Productivity dynamics, performance feedback and group incentives in a sales organization*

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Abstract

This paper investigates the effect of performance feedback on productivity in a company where workers operate in teams and receive a bonus that depends on both individual worker and team productivity. To address this issue, we employ weekly productivity and administrative data obtained from the customer service centre of an insurance company. We find evidence that performance feedback given each Monday morning about past team production and individual rank position within teams influences current individual productivity. The effect of rank position is strongest when bonuses depend on team performance. Overall, our findings suggest that team dynamics may alleviate the free-rider problem often associated with team bonuses, where it is essential that team leaders provide information about individual and team performance in previous periods.

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1 Introduction

Firms use work teams and team bonuses for a number of reasons.[1] However, when assessed strictly in terms of worker motivation, team bonuses appear to be an inefficient way to organize production due to free-rider problems. With a team bonus, individual workers bear the entire cost of their work effort, but receive only a fraction of the bonus generated. Selfish calculation of the costs and benefits thus predicts low effort and performance in teams. However, this outcome potentially differs if workers are sensitive to comparisons with their co-workers, social appraisal, and the pressure to perform that naturally arise when collective achievements determine worker pay. Furthermore, relative performance in the past may then matter for current performance. The strength and structure of such dynamic team effects, and the extend to which they depend on team pay, are the topic of this paper.

We obtain our data from the customer service centre of an insurance company. This is a so-called inbound call centre where agents provide information and sell insurance to those calling in during daytime from Monday to Friday. The agents operate in teams of 8–12 members and receive a bonus that depends on both individual worker sales and team sales. Agents are informed about how well they are doing relative to the average performance of their team. Every Monday morning, the team leaders inform sales agents about their own sales and the average sales in the team in the preceding week. Completely self-contained workers are insensitive to peer comparisons and will be unmoved by information about the previous week's relative performance. However, more socially responsive workers may feel both intrinsic and extrinsic pressure to exert greater effort if they receive negative information about their relative performance (Barankay, 2012).

To examine the effects of information sharing and feedback in a team setting, we use six years of weekly productivity records for individual workers who work in permanent teams to construct a dynamic panel model. We estimate how relative performance ranking the previous week, which is information provided to workers every Monday morning, affects agent productivity in the current week. We do this under two different remuneration schemes: one with a mix of individual and team based bonus, and one where bonus payments are based on individual production only.

[1] These include potential effects on performance, quality, risk sharing, absenteeism, employee turnover, plant structures, operating norms and work processes through information sharing, worker involvement, downtime, etc. (Bishop et al., 2000; Hackman et al., 2000; Harris, 2011; Jones and Kato, 2011).

We find evidence of an inverse relationship between the response in individual performance and the previous quartile rank in the team, where low–ranked workers in a given week respond by increasing sales relative to higher–ranked workers in terms of productivity. Another interesting observation is that the co-worker productivity effects and rank effects disappear and are not significant during a period when individual sales entirely determine the bonus. A transition to team bonus changes how workers respond to changes in the productivity of other team members based on information provided on Monday morning meetings. Overall, our findings suggest that information sharing about own and team productivity, especially in a team bonus setting, may provide greater motivation than the standard principal–agent model suggests.

The empirical literature on team dynamics focuses on three factors: the remuneration scheme (flat-rate, piece-rate, and team-based wages), the information about relative performance within teams (no information versus full information on own and team member performance in previous periods) and the effect of team member productivity (peer effects). Hamilton et al. (2003) and Hansen (1997) assess the productivity effect of switching from individual to team pay, and find that such a change increases average productivity within the firm, indicating that there are other factors than free-rider motivation that play a role in performance in work teams. For example, Hansen (1997) concludes that the change in productivity correlates negatively with the workers' initial productivity. This suggests that team pay creates pressure aimed towards low productivity workers. This interpretation is consistent with Weiss (1987), who finds that the introduction of team pay induces low productivity workers to leave the firm. Babcock et al. (2015) design an experiment to investigate team motivation and find that individuals "work harder" in a team with a team bonus than they do in the presence of individual bonuses. They argue that there are many motivations (altruism, guilt aversion, shame, a longing for positive social appraisal, etc.) that induce individuals to exert extra effort to "avoid letting down their team".

Mohnen et al. (2008) discuss the effect of the information structure on team dynamics where remuneration is based on total production in the group. They analyse a setting where agents obtain information either after the game or at an interim stage, and explain how information affects performance, in particular how low productivity workers increase effort early in the game. Azmat and Iriberri (2016) study the effect of providing relative performance feedback under piece-rate versus flat-rate payment. They find that performance feedback matters under a piece-rate scheme, but not when pay is unrelated to performance. Moreover, the effect of feedback is independent of relative position, that is whether they are above or below the average. However, the effect of performance feedback under team-based payment was not estimated in their study.

The remainder of the paper is structured as follows. Section 2 describes the setting in which we estimate the effect of feedback on performance under different bonus schemes in our observation period from 2003 to the end of 2008. Section 3 details our empirical identification strategy and Section 4 presents the data and econometric specifications. Section 5 provides the empirical results along with sensitivity analysis and Section 6 concludes.

2 The Setting

Our data are from the customer service centre of a large insurance company. The service centre receives incoming calls from existing and potential new customers. The phone system in the customer service centre automatically channels new calls to available operators. The operators, who use the computer system to retrieve information needed to assist customers, and to register new information in the customer database. The operators' main assignment is to provide accurate information in a friendly and courteous way. Their job is to inform existing clients about their insurance coverage, update them on any policy changes that seem relevant and inform them about new products that are available. To provide high-quality services the operators must pay careful attention to the customer's requests and have extensive knowledge about the company's insurance products. In addition, they must handle requests for information as quickly as possible to minimize the time other customers have to wait for assistance. Ideally, most of the work, the provision of information, changes in existing insurance contracts, registration of new contracts, etc., should be done online during the phone call.

