# Team Incentives: Evidence from a Field Experiment*

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**Abstract**

We present evidence from a field experiment to evaluate the effects of team incentives. We compare three common incentive schemes - piece rates, performance feedback, and tournaments - and analyze their effect on two outcomes: team composition and team productivity. A theoretical framework makes precise that increasing the strength of incentives can lead high ability workers to prefer to form teams with similarly skilled colleagues instead of workers they are socially connected to. If however socially connected workers are better able to overcome free-riding, the increased strength of incentives that changes team composition can reduce the firm's average productivity overall. Empirically, the introduction of feedback, and tournaments both increase assortative matching into teams by ability, and make it less likely that workers form teams with colleagues they are socially connected to. Compared to piece rates, the additional provision of feedback significantly reduces average productivity by 14%, while the addition of a tournament significantly increases it by 24%. Both effects are heterogeneous: feedback only affects teams at the bottom of the conditional productivity distribution, and tournaments only affect teams at the top. The analysis highlights new directions for research in understanding how agents react to monetary and non-monetary incentives in workplaces characterized by team production where teams form endogenously.

**Keywords: feedback, teams, tournaments.**

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# 1 Introduction

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 compare three commonly used schemes – piece rates, performance feedback, and monetary prize tournaments – and analyze their effect on two outcomes: how workers sort into teams and team productivity.

Three factors guide our research questions and experimental design. First, despite the pervasiveness of teams in the workplace, field evidence on team incentives is scarce.[1] The existing evidence from individual reward schemes [Prendergast 1999, Lazear 2000] provides limited guidance because the margins along which individuals and teams can respond to incentives differ. Specifically, in addition to changes in individual effort, changes in team incentives can lead to changes in team composition. To the extent that workers effort depends on the identity of their team members, changes in team composition can affect the productivity of the individual teams and of the firm as a whole.

Second, tournaments are widely used to provide incentives across diverse organizations such as salespeople competing for bonuses, managers competing for promotions, and politicians competing for vote shares [Bull *et al* 1987, Baker *et al* 1988]. While several studies have tested whether the response to variation in tournament structure is consistent with theoretical predictions, field evidence on the comparison of monetary prize tournaments against alternative monetary and non-monetary incentive mechanisms is scarce.[2]

Third, whenever tournaments are in place, workers inevitably receive some information on their relative performance, which can have an independent and direct effect on productivity if individuals have concerns for their relative position or status [Moldavanu *et al* 2007, Besley and Ghatak 2008], inequality aversion [Fehr and Schmidt 1999, Charness and Rabin 2002] or conformity [Bernheim 1994]. Our research design allows us to separately identify the effect of feedback from the effect of prize tournaments. As the provision of feedback 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 feedback.[3]

[1] More than 70% of major US firms use some form of team based rewards [Ledford *et al* 1995]. Lazear and Shaw [2007] cite evidence that between 1987 and 1996, the share of large firms that have more than a fifth of their employees in problem solving teams rose from 37 to 66%. The percentage of large firms with workers in self-managed teams rose from 27 to 78% over the same period. In academia, Wuchty *et al* [2007] document the increased use of team production in research across disciplines.

[2] The empirical literature on tournament theory comprises two distinct branches. The first tests whether a particular compensation scheme has a tournament structure, typically using data from the market for CEOs [Gibbons and Murphy 1990, Erikkson 1999, Bognanno 2001], and the second tests whether individual behavior changes with tournament features in a way consistent with theory, using data either from experimental settings [Bull *et al* 1987, Nalbantian and Schotter 1997, Erikkson *et al* 2008, Freeman and Gelber 2008], personnel data [Knoeber and Thurman 1994, Erikkson 1999, Bognanno 2001], or sports [Ehrenberg and Bognanno 1990]. There are few existing field studies – on either individuals or teams – exploring tournament incentives to other incentive schemes such as piece rates or feedback.

[3] The provision of performance feedback within firms appears to be ubiquitous [Murphy and Cleveland 1991]. While there is a long tradition in psychology on the effects of feedback, economists have only recently begun to investigate the causes and consequences of feedback provision. Much of this research has focused on the consequences and optimal provision of feedback to individuals [Lizzeri *et al* 2002, Ederer 2008], and while there is a growing

The firm we study is a leading soft fruit producer in the UK. The field experiment was designed and implemented in collaboration with the farm's CEO during the 2005 harvest season. We altered the work environment for workers at the lowest level of the hierarchy while holding constant the compensation schemes at other tiers of the hierarchy. Workers are organized into teams of five, and their main task is to pick fruit from fields on different sites. At the beginning of the season, teams were paid piece rates based on their aggregate productivity. Halfway through the season we additionally provided feedback to workers by posting daily histograms of each team's productivity. This feedback makes precise the absolute productivity of each team, and their ranking relative to all other teams. Halfway through the remaining part of the season we introduced a monetary prize for the most productive team each week, in addition to the same level of piece rates.

When workers first 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.

We develop a theoretical framework that makes precise how the strength of incentives determine workers' effort and team composition and, through these, productivity. We model the introduction of feedback and tournaments as changes in incentive strength that determine the marginal return to effort. Compared to the baseline piece rates scheme, additionally providing feedback on the performance of all teams might increase the return to effort if, for example, workers have status concerns. Tournaments increase the return to effort further because workers can win a monetary prize with some positive probability.

We model the two key forces that drive team formation in our setting: workers' ability and social connections. The fact that individual earnings are increasing in the ability of team members and that a team can be formed only if all members agree, pushes 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 friends are more able to cooperate in this context [Bandiera *et al* 2005] thus limiting free-riding within teams [Alchian and Demsetz 1972, Holmstrom 1982], and because they enjoy non-pecuniary benefits from interacting with co-workers they are socially connected to [Hamilton *et al* 2003].[4] To the extent that workers are not socially connected to colleagues of similar ability, a trade-off emerges. The theoretical framework then makes precise how the introduction of feedback and tournament prizes affect this trade-off.

empirical literature on the effect of feedback in laboratory settings [Erikkson *et al* 2008], much of the existing field evidence on the effects of interim feedback to individuals in contexts such as education [Bandiera *et al* 2008, Azmat and Iriberri 2009] or the workplace [Blanes i Vidal and Nossol 2009]. Evidence from the laboratory has also tended to focus on feedback to individuals [Freeman and Gelber 2008]. One exception is Sausgruber [2008] who provides experimental evidence on the effects on team performance when told about the performance of one other team, holding team composition constant.

[4]In line with this, Rotemberg [1994] develops a model showing how altruism between co-workers may endogenously form in the workplace to facilitate cooperation among workers engaged in team production. Empirically, Hamilton *et al* [2003] provide evidence from the introduction of team production in a garment firm. They find the most able workers sorted first into teams despite a loss in earnings in many cases, suggesting non-pecuniary benefits associated with teamwork.

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. 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.

The framework also illustrates that strengthening incentives has heterogeneous effects across teams of different ability. When the effect on average productivity is positive, the rise in productivity is larger for the most able teams. When the effect on average productivity is negative, the fall, in absolute value, is larger for the least able teams.

The empirical analysis exploits three data sources. First, the firm's personnel records contain panel data on each team's productivity and actual composition. The second is a worker survey that collects information on each workers' social network of self-reported friends on the farm, individual opinions on collaborative effort within teams, monetary transfers between team members, the desired composition of the team, and on-the-job satisfaction. The third data source is the team exchange records that contain information on the composition of all teams demanded at each team exchange.

Our key results are as follows. First, the introduction of feedback and of monetary prizes leads to significant changes in team composition. Relative to the piece rate regime, the share of team members connected by social ties is lower and team members' ability levels are more similar under the feedback and tournament regimes. Compared to the feedback regime, the addition of the monetary prize tournament does not lead to further changes in how workers sort into teams.

Second, the feedback and tournament schemes have opposite effects on average productivity. Relative to the piece rate regime, the introduction of feedback significantly reduces average team productivity by 14%, while the introduction of tournaments significantly increase it by 24%. As made precise in the theoretical framework, the reduction in average productivity when feedback is provided is consistent with workers being better off sorting into teams on the basis of ability rather than friendship as feedback increases the strength of incentives faced, 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 feedback reduces the firm's productivity overall. In contrast, the tournament incentives are sufficiently high powered so the increase in worker's effort more than offsets any increase in free-riding within teams. Hence the firm's overall 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 feedback reduces the productivity of teams at the bottom of the conditional productivity distribution compared to piece rates, 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 piece rates, while it has no effect on teams below the 30th percentile.

Fourth, we use information on the productivity of teams that remain intact after the change in incentives to evaluate the effect of feedback and tournaments on effort, holding constant team composition. This serves as a good proxy for the strength of the increase in incentives provided by both incentive schemes relative to the piece rate scheme. We find that while the effect of feedback is positive the magnitude appears small. In contrast the introduction of tournaments increases effort by 25% for teams that choose to remain intact.

Finally, qualitative evidence from our worker survey 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.[5]

This paper is the first to provide field evidence on the effect of monetary and non-monetary team incentive schemes. We directly build on laboratory evidence comparing team incentives [Nalbantian and Schotter 1997], and on the existing field evidence on the comparison of individual versus team incentives [Hamilton *et al* 2003]. Our design and analysis has been partly motivated by the observation that because tournaments inevitably provide agents with some feedback on their relative performance, it is impossible to consider the optimal tournament structure without also considering how agents respond to feedback. Our analysis therefore bridges the hitherto separate literatures on tournament theory and on the effects of interim feedback to employees [Lizzeri *et al* 2002, Ederer 2008].

By exploring changes in behavior on a range of dimensions, the analysis highlights new directions for research in understanding how agents react to monetary and non-monetary incentives in workplaces characterized by team production where teams form endogenously. Some of the channels we explore – such as team formation and interactions within teams – have no counterpart when studying the effects of individual incentives. Hence our analysis highlights that standard models of incentive design and how agents react to a given set of incentives, can be extended in important new directions for workplaces endogenously organized into teams.

The paper is organized as follows. Section two describes our setting and field experiment. Section three presents a stylized model of how the formation of teams and effort within teams are affected by team incentives. Section four describes the data sources. Section five provides evidence on the impact of feedback and tournaments on team composition. Section six estimates the effects of each incentive scheme on average team productivity, the dispersion of productivity across teams, and the productivity of teams that remain intact across incentive schemes. Section seven provides descriptive evidence on how interactions among team members change with each incentive scheme. Section eight concludes. All proofs and robustness checks are in the Appendix.

[5]Kandel and Lazear [1992] develop a model of peer pressure in environments where individual $i$'s effort imposes an externality on her peers, as in our setting.

# 2 The Context and Field Experiment

## 2.1 Organization of Production

The firm we study is a leading soft fruit producer in the UK. 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.[6]

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 the 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 do not choose how many hours to work, rather teams are present on their rows 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.

Teams were introduced to save management time, as the allocation of workers to rows is delegated to the teams rather than to the field managers.[7]

Note that 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 specialization within a team, unlike in other well documented team settings [Hamilton *et al* 2003]. However, workers' effort still generates an externality on the other team members through the piece rate compensation scheme which ties earnings to the team's aggregate productivity. In the framework developed below, we assume workers have social preferences towards their friends, so teams comprising workers that are socially connected to each other are better able to internalize the externalities each worker's effort places on her team members and thus ameliorate free-riding within the team.

On average in 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

[6] In order to be recruited, individuals must be full-time university students, and must return 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.

[7] In previous seasons pickers worked independently from each other and were paid individually based on piece rates. As we do not observe an exogenously timed switch from individual piece rates to team pay within the same picking season, we cannot evaluate whether the introduction of team pay had a causal impact on productivity, as in Jones and Kato [1995], Knez and Simester [2001], and Hamilton *et al* [2003]. However we note that the level of productivity in the early part of the 2005 season – when team pay is in place and neither field experiment has been implemented – is higher than the corresponding part of the 2004 season when workers were paid individual piece rates.

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.[8]

Workers and field managers do not choose which fields they work on – at the start of the day they are assigned to a field by the general manager. When teams clear the rows they are initially assigned to, the general manager either re-assigns them to another set of five rows in the same field, or moves them to another field. The order in which fields are picked is pre-determined 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 based on his assessment of field conditions. Finally, workers who do not pick fruit are typically assigned to other tasks such as planting, weeding, packing fruit, or the construction of field tunnels.[9]

## 2.2 Teams

In this setting, workers choose how much effort to exert into picking and the team composition. When workers first 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. Teams are formed weekly at the *team exchange,* which takes place at the end of each pay week. During the team exchange, teams of workers express their preferences to be assigned together for the week. It is feasible for any combination of five workers that are present on the farm to propose forming a team. A given team can form if and only if all five members agree to it so that the assignment of workers to teams represents a coalition proof Nash equilibrium [Bernheim *et al* 1987].[10]

Workers who arrive at the team exchange without having agreed on a team, can use the team exchange to coordinate with workers in a similar position to form a team. If a worker was unable to form a team by the end of the team exchange, they would not be able 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 them to leave the team at the next team exchange.

[8] A separate group of individuals, called field runners, are responsible for physically moving fruit from the field to the packaging plant. They do not themselves pick fruit nor do they manage teams.

[9] The piece rate is the same for all teams on a given field-day and is set to minimize the firm's wage bill each field-day subject to a minimum wage constraint. To set the piece rate, at the start of the day the COO inspects each field to be picked. He then forms an expectation of worker productivity that field-day and sets the piece rate so that a team with average productivity expects to obtain an hourly equivalent of $\underline{w}$. 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.

