WORKING PAPERS IN ECONOMICS

No. 10/13

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November 2013

Abstract

This paper investigates dynamic peer effects in a sales company where workers operate in teams and receive a bonus that depends on both individual worker and team sales. We examine how the past productivity of co-workers affects the current individual performance of team members. To address this question, we employ weekly productivity and administrative data obtained from the customer service center of an insurance company. We find evidence that the past performance of team co-workers influences current performance, and that this effect is larger for agents that ranked in the bottom quartile of team performance in the previous period. The effects are also strongest when bonuses depend on team performance. Overall, our findings suggest that peer effects may alleviate the free-rider problem often associated with team bonuses.

JEL Numbers: C23, J33, M52, D22,
Keywords: Peer effects, dynamic panel data, team incentives, sales organizations

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1 Introduction

Firms use work teams and team bonuses for a number of reasons. However, when assessed strictly in terms of worker motivation it appears as an inefficient way to organize production. 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 peers, social appraisal, and the pressure to perform that naturally arises when collective achievements determine worker pay. Relative performance in the past may then matter for current performance. It is the strength and structure of such dynamic peer effects that is the topic of this analysis.

We obtain our data from the customer service center of an insurance company. This is a so called inbound call center where agents provide information and sell insurance to those calling in. The agents operate in teams and receive a bonus that depends on both individual worker and team sales. Agents register their own sales. They also have a lot of information about how their co-workers are doing. For example, at the start of each week the team leader informs team members of the previous week's aggregate team performance and their progress relative to the team target. Completely self-contained workers are insensitive to peer comparisons and will be unmoved by information about the previous week's relative performance. More socially responsive workers, however, may feel both intrinsic and extrinsic pressure to exert greater effort if they receive negative information about their relative performance.

To examine the dynamic peer effects in this process, we use six years of weekly productivity records for individual workers to construct a dynamic panel model. Holding individual productivity constant, we estimate how changes in average co-worker performance in the preceding week affect agents productivity in the current week. We find evidence of a positive relationship between co-worker productivity and subsequent individual performance. Interestingly, there is an inverse relationship between the response in individual performance and the previous quartile rank in the team. Another interesting observation is that the peer effects disappear during a period when individual sales entirely determine the bonus. Overall, our findings suggest that peer effects are present in our setting and that a team bonus may therefore provide greater motivation than the standard principal-agent model suggests.

Peer pressure and team bonuses were first modeled theoretically by Kandel and Lazear (1992). They show how peer pressure can enhance effort and alleviate the free rider problem associated with a team bonus. However, despite widespread recognition

of their work and the importance of this problem, relatively few empirical studies consider how co-worker performance affects individual effort within work teams. In fact, we are unaware of any work that estimates the kind of dynamic peer effects we explore. However, there are studies on work motivation and performance that have a direct bearing on the effect we attempt to estimate.

To start with, our work relates to existing studies that assess the productivity effect of switching from individual to team pay. Both Hamilton, Nickerson, and Owan (2003) and Hansen (1997) 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 toward low productivity workers. This interpretation is consistent with Weiss (1987), who finds that the introduction of team pay induced low productivity workers to leave the firm. In a more recent study, Babcock, Bedard, Charness, Hartman, and Royer (2011) design an experiment to investigate team motivation. In their experiment, individuals "work harder" in a team, with a team bonus than they do in the presence of individual bonuses. They argue there are many motivations (altruism, guilt aversion, shame, a longing for positive social appraisal, etc) that induce individuals to exert extra effort in order to "avoid letting down their team".

Although peer effects appear particularly relevant when workers come together through some collective remuneration scheme, Mas and Moretti (2009) also find strong peer effects in a fixed wage regime. For instance, they find that high-productivity supermarket cashiers increase the productivity of co-workers in the same shift, and that this effect is especially large when high-productivity workers can directly observe those with lower productivity. Elsewhere, Falk and Ichino (2006) measure peer effects on work performance in an experiment where participants received fixed compensation for inserting letters into envelopes, where some participants worked close to each other and could therefore observe the achievements of a peer. In the individual treatment, they worked in isolation. Falk and Ichino (2006) conclude that productivity is higher when there is a peer working close by, and that the variance in production is lower within than between pairs. Finally Bellemare, Lepage, and Shearer (2010) design an experiment with fixed wages and individual piece rates where workers in one treatment obtain information about the past productivity of their co-workers, but find no evidence of a significant peer effect.

The remainder of the paper is structured as follows. Section 2 provides a theoretical discussion of peer pressure and work effort as it relates to the empirical work in this

analysis. Section 3 describes the setting in which we estimate peer effects in sales teams and explains the changes in the bonus system in our observation period from 2003 to 2009. Section 4 details our empirical identification strategy and Section 5 is about the data and econometric specifications. Section 6 provides the empirical results along with sensitivity analysis and Section 7 concludes.

2 Peer Pressure and Work Effort

This section provides a brief theoretical discussion of how changes in co-worker productivity affect subsequent individual productivity in two different settings; when peer pressure is present and when it is not. To simplify exposition we consider a situation where individual payment fully depend on the overall productivity of the team, and we assume no complementarities in the production process. The model is based on, among others, Kandel and Lazear (1992).