In addition to service provision (helping customers with queries relating to their insurance contracts), the operators sell insurance products. The company offers a bonus to promote sales. With a yearly sales target of NOK 3.6 million (approximately USD 500,000) per full-time agent, the customer service centre is an important source of income for the company, accounting for approximately 30% of total sales in the company in 2008. Our particular call centre is open only during daytime from Monday to Friday, and operates all year round.

Agents work in teams thatare clustered together in open office landscapes. The management's stated goal is to have 8–12 members in each team, but there are periods when teams have fewer permanent members due to turnover. The average length of employment for agents in the call centre over the period of our data is 3.5 years. Some of those who quit get another job in the same company while others leave the company. The call centre recruits new agents twice a year and runs an intensive three–week training programme before agents are allocated to teams that are short–handed of agents (relative to the preferred team size). To the extent that it is possible, the management tries to balance teams with respect to the gender, education, sales experience, and age of the agents. Agents work only for one team. Although there are a few instances, less than a handful, where agents are transferred from one operative team to another. Over the period of our data, three teams were closed, while three new teams were formed.

Each team has a team leader who organizes the work within the team, motivates the agents, and monitors their performance. One of the team leader's tasks is to inform agents about their absolute and relative performance at the start of each week. We hypothesize that the updated information about previous sales in the team affects individual performance in the current week.

Some agents work part-time, usually having a 20% position, many of whom are college students. They are not included in the team bonus system, and work in separate teams. We exclude part-time workers and their teams from the main analysis.

2.1 The bonus scheme

In 2001, the firm introduced a performance bonus to increase sales in the customer service unit. Since the company intended to use performance pay on a regular basis, a union treaty signed by the employer and employee organizations, obliged the firm to negotiate the contract with union representatives. The contract was renegotiated on an annual basis. In the first year, the bonus was based on team performance alone. In 2004, the firm did not reach an agreement with the union and the performance pay contract was not renewed. However, although the management refused to sign the bonus contract in 2004, they had not lost faith in incentive pay. They decided to carry on with performance pay, but the bonus was now introduced as a short term quarterly campaign. By relabelling the scheme as quarterly campaigns, the management did not have to negotiate the outline of the bonus scheme with the union. The first campaign was introduced in the second quarter of 2004 and replaced the negotiated bonus.

The importance of the bonus has increased over time: in 2001, bonus pay amounted to (on average) 7% of salaries; by 2010 it had increased to almost 15% of total worker remuneration. Given that this is a customer service centre, the sales bonus has always been balanced with rewards (based on various indicators) relating to service provision in the firm. However, the sales bonus has always been the most important element in the performance pay scheme, accounting for approximately 80% of variable pay.

Since 2004, the sales bonus has depended on both individual worker and team sales. The relative importance of these two elements has varied somewhat over time, except for the fourth quarter of 2006 when there was a major reform in the bonus scheme. The company increased the power of the bonus and made it 100% dependent on individual sales. This scheme remained in place for two quarters. The company reintroduced a bonus that depended on both individual and team sales in April 2007; see Table 1 for details about the bonus scheme.

Table 1: The evolution of bonus schemes in the call centre

Pay reform	Ind. bonus	Team bonus	Total bonus	Notes
Q1 2003	-	10000	10000	Only team bonus
Q2 2003	-	11000	11000	-
Q2 2004	3000	3000	12000	Team/Individual
Q3 2004	4500	1500	12000	-
Q1 2005	6750	1500	15000	-
Q2 2005	8250	3750	18000	-
Q3 2005	9900	2250	19650	-
Q4 2005	11200/2800	2800/11200	17000	Choice of model
Q4 2006	42250	-	45250	Pointsystem/Individual
Q2 2007	13000	7000	24800	Team/Individual
Q1 2008	16000	7000	30000	50/50 weight on sales and premium
Q2 2008	18000	6000	30000	-
Q4 2008	18000	8000	30000	-
Q1 2009	18000	6000	30000	100% weight on sales premium

Notes: This table shows the maximal total sales bonus payment in NOK that a worker can achieve divided into payments based on individual sales and team sales per quarter. A bonus of NOK 30000 per quarter equals around USD 1600 per month. The maximal total bonus is different from the sum of individual and team payment because the total bonus also depends on other parameters over the period.

A full-time employed agent is assigned a sales target (in 2006 the individual target was to sell 22 units of insurance per week). To obtain the individual sales bonus, agents must surpass their assigned monthly target. The bonus increases in a stepwise fashion for sales above the budget, with the number of steps and the width and height of the steps varying over time. Agents obtain a team bonus if the team sells more than the team target, which is given by the sum of the individual targets in the team. The maximal bonus payment that a worker can achieve varies from NOK 10,000 per quarter at the beginning of the observation period to NOK 45,250 per quarter in the two quarters with a high powered individual bonus. It then drops to around NOK 30,000 in the period after the individual bonus experiment.

The six month period (from 1 October 2006 to 31 March 2007) with high–powered individual incentives provides an opportunity to examine to what extent the feedback on rank position within a team depends on team incentives.

3 Research question and identification

Our data are especially well suited for assessing the following research question: How does feedback to workers on relative performance within a production team impact on subsequent productivity? Will, for example, information that one is at the low end of performance within a team, motivate agents to increase their current effort? Our data also enable us to examine if the response to feedback on past performance depend on the bonus system; that is whether the response depend on there being a team bonus or not.