[10] A drawback of coalition proof Nash equilibrium is that it does not allow players to agree to correlate their play, which may be a realistic possibility when workers can engage in pre-play communication. Moreno and Wooders [1996] discuss the conditions under which a coalition-proof equilibrium exists in this case.

Indeed, we never observe workers being unable to form a team at the exchange.

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 cooperate and overcome the free-rider problem that plagues team production. In Bandiera *et al* [2005] we provide evidence that during an earlier season workers in the same setting were more able to cooperate 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.[11]

## 2.3 The Field Experiment

We designed and implemented a field experiment during the peak period of the 2005 picking season. The experiment altered the work environment for workers at the lowest level of the hierarchy, namely among workers whose main task is to pick fruit from fields. 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 August 4th, we provided daily feedback on team performance. Starting on September 2nd 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.[12]

The design allows us to identify the causal effect on worker behavior of feedback and tournaments from a comparison of outcomes between the control period and those in the feedback or tournament treatments respectively.[13] To avoid confounding effects, 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. Finally, to avoid anticipation effects, neither change was announced to workers or field managers beforehand.

[11] 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, Legros and Newman 2002]. The former case better represents the worker's payoff structure in our setting. Second, Bandiera *et al* [2009] provides evidence in this setting that the ability of individuals is uncorrelated within pairs of workers that report each other as friends.

[12] The details of both treatments, for instance the type of feedback and the value of the prize, were agreed upon with the general management at the start of the season and were kept constant throughout the experiment.

[13] The research design is within-subject as we randomize over time rather than cross-sectionally 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 the treatment.

### 2.3.1 Feedback

During the feedback treatment information on each team's daily productivity was publicly posted at the campsite where workers reside. It was therefore almost costless for workers to acquire this information. Feedback was provided in the format of a simple histogram that informed individuals on: (i) the absolute level of productivity of each team; (ii) the productivity ranking across teams; (iii) the productivity differentials between teams. Although the workers in each team were clearly labelled, data on individual productivity is unavailable and so each worker was assigned the average productivity of the team as a whole. At the end of the work week and prior to the team exchange, the same information was presented ranking productivities for the whole week.

Three points are of note. First, teams work on the same site on the farm and pick the same fruit for each week, and the feedback was split by farm site and fruit type. Hence the productivity comparison between teams is informative about relative team productivities. Second, individual productivity is not measured, so all individuals in the same teams are assigned the same productivity. Hence workers cannot deduce the most and least productive workers, say, in other teams. The feedback therefore provides a noisy signal of the relative productivity of workers. Third, even in the absence of this formal feedback, workers can of course form beliefs on the productivity of their team relative to other teams on the same field-day, as workers on other teams on the field-day are easily observable. The feedback treatment provides workers with precise and objective information about the performance of all teams, and we estimate the causal impact of this feedback on worker behavior over and above any subjective feedback they may have.

### 2.3.2 Monetary Prize Tournament

During the tournament treatment management paid a weekly monetary prize for the most productive team, in addition to providing the same information as in the feedback treatment. As with the feedback, weekly prizes were awarded to the most productive team in each of the two farm sites and each of the two fruit types – this is because of exogenous differences in productivity across farm sites and fruit types. The prize amount was agreed with management at the start of the tournament and held fixed throughout the tournament regime. 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 is likely to lie between these bounds. Regardless of how workers perceive their likelihood to win the prize, the prize was paid in Sterling and likely to be spent in Eastern Europe, so the PPP adjusted prize value was significant.[14]

The experimental design allows us to understand how much of the previously documented effects of tournaments are attributable to the feedback that workers inevitably receive when tour-

[14]Theoretical justifications for the use of tournaments include insuring workers against common productivity shocks [Lazear and Rosen 1981, Green and Stokey 1983, Nalebuff and Stiglitz 1983], heterogeneous workers [O'Keefe *et al* 1984], and moral hazard or monitoring costs [Malcolmson 1986, Bhattacharya and Guasch 1988].

naments are in place. Moreover, for both feedback and tournaments, we provide novel evidence on how such incentives affect the composition of teams that endogenously form or stay together. We therefore decompose the productivity effects of feedback and prizes into those attributable to changes in behavior of the same team, and those caused by workers sorting into teams.

# 3 Theoretical Framework

## 3.1 Set-up

We develop a stylized model to illustrate the effects of increasing the power of team incentives when workers choose both their effort levels and the composition of their team. The framework makes precise the 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 worker $i$ produces output $y_i = \theta_i e_i$ where $\theta_i$ is measures worker $i$'s ability and $e_i$ is the effort she devotes to her main production task of fruit picking. We assume effort entails disutility $\frac{1}{2}e_i^2$ and we normalize the hours worked to one so that effort and productivity are equivalent. There are four workers: two of them are of low ability $\theta_L$ and two are of high ability $\theta_H > \theta_L$. Workers' ability is common knowledge. We thus abstract from feedback providing precise information on workers' ability. Rather we frame our discussion on the effect of feedback in terms of concerns workers have over their status or relative position, as this better fits our setting where the feedback provides only a noisy signal of individual ability, and this makes the comparison between feedback and tournaments more transparent.[15]

Workers form two teams of size two and earnings are shared equally among team members. To create a trade-off between matching by friendship and matching by ability, we assume there are two pairs of friends and each pair comprises one high and one low ability worker. Friendship has two implications. First, friends are assumed to have social preferences so that worker $i$ places some positive weight on the earnings of worker $j$, $\pi_{ij}$, if $i$ and $j$ are friends [Fehr and Fischbacher 2002]. Such social preferences imply that when teams are made of friends, workers partially internalize the externality their effort imposes on their team, thus ameliorating free-riding within the team. Second, we assume working alongside a friend provides a non-pecuniary benefit, $s$.

The model does not aim to explain where such social preferences originate from. There might be peer effects within teams that generate behavior consistent with such preferences [Kandel and Lazear 1992, Mas and Moretti 2008]. Indeed, in previous research in the same setting, we present evidence that workers are better able to cooperate with their friends [Bandiera *et al* 2005], and

[15] In addition, even if workers respond to feedback only because it helps them learn the true ability of other workers, the marginal value of feedback being provided midway through the season might be very low because they are able to form relatively precise estimates of others' ability during the control period in any case. This is because, as described in Section 2, workers are able to observe all other workers in the same field, and the same teams do not always operate together on a field.

the presence of high ability friends on the field raises the productivity of their lower ability friends [Bandiera *et al* 2009].

Finally, we assume that a given level of earnings $w$, yields a benefit $pw$. In this context, $p$ is a comprehensive measure of incentive power. It captures any channel through which the monetary rewards of piece rates and tournaments increase the returns to effort. It also captures any channel through which feedback increases the marginal value of effort, such as status concerns. That feedback increases the marginal return to effort is also consistent with all the existing empirical field evidence on the effect of feedback to individuals. For example, Bandiera *et al* [2008] and Azmat and Iriberri [2009] find positive effects of providing private interim feedback to university and high school students, respectively, on their subsequent academic performance. Blanes i Vidal and Nossol [2009] find that providing feedback to workers in a German wholesale firm increases individual productivity by 5.9%. Hence relative to a scenario in which teams are paid a piece rate, the introduction of feedback and tournament incentives can be represented through a potential increase in $p$.

## 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 $\pi_{ij} = \pi \in (0,1]$, $s_{ij} = s > 0$ if $i$ and $j$ are friends, and $\pi_{ij} = s_{ij} = 0$ otherwise. Holding constant team composition, the first order condition for effort is,

$$e_{ij}^* = \frac{p(1+\pi_{ij})}{2}\theta_i. \tag{2}$$

The existence of friendship ties in the team effectively boosts the incentive power $p$ of a given scheme as each worker internalizes the effect her effort has on her team member's earnings. This implies, all else equal, individual effort and hence total output is higher when workers match by friendship, and in the extreme case where $\pi = 1$, first best efforts are exerted.

Given that workers must form teams of size two, there are two possible patterns of team composition. In the first workers sort by ability, so that one team is made by the two low ability workers and the other by the two high ability workers. In the second workers match with their friends, so that both teams contain one low ability and one high ability worker. As in our empirical context a team can form only if all workers agree to be part of it, we focus on patterns of team composition that are stable, in the sense that no worker is better off by leaving his team and forming a new one with whomever is willing to do so. Whether workers match by ability or by friendship depends on the power of incentives as shown in our first result.

**Result 1 (Team Composition):** *If workers' social preferences ($\pi$) are not too strong and the ability differential not too low, 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.*

The proof is in the Appendix. Intuitively, the low ability workers 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 then need to compare whether the utility of high ability workers is higher by forming a team with their low ability friend rather than with the other high ability worker. High ability workers effectively face no trade-off and always prefer to match with their friend if they place a large weight on their friends earnings ($\pi$ high) or if the ability of their friends is similar to theirs. If not, the utility differential between matching by ability and matching by friendship will depend on the strength of incentives.

Utility (1) depends on earnings and the benefits of socializing with friends, $s_{ij}$. Other things equal, utility increases in the ability of the team member through the effect this has on earnings. An increase in incentive power – caused either by feedback or monetary prizes – 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.[16]

Increasing incentive power can therefore affect both the choice of effort and team composition. If team composition remains unchanged, an increase in $p$ unambiguously increases workers' effort and total productivity. If, however, the increase in $p$ is such that workers switch from matching by friendship to matching by ability, the effects on individual effort, team productivity and total productivity are sometimes ambiguous, as shown 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 match by ability might increase or reduce productivity. In particular:*

*(a) average productivity increases if and only if $p_1 > p_0(1+\pi)$;*

*(b) productivity dispersion unambiguously increases;*

*(c) if average productivity 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 first part of the result follows directly from differentiating the first order condition (2) with respect to $p$, holding all else equal. This is the standard effort effect, which occurs regardless of whether workers work individually or in teams. Result 2 highlights the additional impact on productivity through changes in team composition.

The intuition for part (a) is as follows. When team members are friends, each of them places a positive weight $\pi$ 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

[16] As shown in the proof, the threshold level $\hat{p}$ is increasing in $\pi$, $s$, and $\frac{\theta_L}{\theta_H}$, 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.

to compensate for the fact that workers now fail to internalize the effect of their effort on the earnings of their team members.

Hence while the effect of incentives on effort is unambiguous all else equal, increasing incentive power can lead to changes in team composition that reduce average productivity. This occurs because when incentives are more high powered, high ability workers have higher utility by assortatively matching by ability. However this may be to the detriment of the firm 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. As a result, firm productivity might be lower.

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.

Ultimately, if the increase in incentive power is strong (weak) enough, the productivity of both the most and least productive teams will increase (decrease). For intermediate cases, an increase in incentive power might have different effects on teams at the opposite ends of the productivity distribution.

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. These predictions on how the strength of team incentives affects team composition, the average productivity of teams, the dispersion of productivity across teams, and might have heterogeneous effects across teams at the top and bottom of the productivity distribution, guide the empirical analysis that follows.

# 4 Data and Empirical Method

## 4.1 Data Sources

Our analysis exploits three sources of data. This first is the firm's personnel records which 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. Personnel records also contain information on the identity of all team members, and all teams and field managers on a field-day. Finally, personnel records also allow us to measure key determinants of productivity, such as the workers' experience picking fruit, and the number of days a field has been picked for.

The second data source is a survey we administered to workers. This collects information on workers' background characteristics, their social network of self-reported friends on the farm, and their opinions regarding the interaction between their team members at the time of the survey.[17] The survey helps provide evidence on the relevance of friendship for team formation under piece rates, and how this varies with the provision of feedback or monetary prizes. The survey also sheds light on interactions among team members. In particular, we collect individual opinions on collaborative effort, monetary transfers between team members, the desired composition of the team, and on-the-job satisfaction. We later provide novel evidence on whether and how different incentive schemes affect the interactions and well-being among team members.

The third data source is the team exchange records. These contain information on the composition of all teams demanded at each weekly team exchange. This allows us to measure each worker's demand for team members over time, and compare it to actual team compositions using data from the personnel records described above. Such a comparison shows that teams were indeed formed following the workers' demands and, indeed, we never observe workers being assigned to teams with colleagues other than those demanded at the previous team exchange. The unconditional probability that a given worker is observed working alongside a colleague he demanded at the team exchange is .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. In the Appendix we provide evidence that the incidence of such temporary changes in team size is uncorrelated with incentives and that the discrepancy between actual and desired teams is orthogonal to the treatment regime suggesting management faithfully implemented worker demands from the team exchange throughout the season, irrespective of whether feedback or tournaments were in place.[18]

[17] The survey is translated into Eastern European languages, and administered by enumerators from there. Appendix Table A1 presents descriptive evidence on the characteristics of workers who were interviewed and those who were on the farm's payroll but were not present on survey day.

[18] Using evidence from the worker survey we note that – (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. Similar sentiments were expressed by workers in a pilot study on teams we ran at the end of the 2004 picking season.

## 4.2 Method and Measures

The empirical method follows the outline of the theoretical framework illustrated in Section 3. Motivated by Result 1, we first test whether the introduction of feedback and tournaments represents a sufficiently large increase in incentive power to change the way workers sort into teams. Informed by these findings, we identify the effect of the introduction of feedback and tournaments on average productivity and test whether the effects are heterogeneous across the ability distribution as illustrated by Result 2.

