Behavioral Spillovers in Organizations
A Selective Review

Miguel A. Martínez–Carrasco*

July 15, 2016

Abstract

We present an overview of research on spillover effects within firms and introduce a classification of the literature. We divide spillovers into either technological or social in nature. In our classification, a technological spillover is one in which an agent rationally responds to a cue in the workplace that does not rely on the identity or characteristics of a coworker. Social spillovers, on the other hand, may be thought of as arising from the social preferences of an individual or social norms established in the organization.

*miguel.martinez@udep.pe. Assistant Professor, Department of Economics. Universidad de Piura - Lima. Lima, Peru.

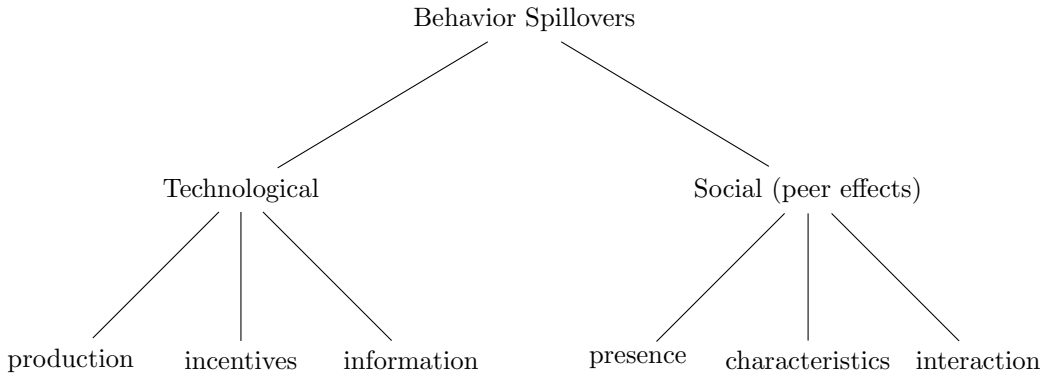
1 Spillovers

Marshak and Radner (1972) define an organization as a group of persons whose actions agree with certain rules that further their common interests. This broadly defines a wide range of interpersonal associations, such as political parties, localities, families or firms. The societal nature of organizations gives rise to the existence of peer influences or spillovers among their members. Actions, decisions, characteristics of the members of an organization may affect the well-being and the actions taken by the rest of their members. Understanding the mechanisms behind these "peer effects" and measuring their magnitude are paramount to optimal organizational structure.

In this review, we focus on experimental and other empirical research that studies these peer effects in the workplace.[1] In recent years, this has been a growth area in empirical microeconomics in both the lab and field. The development and adaptation of new empirical tools, better access to data, and the benefits of laboratory experiments and quasi-experiments are the main reasons behind this progress. This last point was made convincingly by Herbst and Mas (2015), who show that laboratory evidence of peer effects replicate well in field settings.

In the workplace, there are many potential ways on which a worker may affect his or her coworkers. From a theoretical standpoint, there must exist a functional form in which the actions (decisions) of workers interact with each other and these interaction should have an impact on the workers' utility. The purpose of this review is to offer a structured review of these studies by forming a loose taxonomy of the channels of peer influence. The framework, represented by Figure 1, separates spillovers into either technological or social in nature. That is, we classify spillovers based on whether their effects are found inside or outside of the production function.

Figure 1: A Classification of Spillovers



Technological spillovers can be thought of as the mechanical response of rational agents responding to stimulus generated at the workplace, where their answer to these stimuli is independent to the identity of their coworkers. These spillovers might be intrinsic to the production process of the firm; alternatively, a principal or manager could artificially generate them with monetary incentives, firing policies, crafting a corporate culture or

[1] Prior surveys have covered peer effects in education (Epple and Romano (2011)), law enforcement (Rincke and Traxler (2011)) and social interactions (Durlauf and Ioannides (2010)).

the design of information flows. Social spillovers, by comparison, emerge from the social preferences of the workers, which are independent of the formal production process. Social spillovers may activate based on the mere presence of someone else (as in the peer pressure or pro-social behavior literature) or it may depend on the characteristics and the type of interaction with their coworkers. Social spillovers may appear even if workers are technologically independent and there is no interaction among their actions generated by management practices of the firm.

We do not consider these categories discrete or mutually exclusive. Certainly, many studies of peer effects can fit into more than one category and in many situations both technological and social spillovers coexist. Rather, we aim here to compile a diverse array of studies in such a way as to present a structured overview of the literature on peer effects in firms.

We develop this categorization further by expanding on technological spillovers in section 2 and social spillovers in section 3. We classify the main experimental and quasi-experimental studies under these categories in Table 1, and section 5 concludes with a brief discussion. Our primary objective is to provide a guide for those who are interested in these areas of study. This compilation may further benefit practitioners charged with designing or changing a firm's management practices.

2 Technological Spillovers

Technological spillovers are those not related to any social preference of the agent; instead they are part of a rational response to the rules or characteristics at the workplace. In this sense, technological spillovers depend on the existence of coworkers, but they are not the driver of the spillover. Technological spillovers may emerge given an inherent relationship between agents actions through the production function (objective function) affecting their utilities. Or, firm may create this relationship using different managerial and organizational practices e.g. firing policies, promotion policies, contracts and incentives.

2.1 A Production (Objective) Function

Imagine we have a firm with N employees. Assume they all have the same objective function $g(x, \mathbf{a})$ where x is a generic variable representing the particular characteristics of the environment and $\mathbf{a} = \{a_1, ..., a_N\}$, $a_i \in \mathbb{R}$ is the action of agent i. In other words, all agents in the firm have the same common interests.[2] In order to create spillovers, workers' actions should affect their coworkers' utility. Thus, g is not separable in a_i for all i. Given $g(a_i, \bar{a}_{-i})$, where $\bar{a}_{-i}$ is the vector of the action of all the workers but i, we have *positive (negative) spillovers* if g is increasing (decreasing) in $\bar{a}_{-i}$.

A natural assumption is that a worker's actions at the workplace have a cost. This cost is related to the time and effort to take the chosen actions. However, spillovers may emerge

[2] This definition of common interest and workers maximizing the same functional form was used by Marshak and Radner (1972). It allows them to differentiate an organization from a team. The members of a team have a common interest while in the organization this is not necessarily true. We do not use this approach.

even if the worker's action is costless. Imagine two sellers working in the same storefront on a hot day. One worker has a cold and keeps the air conditioner off. The other worker sees reduced sales as a consequence, as fewer buyers enter the store, her productivity and patience are affected by the temperature and she is worried about catching the cold. While this example is not strictly related with the objective function, we can think of similar environments that require coordination among workers' actions to maximize their production. However, the vast majority of those situations are related to costly actions for the workers.

