



Impact of the Information and Communication Technologies on workers' behaviors: an experimental investigation

Peguy Ndodjang Ngantchou

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THÈSE

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Et du Laboratoire Montpelliérain d'Economie Théorique
et Appliquée (LAMETA)

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Présentée par **Peguy Ndodjang**

**Impact of Information and Communication
Technologies on workers' behavior: An
experimental Investigation**

**L'impact des Technologies de l'Information et
de la Communication sur le comportement
des travailleurs : Une approche Expérimentale**

Soutenue le 8 décembre 2016 devant le jury composé de

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L'Université de Montpellier n'entend donner aucune approbation ni improbation aux opinions émises dans cette thèse; ces opinions doivent être considérées comme propres à leur auteur.

Abstract

This dissertation explores the impact of the use of Information and Communication Technologies (ICT) on employees' behaviors. While the neoclassical growth theory considers ICT as an input used in the production process, we relied on the knowledge hierarchy literature which states that technologies have two different key aspects. Information technologies push down the decision making at the employee level while Communication technologies centralize the decision making. We addressed the issues of the more efficient technologies for workers' performance, the costs generated by using the most efficient type of technologies and how the technology-based monitoring may be useful to reduce those costs. We used the experimental methodology since the collection of individuals and team's production is hard with survey data. Our results show that employees prefer Information technologies and those who use it are more productive than others. We also show that work organization and technologies which push down the decision making at the employee level could entail some substantial costs for the firm. Indeed, employees are more willing to engage on time wasting activities in order to influence the principal's decision when they can manipulate information even when there are no monetary incentives to do so. However Technology-based monitoring is quite successful at reducing those costs. Indeed, technology monitoring implies a disciplining effect at the beginning when the sanction is available but this effect lessens over time. Our results show that employees are more productive when they spend more time on internet. Giving constant heightened feedbacks (about their productivity) provided by ICT to workers should be the better way to sensitize them about the extent of technology monitoring and to increase their performance.

Keywords: Behavioral economics; Experimental economics; Information and Communication Technologies; Monitoring; Performance; Incentives

Résumé

Cette thèse explore l'impact des technologies de l'information et de la communication (TIC) sur le comportement des employés. Alors que la théorie néoclassique de la croissance considère les TIC comme un outil utilisé dans le processus de production, nous nous sommes basés sur une théorie qui stipule que les technologies ont deux aspects différents. Les technologies de la communication centralisent la prise de décision tandis que les technologies de l'information déplacent la prise de décision au niveau de l'employé. Nous avons abordé les questions du meilleur type de technologies pour l'amélioration de la performance des employés, des coûts engendrés par l'utilisation de ce type de technologies et de l'impact de la surveillance informatique dans la réduction de ces coûts. Nous avons utilisé la méthode expérimentale pour répondre à ces questions. Nos résultats montrent que les employés préfèrent utiliser les technologies de l'information et ceux qui les utilisent sont plus productifs que les autres. Nous trouvons également que l'environnement de travail et les technologies qui favorisent la prise de décision au niveau de l'employé pourraient engendrer des coûts importants pour l'entreprise. En effet, les employés sont plus disposés à s'engager dans les activités non productives dans le but d'influencer la décision de leur manager, et ce lorsqu'ils peuvent manipuler l'information même en l'absence d'incitations monétaires. Cependant, la surveillance informatique est efficace pour réduire ces coûts néanmoins, son effet diminue au fil du temps. Nos résultats montrent que les employés les plus productifs sont ceux qui ont passé le plus de temps sur internet. Donner aux employés les informations constantes et détaillées (sur leur performance) produites par les technologies pourrait être une façon efficace de les sensibiliser sur l'ampleur de la surveillance informatique afin d'agir sur leur productivité.

Mots clés : Economie comportementale ; Economie expérimentale ; Technologies de l'Information et de la Communication ; Surveillance ; Performance ; Incitations

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“...any action performed on a company computer may subject to monitoring even if it is not transmitted over a network nor stored in a file” (Ariss, 2002, p.554)

A mon grand-père Ngatchou Gabriel

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General Introduction

The use of technologies at workplace has considerably increased in the last decades. Large firms have taken advantage of the great number of communication and coordination capabilities offered by technologies in the spheres of design engineering, production and sale of goods and services (Colombo and Delmastro, 1999). The advancement in Information and Communication Technologies (ICT) entailed a decrease of information and communication costs (Milgrom and Roberts, 1990; Garicano, 2000). The introduction of ICT at workplace has lowered the production costs by allowing the automation of routine tasks which are replaced by computerization (Autor et al., 2003). This computerization ensured that work is being performed as required in the organizational guidelines and thereby lowered human errors in the production process as well as resources waste. This reduction of information and communication costs also led to a better organizational planning and improved organizational communication (Milgrom and Roberts, 1990). This positively impacted firms' performance.

In the economic framework, studies based on the neoclassical growth theory always considered ICT as an input in the production process (Chou et al., 2014). ICT serves as devices which are essential for storing and sharing information and knowledge. According to this theory, ICT results from the technological progress and is a driver of innovation which sustained long-term economic growth (Romer, 1990; Aghion and Howitt, 1992). Although ICT was “identified with the outputs of computers, communications equipment, and software” (Jorgenson, 2001, p.8), prior empirical studies addressed Information and Communication Technologies in terms of investment on ICT capital or computers per person (Brynjolfsson and Hitt, 2000; Black and Lynch, 2001; Colombo and Delmastro, 2004; Bertschek and Kaiser, 2004; Acemoglu et al., 2007). Consequently, these studies did not distinctly take into account the different aspects of technologies.

However, recent studies considered enterprise software systems such as Enterprise Resource Planning (ERP) systems, Supply Chain Management (SCM) systems, Customer Relationship Management (CRM), Computer Assisted Design/Computer Assisted Manufacturing (CAD/CAM), Computer Performance Monitoring (CPM), Corporate Information System and internet/broadband (Falk, 2005; Alder and Ambrose, 2005; Bloom et al., 2014; Sun, 2016). We define ICT as hardware (computers, mobile devices) and software (ERP, CRM, CPM, internet...) that are usually used in the production process of the organization.

This growing body of literature shed light on the distinct effects of Information technologies (IT) and Communication technologies (CT) (Bloom et al., 2014; Sun, 2016). On one hand, IT curtails the costs of acquiring information and by so doing it pushes down decision making at the workforce level. The ease of information access allowed by the use of IT may increase agents' autonomy and discretion concerning decision making. This positive effect called the empowering effect (Bloom et al., 2014), should increase workers' productivity (Garicano, 2000; Bertschek and Kaiser, 2004; Garicano and Rossi-Hansberg, 2006; Bloom et al., 2014; Charness et al., 2012). On the other hand, CT reduces communication costs inside the firm (Bloom et al., 2014); thus decision making is transferred to higher levels of the hierarchy. Because workers' empowerment with IT may lead to a costly loss of control for the principal (Acemoglu et al., 2007), the latter might be more willing to help (keep under control) workers by taking advantage of low communication costs instead of giving them more autonomy. This is the substitution effect (Di Maggio and Van Alstyne, 2013). If workers feel overruled (Aghion and Tirole, 1997), this might negatively impact their performance (Falk and Kosfeld, 2006; Frey, 1993). So, the implementation of new technologies in the work organization may have opposite effects on worker's productivity (Garicano, 2000; Bertschek and Kaiser, 2004; Garicano and Rossi-Hansberg, 2006; Bloom et al., 2014; Martin and Omrani, 2015; Sun, 2016).

These recent studies on ICT also stressed that technologies which foster more autonomy for workers (IT) may lead to a higher workers' productivity (Black and Lynch, 2001; Bresnahan et al., 2002; Brynjolfsson and Hitt, 2000; Garicano, 2000; Garicano and Rossi-Hansberg, 2006; Bloom et al., 2014; Sun, 2016). Therefore, firms should more invest in IT which entails a decentralized work environment. However, according to Cyert and March (1963, p.67): "Where different parts of the organization have responsibility for different pieces of information relevant to a decision, we would expect some biases in the information transmitted due to perceptual differences among the subunits and *some attempts to manipulate information* as a device for manipulating the decision." The manipulation of information can take many forms, "ranging from conscious lies concerning facts, through suppression of unfavorable information, to simply presenting the information in a way that accentuates the points supporting the interested party's preferred decision and then insisting on these points at every opportunity" (Milgrom and Roberts, 1988, p.156). Since manager and workers' interests are not perfectly aligned (Acemoglu et al., 2007), workers may engage on cheating

behaviors to maximize their profits (Nagin et al., 2002). Therefore, the implementation of Information technologies could also be costly for firms.

The use of the technology-based monitoring system (*IT monitoring*) is an important consequence of the introduction of ICT at workplace (Ariss, 2002; Alder and Ambrose, 2005; Sarpong and Rees, 2014; West and Bowman, 2014). “There are many reasons for employers to use modern technology to keep tabs on employees, among them to: prevent misuse of company resources; monitor employee performance; ensure that company security is not breached and guard against legal liability for employee statements or actions” (Ariss, 2002, p.555). This monitoring system keeps details about agents’ attendance (log-in account), time coded log of all activities performed from their computer terminal, the real time of a website visited and its duration, over time, break time etc. Consequently, technology features included in software used by workers allow firms to automatically record indicators of their effort and performance. The use of this effective monitoring system should lead agents to increase their effort (Dickinson and Villeval, 2008; Nagin et al., 2002; Ariss, 2002) and reduce the costs of their empowerment. Nevertheless, the pervasive and invasive nature of the *IT monitoring* may also have a counterproductive effect on workers’ behaviors (Deci, 1975; Fehr and Gächter, 2001; Frey, 1993; Frey and Oberholzer-Gee, 1997; Falk and Kosfeld, 2006). Consequently, the technology-based monitoring may have several effects which could generate opposite results on workers’ behaviors and performance.

