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ABSTRACT

Field Experiments with Firms^{*}

We discuss how the use of field experiments sheds light on long standing research questions relating to firm behavior. We present insights from two classes of experiments: within and across firms, and draw common lessons from both sets. Field experiments within firms generally aim to shed light on the nature of agency problems. Along these lines, we discuss how field experiments have provided new insights on shirking behavior, and the provision of monetary and non-monetary incentives. Field experiments across firms generally aim to uncover firms' binding constraints by exogenously varying the availability of key inputs such as labor, physical capital, and managerial capital. We conclude by discussing some of the practical issues researchers face when designing experiments and by highlighting areas for further research.

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1 Introduction

Firms operate in complex environments: a list of the categories in which they need to make interrelated choices includes employee pay, pricing, product attributes, production technologies, and management. In turn, these decisions involve responding to characteristics that are often hard to measure or uncertain, such as those related to market characteristics, the productivity of individual inputs, and entrepreneurial ability. Due to the complexity of the environment, research based on observational data faces many challenges at uncovering causal relationships and ultimately understanding firms' behavior. In this paper we illustrate how, guided by theory, field experiments can address these challenges and provide new answers to long-standing questions about firms. Do firm choices maximize profits subject to constraints? If so, which constraints bind and inform decision making in firms? If not, why are firms operating inside the frontier?

In this paper we review field experiments that provide preliminary answers to these questions and map directions for further research. We organize our discussion into two classes of work. The first is field experiments conducted *within* firms, in which the units of observation are workers or divisions of a firm. The theory behind many of these experiments views the firm as an organization, emphasizing agency problems. We discuss field experiments that shed light on solutions to the agency problem, from incentive pay to social pressure and non-monetary rewards. The second strand covers field experiments conducted *between* firms, in which the firm is the unit of observation. The theory behind most of these experiments views the firm through the lens of neoclassical production theory, and so we discuss how field experiments have exogenously varied input availability to shed light on constraints firms face.

Throughout we focus on experiments designed to shed light on firms' behavior. This still leaves out a large class of field experiments that are run in collaboration with firms to provide evidence on other issues such as consumer behavior or optimal auction design.¹

Beyond the results of specific field experiment studies, we also believe that economists can reap enormous benefits from establishing working partnerships with firms, and engaging in primary data collection. Thus, we conclude the paper by offering some discussion of the practical issues researchers face in designing and implementing field experiments in firms, and by highlighting research questions that remain relatively untouched by field experiments. We hope that by the end of our discussion, readers have a clear sense of the costs and benefits of field experiments in firm settings, and are motivated to consider this approach themselves.

¹ Further discussion of field experiments on firms is provided in Levitt and List (2009) where they discuss field experiments related to how consumers respond to product attributes and pricing. On auctions, a nascent literature is now emerging that uses field experiments to measure reserve price effects for example (Reiley, 2006; Brown and Morgan (2009); Ostrovsky and Schwarz (2009)).

2 Field Experiments within Firms

Field experiments within firms are generally designed to shed light on how firms can solve agency problems and motivate their employees. In this section we review evidence on the two classical solutions to the agency problem -- monitoring and pay for performance -- and more recent work on non-monetary determinants of motivation such as social relations or status rewards.

Although field experiments within firms have experienced a recent resurgence, they are far from new. One of the first series of field experiments was conducted at the Hawthorne plant of the Western Electric Company, near Chicago, in the 1920s. While the validity of their specific findings has been questioned,² there is no doubt that these experiments lay the groundwork for many issues that are now considered part of mainstream personnel economics (Bloom and Van Reenen, 2010a). For example, they led Mayo (1933) to stress that workers are motivated by both monetary and non-monetary rewards from work, an idea that is being tested by the newest generation of field experiments reviewed below.

2.1 Monitoring and Shirking

The standard agency framework with asymmetric information views employees as rational shirkers: that is, employees consider the marginal costs and marginal benefits of shirking, and decide on their level of effort. Firms thus choose compensation and monitoring policies with shirking in mind. The theory suggests that a reduction in monitoring will tend to increase shirking. Moreover, an increase in shirking resulting from reduced monitoring should be greatest among individuals for whom the ongoing employment relationship is least valuable. Three concerns have plagued non-experimental approaches to testing these ideas: (i) shirking behavior is hard to detect; (ii) the ability of the econometrician to detect shirkers might be endogenously related to the employer's monitoring practices; (iii) unobserved factors, such as hiring policies, may lead monitoring and shirking outcomes to be correlated.

Nagin et al. (2002) address these challenges using a field experiment run by a telephone solicitation firm across four of its sixteen call centers. At each call center, telephone solicitors were paid a piece rate in which salary increased with the number of "successful" solicitations -- where success was reported by the employees themselves. This piece rate created incentives for employees to overstate whether a donation had been promised. To curb opportunistic behavior, the employer monitored by calling back a fraction of those who were reported to have responded positively to a solicitation. Employees were informed when hired that their activities would be checked by callbacks. The results of each week's callbacks were communicated to both employees and their immediate supervisors, and calls were found by the monitors to be unsuccessful were deducted from each individual's weekly incentive pay. Stronger sanctions for such calls were not generally imposed on employees, because it was understood that donors sometimes change their minds after agreeing to pledge money.