Let's assume that the N workers have the same cost function, $c(a_i)$ with $c(0) = 0$, $c_i(a_i) > 0$ and $c_{ii}(a_i) > 0$.[3] The cost function only depends on the action taken by each worker i. A higher a_i implies greater effort exerted on the task which implies a higher total and marginal cost, while no effort incurs no cost. Under these circumstances, if g is a continuous and twice differentiable function exhibiting diminishing marginal returns ($g_i i < 0$), each worker wants to maximize $g(x, \mathbf{a}) - c(a_i)$, which give us the first order condition:

$$g_i(x, \mathbf{a}) - c_i(a_i) = 0$$

Applying the implicit function theory we obtain the impact of a coworker's action on the worker's own action, her strategic response.

$$\frac{\partial a_i^*}{\partial a_j^*} = \frac{g_{ij}(x, \mathbf{a})}{c_{ii}(a_i) - g_{ii}(x, \mathbf{a})}$$

Given the previous assumptions, the denominator in this expression is positive, which implies that the direction of the strategic response depends on the cross-partial of the objective function with respect to the workers' actions. In this case, we have both spillovers and strategic actions. The latter implies that agent's decisions are not independent of the decision of their coworkers. If $g_{ij}(x, \mathbf{a}) \geq 0$ the actions are complementary; and, if $g_{ij}(x, \mathbf{a}) \leq 0$ they are substitutes. The logic behind these results is very intuitive. If the actions of the coworkers are complementaries and my coworker is exerting more effort, the marginal impact of my effort on the production function is higher. If I want to maximize my production I will exert more effort as well. On the other hand, if the actions of a coworker are substitutes and my coworker is exerting more effort, the marginal impact of my effort on the production function is lower. As a consequence, If I want to maximize my production I will exert less effort.

Production functions relating workers actions are common on firms with multidisciplinary teams. Clear examples are R&D departments, start-ups and sports teams. These situations are also adequate to create strategic responses among coworkers. Complementarity among actions may emerge when teams must take coordinated action to maximize their objective function. On the other hand, substitutability among actions may emerge when there are different or competing ways to reach the same objective.

To illustrate further, consider the interactions between players in baseball. As the main

[3] Where $f_i = \partial f / \partial a_i$ and $f_{ii} = \partial^2 f / \partial a_i^2$ for any function f.

objective of a baseball game is to score more runs than the opponent, a team may reach its objective with good pitchers or good batters. Gould and Winter (2009) identify a substitutability relationship among these units using the standard procedure to estimate spillovers (Manski (1993)). Also, they show that there is a complementary relationships among players of the same type (batters or pitchers). The observed result is not driven by a behavioral responses since it differs by player type.[4]

The substitution effect between batter and pitcher actions can be seen as free riding. If one of the units of the team is exerting enough effort to win the game, the other unit may lower effort. However, the authors are not able to disentangle if teams specialized by reinforcing one of these units or it is a conscious selection by the players. The latter is still a remaining question that could have important implications to address different managerial practices across firms and industries.

On the other hand, the complementarity effect among batters or among pitchers requires coordination. Coordination games typically have multiple equilibria. In some cases, workers may end up in a "good" equilibrium of high effort, but there are other cases where the lowest-effort equilibrium prevails.

Arcidiacono, Kinsler, and Price (2015) underline the role of spillovers in men's professional basketball. In order to score, players may look for their own shot (direct effect) or may facilitate plays by their team members (spillover effect). Using an iterative approach develop by Arcidiacono, Foster, Goodpaster, and Kinsler (2012), they find that a standard deviation increase in the spillover effect of one player improves team success by 63% as much as a standard deviation increase in the direct productivity of that player. However, they also found that this spillover was not internalize by the teams through a player's compensation. The authors suggested that as compensation is primarily driven by a player's direct contribution, there is potential for misaligned incentives that may result in self-interested actions at the team's expense.

A common practice across firms and organizations is to offer monetary incentives to workers subject to the fulfillment of a particular objective - a level of production, sales or profits levels. This may take the form of piece rates or bonuses, where the workers payment is a linear transformation of the objective function. If the objective function depends on a coworker's effort and all workers are ex ante identical, the strategic response among workers will exclusively depend on the complementarity or substitutability of actions. In other words, we would return to the coordination and free riding problems mentioned earlier. However, most of the studies describing this type of situation focus on complementary production functions.

In this context, the experimental literature has made important contributions to our understanding of the coordination difficulties when actions are complementary in production. The most frequent coordination model uses on those studies is the weak link game or the minimum effort game from Van Huyck, Battalio, and Beil (1990). In this game, $n \geq 2$ agents have to choose between a natural number from 1 to K. The payoffs are determined

[4] If the response were merely behavioral the players should provide more effort if their team members provide more effort independently of the role they played.

by $\alpha + \beta \times min\{x_1, ..., x_n\} - \gamma x_i$ where x_i is the number selected by a worker. The main features of the game are that the payment is increasing in the minimum effort exerted by a worker and is decreasing in an own worker's effort. Homogeneous effort within a team results in Pareto-ranked Nash equilibria where the highest level of effort dominates lower-effort equilibria. The main experimental results highlight the difficulties in coordinating on the most efficient equilibrium with $n \geq 3$ players (Van Huyck, Battalio, and Beil (1991) and Weber (2006)). However, communication can significantly improve outcomes (Cooper, De Jong, Forsythe, and Ross (1992); Blume and Ortmann (2007)). Incentives also may help to reach more efficient equilibria (Goeree and Holt (2005); Hamman, Rick, and Weber (2007)). Finally, Weber (2006) shows that is easier to sustain coordination when groups start small and grow slowly than when they start with a large number of workers. For a complete review of these and other related results see Camerer and Weber (2012).

Goerg, Kube, and Zultan (2010) analyze one dimension more related to incentive based on team production functions: fairness. They test the theory presented by Winter (2004) that treating equals unequally in terms of their payments is the optimal mechanism when production involves complementarities. The intuition behind this idea is that when equals workers receive different payments, it facilitates coordination by reducing strategic uncertainty about another's actions. Workers update their beliefs expecting that those with higher payments exert higher effort avoiding the usual coordination problem. At the same time, Winter (2004) argues that a more equal payment system is more efficient when workers face a production function with substitutability across worker's actions. To avoid free riding, workers should not expect than one of them will exert more effort. Goerg, Kube, and Zultan (2010) confirm these results, offering the first empirical evidence on the importance of the relationship between equality and the characteristics of the production technology.

2.2 Incentives

Spillovers in organizations may emerge as a consequence of their managerial practices even if each worker has an independent production function. These practices may create a link between workers' production levels, rather than across workers actions, through the compensation scheme or other firm policy. We can divide these practices in two subgroups defined by the type of relationship across worker actions they generate: strategic complementarity or substitutability. In this review, we focus on the empirical contributions.

Substitutability among worker actions can be generated by team-based managerial practices. These could be team sales bonuses or firing policies considering the performance of a team instead of individual performance. In the first case, the objective function is a composite of the production function of each coworker, $h_i = (g_1(a_1), ..., g_N(a_N))$ for $i = 1, ..., N$. In the second case, we can assume that workers receive a fixed payment (g) but the probability to receive the payment (p) is determined by the team production (y), in which case the objective function would be $h_i = p(y(a_1, ..., a_N))g$.

Again, opportunistic behavior may emerge on these circumstances when actions are not observable. A seller may provide less effort if she believes her coworkers are making enough sales or they are producing enough. However, these practices are common in firms. Some questions naturally rise: why do firms favor these practices? Are they as inefficient as the model suggests? Which other variables should we consider in analyzing these practices?

Hamilton, Nickerson, and Owan (2003) gather data from a garment plant that shifted progressively from individual piece rate to group piece rate production over three years, with team-based compensation being optional. They found that the team-based incentives increased a worker's productivity by 18%. However, they show that this result has two important components: a self selection of high ability workers to teams (4%) and a team effect (14%). High ability workers were more likely to join teams first and were less likely to leave the company after they join teams. Teams formed first were more productive than teams formed later on, which directly speaks to the contribution produced by high ability workers.

This evidence suggests that team-based incentives can have positive effects offsetting any negative effect of free riding. While the authors do not shed light on the mechanisms involved, possible explanations are learning across workers, peer pressure, monitoring or the development of new skills. Moreover, the fact that high ability workers join teams at all, despite a loss in earnings in some cases, suggest that there are some type of non-pecuniary benefits. Finally, they show that more heterogeneous teams are more productive, when average ability is held constant. High-ability workers appear to improve team productivity more than low-ability workers hinder.