There are N workers in each team. The effort of worker i in period t, $e_{i,t}$, equals the individual contribution to total production. The cost of effort is given by $C_i(e_{i,t})$ and is increasing and convex in $e_{i,t}$. The total production in the team at time t is given by $y_t = \sum_i e_{i,t}$. The wage in period t, w_t, is assumed to depend on the accumulated production in period t and $t-1$, given by $w_t = \beta\left(y_t + \overline{e}_{i,t-1} + \overline{y}_{-i,t-1}\right)$. β represents the bonus rate set by the company, $\overline{e}_{i,t-1}$ is the individual contribution in period $t-1$ and $\overline{y}_{-i,t-1}$ is the total contribution from the co-workers in period $t-1$. Both $\overline{e}_{i,t-1}$ and $\overline{y}_{-i,t-1}$ are exogenously given at time t. The general individual utility function, given by $u_i = u_i(w_t)$ is increasing and concave, and since w_t is a function of the overall production within the team, the utility function is also concave in co-workers productivity.

Assume no social pressure. Each member of the team will choose effort to maximize the utility of income minus the cost of effort:

$$max_{e_{i,t}} \left\{u_i(w_t) - C_i(e_{i,t})\right\}. \tag{1}$$

The first order condition for optimal effort is given by

$$\beta \frac{\partial u_i(w_t)}{\partial e_{i,t}} - \frac{\partial C_i(e_{i,t})}{\partial e_{i,t}} = 0. \tag{2}$$

We assume that the workers choose their effort strategically in response to co-workers contribution in period $t-1$, that is, $e_{i,t}$ is a function of $\overline{y}_{-i,t-1}$. To determine how worker i respond to changes in co-worker productivity at time $t-1$ we differentiate

(2) with respect to $\overline{y}_{-i,t-1}$:

$$\frac{de_{i,t}}{d\overline{y}_{-i,t-1}} = \frac{-\beta^2\partial^2 u_i(\cdot)/\partial e_{i,t}\partial\overline{y}_{-i,t-1}}{\beta^2\partial^2 u_i(\cdot)/\partial e_{i,t}^2 - \partial^2 C_i(\cdot)/\partial e_{i,t}^2} < 0. \tag{3}$$

The denominator is negative, and the sign of the expression is therefore given by the opposite of the sign of the numerator. The term $\partial^2 u_i(\cdot)/\partial e_{i,t}\partial\overline{y}_{-i,t-1}$ is the effect on the marginal benefit of worker i of an increase in co-workers contribution at time $t-1$, and is negative due to the concavity in the utility function. Increases in co-worker productivity at time $t-1$ will have a positive effect on individual payment - constituting a decrease in the marginal benefit of effort. In other words, the marginal benefit will decline for every level of effort, and in order for (2) to hold, the optimal effort of worker i must fall. In the absence of any social considerations, increases in co-worker productivity will result in more free-riding, and therefore a decline in individual effort.

The prediction in (3) is based on a strong assumption that workers do not have social preferences. Theoretical work by Kandel and Lazear (1992), Barron and Gjerde (1997) and Huck, Kübler, and Weibull (2012) among others propose that social norms and social pressure within the team may internalize the externalities caused by team based incentives. Fehr and Gächter (2000) defines a social norm as "a behavioral regularity that is based on a social shared belief how one ought to behave and which triggers the enforcement of the prescribed behaviour by informal social sanctions". Following Kandel and Lazear (1992) we introduce a "peer pressure" function capturing these types of social effects:

$$\text{Peer pressure} = P(e_{i,t}, \frac{1}{N-1}\overline{y}_{-i,t-1} - \overline{e}_{i,t-1}). \tag{4}$$

The peer pressure is here assumed to be an increasing function in the distance between average co-worker productivity and individual productivity at time $t-1$ and decreasing in individual productivity at time t, that is, the worker may reduce the pressure as a result of previous gaps in productivity levels by increasing effort at time t. The general problem for worker i is still to maximize the net utility, but compared to (1) he must now take account of the effect individual effort has on the social pressure. The general problem can now be formulated as

$$max_{e_i}\left\{u_i(w_t) - C_i(e_{i,t}) - P(e_{i,t}, \frac{1}{N-1}\overline{y}_{-i,t-1} - \overline{e}_{i,t-1})\right\}, \tag{5}$$

with first order condition:

$$\beta \frac{\partial u_i(w_t)}{\partial e_{i,t}} - \frac{\partial C_i(e_{i,t})}{\partial e_{i,t}} - \frac{\partial P(\cdot)}{\partial e_{i,t}} = 0. \tag{6}$$

Social pressure means that $\partial P(\cdot)/\partial e_i < 0$, that is, increased individual effort reduces the social pressure. To determine how worker i respond to changes in co-worker productivity at time $t-1$, taking account of the social pressure in the team, we differentiate (6) with respect to $\overline{y}_{-i,t-1}$:

$$\frac{de_{i,t}}{d\overline{y}_{-i,t-1}} = \frac{-\beta^2 \partial^2 u_i(\cdot)/\partial e_{i,t} \partial \overline{y}_{-i,t-1} + [1/(N-1)]\, \partial^2 P(\cdot)/\partial e_{i,t} \partial \overline{y}_{-i,t-1}}{\beta^2 \partial^2 u_i(\cdot)/\partial e_{i,t}^2 - \partial^2 C_i(\cdot)/\partial e_{i,t}^2 - \partial^2 P(\cdot)/\partial e_{i,t}^2}. \tag{7}$$

The sign of the expression in (7) is again given by the opposite of the sign of the numerator. The first term captures the "free-rider" effect - pulling down the response to previous co-worker productivity. The second term is the effect on the marginal pressure from an increase in previous co-worker productivity. All else equal, a higher level of previous co-worker productivity will increase the marginal pressure aimed at worker i. This implies that the benefit, in terms of reduced social pressure, will increase ($\partial P(\cdot)/\partial e_i$ becomes more negative). As a result, the term $\partial^2 P(\cdot)/\partial e_i \partial \overline{y}_{-i,t-1}$ must be negative, and therefore mitigates the free-rider effect in (7). This is also intuitive. If increases in previous co-worker productivity is to increase worker i's level of effort at time t there must be a gain by doing this, and this gain is a reduction in the marginal pressure. The implication from this result is that as long as $\partial^2 P(\cdot)/\partial e_i \partial \overline{y}_{-i,t-1}$ is negative the presence of social pressure might mitigate the free-rider problems within the team, and if the pressure is strong enough, the sign of equation (7) might turn positive.