The productivity of an agent in a particular week is determined by the innate ability and effort of the agent and by external factors (demand factors). Ability is given, but effort is chosen and will depend (among other things) on the pay system (financial incentives), on feedback and encouragement from the team leader, and on co-worker peer effects. Ideally, we would randomize changes in all of these variables and estimate their causal effects on productivity. Although we do not have an ideal randomized design, the fact that we have very accurate and detailed individual productivity data over many time periods enables us to analyse the data with fixed effects for workers, weeks and team-specific time trends.

However, even with such detailed data, it is challenging to identify peer effects within a production team (Manski, 1993; Angrist, 2014). The reflection problem and common productivity shocks within a team make it difficult to isolate how the performance of teammates affects that of individual team members within a week. Instead, we focus on a different question, namely, how previous relative performance within a team affects current performance.

We are in a position to estimate this effect because workers obtain information on their relative performance in the previous week every Monday morning. There is substantial variation in relative performance from week to week and part of this variation is exogenous; that is, it depends on team composition (the team members who were active that previous week) and on external factors (the number of incoming calls, the type of customer that calls in, etc.). We use that variation to estimate how relative performance affects current performance. A major concern in this estimation is reversion to the mean; in that case, the change in performance from week to week would be mechanical. To check for this, we first note that reversion to the mean should be symmetrical (those who performed well in week $t-1$ should reduce their performance while those who were at the bottom should improve their performance). Second, we carry out placebo estimation where we randomly place workers in teams and run the same analysis.

Because workers rarely change teams, issues related to endogenous team formation are not important in our context. The company has a policy that teams should be as equal as possible. Thus, there should be no ex ante selection into teams in the service centre. The teams seem to be balanced in relation to factors such as gender, age, work experience, skills, etc. We note some variation in observed variables between the approximately 25 sales teams in the firm. For instance, the male percentage varies from 36 to 57 (min-max), and the mean age varies from 27 to 37 years, so the balancing of workers is not ex post perfect. Because there are relatively few workers in each team, some variation in mean characteristics of team members is inevitable.[2]

4 Data

The novelty of this paper lies in the productivity data we use to estimate the effect of incentives, rank-position, and co-worker productivity within teams. We observe individual productivity, defined as the number of units sold per logged work hour (log-in time on the telephone system) on a weekly basis from Week 1 in 2003 to Week 52 in 2008.

There are several reasons why these data are attractive for our purposes. First, the frequency of the data enables us to replicate the information structure within the company, making it possible to identify policy–relevant effects. Second, the

[2]Our empirical specification uses fixed effects for workers, weeks and team-specific time trends. Thus, we do not include variables such as gender, age, and work experience in our estimation equation. Other variables that are time constant, for example education, are also not included in the empirical analysis.

employees are in well-defined teams. Accordingly, in a given week, we know the exact contribution of each member's output in the group, making it possible to identify the production gaps. Finally, as the number of sold products determines the team bonus, we are able to link our measure of productivity directly to the externalities within the team.

Not only is it rare to have detailed and frequent observations of individual productivity over such a long time span, it is also rare to have performance data from a normal firm. Most case studies on performance pay are conducted in the laboratory or, if in the field, data are gathered from workers in rather particular occupations, such as fruit picking, tree logging, windscreen installers and cashiers in retail shops etc. The fraction of workers employed in such industries, where contracts are short term and no or little formal education is required, is small. In contrast, the customer service industry is large and fast growing. In our case, most of the workers have a bachelor's degree and the length of average employment is 3,5 years.

As noted in our description of the performance pay scheme, there has always been some balance between the sales bonus and bonus payments linked to various indicators of the quality of the services provided. Most of these comprise aggregate performance at the centre level (average waiting time for callers, average renewal rates of existing customers). We do not have individual data on any of these service indicators. Thus, we focus solely on sales productivity in this analysis.

4.1 Group variables

We use two separate measures to capture the gaps in productivity between individual agents and their teammates. Our first measure is the absolute distance between the productivity levels of the individual and the average co-worker. There is arguably a positive relation between lagged average co-worker productivity and current productivity because of the presence of team dynamics. Our second measure to capture productivity gaps is the quartile rank, that is, an individual worker's position relative to co-workers. Given our context of well-defined teams, it is reasonable to assume that social pressure is aimed towards agents in the lower part of the productivity distribution as these agents reduce the expected income of their team members. In this case, the increase in productivity should be inversely related to the previous quartile rank, that is, the effect on subsequent productivity should be greater when the agent is placed in the bottom part of the productivity distribution (first quartile) compared with the upper part of the productivity distribution (fourth quartile), all else being equal.

The rank measure can be defined in different ways. We could use an indicator for top performers, or an indicator for production above or below the average (or median). We could in principle also use more than four quartiles. However, the average number of persons working is on average eight per team each week. The results do not change if we use three or five quartiles. We do not find any significant results if we divide the sample in two.

4.2 Descriptive statistics

Our sample includes full-time employees working during the period 2003–2008. There are a number of other available performance variables, including the monetary value of the sold products, the number of answered phone calls and absence for sickness. However, we choose to base our measure of productivity on the number of sales, rather than their value, because it links to the bonus reward throughout the entire period under study. We observe the number of sales each week and logged work hours (log-in time), defined as the amount of time workers are logged on to the computer system. Agents are required to log on to the phone system after they arrive at work and log off if instructed to do back-office work, participate in courses, training, meetings, or when taking breaks, etc.

We exclude weekly observations when (1) the log–on time is less than one hour per week, (2) the workers have not answered any incoming calls during a week, and (3) when there are fewer than four co-workers on the team. We also exclude workers logged on to the computer system for less than 10 hours per week on average during the entire period. This eliminates team leaders who may log on for short periods when there is heavy traffic on the lines. Table 2 provides descriptive statistics for the sample of workers we use in the analysis.