Chan, Li, and Pierce (2014a) study cosmetics sales in large department stores. They find that more heterogeneous teams - in terms of ability - perform better under team-based incentives contracts than with individual-based contracts. High ability workers have a positive impact on coworkers in team-based incentives contracts while a negative one in individual-based contracts. In the former, high ability workers help their coworkers to obtain more clients. In the latter, high ability workers take clients from low-ability coworkers. Interestingly, they find that high ability workers on team based incentives have a strong negative impact on outside peers, while they have little impact when under individual-based contracts. Also, in team-based contracts, high ability workers are more responsive to outside peers stars and outside competition and less willing to negotiate on price.

Boning, Ichniowski, and Shaw (2007) also find a positive impact on firm productivity from group incentive pay in U.S. steel mills. More importantly, they also analyze the impact of using group incentive pay with problem-solving teams, created within the firm to share information and make decisions. Here they find that the positive impact on productivity is even larger, especially in more complex production environments. The average productivity effect corresponds to an annual increase of approximately 3,000 additional tons of steel valued at over $1.4 million. Problem-solving teams are a mechanism to enhance communication across workers with independent but interrelated tasks. We discuss further managerial practices improving information flows an communication in the next

section. However, in the context of this paper, the problem-solving practice complements the group incentive payment, as without it workers would not have incentive to share private information.

Firing policies can also generate interdependence in worker actions. Amodio and Martinez-Carrasco (2016) evaluates the impact on workers productivity of an exogenous increment on neighboring coworkers productivity driven by an improvement in the input quality managed by the coworker. They use data from an egg production company in Peru and find evidence of negative spillovers. In particular, estimates imply that a one standard deviation increase of average coworkers' daily output is associated with a decrease in own daily output of almost a third of its standard deviation. Workers are assigned to sheds that form between two and four production units. The authors find that the firm takes into account the productivity of the whole shed when deciding which worker to dismiss. This generates free riding among workers, especially when a worker with low productive inputs has a neighbor with high productive inputs. Interestingly, the negative spillover disappears when workers are exposed to a monetary incentive - a piece rate that activates when the input is productive enough - or when workers consider their neighbors as friends.

On the other hand, complementarities among worker actions emerge when managerial practices try to promote an equilibrium where all workers coordinate on the most efficient equilibrium. The most common practices to pursue this objective are creating relative incentives or organizational culture of cooperation. Relative incentive can take the form of rankings, tournaments or a payment function depending inversely on the average team production ($\bar{a}$) and positively on own production as in Bandiera, Barankay, and Rasul (2005, 2006), where $g_i(a_i/\bar{a})$ is the payment function of worker i. Managerial practices promoting cooperation are more difficult to define precisely; they can take several forms and more empirical research is necessary. However, theoretically these practices may generate a particular communication code, similar beliefs or behavioral patterns.

Theoretically, workers should exert high effort under relative incentives to out-work their teammates. However, empirically we need to consider other important factors,for instance, social connections. Bandiera, Barankay, and Rasul (2005, 2006) study the case of fruit pickers in a leading farm in UK that switched from a relative incentive scheme to a piece rate scheme. They found that average worker productivity was 50% higher under piece rate than under relative incentives. The explanation behind this finding is that workers internalize part of the externality they produce on their coworkers if they exert too much effort. This social pressure is present only when workers can monitor or be monitored by others.

In the context of the same firm, Bandiera, Barankay, and Rasul (2013) conduct a field experiment introducing rank incentives and tournaments on top of team-based piece rates. Rankings incentives were executed by the publication of daily and weekly information on the productivity by team, while tournaments included a weekly monetary prize for the most productive team by farm site and fruit type. They found that rank incentives and tournaments increase the probability to form teams with other workers of similar ability. However,rank incentives reduce productivity by 14%, while tournaments increase productivity by 24% on average. The reason is an asymmetric response by high and

low ability teams: rank incentives only reduce the productivity of the worst teams while tournaments only increase the productivity of the best teams.

Tournaments have also been studied using closely controlled laboratory experiments. Nalbantian and Schotter (1997) found that competition and monitoring produced better results - and results more in line with theoretical predictions - than alternative incentive schemes. Bull, Schotter, and Weigelt (1987) find that uncertainty over opponent actions increases variance in tournaments (compared to playing a computer opponent), but higher levels of information reduce variance in effort. Schotter and Weigelt (1992) find that in tournaments with asymmetry in ability (cost of effort) and winning threshold cause over-exertion of effort, while just one of these features alone leads to under-exertion. Orrison, Schotter, and Weigelt (2004) find that behavior is insensitive to the number of participants when half of them receive a prize. However, when more than half receive a prize the effort exerted decreases.

Most of the tournament experiments confirm the theoretical predictions pointing out cases where agents over or under performed effort. However, tournaments could also generate changes in other aspects of worker behavior. Carpenter, Matthews, and Schirm (2010) study the possibility to sabotage other participants in a tournament framework with a real effort task. The results show a tendency to sabotage another's effort through quality ratings. This behavior is costly, as saboteurs produce less and the quality of their performance decreases. There seems to be a substitution between worker effort and the ability to change the perception of a coworker's effort. So, under production complementarity, a worker may try to reduce the perception of their coworker's effort instead of increasing their own effort.

Finally, managerial practices may generate spillovers even in the absence of complementarity or substitutability relationship among workers. For instance, Bandiera, Barankay, and Rasul (2007, 2009) study a contractual change among managers in the fruit pickers industry. Managers move from a fixed wage scheme to a piece rate scheme depending on average productivity of lower-tier workers. The authors find that after this change, managers selected more able workers prioritizing high productivity workers instead of those with whom had social ties. Further, managers exert more effort monitoring high ability workers within their selected teams. Both behavioral responses from the manager increase the mean and the dispersion of workers productivity.

2.3 Information

Information transmission among workers is another important source of technological spillovers. It can take several forms: the production process may allow some workers to observe each other, the structure of the organization may foster the communication among some units of the firm or more experienced workers may teach less experienced ones. All of these manifestations have a common factor, workers have different private information, but may share under some circumstances.

In terms of the model, workers make their decision after observing a signal y_i of the

state of the world. As a consequence, their actions are a function of this signal, $a_i = \alpha y_i$. As in Marshak and Radner (1972), information can be the result of an information gathering procedure. Workers may use different methods to gather information, which may be related to experience, ability and the organization's communication technology. To formalize, we can introduce an information function relating the worker's signal to the state of the world, $y_i = \eta_i x$, which sends noisy information to the workers. Hiring decisions and the selection of a communication technology have a direct impact on the information function. Likewise, the characteristics of the information function will impact the optimal organization of the firm. For instance, it is natural to assume that the information function may present decreasing returns to the informativeness of the signal as the complexity of the state of the world increases. In this situation, the organization could divide the state of the world into different partitions, with each partition assigned to a different group or division. The informational spillovers would thus depend on the type of workers in a unit as well as the communication technology both across and within the unit. Finally, the flow of information can be controlled to determine the order in which workers receive the information, creating hierarchies or organizational structures in the firm, as well as different allocation of decision rights and authority.

These theoretical considerations related to informational spillovers are much more developed than the empirical evidence. The main difficulties lie in the availability of data that would allow accurate identification of the informational spillovers. Issues such as sorting across workers or unobserved common shocks are common. In addition, much of the transmission of information among workers may be through informal channels that are difficult (if not impossible) to measure. We can, however, begin with some simpler questions: Do learning spillovers exists? How important are they to an organization?