3 The Setting

Our data are from the customer service center in a large Norwegian insurance company. The service center receives incoming calls from existing and potential new customers. 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 600,000) per full-time agent, the customer service center is an important source of income for the company, accounting for approximately 30% of total sales in the company.

The phone system in the service center automatically links incoming calls to an

available operator, and the employees use the computer system to retrieve the information necessary to assist the customer and to register any changes in insurance contracts. Agents work in teams, each consisting of 8-12 members, with the agents in a team grouped together in small islands within a larger open office landscape. Each team has a team leader who organizes the work within the team, motivates the agents, and monitor their efforts.

3.1 The Bonus Scheme

In 2001, the firm introduced a performance bonus to increase sales in the customer service unit. The importance of this bonus has steadily increased over time: in 2001, bonus pay amounted to (on average) 7% of salaries; by 2010 it had increased to almost 15% of total remuneration. Given this is a customer service center, the sales bonus balances with rewards (based on various indicators) relating to service provision in the firm. However, of these, the sales bonus is the most important, accounting for approximately 80% of variable pay.

The sales bonus depends on both individual worker and team sales, with the relative importance of these two elements varying over time. Until April 2004, team sales solely determined the bonus: since then, a combination of individual and team sales. In one period (2005/06), teams were able to vote on three alternatives: a scheme where 80% of the sales bonus depended on team sales and 20% on individual sales, a 50-50 alternative, or one with an 80% weighting on individual sales. In the fourth quarter of 2006, the company increased the power of the bonus and made it 100% dependent on individual sales. This particular regime remained in place for two quarters, with the company then reintroducing a bonus that again depended on both individual and team sales.

A full-time employed agent is assigned a sales target (in 2006 the individual target was 22 units of insurance per week). To obtain the individual sales bonus, agents must sell more than the 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.

Table A.1 in the appendix depicts the evolution of the bonus schemes, and the maximum payment per quarter over the period (note that the bonus depends on monthly performance, but is paid on a quarterly basis).

4 Identification

Estimating peer effects and social interactions between individuals is not a trivial task. Apart from the more specific problems of separating peer pressure from alternative interpretations (i.e. the effects of the team leader, mutual learning, information exchanges, etc.) the literature has largely focused on problems that are more general. Endogenous formation of peer groups (i.e. selection problems) and correlated effects may be problematic, and Moffitt (2001) argues that such effects may explain most of the early empirical evidence on social interactions. In our context, these problems are not our main concern, as the teams have the same working conditions, management, etc. The peer groups are well-defined teams, where there is balance in the allocation of team members and equalalization in relation to factors such as age, education, gender, work experience, skills, etc. In other words, there is no systematic selection into the teams in the service center.

A more problematic concern is the reflection problem (Manski, 1993), meaning that the productivity of worker i may affect the productivity of worker j and vice versa. Some recent studies have attempted to resolve these problems with instrumental variable approaches or natural experiments, e.g. Hesselius, Nilsson, and Johansson (2009) and Dahl, Løken, and Mogstad (2012), while others have employed more subtle techniques. For example, Mas and Moretti (2009) consider the productivity of cashiers in a supermarket chain, and solve the reflection problem by first estimating the workers permanent productivity, thereby estimating how the average ability of co-workers affect worker i's productivity, where they argue that the timing of changes in the average ability of co-workers within a day is exogenous. In our setting, this approach is computationally difficult, and not necessarily the best approach. In our firm, team-based incentives link the workers together and therefore it is the workers' productivity not their permanent productivity that generates the externality, even though there is, of course, a positive relationship between permanent and actual productivity over time.

The theoretical framework presented in Section 2 postulated that peer pressure depended on preceding gaps between the productivity levels of individual and co-workers. In other words, our model assumes that co-worker productivity affects individual productivity with a lag. The assumption of a dynamic peer effect resolves the reflection problem, but at this point we have done little more than to assume so. To justify better our hypothesis of a dynamic peer effect, we now take a closer look at the information structure within the call center.

Agents know their own sales in the previous week and the average team sales. They obtain this information from the team leader who, at the start of each workweek, in-

forms the team on how much they sold the previous week (total and average sales). While it is not permissible for the team leaders to provide information on individual sales to other team members, they do list the three best performers on a whiteboard each week. Given this information structure, it is plausible that low performance will ignite both external peer pressure (the other team members know that I underperformed last week) and internal pressure (I know that I performed under par last week) that will both enhance productivity in the current week. Hence, in this work environment, it is natural to explore to what extent peer effects arrive with a lag, that is, if workers respond to previous gaps in productivity levels by increasing their subsequent effort. Of course, peers may also influence each other's productivity within a given week, or on a more permanent basis. We do not test for such peer effects in this analysis.

5 Data

The novelty of this paper lies in the detailed productivity data we use to estimate peer effects within teams. We observe individual productivity, defined as the number of units sold per effective work hour, 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 the dynamic peer effect. Second, the 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.

As noted in our presentation 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 center 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.

5.1 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. Holding own-lagged productivity constant, there is arguably a positive relation between lagged average co-worker productivity and current productivity because of the presence of peer pressure. 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 toward 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 compared with the upper part of the productivity distribution, all else being equal.