The investigation on ICT use at the level of workers is crucial to reap the full potential of technologies. The aim of this dissertation is to assess the following question: How does ICT use impact individual workers’ behaviors? More precisely, are Information technologies better than Communication technologies for workers’ performance? Is it costless for firms to empower workers? What is the overall effect of the technology-based monitoring on workers’ productivity and behaviors?

The issue of ICT at the workers’ level is worthwhile since evidence suggest that the implementation of technologies at workplace has to be combined with organizational changes for more efficiency (Milgrom and Roberts, 1990; Brynjolfsson and Hitt, 2000; Black and Lynch, 2001; Bresnahan et al., 2002; Garicano, 2000; Bertschek and Kaiser, 2004; Garicano and Rossi-Hansberg, 2006; Bloom et al., 2014). Assessing the question of the impacts of ICT use on workers’ behaviors may enable us to fill the gap of the scarcity of studies on this issue (Martin and Omrani, 2015; Sun, 2016). This could be useful to know which changes should

be adopted and how organizational changes should be adapted in order to maximize firms' efficiency.

Indeed, some changes like employee involvement in decision making, compensation, enhancement group work, flattering hierarchies, work allocation, scheduling etc. directly concern the workforce (Bertschek and Kaiser, 2004; Falk, 2005). Employees can work where and when they feel the most comfortable and productive. Distance and space are no more constraints for firms as ICT use enabled teleworking, virtual teams and work at home. However, some studies have linked the use of ICT with anxiety, depression, decrease in job satisfaction (Aubert et al., 2004). Employees often feel stressed and distrusted because their privacy is violated by the technology-based monitoring (Ariss, 2002). So the implementation of technologies could also negatively impact workers' performance.

All these changes and capabilities generated by the widespread of ICT in workplace are likely to impact workers' productivity. It is clear that effects of ICT use on workers' performance may vary according to organizational changes regarding human resources management (Black and Lynch, 2001). These technological and organizational changes may also impact workers' behaviors (Sun, 2016). Even though technological changes facilitated by ICT contributed to the increase of firms' productivity (Black and Lynch, 2001; Bresnahan et al., 2002; Brynjolfsson and Hitt, 2000), these changes also incurred substantial costs of workplace reorganization (Colombo and Delmastro, 2004; Bertschek and Kaiser, 2004). Indeed, firms did not only face investment costs on new technologies but also costs of implementing organizational changes (Schaefer, 1998), engendered by the decrease of information and communication costs (Black and Lynch, 2001).

Organizational costs could be generated by workers' behaviors who are reluctant to organizational changes (Schaefer, 1998) or who could attempt to influence these changes in favor of their own interests (Milgrom, 1988; Milgrom and Roberts, 1988, 1990b). Also, there are several cases where agents got fired because of technologies misuse. These misuses of computer systems and technology resources may have a negative impact on the firm efficiency (Koch and Nafziger, 2015). Investigating the impacts of ICT use on workers' behaviors might contribute to minimize costs engendered by technological changes.

Method

We used the experimental methodology for addressing the impacts of ICT use on workers' behaviors issues. This method enabled to overcome some difficulties that are usually met when some studies aim to test empirically the predictions of firm theories (Powell, 2014). For example according to Nagin (2002, p.850), "... it will be very difficult to disentangle the effects of monitoring strategies from responses to other unobserved features of the firm's employees or its human resource system.". Details regarding individuals and teams' production are generally difficult to measure and collect with surveys. This is the added value provided by the experimental methodology to the literature in economics. Indeed, we simulated realistic work environment in the laboratory with real-effort tasks in our experiments. This permitted us to observe and collect data regarding manager and workers' productivity and behaviors. In a controlled and repeated laboratory environment, we were able to test specific key variables of predictions from theoretical models that we relied on for our investigation. The experimental method allowed us to confirm some causal relationships which underlined these theories (Falk and Fehr, 2003; Ostrom, 2006; Charness and Kuhn, 2011; Camerer and Weber, 2013).

Virtual Organization software

We used the Virtual Organization (VO) software¹ to conduct two experiments in California (Orange) and one in France (Dijon). The VO software aims to propose a new approach of analyzing organizations. The most important contribution of this software is to reproduces some features of real workplace environment such as real-effort work task as well as real-time monitoring and real-time access to Internet (Corgnet et al., 2015). So the VO platform can be considered as a mix between lab and field experiments. This software allows a tight control for the experimenter as well as relevant levels of realism. More information is available on the Virtual Organizations website².

The VO platform permitted us to take account of relevant Information technologies such as internet and the technology-based monitoring as well as Communication technologies through the *chat* option embedded in this software. There are nine main features that can be explored by using the VO software: Work, Incentives, Leisure, Hierarchy, Supervision (Peer Pressure),

¹ The principal investigators behind the Virtual Organization software are Dr. Stephen Rassenti (Chapman University), Dr. Brice Corgnet (EM Lyon) and Dr. Roberto Hernan Gonzalez (Nottingham University).

² <https://sites.google.com/site/corgnetb/virtual-organizations>.

Influence activities, Promotion (Firing and Retirement), Help (Teamwork) and Voting. However, we will only present features that we used to run our experiments.

The Virtual Organization software considers organization with three levels of hierarchy. On top of the organization there are *E-Subjects*, they can promote and fire other subjects. *C-Subjects* are in the middle of the firm. They can promote and fire *B-Subjects* which are at the bottom of the organization. They can also allocate payoff as well as dole out bonuses to them. We designed organizations with two ladders (*C-Subjects* and *B-Subjects*) to simplify our investigation. All these types of subjects can communicate through the *chat* option embedded in the VO software. To implement the Communication technologies in Chapter I, we decided to set up a vertical communication between *C-Subjects* and *B-Subjects* only. *B-Subjects* were not allowed to communicate amongst themselves.

All subjects are able to perform a *Work task*. The task consists in summing up numbers in a table or auditing it for errors. It is a long, repetitive and effortful task (e.g. Dohmen and Falk, 2011; Eriksson et al., 2009; Niederle and Vesterlund, 2007) that was designed to reduce as much as possible the intrinsic motivation derived from performing the task just for its sake (Corgnet et al., 2015). We designed a more laborious task by filling some tables with decimal numbers in order to implement what Bloom et al. (2014) called “problems to solve” in the experiment of Chapter I.

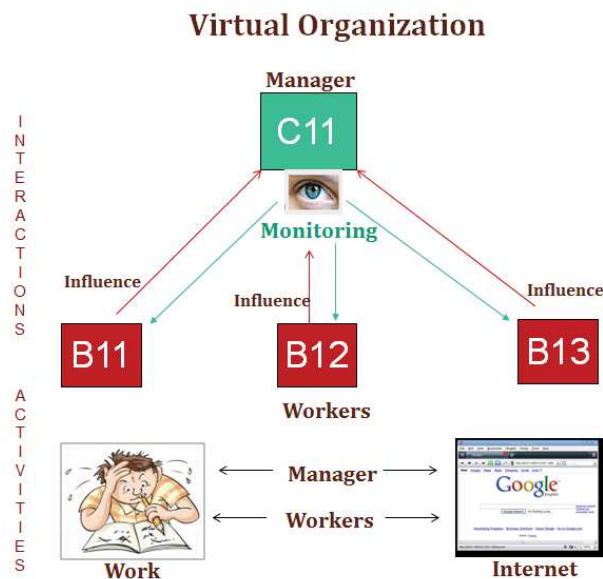
One of the most important features available on the VO software is the *Internet* option. Indeed, the Virtual organization platform is the first software for experiments that implements the use of Internet at work environment. Subjects can switch to this real leisure activity at any time during the experiment. They are informed about the confidentiality of their internet usage. The last web page they visited is automatically displayed when they return to the Internet screen after switching to another activity. Since the internet browser is embedded in the software, we were able to keep record of time spent by subjects on Internet, as well as the number of times they switch to this activity to another.

By using the *Boost* option of the VO software, subjects can falsely increase the level of production as observed by others. By cheating, subjects give wrong information that makes them look good compared to others in order to influence the decision of their line manager. We chose to set a cost in terms of time as subjects were unable to undertake another activity

while using the *Boost* option. This allows subjects to be caught while cheating. In our experiments, only *B-Subjects* were able to use the *Boost* option.

The Virtual Organization software also enabled us to implement the intrusive and invasive technology-based monitoring. As mentioned above, this software allows implementing a real-time supervision. Indeed, subjects are able to monitor others' activities at any time during the experiment. In our experiments, only *C-Subjects* were allowed to supervise *B-Subjects* and we decided not to inform supervisees as "...any action performed on a company computer may subject to monitoring even if it is not transmitted over a network nor stored in a file" (Ariss, 2002, p.554). There are *Summary View* and *History table* features we set up to control information displayed for the supervisor. The VO software allowed us to measure the time spent by *C-Subjects* in monitoring *B-Subjects* as well as how many times subjects were supervised.

Figure 1: Virtual organization, interactions and activities



We used STATA to analyze data from experiments. We also used the clustered version of the Wilcoxon rank-sum test as well as linear panel regressions with random effects and clustered standard errors for teams. This allowed us to take into account the fact that the performance of subjects in the same team may be correlated. Indeed, we used team incentives and the relative contribution of each subject was displayed on a subjects' screen during each the period. Also, the pay of other team members was displayed at the end of each period. This may affect subjects' motivation. So, this correction was especially relevant.

