Behavioral Spillovers in Organizations
A Selective Review

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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.

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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. 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 $g(x, a)$ where $x$ is a generic variable representing the particular characteristics of the environment and $a = \{a_1, ..., a_N\}$, $a_i \in \mathbb{R}$ is the action of agent $i$. In other words, all agents in the firm have the same common interests. 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
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 $c_{ii}(a_i) > 0$. 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 ($g_{ij} < 0$), each worker wants to maximize $g(x, a) - c(a_i)$, which give us the first order condition:

$$g_i(x, a) - c_i(a_i) = 0$$

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

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

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 $g_{ij}(x, a) \geq 0$ the actions are complementary; and, if $g_{ij}(x, a) \leq 0$ 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

\^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, work-
ers 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 work-
ers 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 work-
ers 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 un-
derstanding 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 ≥ 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 $h_i = p(y(a_1, ..., a_N))g$.  

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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. Nal-
bantian and Schotter (1997) found that competition and monitoring produced better re-
sults - 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 perfor-
ence 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 complemen-
tarity 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, man-
agers 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 exist? 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 of 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 present 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.\footnote{A more complete review on the literature of technology adoption on Foster and Rosenzweig (2010).}

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.
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

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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 \( P_i(\bar{e}) \) where \( \bar{e} = \{e_1, \ldots, e_N\} \) on a team with \( N \) members. This function may generate strategic responses across workers as 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)](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)](mentioned earlier) 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)](mentioned earlier) 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)](mentioned earlier) 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)](mentioned earlier) 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)](mentioned earlier) 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-coethic to coethic downstream workers. Along this line is discrimination which is not based on statistical discrimination, i.e. output, but based on irrelevant characteristics like ruralness 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 employee’s network contacts influence the employee’s 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.
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