta Z_{ft} + \tau_\theta t, \tag{6}$$

where all variables are as defined previously. Columns (3a)–(3e) in Table 3 report the simultaneous estimates of equation (6) at various quantiles θ. The results illustrate that the previously documented average effects of rank incentives and tournaments mask substantially different changes throughout the conditional distribution of log productivity that are consistent with the theoretical predictions. More precisely, the effect of rank incentives is negative and precisely estimated up to the 25th quantile. Rank incentives reduce the productivity of the team at the 10th quantile by 34%, and that of the team at the 25th quantile by 13%. There is a significant difference between these two effects as reported at the foot of Table 3. The provision of rank incentives has no effect on teams whose conditional productivity is above the median.

In contrast, the effects of tournaments are positive and precisely estimated only on the three highest quantiles—at the 50th, 75th, and 90th quantiles—and the effect is monotonically increasing moving to higher quantiles. At the median, team productivity increases by 31%, by 39% at the 75th quantile, and by 46% at the 90th quantile. These differences between quantile effects are significantly different from zero as reported at the foot of Table 3.

Figure 5 provides a graphical representation of the results by plotting the estimates of β_θ and γ_θ at every $\theta \in (0, 1)$, and the associated bootstrapped 90% confidence interval. This emphasizes that the pattern described previously holds throughout the distribution of conditional productivity. In particular, the figure shows that (i) $\beta_\theta \leq 0$ and $\gamma_\theta \geq 0$ at all θ, (ii) β_θ and γ_θ are increasing in θ, and (iii) we can reject $\beta_\theta = 0$ for all $\theta < 0.4$ and can reject $\gamma_\theta = 0$ for all $\theta > 0.3$.

The estimates from Table 3 also imply that, compared to piece rates, the overall tournament effect $((1+\beta_\theta)(1+\gamma_\theta)-1)$ is negative and significant only for $\theta = 0.10$ (-0.326 with p-value .048) while it is positive and significant for $\theta = 0.50$, $\theta = 0.75$, and $\theta = 0.90$ (0.296, 0.315, 0.419, respectively, all with p-values of .000), implying that strengthening incentives by adding a tournament *does* lead

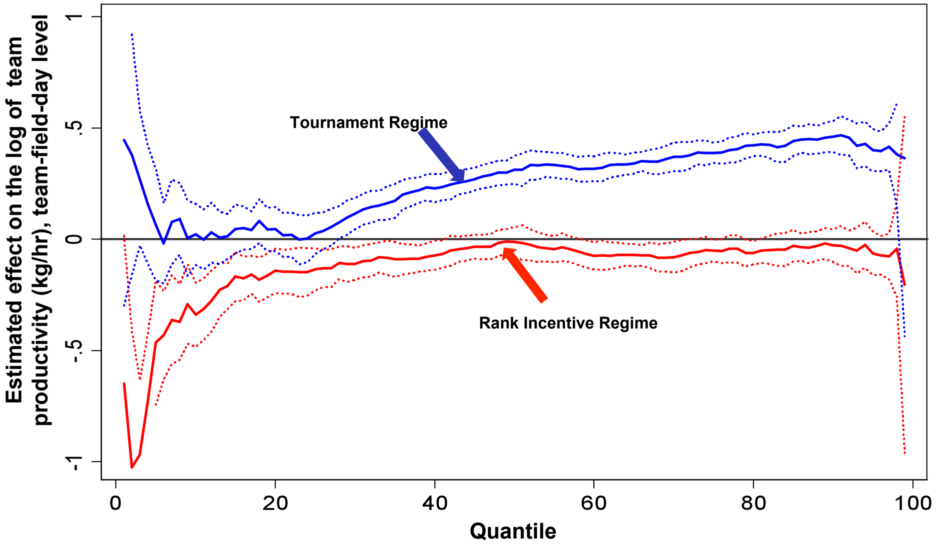

FIGURE 5. Quantile regression estimates. The figure graphs the estimated effect of the rank incentive regime and of the tournament regime on the log of team productivity at each quantile of the conditional distribution of the log of team productivity, and the associated 90% confidence interval, with bootstrapped standard errors based on 500 replications. The controls are the log of average team picking experience, the log of the field life cycle plus one, a linear time trend, and field fixed effects. The field life cycle is defined as the nth day the field is picked divided by the total number of days the field is picked over the season.

to higher productivity for teams on the right tail of the conditional productivity distribution.