To test whether the introduction of feedback and tournaments affects team composition, we first need to measure ability and social connections. To measure social ties we use our worker survey which collected information on each workers' social network of friends on the farm. In particular 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, the majority of friendships are newly formed in the workplace, and pre-existing friendships are more likely to be reciprocal.[19]

To measure individual ability, we exploit the fact that each worker is 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 $t$, $I_t$ and $P_t$ are dummies for when the feedback 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, $\lambda_f$, account for unobserved and permanent differences in productivity across

[19] 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. The first named friend of $i$ is also more likely to be a pre-existing friend and to report $i$ as a friend of theirs. The high frequency of interaction between friends outside of the work environment implies friendship networks might be qualitatively more important drivers of behavior than other networks, say based on similarity in gender or nationality. 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 we may well capture the strongest friendship bonds in the workplace, and it is these bonds, if any, that are likely to be informative about how workers trade-off friends for workers of high ability when forming their team.

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 these ability measures is that worker $w$ must have picked for at least six field-days throughout 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 for example. 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.[20]

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, and of their risk aversion. 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 the absolute difference in ability in any given worker pair, $|\widehat{\sigma}_w - \widehat{\sigma}_{w'}|$, averaged over all feasible pairs of workers is significantly smaller, at the 1% significance level, when the pair report having the same pay preferences.

Finally, the composition of friendship networks is such that workers face a real trade-off between forming teams with their friends or colleagues of similar ability. In other words, ability is not correlated with friendship ties. For instance, the coefficient of variation of $\widehat{\sigma}_w$ among friends averaged over all friendship networks is .20. This is not significantly different to the coefficient of variation of $\widehat{\sigma}_w$ among all workers, .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 [Bandiera *et al* 2009].

# 5 Team Composition

Guided by the theoretical framework, our empirical analysis is organized into two main parts. This section analyzes the effect of the introduction of feedback and tournaments on team composition, the next analyzes the effect on productivity.

Throughout, the composition of the workforce is constant, namely workers do not leave or

[20] 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 (3) using only productivity data from the control regime. Doing so would mechanically lead to teams to be appear to be more homogeneous in terms of ability in the control regime.

join the firm in response to the change in incentives. This is 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 feedback or tournaments. In line with this, the histogram of arrival and departure times in Figure A1 shows the majority of workers arrive to the farm before the provision of feedback, they stay throughout the feedback and tournament regimes, and leave at the end of the season, coinciding with the end of our study, in the first week of October.

## 5.1 Descriptive Evidence

To begin with we present descriptive evidence on team composition and how this varies depending on whether the team was formed during the piece rate, feedback, or tournament regime. Figure 1A plots the kernel density of the number of friendship links in a team, divided by the total number of potential links. The measure is bounded between zero, namely when no team members are linked by friendship ties, and one, namely when all team members report all others as friends.

This shows that friendship ties between team members differ across teams that form under each incentive scheme. The mean share of friendship ties .21, .13 and .12 in teams formed during the piece rate, feedback and tournaments 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 feedback or tournaments 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. In contrast neither the means nor the distributions differ between the feedback and tournaments regimes. Hence the introduction of monetary prizes appears to have no additional effect on sorting into teams by friendship over and above that caused by the provision of feedback on the team's relative performance.

Figure 1B 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 the introduction of feedback and tournaments 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 feedback and tournaments treatments, compared to the control regime.

A Kolmogorov-Smirnov test rejects the null of equality of the distribution functions both between the control and the feedback regime and between the feedback and the tournaments regime. Hence the introduction of monetary prizes has an additional effect on sorting into teams by ability over and above that caused by the provision of feedback on the team's relative performance. In line with this, we find the variation in ability *within* a given team is lower for teams formed during the feedback and tournament regimes. The average coefficient of variation of ability of team members is .14 for teams formed during the piece rate regime, and .11 for teams formed during the feedback and tournament regimes. The p-value of the null hypothesis of equality between control

and feedback is .02, and between feedback and tournaments .87.

Mapping these results back to the theoretical framework, the data suggests the provision of feedback and tournaments 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 sort by ability. Denoting the strength of incentives under the piece rate, feedback, and tournament regimes as $p_0$, $p_F$, and $p_T$ respectively, these documented changes are therefore consistent with $p_T$ and $p_F$ both being greater than the threshold value $\hat{p}$, that 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 $p_F$ are both greater than the threshold $\hat{p}$ is consistent with there being no additional changes in worker sorting when moving from the feedback regime to the tournament regime.

## 5.2 Team Regressions

To present formal evidence on the effect of the introduction of feedback and tournaments on team composition, we first estimate the following regression specification,

$$c_i = \alpha I_i + \beta P_i + \kappa_i \tag{4}$$

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. $I_i = 1$ if team $i$ was formed during the feedback regime and 0 otherwise. $P_i = 1$ if team $i$ was formed during the tournament prize regime and 0 otherwise. The coefficients $\alpha$ and $\beta$ thus measure the difference in team composition between the piece rate regime, and the feedback 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 $\kappa_i$ 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.

Columns 1 and 5 of Table 1 illustrate the differences in team composition across regimes. Column 1 shows that compared to teams formed during the piece rate regime, the share of friendship ties in teams formed during the feedback regime is 7% lower and in teams formed during the tournaments 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 5 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.

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 1. Hence although the provision of feedback induces workers to sort more by ability and less by friendship, the introduction of monetary prize tournaments does not additionally affect the trade-off between sorting into teams along these dimensions. In terms of the model developed, this is consistent with $p_T$ and $p_F$ both

being greater than the threshold value $\hat{p}$.

While both the introduction of feedback and tournaments is exogenous, the different regimes are in place at different points in time thus $\alpha$ and $\beta$ might be biased by the fact that team composition naturally changes with time. The remaining columns in Table 1 augment (4) to provide evidence to address these concerns. To begin with we test whether the changes in team composition pre-date the introduction of feedback. To do so, we divide the piece rate period in two four-week periods and test whether teams formed during the first and second half differ. Columns 2 and 6 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 feedback regime are of similar composition with p-values well below 1%.

Next, we show that team composition changes discontinuously after the introduction of feedback and stays constant thereafter. To do so, in Columns 3 and 7 we divide the feedback and tournaments regimes in two periods of equal length. Comparing the coefficients for teams formed in the two sub-periods within each regime, shows that in most cases teams formed during the two sub-periods have similar composition.[21]

A final 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 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 feedback or tournaments. 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. Columns 4 and 8 show 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.

Overall the evidence indicates that relative to when teams are paid a piece rate, additionally introducing feedback and tournaments affect team composition. Both changes are in line with the assumption that both the introduction of feedback and tournaments strengthen incentives and increase the returns for high ability workers to match with one another, as made precise in Result 1 of the model. An explanation for why publicly provided feedback increases the returns to effort is because workers care about their relative social status as measured by their place in the productivity distribution at the workplace, although we cannot rule out altogether that feedback on team performance matters because it allows workers to learn the abilities of other workers. In either case, the provision of feedback is consistent with an increase in the returns to effort, $p$. The data suggests this increase provides a sufficiently strong motive for high ability workers to leave low productivity teams, even if they receive some non-pecuniary benefits $s_{ij}$ from working in a

[21] Taken together, these results highlight that the effect of feedback on how workers sort is relatively constant within the feedback regime. Although we cannot rule it out altogether, this suggests workers are unlikely to be responding to feedback because it allows them to learn the precise abilities of other workers. Rather, workers may respond to feedback because of concerns they may have over their relative position or status, and this causes the provision of feedback to effectively increase the returns to effort, $p$.

team with others they are socially tied to.[22,23]

The analysis in this section uses information on the actual composition of teams. In the Appendix we present evidence on how worker demands at each team exchange translate into actual assignments into teams. We find that conditional on time varying factors, demands are likely to translate into assignments with a high probability, and that the translation of demands to assignments by the general manager does not vary with either incentive treatment. This suggests management faithfully implemented worker demands from the team exchange throughout the season, irrespective of whether feedback or tournaments were in place.

# 6 Team Productivity

## 6.1 Time Series Descriptives

We focus on fruit picking operations for the main type of fruit during the 2005 peak picking season from June 1st until October 6th. 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, feedback, and tournament regimes. The final sample contains 2914 observations at the team-field-day level, covering 407 teams, 15 fields, and 109 days. The control regime is in place for 40% of the field-days, the feedback regime for 24%, and the tournament regime for the remaining 36%.[24]

Figure 2A shows the time series of daily 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. The figure illustrates that average productivity drops with the provision of feedback on teams' performances, and rises with the introduction of the monetary prize tournament. The average productivity levels during each regime and a test of the null hypothesis of equality are reported in the upper panel of Table 2. This shows that, unconditionally, the provision of feedback reduces productivity by 31%, and the introduction of monetary prizes for the best team increases it by 36%. In both cases the null hypothesis of equal means can be rejected at conventional levels. Although productivity rises moving from the feedback treatment to the tournament treatment, compared to the control regime, productivity under tournaments remains 8% lower, an effect which is significant at the 10% level.

The theoretical framework makes clear that team incentives affect the dispersion of productiv-

[22]The view that individuals are concerned about their relative status is supported by not only the earlier cited research in economics, but also research in psychology [Kluger and DeNisi 1996], neuroscience [Fleissbach *et al* 2007] and the determinants of happiness [Layard 2005].

[23]An alternative view from the social psychology literature is that the provision of feedback to workers' may reduce cooperation between co-workers because of biased self-attribution problems that lead them to learn more positively about their own ability than about others' abilities. Corgnet [2008] develops a model along these lines and shows that in the presence of such biases, feedback results in conflicts in beliefs among workers and leads teams to split. Such models would not explain why socially connected teams are more likely to split with feedback.

[24]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.

ity, as well as its mean value. Figure 2B plots the daily time series of the dispersion of productivity between teams in the same field-day. The measure of dispersion 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 2B shows that both the introduction of feedback and the introduction of prizes increase the dispersion in productivity relative to the control regime. The lower half of Table 2 reports the average dispersion levels during each regime and a test of the null hypothesis of equality across regimes. This indicates the provision of feedback significantly increases dispersion by 50% relative to its value during the control regime. The dispersion in productivity increases by a further 10% with the introduction of prizes but this difference is not significant.

Tournaments inevitably comprise an element of feedback and a financial reward, and our two field experiments are designed to disentangle these separate effects. Taken together, the descriptive evidence indicates that tournaments affect both the mean and the dispersion of productivity, and that these effects are due both to the feedback inherent within tournaments, as well as the monetary prizes offered in the tournament. Both elements are associated with a rise in dispersion, but have opposite effects on mean productivity – feedback reduces it and prizes increase it. This suggests the documented average productivity effects of tournaments in the existing literature likely underestimate the true effect, holding constant feedback to employees.[25]

While the introduction of feedback and prizes is exogenously timed, 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, most importantly the workers' experience and the fields' natural depletion rate. Hence any natural downward trend in productivity in the fields we focus on, might lead us to overestimate any negative effect of feedback, and underestimate the effect of the tournament relative to the control regime under piece rates alone. The next subsections estimate the productivity effects of the introduction of feedback and prizes over and above any natural time variation in productivity.

## 6.2 Team Productivity: Average Effects

To shed light on the mechanisms behind the aggregate time series patterns described in Figure 2, we estimate the effect of feedback and tournaments on productivity at the team-field-day level using the following panel data model, controlling for some time varying determinants of productivity,

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

where $y_{ift}$ is the log productivity of team $i$ on field $f$ and day $t$, $I_t$ is an indicator variable that is equal to one when feedback is provided, $P_t$ is an indicator variable that is equal to one when monetary prizes are provided. The provision of prizes necessarily implies feedback, thus $P_t = 1$

[25] A branch of the theory literature on feedback has focused on the strategic manipulation of feedback by the principal, say to induce greater competition between agents in a tournament [Malcolmson 1984]. Such manipulation did not take place during the field experiment.

implies $I_t = 1$. The coefficients of interest are $\beta$, which measures the impact of feedback on productivity relative to the control period, and $\gamma$, which measures the effect of tournaments, that is the combined effect of feedback and monetary prizes, relative to the control period.

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, $t$, to capture learning by management. Field fixed effects, $\lambda_f$, account for unobserved and permanent differences in productivity across fields. Finally, 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.[26]

Table 3 reports the results. Column 1 shows the introduction of feedback and monetary prizes have an effect on productivity over and above natural changes due to the time-varying factors controlled for in (5). The introduction of feedback to teams reduces average team productivity by 15%, and the introduction of tournaments increase it by 24%, both relative to the control regime. The findings indicate that the unconditional difference in means shown in Table 2 indeed fails to capture naturally occurring changes in productivity. In particular, the negative productivity trend due to field depletion dominates the positive trend due to increased experience, and productivity naturally declines throughout the season.

Column 2 tests for anticipation effects by additionally controlling for two indicator variables set to one during the week preceding the introduction of feedback and tournaments respectively, in (5). In line with workers being unaware of either experiment before it was actually introduced, the result shows that neither effect is present before the introduction of the respective treatments. The fact that productivity is naturally declining, and is thus higher before the introduction of feedback, increases in absolute magnitude, the estimated feedback effect to -22%, and increases the precision of the estimate to the 1% level. Similarly, the fact that productivity is naturally declining over time as fields deplete, increases the estimated tournament effect to 33%.[27]

We can benchmark the magnitude of these 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, in the laboratory Nalbantian and Schotter [1997] find that average effort increases by 66% when moving from team piece rates to a tournament between two teams with one prize. Freeman and Gelber [2008] 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.

[26] We have experimented with alternative forms of clustering such as within team or placing more parametric structure on the disturbance terms within a team over time. The reported results based on clustering by field-day are the most conservative in terms of the estimated standard errors suggesting common shocks at the field-day are of first order and dominate any serial correlation in productivity shocks within teams over time. This is not altogether surprising given that teams are rarely observed operating on the same field on consecutive days.