Conceptual framework

We started our investigation by testing the theory of “knowledge hierarchy” which points out that technologies have two key aspects which have different impacts on workers’ performance (Garicano, 2000; Garicano and Rossi-Hansberg, 2006; Bloom et al., 2014) in Chapter I. Information technologies (IT) lead to decentralization while Communication technologies (CT) entail a centralization of decision making (Garicano, 2000; Garicano and Rossi-Hansberg, 2006; Bloom et al., 2014). The theoretical model which underlies the knowledge hierarchy literature is interesting because it serves as a framework to study the different aspects of ICT. The important finding of this theory is that both communication and Information technologies increase workers’ productivity. Nevertheless, Information technologies which allow more autonomy to workers lead to a higher performance. Our between subjects experimental design allowed us to compare workers’ productivity regarding Information technologies and Communication technologies use. One of our important contributions to the literature was to investigate workers’ performance about devices embedding both IT and CT. This allowed us to study workers’ preference between these two technologies.

In Chapter II, we aimed to investigate organizational costs generated by workers’ behaviors when technologies push decision making at their level (Chapter I). The influence costs theory has highlighted substantial costs engendered by workers who are willing to manipulate information (Milgrom and Roberts, 1988). According to Milgrom and Roberts (1988), influence costs are costs generated by agents’ activities to provide information which makes them look good relatively to others in the way that it would affect the principal’s decisions on their behalf. We tested some features of influence costs theory. The costs of influence activities depend on how the information is gathered and on the reward systems in the organization. We focused on the impact of influence activities on the principal’s discretion regarding the allocation of pay but we also ran treatments with fixed pay reward system.

To avoid agents to engage on time wasting activities (Chapter II), firms can take advantage on invisible, pervasive and invasive monitoring system allowed by technologies. Chapter III aimed to investigate the effects of the technology-based monitoring on workers’ behaviors concerning working, leisure (browsing the web) and cheating (manipulation of information) activities. Although some technologies provide more autonomy to workers (Chapter I), they also allow the manager to easily evaluate their effort by providing a heightened transparency of the work process and the instant availability of work performance indicators. This chapter

also enabled us to understand why some workers abuse the use of technologies even though they sign the IT chart. We also addressed the issue of the principal's behavior regarding this monitoring system.

This dissertation may contribute to a better knowledge and understanding of the ICT use on workers' behaviors in the light of theoretical predictions. Our findings may rise up managerial attention on the effects of ICT use at workplace regarding productivity and technology-based monitoring. Our three chapters have given rise to submitted and accepted papers in top tier journals with the contribution of co-authors and can be read independently.

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**Chapter I: The effects of Information Technologies versus
Communication Technologies on workers'
performance: An experimental evidence**

I1. Introduction

New technologies are regularly integrated in firms with the aim to improve workers' productivity (Falk, 2005). Although significant changes in the workplace are the result of the widespread use of Information and Communication Technologies (ICT) (Black and Lynch, 2001), studies on its impact at the level of workers are scarce (Martin and Omrani, 2015; Sun, 2016). Indeed, ICT has intensely reshaped the workplace and completely modified the way employees used to work. We consider new technologies such as hardware and software (computers, internet, ERP, ect...) that are most often used in the production process (Colombo and Delmastro, 2004). These sophisticated technologies are used to accomplish routine as well as some complex tasks. The introduction of ICT at the workplace entails the decrease of acquiring, verifying, and communicating information costs and thus leads to a better organizational planning and improves organizational communication (Milgrom and Roberts, 1990). Therefore, the use of ICT has simplified the way employees perform their work as well as their management in the firm (Alder and Ambrose, 2005). ICT also enables adjustments in authority relationships by modifying the coordination of the decision-making process (Falk, 2005; Sun, 2016).

All these changes generated by the diffusion of ICT in the workplace impacted workers' productivity but outcomes are unclear (Martin and Omrani, 2015; Sun, 2016). Also, several studies on the impact of ICT use on the firm productivity showed that the implementation of technologies has to be combined with some organizational changes for more efficiency (Milgrom and Roberts, 1990; Brynjolfsson and Hitt, 2000; Black and Lynch, 2001; Bresnahan et al., 2002). These organizational changes such as "...compensation, information sharing, employee involvement in decision-making, and scheduling" (Falk, 2005, p.1230) which directly concern workers, affect their productivity and consequently the efficiency of the firm. So, to implement or adapt organizational changes which maximize the firm performance, the crucial question is how does the use of technologies impact workers' performance? By adopting changes which may increase workers' performance, the firm should reap more benefits of ICT use. Also, since changes imply some costs for the firm (Bertschek and Kaiser, 2004; Falk, 2005; Colombo and Delmastro, 1999), the investigation of ICT effects at level workers should be needed to decrease the costs of these changes and to limit the waste of resources and the misuse of technologies by workers.

Our research question is worthwhile because the implementation of ICT in the work organization may have opposite effects on worker's productivity (Garicano, 2000; Bertsek and Kaiser, 2004; Garicano and Rossi-Hansberg, 2006; Bloom et al., 2014; Martin and Omrani, 2015; Sun, 2016). On one hand, ICT enables workers to easily process information, create new information and selectively access new information inside the firm. Hardware and software also allow firms to retrieve and store large amounts of data faster; ICT plays a strategic role in the diffusion of organizational data at all hierarchical levels. Consequently, workers at the lower level of the hierarchy may easily access to available information for making decisions without seeking instructions from their manager. Decisions which can be made quickly by workers may be efficient since available information is relevant. Moreover, workers may solve a wide range of problems they face without need to rely on their manager. So, the redistribution of information access in the firm due to ICT entails more autonomy and discretion for workers concerning the acquisition of information and decision making (Brynjolfsson and Hitt, 2000; Sun 2016); this should have a positive effect on workers' productivity (Garicano, 2000; Bertsek and Kaiser, 2004; Garicano and Rossi-Hansberg, 2006; Bloom et al., 2014; Charness et al., 2012).

On the other hand, ICT enables faster communication between workers and manager (Green, 2006). Indeed, ICT also allows the manager to communicate easily and cheaply across time and geographic locations with one or several workers at the same time. Because the interests of the manager and workers are not perfectly aligned, workers' autonomy may generate a costly loss of control for the manager (Acemoglu et al., 2007). Therefore, the manager may limit workers' autonomy by taking advantage of the communication tools entailed by technologies. Thereby, workers' discretion engendered by ICT may be restricted by the manager who doesn't want to lose his authority and control on workers' activities. Also, the manager could not be confident about the efficiency of decision made by employees (Acemoglu et al., 2007). Accordingly, workers should need the validation of their decision and rely on the manager to have the relevant information before performing their activities. The centralization of the decision making process by the manager will lead to a decrease of workers' discretion. This situation is likely to jeopardize communication if workers feel overruled (Aghion and Tirole, 1997) and could negatively impact their performance (Falk and Kosfeld, 2006; Frey, 1993).

In this chapter, our first contribution is to fill the gap of the lack of studies on effects of ICT use at workers level. To do so, we use the experimental method to test the model developed

by Bloom et al. (2014) based on the “knowledge hierarchy” theory of Garicano (2000). This model distinguishes Information Technologies (IT) from Communication Technologies (CT). Bloom et al. (2014) focused on the impact of Information versus Communication technologies on the allocation of decision making between manager and workers. This model allows us to take into account different aspects of technologies for investigating the impacts of the use of ICT on workers’ performance. One important insight of this model is to show that Information technologies which engender a greater workers’ autonomy lead to a highest workers’ productivity. Our research question appears more relevant since there are some hardware like computers or software like ERP (Enterprise Resource Planning) which encompass both communication and information systems.

The experimental method is very useful for that purpose since individuals and teams’ production are hard to collect with survey data. Experimental data enable us to deepen existing analyses in a highly controlled environment. Our experimental design allows us to compare workers’ performance with Information technologies and Communication technologies. More precisely, agents were autonomous to solve problems by searching solution in PDF files (IT) or needed to chat with the principal to ask for solution to solve problems (CT). Autonomy is defined as the high degree of discretion provided by Information technologies to workers for decision making in problems solving (Sun, 2016). Our experimental design also enables us to observe workers’ performance with a device which encompasses both IT and CT.

Our second contribution to the literature is to investigate workers’ performance with devices that embedded both IT and CT and workers’ preference regarding IT and CT. Our experimental design consists in four treatments. The baseline treatment is treatment without technologies. In the IT and CT treatments, participants were able to use information or Communication technologies and in the ICT treatment, both technologies were available. Consistent with the theoretical predictions of the model developed by Bloom et al. (2014), our results point out that workers solve more problems when they use Information technologies and that Communication technologies lead workers to rely more on the manager. Our experimental results show that teams’ production is higher with Information technologies users and lower with Communication technologies users compared to teams with technologies non-users. We also find that when both technologies are available no worker use Communication technologies. The chapter is organized as follows: Section 2 summarizes the related literature and presents our hypotheses. Section 3 describes the experimental design.

Section 4 provides experimental procedures. Section 5 presents main results and section 6 concludes.

I2. Literature overview and behavioral hypotheses

The investigation on the effects of the ICT use at the level of workers is crucial for researchers as well as managers to determine how firms which implement ICT are much better organized and managed (Milgrom and Roberts, 1990). It is clear that these effects may vary according to organizational changes regarding human resources issues (Black and Lynch, 2001) but, there is a lack of studies which investigate the impacts of technologies use at the employees and managers' level (Martin and Omrani, 2015; Sun, 2016). Bloom et al. (2014) present a model of the hierarchical organization of decision making in an economy where knowledge is an essential input in production and agents are heterogeneous in skills. This model which investigates the effects of Information technologies (IT) versus Communication technologies (CT) in the firm states that IT and CT have different effects on agents' and principals' productivity. Contrary to Aghion and Tirole (1997) and Acemoglu et al., 2007 which state that the implementation of ICT will lead to the decentralization of decision making inside the firm, Garicano, (2000); Garicano and Rossi-Hansberg, (2006); Bloom et al. (2014) suggest that the implementation of ICT use at workplace has two key aspects which impact differently the decision making in firms. Information technologies and Communication technologies have to be taken separately in order to better understand the impacts of ICT use on workers' performance (Garicano, 2000; Garicano and Rossi-Hansberg, 2006; Bloom et al., 2014).