The increased dispersion and the differential impacts on the productivity of the best and worst teams under each incentive scheme is again consistent with the strength of incentives under each scheme being such that $p_T > p_0(1 + \pi) > p_Z$.[19]

Finally, we note that the quantile regression estimates provide further reassurance that our findings are unlikely to be spuriously generated by time-varying unobservables that are correlated with the introduction of the two treatments. For this to be the case, the relevant omitted variable would have to be negatively correlated with the productivity of teams on the left tail of the productivity distribution only during the rank incentive regime, and positively correlated with the productivity of the teams on the right tail only during the tournament regime.

19. Of course there can be additional mechanisms at play that are not captured. For example, γ_θ might also in part capture how employees respond to the employer acting more generously, in that she is willing to share a greater proportion of profits with her workers (Akerlof, 1982). In this sense the productivity responses might be a form of gift exchange from workers to generous employers, albeit where the degree of gift exchange then appears to be proportionately larger among more productive teams.

5.4. Team Productivity: Effort Responses

Finally, we use information on teams that *remain together* after the change in incentives to provide evidence on how the introduction of rank incentives and prizes affect effort, keeping team composition constant. Of the 407 teams, 14 are observed under all three incentive schemes, and 65 are observed under at least two. To identify the effect of rank incentives and prizes on effort we estimate the following panel data specification:

$$y_{ift} = \beta R_t + \gamma T_t + \lambda_f + \delta X_{ift} + \eta Z_{ft} + \theta t + \alpha_i + u_{ift}, \qquad (7)$$

where α_i is a team fixed effect and all other variables are as previously defined. The coefficients of interest, β and γ, are now identified from variation within the same team—namely holding *constant* team composition. As the model highlights, the fact that these teams remain intact despite the change in incentives implies these teams are obviously not representative of the average team in our sample. So the estimates of β and γ are internally consistent but they do not provide any information on how the productivity of the teams that broke up would have changed had these teams remained together.

Column (4) in Table 3 reports the estimates from equation (7) for the sample of teams that are observed in all three regimes. In line with the prediction of incentive theory that more high-powered incentives should elicit higher effort, column 4 shows that the estimates of both β and γ are positive. While the point estimate on the effect of rank incentives is positive, it is not significantly different from zero. The effect of tournaments is economically and statistically significant: the productivity of the same team increases by 25%. The effect of tournaments compared to piece rates is large but not precisely estimated, the point estimate is 0.311 with standard error 0.212. Column (5) estimates equation (7) for the sample of teams that are observed in at least two of the three regimes. The results are qualitatively similar to those in column 4.[20]

Taken together, our findings indicate that both the introduction of nonmonetary rank incentives and tournaments increases incentive power p, and that the latter is more powerful, so $p_T > p_Z$. These results emphasize that the negative effect of rank incentives is primarily due to the endogenous changes in team composition, rather than changes in behavior of the same team. In contrast, the provision of monetary prizes affects firm performance through both endogenous changes in team composition and changes in behavior within the same team.

20. On the plausibility of the magnitude of the tournament effect, we note that while there is only one monetary prize on offer each week, the monetary value of prizes varies between 5% and 20% of teams' weekly earnings depending on the assumptions made on the probability of any given team winning the prize. We note that the productivity distribution is rather condensed across the best-performing teams. For example, in the last week under the control regime, the average productivity of the median team is 8.23 kg/hr, and that of the team at the 90th percentile is 10.08 kg/hr. This difference is small relative to the mean productivity, suggesting that many teams at or above the median might reasonably expect to be able to win the prize.

5.5. *Additional Evidence from Surveys*

The evidence suggests that as team incentives become more high-powered, workers match more assortatively by ability and match less according to social connections. To provide evidence on how these changes in team composition affect within-team interactions, we use evidence from our worker survey. The survey was administered both in the control and tournament regime, with each worker being interviewed once overall. In each survey, workers are interviewed a few weeks after they arrived on the farm and have had an opportunity to form friendships. Moreover, the survey questions explicitly ask workers to record their preferences and opinions for their team at the time of the survey.

Given the cross-sectional nature of the data, we are of course unable to identify whether the same worker changes her behavior after the introduction of rank incentives and prizes. However, a comparison of survey responses between the two cohorts of workers under the control and tournament regimes is still informative because the date on which a given worker is surveyed only depends on the date of his arrival at the farm, which is determined by factors orthogonal to behavior within the workplace, such as the individual's university term dates. Table A.4 shows that as term dates are correlated within country, worker's nationalities differ across the two survey dates but they do not differ on other dimensions—such as gender, where they reside on the farm, their motivations for coming to work on the farm, and their preferred pay scheme.