[27] The fact that the dummy on the week preceding the introduction of feedback is positive and significant at the 10% level could be taken as evidence that workers anticipated feedback would be provided. This would be consistent with any model of feedback in which preferences are not separable over time [Lizzeri *et al* 2002], and would also be consistent with the empirical findings of Blanes i Vidal and Nossol [2009] who interpret such pre-effects as evidence of workers having concerns over their relative position or status *per se*, which can generate rat races within organizations [Akerlof 1976].

To internally benchmark the magnitude of the effects, we compare them to the effect of picking experience on productivity. We find that evaluated at the mean, the elasticity of productivity with respect to the team's average picking experience is .125 and this is significantly different from zero at the 1% significance level. The estimated feedback effect on productivity is then equivalent to a decrease, from the mean, of 1.5 standard deviations in picking experience. Similarly, the estimated tournament effect on productivity is equivalent to an increase, from the mean, of 2.5 standard deviations in picking experience. The implied incentive effects are therefore quantitatively large relative to another important determinant of team productivity.

We note that while (5) directly controls for the main time-varying determinants of productivity, the main identification concern is that other time-varying unobservables generate a spurious correlation between the treatments and productivity. The fact that $\beta$ and $\gamma$ 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 A2 in the Appendix presents a series of more flexible time specifications to address further concerns related to time trends in productivity.[28]

Mapping these results back to the model developed in Section 3, we denote the strength of incentives under the control, feedback, and tournament regimes as $p_0$, $p_F$, and $p_T$ respectively. The documented average effects in Table 3 are therefore consistent with,

$$p_T > p_0(1+\pi) > p_F. \tag{6}$$

Following on from Result 2, the data suggests that while the tournament unambiguously increase the returns to effort, the incentive power of feedback is sufficiently strong to induce teams to be less likely to form along friendship lines, so $p_F > \widehat{p}$, but is not sufficiently strong to offset the increase in free-riding within newly teams made up of members with weaker social ties among themselves.

## 6.3 Team Productivity: Dispersion

Figure 2B provides descriptive evidence that the introduction of feedback and tournaments increases the dispersion of productivity at the field-day level. The provision of feedback and monetary prizes can have heterogeneous effects across teams as highlighted by the theoretical framework in Section 3. We now investigate whether the change in team incentives affects the dispersion of productivity controlling for other observables correlated to the dispersion, and establish whether the increased dispersion is due to the slowest teams becoming slower, the fastest teams becoming faster, or both. To do so, we use quantile regression methods to estimate the conditional

[28] In the Appendix we also address a second broad class of concern by presenting evidence on whether the introduction of feedback and monetary prizes are both orthogonal to changes in the behavior of management along other margins that can affect productivity. We show results on a number of dimensions that imply field managers are unlikely to be changing their behavior with the changes in incentives to workers, and nor is the algorithm by which the general manager assigns workers to tasks affected by the change in incentives to workers.

distribution of log productivity at different quantiles $\theta$,

$$Quant_\theta(y_{ift}|.) = \beta_\theta I_t + \gamma_\theta P_t + \phi_{\theta f}\lambda_f + \delta_\theta X_{ift} + \lambda_\theta Z_{ft} + \tau_\theta t, \quad (7)$$

where all variables are as defined previously. Columns 3a to 3e in Table 3 report the simultaneous estimates of (7) at various quantiles $\theta$. The results illustrate that the previously documented average effects of feedback and tournaments mask substantially different changes throughout the conditional distribution of log productivity.

More precisely, the effect of feedback is negative and precisely estimated up to the 25th quantile. Feedback reduces 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. Moreover, the provision of feedback has no effect on teams whose conditional productivity is above the median. Hence, the reason why the dispersion of productivity increases with the provision of feedback is because the lowest productivity teams experience a further decline in productivity when feedback is provided relative to the control regime.

In contrast, the quantile effects of tournaments are positive and precisely estimated only on the three highest quantiles – at the 50th, 75th, and 90th quantiles, and the tournament effect is monotonically increasing moving to higher quantiles. At the median, team productivity increases by 31%, by 38% at the 75th quantile, and by 46% at the 90th quantile. These differences between quantile effects are significantly different from zero at conventional levels as reported at the foot of Table 3. Hence, the reason why the dispersion of productivity increases with the provision of monetary prizes is because the highest productivity teams experience an increase in productivity when monetary prizes are offered relative to the control regime, in line with tournament theory.

Figure 3 provides a graphical representation of the results by plotting the estimates of $\beta_\theta$ and $\gamma_\theta$ at every $\theta \in (0, 1)$, and the associated bootstrapped 90% confidence interval. This emphasizes the pattern described above 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 $\theta$; (ii) $\beta_\theta$ and $\gamma_\theta$ are increasing in $\theta$, (iii) we can reject $\beta_\theta = 0$ for all $\theta < .4$ and can reject $\gamma_\theta = 0$ for all $\theta > .3$.

Our design also isolates the 'pure prize effect' of the employer providing higher expected wages, conditional on feedback being provided to employees. This is equal to the tournament effect minus any implied effect of feedback *per se*, $\widehat{\gamma}_\theta - \widehat{\beta}_\theta$. The estimates indicate that the negative feedback effect and the pure prize effect appear to be of equal and opposite magnitude for the least productive teams, implying that their productivity under tournaments is the same as in the control regime. The tournament effect $\widehat{\gamma}_\theta$ however dominates for the most productive teams and the pure prize effect $\widehat{\gamma}_\theta - \widehat{\beta}_\theta$ is larger for the teams at the top of the productivity distribution.

This pure prize effect can be interpreted in at least two ways. First it captures how employees respond to the employer acting more generously *per se*, in that she is willing to share a greater proportion of profits with her workers. In this sense the productivity responses might be a form of gift exchange from workers to generous employers [Akerlof 1982], where the degree of gift exchange then appears to be larger in percentage terms among more productive teams. An alternative

interpretation is that once monetary prizes are introduced this may alter workers perceptions of why feedback is provided, namely to validate why a prize is deserved by the winning team, rather than provide feedback merely to shame or embarrass the worse performing teams.

The increased dispersion and the differential effects on the productivity of the best and worse teams under each incentive scheme are rationalized within the framework presented earlier. The pattern of results is again consistent with $p_T > p_0(1+\pi) > p_F$. Of course there can be additional mechanisms at play that are not captured in our framework. For example, if it is costly for workers to be dropped from their team and have to search for a new team, this can serve as a disciplining device for workers to exert effort throughout the work week. This, in turn, increases the power of incentives for workers at the bottom of the productivity distribution and might also help explain why the prize effect is positive even for the worse performing teams.

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 feedback regime, and positively correlated with the productivity of the teams on the right tail only during the tournament regime.

## 6.4 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 feedback and tournaments 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 feedback and tournaments on effort we estimate the following panel data specification with team fixed effects, $\alpha_i$,

$$y_{ift} = \beta I_t + \gamma P_t + \lambda_f + \delta X_{ift} + \eta Z_{ft} + \theta t + \alpha_i + u_{ift}, \tag{8}$$

where all other variables are as previously defined. The coefficients of interest, $\beta$ and $\gamma$, are now identified from variation within the same team – namely holding team composition constant. In the absence of individual productivity data, it is not possible to measure such effort responses in teams that do not remain intact across incentive regimes.

Column 4 in Table 3 reports the estimates from (8) 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 $\beta$ and $\gamma$ are positive. While the point estimate on the effect of feedback 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% following the introduction of the tournament scheme. Column 5 estimates (8) 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.

On the plausibility of the magnitude of the tournament effect, we note first that 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 8.23kg/hr, and that of the team at the 90th percentile is 10.08kg/hr. This difference is small relative to the mean productivity, suggesting many teams at or above the median might reasonably expect to be able to win the prize.[29]

Second, given team formation is endogenous in our setting, the option for team members to refuse continuing working with an individual provides a potentially very strong incentive device to individuals to exert effort throughout the week. It is costly for workers to be excluded from a well performing team because of there is an opportunity cost of lost earnings had they remained within a productive team – these cost exist because teams are paid piece rates, and remain significant even if the team never actually wins the prize. Workers may be willing to exert more effort during the week to avoid such costs at the end of the week should they be excluded from their current team. This may exacerbate the response to tournaments in any team setting in which workers endogenously sort into teams, such as here and in the well documented team setting of Hamilton *et al* [2003], relative to workplaces in which tournaments are established between individuals.

Taken together our findings indicate that both the introduction of feedback and tournaments increase incentive power, $p$, and that the latter is more powerful, so $p_T > p_F$. Although both the introduction of feedback and tournaments lead to a change in team composition as suggested by the theoretical framework, only the introduction of tournaments leads to an increase in effort that is large enough to overcome the negative impact of the change in team composition on average productivity resulting from a loss of social connections within teams.

# 7 Interactions Within Teams

The evidence suggests that as team incentives become more high powered, workers match more assortatively by ability and match less according to social connections. These changes can alter interactions within the team, an effect which is not captured in our stylized theoretical framework. To provide evidence on this, we use our survey of workers' opinions on the interactions between team members. We exploit the fact that the survey was administered both in the control and tournament regime, with each worker being interviewed once overall. Ideally we would have liked to compare responses under all three regimes, although we note the probability of matching by friendship is identical in the feedback and tournament regimes, so that evidence from the latter can be informative on the former.

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

[29] Such fierce competition across teams for the prize may imply that it is indeed optimal for there to be one prize across teams, despite the large heterogeneity in ability across workers.

record their preferences and opinions for their team at the time of the survey.[30]

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 tournaments. 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. This arrival date is determined by factors orthogonal to behavior within the workplace, such as the individual's university term dates and the precise time at which their work permit is issued. Importantly for our purposes, the workers' arrival date is chosen before they are aware of the incentive schemes in place, as this was exogenously engineered by us without informing workers beforehand.

Table A4 presents descriptive evidence on workers by survey date. This highlights that as term dates are correlated within country, worker's nationalities differ across the two survey dates, as expected. In turn this may determine why workers surveyed during the control regime report significantly more friends than those interviewed during the tournament regime. Reassuringly, the ratio of the number of reported friends of worker $i$ to the number of times worker $i$ is herself named as a friend is no different across the samples. 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, the workers do not differ across the survey waves.

## 7.1 Interactions With Team Members

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. A comparison of responses across control and tournament groups thus captures changes in the strongest preferences.

The results suggest that when operating under tournaments, team interactions differ on the following dimensions. First, 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 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 monetary prizes 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. The result is not driven by workers across the two surveys waves being differentially experienced – both surveys take place some two weeks after

[30] The first survey was conducted on 20th July during the control regime. The second survey wave took place on the 7th of September during the tournament regime.

workers first arrive to the farm. 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.[31]

Second, compensatory transfers from slow to fast workers are significantly more likely to occur under tournaments than the control regime. This is the case both if such transfers are measured by fast pickers being rewarded in cash by other team members, or if slow pickers pay compensation to other team members. This is consistent with a reduction in social connections between workers in teams that might facilitate transfers along other non-monetary dimensions, again as suggested by the evidence in the previous Section.[32]

## 7.2 Workers' Welfare

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 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 although there may be changes in which workers are demanded at team exchanges between one regime and another, within a regime workers are in equilibrium able to choose their team members optimally in the sense they do not express desires to change the team they are currently in.

Second, we note that significantly more workers report they 'felt happy in relation to work' under the tournament regime. 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. Finally, we note that workers do not report higher levels of life satisfaction in response to the question, 'overall, how satisfied are you with your life?'. Reassuringly this indicates that the previously documented differences in reports on job satisfaction are not due to the fact that workers surveyed during the tournament regime are exogenously happier, and that temporary experiences over the picking season do not impact in major ways on workers' overall life assessment.

[31] More precisely, 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, and estimate robust standard errors. The reported p-value in Column 4 is for the null hypothesis that the survey dummy is equal to zero.

[32] There are other dimensions of team interactions that we also surveyed workers on – such as whether they satisfied with communication in the team, whether they never argue with their team members, and whether they have a lot of fun with their team on the field. There are no significant differences along these dimensions for the two survey waves as expected given that there are no clear predictions on how these margins should alter with the introduction of feedback or tournaments.

# 8 Conclusions

We have provided evidence from a field experiment on the interplay between three common workplace features: team production, performance feedback, and tournaments. The research design combined with personnel and survey data allows us to provide evidence on the effect of feedback 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. There is an increased prevalence of self formed teams in manufacturing industries, and their usage is commonplace within smaller professional organizations such as those practising law, medicine, management consultancy, and academia.

Clearly, our research design only allows us to evaluate the specific feedback and tournament schemes we introduced, and a rich set of questions remain on the optimal feedback to provide or tournament structures to use in workplaces organized into endogenously formed teams. Our design and analysis has been partly motivated by the observation that because tournaments inevitably provide agents with some feedback on their relative performance, it is impossible to consider the optimal tournament structure without also considering how agents respond to feedback.

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. We have shown how feedback and monetary prize incentives affect productivity through three channels when the workplace is organized into teams – individual effort devoted to tasks, how workers sort into teams, and peer pressure or other interactions between team members. As mentioned earlier, a fourth channel related to changes in the composition of the workforce in the firm as a whole, is closed down in this study because workers face a high cost of quitting the firm – 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 feedback or tournaments.[33]

Such selection effects – that have been found to be of first order importance in studies of individual compensation schemes [Lazear 2000] – are muted in our setting. We might for example expect the least productive workers to prefer to exit the firm once performance feedback is provided, reducing the productivity dispersion all else equal. On the other hand, more able workers that also have strong concerns for their social status may be attracted to firms that provide such public feedback. Whether this increases or decreases the dispersion of productivity depends on the ability of these new workers relative to the existing workforce.[34]

[33]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.