The average team sales excluding worker i are 22.18 sold products per week, and the figure per logged work hour (log-in time) excluding worker i is 1.05. The average number of hours logged on the telephone system is 23.89, defined as logged work hours per week (log-in time). The average individual productivity is 1.05 sold products per logged hour of work, with a standard deviation of 1.082 per logged hour of work. As seen, there is less variation in average co-worker productivity over time, indicating that shocks to individual productivity tend to cancel each other out within groups. The standard deviation for average team sales per logged work hour (excluding worker i) is 0.57.

On a typical week, the average number of team members who are present is 8.3. Team sizes are relatively stable over time. Importantly, changes in team size may

Table 2: Descriptive statistics, 2003-2009

	Mean	Std.dev.
Number of sales	22.18	13.69
Hours logged on to the telephone system	23.89	9.234
Sales per logged work hour	1.051	1.082
Average team sale (excluding worker i)	22.18	7.994
Average team logged work hours (excluding worker i)	23.89	7.743
Average team sale per logged work hour (excluding worker i)	1.05	0.57
Team size (present)	8.29	2.414

Notes: This table reports means and standard deviations. The average number of individuals in a given week is around 300, and the average number of weekly observation per individual is around 90.

affect individual productivity because the cost associated with the monitoring of co-workers increases as team size increases. An increase in team size may therefore result in a lower level of monitoring with ensuing effects on individual productivity. The co-ordination costs of larger teams increase (Hackman et al., 2000).

In addition to average co-worker productivity, we also use the quartile rank to measure the productivity gaps. To identify how the previous position relative to co-workers influences individual productivity, all else being equal, there must be some mobility in the quartile rank from week to week. Table 3 provides a transformation matrix for the quartile rank, indicating some stability from week to week, especially in the lower quartiles. For instance, 34.13% of workers in the fourth quartile in period t remain in the fourth quartile in the next period. Nonetheless, there may be sufficient mobility to identify differences in productivity levels as a result of the previous position relative to co-workers.[3]

Both pressure from team members and self-respect may induce workers to make up for large negative productivity gaps in the previous week between themselves and the team average. Team pressure requires some stability in the composition of the team over time. Assume, for example, that none of your co-workers this week were present the previous week. In this situation, these co-workers do not have the

[3]The mobility between quartiles is likely a result of two factors, namely, variation in individual productivity from week to week, and changes in the composition of teams. In other words, a worker positioned in the first quartile in one week may end up in a higher quartile the next week because of a different team composition owing to sick leave, recreational leave, seminar activity, etc., and not necessarily because of changes in individual productivity.

Table 3: Transformation matrix for position in the productivity distribution

	Q1 (t+1)	Q2 (t+1)	Q3 (t+1)	Q4 (t+1)	Total
Q1 (t)	40.33	24.87	22.25	12.55	100
	(3,969)	(2,447)	(2,190)	(1,235)	(9,841)
Q2 (t)	32.28	25.26	26.20	16.26	100
	(2,470)	(1,933)	(2,005)	(1,244)	(7,625)
Q3 (t)	24.33	23.67	30.09	21.90	100
	(2,103)	(2,046)	(2,601)	(1,893)	(8,643)
Q4 (t)	19.17	18.53	28.18	34.13	100
	(1,259)	(1,217)	(1,851)	(2,242)	(6,569)
Total	29.97	23.37	26.44	20.22	100
	(9,801)	(7,643)	(8,647)	(6,614)	(32,705)

Notes: Numbers are in percent. Number of observations in parentheses. Q1 = quartile 1, Q2 = quartile 2, Q3 = quartile 3, and Q4 = quartile 4 of the productivity distribution, where Q1 indicates low productivity and Q4 high productivity in a given week.

opportunity to exert pressure based on your performance the previous week. In our setting, this is equivalent to a situation where the workers cannot observe the effort of their co-workers, and internal pressure (i.e., altruistic behaviour, competitive spirit, etc.) will be the only effective source of pressure.

4.3 Econometric specifications

Our dependent variable, $y_{i,g,t}$, is the productivity of worker i in group/team g at week t. We specify an empirical model using both own lagged individual production (i.e., a dynamic specification) and team variables, and we estimate different variants of the following model:

$$\begin{aligned} y_{i,g,t} &= \alpha_i + \beta_1\, y_{i,g,t-1} + \beta_2\, x_{g,t} + \beta_4\, \overline{y}_{-i,g,t-1} \\ &+ \theta_1 Q^1_{i,g,t-1} + \theta_2 Q^2_{i,g,t-1} + \theta_3 Q^3_{i,g,t-1} + \mu_t + \mu_g t + \varepsilon_{i,g,t}, \end{aligned} \tag{1}$$

where $y_{i,g,t-1}$ is the sales of an individual in the previous period per hour worked, and β_1 captures the dependence in own productivity over time. $x_{g,t}$ is a vector of exogenous variables including team size. α_i represents the individual specific fixed effects, $\mu_g t$ captures team specific time trends, and μ_t is a set of dummy variables for time (week fixed effects). The variable $\overline{y}_{-i,g,t-1}$ is the average productivity of the other members of the team in the previous week, and the coefficient β_4 measures the effect of an increase in co-worker productivity on subsequent individual productivity the next week.

We also build on Rees et al. (2003), where we estimate how individual productivity is affected by the position relative to the other members of the team. We thus include dummy variables for the position in quartile j, where $Q^j_{i,g,t-1}$, $j = 1, 2, 3, 4$. The base category is a position in the fourth quartile (highest performers), while the first quartile indicates low performance in week t. The parameters θ_j measure the effect on productivity in week t associated with placement in quartile j relative to placement in the upper quartile in week $t-1$. To the degree productivity pressure is aimed towards agents in the bottom quartiles, we expect the parameters θ_j to be positive.