5.2 Descriptive statistics

Our sample includes full-time employees working during the period 2003 to 2009. There are a number of other available performance variables, including the monetary value of the sold products and the number of answered phone calls, absence for sickness, etc. 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 the effective work hours, defined as the amount of time workers log on to the computer system. Agents are required to log on to the phone system immediately after they arrive at work and only log off if instructed to do back-office work, participate in courses, training, meetings, etc.

We excluded weekly observations when (1) the log on time is less than one hour per week, (2) the workers have not answered any incoming calls, and (3) when there are fewer than four co-workers on the team. We also excluded 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 a lot of traffic on the lines. Table 1 provides descriptive statistics for the sample of workers we use in the analysis.

Table 1 about here

The average individual productivity is 1.05 sold products per effective hour of work, with a standard deviation of 1.089 per effective hour of work. As shown, 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 effective work hour (excluding worker i) is 0.57. The average team sale excluding worker i is 23.28 sold products per week, and the average team sale per effective work hour excluding worker i is 1.05. Average hours logged on the telephone system is 24.60 hours, defined as effective work hours per week.

The average team consists of about eight co-workers. Team sizes are relatively stable over time. Importantly, changes in team size may 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.

In addition to average co-worker productivity, we also use the quartile rank to measure the productivity gaps. In order 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 A.2 provides a transformation matrix for the quartile rank, indicating some stability from week to week, especially in the lower quartiles. For instance, 34.39 percent of workers in in the fourth quartile in period t remain in the fourth quartile in the next period. Nonetheless, there may be sufficient mobility for us to identify differences in productivity levels as a result of the previous position relative to co-workers.[1]

We have argued that both peer pressure and self-respect may induce workers to make up for large negative productivity gaps in the previous week between themselves and the team average. Peer pressure requires some stability in the composition of the team over time. Assume for example that none of your co-workers this week was present the previous week. In this situation, these co-workers do not have the 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 behavior, competitive spirit, etc.) will be the only effective source of pressure. Table A.3 in the appendix indicates that the average number of co-workers is slightly less than seven, and that 6.4 (or 92 percent) of these co-workers were, on average, present the previous week. This relatively high level reflects that the composition of the teams is relatively stable over time, and that social pressure may therefore be an effective motivational mechanism given the assumed dynamics.

[1]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.

5.3 Econometric specifications

Our first model is the dynamic linear-in-means model given by:

$$y_{i,g,t} = \alpha_i + \gamma y_{i,g,t-1} + \beta x_{g,t} + \theta \overline{y}_{-i,g,t-1} + \mu_t + \mu_g + \varepsilon_{i,g,t}, \tag{8}$$

where $y_{i,g,t}$ is the productivity of worker i in group g at time t, and $x_{g,t}$ is a vector of exogenous variables including current and lagged team size. α_i represents the individual specific fixed effects, μ_g captures team specific fixed effects and μ_t is a set of dummy variables for time. 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 θ measures the effect of an increase in co-worker productivity on subsequent individual productivity.

The model presented above is not subject to simultaneity, but the dynamic structure of 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 econometric consequences of these problems may be severe in short panels, and for fixed T we have an inconsistent estimator. 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, and it can be shown that the bias for $N \to \infty$ and fixed T is given by (Verbeek, 2008):

$$-\frac{\sigma_\varepsilon^2}{T^2}\left[\frac{(T-1) - T\gamma + \gamma^T}{(1-\gamma)^2}\right]. \tag{9}$$

For fixed T the estimator for γ has a downward bias, but as the number of time periods increases the bias goes toward zero. As a result, the fixed-effects estimator is consistent as both $N \to \infty$ and $T \to \infty$. The severity of the problem therefore depends on the number of time periods available. In long panels the dynamic panel bias becomes insignificant, and a straightforward fixed-effects estimator works fine (Roodman, 2006). Our data contains weekly observations over 6 year (312 time periods in total) where the average individual is observed in approximately 90 periods.

Our second model builds on Rees, Zax, and Herries (2003). Here we estimate how individual productivity is affected by the position relative to the other members of the

team. The model is given by:

$$\begin{aligned} y_{i,g,t} &= \alpha_i + \gamma y_{i,g,t-1} + \beta x_{g,t} + \theta_1 Q^1_{i,g,t-1} + \theta_2 Q^2_{i,g,t-1} + \theta_3 Q^3_{i,g,t-1} \\ &+ \mu_t + \mu_g + \varepsilon_{i,g,t}, \end{aligned} \tag{10}$$

where $Q^j_{i,g,t-1}$, $j = 1, 2, 3$ are dummy variables for the position in quartile j. The base category is a position in the fourth quartile. Holding lagged individual productivity constant, the parameters θ_j measures 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 peer pressure is aimed towards agents in the bottom quartiles we expect the parameters θ_j to be positive.