Panel A of Table 4 presents workers' self-reported interactions with their team members during the week preceding the survey. For each statement, workers were asked whether they strongly agreed, agreed, disagreed, or strongly disagreed with it. We then define a dummy equal to one if the worker strongly agrees with the statement. The results suggest that under the tournament regime significantly fewer people report pushing their team members to work hard, and significantly fewer workers report giving team members instructions during the tournament regime. In line with this, fewer people agree strongly with the statement that they are pushed by other team members or receive instructions, although these differences are not precisely estimated.

The fact that team members are less likely to be pushed hard or given fewer instructions when tournaments are in place is consistent with the hypothesis that when teams are not formed among friends, peer pressure is weaker, and this is especially detrimental for low-ability workers. The result is also consistent with teams being formed by workers of similar ability who therefore face a reduced need to push one another. Moreover, the final column reports the p-value on the null that the survey responses are not significantly different from each other conditional on the worker's nationality, which does differ across the survey waves.[21]

Panel B of Table 4 provides descriptive evidence on workers' assessment of their satisfaction on three dimensions: team composition, work and life in general. First, we

21. We estimate a probit model of whether the worker strongly agreed with the survey question or not, against a dummy for the survey period and dummies for whether the respondent is Polish or Ukrainian. The p-value in column (4) (Table 4) is for the null hypothesis that the survey dummy is equal to zero.

TABLE 4. Within team interactions and well being.

Means and standard deviation in parentheses, p-values in brackets	(1) Surveyed in Control Period	(2) Surveyed in Tournament Period	(3) Difference [p-value]	(4) Conditional Difference [p-value]
A. Team Interactions				
I push other team members to work harder	.630	.450	[.014]	[.037]
	(.485)	(.501)		
I am pushed to work harder by other team members	.481	.463	[.798]	[.868]
	(.502)	(.502)		
I give instructions to other team members	.324	.175	[.021]	[.036]
	(.470)	(.043)		
I follow instructions given by other team members	.389	.300	[.209]	[.683]
	(.490)	(.461)		
B. Workers' Satisfaction				
Are you content with the composition of your team? [yes = 1]	.743	.776	[.623]	[.447]
	(.439)	(.420)		
Would like more friends on team	.120	.125	[.924]	[.658]
	(.327)	(.332)		
Would like more fast pickers on team	.157	.150	[.890]	[.587]
	(.366)	(.359)		
You felt happy in relation to work	.068	.216	[.004]	[.026]
	(.253)	(.414)		
Overall, how satisfied are you with your life?	.262	.301	[.544]	[.755]
	(.442)	(.462)		

Notes: The first survey was conducted on 20th July during the control regime – 108 workers were interviewed in this wave. The second survey wave took place on the 7th of September during the monetary prize regime – 80 workers were interviewed in this wave. For each survey question on team interactions, workers could choose whether they strongly agreed, agreed, disagreed or strongly disagreed with each of the statements above. For each statement we define a dichotomous variable that is equal to one if the worker "strongly agrees" with the statement, and is zero otherwise. For the questions related to changes in the team composition, we define a dichotomous variable that is equal to one if the worker says they would prefer to leave their team composition unchanged along the particular dimension, and zero otherwise. For the question on "overall, how satisfied are you with your life?", we define the dichotomous variable is equal to one if respondents said they were "very satisfied", rather than "fairly satisfied", "not very satisfied", or "not at all satisfied". In Column 3, the p-value on the difference is from a test of the null hypothesis that the responses are equal across survey waves against a two sided alternative. In Column 4 we first estimate a probit model of the survey response regressed against the survey period and dummy variables for whether the respondent is Polish or Ukrainian, and estimate robust standard errors. The reported p-value is for the null hypothesis that the survey dummy is equal to zero. All team related questions refer to the team the worker is working in on survey date.

note that under both regimes, workers are generally content with the composition of their team in the week of the survey. Moreover, workers express no desire to change the composition of their team along the dimensions of friendship or ability. This suggests that within a regime workers are in equilibrium.

Second, we note that significantly more workers report they 'felt happy in relation to work' under the tournament regime while satisfaction with life in general is similar in the two regimes. The percentage of workers strongly agreeing with the statement increases threefold from 6.8% under the control regime to over 21% under the tournament regime. This significant increase is robust to conditioning on worker nationalities, and also to controlling for the worker's team pay during survey week. Hence worker responses appear to reflect that stronger incentives and the change in team composition that these cause result in higher utility, as suggested by Result 1, rather than workers surveyed during the tournament regime being happier with life in general.