Wang, Azoulay, and Zivin (2010) analyzes the impact of the sudden death of high-output researchers on the productivity and output quality of their coauthors. They found a lasting 5% to 8% decrease in quality adjusted publication output of the deceased's colleagues. Taking advantage of the heterogeneity in collaborators' characteristics, the authors explore several possible mechanisms. In particular, they do not find a more significant impact on close or recent collaborators, reducing the likelihood of physical determinants of the collaboration. Nor is imperfect skill substitution the main driver of the negative effect. They do not find either a more negative effect on the social components of the co-authorship relation. However, the impact is stronger for those coauthors working on similar topics, confirming evidence of a knowledge spillover in related research. Oettl (2012) similarly finds a higher reduction on collaborators' quality-adjusted productivity when their "superstar" coauthor had a higher helpfulness measure. On the other hand, Waldinger (2010) uses the dismissals of scientists by the Nazi government in 1933 as exogenous variation in the peer groups of the remaining scientists. He finds no evidence of local spillovers when regressing the number of publications against average peer quality and number of peers. The latter results reinforce the idea that local spillovers may be less important than the closeness of the research to knowledge spillovers.

Knowledge spillovers are also seen in many studies of technology adoption by farmers in developing countries. A well-studied case is the decision os Indian farmers on whether

or not to use a new hybrid of seed. Farmers could learn about the productivity (and profitability) of the seed through experimentation or learning from neighbors. Besley and Case (1994) find that farmers use some sophistication in their decision making, as bayesian models fit the observed data better than models with myopic agents. Foster and Rosenzweig (1995) study the same case and find that higher levels of local experimentation with a technology increases adoption, but at decreasing rates. Also, farmers with more experienced neighbors are more productive than those with less experienced neighbors. Lastly, they also presented empirical evidence of free riding behavior wherein a farmer reduces costs by relying on his neighbor to gain relevant experience, waiting to increase his use of the new technology until it is more profitable. The latter suggests that own experimentation and a neighbor's experimentation are substitutes, though Munshi (2004) argues that these spillovers rely on relative homogeneity of worker and land.

Other studies examine the effects information networks formed by farmers on knowledge spillovers. Conley and Udry (2010) use survey-generated information networks to show that pineapple farmers in Ghana follow the decisions made by more experienced and unexpectedly successful farmers (and avoid following decisions of less successful farmers), but only if the farmers are in their information network. Bandiera and Rasul (2006) use communication networks of sunflower farmers in Mozambique to estimate a u-inverse relationship between their network-accumulated experience with a new technology and the propensity to adopt. Essentially, probability to adopt the new technology is higher when more members of their networks has adopted it (i.e. a learning externality), but the value of the experimentation decreases as well, delaying adoption. However, like the previous studies, they find that more experienced farmers are less sensitive to decisions of their network connections.[5]

There are fewer studies analyzing informational spillovers at the firm level. An important contribution from the industrial organization literature is based on modifications of standard learning curve estimations. These methods involve estimating the main parameters of a production function, depending on the production inputs and on the accumulated experience gained prior to the period under analysis. However, the accumulated experience can take different forms, including learning by doing, knowledge depreciation or learning from others. In the semiconductor industry, studies find that knowledge spillovers between firms were less impactful than learning within the firm, with inter-generational spillovers within firms having a sizeable effect (Irwin and Klenow (1994); Gruber (1998)). Other studies have incorporated models of learning by doing and forgetting to find evidence of knowledge depreciation, in addition to knowledge spillovers, in shipbuilding during World War II (Argote, Beckman, and Epple (1990); Thornton and Thompson (2001)) and aircraft production (Benkard (2000)).

As you can notice, most of the research looks at situations across firms or products. Knowledge of these spillovers at the worker level are scarce and more studies are required. One exception is the paper of Chan, Li, and Pierce (2014b). Once again, they analyze cosmetics sales data in a Chinese department store. They use a model of learning by doing and forgetting, as those mentioned above, but they included peer-based learning measures.

[5] A more complete review on the literature of technology adoption on Foster and Rosenzweig (2010).

In particular, they use the average difference of each agent's experience with respect to their colleagues in the same counter and across counters.They are the first to highlight the importance of inter-group and intra-group learning spillovers. Also, they show that with more complex products, inter-organizational spillovers are more important, which suggest that active teaching may be more beneficial than passive spillovers through observation. However, the mechanisms are not observed and more studies are necessary.

The information spillovers covered here rely on a subset of the workers have more information than another. This raises several normative questions from an organizational perspective: should the organization provide some workers with more information? What is the role of training programs? Two studies give insight here using randomized field data from the call center of a multi-national phone company in the Netherlands. The firm selected its more experienced workers to undergo a training course to minimize call time, with the selected workers randomly assigned to an early or later training date. De Grip and Sauermann (2012) found that after controlling for individual fixed effects, worker spillovers, and time trend, the training increased agents' performance by 9.9% on average. Lindquist, Sauermann, and Zenou (2015) analyze the same case but exploit the network structure of each worker. Controlling for individual, team and week fixed effects; the authors find that a 10% increase in average co-worker productivity produces a 1.7% increase in a worker's own productivity, primarily attributable to conformity. However, when they analyze the effect of trained workers on their peers, they found that the productivity of treated peers (those with trained coworkers) is 8.5% higher than that of the control peers (those without trained coworkers) during the 10 weeks following the training experiment. As with the spillovers in the agriculture studies, the largest effect of trained coworkers is seen in less experience peers. This evidence shows that considering informational spillovers is vital to the evaluation of training programs within a firm. However, our understanding of which workers should receive the training and which type of organizational structure generates more spillovers is still limited.

3 Social Spillovers

The workplace is a place of social relationships and interaction. These can result in social spillovers that affect behavior at the workplace. Social Spillovers are those generated by the presence of other workers, the characteristics of workgroup members or the type of interaction with them. A recent meta-study by Herbst and Mas (2015) reanalyzes the results of 35 lab and field studies on the presence of peers. Overall, they find a positive spillover effect with workers working harder in the presence of peers. One important conclusion of the paper is that the average magnitude of the spillovers measured in the lab studies was nearly identical to the magnitude measured in the field studies.[6]

Theoretically, a social spillover implies that there exists a function affecting workers utility

[6] There is also a large and growing literature exploiting random assignment in sports events to estimate potential spillover effects. Brown (2011) observes a negative impact on performance when being matched with a superstar, while Babington, Goerg, and Kitchens (2016) if at all a slightly positive impact when being matched with a superstar. Yamane and Hayashi (2015) observe a positive relationship between the performances of adjacent competitors, while Guryan, Kroft, and Notowidigdo (2009) no peer effects.

that activates when she is not working alone. The most common representation of this function is to linearly introduce in the worker's utility a function depending on workers effort as in Kandel and Lazear (1992), $P_i(\bar{e})$ where $\bar{e} = \{e_1, ..., e_N\}$ on a team with N members. This function may generate strategic responses across workers as the in the technological spillovers. However, notice that the main difference is that the impact of these preferences are not necessarily homogeneous across workers. The composition of the team in terms of their social preferences will determine the average effect captured empirically.

Because the possibility to observe one's peers or to receive information about them gives rise to social spillovers, organizations may change their structure, communication technology or team composition in order to maximize productivity using these spillovers. That is, a firm can take advantage of the social preferences of its workers. However, there is a degree of endogeneity, as the worker can also decide who to observe or with whom to communicate. Recent theoretical contributions have tried to model the effects of network structure on the sign and size of these spillovers. This theoretical work is outside the objective of this review, but see Jackson (2010) for more information.