Both models presented above are subject to the dynamic panel bias. Although the fixed effect estimator is consistent in a large T perspective there are in theory a relatively simple way to avoid this problem by using internal instruments. Taking first differences of (8) eliminates the fixed effects from the model:

$$\begin{aligned} y_{i,g,t} - y_{i,g,t-1} &= \gamma(y_{i,g,t-1} - y_{i,g,t-1}) + \theta(\overline{y}_{-i,g,t-1} - \overline{y}_{-i,g,t-2}) \\ &+ (\varepsilon_{i,g,t} - \varepsilon_{i,g,t-1}). \end{aligned} \tag{11}$$

The transformation above has made $y_{i,g,t-1}$ endogenous and the OLS estimator based on (10) is inconsistent. However, Anderson and Hsiao (1981) suggest an instrumental variable approach where we use $y_{i,g,t-2}$ or $y_{i,g,t-2} - y_{i,g,t-3}$ as instruments. These are per definition correlated with $y_{i,g,t-1} - y_{i,g,t-2}$ but not with $\varepsilon_{i,g,t-1}$, unless $y_{i,g,t}$ exhibits autocorrelation, and are therefore valid instruments. Furthermore, it is difficult to argue that the average productivity of the other members of the team are unrelated to individual productivity in the same period; $\overline{y}_{-i,g,t-1}$ may therefore be correlated with $\varepsilon_{i,g,t-1}$. We therefore treat $\overline{y}_{-i,g,t-1}$ as endogenous in (10) using $\overline{y}_{-i,g,t-2}$ or $\overline{y}_{-i,g,t-2} - \overline{y}_{-i,g,t-3}$ as instruments.[2]

6 Results

6.1 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 effective work hour (logprod). All regressions include weekly fixed effects to control for time trends and seasonal variation

[2]Note that the model in (10) allows for a correlation between $\overline{y}_{-i,g,t-1}$ and $\varepsilon_{i,g,t-2}$.

in the data. The regressions also include individual and team-specific fixed effects to control for unobserved heterogeneity between workers and teams in the service center.

Table 2 provides the baseline results. The results in columns (1) and (2) are based on the dynamic linear-in-means model, while the results in columns (3) and (4) also consider the relative position in the productivity distribution. In principle, there are two ways an agent can increase their own productivity in our setting; by answering more calls or by increasing the sales effort per answered call. As our dependent variable controls for effective 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. The two remaining control variables in Table 2 are current and lagged team size. While we can see that the current team size has no effect on productivity, the lagged team size has a negative effect on subsequent productivity. The estimated effect is identical in all models, where a one-unit increase in team size results in a reduction in individual productivity of approximately 0.8 percent the following week.

Table 2 about here

The results of the dynamic linear-in-means model in columns (1) and (2) suggest a positive relationship between average co-worker productivity and subsequent individual productivity. The results in column (1) control for team-specific effects, indicating that a 10 percent increase in co-worker productivity is associated with a 0.26 percent increase in individual productivity the following week, all other things being equal. However, the estimated coefficient is relatively small in magnitude and only significant at the 10 percent level. The results in column (2) do not include the team-specific effects, and the corresponding increase in individual productivity here is 0.5 percent, indicating the presence of unobserved effects within the team that affect both individual and co-worker productivity. The results in column (1) are therefore a more reasonable estimate of the social interaction effect. The positive estimate indicates that there are mechanisms present within the teams that partly internalize the positive externality caused by team-based incentives. In other words, the workers correct for gaps in earlier productivity levels by increasing effort the following week.

It is reasonable to assume that any pressure within the team in favor of performance is primarily toward agents in the bottom part of the productivity distribution. Holding individual productivity constant, 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 (3) and (4) in Table 2 we therefore include the previous quartile rank as an independent variable. The results in column (3) 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, but again not statistically significant.

One possible explanation for these results is that changes in the average co-worker level of productivity and the position of individual workers relative to co-workers capture the same effects, making it difficult to separate them. In column (4), we therefore exclude average co-worker productivity, and analyze how the position relative to co-workers affects individual productivity, all else being equal. The effect of placement in the first quartile relative to placement in the fourth quartile here is positive and statistically significant at the 5 percent level. Holding lagged individual productivity constant, we estimate the subsequent increase in productivity level associated with placement in the bottom quartile to be about 3.3 percent higher relative to placement in the upper quartile. The relative effect of placement in the second quartile is also positive, but not statistically significant. The results presented here are then consistent with those in columns (1) and (2), where the workers correct for gaps in previous productivity levels by increasing effort the following week.

Note that the baseline results do not say anything about the underlying mechanisms. Social pressure, pressure from the team leader and/or information exchanges and cooperation between the members of the team could all then potentially explain these results. However, the results do indicate that workers take account of the effects of their efforts on their co-workers, either because they feel pressure to do or because they use relevant new information.

6.2 Robustness checks

This subsection presents two robustness checks for the results in Table 2. We first estimate the models using the instrumental variable approach suggested by Anderson and Hsiao (1981), which yields consistent estimates in the absence of serial correlation. We then perform a placebo test to ensure that the estimated effects in Table 2 are specific to the team by creating pseudo teams, that is, we include each worker with a random set of co-workers and re-estimate the models in Table 3. Both social pressure, pressure from the team leader and cooperation between workers should be most prominent within the teams workers actually belong to. If the same effects appear in the

pseudo teams, there must instead be some alternative explanations for the identified effects.

6.2.1 Instrumental variable results

The instrumental variable results for models (1), (3) and (4) in Table 2 are included in the appendix. Columns (1) and (2) in Table A.4 presents the results from the dynamic linear-in-means model where we use endogenous variables lagged two periods and the first-differences of these variables as instruments, respectively.[3] As shown, the coefficient for lagged average co-worker productivity is positive but insignificant in both models. At the same time, the coefficient for lagged individual productivity is small and only significant in the model when specifying the instruments in levels. The same pattern appears in the models including the position relative to co-workers.[4] The coefficients are small with correspondingly large standard errors. The reduced-form estimates (not shown) indicate that the instruments are relevant, that is, they explain variation in the endogenous variables. Table A.4 also provides the results from an Arellano-Bond test for second-order serial correlation in the differentiated error terms for which we are unable to reject the null hypothesis, suggesting that the error terms in levels are serially uncorrelated. The instruments are therefore valid. Although the Anderson-Hsiao approach in theory yields consistent estimates, past studies show that it has a number of weaknesses, including large variances and standard errors (see, for example, Arellano (1989) and Arellano and Bover (1995)).