[34]Sorting effects have begun to be explored in laboratory settings. For example, Dohmen and Falk [2006] find sorting effects to be as important as the direct incentive effects of incentive pay, and they also find that sorting decisions vary by gender, risk attitudes, and overconfidence. Damiano *et al* [2009] present a theoretical analysis of worker sorting into firms when workers have concerns over their relative and absolute ranking.

Second, and following on from the first point, 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 cooperation or increase sabotage between teams [Lazear 1989, Carpenter *et al* 2008]. In our context, there is little scope for such sabotage as teams are assigned their own rows to pick on and do not share tools for example as in Drago and Garvey [1998].

Within teams, we document how worker interactions change with team incentives. However, in our setting the types of worker interaction within teams may be limited because of the relatively simple nature of their main task, because there are no complementarities between worker efforts arising from the production function, and limited scope for workers to specialize within the team. It remains an open question as to whether incentives alter interactions within teams as a function of these three features of the task being performed.[35]

Finally, 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 homogenous on observables to begin with. Both these factors cause social connections to be stronger than in the representative firm. On the other hand, workers 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 non-monetary incentives for teams.

# 9 Appendix

## 9.1 Proofs

**Proof of Result 1:** We compare the utility levels of the high ability worker in the two possible cases of matching by ability or friendship. Substituting (2) into (1) in the two cases yields,

$$U_i(e_i^*(\theta_H), e_j^*(\theta_H)) = \frac{p^2\theta_H^2}{8} + \frac{p^2\theta_H^2}{4}, \tag{9}$$

$$U_i(e_i^*(\theta_H), e_j^*(\theta_L)) = \frac{(1+\pi)^2 p^2\theta_H^2}{8} + \frac{(1+\pi)^2 p^2\theta_L^2}{4} + s. \tag{10}$$

We note that $U_i(e_i^*(\theta_H), e_j^*(\theta_H)) > U_i(e_i^*(\theta_H), e_j^*(\theta_L))$ if and only if $p > \hat{p} = \frac{s}{\left(\frac{3}{2} - (1+\pi)^2(R^2+1/2)\right)\theta_H^2}$, where $R = \frac{\theta_L}{\theta_H}$. We note that $\hat{p} > 0$ if $\frac{3}{2} - (1+\pi)^2(R^2+1/2) > 0$, which is the condition that guarantees that matching by ability yields higher utility than matching by friendship when

[35] Boning *et al* [2007] provide evidence that the effects of team pay on productivity are larger when teams have more complex tasks to solve. Burgess *et al* [2009] show that following the introduction of office-wide incentives, the managers of two tax collection agencies in the UK increased productivity by reallocating workers across tasks.

$s = 0$. If not, workers always prefer to match by friendship and effectively face no trade-off. It is straightforward to show $\frac{\partial \hat{p}}{\partial \pi} > 0$, $\frac{\partial \hat{p}}{\partial s} > 0$ and $\frac{\partial \hat{p}}{\partial R} > 0$.■

**Proof of Result 2:** Parts (a) and (b) follow directly from the assumptions. Part (c) follows from the comparison of worker effort under the two regimes. When $p = p_0$ and teams are formed among friends, worker $i$'s effort is $\frac{p_0(1+\pi)}{2}\theta_i$, whereas when $p = p_1$ and workers match by ability, worker $i$'s effort is $\frac{p_1}{2}\theta_i$. Hence average productivity increases if and only if $p_1 > p_0(1+\pi)$.

Parts (d) and (e) follow from the comparison of the productivity of each team under the two regimes. At $p = p_0$ teams are formed among friends and both teams produce $\frac{p_0(1+\pi)}{2}\theta_H^2 + \frac{p_0(1+\pi)}{2}\theta_L^2$. At $p = p_1$ workers match by ability, the most productive team produces $p_1\theta_H^2$ and the least productive team produces $p_1\theta_L^2$.

Thus the productivity of the most productive team increases if only if $p_1 > p_0(1+\pi)\frac{1+R^2}{2}$. Since $\frac{1+R^2}{2} < 1$, $p_1 > p_0(1+\pi)$ implies $p_1 > p_0(1+\pi)\frac{1+R^2}{2}$. The productivity of the least productive team increases if only if $p_1 > p_0(1+\pi)\frac{1+1/R^2}{2}$. Since $\frac{1+1/R^2}{2} > 1$, when $p_0(1+\pi) < p_1 < p_0(1+\pi)\frac{1+1/R^2}{2}$, average productivity increases while the productivity of the bottom team decreases. When $p_0(1+\pi) < p_0(1+\pi)\frac{1+1/R^2}{2} < p_1$ the productivity of the bottom team increases. This proves part (d). Extending the argument to the $p_1 < p_0(1+\pi)$ case proves part (e).■

## 9.2 Selection into the Worker Survey

The worker survey is administered on two different dates over the peak picking season – once during the control regime and once during the tournament regime. It is administered in the evening after workers have returned from the fields. We aimed to interview all workers present on the survey date, and obtained a 95% response rate. Of the 265 individuals whose primary task is to pick fruit, 11 were not surveyed as they were not present on the farm on either survey date, namely they arrived after the first and left before the second. We surveyed 177 workers and the remaining 77 were not present on the campsite at the time of the survey, most likely because they were engaged in other non-work related activities away from the farm site at the time of the survey. Table A1 presents descriptive evidence on the characteristics of workers who were interviewed and those who were on the farm's payroll but were not present on survey day. Information available on both sets of workers mostly relates to that contained in personnel records.

Three points are of note. First, those surveyed have similar productivity – averaged across all the teams they are part of – to those not surveyed. This is true both for productivity on average, and also the entire distribution of productivity as shown in the last column by the p-value on the equality of distributions from a Mann-Whitney test. Similarly, the picking experience does not differ across surveyed and non-surveyed workers. Hence it is not the case that the most productive workers are too busy or too tired to be interviewed. Second, the gender and nationality composition of the two groups is quite similar, suggesting they do not differ in the potential social networks they could form in the workplace. Third, surveyed workers are more than twice as likely to name another surveyed worker as their friend, as they are to name an individual who was not surveyed. This is consistent with non-surveyed workers not being present at the time of the

survey due to social engagements away from the workplace, and indicates that the social networks of non-surveyed workers do not overlap with those of surveyed workers.

## 9.3 Robustness Checks on the Team Productivity Estimates

### 9.3.1 Time Effects

Column 1 of Table A2 estimates (5) restricting the control regime to the four weeks immediately preceding the feedback treatment, rather than exploiting the full span of data. This allows us to check whether the estimated effects of each treatment are sensitive to time trends during the control regime. Compared to the baseline estimate in Column 1 of Table 3, the feedback effect is larger in absolute magnitude and more precisely estimated, and the tournament effect is slightly smaller but still precisely estimated. The different estimates between the baseline sample and this shorter sample are likely to stem from a decline in average productivity at the start of the picking season, as shown on Figure 2A. This might be caused by short run logistical problems early in the season or because it takes some time for management to learn which workers are best suited to each task in the workplace. In any case, once this initial downward productivity trend is discarded in the shorter sample, we are then able to more precisely identify the negative effect of feedback on average productivity.

Column 2 checks for whether the feedback and tournament effects themselves vary over time. To do this we split each of the treatment regimes into two week periods and so estimate whether the effects vary between the first and second fortnight. The results shows that the feedback effect becomes more pronounced the longer the provision of feedback has been in place for. In contrast, the point estimates on the tournament effects suggest the effect of the monetary prize becomes slightly stronger the longer such prizes have been offered for. Reassuringly, the estimated effects of feedback or tournaments therefore appear to be neither short run changes based on hot decision making [Gneezy and List 2006, Levitt and List 2007], nor mere responses to changing work conditions *per se* as in a Hawthorne effect. Rather, as workers have more team exchanges in which to respond to the treatments, the effects of each appear to become stronger. The pattern of coefficients found also helps rule out the baseline estimates are merely picking up any underlying aggregate time trend.[36]

Finally, Column 3 addresses the concern that workers are more likely to be close to their date of departure from the farm the longer the tournament has been in place for. If, for example, workers have income targets over the season, then any shortfall in the income earned and that they expected to earn at the start of the season, can only be made up by working harder late in the season. This would lead to a spuriously positive effect of the tournament. To check for this we additionally control for the average number of days until departure for members of team $i$ on field $f$ and day $t$. The results shows the baseline estimates of the feedback and tournament effects

[36] In the long run, once workers have learned their place in the productivity distribution, then, on the margin, feedback should no longer be informative. The results suggest that it takes longer than the four weeks in which feedback is exclusively provided, for workers to fully learn the entire productivity dispersion across workers.

to be unchanged, nor do we find any evidence that team productivity systematically varies with how close members of the team are to leaving the farm.

### 9.3.2 Management Practices

The remaining Columns of Table A2 check whether the main effects documented in Table 3 reflect changing patterns of behavior among workers – who are exposed to experimental changes in their work environment – rather than management, whose compensation schemes are left unchanged. There are two separate causes of concern. First, the behavior of managers may naturally change over time and it is these changes that are spuriously attributed to the estimated treatment effects. Second, with the change in team incentives that workers are subject to, workers may engage in influence activities or other inefficient behaviors in order to change the behavior of their managers [Milgrom 1988]. In this case the baseline results capture the total effect of each treatment rather than the pure effect caused only by changes in worker behavior, all else equal.

The first dimension of management behavior we explore relates to the composition of workers in teams observed picking. More formally, Column 4 of Table A2 estimates (5) restricting the sample to teams made of workers who pick for at least one week in each of the three regimes. This allows us to focus directly on those individuals that are picking throughout the peak picking season and so minimizes any potential contamination of the results caused by changes in the composition of pickers, which might be driven by changes in the behavior of management rather than workers across regimes. The result shows that, although the estimates are slightly less precise in this smaller sample relative to the baseline sample as expected, it remains the case that feedback significantly reduced team productivity and tournaments significantly increase team productivity. In the next subsection we further analyze, at the individual worker level, the selection of workers by the general manager into picking and other tasks, and whether this varies by the treatments.

Columns 5 to 8 check whether changes in managerial behavior might be driving the findings by exploring outcomes at the field-day level. Column 5 estimates whether the number of teams on the field is significantly changed by the regime, conditional on the average picking experience of teams present, the field life cycle, a linear time trend, and field fixed effects. Standard errors are clustered by field to allow for general forms of serial correlation in shocks to the demand for teams within a field over time. Reassuringly the result shows there is no significant change in the number of teams on the field over regimes. This is bolstered by the result in Column 7 that shows there is no significant change in the number of teams per field manager across the incentive schemes. Hence it is not the case that the documented productivity changes at the team level are driven by changes in the span of control of field managers for example.

Along similar lines, Column 8 checks whether the days between when the same field is operated change significantly with the treatments. If for example teams are able to successfully lobby to pick on fields that have been left unpicked for longer – and so where productivity is expected to be higher – and they do this when feedback or monetary prizes are provided, our previous results would capture the total effect of the change in incentives, including workers lobbying managers,

rather than a pure incentive effect. Reassuringly the result does not support this claim.

Finally, note that in some circumstances 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. If teams are able to lobby managers to remove certain workers from their team, or the conduct of the team exchange becomes less lax over time so that teams are more likely to only comprise four workers, then some of the estimated effects of the treatments might actually be attributable to other such factors. To check for this in Column 8 we define the dependent variable to be the share of teams on the field-day that are temporarily reduced to less than five members. We find no systematic change in this share with the provision of feedback or tournaments.

## 9.4 The Assignment of Workers to Teams

We address the concern that how worker demands in the team exchange translate into actual assignments by the general manager might vary systematically with the team incentives in place so that demands may be more reliable indicators of worker preferences over matching at some parts of the season than others. To do so we construct a panel data set where the unit of observation is at the worker $i$-worker $j$-team exchange $t$ level. We restrict the analysis to: (i) pairs of workers who are both present on the farm at exchange $t$ and can therefore feasibly demand to work with one another; (ii) workers that are surveyed and so friendship data exists for; (iii) workers that make at least one demand during the team exchanges, or are demanded by at least one other worker during the team exchanges. We include only one observation per worker $i$-worker $j$ pair in each team exchange given that demands at the team exchange must be reciprocal. The final data set then contains 558340 observations, covering 50933 worker pairs over the 16 weekly team exchanges that take place during the peak picking season. We then estimate the following specification at the worker $i$-worker $j$-team exchange $t$ level,

$$A_{ijt} = \alpha_{ij} + \beta s_{ijt} + \delta \left[ s_{ijt} \times I_t \right] + \zeta \left[ s_{ijt} \times P_t \right] + \tau_t + u_{ijt}, \tag{11}$$

where $A_{ijt}$ is equal to one if the general manager actually assigns worker $i$ and $j$ to work together in a team after team exchange $t$ has taken place, $s_{ijt}$ is equal to one if worker $i$ demands to work with $j$ at team exchange $t$ and zero otherwise, and all other variables are as previously defined. We cluster standard errors by team exchange.

The result in Column 1 of Table A3 shows that demands are likely to translate into assignments ($\widehat{\beta} > 0$) with a high probability, and that the translation of demands to assignments by the general manager does not vary with either treatment ($\widehat{\delta} = \widehat{\zeta} = 0$). This suggests management faithfully implemented worker demands from the team exchange throughout the season, irrespective of whether feedback or tournaments were in place.