6. Conclusions

We have provided evidence from a field experiment on the effects of team incentives. We have evaluated the impact of rank incentives and tournaments relative to piece rates on two outcomes: team composition, and team productivity. As the former has no counterpart when studying the effects of *individual* incentives, the analysis highlights that standard models of incentive design and how agents react to a given set of incentives, can be extended in new directions for workplaces organized into teams, and where team formation is endogenous. This is important given the increased prevalence of self-formed teams in manufacturing industries, and their usage is commonplace within professional organizations such as those practicing law, medicine, and academia.

Although many of the mechanisms we have provided evidence on would in general operate in other settings, it is important for the external validity of our results to highlight what is specific to this setting and how the results might differ in other contexts. A key feature of our setting is that workers face a high cost of quitting the firm as their outside option is to return home or to move to another farm that their work permit allows, and our time frame is too short for new workers to join the farm in response to the introduction of rank incentives or tournaments.[22] The selection effect of incentives, which is of first-order importance in other studies (Lazear, 2000), is thus muted in our setting. As earnings depend on productivity, we expect the least productive workers to quit, and more able workers to join. This change in the composition of the workforce would strengthen the positive effect of tournaments on productivity, as the workers for whom the effect is negative would prefer to quit. Second, as the dispersion of productivity across teams increases, so does the inequality in pay across teams, as they are paid piece rates. In general, such pay inequality might reduce co-operation or increase sabotage between teams (Lazear, 1989; Drago and Garvey, 1998; Carpenter, Matthews, and Schirm, 2010). In our context, there is little scope for such sabotage as teams are assigned their own rows to pick, but such detrimental impact of high-powered incentives might be more relevant in other contexts.

A third important feature of our setting is that social connections between workers differ from other workplaces, both because workers live and work on the farm, and also because the workforce is relatively homogeneous on observables to begin with. Both these factors cause social connections to be stronger than in the representative

22. Of course workers can voluntarily leave the farm at any time. However, we observe none choosing to do so presumably because their earnings are considerably higher than in any temporary employment they can find in their home country.

firm. On the other hand, worker tenure in our firm is rarely longer than six months because workers are hired seasonally and they are not re-hired in later seasons. This short horizon for interactions might weaken the social ties between workers. Absent such strong social ties, we might expect workers to initially sort into teams along another margin that reduces free-riding in teams.

Together these considerations provide a wide research agenda to pursue to better understand team production and how workers respond to monetary and nonmonetary incentives for teams.

References

Akerlof, George A. (1982). "Labor Contracts as a Partial Gift Exchange." *Quarterly Journal of Economics*, 97, 543–569.

Bandiera, Oriana, Iwan Barankay, and Imran Rasul (2005). "Social Preferences and the Response to Incentives: Evidence From Personnel Data." *Quarterly Journal of Economics*, 120, 917–962.

Bandiera, Oriana, Iwan Barankay, and Imran Rasul "Incentives for Managers and Inequality Among Workers: Evidence From a Firm Level Experiment." *Quarterly Journal of Economics*, 122, 729–775.

Bandiera, Oriana, Iwan Barankay, and Imran Rasul (2009). "Social Connections and Incentives in the Workplace: Evidence from Personnel Data." *Econometrica*, 77, 1047–1094.

Barankay, Iwan (2010). "*Rankings and Social Tournaments*." Working paper, University of Pennsylvania.

Bernheim, B. Douglas, Bezalel Peleg, and Michael D. Whinston (1987). "Coalition-Proof Nash Equilibria I. Concepts." *Journal of Economic Theory*, 42, 1–12.

Besley, Timothy and Maitreesh Ghatak (2008). "Status Incentives." *American Economic Review Papers and Proceedings*, 98, 206–211.

Blanes i Vidal, Jordi and Mareike Nossol (2011). "Tournaments without Prizes: Evidence from Personnel Records." *Management Science*, 57, 1721–1736.

Bognanno, Michael L., (2001). "Corporate Tournaments." *Journal of Labor Economics*, 19, 290–315.

Bull, Clive, Andrew Schotter, and Keith Weigelt (1987). "Tournaments and Piece Rates: An Experimental Study." *Journal of Political Economy*, 95, 1–33.

Carpenter, Jeffrey, Peter Hans Matthews, and John Schirm (2010). "Tournaments and Office Politics: Evidence from a Real Effort Experiment." *American Economic Review*, 100(1), 504–517.