A relatively easy way to evaluate the performance of the instrumental variable estimator is to compare the estimates from the fixed-effects model with the corresponding results from an ordinary least squares (OLS) regression. In an OLS regression, the lagged dependent variable will be positively related to the error term (through the individual-specific fixed effect), biasing the coefficient upwards. Conversely, the coefficient from the fixed-effects regression will generally have a downward bias, and a credible estimate of the true parameter should therefore lie within or near the range between these two values (Roodman, 2006). Based on the OLS estimates and the estimated coefficients in Table 3, we obtain the following bounds for the true parameter; [0.13; 0.30] based on the dynamic linear-in-means model, [0.142; 0.274] based on model (3) in Table 2 and [0.146; 0.277] based on model (4) in Table 2. The estimates from the instrumental variable approach lies well outside these intervals, giving us ample reasons to question the credibility of these estimates.

[3] Both lagged individual productivity and average co-worker productivity are treated as endogenous in this model.

[4] Note that the quartile ranks are treated as endogenous in the first-differenced model.

6.2.2 Placebo tests

The results in Table 2 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 reestimating the models in Section 6.1. If gaps in productivity from a random set of co-workers affect individual productivity, we cannot explain the results in Table 2 using team-related factors.

Table 3 about here

Table 3 provides the results of the placebo test. As shown, individual productivity is unrelated to both average productivity and 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 2 relate to the team to which workers actually belong.

6.3 Mechanisms

The results in Table 2 are intended to capture the peer effects arising from team-based compensation, where the "peer effects" include a number of potential mechanisms.

One such mechanism is social pressure, where the workers experience disutility if observed behaving selfishly by their peers. In this case, the workers correct for gaps in previous productivity levels because of sanctions and social punishment by their peers. Alternatively, social pressure could result from altruistic behavior 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 payoff for their co-workers.

Separating these social channels may be important because workplaces are differently organized. In settings where the workers are unable to observe each other's efforts, altruistic behavior is the only effective mechanism for internalizing the externalities present in many occupations. Separating the different social channels is, however, 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, Barankay, and Rasul (2005) and Mas and Moretti (2009), finds that 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 cooperation 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, Balasubramanian, and Roth (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 peer effects arising from team-based compensation, whereas the team leader effect may be important, even in the absence of team-based compensation. In order 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 peer effects from the team leader effect. The following section tries to shed some light on this issue.

6.4 Individual incentives and team dynamics

In the fourth quarter of 2006, the compensation structure in the service center changed dramatically, and the basis used for the compensation of workers was now largely individual productivity. Under the new compensation system, the workers received NOK 100 per sale over a predetermined target level (325 units per quarter). The sales bonus was based solely on individual sales, but it was adjusted by a factor between 0.7 and 1.3 based on how well the team did on some "service quality" indicators.

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 transition to individual incentives, however, may help us separate the peer effects from the team leader effect. In theory, the transition from team-based incentives to individual incentives will eliminate the externalities between the members of the team, which in turn will eliminate, or at least limit, the incentives to exert pressure and to cooperate. 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 when worker compensated is solely associated with individual productivity.

In other words, if the results in Table 2 are unambiguously a result of pressure and sanctions from the team leader, there should be no differences in the effects identified during the reform. On the other hand, if the positive effect on productivity from previous gaps in productivity changes during the period when compensation depended on individual productivity, peer effects must be an important mechanism. The transition to individual incentives may therefore help us separate the underlying mechanisms explaining the identified effects in Table 2.

To analyze whether the transition to compensation based on individual performance had an impact on the identified effects in Table 2, we interact the relevant background variables with a dummy variable equal to one when the workers were compensated based on individual productivity and zero when worker compensation also depended on the overall productivity of the team. Any significant coefficients for these interaction terms will indicate that the transition to individual incentives had an impact on how workers responded to previous gaps in productivity levels.

Table 4 about here

Table 4 shows the results from the transition to individual incentives. Here, the average co-worker productivity and the position of workers relative to the other members of the team are interacted with a dummy variable taking the value of one in the period when worker reward depended on individual productivity. Using the dynamic linear-in-means model, we find no differences in the estimated effects. Based on the results in (1), the average co-worker productivity has no effect on individual productivity, neither when worker compensation depends on team productivity, nor when rewarded only for individual productivity. We also note that these results are very sensitive to the inclusion of team fixed effects.

The results in columns (3) and (4) are more interesting. Both models indicate that placement in the bottom quartile has a positive effect on subsequent productivity when the workers were able to earn a bonus based on team productivity.[5] The relative effect associated with placement in the bottom quartile is significantly lower, and negative, during the period when worker compensation solely depended on individual productivity, indicating that the pay reform had an impact on the identified effects. As there was no change in the team leader's incentives during the pay reform, there is no reason to believe that pressure and sanctions associated with the team leader would change.

The negative impact of the effect associated with placement in the bottom quartile

[5] The results in column (4) also indicate that placement in the second quartile has a positive effect on subsequent productivity outside the pay reform.

may therefore indicate that pressure and sanctions associated with the team leader are not the mechanism underlying the results in Table 2. As a result, peer effects must be present in our setting. The findings in this section are consistent with a status report by the company for the fourth quarter of 2006, where it was claimed that the "team spirit", or the feeling of belonging to a team, was lost, and that the transition to individual incentives gave less priority for team members to help each other.