In the following we will discuss three types of social spillovers, which will have some overlap with the papers analyzed in Herbst and Mas (2015). First, we discuss research on "pure" peer effects, followed by spillovers in and between teams, the impacts of individual characteristics on peer effects, and the structure of interaction.

3.1 (Pure) Peer effects

Charness and Kuhn (2011) define pure peer effects as the resulting spillovers from the mere presence of another worker. Thus, pure peer effects are not the direct result of a joint production technology (e.g., team work) or payoff schemes (e.g., group compensations). They result from the mere presence of another individual or group working close by.

Falk and Ichino (2006) study pure peer effects in a realistic work setting in which subjects stuff letters into envelops and are paid independently of their output. The authors compare the output of workers working on this task alone with the output of workers working in a pair treatment in which two workers are working side by side. The pair treatment manipulates only the presence of another worker, allowing the estimation of pure peer effects as neither the payments nor the outputs of the workers depend on each other. Strong correlations between the output of adjacent workers are observed. The standard deviation of output for the workers in pairs is significantly lower compared to standard deviation of output from subjects working alone. In addition, paired workers produce on average higher outputs compared to the ones working on their own. Falk and Ichino compare their estimates of the strength of the peer effects with the ones of Ichino and Maggi (2000) who estimate peer effects with observational data. Interestingly, these estimates are very similar, anticipating the results of Herbst and Mas (2015).

However, it seems that the power of pure peer effects depends on the exact details of the work environment. Georganas, Tonin, and Vlassopoulos (2015) observe no correlation

between outputs in an anonymous lab experiment. In their experiment the observability of performance is manipulated with subjects being observed by others, subjects observing an other subject's performance without being observed themselves or subjects working on their own. In their treatments with no payoff externalities they observe a non-linear effect of peer pressure on subjects observing the performance of other subjects. The relationship is U-shaped with a positive effect of observing high productivity and a puzzling positive effect of observing low productivity. Veldhuizen, Oosterbeek, and Sonnemans (2014), too, vary the observability in an anonymous lab experiment but fail to observe any peer effects in lab experiments.

These results suggests that pure peer effects are more fragile in anonymous environments while personal presence/interactions seem to facilitate peer effects. The studies of Mas and Moretti (2009) and Bandiera, Barankay, and Rasul (2010)(mentioned earlier) provide support for this conjecture, as both studies report spillovers that appear to be larger for workers who interact frequently. Mas and Moretti (2009) use scanner data over a two-year period to measure productivity of cashiers in a US supermarket chain. Workers' effort measured by scanned items per second is positively correlated to the productivity of workers who see the cashier. However, it is not correlated with the productivity of workers who do not see the cashier. Bandiera, Barankay, and Rasul (2010) find that fruit pickers are more productive when they work with more able friends, while it decreases significantly when they work next to friends who are less able.

3.2 Social Spillovers within and between Teams

Pure peer effects are present without any dependencies between workers. But, spillovers and peer pressure can also be present and stronger in teams in which either output or payments depend on all team members.

Mohnen, Pokorny, and Sliwka (2008) use a model of in-equity aversion to explain peer pressure in teams and test its prediction in a lab experiment. Subjects perform a real effort task for several periods and each solved problem had a fixed monetary value. In the first and the last period subjects directly received this value. In the other periods subject decided first if they would perform the real effort task or choose an outside option. If they choose the real effort task the value would be transferred to a team account and then equally distributed among the team members, if they choose the outside option they would receive an amount that was directly transferred to their private account. The treatments manipulate whether the solved real effort tasks and the resulting contribution to the team account were observable or unobservable. When contributions are unobservable workers behave selfish and choose the option that only benefits their private account. However, transparent contributions lead to higher efforts and thus higher efficiency. The results support the view of Kandel and Lazear (1992) that peer pressure can help reduce moral hazard in teams.

Spillovers are not only present between workers and within teams, they can also occur between teams. Sausgruber (2009) uses a lab experiment to investigate exactly this spillover between teams. In each team the payoffs depend on the joint output, but payoffs do not

depend on the other teams output. As soon as the member of one team receive information on the output of the other team a high correlation between team efforts emerges; the output of matched teams becomes more homogenous. Yet, being matched with another team does not result in an overall higher efficiency. Similar to previous reported individual results this suggests that output adjustments are not necessarily always positive and output increasing.

3.3 Individual Characteristics and Peer Effects

The previously discussed spillovers occur when output or contributions are observed. However, spillovers can result from other characteristics. Ichino and Maggi (2000) investigate significant regional differentials in shirking among bank employees and link them to individual backgrounds, group-interaction, and sorting effects.

Social distance seems to favor spillovers as productivity spillovers were observed for relatively small (social) distances by Mas and Moretti (2009) and Bandiera, Barankay, and Rasul (2010). Related to social distance is the discrimination based on ethnicity in a production process. Hjort (2014), report how ethnicity influences supply decisions in production process. Their data reveals undersupply to non-coethnic down-stream workers and a shift in the supply from non-coethnic to coethnic downstream workers. Along this line is discrimination which is not based on statistical discrimination, i.e. output, but based on irrelevant characteristics like rualness and ethnicity of workers (e.g., Chmura, Goerg, and Weiss (2016)). Spillovers based on discrimination are not the focus of this paper and the interested reader is referred to Charness and Kuhn (2011) and Lane (2016).

Other spillovers are based on social comparison or inequity aversion. Workers who work independently of each other can still compare their wages and be affected by this comparison. Abeler, Altmann, Kube, and Wibral (2010) observe that paying equal wages can lower effort levels substantially. They argue that the reduction in average effort is driven by workers who exerted high effort but received the same wage as workers exerting lower effort. Thus, the equity principle is violated and agents withdraw effort. In contrast to this Charness and Kuhn (2007) find no effects if they allow for the comparison of wages between otherwise independent workers. A crucial difference between the two papers is that, in Abeler et al workers have full control over their output, while Charness and Kuhn generate heterogeneity in workers' abilities. Abeler et al conclude that "Charness and Kuhn's results rather apply to groups of workers that are loosely related and know little about each other, while [their] focus is on close co-workers who have a good understanding about their peers' abilities and efforts" (p. 1303). Again an argument in line with our previous observations.

One could argue that most effects that result from other-regarding preferences in situations in which workers decisions are from a rational economic perspective independent would fit into this category. Since this would go beyond the scope of this paper we refer the interested reader to the review by Cooper and Kagel (2012). In addition, the topic of conditional cooperation (Fischbacher, Gächter, and Fehr (2001)) and reciprocity is important in this context, but we will not extend our discussion to include social dilemmas

like public good games.

3.4 Structure of Interaction

The structure of the interaction influences the magnitude of social spillovers. As previously discussed the spillovers and peer effects seem to be smaller in anonymous interactions.

Spillovers can also occur if the interaction takes place in networks. Beugnot, Fortin, Lacroix, and Villeval (2013) analyze with the help of laboratory experiments spillovers in different types of networks. In the case of recursive networks, workers observe the previous performances of up to two workers in the same task and in simultaneous networks workers observe the performance of another worker while being observed by a third worker. Beugnot, Fortin, Lacroix, and Villeval (2013) demonstrate that individual performances increase with peers' performances in the recursive network. In the simultaneous network, peer effects depend on the gender of the worker and only for men large and significant effects can be observed.