The dynamic structure of the model, by including $y_{i,g,t-1}$ as an independent variable in the model, raises two new problems that are closely related. First, the average co-worker productivity at time $t-1$ may be affected by individual productivity at time $t-2$. In other words, individual productivity may affect the productivity of the other members of the team in a later period. This implies that $\overline{y}_{-i,g,t-1}$ is correlated with the error term in period $t-2$. In this case $\overline{y}_{-i,g,t-1}$ is said to be weekly exogenous, or predetermined. The second problem arises because the model in itself is a dynamic panel data model; lagged individual productivity is included among the background variables, and is per definition correlated with the error term in period $t-1$. The problem arises because the error term in the fixed effect transformation contains the history of the error terms in all periods. Nickell (1981) was the first to give an analytical expression of the bias. However, as the number of time periods increases, the bias goes towards zero. As a result, the fixed effects estimator is consistent as both $N \to \infty$ and $T \to \infty$. In long panels, the dynamic panel bias becomes insignificant, and a straightforward fixed effects estimator works fine (Roodman, 2009). Our data contain weekly observations over six years (312 time periods in total) where the average individual is observed in approximately 90 periods.[4]

[4] Although the fixed effects estimator is consistent in a large T perspective there is in theory a relatively simple way to avoid this problem by using internal instruments after taking first differences of the estimation equation (Anderson and Hsiao, 1981).

5 Results

5.1 Baseline results

This section presents the baseline results from the models presented in the previous section. The dependent variable is the log of sales per logged work hour. All regressions include weekly fixed effects to control for time trends and seasonal variation in the data. These indicator variables will also capture the effect of different bonus systems since the bonus system applies for all workers and teams in the company but differs over time according to Table 1. The regressions also include individual and team-specific fixed effects to control for unobserved heterogeneity between workers and teams in the service centre. Individual time-constant variables, such as gender and education, are not included in the regressions. Variables that are correlated with time, such as age and seniority, are also not included.

The results in column (1) in Table 4 are based on the dynamic linear-in-means model from equation (1), but exclude the quartile indicator variables; the results in columns (2) and (3) also consider the relative position in the productivity distribution. Column (4) estimates the same model as in column (3) using the Anderson-Hsiao (IV-first-difference) estimator, which gave relatively large standard errors throughout.

In principle, there are two ways an agent can increase their own productivity in our setting, namely, by answering more calls or by increasing the sales effort per answered call. As our dependent variable controls for logged work hours, we do not distinguish between these two effort channels.

The lagged dependent variable is positive and statistically significant in all models indicating that shocks to individual productivity persist over time. We also control for team size in Table 4, which has a negative effect on productivity. The estimated effect is similar in models reported in columns (1)–(3), where a one-unit increase in team size results in a reduction in individual productivity of approximately 0.6%.

The results of the dynamic linear-in-means model in column (1) suggest a positive relationship between average co-worker productivity and subsequent individual productivity (β_4 in equation (1)). The results in column (1) indicate that a 10% increase in co-worker productivity is associated with a 0.4% increase in individual productivity the following week. The estimated coefficient is relatively small in magnitude. The positive estimate indicates that there are mechanisms present within the teams that partly internalize the positive externalities caused by team-based

Table 4: Dynamic fixed effects estimation of co-worker and rank effects on individual productivity from 2003 to 2009.

	(1)	(2)	(3)	(4)
Individual productivity, previous week	0.130***	0.144***	0.151***	0.0357**
	(0.0059)	(0.0098)	(0.0087)	(0.0159)
Team size, previous week	-0.0067***	-0.0066***	-0.00650**	-0.0114
	(0.00254)	(0.00255)	(0.00255)	(0.0118)
Peers' average productivity, previous week	0.0398***	0.0257		
	(0.0127)	(0.0149)		
First quartile, previous week		0.0293*	0.0433***	0.0283
		(0.0156)	(0.0134)	(0.0223)
Second quartile, previous week		0.0160	0.0247**	0.0044
		(0.0123)	(0.0112)	(0.0181)
Third quartile, previous week		0.0139	0.0190**	0.0135
		(0.0101)	(0.0096)	(0.0150)
Worker fixed effects	Yes	Yes	Yes	FD
Week fixed effects	Yes	Yes	Yes	Yes
Team-specific trends	Yes	Yes	Yes	Yes
Observations ($N \times T$)	28996	28996	28996	23048

Notes: The dependent variable is log of sales per logged hours of work as a measure of individual productivity. First quartile previous week means that the worker is ranked in the lowest productivity quartile the previous week. Team-specific trends are linear. Column (4) reports the results from an Anderson-Hsiao (IV-first-difference) estimator. Stars denote significance: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

incentives. In other words, the workers correct for gaps in earlier productivity levels by increasing effort the following week.[5]

It is reasonable to assume that any pressure within the team in favour of performance is primarily aimed towards agents in the bottom part of the productivity distribution. The subsequent productivity level associated with placement in the bottom part of the productivity distribution should then be higher than that for placement in the upper part of the productivity distribution. In columns (2) and (3) in Table 4, we therefore include the previous quartile rank as an independent variable, as in equation (1). The results in column (2) thus control for both average co-worker productivity and the individual worker's position relative to co-workers. The effect of an increase in co-worker productivity is positive, but not significant in this model. The effect of placement in the lower part of the productivity distribution is also positive, and significant at the 10% level.