² As one example, between 1924 and 1927 the level of lighting was systematically changed for experimental groups in different departments (Mayo 1933). Levitt and List (2011) recently recovered the thought-to-be-lost data from this experiment, and find little evidence that workers reacted to the differences in lighting.

To see if the costs of this monitoring system could be reduced, the company experimentally varied the fraction of bad calls that were reported back to employees and supervisors from 0% to 2%, 5% and 10% in the four experimental sites, while keeping the actual audit rate at 25% in all four sites. By working with the firm, the researchers were able to collect survey data on employee attitudes toward the job, their expected job tenure, and their perceived difficulty of finding a comparable job.

The findings indicate that workers' responses are very heterogeneous. Between 10% and 41% of the employees in the four experimental sites behave as “rational cheaters”, that is, they respond to a reduction in the perceived cost of opportunistic behavior by increasing the rate at which they shirk. The remaining 59% to 90%, however, do not increase shirking following the reduction in monitoring rates. Using the survey data collected, the authors find the employees who responded to reductions in monitoring tended to be those who perceived the employer as being unfair and uncaring and that, in contrast with the rational cheater model, individuals with good outside options did not increase shirking by more than other workers when the rate of monitoring declined. This heterogeneity highlights that the optimal monitoring scheme will need to balance the requirement to reduce the shirking behavior of some workers inclined to rationally cheat, against those that are unlikely to do so under normal circumstances.

2.2 Monetary Incentives

In the many circumstances in which monitoring is not practically feasible, the agency problem can be addressed by designing incentive schemes that align the employees' interests with the principal. A wide class of schemes such as piece rates, bonuses and prizes achieve this goal by making the employees' pay an increasing function of their performance.

Agency theory makes precise that such “pay for performance” schemes affect productivity both by increasing the productivity of existing employees (the incentive effect) and by attracting more productive employees to the firm (the selection effect). The incentive effect arises because pay for performance schemes increase the marginal benefit of effort, which leads employees to work harder, other things equal. The selection effect arises because high ability employees who are capable of achieving high performance can achieve higher pay, and are thus attracted by schemes that reward performance, other things equal. Both the incentive and selection effects increase the variance as well as the mean of productivity and pay, as more able workers can respond more to the increase in incentive power.

Testing the rich predictions of agency theory using non-experimental data faces serious econometric challenges, most importantly that observed incentive contracts might be endogenous to firm's performance (Prendergast, 1999, Chiappori and Salanie, 2003). Field experimenters can tackle this challenge directly by engineering exogenous changes in incentive schemes across, or, most commonly, within firms.

Moreover, high powered incentive schemes might affect productivity through channels that are typically not measured in secondary data. For instance, the increase in pay inequality can reduce workers' morale and lead to sabotage, or the change in the composition of the peer group due to the selection effect might affect workers' behavior over and above the effect of the compensation scheme. Field experimenters are well placed to work with firms to collect primary data on the relevance of these mechanisms, for instance by measuring social ties within the firm.

Among the first of the field experiments designed to measure incentive effects of monetary compensation schemes is Shearer (2004), who estimates the productivity gains moving from a fixed wage to a piece rate scheme for tree planters in British Columbia, Canada. Workers were randomly assigned to plant under one of the incentive schemes at the start of a work day. Workers' productivity increased by 20% moving from fixed wages to piece rates. In line with the prediction of agency theory, the standard deviation of output across workers was higher under piece rates. Shearer also develops and estimates a structural model of workers' behavior to shed light on: (i) what would have been the productivity gains if management was imperfectly informed about planting conditions; (ii) how workers would have responded to an efficiency wage scheme.

Combining research methods like this is to be encouraged. In many scenarios, it would be ideal to combine evidence from field experiments with structural modeling to posit an underlying behavioral mechanism behind the effects, to assess the sensitivity of the estimates to slight alterations in the economic environment, and to make headway in understanding the optimal compensation structures. Of course, the validity of the structural model can itself be tested by exploring whether it predicts the responses observed to the exogenous variation engineered by the field experiment. For example, Cho and Rust (2009) follow this approach in using a field experiment to validate a structural model of rental rates for automobiles.

While recent field experiments have made substantial progress in identifying the causal effect of performance pay on workers' effort, they have been less successful at pinning down selection effects.³ This is a priority for future research as the available non-experimental evidence suggests that selection effects are at least as important as incentive effects. In a non-experimental study that exploits the roll-out of a new piece rate scheme in a manufacturing firm, Lazear (2000) shows that selection effects explain half of the 44% increase in worker productivity that followed the introduction of piece rates.

Identifying selection effects poses a difficult challenge for field experimenters both because it requires information on the entire pool of potential employees and because the time horizon of field experiments is often considerably shorter than that needed for existing workers to quit and new workers to join a firm. Varying incentives across divisions or plants of the same firm while allowing employees to move across divisions might be a way to address both issues.