6.5 Heterogeneity

Extant studies, including Mas and Moretti (2009), find that low productivity workers are most sensitive to changes in co-worker productivity. Similarly, Hansen (1997) concludes that the effect on productivity when moving from individual to team-based incentives are inversely related to the workers initial productivity, indicating that group-based incentives may have positive effects on average productivity, especially for those workers who are initially less productive, suggesting that social pressure is primarily aimed toward low productivity workers. Alternatively, these workers benefit most from cooperation and information exchanges within teams.

In order to examine whether there are any differences between how high and low productivity workers respond to changes in co-worker productivity, we create a measure of ability to separate the two worker categories. Existing studies, including Hamilton, Nickerson, and Owan (2003), define worker ability as average worker productivity in the absence of any externalities between workers. Similarly, Mas and Moretti (2009) estimate worker ability by explicitly recognizing the social interactions between employees. We define our simple measure of ability as the estimated worker fixed effect from a regression of worker productivity on the time and team dummies. We then use the estimated fixed effect, rather than average productivity, to control for any trends and seasonal variation in the data. Using worker fixed effect as a measure of ability is not without its flaws, mainly because it does not consider the interactions between team members resulting from the team-based compensation structure.[6] However, the measure is probably sufficient to separate low from high productivity workers in the call center.

Based on the fixed effect measure of productivity, we define workers with permanent productivity below the average as low productivity workers. We then estimate the dynamic linear-in-means model conditional on differences in the workers' permanent productivity.

[6] To the extent social pressure and cooperation, because of team-based compensation structure, have a positive effect on worker productivity, our ex post measure of ability will be biased upwards.

Table 5 about here

Table 5 present the results from the dynamic linear-in-means model conditional on differences in permanent productivity. Columns (1) and (2) provide the results when we condition on low productivity workers while columns (3) and (4) show the corresponding results for high productivity workers. The results are in line with the premise that low productivity workers are most sensitive to changes in co-worker productivity levels, where previous gaps between individual and co-worker productivity has a positive effect on subsequent individual productivity only for workers with low permanent productivity.[7] This indicates that the aiming of social pressure is primarily toward low productivity workers. The results are also in line with cooperation in the teams, given low productivity workers benefit most from information exchanges and help by co-workers.

The results presented here concur with the results of Mas and Moretti (2009). They argue that this finding is important because it implies that the mix of workers that maximize productivity is that which maximizes skill diversity within teams. Hamilton, Nickerson, and Owan (2003) supports this argument empirically, where they find that the spread in permanent productivity within teams has a positive effect on overall team productivity. Overall productivity is therefore higher when both high and low productivity workers are employed on the same team, compared to the situation where some teams consist of only low-productivity workers and other only of high-productivity workers.

7 Conclusion

The focus of this paper has been to analyze how gaps between individual and co-worker productivity affects subsequent individual productivity. Our first measure of gaps in productivity was the absolute distance between individual and co-worker's productivity levels, and 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 percent increase in average co-worker productivity results in a 0.25 percent increase in individual productivity the following week.

Our second measure of the productivity gap was the position of workers relative to co-workers, where the results indicated 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

[7] The qualitative results does not depend on the inclusion of team fixed effects.

3.3 percent 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 more ambiguous goal with our paper was to identify 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 answer this question, we used a transition to individual incentives where there are no externalities between the workers. The results indicated that the relative effect of placement in the first quartile was significantly lower, or evan negative, during the period when worker compensation depended solely on individual productivity alone. Given no change in the team leaders' incentives during this reform, 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.

Whie we are not able to identify whether the effects are a result of social pressure or cooperation within the teams, the results of this analysis are 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.

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Table 1: Descriptive statistics, 2003-2009.

	Mean
Number of sales	23.28
	(13.59)
Hours logged on (effective work hours)	24.60
	(8.659)
Sales per effective work hour	1.051
	(1.089)
Average team sale (excluding worker i)	23.28
	(7.339)
Average team effective work hours (excluding worker i)	24.60
	(4.949)
Average team sale per effective work hour (excluding worker i)	1.05
	(0.57)
Team size	7.954
	(1.994)

Standard deviations in parentheses

Table 2: Fixed effect results of peer effect on individual productivity from 2003 to 2009. Dependent variable is log of sales per effective hours of work.

	(1)	(2)	(3)	(4)
Individual productivity, previous week	0.130***	0.136***	0.142***	0.146***
	(0.0108)	(0.0108)	(0.0165)	(0.0142)
Team size, current week	0.00499	0.00545	0.00501	0.00492
	(0.00333)	(0.00338)	(0.00333)	(0.00333)
Team size, previous week	-0.00811**	-0.00821**	-0.00799**	-0.00787**
	(0.00351)	(0.00365)	(0.00352)	(0.00353)
Peers' average productivity, previous week	0.0259*	0.0496***	0.0135	
	(0.0150)	(0.0160)	(0.0179)	
First quartile, previous week			0.0267	0.0337**
			(0.0189)	(0.0159)
Second quartile, previous week			0.0153	0.0197
			(0.0141)	(0.0127)
Third quartile, previous week			0.0152	0.0177
			(0.0114)	(0.0109)
Worker fixed effects	Yes	Yes	Yes	Yes
Team fixed effects	Yes	No	Yes	Yes
Week effects	Yes	Yes	Yes	Yes
Observations	27131	27131	27131	27131

Notes: Cluster-rubust standard errors in parentheses. Stars denote significance: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 3: Placebo results

	(1)	(2)	(3)
Individual productivity, previous week	0.138***	0.141***	0.141***
	(0.0107)	(0.0161)	(0.0143)
Pseudo team size, current week	0.0000344	0.00000349	0.00000343
	(0.00128)	(0.00129)	(0.00129)
Pseudo team size, previous week	0.00174	0.00172	0.00172
	(0.00150)	(0.00150)	(0.00150)
Pseudo peers' average productivity, previous week	0.00279	-0.000465	
	(0.0130)	(0.0175)	
First quartile in pseudo team, previous week		0.00889	0.00864
		(0.0193)	(0.0146)
Second quartile in pseudo team, previous week		0.0190	0.0188
		(0.0141)	(0.0118)
Third quartile in pseudo team, previous week		0.0142	0.0141
		(0.0110)	(0.00996)
Worker fixed effects	Yes	Yes	Yes
Week fixed effects	Yes	Yes	Yes
N	27131	27131	27131

Cluster-robust standard errors in parentheses. 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.