One possible explanation for the change in the effect of average co-worker productivity from model (1) to (2) might be that the position of individual workers relative to co-workers captures the same effects, making it difficult to separate them. In column (3), we therefore exclude average co-worker productivity, and analyse how the position relative to co-workers affects individual productivity. The effect of placement in the first quartile relative to placement in the fourth quartile here is positive and statistically significant at the 1% level. We estimate the subsequent increase in productivity level associated with placement in the bottom quartile to be about 4.3% higher relative to placement in the upper quartile. The relative effect of placement in the second quartile is also positive but the effect is smaller (2.5%). The effect in the third quartile is 1.9%. The results presented here are then consistent with those in column (1), where the workers correct for gaps in previous productivity levels by increasing effort the following week.[6] Column (4) presents the results from the IV-approach mentioned in footnote 4, but this model gave large standard errors.

The baseline results in Table 4 do not reveal anything about the underlying mechanisms. Social pressure, pressure from the team leader, and/or information exchanges and co-operation between the members of the team could all then potentially explain these results. However, the results indicate that workers take account

[5] The effect of average co-worker productivity on subsequent individual productivity is in the range 0.25–0.5 in alternative models such as in a random-effects specification and a "static" fixed effects specification where β_1 in equation (1) is assumed to be zero. The estimated effects in these models are significant at the 1% level. These results are available upon request.

[6] The correlation between individual productivity previous week and first quartile previous week is -.604, and the correlation between individual productivity previous week and fourth quartile previous week is +.556.

of the effects of their efforts on their co-workers, either because they feel pressure to do so or because they use relevant new information.

5.1.1 Placebo tests

The results in Table 4 are consistent with both social pressure, pressure from the team leader and information exchanges, and cooperation between the team members. To test whether the results are specific to the teams to which workers actually belong, we form pseudo teams, that is, we create new teams by drawing random samples of workers and re-estimating the models. If gaps in productivity from a random set of co-workers affect individual productivity, we cannot explain the results in Table 4 using team-related factors.

Table 5 provides the results of the placebo test. As shown, individual productivity is unrelated to either average productivity or worker position relative to a random set of co-workers the previous week. Based on these results, we conclude that the effects identified in Table 4 relate to the team to which workers actually belong.

5.2 Mechanisms

The results in Table 4 are intended to capture the team effects arising from team-based compensation, where the team effects include a number of potential mechanisms.

One such mechanism is social pressure, where the workers experience disutility if observed behaving selfishly by their co-workers. In this case, the workers correct for gaps in previous productivity levels because of sanctions and social punishment by their co-workers. Alternatively, social pressure could result from altruistic behaviour whereby a worker experiences disutility even if no one notices. In this case, the workers correct for gaps in previous productivity levels because they truly care about the levels of pay-off for their co-workers.

Separating these social channels may be important because different workplaces are organized differently. In settings where the workers are unable to observe each other's efforts, altruistic behaviour is the only effective mechanism for internalizing the externalities present in many occupations. However, separating the different social channels is difficult in our setting because the construction of teams is such that all team members are able to monitor the effort of their co-workers. The existing literature, including Bandiera et al. (2005) and Mas and Moretti (2009), finds that

Table 5: Placebo results of team composition on individual productivity

	(1)	(2)	(3)
Individual productivity,	0.132***	0.143***	0.137***
previous week	(0.0059)	(0.0095)	(0.0083)
Pseudo team size	0.00109	0.00121	0.00076
previous week	(0.00135)	(0.00135)	(0.00129)
Pseudo peers' average	-0.00627	-0.0165	
productivity, previous week	(0.0120)	(0.0140)	
First quartile in pseudo team,		0.0199	0.0103
previous week		(0.0156)	(0.0130)
Second quartile in pseudo team,		0.0140	0.0074
previous week		(0.0122)	(0.0111)
Third quartile in pseudo team,		0.0039	-0.0001
previous week		(0.0100)	(0.0096)
Worker fixed effects	Yes	Yes	Yes
Week fixed effects	Yes	Yes	Yes
Team-specific trends	Yes	Yes	Yes
$N \times T$	28593	28593	28996

Notes: The dependent variable is log of sales per logged hours of work as a measure of individual productivity. Team-specific trends are linear. Stars denote significance: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. The pseudo teams are formed by drawing random samples of workers in the call centre.

externalities are in fact internalized only when the workers can be monitored by their co-workers, indicating that social external pressure is an important mechanism. However, our data are unable to provide evidence to support this conclusion.

A second underlying mechanism is co-operation and information exchanges between the members of the team. In settings where individual payment depends on co-worker productivity the incentives to assist each other should be large, and Siemsen et al. (2007) theoretically show that team-based incentives may give workers an incentive to help each other in equilibrium. In this case, previous gaps in productivity may have a positive effect on subsequent productivity because of new information about the state of demand and assistance from co-workers.

The third possible mechanism explaining the results concerns the team leader. In this case, previous gaps in productivity may have a positive effect on worker productivity because of pressure and sanctions from the team leader. At the same time, the team leader may be an important source of information for workers.

We may consider both social pressure and cooperation between team members as co-worker effects arising from team-based compensation, whereas the team leader effect may be important, even in the absence of team-based compensation. To evaluate whether mechanisms exist within the teams that partly internalize the externalities caused by team-based incentives, it is therefore important to separate the co-worker effects from the team leader effect. The following section attempts to shed some light on this issue.

5.3 Individual incentives and team dynamics

In the fourth quarter of 2006, the compensation structure in the service centre changed radically; the power of the incentives increased and the sales bonus was completely individualized. The new bonus scheme was in operation for a relatively short period, and in the second quarter of 2007, the company reverted to the system where individual payment depended on both individual and team sales. The six month period (from 1 October 2006 to 31 March 2007) with high-powered individual incentives provides an opportunity to examine to what extent the feedback on rank position within a team depends on team incentives. This analysis may elucidate why agents with low performance in the previous week increase their current effort; that is, whether it results from team pressure or pressure from the team leader. The transition from team-based incentives to individual incentives eliminates the externalities between the members of the team, which in turn eliminates, or at least limits, the incentives to exert pressure and co-operate within a team. The team leaders earn a fixed wage throughout the period, and there is no reason to believe that pressure and sanctions from the team leader would change based on workers' remuneration scheme.