## 9.5 The Assignment of Workers to Tasks

Table A3 presents evidence on how the general manager assigns individual workers to various tasks in the workplace. These tasks include picking fruit, weeding, planting, or to be left unemployed for the day. The null hypothesis is that the behavior of the general manger is unaffected by the provision of feedback or monetary prizes to bottom tier workers. We consider the sample of all workers that are available to pick fruit for at least two weeks before the start of the feedback treatment and at least two weeks after the introduction of the tournament treatment. This represents the pool of workers over which the general manager makes his selection decision. There are 243 workers and 110 days in this sample.

To shed light on the determinants of worker assignment to tasks we condition on farm level variables that affect the probability of being assigned to tasks independently of the incentive schemes in place. We then estimate a linear probability model of the form,

$$p_{it} = F(I_t, P_t, X_t^D, X_t^S, X_{it}), \tag{12}$$

where $p_{it}$ equals one if worker $i$ is selected by the general manager to pick on day $t$, and is zero otherwise, and $I_t$ and $P_t$ represent the treatment dummies defined earlier. $X_t^D$ and $X_t^S$ proxy the demand and supply of labor on day $t$. We measure the demand for labor by controlling for the number of fields and sites that are operated on day $t$ for each variety of fruit. We measure the supply of labor as the number of workers on the farm that are available to pick fruit on day $t$. In addition we control for a cubic time trend. Finally, the time varying worker characteristic we control for in $X_{it}$ is the cumulative number of days worker $i$ has been present on the farm for.

We estimate (12) using GLS where we estimate panel corrected standard errors allowing for first order autocorrelation within each worker to capture persistent shocks to the worker, such as her health status, that affect the likelihood of her being assigned to any given task . The error terms are also allowed to be worker specific heteroscedastic and contemporaneously correlated across workers to capture common shocks to worker assignments to tasks.

Column 2 of Table A3 shows that others things equal, the likelihood of being selected to pick fruit does not significantly differ between the control period, and neither the feedback treatment nor the tournament treatment. Hence the timing of the treatments does not appear to coincide with aggregate changes in the demand for workers to engage in picking tasks. Column 3 shows that conditional on being selected to conduct a task – be it picking or non-picking – the probability of being assigned specifically to picking tasks does not vary over the regimes.

Column 4 defines the dependent variable $p_{it}$ to be equal to one if worker $i$ only engages in picking tasks on day $t$, and is zero otherwise. This allows us to focus in on whether the general manager changes the selection of workers that are exclusively picking in response to the incentive schemes. The result shows this not to be the case.

While the specifications so far focus on whether there is a change in assignment probabilities for the average worker, the next two columns address whether the marginal worker assigned to specialize in picking tasks varies with the change in worker incentives. To do so we exploit the

worker survey and explore whether there are heterogeneous effects of the treatments on assignment along two dimensions: (i) whether the worker reports their primary reason for coming to work was money, or not; (ii) the preferred pay scheme of the worker, be it a fixed hourly wage, an individual piece rate, or a team based piece rate.

On the first heterogeneous effect, Column 5 shows that workers who report coming for money – who may be better motivated – are not differentially likely to be assigned by the general manager to engage exclusively in picking under either incentive scheme. If anything, the pattern of coefficients suggests that those not motivated by money are more likely to be assigned to picking under the tournament regime, when team productivity has been shown to rise significantly. On the second heterogeneous effect, Column 6 shows that workers who prefer piece individual or team piece rates, relative to those that prefer hourly wages, are no more likely to only pick under either treatment. Again, if anything the result hints at workers that prefer fixed hourly wages – and so are presumably less motivated or of lower ability – are marginally more likely to pick when the tournament is introduced, although this effect is not significant at conventional levels.

Overall these findings provide little to suggest the average or marginal worker selected by the general manager to pick varies with the team incentive schemes in place, or that changes in how the general manager assigns workers over time leads to overestimating the feedback and tournament effects. In turn, this implies the documented baseline effects of feedback and tournaments reported throughout represent changes in behavior of the bottom tier of workers – whose incentives have explicitly been experimentally varied – and do not capture any additional effects caused by changes in behavior of the general manager.

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## Table 1: Team Composition - Team Level Regressions

### Robust standard errors in parentheses clustered by team exchange

| Dependent Variable: | Share of Friendship Links | | | | Team Members' Ability: Coefficient of Variation | | | |
|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| **Team formed under feedback 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 | -.016 | | .007 | .007 | -.000 |
| | | (.016) | (.016) | (.016) | | (.007) | (.007) | (.009) |
| **Team formed under first half of feedback regime** | | | -.064** | -.064** | | | -.013 | -.022* |
| | | | (.024) | (.024) | | | (.013) | (.013) |
| **Team formed under second half of feedback regime** | | | -.082*** | -.082*** | | | -.023*** | -.021*** |
| | | | (.012) | (.012) | | | (.007) | (.006) |
| **Team formed under first half of tournament regime** | | | -.101*** | -.102*** | | | -.020*** | -.017*** |
| | | | (.015) | (.015) | | | (.005) | (.004) |
| **Team formed under second half of tournament regime** | | | -.072*** | -.071*** | | | -.019 | -.013 |
| | | | (.011) | (.011) | | | (.014) | (.012) |
| **Log (mean days on farm on date of formation)** | | | | .014 | | | | -.045*** |
| | | | | (.028) | | | | (.012) |
| **P-value Test 1: Feedback=Tournament** | .424 | .424 | | | .840 | .840 | | |
| **P-value Test 2: Second half control=Feedback** | | .000 | .043 | .043 | | .001 | .086 | .085 |
| **P-value Test 3: First half=Second half-Feedback** | | | .481 | .475 | | | .506 | .947 |
| **P-value Test 4: First half=Second half-Tournament** | | | .018 | .017 | | | .961 | .726 |
| **Adjusted R-squared** | .080 | .081 | .083 | .083 | .019 | .019 | .016 | .071 |
| **Observations** | 656 | 656 | 656 | 656 | 594 | 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. We limit this to teams for who 80% of their members have either of these measures defined. In Columns 4 and 8 we control for the log of the average number of days the team members have been present on the farm for.

## Table 2: Time Series Descriptives on Productivity by Regime

| | Control Regime | Feedback Regime | Tournament Regime | $H_0$: Control = Feedback | $H_0$: Feedback = Tournament | $H_0$: Control = Tournament |
|---|---|---|---|---|---|---|
| **Average productivity (kg/hr)** | 9.13<br>(2.05) | 6.31<br>(1.58) | 8.37<br>(1.78) | [.000] | [.000] | [.091] |
| **Productivity dispersion** | .318<br>(.206) | .479<br>(.258) | .529<br>(.281) | [.004] | [.497] | [.000] |

**Notes:** 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 tournament 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.

## Table 3: The Effect on Feedback and Tournaments 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 field-day**

| | (1) Baseline | (2) Pre-trend | (3a) 10th | (3b) 25th | (3c) 50th | (3d) 75th | (3e) 90th | (4) Team FE - 3 Regimes | (5) Team FE- 2 Regimes |
|---|---|---|---|---|---|---|---|---|---|
| **Feedback** | -.147* | -.218*** | -.340*** | -.135** | -.012 | -.052 | -.029 | .048 | -.092 |
| | (.081) | (.085) | (.125) | (.064) | (.035) | (.035) | (.045) | (.114) | (.114) |
| **Tournament** | .244*** | .328*** | .021 | .025 | .312*** | .388*** | .461*** | .250** | .212** |
| | (.068) | (.102) | (.110) | (.077) | (.041) | (.033) | (.051) | (.112) | (.096) |
| **Week preceding feedback** | | .154* | | | | | | | |
| | | (.083) | | | | | | | |
| **Week preceding tournament** | | -.075 | | | | | | | |
| | | (.102) | | | | | | | |
| **Feedback effects equal: 10th and 25th quantiles** | | | [.066] | | | | | | |
| **Tournament effects equal: 10th and 25th quantiles** | | | [.971] | | | | | | |
| **Feedback effects equal: 25th and 50th quantiles** | | | | [.031] | | | | | |
| **Tournament effects equal: 25th and 50th quantiles** | | | | [.000] | | | | | |
| **Feedback effects equal: 50th and 75th quantiles** | | | | | [.251] | | | | |
| **Tournament effects equal: 50th and 75th quantiles** | | | | | [.040] | | | | |
| **Feedback effects equal: 75th and 90th quantiles** | | | | | | [.533] | | | |
| **Tournament 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 (clusters)** | 2914 (466) | 2914 (466) | 2914 (466) | 2914 (466) | 2914 (466) | 2914 (466) | 2914 (466) | 349 (222) | 893 (322) |

**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 feedback variable is a dummy equal to one in the week prior to the introduction of feedback, 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 field-day 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.

## Table 4: Within Team Interactions, Opinions, 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) | | |
| **Fast pickers are rewarded in cash by other team members** | .287 | .425 | [.050] | [.059] |
| | (.454) | (.497) | | |
| **Slow pickers pay other team members to compensate** | .241 | .413 | [.012] | [.029] |
| | (.430) | (.495) | | |
| **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 tournament 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.

**Table A1: Characteristics of Surveyed and Non-Surveyed Workers**

**Means, standard errors in parentheses, p-value on Mann Whitney Test in brackets**

| | | Surveyed | Not Surveyed | Difference (standard error) | Mann-Whitney Test of Equality of Distributions |
|---|---|---|---|---|---|
| **A. Number (%) of Workers** | | 177 (70.0) | 77 (30.3) | | |
| **B. Productivity, Work Experience, and Ability** | **Productivity [kg/hr]** | 8.12 | 7.96 | .159 | [.608] |
| | | (.212) | (.326) | (.389) | |
| | **Total picking experience [field-days]** | 70.6 | 72.7 | -2.14 | [.365] |
| | | (4.46) | (9.07) | (10.1) | |
| **C. Friendship Networks** | **Number of times mentioned as a friend by a** | 2.72 | 1.30 | 1.42*** | [.000] |
| | | (.158) | (.171) | (.232) | |
| **D. Worker Characteristics** | **Gender [female=1]** | .362 | .377 | -.015 | - |
| | | (.036) | (.056) | (.066) | |
| | **Live on main farm site [yes=1]** | .678 | .753 | -.075 | |
| | | (.035) | (.049) | (.061) | |
| | **Main nationality** | Ukranian (36.7%) | Ukranian (35.1%) | - | |

**Notes:** *** denotes significance at 1%, ** at 5%, and * at 10%. This data is obtained from the firm's personnel records and the survey we administered to workers. Total picking experience is the number of field-days the worker picks on over the entire season. There are eight nationalities represented among the workers. The standard errors on the differences are estimated from running the corresponding least squares regression allowing for robust standard errors.

## Table A2: Robustness Checks on The Effect on Feedback and Tournaments on Team Productivity

**Dependent Variable (Columns 1 to 4) = Log of team's productivity on the field-day (kilograms/hour)**

**Standard errors in parentheses, clustered by field-day (Columns 1-4), and by field (Columns 5-8)**

| | Time Concerns | | | Management Practices | | | | |
|---|---|---|---|---|---|---|---|---|
| | (1) Shorter Control Regime | (2) Quarters | (3) Days to Go | (4) Same Workers | (5) Number of Teams on Field | (6) Number of Teams per Field Manager | (7) Days Since Field Was Last Picked | (8) Share of Teams With Less Than Five Members |
| **Feedback** | -.204** | | -.142* | -.210* | -.221 | -.012 | 1.69 | 1.69 |
| | (.087) | | (.085) | (.108) | (.592) | (.147) | (1.34) | (1.34) |
| **Tournament** | .165** | | .246*** | .141* | -.890 | .179 | 1.46 | 1.46 |
| | (.079) | | (.069) | (.076) | (.843) | (.161) | (.914) | (.914) |
| **Feedback weeks 1 and 2** | | -.093 | | | | | | |
| | | (.089) | | | | | | |
| **Feedback weeks 3 and 4** | | -.221** | | | | | | |
| | | (.103) | | | | | | |
| **Tournament weeks 1 and 2** | | .271*** | | | | | | |
| | | (.075) | | | | | | |
| **Tournament weeks 3 and 4** | | .332*** | | | | | | |
| | | (.097) | | | | | | |
| **Days to go** | | | .006 | | | | | |
| | | | (.027) | | | | | |
| **Field fixed effects** | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| **Additional controls** | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| **Adjusted R-squared** | .338 | .312 | .310 | .303 | .503 | .463 | .077 | .077 |
| **Number of team-field-day observations (clusters)** | 2533 (400) | 2914 (466) | 2914 (466) | 1493 (429) | | | | |
| **Number of field-day observations (clusters)** | | | | | 466 (15) | 466 (15) | 459 (15) | 459 (15) |

**Notes:** *** denotes significance at 1%, ** at 5%, and * at 10%. The unit of observation is the team-field-day in Columns 1 to 4, and the field-day in Columns 5 to 8. All continuous variables are in logarithms in Columns 1 to 4. Standard errors are clustered by field-day in Columns 1 to 4, and are clustered by field in Column 5 to 8. In Columns 1 to 4 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 the field-day level specifications, an analogous set of controls - where picker experience is averaged within the field-day - are included in levels. In Column 1, we restrict the control regime to the four weeks preceding the feedback experiment. In Column 2 we split the Feedback and Tournament regimes in two periods of two weeks each. In Column 3 we control for the average number of days left before the team members departure. In Column 4 we restrict the sample to teams made of workers who pick for at least one week in each of the three regimes. The dependent variable in Column 5 is the number of teams that are picking on the field-day. The dependent variable in Column 6 is the number of teams per field manager. The dependent variable in Column 7 is the number of days since the field was last picked. The number of observations drops in Column 7 because we drop the first day a field was picked. The dependent variable in Column 8 is the share of teams that are temporarily reduced to