Greater knowledge about selection effects would also help in understanding whether and how the compensation policies of a given firm have spillover effects on other firms that compete for similar

³ Niederle and Vesterlund (2007) explores selection effects of incentives in a laboratory setting.

workers -- which in turn would help tie together the two disparate literatures on within-firm compensation policies and equilibrium wage-setting behavior.

2.3 Monetary Incentives and the Social Organization of the Workplace

Until recently, the importance of the interaction between social relations and monetary incentives in the workplace has been addressed mainly in the organizational and business sociology literatures. However, such concerns have begun to be incorporated in economic theory; for example, Kandel and

Lazear (1992) and Rotemberg (1994) extend standard agency models to take into account peer effects and social concerns. Moreover, credible evidence on the existence and magnitude of such social mechanisms has begun to emerge using non-experimental methods in combination with personnel data (Mas and Moretti, 2009, Bandiera et al., 2010b). Identifying the causal effects of social relations using non-experimental data faces two main challenges: (i) the observed variation in incentives might be correlated with other unobservable determinants of performance; (ii) firm personnel

records rarely contain information on social connections within the firm.⁴

In this section we discuss a series of three of our own field experiments (Bandiera, Barankay and Rasul 2005, 2007, 2009, 2010a) that provide novel evidence on the interplay of incentives and the social organization of the workplace, namely the social relations that exist between a group of co-workers or between workers and managers. The firm we study is a leading U.K. producer of “soft fruit” – a broad category that might include fruits like plums, cherries, peaches, strawberries, raspberries, and grapes. The firm's hierarchy has four layers: the owner and chief executive officer, the general manager, field managers, and workers. The main task of the bottom-tier workers is to pick fruit. Around forty workers pick on any given field on a given day. Within a field, workers are allocated their own row of fruit to pick, and worker's productivity is defined as kilograms picked per hour. Managers organize field logistics, e.g. they assign workers to rows and make sure workers' full crates are replaced with empty ones. Managers choose how much effort to exert and how to allocate effort to different workers. In this setting, managerial effort is complementary to worker's effort, namely, for a given effort level of the worker, his productivity is higher the more effort the manager targets towards him. For example, by re-assigning him to a new row as soon as he is done with the previous one, and removing his full crates quickly.

The general manager, who is a permanent employee of the farm, decides which of the workers present on the farm are selected to pick fruit each day, which are assigned to non-picking tasks, and which are left unemployed for the day.

In our setting, workers and managers are hired seasonally from Eastern Europe and live on the farm for the duration of their stay, thus they have opportunities to form social connections. These connections can be measured by asking workers to report colleagues they are socially linked to, or indirectly by using common characteristics – like a common language – that predict social links. In two of the three

⁴ List and Rasul (2011) provide a more comprehensive review of this literature.

experimental seasons, the group of co-workers a given worker is assigned to work with varies across fields and days, and this variation is orthogonal to other determinants of productivity. This creates plausibly exogenous variation in the presence of socially connected workers that can be used to identify the effect of social connections on behavior and productivity.

Our three experiments ran during the 2002, 2003 and 2005 picking seasons. The workforce changes annually, so that workers and managers are exposed to one experiment only. Each experiment induces exogenously timed changes to the incentive structure of one layer of the hierarchy. In all cases the experimental treatments are applied simultaneously to all relevant agents. The rationale behind the within-subject design is that, like most other firm settings, it was impossible to prevent information spillovers between treated and control groups. Moreover, the composition of the workforce is fixed for the duration of each season, thus we focus on incentives rather than selection effects throughout.

A direct consequence of the experimental design is that time-varying unobservables represent the main identification threat. This is addressed by allowing flexible interactions with time effects and by using difference-in-difference estimators that combine data from the experimental seasons and from 2004 during which no experiments were implemented.

In our first experiment, we exogenously varied the workers' compensation scheme from relative compensation to piece rates. Under relative compensation, workers are paid a unit price for each kilogram of fruit picked that is negatively related to average productivity on the field-day – thus, if average productivity on a certain day was high, the unit price paid to workers is lower. Under piece rates, workers are paid for each kilogram of fruit picked. Under relative compensation, each worker imposes a negative externality his colleagues: any worker who increases effort will raise average productivity and reduces the unit wage for all co-workers on the field. Under piece rates, this externality does not exist. As a consequence, under relative compensation the socially optimal level of effort is lower than the private optimum, whereas under piece rates the two coincide. The comparison of productivity under the two schemes reveals whether, and to what extent, workers are able to cooperate.

In our 2005 paper we show that productivity is 50% higher under piece rates. Calibration of the first-order conditions of worker's individual effort choice problem reveals this productivity differential to be consistent with the assumption that under relative incentives, workers internalize the negative externality their effort imposes on co-workers. This social incentive is equivalent to them placing a weight of two-thirds on all co-workers' pay. We find that workers internalize the externality more when they work alongside their friends as opposed to colleagues they are not socially linked to, and this effect is larger in smaller groups. Again, the effect disappears under piece rates. Finally, we find that cooperation collapses when workers cannot monitor each other, namely moving to piece rates does not increase workers' productivity when they pick from a plant whose physical characteristics make it difficult for each worker to see her colleagues. This finding rules out pure altruism as a mechanism to sustain cooperation in this setting.