Clark, Andrew E., David Masclet, and Marie-Claire Villeval (2010). "Effort and Comparison Income: Experimental and Survey Evidence." *Industrial and Labor Relations Review*, 63, 407–470.

Delfgaauw, Josse, Robert Dur, Joeri Sol, and Willem Verbeke (2009). "Tournament Incentives in the Field: Gender Differences in the Workplace." IZA Discussion Paper No. 4395.

Drago, Robert and Gerald T. Garvey (1998). "Incentives for Helping on the Job: Theory and Evidence." *Journal of Labor Economics*, 16, 1–25.

Ehrenberg, Ronald G. and Michael L. Bognanno (1990). "The Incentive Effects of Tournaments Revisited: Evidence from the European PGA Tour." *Industrial and Labor Relations Review*, 43, 74S–88S.

Eriksson, Tor (1999). "Executive Compensation and Tournament Theory: Empirical Tests on Danish Data." *Journal of Labor Economics*, 17, 262–280.

Fliessbach, K., B. Weber, P. Trautner, T. Dohmen, U. Sunde, C. E. Elger, and A. Falk (2007). "Social Comparison Affects Reward-Related Brain Activity in the Human Ventral Striatum." *Science*, 318(5854), 1305–1308.

Freeman, Richard B. and Alexander M. Gelber (2009). "Prize Structure and Information in Tournaments: Experimental Evidence." *American Economic Journal: Applied Economics*, 2, 149–164.

Gibbons, Robert and Kevin J. Murphy (1990). "Relative Performance Evaluation for Chief Executive Officers." *Industrial and Labor Relations Review*, 43, 30S.

Hamilton, Barton H., Jack A. Nickerson, and Hideo Owan (2003). "Team Incentives and Worker Heterogeneity: An Empirical Analysis of the Impact of Teams on Productivity and Participation." *Journal of Political Economy*, 111, 465–497.

Kahneman, Daniel, Alan B. Krueger, David Schkade, Norbert Schwarz, and Arthur A. Stone (2006). "Would you be Happier if you were Richer? A Focusing Illusion." *Science*, 312(5782), 1908–1910.

Kluger, Avraham N. and Angelo DeNisi (1996). "Effects of Feedback Intervention on Performance: A Historical Review, a Meta-analysis, and a Preliminary Feedback Intervention Theory." *Psychological Bulletin*, 119, 254–284.

Knoeber, Charles R. and Walter N. Thurman (1994). "Testing the Theory of Tournaments: An Empirical Analysis of Broiler Production." *Journal of Labor Economics*, 12, 155–179.

Kosfeld, Michael and Susanne Neckermann (2011). "Getting More Work for Nothing? Symbolic Awards and Worker Performance." *American Economic Journal Microeconomics*, 3, 86–99.

Kremer, Michael (1993). "The O-Ring Theory of Economic Development." *Quarterly Journal of Economics*, 108, 551–575.

Layard, Richard (2006). *Happiness—Lessons from a New Science*. Penguin, p. 272.

Lazear, Edward P. (1989).Pay Equality and Industrial Politics." *Journal of Political Economy*, 97, 561–580.

Lazear, Edward P. (2000). "Performance Pay and Productivity." *American Economic Review*, 90(5), 1346–1361.

Lazear, Edward P. and Kathryn L. Shaw (2007). "Personnel Economics: The Economist's View of Human Resources." *Journal of Economic Perspectives*, 21(4), 91–114.

Ledford Jr, Gerald E., Edward E. Lawler III, and Susan A. Mohrman (1995). "Reward Innovations in Fortune 1000." *Compensation Benefits Review*, 27, 76–80.

Moldovanu, Benny, Aner Sela, and Xianwen Shi (2007). "Contests for Status." *Journal of Political Economy*, 115, 338–363.

Nalbantian, Haig R. and Andrew Schotter (1997). "Productivity Under Group Incentives : An Experimental Study." *American Economic Review*, 87(3), 314–341.

Newman, A. and P. Legros (2002). "Monotone Matching in Perfect and Imperfect Worlds." *The Review of Economic Studies*, 69, 925–942.

Rosen, Sherwin (1986). "Prizes and Incentives in Elimination Tournaments." *American Economic Review*, 76(4), 701–715.

Supporting Information

Additional Supporting Information may be found in the online version of this article at the publisher's website:

Team Incentives: Evidence from a Firm Level Experiment