Kane, Ransbotham, and Boynton (2012) investigate performance spillovers between knowledgeable workers in networks using data from digital communications. Using email data from partners and senior associates of a large professional services firm they analyze how an employee's performance evaluations are influenced by the evaluations of others. Kane, Ransbotham, and Boynton (2012) observe positive performance spillovers as the performances of an employees network contacts influence the employees' own performances.

4 Conclusion

This review is an step towards a better understanding of spillovers within organizations. The development of new methodologies and access to better information has led to a better understanding of the empirical effects of spillovers. Several theoretical results have been confirmed in different environments and now we can use them as the foundation for new avenues of study. How to improve coordination across workers and reduce free-riding are important topics that have been mostly addressed by both team-based monetary incentives or relative compensations. Other factors controlled by managers, such as firing policies, organization of the production process or the structure of the information flows have received less attention, as these factors are more difficult to control or change in naturally occurring environments. However, there is cause for hope. Findings from laboratory experiments have begun to shed light on these issues and organizations - perhaps due to the success of lab studies - are becoming less reluctant to experiment with these changes, which could open a space to pursue field research in these areas.

The interaction between these policies and other firm-specific environments have consequences that we are just beginning to analyze. Social connectivity of workers, worker heterogeneity, the availability of different worker types in the market or differences on

social norms could vary the effectiveness of different policies. Some environmental effects may not be firm-specific but rather country- or region-specific. These variables may also interact with the type of social preferences among a workgroup, which may determine the sign and size of observed effects.

Finally, there is a discussion that is still missing in the empirical economic literature. That is, whether the organizations want to strengthen or weaken the existence of spillovers. While the literature has been able to identify many cases of spillovers, they have not analyzed whether an organization can promote some particular type of informational transmission across workers without having a potentially adverse effect in other areas. Which channel is the most efficient, which type of information and how the organization will implement it are still open questions that bear further study. Thankfully, there is sufficient interest from both academia and industry to push forward on these issues.

Table 1. A Classification of Organizational Spillovers: Empirical Studies

Panel A: Technological Spillovers			
	Auhor	**Year**	**Title**
Production Funtions	Arcidiacono, Kinsleder and Price	2015	Productivity Spillovers in Team Production: Evidence from Professional Basketball
	Blume and Ortmann	2007	The effects of costless pre-play communication: Experimental evidence from games with Pareto-ranked equilibria
	Brandts and Cooper	2006	A change would do you good.... An experimental study on how to overcome coordination failure in organizations
	Cooper, De-Jong, Forsythe and Ross	1992	Forward induction in coordination games
	Goeree and Holt	2015	An experimental study of costly coordination
	Goerg, Kube and Zultan	2010	Treating Equals Unequally: Incentives in Teams, Workers' Motivation, and Production Technology
	Gould and Winter	2009	Interactions between workers and the technology of production: Evidence from professional baseball
	Hamman, Rick and Weber	2007	Solving coordination failure with "all-or-none" group-level incentives
	Van Huyck, Battalio and Beil	1991	Strategic uncertainty, equilibrium selection, and coordination failure in average opinion games
	Weber	2006	Managing growth to achieve efficient coordination in large groups
Incentives	Aakvik, Hansen and Torsvik	2013	Dynamic peer effects in sales teams
	Amodio and Martinez Carrasco	2016	Input allocation, workforce management and productivity spillovers: Evidence from personnel data
	Arpey	2014	Peer effects among weavers: evidence from a chinese textile firm with a relative group incentive scheme
	Bandiera, Barankay and Rasul	2005	Social preferences and the response to incentives: Evidence from personnel data
	Bandiera, Barankay and Rasul	2006	The Evolution of Cooperative Norms: Evidence from a Field Experiment
	Bandiera, Barankay and Rasul	2013	Team incentives: evidence from a firm level experiment
	Bandiera, Barankay and Rasul	2007	Incentives for Managers and Inequality among Workers: Evidence from a Firm-Level Experiment
	Bandiera, Barankay and Rasul	2009	Social connections and incentives in the workplace: Evidence from personnel data
	Boning, Ichniowski and Shaw	2007	Opportunity Counts: Teams and the Effectiveness of Production Incentives
	Bull, Schotter and Waigelt	1987	Tournaments and piece rates: An experimental study
	Carpenter, Matthews and Schirm	2010	Tournaments and office politics: Evidence from a real effort experiment
	Chan, Li and Pierce	2014	Compensation and peer effects in competing sales teams
	Goto, Aida, Aoyagi amd Sawada	2011	Incentives and Social Preferences in a Traditional Labor Contract: Evidence from Rice Planting Experiments in the Philippines
	Hamilton, Nickerson and Owan	2003	Team incentives and worker heterogeneity: An empirical analysis of the impact of teams on productivity and participation
	Muller and Schotter	2010	Workaholics and dropouts in organizations
	Nabaltian and Schotter	1997	Productivity under group incentives: An experimental study
	Orrison, Schotter and Weigelt	2004	Multiperson Tournaments: An Experimental Examination
	Schotter and Weigelt	1992	Asymmetric Tournaments, Equal Opportunity Laws, and Affirmative Action: Some Experimental Results

Panel A: Technological Spillovers (continued)

		Auhor	Year	Title
Information	**Information Flows**	Amodio and Martinez Carrasco	2016	Input allocation, workforce management and productivity spillovers: Evidence from personnel data
		Azoulay, Graff and Wang	2010	Superstar Extinction
		Boning, Ichniowski and Shaw	2007	Opportunity Counts: Teams and the Effectiveness of Production Incentives
		Oettl	2011	Reconceptualizing stars: Scientist helpfulness and peer performance
		Waldinger	2010	Quality matters: The expulsion of professors and the consequences for PhD student outcomes in Nazi Germany
	Learning	Argote, Beckman and Epple	1990	The persistence and transfer of learning in industrial settings
		Bandiera and Rasul	2006	Social networks and technology adoption in northern Mozambique
		Benkard	2000	Learning and Forgetting: The Dynamics of Aircraft Production
		Besley and Case	1994	Diffusion as a Learning Process: Evidence from HYV Cotton
		Chan, Li and Pierce	2014	Learning from peers: Knowledge transfer and sales force productivity growth
		Cornelissen, Dustmann, and Schönberg	2013	Peer effects in the workplace
		De Grip and Sauermann	2012	The effects of training on own and co-worker productivity: Evidence from a field experiment
		De Grip, Sauermann and Sieben	2016	The role of peers in estimating tenure-performance profiles: Evidence from personnel data
		Foster and Rosenzwring	1995	Learning by doing and learning from others: Human capital and technical change in agriculture
		Irwin and Klenow	1994	Learning-by-doing spillovers in the semiconductor industry
		Lindquist, Sauermann and Zenou	2015	Network Effects on Worker Productivity
		Martins and Jin	2010	Firm-level social returns to education
		Munshi	2004	Social learning in a heterogeneous population: technology diffusion in the Indian Green Revolution
		Nix	2016	Learning Spillovers in the Firm
		Thornton and Thompson	2001	Learning from experience and learning from others: An exploration of learning and spillovers in wartime shipbuilding
		Udry and Conley	2008	Learning about a new technology: Pineapple in Ghana