Our second experiment exogenously varied managers' pay from fixed wages to fixed wages plus a performance bonus that increases in the average productivity of the workers managed. In this experiment, workers were paid piece rates throughout. Our 2007 paper shows that the introduction of managerial bonuses increases both the mean and the dispersion of workers' productivity. One reason was that, as theory suggests, that after the introduction of performance pay, managers target their effort towards more able workers. Another reason, again suggested by theory, is that workers with the highest productivity are more likely to be selected into the workforce when managers are paid performance bonuses. Least able workers are employed less often and workers at the bottom of the productivity distribution are never selected to pick.

Our 2009 paper further analyzed the data from this second experiment, with a focus on the interplay between managerial incentives and the social connections between workers and managers. We find evidence that when managers were paid fixed wages, they targeted workers to whom they were socially connected, regardless of ability level. When managers were paid as a function of firm performance, they targeted high ability workers, regardless of social connections. The findings suggest that social connections have a sizeable impact on productivity: when managers were paid fixed wages, the average worker was 9% more productive on days when he was socially connected to his managers.

Our third experiment evaluates different compensation schemes under team production. From 2005 onwards, workers were organized in teams of five. Workers were allowed to choose the composition of their team, as long as all five members agreed. Compared to previous seasons, the social organization of the workplace is thus endogenous.

In our 2010a paper, we compare three forms of team incentives: team piece rates, rank incentives (namely publicly provided information on each team productivity), and monetary prizes assigned to the most productive teams. The experiment is again closely tied to an underlying model that suggests two key forces that drive team formation: workers' ability and social connections. On one hand, workers have incentives to match by ability. On the other hand, workers might prefer to form teams with friends, both because this might limit free-riding within teams, and also because they enjoy non-pecuniary benefits from interacting with co-workers to whom they are socially connected. Our experiment is designed to exogenously alter the trade-off to sorting into teams by friendship relative to ability.

We show that strengthening incentives, either through rank incentives or monetary prizes, makes workers more likely to form teams with others of similar ability instead of with their friends. However, rank incentives and monetary prizes have opposite effects on average productivity: rank incentives significantly reduce it by 14%, while monetary prizes significantly increase it by 24%. Both effects are heterogeneous: rank incentives only reduce the productivity of teams at the bottom of the productivity distribution, and monetary prizes only increase the productivity of teams at the top. Focusing on the teams that remain intact after each change in incentives we show that the documented negative effect of rank incentives is primarily due to the endogenous changes in team composition, rather than changes in behavior of the same team. In contrast the provision of monetary prizes affects firm performance through both the endogenous changes in team composition and changes in behavior within the same team.

Taken together, this set of field experiments yields several lessons. Social connections can drive behavior in the workplace: workers and managers internalize the effect of their effort on colleagues to whom they are socially connected. Moreover, social connections and monetary incentives interact, and the extent to which agents internalize the externality depends on the strength of monetary incentives. Firms should take these potential interactions into account. Indeed, such differences in the social organization of workplaces might help explain some part of the productivity differences in otherwise observationally similar firms. This set of experiments also illustrates the advantages of combining the variation exogenously created by the field experimenter (the incentive scheme) with other sources of variation that occur naturally in a real world environment (social ties, monitoring possibilities, peer groups). This combination of experimental rigor and collecting primary data is perhaps the most attractive feature of field experiments.

The findings open up new questions for theoretical research on organizations. For instance, relative incentives led to lower productivity because workers internalized the negative externality to some extent. This finding speaks directly to Lazear's (1989) observation that workers are rarely compensated according to rank-order tournaments, and point to new and interesting directions for theory to develop on the optimal provision of incentives under more robust assumptions on worker preferences.

More broadly, the findings raise the issue of whether incentive policies are indeed chosen optimally, or whether firms are effectively within the efficiency frontier. As we shall see, other field experiments also cast doubt on whether firms make optimal choices. The concluding section will bring these together and discuss implications for future research.

2.4 New Topics in Within-Firm Field Experiments

A vigorous literature based on within-firm field experiments is beginning to emerge. Some of the topics focus on organizational features of firms, extending the kind of approaches discussed above. For example, new field experiments are being designed to test alternative ways to motivate employees. A natural candidate is non-monetary incentives in the form of status or social recognition rewards, such as 'employee of the month' job titles. The notion that individuals crave status has long been studied and more recently formalized (Moldavanu et al., 2007, Besley and Ghatak 2008). In a field experiment run in collaboration with a public health organization, Ashraf et al., (2011) randomized 800 community agents hired to sell condoms in urban compounds into four monetary and non-monetary rewards treatments. Agents who are assigned to the non-monetary rewards treatment, namely stars for performance plus a public ceremony for top performers, sell twice as many condoms as agents who are offered a financial margin on each pack sold.

Another personnel policy that is being subject to experimental scrutiny is the provision of performance feedback. In a recent field experiment conducted with 330 employees recruited via Mechanical Turk, a platform run by Amazon.com for work submitted online, Barankay (2010) suggests the provision of individual performance feedback might reduce the productivity of workers, unless the feedback is unexpectedly positive.