To examine this question, we include interaction terms between the bonus system (IB_t) and quartile rank ($Q_{i,g,t-1}$) in the model, where IB_t is an indicator variable equal to one when the workers were compensated based on individual productivity only ($IB =$ Individual Bonus) and zero when worker compensation also depended on the overall productivity of the team. The empirical specification builds on equation (1) and can be written in the following way:

$$\begin{aligned} y_{i,g,t} &= \alpha_i + \beta_1 \, y_{i,g,t-1} + \beta_2 \, x_{g,t} + \beta_3 \, IB_t \\ &+ \theta_1 Q^1_{i,g,t-1} + \delta_1 Q^1_{i,g,t-1} IB_t + \theta_2 Q^2_{i,g,t-1} + \delta_2 Q^1_{i,g,t-1} IB_t \\ &+ \theta_3 Q^3_{i,g,t-1} + \delta_3 Q^1_{i,g,t-1} IB_t + \mu_t + \mu_g + \varepsilon_{i,g,t}, \end{aligned} \tag{2}$$

Any significant coefficients for interaction terms between IB_t and $Q_{i,g,t-1}$, that is $\delta_1, \delta_2, \delta_3$, indicate that the transition to individual incentives had an impact on how workers responded to previous gaps in productivity levels. The results in column (1) of Table 6 show that the average co-worker productivity has no effect on individual productivity, neither with nor without team incentives.

The results in columns (2) and (3) in Table 6 are more interesting. Column (2) shows the results from the dynamic specification, while column (3) shows the results without a lagged dependent variable. Both models indicate that placement in the bottom quartile has no or a negative effect on current productivity during the period when worker compensation solely depended on individual productivity. This shows that the effects reported in Table 4 are driven by team incentives; that is, without team incentives, there is no indication that low performance in the previous week spurs extra effort in the current week. This finding is consistent with an internal assessment (given to us by the management) of the company's experiment with individual bonuses. A downside to abolishing the team pay was that it took away the team spirit, the feeling of belonging to a production team and the willingness to co-operate with other team members.

Table 6: Transition from team to individual bonus (IB) system. Dynamic fixed effects specification

	(1)	(2)	(3)
Peers' average productivity,	0.0382***	0.0258*	
previous week	(0.0131)	(0.0149)	
Peers' average productivity × IB,	0.0195		
previous week	(0.0431)		
First quartile,		0.0341**	0.0481***
previous week		(0.0159)	(0.0136)
First quartile × IB,		-0.0564*	-0.0563*
previous week		(0.0314)	(0.0314)
Second quartile,		0.0180	0.0268**
previous week		(0.0126)	(0.0115)
Second quartile × IB,		-0.0233	-0.0234
previous week		(0.0333)	(0.0333)
Third quartile,		0.0140	0.0191*
previous week		(0.0104)	(0.0100)
Third quartile × IB,		0.0001	-0.0001
previous week		(0.0319)	(0.0319)
$N \times T$	28996	28996	28996

Notes: The dependent variable is log of sales per logged hours of work as a measure of individual productivity. Stars denote significance: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. IB (Individual Bonus) is an indicator variable equal to one in the period where the workers were rewarded based on individal productivity (number of sales) alone (from the fourth quarter of 2006 to the second quarter of 2007), and not on team sales. Other controls include individual productivity and team size. All regressions include fixed effects for worker, week, and team-specific linear trends.

6 Conclusion

The focus of this paper has been to analyse how gaps between individual and co-worker productivity affect subsequent individual productivity. Our first measure of gaps in productivity was the absolute distance between individual and co-worker productivity levels. The results indicate, all else being equal, a positive relationship between average co-worker productivity and subsequent individual productivity. The estimated effect is relatively small, where a 10% increase in average co-worker productivity results in a 0.4% increase in individual productivity the following week. Herbst and Mas (2015) reviews the estimated spillover effect of worker productivity on the productivity of co-workers in both laboratory experiments and field studies, and finds an average effect of 1.2%. Cornelissen et al. (2013); Jackson and Bruegmann (2009) find similar results to ours. Herbst and Mas (2015) reviews the literature and shows that our findings are at the conservative end.

Our second measure of the productivity gap was the position of workers relative to co-workers. The results indicate that placement in the bottom quartile of the productivity distribution has substantial effects on subsequent productivity, whereas the productivity level associated with placement in the first quartile is about 4% higher when compared with placement in the lowest quartile. While the underlying mechanisms are unknown based on the baseline results, they indicate that the workers correct for gaps in productivity by increasing effort the following week.

A secondary objective of our study was to explore whether the effects are caused by team-based compensation structures; that is, whether the workers themselves internalize the positive externalities that are present in our setting. To address this issue, we used a transition to individual incentives where there are no externalities between the workers. The results indicate that the relative effect of placement in the first quartile was significantly lower, or even negative, during the period when worker compensation depended solely on individual productivity alone. Given no change in the team leader's incentives during periods with individual-based bonuses, the results indicate that peer effects must be present in our setting, and that the transition to individual incentives largely shifted the focus of workers away from the efforts of their co-workers. This aligns well with the company's own assessment of the situation.

While we are not able to identify whether the effects are a result of social pressure or co-operation within the teams, the results of this analysis could be important for the designers of these types of bonus schemes. Overall, our results indicate that there are mechanisms within the teams that partly internalize the externalities caused by team-based compensation structures, meaning that free-rider effects are not a serious problem, at least in our particular setting.