Table 4: Results from the transition to individual incentives.

	(1)	(2)	(3)	(4)
Peers' average productivity, previous week	0.0255	0.0492***	0.0136	
	(0.0160)	(0.0171)	(0.0179)	
Peers' average productivity*reform, previous week	0.00512	0.00505		
	(0.0483)	(0.0510)		
First quartile, previous week			0.0317*	0.0388**
			(0.0191)	(0.0164)
First quartile*reform, previous week			-0.0601*	-0.0601*
			(0.0354)	(0.0354)
Second quartile, previous week			0.0172	0.0216*
			(0.0144)	(0.0131)
Second quartile*reform, previous week			-0.0227	-0.0227
			(0.0346)	(0.0346)
Third quartile, previous week			0.0153	0.0178
			(0.0119)	(0.0115)
Third quartile*reform, previous week			-0.000441	-0.000479
			(0.0336)	(0.0337)
Worker fixed effects	Yes	Yes	Yes	Yes
Team fixed effects	Yes	No	Yes	Yes
Week fixed effects	Yes	Yes	Yes	Yes
Other controls	Yes	Yes	Yes	Yes
Observations	27131	27131	27131	27131

Notes: Cluster-robust standard errors in parentheses. Stars denote significance: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Reform is a dummy variable equal to one in the period where the workers was rewarded based on individal productivity (number of sales) alone (from the fourth quarter of 2006 to the second quarter of 2007.

Table 5: Heterogenous peer effects

	Low-productivity workers		High-productivity workers	
	(1)	(2)	(3)	(4)
Peers' average productivity	0.0427*	0.0724***	0.00753	0.0331
	(0.0229)	(0.0234)	(0.0215)	(0.0227)
Worker fixed effects	Yes	Yes	Yes	Yes
Team fixed effects	Yes	No	Yes	No
Week fixed effects	Yes	Yes	Yes	Yes
Other Controls	Yes	Yes	Yes	Yes
Observations	13937	13937	13194	13194

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

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

Pay reforms	Individual 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 percent weight on sales premium

The table shows the total individual- and team paymant based on sales.The total bonus is different from the sum of individual- and team payment because the total bonus also depends on other parameters over the period.

Table A.2: Transformation matrix for position in the productivity distribution

	Quartile 1 (t+1)	Quartile 2 (t+1)	Quartile 3 (t+1)	Quartile 4 (t+1)	Total
Quartile 1 (t)	40.81	24.72	22.11	12.35	100
	(3,677)	(2,727)	(1,992)	(1,113)	(9,009)
Quartile 2 (t)	32.6	25.35	26.27	16.02	100
	(2,254)	(1,766)	(1,830)	(1,116)	(6,966)
Quartile 3 (t)	24.30	23.49	30.30	21.91	100
	(1,925)	(1,861)	(2,401)	(1,736)	(7,923)
Quartile 4 (t)	18.86	18.38	28.36	34.39	100
	(1,130)	(1,101)	(1,699)	(2,060)	(5,990)
Total	30.07	23.27	26.51	20.16	100
	(8,986)	(6,955)	(7,922)	6,025	(29,888)

Number of observations in parentheses

Table A.3: Stability in team composition

	Mean
Number of coworkers	6.954
	(1.994)
Number of coworkers also present the previous week	6.443
	(2.062)
Share of coworkers also present the previous week	0.925
	(0.125)
Standard deviations in parentheses	

Table A.4: Instrumental variable results for the first differenced model where lagged individual productivity, lagged peers' average productivity and the quartile rank are treated as endogenous. Estimation period is from 2003 to 2009.

	(1)	(2)	(3)	(4)	(5)	(6)
Individual productivity, previous week	0.0233*	0.0139	0.0186	-0.000628	0.0236	0.00770
	(0.0124)	(0.0160)	(0.0187)	(0.0258)	(0.0175)	(0.0237)
Peers' average productivity, previous week	0.0148	0.0184	0.0194	0.0332		
	(0.0251)	(0.0342)	(0.0280)	(0.0393)		
First quartile, previous week			-0.00483	-0.0214	0.00403	-0.00683
			(0.0237)	(0.0345)	(0.0214)	(0.0302)
Second quartile, previous week			-0.0159	-0.0400	-0.0104	-0.0308
			(0.0183)	(0.0267)	(0.0171)	(0.0245)
Third quartile, previous week			0.00513	-0.00408	0.00839	0.00133
			(0.0147)	(0.0215)	(0.0142)	(0.0208)
Team fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Week effects	Yes	Yes	Yes	Yes	Yes	Yes
Instruments	Level	Diff	Level	Diff	Level	Diff
Arrelano-Bond test for second order serialcorrelation in the first diff. model. (p-value)	0.6593	0.9693	0.6648	0.8697	0.6638	0.8831
N	24484	22098	24484	22098	24484	22098

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

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