The first key aspect is Information technologies (IT). The ERP (Enterprise Resource Planning) which is an example of this type of technologies provides a range of information regarding the production, like energy use, inventories and human resources (Bloom et al., 2014). Information technologies reduce the cost of accessing information for the agent and also facilitate the recording and the storage of information. So, Information technologies push down the decision making because workers easily have access to more information that they need to make a decision (Garicano and Rossi-Hansberg, 2006). These technologies provide an “empowering effect” by allowing agents to handle more of the problems they face with no need to rely on the manager (Bloom et al., 2014).

The second key aspect is the Communication technologies (CT). These technologies reduce the cost of communication inside the firm, between workers and managers and between workers. This kind of technologies lowers the costs of control and the collaboration between members of the firm. The introduction of intranets, the spread of cheap wired and wireless communications and the presence of LAN/WAN system are the implementation of Communication technologies (Bloom et al., 2014). The easy sharing of documentation engendered by Communication technologies fosters the transfer of decision making to the principal because it is cheaper for the agent to rely on him to make decisions. CT is likely to reduce the agent's autonomy (Bloom et al., 2014).

According to this theoretical model, information and communication technologies have very different impacts on the decision making at each level of an organization. Both lead to the increase of the productivity by solving problems but in different ways: Information technologies increase workers' autonomy and then positively impact workers' productivity while Communication technologies decrease workers' discretion in the decision making process. CT may also negatively affect the principal's performance because he will devote a large portion of his time to help other employees (Di Maggio and Van Asltyne, 2013). Moreover, workers' performance is supposed to be higher with the use of Information technologies (Bloom et al., 2014). Information technologies facilitate the acquisition of the knowledge since learning costs are lower, the production increases and a larger proportion of problems get solved by workers (Garicano and Rossi-Hansberg, 2006). This is consistent with previous studies which state that the positive effects of ICT are more salient in a decentralized work environment which allows more autonomy for employees as they have a greater voice in decision making (Garicano, 2000; Bertschek and Kaiser, 2004).

Sliwka (2001) showed that agents' motivation to work hard increases when they have the discretion on how to perform their work in the sense that they make decisions themselves on how to carry it out. A work environment which transfers the decision making at the employee level increases his incentive to acquire information (Aghion and Tirole, 1997). According to Charness et al. (2012), when agents get a higher scope of decision making they feel more autonomous, their sense of responsibility increases and they reciprocate by increasing their performance. Sun (2016) which focus on how the use of ICT impact the decision-making at workers' level, showed that the positive effect of ICT on firm performance may be partially attributed "to its beneficial use in coordination and tendency to foster more autonomy". All

these papers showed theoretical and empirical evidence of the theoretical predictions of the Knowledge hierarchy model but up to now, none experimental studies highlight this evidence.

The model:

Bloom et al. (2014) present a simplified version of the theory of “knowledge hierarchy” (Garicano, 2000). There are 3 levels in the hierarchy of the firm: The corporate manager on the top of the firm, middle managers in the middle of the hierarchy and production workers at the bottom floor. There are 2 types of decisions that have to be made in the firm: production decisions and non-production decisions. Production decision is related to workers’ discretion about task to perform and is split between middle manager and productions workers. The non-production decision (investment, hiring, marketing...) concerns middle and corporate managers. To simplify our investigation, we consider a firm with two ladders (middle managers and production workers) and production decisions only. We will refer to middle managers as managers and production workers as workers.

The objective of the firm is to maximize the profit under a knowledge hierarchy by solving problems. We start by presenting 3 assumptions developed by Bloom et al. (2014). The production needs time and knowledge which is costly to acquire and can be communicated. So, a worker can solve a problem or rely on the manager for help. The output of problem solved by a worker is normalized to 1. Some recurrent problems are distributed according to a probability density function $f(z)$ whose cumulative distribution function is $F(z)$. Knowledge z is normalized in $[0, 1]$ and knowledge acquisition cost is proportional to the knowledge level ($a_i z$). A worker can solve a fraction of $F(z_p)$ problems and requests managers for help with a fraction of $1 - F(z_p)$. The communication cost incurred by manager’s help is h per units of time. More common problems are easier and solved by workers i.e. $f'(z) < 0$. A manager will need a total time of $h [1 - F(z_p)]$ to help each worker. For optimal production, the number of middle managers required is $h [1 - F(z_p)] = n_m$

The wages of managers and workers are w_n and w_p according to their knowledge level. If the firm faces N problems, the maximization of the profit of the firm per problem can be written as:

$$\pi = N - N(a_p z_p + w_p) - n_m(a_m z_m + w_m)$$

by replacing n_m in the equation below we can write the maximization program as follow:

$$\text{Max } \pi_{(z_p)} = N (1 - (a_p z_p + w_p) - h[1 - F(z_p)](a_m + w_m))$$

The optimal organization will face a tradeoff between information acquisition and helping costs. The reduction of information acquisition costs (a) allowed by IT may lead to an increase of workers' knowledge and thus of their autonomy therefore, they will solve more problems. The reduction of communication costs (h) allowed by CT may lead to a decrease workers' autonomy as it is cheaper to ask for help.

Based on the predictions of the theoretical model, we formulate the following hypotheses:

Hypothesis 1: Solving problems

We expect: i) Information technologies users to have the higher number of problems solved compared to non-users. ii) Communication technologies users will have the lower number of problems solved compared to non-users.

Garicano, (2000); Garicano and Rossi-Hansberg, (2006); Bloom et al. (2014) associate Information technologies with more agility for the agent to make autonomous decisions, there is evidence of the positive impact of autonomy on effort (Aghion et al., 2013; Charness et al., 2012; Sliwka, 2001). Also, Chen et al. (2013) find that people who use a search technology are more efficient than non-users. Thanks to the theoretical predictions and findings, we can also formulate the following hypothesis:

Hypothesis 2: Production (routines tasks + problems)

We expect: i) IT users will be more productive than non-users. ii) Agents using Communication technologies will produce less than non-users. iii) Team production will be higher with IT users and lower with CT users.

According to the team theory (Bolton and Dewatripont, 1994; Marschak and Radner, 1972; Sah and Stiglitz, 1986; Van Zandt, 1999) and the recent contribution of Di Maggio and Van Alstyne (2013), the flow of information between principal and agents drives individual behaviors. It has been shown that there is a trade-off for the agent between acquiring himself the information to make a decision and asking for the relevant information to the manager. If agents rely more on managers to ask for help since communication costs are low, principals will spend more time solving problems faced by agents. This effect is called the “substitution effect” by Di Maggio and Van Alstyne (2013) and leads us to formulate the following hypotheses:

Hypothesis 3 (Preference between technologies and principal's production)

We expect: i) Agents will rely less on principal when Information technologies will be available. ii) The principal's production will be lower when he will be solicited to solve problems.

We summarize our main hypotheses in the table below:

Table I. 1: Expected effects of IT and CT on workers' productivity

	Number of problem solved	Requesting help	Agents' production	Principal's production	Team production
IT	+	-	+	Not tested	+
CT	-	+	-	-	-

I3. Experimental design and procedures

We ran our experiment through the Virtual organization software³ (Corgnet et al., 2015) which allows for the reproduction of relevant features of a real workplace environment. As discussed in the presentation of the model, we considered a firm with two ladders (principal and agents) and productive decisions only. We built our experimental design in a way that agents faced routine tasks and problems in the production process. They were able to find the solution on their own through Information technologies or they could rely on the principal to solve problems through Communication technologies or both according to the treatment.

I3.1. The work task (routine task and problems)

The experiment conducted was based on a real effort task that consisted of summing up 25 repetitive numbers in a table (Corgnet et al., 2015; Dohmen and Falk, 2011; Ericksson et al., 2009; Niederle and Vesterlund, 2007). In each period, participants were asked to solve as many different tables as they wanted according to their ability and were paid accordingly. Each table had five rows and five columns of randomly-generated numbers; the use of pen,

³The Virtual Organization software built at the Economic Science Institute (ESI) of Chapman University. <https://sites.google.com/site/corgnetb/virtual-organizations>

scratching paper, calculator or any other computer-based devices was not allowed. Participants had to provide a separate subtotal for all of the 4 columns before providing the final answer of the table. Once the final sum was submitted, a gain or a loss followed by a new table appeared on the screen depending on whether the answer was correct or not. To implement the occurrence of routine tasks and problems during the production process, we designed 2 types of tables: easy tables and difficult tables. So, the work task is made up of routine tasks (easy tables) and problems (difficult tables) solved.

Figure I. 1: Screen shot of the work task

Column1	Column2	Column3	Column4	Column5
12.00	0.75	3.00	0.75	3.25
0.00	1.35	3.25	3.25	2.00
0.75	1.35	2.00	3.25	2.00
3.25	3.25	1.35	0.75	0.75
1.35	1.00	3.25	0.75	2.00
Sum Column				

The easy tables were tables with integers between zero and three and the difficult tables were tables with decimal numbers only. Those numbers were generated randomly with the same level of difficulty for each participant⁴. The decimal numbers were equal to 0.65, 1.5, 2.35, and 3.45 as shown in Figure I.1. Each difficult table had an integer in the first cell as the table's number which was useful to quickly identify the problem when using Communication technologies. The frequency of the problems to solve was the same for all participants.