Panel B: Social Spillovers

	Auhor	Year	Title
Pure Peer Effects	Bandiera, Barankay and Rasul	2010	Social incentives in the workplace
	Bellemare, Lepage and Shearer	2010	Peer pressure, incentives, and gender: An experimental analysis of motivation in the workplace
	Charness and Kuhn	2011	Lab labor: What can labor economists learn from the lab?
	Falk and Ichino	2006	Clean evidence on peer effects
	Georganas, Tonin, and Vlassopoulos	2015	Peer pressure and productivity: The role of observing and being observed
	Goto, Aida, Aoyagi and Sawada	2011	Incentives and Social Preferences in a Traditional Labor Contract: Evidence from Rice Planting Experiments in the Philippines
	Guryan, Kroft and Notowidigdo	2009	Peer effects in the workplace: Evidence from random groupings in professional golf tournaments
	Herbst and Mas	2015	Peer effects on worker output in the laboratory generalize to the field
	Ichino and Maggi	2000	Work environment and individual background: explaining regional shirking differentials in a large italian firm
	Mas and Moretti	2009	Peers at work
	Veldhuizen, Oosterbeek and Sonnemans	2014	Peers at Work: From the Field to the Lab
	Yamane and Hayashi	2015	Peer Effects among Swimmers
Social Spillovers in Teams	Mohnen, Pokorny, and Sliwka	2008	Transparency, inequity aversion, and the dynamics of peer pressure in teams: Theory and evidence
	Corgnet, Hernan-Gonzalez, and Rassenti	2015	Peer Pressure and Moral Hazard in Teams: Experimental Evidence
	Georganas, Tonin and Vlassopoulos	2015	Peer pressure and productivity: The role of observing and being observed
	Sausgruber	2009	A note on peer effects between teams
	Thöni and Gächter	2007	Understanding social interaction effects in the workplace: An experimental approach
Individual Characteristics	Abeler, Altmann, Kube and Wibral	2010	Gift exchange and workers'fairness concerns: when equality is unfair
	Bandiera, Barankay and Rasul	2010	Social incentives in the workplace
	Charness and Kuhn	2011	Lab labor: What can labor economists learn from the lab?
	Charnnes and Kuhn	2007	Does pay inequality affect worker effort? Experimental evidence
	Fischbacher, Gächter and Fehr	2001	Are people conditionally cooperative? Evidence from a public goods experiment
	Hjort	2014	Ethnic divisions and production in firms
	Ichino and Maggi	2000	Work environment and individual background: explaining regional shirking differentials in a large italian firm
	Chmura, Goerg and Weiss	2016	Natural groups and economic characteristics as driving forces of wage discrimination
	Lane	2016	Discrimination in the laboratory: A meta-analysis of economics experiments
	Mas and Moretti	2009	Peers at work
Structure of Interaction	Beugnot, Fortin, Lacroix and Villeval	2013	Social networks and peer effects at work
	Kane, Ransbotham and Boynton	2012	Is High Performance Contagious among Knowledge Workers?

References

Aakvik, A., F. Hansen, and G. Torsvik (2013): "Dynamic Peer Effects in Sales Teams," .

Abeler, J., S. Altmann, S. Kube, and M. Wibral (2010): "Gift exchange and workers'fairness concerns: when equality is unfair," *Journal of the European Economic Association*, 8(6), 1299–1324.

Amodio, F., and M. A. Martinez-Carrasco (2016): "Input allocation, workforce management and productivity spillovers: Evidence from personnel data," .

Arcidiacono, P., G. Foster, N. Goodpaster, and J. Kinsler (2012): "Estimating spillovers using panel data, with an application to the classroom," *Quantitative Economics*, 3(3), 421–470.

Arcidiacono, P., J. Kinsler, and J. Price (2015): "Productivity Spillovers in Team Production: Evidence from Professional Basketball," *Journal of Labor Economics*.

Argote, L., S. L. Beckman, and D. Epple (1990): "The persistence and transfer of learning in industrial settings," *Management science*, 36(2), 140–154.

Arpey, N. (2014): "Peer Effects Among Weavers: Evidence from a Chinese Textile Firm with a Relative Group Incentive Scheme," .

Babington, M., S. J. Goerg, and C. Kitchens (2016): "Do Tournaments with Superstars Encourage or Discourage Competition?," *Working Paper*.

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

——— (2006): "The Evolution of Cooperative Norms: Evidence from a Field Experiment," *Advances to Economic Analysis and Policy*, 6(2).

——— (2007): "Incentives for Managers and Inequality among Workers: Evidence from a Firm-Level Experiment," *The Quarterly Journal of Economics*, 122(2), 729–773.

——— (2009): "Social connections and incentives in the workplace: Evidence from personnel data," *Econometrica*, 77(4), 1047–1094.

——— (2010): "Social incentives in the workplace," *Review of Economic Studies*, 77(2), 417–458.

——— (2013): "Team incentives: evidence from a firm level experiment," *Journal of the European Economic Association*, 11(5), 1079–1114.

Bandiera, O., and I. Rasul (2006): "Social networks and technology adoption in northern Mozambique," *The Economic Journal*, 116(514), 869–902.

Bellemare, C., P. Lepage, and B. Shearer (2010): "Peer pressure, incentives, and gender: An experimental analysis of motivation in the workplace," *Labour Economics*, 17(1), 276–283.

Benkard, C. L. (2000): "Learning and Forgetting: The Dynamics of Aircraft Production," *The American Economic Review*, 90(4), 1034–1054.

Besley, T., and A. Case (1994): "Diffusion as a learning process: evidence from HYV Cotton," .

Beugnot, J., B. Fortin, G. Lacroix, and M. C. Villeval (2013): "Social networks and peer effects at work," *Mimeo*.

Blume, A., and A. Ortmann (2007): "The effects of costless pre-play communication: Experimental evidence from games with Pareto-ranked equilibria," *Journal of Economic theory*, 132(1), 274–290.

Boning, B., C. Ichniowski, and K. Shaw (2007): "Opportunity Counts: Teams and the Effectiveness of Production Incentives," *Journal of Labor Economics*, 25(4), 613–650.

Brandts, J., and D. J. Cooper (2006): "A change would do you good.... An experimental study on how to overcome coordination failure in organizations," *The American Economic Review*, 96(3), 669–693.

Brown, J. (2011): "Quitters never win: The (adverse) incentive effects of competing with superstars," *Journal of Political Economy*, 119(5), 982–1013.

Bull, C., A. Schotter, and K. Weigelt (1987): "Tournaments and piece rates: An experimental study," *Journal of political Economy*, 95(1), 1–33.

Camerer, C. F., and R. A. Weber (2012): "Experimental Organizational Economics," *The Handbook of Organizational Economics*, p. 213.

Carpenter, J., P. H. Matthews, and J. Schirm (2010): "Tournaments and office politics: Evidence from a real effort experiment," *The American economic review*, 100(1), 504–517.

Chan, T. Y., J. Li, and L. Pierce (2014a): "Compensation and peer effects in competing sales teams," *Management Science*, 60(8), 1965–1984.

——— (2014b): "Learning from peers: Knowledge transfer and sales force productivity growth," *Marketing Science*, 33(4), 463–484.

Charness, G., and P. Kuhn (2007): "Does pay inequality affect worker effort? Experimental evidence," *Journal of labor economics*, 25(4), 693–723.

——— (2011): "Lab labor: What can labor economists learn from the lab?," *Handbook of labor economics*, 4, 229–330.

Chmura, T., S. J. Goerg, and P. Weiss (2016): "Natural groups and economic characteristics as driving forces of wage discrimination," *European Economic Review*.

Conley, T. G., and C. R. Udry (2010): "Learning about a new technology: Pineapple in Ghana," *The American Economic Review*, 100(1), 35–69.

Cooper, D. J., and J. H. Kagel (2012): "Other Regarding Preferences: A Selective

Survey of Experimental Results," *The Handbook of Experimental Economics (forthcoming)*.