Despite rapid progress in these areas, evidence on other key organizational features is still lagging behind theory. The best example is perhaps the distribution of authority within firms, which has been at the core of theoretical studies of the firms since Coase (1937)'s seminal contribution. Modern theoretical work highlights the role of authority as determinant of incentives (Aghion and Tirole, 1997) or as a coordination device (Garicano, 2000, Alonso et al., 2008). We envisage future field experiments designed to shed light on the effect of organizational design on firm performance.⁵

3 Field Experiments Across Firms

Field experiments which take the firm as the unit of observation often seek to exogenously vary the availability of key inputs, and in this way seek to uncover the constraints faced by firms. Many of the experiments reviewed in this section are implemented in developing countries from South Asia to Latin America, both because identifying the constraints faced by firms is key to understand the development process and because, in practical terms, it is cheaper to create sizeable shocks to inputs when the value of a firms' stock of inputs is small.

3.1 Physical Capital and Access to Finance

A field experiment by de Mel et al. (2008) among small and medium enterprises in Sri Lanka illustrates how field experiments can illuminate the long standing question of how credit market imperfections and liquidity constraints may affect firm growth. They sample 408 enterprises, equally split between retail sales and manufacturing/services, that have less than \$1,000 invested in capital. Around half were randomly assigned to receive one of four treatments: \$100 in cash, \$200 in cash, \$100 in inventories or equipment, \$200 in inventories or equipment, as chosen by the firm owner. These transfers are large compared to the existing capital stock and median monthly profits. The experiment was accompanied by a quarterly panel survey on investment decisions, profits, and also personal characteristics of the owner such as wealth, risk aversion, and cognitive ability. The experiment was framed as random compensation for participation in the survey. Hence owners did not know about the existence or scope of the experiment.

⁵ Non-experimental evidence on the determinants of the distribution of authority and its effects on firm performance is also being established. Bloom et al. (2010) develop a survey instrument to measure the level of centralization of decision making in 4000 firms across 12 countries, which shows that highly centralized structures are more likely to occur in developing countries and where product market competition is low. Wu (2010) exploits a natural experiment and detailed personnel data from a Chinese newspaper to provide evidence on the effect of centralizing decision making authority on the effort and performance of managerial editors and reporters. In his setting, centralizing authority reduces the effort of managers and increases the effort of workers, overall increasing the quality of the average article. More importantly, authority has a significant impact on incentives despite the fact that reporters were already on high powered performance pay.

The experiment yields three key findings. First, both types of transfers increase capital stock and profits. Transfers also increase the hours worked by the owner, indicating complementarity between capital and labor hours.

Second, the return to the additional capital is around 5-6% per month, giving a real annual return well above the market lending rate. Third, the authors develop a model that makes precise how missing credit or insurance markets can generate the observed discrepancy between returns to capital and lending rates. The balance of evidence indicates that results are driven by missing credit markets, not by risk aversion to borrowing.

Several methodological points are of note. First, using GPS coordinates, the authors show that the treatment has spillover effects on nearby firms. Interestingly, the authors show that spillovers are entirely driven by firms in the bamboo industry, where the harvesting of bamboo is subject to government restrictions and treated firms crowd out others by purchasing all of the available supply. These findings illustrate the potential of field experiments to shed light on the functioning of markets, not just firms in isolation. Second, the authors show how to deal with an attrition rate that was 5% higher for control firms than for treatment firms using the methodology proposed by Lee (2009), which estimates upper and lower bounds for the treatment effect and allows them to show that the estimated treatment effects and return to capital are robust to attrition. Third, the authors also compare the difference between experimental and non-experimental methods. Compared to a 5.3% monthly return to capital estimated via experimental methods, ordinary least squares, random effects and firm fixed effects models yield estimates of 2.6, 1.7 and 0.07 percent, respectively.

McKenzie and Woodruff (2008) implemented the same experiment with 137 small and medium retail firms in Mexico, and also find high rate of returns to capital, especially for firms that report being credit constrained/not having access to formal loans. Overall, these field experiments provide a useful answer to an important question, as well as providing guidance for future field experiments. In particular they illustrate how experiments can go beyond understanding the decision process of a single firm and provide evidence on the nature of spillovers and market interactions.

3.2 Managerial Capital and Enterprise Training

Economic theory has long taught that managerial capital is an important input in production (Lucas, 1978, Rosen, 1982). However, systematic empirical evidence about the effects of managerial capital was, until recently, almost nonexistent in part because of the difficulties in measuring managerial capital. In addition, managerial capital seems likely to be related to characteristics of the firm and perhaps to unobservable traits about management and workers in ways that made it very difficult to draw causal inferences.

However, two recent methodological improvements have led to substantial progress. First, some studies have focused on management practices that can be measured systematically. As they discussed in this journal, Bloom and Van Reenen (2010b) have developed a standard measure of management practices

and used it to survey managers in 6000 manufacturing firms in 17 developed and developing countries. Their work shows a robust correlation between the quality of management practices and firm performance both across and within countries. Second, researchers have begun designing field experiments aimed at evaluating the causal impact of managerial practices on firm performance.