To solve difficult tables which were more laborious to sum up mentally, agents were allowed to use Communication technologies, Information technologies or both according to the treatment. Communication technologies enabled agents to ask for help to the principal who received 2 PDF files with the solutions of difficult tables at the beginning of the experiment. Information technologies allowed agents to solve a given table by looking up directly the solution in one or both PDF files available on their computer's desktop. Asking for help to the principal or looking up in PDF files entailed some costs that were directly subtracted from the

⁴The work task started by an easy table followed by a difficult table and so on.

individual earnings of each participant at the end of the experiment according to their declaration⁵.

I3.2. Information technologies

Information technologies provide a range of information regarding the production, and reduce the cost of accessing information stored in database for the agent. One of the most important features of IT is that it allows agents to have more autonomy (Bloom et al., 2014). Autonomy being defined as the facility the IT use offers to workers to have more freedom and discretion in decision making (Sun, 2016).

Figure I. 2: Example of PDF file_2 (Information Technology)

PDF 2

Tables are laid horizontally, each line is a table, the system first goes from left to right then top to bottom, that means the first 5 numbers corresponding to the first row of the table, the 5 following numbers corresponding to the second row consecutively. The sum of the 5 columns and the final sum will be the 6 last numbers in cells at the end of the line.

Advice: Several Dtables could have the same table's number; you will need to check the first row of the table to be sure that you are reading the right Dtable before to copy answers. The first five numbers of a line corresponds to the table's number plus the 4 numbers of the first row of the table.

<u>Dtables</u>	Sum of the 5 columns					Final sum
	C 1	C 2	C 3	C 4	C 5	
44,1.5,0.65,0.65,2.35,3.45,0.65,2.35,0.65,2.35,0.65,1.5,2.35,1.5,1.5,1.5,2.35,2.35,0.65,2.35,3.45,0.65,3.45,0.65,2.35	53.05	6.65	11.15	3.1	10.9	85.85
10,1.5,3.45,0.65,3.45,3.45,0.65,1.5,3.45,3.45,2.35,1.5,3.45,1.5,2.35,3.45,2.35,3.45,3.45,1.5,0.65,0.65,0.65,2.35	20.75	6.65	12.5	8.7	15.05	64.65
11,1.5,0.65,2.35,3.45,0.65,2.35,3.45,3.45,2.35,1.5,1.5,1.5,2.35,0.65,0.65,1.5,3.45,0.65,0.65,1.5,1.5,2.35,1.5	14.45	7.5	8.6	12.1	10.3	53.95
49,3.45,1.5,0.65,3.45,1.5,2.35,3.45,1.5,2.35,3.45,3.45,1.5,2.35,0.65,0.65,2.35,3.45,0.65,2.35,0.65,2.35,0.65,1.5,3.45	55.25	13.95	10.55	5.65	12.25	98.65
12,1.5,1.5,0.65,2.35,3.45,3.45,1.5,0.65,1.5,0.65,1.5,3.45,1.5,1.5,1.5,2.35,2.35,0.65,2.35,0.65,3.45,3.45,3.45,0.65	18.25	12.25	12.25	5.9	8.35	58
10,0.65,1.5,0.65,3.45,3.45,0.65,1.5,3.45,3.45,2.35,1.5,3.45,1.5,2.35,3.45,2.35,3.45,3.45,1.5,0.65,0.65,0.65,1.5	20.75	5.8	10.55	8.7	14.2	61
11,0.65,1.5,2.35,3.45,0.65,2.35,3.45,3.45,2.35,1.5,1.5,1.5,2.35,0.65,0.65,1.5,3.45,0.65,0.65,1.5,1.5,2.35,1.5	14.45	6.65	9.45	12.1	10.3	53.95
12,2.35,0.65,0.65,2.35,3.45,3.45,1.5,0.65,1.5,0.65,1.5,3.45,1.5,1.5,1.5,2.35,2.35,0.65,2.35,0.65,3.45,3.45,3.45,1.5	18.25	13.1	11.4	5.9	9.2	58.85
43,1.5,0.65,3.45,3.45,1.5,2.35,3.45,0.65,3.45,1.5,1.5,1.5,1.5,0.65,1.5,1.5,3.45,1.5,1.5,2.35,1.5,1.5,1.5	48.15	9.2	8.6	9.55	11.4	87.9
13,3.45,1.5,3.45,3.45,3.45,3.45,1.5,1.5,2.35,0.65,1.5,1.5,2.35,3.45,3.45,2.35,0.65,1.5,1.5,3.45,2.35,2.35,0.65,2.35	24	13.1	7.5	8.45	13.1	67.15
14,3.45,3.45,2.35,0.65,2.35,3.45,2.35,0.65,2.35,0.65,3.45,0.65,0.65,0.65,1.5,2.35,3.45,0.65,0.65,1.5,2.35,2.35,0.65,0.65	20	15.05	12.25	3.95	4.95	57.2
10,0.65,3.45,0.65,3.45,3.45,0.65,1.5,3.45,3.45,2.35,1.5,3.45,1.5,2.35,3.45,2.35,3.45,3.45,1.5,0.65,0.65,0.65,1.5	20.75	5.8	12.5	8.7	14.2	62.95

To mimic the autonomy associated with Information technologies, our design provided agents to have more agility to solve a problem by looking up themselves the solution for difficult tables in 2 PDF files. These PDF files were referred to as PDF1 and PDF2 on the desktop of the computer terminals at which they were seated. In the PDF1, only the 5 columns with solutions were available while PDF2 provided the 5 columns with solutions plus the final sum. On each PDF file, tables were laid horizontally and each line corresponded to a table. To find the solution, participants just had to read the 5 last numbers in PDF1 (or 6 in PDF2) at the end of each line. To implement the looking up action, we set up several tables with the same number of tables (see Figure I.2). To quickly solve a difficult table, agents had first to find the table's number they were summing up in the PDF file and then had to check the row

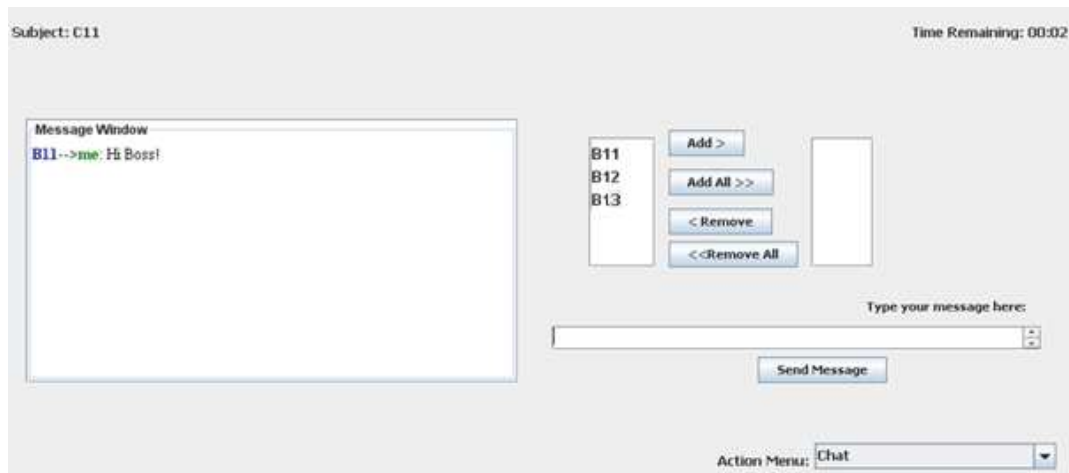
⁵ Thereby, agents were able to cheat by reporting a wrong number of times they used PDF files but, we were able to correct their declaration.

of the table (the first 5 numbers of the each) to make sure they are reading the right table before copying the answers.

I3.3. Communication technologies

Communication technologies facilitate the communication between the principal and agents (Bloom et al., 2014). Then agents can rely on the principal to solve a problem they faced. In our design, we used the *Chat option* of the virtual organization software to mimic the reliance of the agent to the principal through Communication technologies. Each agent was able to ask for a solution to the principal by clicking on the *Chat* option in the action menu on his screen. Agents had access to a chat room through which they could send to and receive messages from the principal only. The *Chat* option enabled agents to ask for help to solve a problem they were facing or to make sure they correctly solved the problem. To do so, they just had to specify the number of the table and the type of solution (PDF1 or PDF2) they wanted to the principal for solving easily and quickly a problem. Each time a participant received a message but was not currently on the chat screen, a pop-up window warned him. All participants were free to discuss any and all aspects of the experiment, but they were not allowed to reveal their name, discuss side payments outside the laboratory, or engage in inappropriate language.

Figure I. 3: example of chat screen (Communication technology)



The principal received two PDF files with solutions of difficult tables only at the beginning of the experiment. To implement the fact that the principal has the knowledge to solve problems (Bloom et al., 2014), we gave him only right answers of all difficult tables in PDF files. Actually, the number of a table was directly followed by the sum of each column (PDF1_p)

plus the final answer (PDF2_p). The principal did not need to check the first row of the table like agents with Information technologies.

I3.4. Principal's working activities

The principal just as agents had to sum up numbers as he wanted. In treatments where Communication technologies were available, the principal was able to use the *Chat* option to give answers when requested. The time wasted to communicate with agents is a kind of helping costs. The principal was also able to monitor the contribution of agents at any time during the experiment by clicking on the *Watch* option in the action menu on his screen.

I4. Procedures and treatments

I4.1. Experimental procedures

We ran our experiment in the Laboratory of Experimentation in Social Sciences and Behavioral Analysis (LESSAC) from Burgundy School of Business (France). We recruited 108 students (70% females) from this Business School. The number of participants varied from 20-32 per session. Each session lasted almost one hour with 5 periods of 7 minutes. We conducted those sessions between February and March 2015.