Cooper, R., D. V. De Jong, R. Forsythe, and T. W. Ross (1992): "Forward induction in coordination games," *Economics Letters*, 40(2), 167–172.

Corgnet, B., R. Hernan-Gonzalez, and S. Rassenti (2015): "Peer Pressure and Moral Hazard in Teams: Experimental Evidence," *Review of Behavioral Economics*, 2(4), 379–403.

Cornelissen, T., C. Dustmann, and U. Schönberg (2013): "Peer effects in the workplace," *Conditionally accepted at American Economic Review*.

De Grip, A., and J. Sauermann (2012): "The effects of training on own and co-worker productivity: Evidence from a field experiment," *The Economic Journal*, 122(560), 376–399.

De Grip, A., J. Sauermann, and I. Sieben (2016): "The role of peers in estimating tenure-performance profiles: Evidence from personnel data," *Journal of Economic Behavior and Organization*, 126, 39–54.

Durlauf, S., and Y. Ioannides (2010): "Social Interactions," *Annual Review of Economics*, 2(1), 451–478.

Epple, D., and R. Romano (2011): "Peer effects in education: A survey of the theory and evidence," *Handbook of social economics*, 1(11), 1053–1163.

Falk, A., and A. Ichino (2006): "Clean evidence on peer effects," *Journal of Labor Economics*, 24(1), 39–57.

Fischbacher, U., S. Gächter, and E. Fehr (2001): "Are people conditionally rative? Evidence from a public goods experiment," *Economics letters*, 71(3), 397–404.

Foster, A. D., and M. R. Rosenzweig (1995): "Learning by doing and learning from others: Human capital and technical change in agriculture," *Journal of political Economy*, pp. 1176–1209.

——— (2010): "Microeconomics of technology adoption," *Annual Review of Economics*, 2.

Georganas, S., M. Tonin, and M. Vlassopoulos (2015): "Peer pressure and productivity: The role of observing and being observed," *Journal of Economic Behavior and Organization*, 117, 223–232.

Goeree, J. K., and C. A. Holt (2005): "An experimental study of costly coordination," *Games and Economic Behavior*, 51(2), 349–364.

Goerg, S. J., S. Kube, and R. Zultan (2010): "Treating Equals Unequally: Incentives in Teams, Workers' Motivation, and Production Technology," *Journal of Labor Economics*, 28(4), 747–772.

Goto, J., T. Aida, K. Aoyagi, and Y. Sawada (2011): "Incentives and Social Pref-

erences in a Traditional Labor Contract: Evidence from Rice Planting Experiments in the Philippines," *University of Tokyo*.

Gould, E. D., and E. Winter (2009): "Interactions between workers and the technology of production: Evidence from professional baseball," *The Review of Economics and Statistics*, 91(1), 188–200.

Gruber, H. (1998): "Learning by doing and spillovers: further evidence for the semiconductor industry," *Review of Industrial Organization*, 13(6), 697–711.

Guryan, J., K. Kroft, and M. J. Notowidigdo (2009): "Peer effects in the workplace: Evidence from random groupings in professional golf tournaments," *American Economic Journal: Applied Economics*, 1(4), 34–68.

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

Hamman, J., S. Rick, and R. A. Weber (2007): "Solving coordination failure with "all-or-none" group-level incentives," *Experimental Economics*, 10(3), 285–303.

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

Hjort, J. (2014): "Ethnic divisions and production in firms," *The Quarterly Journal of Economics*, 129(4), 1899–1946.

Ichino, A., and G. Maggi (2000): "Work Environment And Individual Background: Explaining Regional Shirking Differentials In A Large Italian Firm," *Quarterly Journal of Economics*, 115(3).

Irwin, D. A., and P. J. Klenow (1994): "Learning-by-doing spillovers in the semiconductor industry," *Journal of political Economy*, pp. 1200–1227.

Jackson, M. O. (2010): *Social and Economic Networks*. Princeton University Press.

Kandel, E., and E. P. Lazear (1992): "Peer pressure and partnerships," *Journal of political Economy*, pp. 801–817.

Kane, G., S. Ransbotham, and A. Boynton (2012): "Is High Performance Contagious among Knowledge Workers?," *Working paper*.

Lane, T. (2016): "Discrimination in the laboratory: A meta-analysis of economics experiments," *European Economic Review*.

Lindquist, M., J. Sauermann, and Y. Zenou (2015): "Network Effects on Worker Productivity," *Stockholm University*.

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

Marshak, J., and R. Radner (1972): "Economic theory of teams," *Yale University-Press*.

Martins, P. S., and J. Y. Jin (2010): "Firm-level social returns to education," *Journal of Population Economics*, 23(2), 539–558.

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

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

Müller, W., and A. Schotter (2010): "Workaholics and dropouts in organizations," *Journal of the European Economic Association*, 8(4), 717–743.

Munshi, K. (2004): "Social learning in a heterogeneous population: technology diffusion in the Indian Green Revolution," *Journal of development Economics*, 73(1), 185–213.

Nalbantian, H. R., and A. Schotter (1997): "Productivity under group incentives: An experimental study," *The American Economic Review*, pp. 314–341.

Nix, E. (2016): "Learning Spillovers in the Firm," *Working paper*.

Oettl, A. (2012): "Reconceptualizing stars: Scientist helpfulness and peer performance," *Management Science*, 58(6), 1122–1140.

Orrison, A., A. Schotter, and K. Weigelt (2004): "Multiperson Tournaments: An Experimental Examination.," *Management Science*, 50(2).

Rincke, J., and C. Traxler (2011): "Enforcement spillovers," *Review of Economics and Statistics*, 93(4), 1224–1234.

Sausgruber, R. (2009): "A note on peer effects between teams," *Experimental Economics*, 12(2), 193–201.

Schotter, A., and K. Weigelt (1992): "Asymmetric Tournaments, Equal Opportunity Laws, and Affirmative Action: Some Experimental Results," *The Quarterly Journal of Economics*, 107(2), 511–539.

Thöni, C., and S. Gächter (2007): "Understanding social interaction effects in the workplace: An experimental approach," Discussion paper.

Thornton, R. A., and P. Thompson (2001): "Learning from experience and learning from others: An exploration of learning and spillovers in wartime shipbuilding," *American Economic Review*, pp. 1350–1368.

Van Huyck, J. B., R. C. Battalio, and R. O. Beil (1990): "Tacit coordination games, strategic uncertainty, and coordination failure," *The American Economic Review*, 80(1), 234–248.

——— (1991): "Strategic uncertainty, equilibrium selection, and coordination failure in average opinion games," *The Quarterly Journal of Economics*, pp. 885–910.

Veldhuizen, R. v., H. Oosterbeek, and J. Sonnemans (2014): "Peers at work: From the field to the lab," *Tinbergen Institute Discussion Paper 14-051*.

Waldinger, F. (2010): "Quality matters: The expulsion of professors and the consequences for PhD student outcomes in Nazi Germany," *Journal of Political Economy*, 118(4), 787–831.

Wang, J., P. Azoulay, and J. G. Zivin (2010): "Superstar Extinction," *Quarterly Journal of Economics*, 125(2).

Weber, R. A. (2006): "Managing growth to achieve efficient coordination in large groups," *The American Economic Review*, 96(1), 114–126.

Winter, E. (2004): "Incentives and discrimination," *The American Economic Review*, 94(3), 764–773.

Yamane, S., and R. Hayashi (2015): "Peer Effects among Swimmers," *The Scandinavian Journal of Economics*, 117(4), 1230–1255.