To evaluate the effect of business training on the performance of micro enterprises, Karlan and Valdivia (2010) and Drexler et al. (2010) examine the experience of clients of a microfinance institution in Peru and the Dominican Republic, respectively. Both studies randomize micro entrepreneurs in a treatment group that receives financial training, which includes basic accounting, marketing and pricing, and a control group that does not. Common findings emerge from these studies. Neither finds an effect of business training on sales, profits or employment. Both find that training reduces business seasonality by increasing sales in “bad” months. These are intriguing results will lead to significant advances in understanding the constraints faced by microenterprises.

Bloom et al. (2011) develop a field experiment to evaluate the effect of modern management practices on the performance of large Indian firms in the textile industry. Working in collaboration with a leading international management consulting firm, the researchers offered free management consulting service to a randomly selected group of 14 out of 20 plants belonging to 17 large manufacturers. A further 8 plants belonging to the same firms were also surveyed. The consulting intervention targeted 38 key practices that capture standard manufacturing principles in high-income countries.

The design of this field experiment illustrates the trade-off between sample size and the complexity of the intervention needed to study a cross-section of large firms. Consultancy and data collection costs -- \$75,000 per treated firm, \$20,000 per control plant -- limited the sample size to 20 units. Standard statistical tests that rely on asymptotic properties cannot be used in this context, because the number of observations is too small. Collecting data over a long time horizon partially helps as there are procedures that rely on asymptotic approximations along the time dimension (Ibramigov and Mueller, 2009). In addition, statistical power can be sustained in such small samples by collecting data directly from machine logs, focusing on similar firms using identical technologies, and collecting high frequency repeated measures (McKenzie 2010). The key finding is that managerial capital improved quality and efficiency, reduced inventory, and raised average productivity by 11%. The resulting increase in yearly profits was estimated to be over 90% the market cost of the consulting services that firms would have paid in the first year.

Again, such findings raise the obvious questions of why profitable practices were not adopted before the intervention. Interviews with owners and senior managers reveal that incorrect beliefs about the profitability of the practices were the main cause of non-adoption, but even when these incorrect beliefs were pointed out, firms were very slow to adopt the new practices; most of the owners attributed this to lack of time. However, it also seemed most Indian textile firms did not need to adopt the new practices because they did not need to in order to compete with other domestic firms, and high tariffs shielded them from international competition. The study thus raises what seems to be a recurrent question that arises in field experiments with firms: What are the constraints that discourage firms from making changes that clearly seem to be profitable?

3.3 Labor

An alternative kind of between-firms study, more common in high-income countries, are field studies designed to measure and discriminatory practices by exogenously varying the applicant pool available to firms. The typical “audit” study presents employers with two sets of job applicants who are identical along all relevant employment characteristics except the comparative static of interest, like race, gender, or age (Heckman and Siegelman 1993, Riach and Rich 2002).

Bertrand and Mullainathan (2004) design a field experiment along these lines by employers by sending resumes with randomly assigned white- or black-sounding names to over 1,300 help-wanted ads in Boston and Chicago newspapers. They also randomly vary the quality of the resume by adding experience, skills or honors. They find that white names receive 50% more callbacks for an interview than black names. This racial gap is uniform across occupation, industry, and employer size. Additionally, the return to higher-quality resumes is higher for whites than blacks, implying that the racial gap is larger for more qualified applicants.

The authors findings are consistent with a model of lexicographic search, whereby the employers stop reading (and hence fail to see all credentials) once they see a black name. While such practice is indeed consistent with the findings, more work is needed to provide direct evidence on its relevance compared to statistical and taste-based discrimination models. If the search process is lexicographic, future work needs to understand why such methods emerged in the first place and why they are optimal. Time constraints are one possible ingredient here; indeed, although time constraints are rarely made explicit in economic modeling of firms, they may help to explain experimental results in many diverse contexts. More generally, these types of audit experiments could be fruitfully applied to analyze the practical relevance of other applicant traits such as gender, education, and past employment history. This would allow to provide a consistent picture of firms' preferences and constraints on hiring decisions.

4 Practical Considerations

The growing literature using field experiments on firms has begun to provide insights on long standing areas of economics research related to firm behavior. In the hope that some readers may be interested in undertaking this kind of research, in this section we discuss two practical considerations that arise in doing such experiments -- on design and ethical issues. In the final discussion, we then draw together some common lessons from the studies presented to highlight some areas to which we think future research should be directed.

4.1 Design

The design of a field experiment ought to be grounded in economic theory so that null and alternative hypotheses can be mapped back to an underlying model of firm behavior. Once null and alternative hypotheses are precisely defined, this will guide the collection of primary and secondary data.

Researchers then need to choose the unit over which to introduce experimental variation: for field experiments involving firms, this can involve engineering experimental variation across firms or within a firm. On the former, the unit might be inputs, whose characteristics are exogenously varied across firms, or the unit might be firms themselves who are then exogenously assigned to different environments. This latter type of field experiment design remains scarce, but we discuss potential developments below.