Participants were randomly matched in a team of 4 members and assigned to one of the two existing roles. Each team consisted of one principal and three agents. Participants kept the same role and the same partners for the whole duration of the experiment. First, all participants received sheets with instructions and screen captures of the software. They had 10 minutes to read the instructions with the monitor which was reading aloud according to the treatments described below. Second, participants entered in a training period⁶ to make sure they well understood the instructions and were able to use the VO software tools. Participants with the role of principal received the PDF files during this stage. A few days before, participants were asked to play a beauty contest game repeated 10 times. They were divided in groups of 8 members. They also filled in a Raven test. Their score of these two quizzes is what we refer to as "*Ability*" in the rest of the chapter. The participants' earnings at the end of

⁶ Participants were informed of their role at this stage.

the experiment were computed as the sum of the earnings in the 5 periods. On average, participants earned a payoff of €4.7 regardless their role.

I4.2. Treatments

Our experimental design consisted in four (between-subjects) treatments (see Table I.2). In the baseline treatment, participants were unable to use any type of technologies. In the *IT treatment*, participants were able to use the Information technologies by accessing directly the PDF files on their computer's desktop. Agents on *CT treatment* were allowed to use the *Chat* option as Communication technologies to ask for solutions. Participants were able to use both information and Communication technologies in the *ICT treatment*. In *IT treatment* and *ICT treatment*, participants were able to use Information technology, we will refer to these treatments as ITs treatments, we will also use CTs treatments to talk about treatments which allowed Communication technologies (CT and *ICT* treatments).

Table I. 2: Summary of treatments

Treatments	Technologies	Number of participants (team)
Baseline	No technologies	32 (8)
IT treatment	Information technologies only	28 (7)
CT treatment	Communication technologies only	20 (5)
ICT treatment	Information and Communication technologies	28 (7)

Regardless the difficulty level of a table, each correct answer paid 50 cents that was added to the total production of the group and each incorrect answer generated a penalty of 25 cents that was subtracted to the total production of the group. At the end of a given period, each agent of the group received 20 % of the total production while the principal received 40% of this amount. Using information or communication technologies entailed some costs that were directly subtracted from the individual earnings of the participant at the end of the experiment. The cost of using technologies depended on the type of the PDF files, access to PDF1 costed 10 cents for solutions used for each table and access to PDF2 costed 20 cents. Participants

were invited to write down on a paper how many times they used or asked for answers from each type of PDF files at the end of each period⁷.

Table I. 3: Summary of experimental design

	108 participants were matched in organization of 4 members : one principal and three agents			
Treatments	No Tech	IT	CT	ICT
Kind of Technologies	×	Information	Communication	Information & communication
Implementation	×	Agents can search solution on PDF files	Agents can chat with principal to ask for solutions	Agents can search and chat
First stage	Ability test (few days before)			
Second stage	Session (5 periods of 7 minutes each)			
Third stage	Payment stage (at the end of the experiment)			
END				

I5. Results

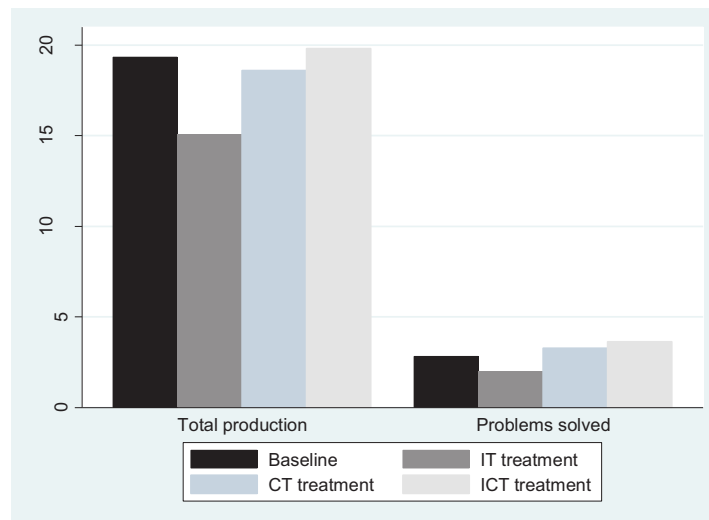
We start this section by presenting descriptive statistics regarding production and problems solved by agents in all treatments. The production is summarized as the amount generated by each table (difficult + easy) correctly solved minus the amount generated by incorrect tables. In the second part of this section, we will present econometric results regarding technologies users compared to non-users.

⁷ The software enabled us to verify agents' declaration only; we needed to rely on principals' declaration to complete data regarding their use of PDF files.

I5.1. Descriptive statistics of treatments

The figure below (Figure I.4) displays the average production and number of problems solved by agents only in each treatment. We observe that agents in *ICT treatment* were more productive on average and agents in *IT treatment* were less productive compared to others ($99.05 > 96.67 > 93 > 75.23$, see Table I.8 in appendix I). This result suggests that the production is higher when both Information and Communication technologies are available. We also observe that agents' production in treatments which allow only one kind of technologies was lower than agents' production in the baseline. These results are only significant when we compare *IT treatment* with baseline and *ICT treatment* ($z = 1.95, p = 0.04$ and $z = -1.84, p = 0.07$ respectively).

Figure I. 4: Average of agents' production and problems solved for each treatment



We also observe that agents in *ICT treatment* solved more problems than others and agents in *IT treatment* solved fewer compared to others. However, results are only significant when we compare *ICT treatment* and *IT treatment* ($z = -1.93, p = 0.05$). When we deeply looked data related to production, we realized that some agents in the baseline treatment did not solve difficult tables. Indeed, some of them willingly entered wrong answers (when they faced a difficult table) in order to quickly move on to an easy table. Another reason which can explain why agents in baseline treatment were more productive is that participants in treatments with technologies were very slow in adapting to technologies. Indeed, some agents used more technologies over time. In our experiment 16.7% of participants in ITs treatments and 19.4%

of participants in CTs treatments used at least once Information technologies or Communication technologies respectively.

I5.2. Econometric results

This section presents our econometric analyses of the effects on IT and CT on agents' performance. We also present our detailed analyses on the effect of using IT and CT on principals and teams' production by taking advantage of experimental data that perfectly measure the outcome of work.

I5.2.1. Solving problems

Results reported in Table I.3 present linear panel regressions estimated with random effects which analyze the impacts of IT and CT on agents' solving problem activity. We create dummy variables *IT users* and *CT users* which take value one if a given agent used IT or CT to solve a problem during a period and zero otherwise. The models are estimated with random effects and clustered standard errors for organizations to take account the fact that observations may not be entirely independent.

In line with descriptive statistics, we find that IT users solved more problems than non-users (see dummy *IT users* in columns 1, 2 and 5). We observe that the coefficient is higher on ITs treatments. Indeed, IT users solved more than one problem on average (1.14) compared to non-users in ITs treatments (0.45) as well as in all treatments (0.53). These differences between users and non-users are statistically significant in ITs treatments ($z = -2.83$, $p = 0.005$) and in all treatments ($z = -2.68$, $p = 0.007$). These results are consistent with the finding of Chen et al. (2013) which showed that people who use a search technology are more efficient than non-users. We also observe that costs of using IT are positively related to solving problems; the more agents used IT the more they solved problems. We also find that CT users solved fewer problems than non-users (see dummy *CT users* in columns 3, 4 and 5). The coefficient is higher on CTs treatments and costs generated by CT use have a positive relationship with the number of problems solved.

These results are in line with our hypothesis 1 related to solving problems and support predictions of the theoretical model of knowledge hierarchy. Agents are more productive when using Information technologies (Garicano, 2000; Garicano and Rossi-Hansberg, 2006; Bloom et al., 2014). We also observe a positive trend in problems solved regardless

regressions; this is consistent with learning effects (Charness and Campbell, 1988). We observe that the relationship between problems solved and the variable *Ability* is positive but only significant on ITs treatments.

Table I. 4: Linear panel regression assessing the impact of IT and CT use by agents for solving problems

	Number of problems solved				
	ITs treatments	All treatments	CTs treatments	All treatments	All treatments
	(1)	(2)	(3)	(4)	(5)
Using IT	0.53*** (0.13)	0.29** (0.14)			0.30** (0.14)
Using CT			-0.50*** (0.12)	-0.40*** (0.11)	-0.41*** (0.10)
Costs	0.04*** (0.00)	0.04*** (0.01)	0.05*** (0.01)	0.05*** (0.01)	0.04*** (0.00)
<i>Working_time</i>	-0.00 (0.00)	0.00 (0.00)	-0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
Trend	0.06** (0.03)	0.07*** (0.02)	0.07** (0.03)	0.07*** (0.02)	0.07*** (0.02)
<i>Ability</i>	0.07*** (0.02)	0.02 (0.02)	0.02 (0.03)	0.02 (0.02)	0.02 (0.02)
Male dummy	0.06 (0.12)	0.16 (0.10)	0.30** (0.14)	0.18* (0.11)	0.17 (0.12)
Constant	-0.38 (0.28)	-0.21 (0.24)	0.19 (0.30)	0.02 (0.28)	0.04 (0.28)
Observations	210	405	180	405	405
Number of agents	42	81	36	81	81
Number of teams	14	27	12	27	27
R ² overall	0.424	0.219	0.311	0.218	0.219
Model test chi2	234.23***	135.96***	197.47***	173.11***	177.06***

Notes: Estimation output using robust standard errors clustered at the team level (in parentheses).
Coefficients * significant at 10%; ** significant at 5%; *** significant at 1%

We summarize our findings regarding the effect of IT and CT use on agents' problems solving as follows:

Result 1: i) IT users solve more problems than non-users. ii) CT use reduces the number of problems solved by agents.

I5.2.2. Agents' production

In Table I.4, we report results regarding agents' production. The first two columns are related to IT users and the following two columns to Communication technologies use while the last column encompasses both technologies users.

Table I. 5: Linear panel regression assessing the use of IT and CT on agents' production.