## Table A3: The Assignment of Workers to Tasks and Teams

**Standard errors clustered by team exchange in Column 1**

**GLS panel corrected standard errors allowing for first order autocorrelation within worker in Columns 2-6**

| Dependent Variable: | (1) Assignment to Demanded Team Member | (2) Picking | (3) Picking Conditional on Employed | (4) Only Picking | (5) Only Picking | (6) Only Picking |
|---|---|---|---|---|---|---|
| **Demand** | .699*** | | | | | |
| | (.032) | | | | | |
| **Demand x Feedback** | .053 | | | | | |
| | (.036) | | | | | |
| **Demand x Tournament** | .029 | | | | | |
| | (.022) | | | | | |
| **Feedback** | | -.019 | -.006 | .002 | .004 | .029 |
| | | (.020) | (.015) | (.023) | (.025) | (.032) |
| **Tournament** | | -.018 | -.006 | .028 | .041* | .054* |
| | | (.020) | (.015) | (.022) | (.025) | (.032) |
| **Feedback x Came for money [Yes=1]** | | | | | -.005 | |
| | | | | | (.030) | |
| **Tournament x Came for money [Yes=1]** | | | | | -.037 | |
| | | | | | (.033) | |
| **Feedback x Prefer individual piece rate** | | | | | | -.052 |
| | | | | | | (.042) |
| **Feedback x Prefer team piece rate** | | | | | | -.050 |
| | | | | | | (.077) |
| **Tournament x Prefer individual piece rate** | | | | | | -.052 |
| | | | | | | (.046) |
| **Tournament x Prefer team piece rate** | | | | | | -.087 |
| | | | | | | (.086) |
| **Mean of dependent variable in control period** | .017 | .509 | .666 | .450 | .450 | .534 |
| **Mean of dependent variable in control period if demand=1** | .758 | | | | | |
| **Mean of dependent variable in control period if demand=0** | .009 | | | | | |
| **Fixed effects** | Team Exchange, Worker Pair (i,j) | Worker, Date | Worker, Date | Worker, Date | Worker, Date | Worker, Date |
| **Number of observations (worker-day level)** | | 25538 | 20128 | 25538 | 25538 | 15168 |
| **Number of observations (worker i-worker j-team exchange t level)** | 558340 | | | | | |

**Notes:** *** denotes significance at 1%, ** at 5%, and * at 10%. In Column 1 the unit of observation is worker i-worker j-team exchange t, and standard errors clustered by team exchange are reported in parentheses. The sample includes all team exchanges that take place from June 1st until October 1st. The sample includes workers that are surveyed and so friendship data exists for, and those that make at least one demand during the team exchanges, or are demanded by at least one other worker during the team exchanges. There is one observation per worker i-worker j pair in each team exchange. The dependent variable a dummy equal to one if worker i and worker j are actually assigned to work together in the week after team exchange t. In this column, we control for team exchange fixed effects and worker i-worker j pair fixed effects. In Columns 2 to 6 the unit of observation is the worker-day. Panel corrected standard errors allowing for first order autocorrelation within each worker are in parentheses. The error terms are also allowed to be worker specific heteroscedastic and contemporaneously correlated across workers. The sample is based on workers that are present for at least two weeks before the start of the feedback regime and two weeks after the introduction of the tournament regime. There are 243 workers and 110 days in the sample. The dependent variable in Columns 2 and 3 is equal to one if the worker is assigned to any picking tasks on the day, and is zero otherwise. In Column 3 the sample is restricted to those days where the worker is assigned to some task. The dependent variable in Columns 4 to 6 is equal to one if the worker is assigned to only picking tasks on the day, and is zero otherwise. In Columns 2 to 6 we control for the number of fields and sites that are operated on day t for each variety of fruit, the number of workers on the farm that are available to pick fruit on day t, a cubic time trend, and the cumulative number of days worker i has been present on the farm for. The "came for money" and "preferred pay scheme" questions are from the worker survey. The omitted category for he preferred pay scheme question is a fixed hourly wage.

# Table A4: Worker Characteristics by Survey Date

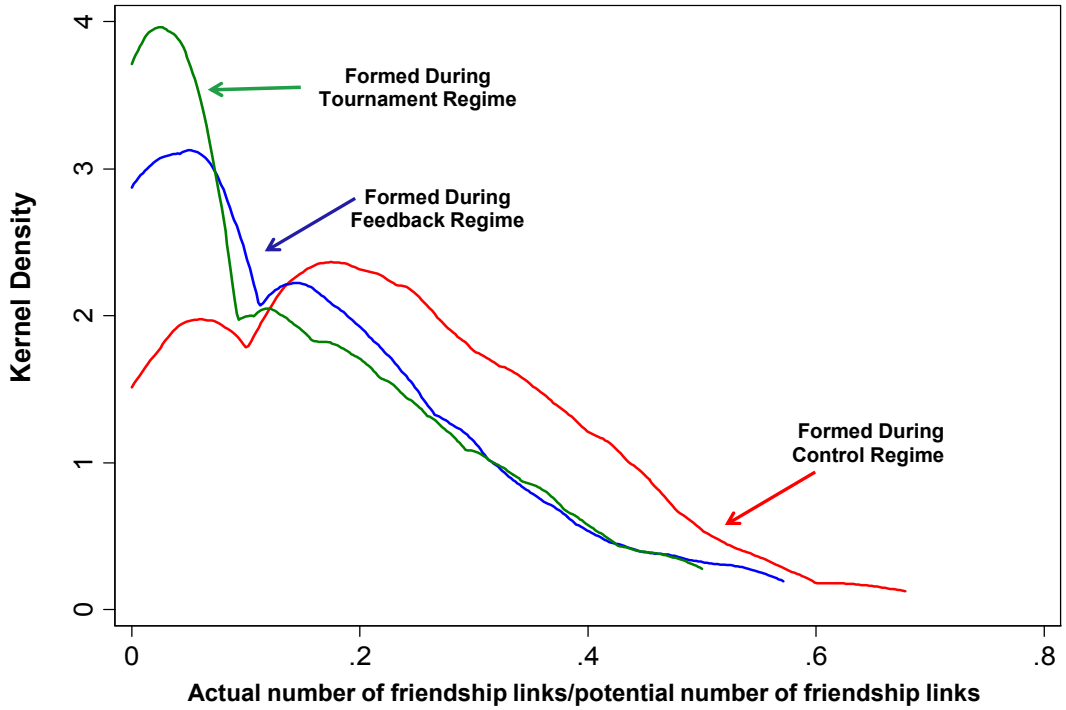
## Means and standard deviation in parentheses

| | Surveyed in Control Period | Surveyed in Tournament Period | Difference [p-value] |
|---|---|---|---|
| **Individual Characteristics** | | | |
| **Gender [female = 1]** | .361 | .338 | [.739] |
| | (.483) | (.476) | |
| **Nationality: Ukrainian** | .411 | .202 | [.000] |
| | (.494) | (.404) | |
| **Nationality: Polish** | .137 | .483 | [.000] |
| | (.345) | (.503) | |
| **Lives on main site [yes = 1]** | .645 | .614 | [.655] |
| | (.480) | (.490) | |
| **Social Network Characteristics** | | | |
| **Number of friends** | 4.40 | 3.21 | [.001] |
| | (2.32) | (2.35) | |
| **Number of times named as a fri** | 3.19 | 2.21 | [.001] |
| | (2.17) | (1.83) | |
| **Number of friends/number of times named as a friend** | 1.73 | 1.89 | [.526] |
| | (1.49) | (1.85) | |
| **Attitudes** | | | |
| **Main reason for coming: pay** | .556 | .500 | [.453] |
| | (.499) | (.056) | |
| **Main reason for coming: university work experience** | .111 | .200 | [.429] |
| | (.660) | (.877) | |
| **Would prefer an individual piece rate** | .250 | .213 | [.551] |
| | (.435) | (.417) | |
| **Would prefer a fixed wage** | .704 | .738 | [.613] |
| | (.459) | (.443) | |

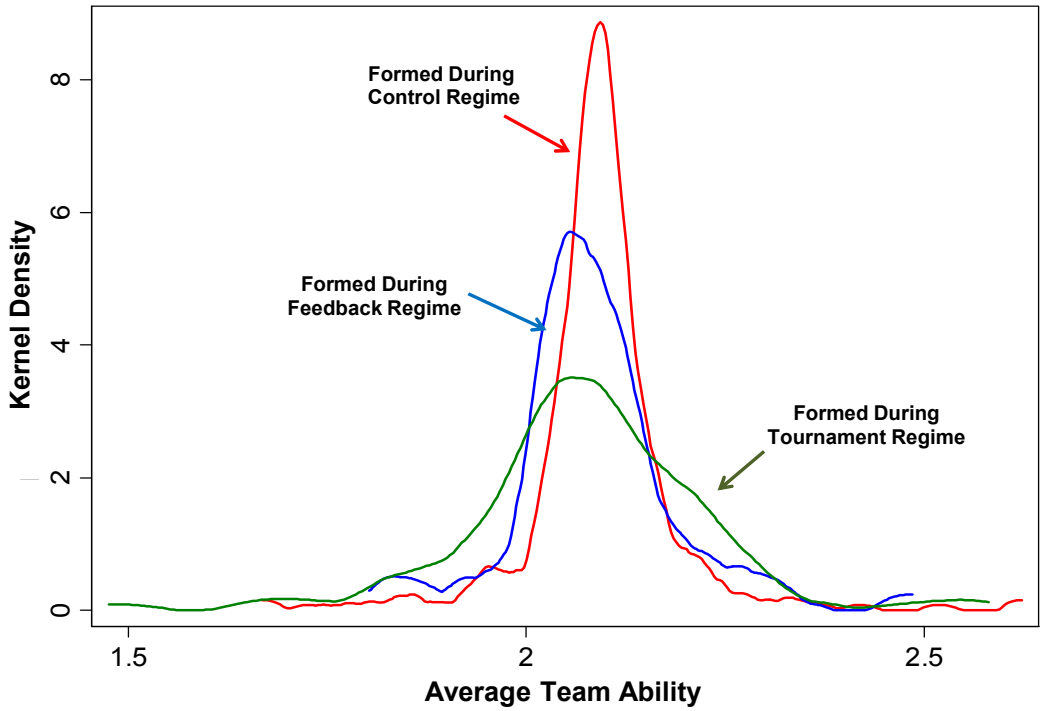
**Notes:** The first survey was conducted on 20th July during the control regime. The second survey wave took place on the 7th of September during the tournament regime. P-values are reported for the null hypothesis of the variable being equal across the survey waves, against a two sided alternative. There are four sites on the farm – the main site is defined to be the site on which the majority of workers reside. The "number of times named as a friend" is the number of times the worker is named as a friend of all other workers that were surveyed in both waves. In the question on "main reason for coming", workers could respond with one of the following answers – "pay", "it is a work experience for my university degree course", "to learn English", or "to make friends". In the question on pay preference workers were asked "how would you like to be paid?" There were three possible responses - a fixed wage, individual piece rate, or team piece rate.