Estimating team effects involves many challenges. First, the selection issue is a natural concern in identifying co-worker effects. Our teams are set up by the management of the company based on a policy that teams should be as equal as possible according to factors such as age, education, gender, work experience, and skills, contrary to studies of endogenous team formation; see, for example Bandiera et al. (2011). Even though we find some differences in team characteristics, information from the company indicates that the teams are fairly balanced, and that our results are not driven by team differences due to selection. We rarely observe that workers change team.

A second issue is related to the bonus and compensation scheme in our data. The call centre agents not only sell products but also provide customer service. They are evaluated and compensated on both of these tasks. Moreover, the company's bonus scheme changed frequently during the sample period, which could mean that we are not in equilibrium. Frequent changes could also lead to the employee gaming of the compensation system. Thus, it might be difficult to establish a solid relationship between co-worker effects and team-based bonus in our data. Third, our identification strategy requires some stability in the composition of the team over time. Not all workers are selling products every week because of sickness absence, holidays, administrative duties, and quitting the job. If demand is constant over time, and the number of team workers varies somewhat from week to week, this could give rise to naturally occurring demand spillover effects instead of co-worker effects.

In addition, our model specification requires a key assumption; that is, worker productivity is impacted by team interactions from the previous week but not from the current week. If contemporary peer effects are in place, this could bias the results. Our model is based on the information flow in the company, in particular that agents are informed about sales of team members the previous week on Mondays. Thus, they are able to act on this information in that week. If sales vary randomly from week to week, where lower sales one week are followed by a recovery the next week, our identified effect resembles the mean reversion problem. We ran a placebo test to ensure that the estimated effects are specific to the team by creating pseudo teams, that is, we included each worker with a random set of co-workers and re-estimated the models. Our results disappear in placebo experiments where workers are randomly allocated to teams, which suggests that co-worker productivity of team members matters.

References

Anderson, T. W. and Hsiao, C. (1981). Estimation of dynamic models with error components. *Journal of the American Statistical Association*, 76(375):598–606.

Angrist, J. D. (2014). The perils of peer effects. *Labour Economics*, 30:98–108.

Azmat, G. and Iriberri, N. (2016). The provision of relative performance feedback: An analysis of performance and satisfaction. *Journal of Economics & Management Strategy*, 25(1):77–110.

Babcock, P., Bedard, K., Charness, G., Hartman, J., and Royer, H. (2015). Letting down the team? social effects of team incentives. *Journal of the European Economic Association*, 13(5):841–870.

Bandiera, O., Barankay, I., and Rasul, I. (2005). Social preferences and the response to incentives: Evidence from personnel data. *The Quarterly Journal of Economics*, 120(3):917–962.

Bandiera, O., Barankay, I., and Rasul, I. (2011). Field experiments with firms. *The Journal of Economic Perspectives*, pages 63–82.

Barankay, I. (2012). Rank incentives: Evidence from a randomized workplace experiment. *Discussion paper.*

Bishop, J. W., Scott, K. D., and Burroughs, S. M. (2000). Support, commitment, and employee outcomes in a team environment. *Journal of Management*, 26(6):1113–1132.

Cornelissen, T., Dustmann, C., and Schönberg, U. (2013). Peer effects in the workplace. *IZA DP No. 7617 (forthcoming American Economic Review).*

Hackman, J. R., Wageman, R., Ruddy, T. M., and Ray, C. R. (2000). *Team effectiveness in theory and practice.* Blackwell, Oxford, UK.

Hamilton, B. H., Nickerson, J. A., and Owan, H. (2003). Team incentives and worker heterogeneity: An empirical analysis of the impact of teams on productivity and participation. *Journal of Political Economy*, 111(3):pp. 465–497.

Hansen, D. G. (1997). Worker performance and group incentives: A case study. *Industrial and Labor Relations Review*, 51(1):pp. 37–49.

Harris, T. E. (2011). Toward effective employee involvement: An analysis of parallel and self-managing teams. *Journal of Applied Business Research (JABR)*, 9(1):25–33.

Herbst, D. and Mas, A. (2015). Peer effects on worker output in the laboratory generalize to the field. *Science*, 350(6260):545–549.

Jackson, C. K. and Bruegmann, E. (2009). Teaching students and teaching each other: The importance of peer learning for teachers. *American Economic Journal of Applied Economics*, 1(4):85–108.

Jones, D. C. and Kato, T. (2011). The impact of teams on output, quality, and downtime: An empirical analysis using individual panel data. *Industrial & Labor Relations Review*, 64(2):215–240.

Manski, C. F. (1993). Identification of endogenous social effects: The reflection problem. *The Review of Economic Studies*, 60(3):531–542.

Mas, A. and Moretti, E. (2009). Peers at work. *The American Economic Review*, 99(1):pp. 112–145.

Mohnen, A., Pokorny, K., and Sliwka, D. (2008). Transparency, inequity aversion, and the dynamics of peer pressure in teams: Theory and evidence. *Journal of Labor Economics*, 26(4):693–720.

Nickell, S. (1981). Biases in dynamic models with fixed effects. *Econometrica*, 49(6):pp. 1417–1426.

Rees, D. I., Zax, J. S., and Herries, J. (2003). Interdependence in worker productivity. *Journal of Applied Econometrics*, 18(5):585–604.

Roodman, D. (2009). How to do xtabond2: An introduction to difference and system gmm in stata. *Stata Journal*, 9(1):86–136(51).

Siemsen, E., Balasubramanian, S., and Roth, A. V. (2007). Incentives that induce task-related effort, helping, and knowledge sharing in workgroups. *Management Science*, 53(10):1533–1550.

Weiss, A. (1987). Incentives and worker behavior. In Nalbantian, H., editor, *Incentives, Cooperation, and Risk Sharing*. Rowan and Littlefield, Towota, N.J.