	Agents' production				
	ITs treatments	All treatments	CTs treatments	All treatments	All treatments
	(1)	(2)	(3)	(4)	(5)
Using IT	101.76*** (9.13)	89.25*** (12.85)			88.24*** (12.10)
Using CT			-40.04* (21.41)	-33.18* (18.58)	-26.25* (15.14)
<i>Working_time</i>	-0.09 (0.14)	0.02 (0.08)	-0.04 (0.12)	-0.02 (0.11)	-0.02 (0.09)
Trend	3.09 (2.32)	2.31 (2.08)	4.03 (3.67)	4.31* (2.38)	2.61 (2.09)
<i>Ability</i>	6.07*** (1.60)	2.59 (1.75)	3.42** (1.71)	1.94 (1.65)	2.30 (1.70)
Male dummy	-3.82 (9.34)	7.79 (8.24)	26.91** (10.98)	12.91 (9.40)	8.72 (8.59)
Constant	38.44 (42.67)	45.40* (25.82)	67.35* (38.92)	66.34* (35.74)	61.61** (29.38)
Observations	210	405	180	405	405
Number of agents	42	81	36	81	81
Number of teams	14	27	12	27	27
R ² overall	0.270	0.122	0.095	0.035	0.122
Model test chi2	269.16***	123.63***	24.82***	18.00***	176.18***

Notes: Estimation output using robust standard errors clustered at the team level (in parentheses).
Coefficients * significant at 10%; ** significant at 5%; *** significant at 1%

These results are consistent with our hypotheses 2i and 2ii. We find that IT users were more productive compared to non-users (see dummy *IT users* in columns 1, 2 and 5). The production of IT users was 66.66 % higher compared to non-users in ITs treatments ($z = -2.67, p = 0.01$) and 49.72 % higher compared to non-users in all treatments ($z = -2.54, p = 0.01$). As expected, CT users were less productive than non-users in CTs treatments and in all treatments (see dummy *IT users* in columns 3, 4 and 5). The production of CT users was equal to 90 cents on average compared to 98.10 cents and 91.15 cents for non-users in CTs treatments and all treatments respectively. The R^2 is very low showing that models related to CT users do not well explain agents' production. The trend variable reveals that agents were significantly more productive over time but the result is only significant when we compare CT users and non-users in all treatments. The variable *Ability* is positively related to the production regardless the kind of technologies used. However, the result is only significant on ITs and CTs treatments. Results reported in column (5) confirm previous findings; IT users are more productive and CT users are less productive than technologies non-users.

To compare team production between technologies users and non-users, we create dummy variables *IT team* and *CT team* that take value one if agents used IT or CT respectively in a team and zero otherwise. Consistent with our hypothesis 2iii, teams with IT users were more productive than teams with no IT users and teams with CT users produced less compared to teams without CT users (see dummy variables of Table I.9 in appendix I). The production of teams with IT users was equal to € 4.63 on average compared to € 3 ($z = -1.94, p = 0.05$) and € 3.59 ($z = -1.89, p = 0.06$) for teams without IT users in ITs treatments and all treatments respectively. We observe the opposite relation regarding CT users; teams' production with CTs users was 15.98% lower compared to the production of teams without CTs users in CTs treatments. However, teams' production with CTs users was 5.84% higher when we compare CT use in all treatments; these results are not statistically significant. We observe a positive trend in teams' production.

Result 2: i) IT users are more productive than non-users. ii) Agents using Communication technologies produce less than non-users. iii) Team production is higher with IT users and lower with CT users.

I5.2.3. Preference between technologies and principal's activities

In line with our hypothesis 3i, agents in *ICT treatment* used less Communication technologies than agents in *CT treatment* (see dummy *ICT treatment* on Table I.10 in appendix I). Indeed, when both IT and CT were available, agents preferred using Information technologies to solve problems. Moreover, in the *ICT treatment*, agents did not request for help to solve problems after the practice period. We suggest that agents prefer to be autonomous than to be assisted.

Table I. 6: Linear panel regression for the time devoted to work by principals

	Production		<i>Working_time</i>	
	CTs treatments	All treatments	CTs treatments	All treatments
	(1)	(2)	(3)	(4)
<i>Working_time</i>	0.28* (0.15)	0.16* (0.09)		
<i>Being solicited</i>	-34.64 (33.79)	-38.22* (22.41)	-156.24** (21.47)	-148.64*** (23.98)
Trend	31.38** (13.41)	20.28*** (6.11)	19.016** (9.67)	11.18** (4.85)
<i>Ability</i>	7.66 (5.48)	3.45 (3.40)	2.56 (2.05)	2.56 (2.40)
Male dummy	98.71** (40.64)	80.47* (45.50)	5.39 (14.25)	18.17 (12.14)
Constant	-111.86** (49.95)	-42.28 (40.88)	270.089*** (40.21)	285.38*** (31.80)
Observations	60	135	60	135
Number of principals	12	27	12	27
Number of teams	12	27	12	27
R2 overall	0.453	0.220	0.563	0.371
Model test chi2	290.23***	32.96***	283.79***	146.87***

Notes: Estimation output using robust standard errors clustered at the team level (in parentheses).

Coefficients * significant at 10%; ** significant at 5%; *** significant at 1%.

Table I.5 presents results for regressions that we performed to test our hypothesis 3ii, we looked at the principal's behavior regarding the working activity. The variable *Being solicited* refers to principals which were solicited by agents through Communication technologies. The first two columns are related to principals' production while the last two columns concern the time dedicated to work. We can see that principals produced less when they were solicited to

solve problems through Communication technologies (see dummy *Being solicited* in columns 1, 2). However, the coefficient is higher and significant when we compare principals in all treatments only. This finding is in line with our hypothesis 3ii. We observe that the time dedicated to work is positively and significantly related to the production in CTs and all treatments. The trend variable reveals that principals were significantly more productive over time.

The time dedicated to work could explain why principals who were solicited to solve problems were less productive. Indeed, the time spent by those principals to sum up tables was lower compared to the time spent by those who were not solicited. On average, this time was 30.08% lower ($z = 2.88$, $p = 0.004$ in CTs treatments) and 27.35% lower ($z = 3.09$, $p = 0.002$ in all treatments) for principals in teams with CT users compared to principals in teams with no CT users. As expected, if principals devote a large proportion of time to help agents, they will have less time to work. This result is consistent with the substitution effect (Di Maggio and Van Alstyne, 2013). We observe a positive trend in time spent to work.

We summarize our findings regarding the effects on the principal's activities as follows:

Result 3 Agents use less CT when Information technologies are available. ii) The production of principals is lower when they are solicited to solve problems compared to those who are not solicited.

Table I.6 summarizes our main results regarding the investigation on ICT effects at the workplace.

Table I. 7: Main effects of IT and CT

	Problems solved	Requesting help	Agents' production	Principal's production	Team production
IT	+ ⁸	Not significant	+	Not tested	+
CT	-	+	-	-	-

⁸ Symbols + and – refer to observed effects of technologies on CT and IT users compared to non-users.

I.6. Conclusion

In this first chapter, we aimed to investigate the effects of Information and Communication Technologies use on workers' performance. The implementation of ICT at workplace has reshaped the way employees perform their work. Changes generated by the diffusion of ICT impacted workers' productivity but there is a lack of studies which investigate ICT use effects at the level of workforce. The combination of technologies and required organizational changes may lead to an increase of workers' performance. Hence, firms should reap more benefits of ICT use. Our first contribution was to test the theory of hierarchical organization of decision making developed by Bloom et al. (2014). Their model distinguishes Information Technologies (IT) from Communication Technologies (CT). This theory enabled us to take into account different aspects of technologies since evidence shows that its introduction in the workplace may have counterproductive effects on workers' performance.

Our experimental design consisted in four treatments: the baseline treatment with no technologies, IT and CT treatments with Information or Communication technologies respectively. Our second contribution to the literature was to design a treatment (the fourth one) in which IT and CT were available for workers since both information and communication systems are incorporated in some technology devices. Our findings support theoretical predictions of the model relied on the "knowledge hierarchy" theory of Garicano (2000). Information technologies users are more productive and solve more problems than non-users. CT users are less productive and solve fewer problems than workers who do not use Communication technologies. We also found that workers prefer to use Information technologies rather than Communication technologies. Indeed when they had the choice between both types of technologies, none of them chose Communication technologies in the fourth treatment. The use of Communication technologies is also detrimental for principals because they spend more time to help agents.

Our work brings into managerial attention the opposite effects of ICT use on workers' performance. Indeed, ICT play a key role in the management of organizations and may not always lead to an increase of workers' performance. Indeed, Communication technologies may have negative effects on workers' autonomy and team leaders' production. This could be detrimental on the firm efficiency. Information technologies give more autonomy to workers. So, managers must ensure that employees have required skills and knowledge to make right decisions that should positively impact the firm performance. The distinction between

Information technologies and Communication technologies is crucial for the decision making in the firm. In other words the allocation of decision making in the firm may depend in part on the kind of technologies used in the firm. For example, the use of Information technologies should be combined with a decentralized organization in order to derive full potential of technologies and to avoid counterproductive behaviors. Managers should also consider the preference of workers for Information technologies and autonomy. That may curtail organizational costs due to technological changes.

Our experimental design did not allow us to test all aspects of Communication technologies in the firm. Indeed, the decrease of Communication costs in the firm may also lead to an increase of information sharing between workers for solving problems. This horizontal communication may enable workers to use more communication technologies by relying less on managers which may spend more time to their own work. Another limit of our work is that our experimental design could have been simpler. One PDF file could have been enough to implement Information technologies. Further researches could focus on other payment schemes. Workers' preference between Information technologies and Communication technologies may differ in a competitive payment system. Also, studies on Communication technologies effects on workers' cooperation may be worthwhile. Since the selfish behavior may lead workers to maximize their profit, is it costless for the firm to give them more autonomy?