On experimentation within firms, the unit is most often workers, although plants or firm divisions might also be used. On experimentation at the worker level, at one end of the spectrum, workers are simultaneously randomly assigned to control and treatment groups, as is typically done in policy evaluation and in randomized controlled trials. At the other end of the spectrum, all workers are treated but the timing of the treatment is exogenously chosen by the researchers. Each approach has its own costs and benefits, and these are likely to differ across firm settings.

The main benefit of having a control group is that common trends can be weeded out by using a difference in difference estimator. The main cost is that the estimated effect of the intervention might be biased because the control group might react to not having received the treatment. Whether this creates a positive or negative bias depends on whether the control group tries to differentiate themselves from, or to emulate, the treated group. This is a first order issue in field experiments with firms where it is often harder to geographically or informationally isolate treatment and control groups, so controls are likely to find out about the experiments. The threat of contamination can be eliminated by separating the groups, but this typically causes them to be subject to different workplace conditions, making the control group a poor counterfactual for what would have happened to the treated in the absence of treatment.

Switching all agents between control and treatment at an exogenously chosen time has the benefit of eliminating the contamination bias and to increase statistical power, as the effect of treatment can be estimated by comparing each agent to himself without the treatment, thus eliminating all sources of unobservable heterogeneity (List et al., 2010). The cost is that the estimated effect of the treatment might be biased because of unobservable determinants of changes in behavior. This concern might be addressed by collecting a sufficiently long time series during both treatment and control periods, or, if seasonality or cyclicity is a potential threat, by collecting information from a different period during which no treatment was introduced, to purge estimates of variation due to such naturally occurring fluctuations. Such an approach might further be made feasible because a practical issue that often arises for field experiments on firms is that firms often express no desire to treat similar workers in the same plant or firm location in different ways.

A recent field experiment illustrates how different randomization strategies can lead to different estimate. Shi (2010) compares productivity under fixed wages and piece rates for workers engaged in tree thinning in a fruit orchard in Washington, USA. As the firm has multiple sites, in one site she switches ten workers simultaneously from wages to piece rates and observes them for three days under each treatment, whereas in another site she switches seven workers to piece rates and keeps another seven as controls with fixed wages for one day, identifying the effect from the difference in difference

between the two days. The estimated productivity increase is 23% in the first design – similar to the estimates in Shearer (2004) – while the estimated effect increases to 43% in the second design. Shi (2010) reports that workers in the control group became informed of the existence of a treatment group and were not pleased by it. This could have reduced their productivity leading to an overestimate of the effect, but her data is not rich enough to shed light on the mechanism. Understanding such contamination effects is crucial to being able to compare findings across experiments and such issues are beginning to be explored by field experimenters.

4.2 Ethics

Field experiments involve human subjects, and thus typically fall under the oversight of the Institutional Review Board run by an institution of higher education or a funding agency. In turn, these boards are typically guided by the ethical principles set forth by a U.S. government report called the Belmont Report (named after the conference center where it was drafted in 1978). The three fundamental ethical principles in the Belmont Report for all human subjects research are respect for persons, beneficence, and justice.⁶

Recent years have seen some convergence in institutional review board practices across institutions.

One question of particular interest to economists is whether all participants in an experiment must consent in advance because the knowledge of participating in an experiment may bias the results. A common rule is that institutional review boards allow the use of such “deception” if certain conditions are met. First, the research involves no more than minimal risk. Second, the waiver will not impact adversely subjects' rights and welfare, which includes no reduction in compensation, employment benefits, or mental well-being. Moreover, if subjects do not wish to participate in the research there is to be no adverse effect on them either. Third, the research could not practically be carried out without the waiver. Finally, subjects will be provided with additional pertinent information about participation -- a condition that can often be met by debriefing subjects at the end of the study.

Experiences with waivers of informed consent still vary across institutions. Some institutional review boards simply allow for the waiver. Other boards require subjects to be informed they are part of a research study (rather than an “experiment”), that they can opt out of the study without any consequence, and that they are provided with the contact details of the researcher. This need not compromise the conduct of field experiments within firms as long as such requirements are equally applied to treatment and control groups.

A distinctive characteristic of field experiments with firms that has important implications for how field experiments should be judged by institutional review boards is that firms are likely to experiment on their own, or be advised by for-profit consultancies, and the ethical guidelines they must adhere to in

⁶ The report is located at <http://www.hhs.gov/ohrp/humansubjects/guidance/>.

this case are likely to be much less stringent than those faced by academics.⁷ Researchers might then be crowded out by for-profit evaluation consultancies that are not subject to the same ethical requirements, and this might reduce the involvement of academics in field experiments, and create a strong selection of the type of experiments that can be subject to scientific scrutiny. The severity of this concern depends on how the attitude of Institutional Review Boards vis-à-vis academics involvement with firms will evolve in the future. For instance, will researchers be allowed to advise firms on experiments that do not meet academic ethical guidelines but would be implemented regardless of academic involvement? Will researchers be allowed to analyze data from experiments that do not meet academic ethical guidelines but were initiated by the firms themselves? The answers to these questions will have profound implications for the future of field experiments with firms.