## Figure 1: Team Composition by Incentive Regime

### Figure 1A: Friendship Links

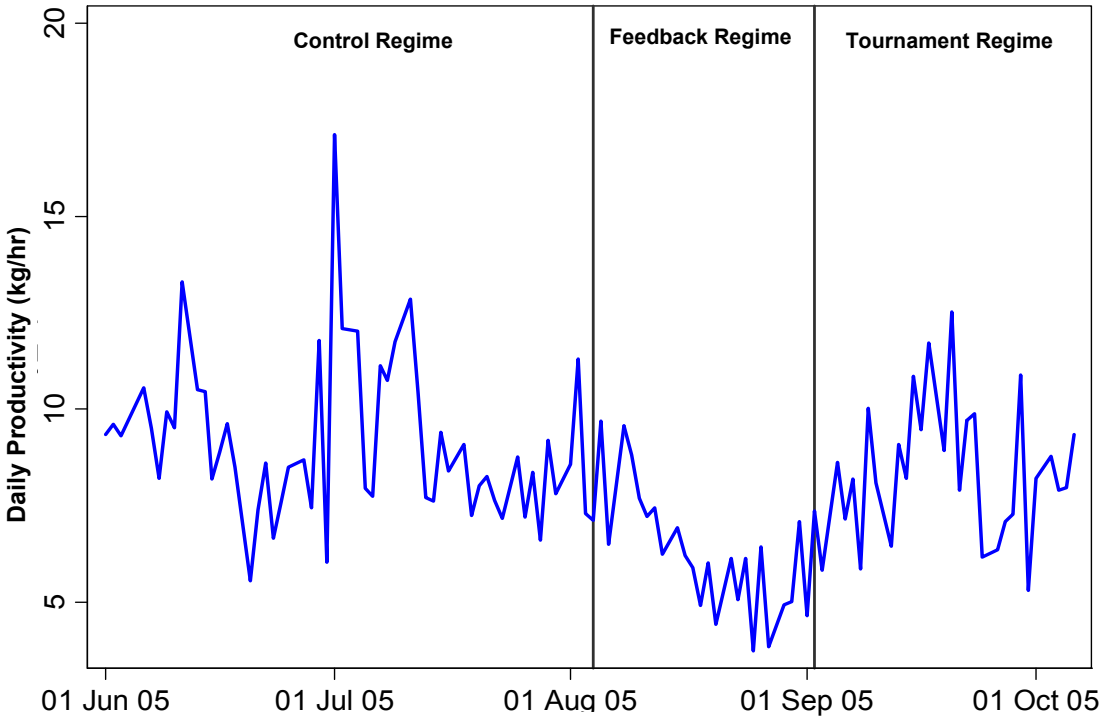



### Figure 1B: Team Mean Ability

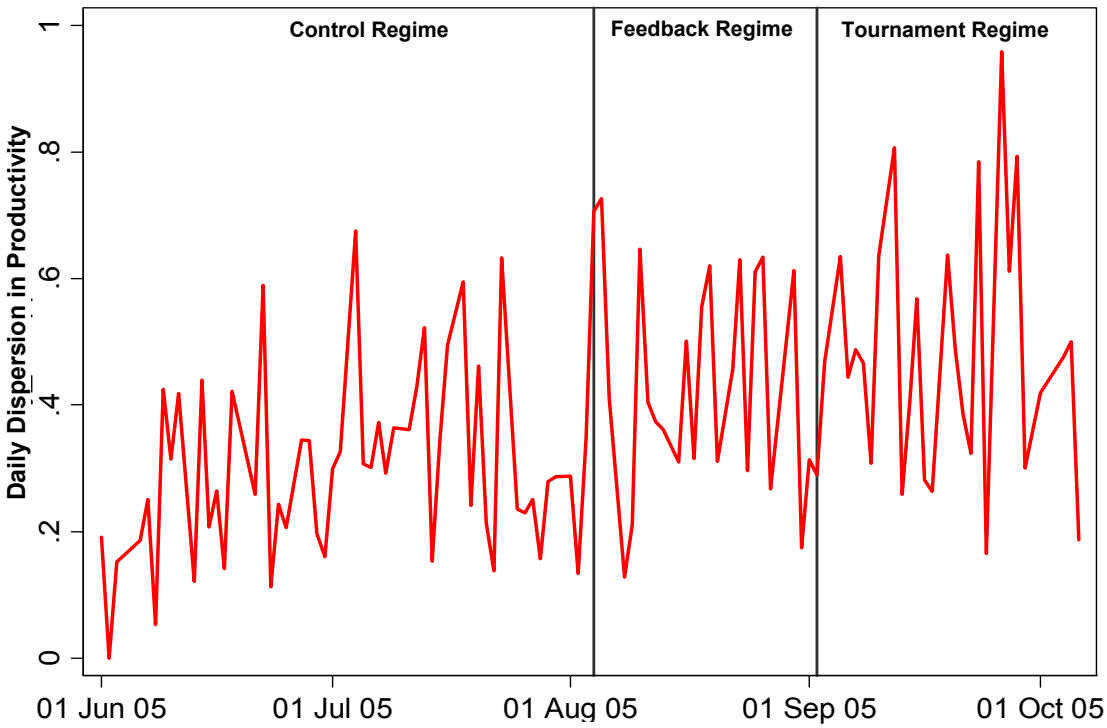



**Notes:**. Figure 1A shows kernel density estimates of the share of friendship links in team that first formed during the control regime, first formed during the feedback regime, and first formed during the tournament regime. There are 351, 126, and 211 such teams, respectively. The share of friendship 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 1B shows kernel density estimates of the average ability of teams that first formed during the control regime, first formed during the feedback 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 Figures 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 2A: Average Productivity

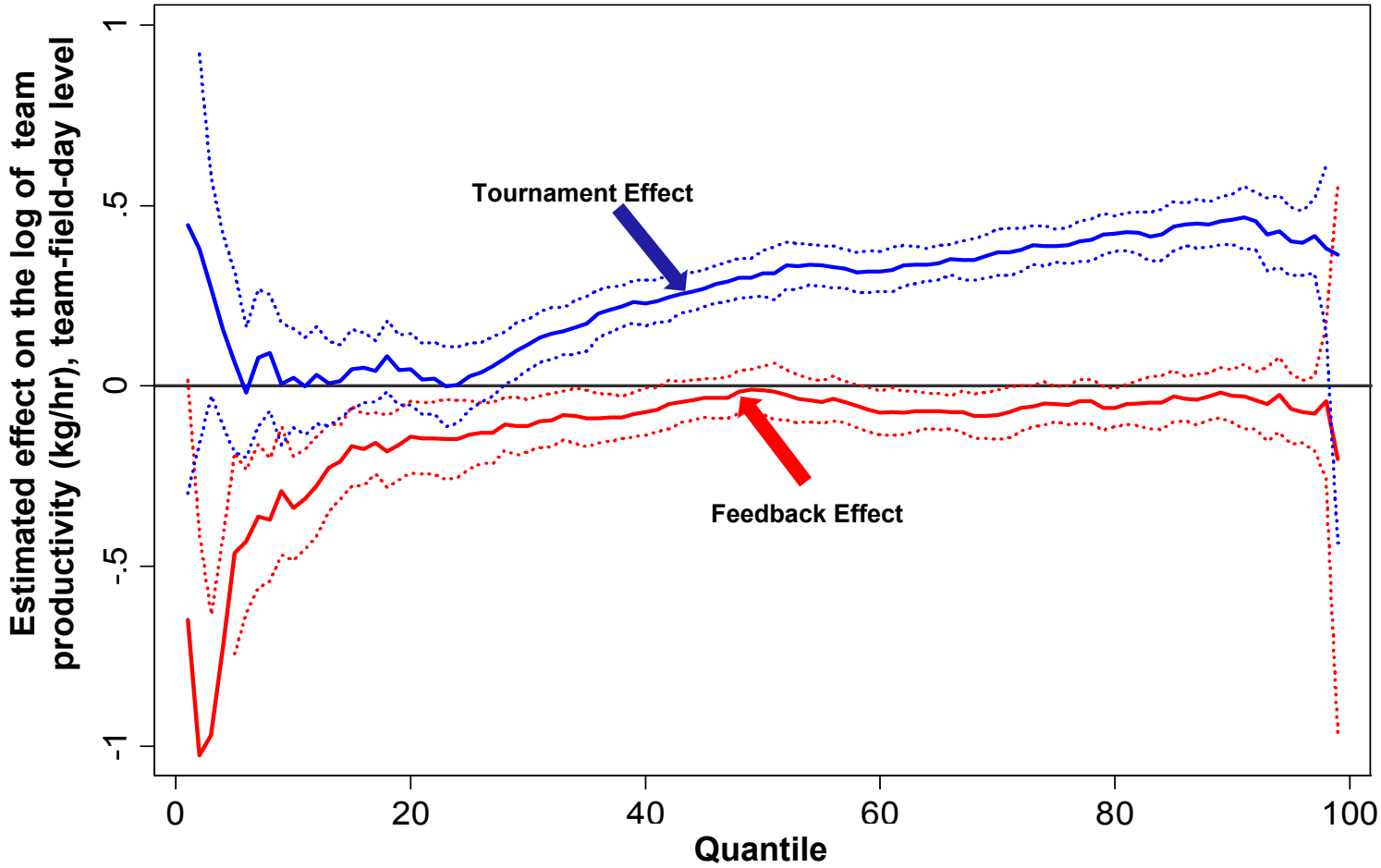



## Figure 2B: Dispersion (IQR/Mean) of Productivity




**Notes:** The figures 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 June 1st to October 6th. Of these, 54 days are in the control regime, 24 in the feedback regime and 30 in the tournament regime.

# Figure 3: Quantile Regression Estimates




**Notes:** The figure graphs the estimated effect of the feedback 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.

**Figure A1a: Worker First Day in Payroll Data**

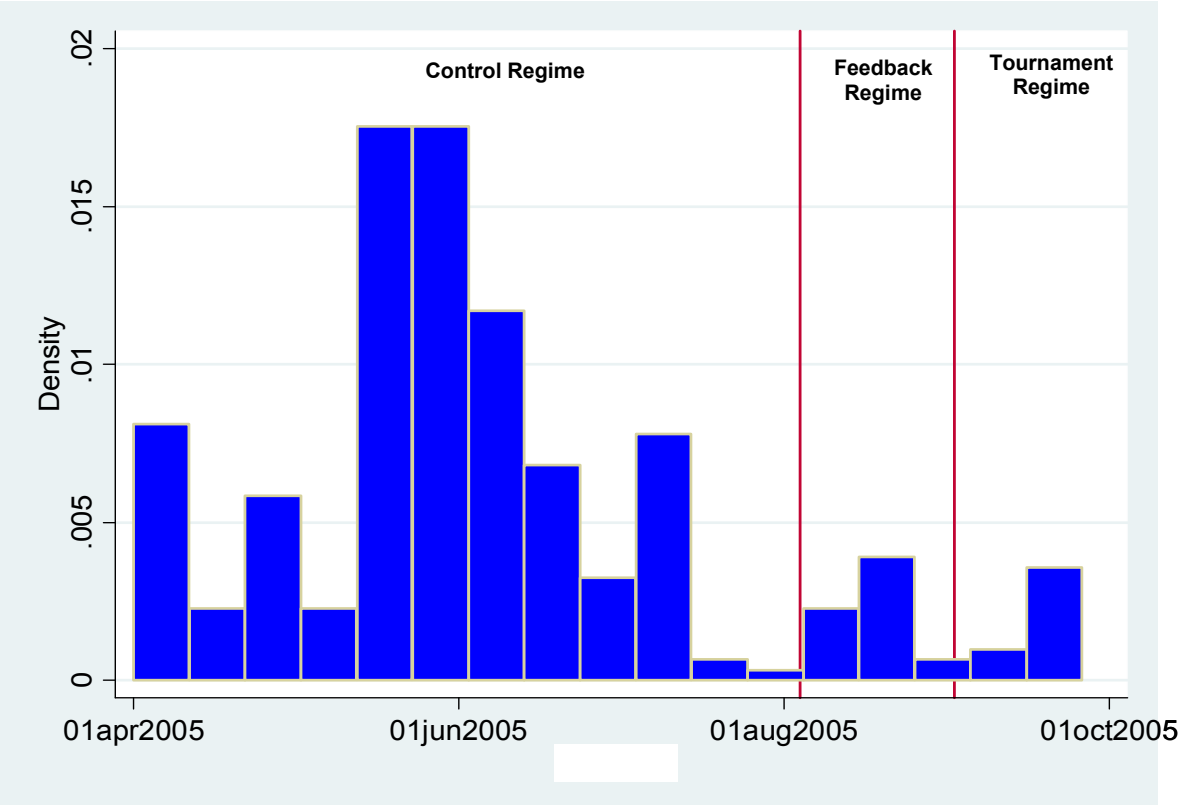
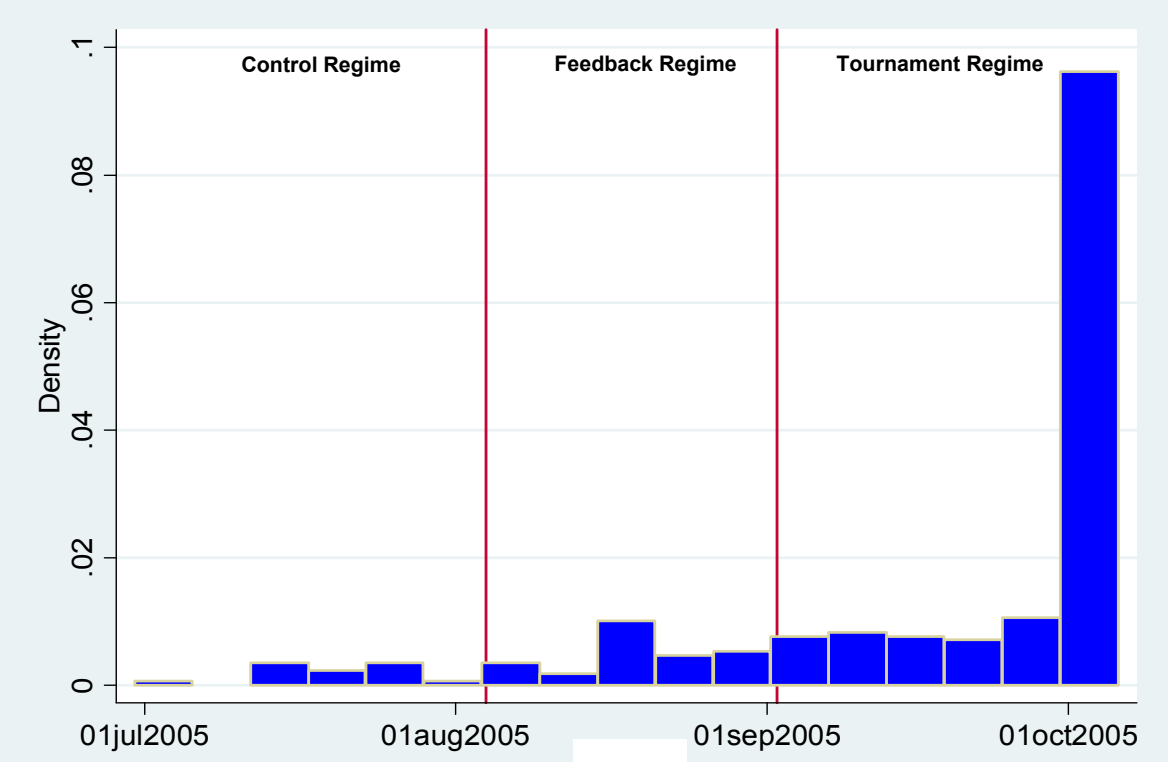



**Figure A1b: Worker Last Day in Payroll Data**




**Note:** The figures show the histogram of the first and last day each worker is recorded in the payroll data, for workers that are present on the farm for at least one week.