5 Common Lessons and Future Directions

Field experiments are at the heart of a growing empirical literature that is expanding economists' understanding of firm behavior. In this concluding discussion, we draw together some common lessons from these studies and suggest some future directions.

A common feature of most field experiments with firms is that they identify partial equilibrium effects as they typically affect only one or at most a sample of firms within one industry. General equilibrium effects might of course differ, depending in part on whether the returns to the experimental innovation can be competed away. For instance, if high powered incentives benefit the firm by attracting better workers, no firm can gain by offering high powered incentives when all firms do the same. In contrast, if high powered incentives increase workers' productivity all firms can benefit from offering high powered incentives, thus increasing aggregate productivity.

The question that naturally arises is then: if these aggregate gains are possible, why don't firms reap them? Indeed one puzzling finding is that almost all the field experiments reviewed have brought large benefits to the firm. In part this is driven by endogenous experimental selection: firms would not agree to implement experiments that are expected to have detrimental consequences. Yet, the fact that in so many cases researchers have managed to increase profits appears at odds with the common assumption that firms are pressured by competitive forces to make at least close to optimal choices. For example, the incentive schemes introduced in our field experiments at the fruit-picking firm increased productivity and profits, and were later kept in place by the firm. Likewise, the modern managerial practices introduced by Bloom et al. (2010a) increased profits and were kept in place after the end of the experiment. In both cases, the owners attributed the failure to explore these options earlier as due to the high opportunity cost of their time. The same constraint seems to be binding in very competitive environments, as the one where the firm analyzed by Bandiera et al. (2007) operates, and in settings where competition is very mild, as for the firms surveyed by Bloom et al. (2011).

⁷ We thank the editor, David Autor, for raising this point.

This finding suggests promising new avenues for future research aimed at providing evidence on the importance of time constraints in firms. The importance of time constraints at top-tiers of organizational hierarchies has been recognized in theory (Bolton and Dewatripont, 1994, Garicano, 2000), but evidence on whether and how managers allocate their time to maximize firm performance is scant. Bandiera et al. (2011) have developed a survey methodology to measure how chief executive officers spend their time, and show how the pattern of time allocation can be used to provide observational evidence on the internal and external constraints faced by firms. Combining their survey methodology with field experiments has the potential to make substantial progress to understand these issues.

In turn, scarcity of managerial time can be symptomatic of two other problems. First, if the owner or chief executive officers must control all aspects of the business, the scope and size of the firm is necessarily limited. Delegation of authority and decision making is an essential ingredient for firm expansion, and yet we have a very limited empirical understanding of why some owners fail to delegate. Agency problems and the inability to motivate lower tier managers seem intuitively important, as reported by the firm owners surveyed by Bloom et al. (2011), but more evidence is needed on how these can be tackled. Field experiments that vary the distribution of authority or the agency constraints could potentially provide this. Second, there is often a lack of managers with adequate human capital and talent, whether due to a market failure in education or a skewed distribution of talent. These constraints are not amenable to experimental variation, but by providing evidence on the internal constraints of firms, field experiments can help guide research on these topics too.

Our discussion so far has been based on the assumption that firms maximize profits subject to constraints. But rather than focusing on constraints to optimizing behavior, a growing body of observational studies suggests the alternative view that firms might not maximize profits, either because they are led by managers who enjoy the “quiet life” (Bertrand and Mullainathan, 2003) or because they are owned by families whose objective function has a non-monetary component deriving from direct control (Bertrand and Schoar, 2006). A burgeoning body of work uses field experiments to understand consumer preferences and optimizing behavior. It is worth exploring whether similar strategies could be adopted to shed light on departures from the assumption of profit maximization by firms.

Field experimenters have also begun to explore the behavior of not-for-profits. While there exists a vibrant literature using field experiments on fund-raising activities of such organizations, many other issues remain unexplored. Theoretical contributions from Benabou and Tirole (2003) and Besley and Ghatak (2005) make clear that the provision of incentives for pro-social tasks raises different issues than for private tasks on at least two dimensions. First, to the extent that agents engaged in pro-social tasks are intrinsically motivated, financial rewards that might successfully elicit effort for private tasks could reduce effort if the rewards crowd out intrinsic motivation. Second, the type of incentive mechanism might affect the composition of the pool of agents who choose to participate in the activity. In particular, high-powered financial incentives might attract individuals who are motivated by financial returns instead of individuals who share the pro-social orientation of the organization, with undesirable consequences. Laboratory experiments show that the effect of financial rewards differs when the task has social value – but field evidence on these issues is scant.

The issue of how firms and individuals at different layers of the hierarchy match endogenously based on their respective characteristics has many applications.⁸ Field experiments on discrimination provide some evidence on how firms hire workers, but clearly many questions remain open. We envisage field experiments that create exogenous variation in the parameters of the matching process, by, for instance, varying the information set available to employers and employees, or by reducing search costs through the introduction of electronic market places where employers and employees can meet. Advances in field experiments in these directions, perhaps in some cases intervening at the level of markets as a whole, would take the approach into an exciting new realm.

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⁸ This is often seen as a limitation for most observational studies, because many observed patterns of outcomes can be ascribed to endogenous matching (Ackerberg and Botticini, 2002).

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