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Appendix I

Table I. 8: Average agents' production in cents and (number of problems solved)

Production (problems solved)	Number of agents	Average	Standard deviation
Baseline	24	96.67 (0.57)	5.23 (0.06)
IT treatment	21	75.24 (0.4)	5.57 (0.06)
CT treatment	15	93 (0.65)	7.69 (0.09)
ICT treatment	21	99.05 (0.72)	6.82 (0.08)

Table I. 9: Linear panel regression for the impact of IT and CT use on teams' production

	Team production
<i>IT team</i>	127.35*** (49.30)
<i>CT team</i>	-93.86*** (28.39)
<i>Working_time</i>	0.18 (0.13)
<i>Ability</i>	-4.62 (6.01)
Trend	29.85*** (8.63)
Constant	270.08*** (74.34)
Observations	540
Number of participants	108
Number of teams	27
R2 overall	0.225
Model test chi2	36.80***

Notes: Estimation output using robust standard errors clustered at the team level (in parentheses). Coefficients * significant at 10%; ** significant at 5%; *** significant at 1%.

Table I. 10: Linear panel regression assessing the preference of agents between IT and CT

	Receiving problem to solve
ICT treatment	-0.20*** (0.03)
Costs	-0.00 (0.00)
Trend	0.02 (0.02)
<i>Ability</i>	0.00 (0.01)
Male dummy	0.06 (0.04)
Constant	0.10* (0.06)
Observations	180
Number of principals	36
Number of teams	12
R2 overall	0.138
Model test chi2	96.08***

Notes: Estimation output using robust standard errors clustered at the team level (in parentheses). Coefficients * significant at 10%; ** significant at 5%; *** significant at 1%.

Instructions – Baseline

You have exactly 10 minutes to go through the instructions. You will have enough time to read the instructions carefully.

You are going to participate in an experiment about decision making. You will be paid in cash for your participation at the end of the experiment. Different participants may earn different amounts. What you earn depends on your decisions and the decisions of others. Please note that during the experiment communication is not allowed. If you have questions, please raise your hand and a monitor will come by to answer your question. If any difficulties arise after the experiment has begun, raise your hand, and someone will assist you.

This experiment involves a team of 4 members and consists of 5 periods of 7 minutes each. There are *two* types of team members referred to as subject *B* and subject *C*. 3 members will be subjects *B* and *one* will be subject *C*. You will learn the type of subject you are when the experiment starts. Your individual earnings at the end of the experiment are computed as the sum of your earnings in the 5 periods.

In each period of this experiment both subjects *B* and subject *C* will be able to sum up numbers in a table (work task). Subject *C* will have access to another activity that consists in monitoring other team members. To switch from one activity to another you just have to click on the corresponding option of the action menu displayed on your screen. The activities are referred to as *Task* (sum up numbers in a table) and *Watch* (monitor subjects *B* contributions – only available to *C*). Each activity is undertaken separately, in a different screen.

Your experiment ID will be displayed on the top left corner of your screen once the experiment starts. It will consist of the letter *B* followed by a number if you are of type *B*. If you are the subject *C* your ID will be *C11*. The experiment will start by a practice period.

Task – summing up numbers

The task consists in summing up 25 numbers in a table with 5 rows and 5 columns. Each team member is given a different set of tables with the same level of difficulty. Before providing your final answer (the total sum of all numbers in the table) you have to fill in the 5 cells that correspond to the sums of the 5 columns. Filling in these 5 cells does not directly generate earnings but it can help you to compute the final sum. Only after filling in all these cells you will be allowed to provide a final answer (the total sum) in the box located below the table on the left. Notice that **you are not allowed** to use a calculator or any other electronic, computer-based or internet-based devices to sum up numbers.

If you do, you will be excluded and you will not be paid.

There are 2 types of tables: Itables and Dtables. Itables are tables with integers only and Dtables are tables with decimal numbers. Only the final answer (total sum of the table) is rewarded. Intermediate sums of all columns are required but are not rewarded.

Each time you answer the task correctly (your final sum is correct) you generate 50 cents of *Total production*. This 50 cents is not directly added to your individual earnings. Subject *C*

always gets 40% of *Total production* while each subject *B* gets 20% of the total profit contributed by all members undertaking the task.

- If you sum up the numbers of a table correctly then each subject in the experiment (including yourself) gets 50 cents times the *percentage* of *Total production* that he or she is assigned.
 - 20 cents ($40\% \times 50$) if you are subject *C*
 - 10 cents ($20\% \times 50$) if you are subject *B*
- If you answer the task incorrectly you generate a penalty of 25 cents that is subtracted from *Total production*. So when you answer incorrectly your individual earnings decrease by:
 - 10 cents ($40\% \times 25$) if you are subject *C*
 - 5 cents ($20\% \times 25$) if you are subject *B*
- **EXAMPLE:** In the first period you provided 7 correct answers completing the task while providing 3 incorrect answers. Also, the other three team members in the experiment provided a total of 24 correct answers in the task while providing 5 incorrect answers.

Your *earnings* (“**My Period Earnings**”) for that period are equal to:

- *Earnings*: $40\% \times (31 \times 50 - 8 \times 25) = \mathbf{540}$ cents if you are subject *C*
- *Earnings*: $20\% \times (31 \times 50 - 8 \times 25) = \mathbf{270}$ cents if you are subject *B*

The amount of money you generate by undertaking the task is displayed in the second column “**My Production**” of the history table at the bottom of the screen. The total amount of money generated by all 4 members (subject *C* + 3 subjects *B*) on the task is displayed in the sixth column “**Total Production**” of the history table at the bottom of the screen.

Monitoring: only for subject *C*

If and only if you are subject *C*, you can monitor the contribution of the three subjects *B* at any time during this experiment. You can do so by clicking on the *Watch* option in the action menu. You will be faced with a monitoring screen with 3 columns, each of them corresponding to one of the subjects *B* in the experiment. The head of each column indicates the experiment ID of the subject. You can monitor or stop monitoring all *B* subjects’ contributions at the same time by clicking on the buttons displayed in the top right corner of the screen.

To stop monitoring a given subject you have to click on the corresponding column header. You will be informed in real time of the production and contribution to Total production (in % terms) of the selected subject *B*.

Instructions – IT treatment

You have exactly 10 minutes to go through the instructions. You will have enough time to read the instructions carefully.

You are going to participate in an experiment about decision making. You will be paid in cash for your participation at the end of the experiment. Different participants may earn different amounts. What you earn depends on your decisions and the decisions of others. Please note that during the experiment communication is not allowed. If you have questions, please raise your hand and a monitor will come by to answer your question. If any difficulties arise after the experiment has begun, raise your hand, and someone will assist you.

This experiment involves a team of 4 members and consists of 5 periods of 7 minutes each. There are *two* types of team members referred to as subject *B* and subject *C*. 3 members will be subjects *B* and *one* will be subject *C*. You will learn the type of subject you are when the experiment starts. Your individual earnings at the end of the experiment are computed as the sum of your earnings in the 5 periods.

In each period of this experiment both subjects *B* and subject *C* will be able to sum up numbers in a table (work task). Subject *C* will have access to another activity that consists in monitoring other team members. To switch from one activity to another you just have to click on the corresponding option of the action menu displayed on your screen. The activities are referred to as *Task* (sum up numbers in a table) and *Watch* (monitor subjects *B* contributions – only available to *C*). Each activity is undertaken separately, in a different screen.

Your experiment ID will be displayed on the top left corner of your screen once the experiment starts. It will consist of the letter *B* followed by a number if you are of type *B*. If you are the subject *C* your ID will be *C11*. The experiment will start by a practice period.

Task – summing up numbers

The task consists in summing up 25 numbers in a table with 5 rows and 5 columns. Each team member is given a different set of tables with the same level of difficulty. Before providing your final answer (the total sum of all numbers in the table) you have to fill in the 5 cells that correspond to the sums of the 5 columns. Filling in these 5 cells does not directly generate earnings but it can help you to compute the final sum. Only after filling in all these cells you will be allowed to provide a final answer (the total sum) in the box located below the table on the left. Notice that **you are not allowed** to use a calculator or any other electronic, computer-based or internet-based devices to sum up numbers but, you will be able to look up some solutions in 2 PDF files if you want to provide quickly the final sum of tables.

If you do, you will be excluded and you will not be paid.

There are 2 types of tables: Itables and Dtables. Itables are tables with integers only and Dtables are tables with decimal numbers. Only the final answer (total sum of the table) is rewarded. Intermediate sums of all columns are required but are not rewarded.

Each time you answer the task correctly (your final sum is correct) you generate 50 cents of *Total production*. This 50 cents is not directly added to your individual earnings. Subject *C*

always gets 40% of *Total production* while each subject *B* gets 20% of the total profit contributed by all members undertaking the task.

- If you sum up the numbers of a table correctly then each subject in the experiment (including yourself) gets 50 cents times the *percentage of Total production* that he or she is assigned.
 - 20 cents ($40\% \times 50$) if you are subject *C*
 - 10 cents ($20\% \times 50$) if you are subject *B*
- If you answer the task incorrectly you generate a penalty of 25 cents that is subtracted from *Total production*. So when you answer incorrectly your individual earnings decrease by:
 - 10 cents ($40\% \times 25$) if you are subject *C*
 - 5 cents ($20\% \times 25$) if you are subject *B*
- **EXAMPLE:** In the first period you provided 7 correct answers completing the task while providing 3 incorrect answers. Also, the other three team members in the experiment provided a total of 24 correct answers in the task while providing 5 incorrect answers.

Your *earnings* (“**My Period Earnings**”) for that period are equal to:

- *Earnings*: $40\% \times (31 \times 50 - 8 \times 25) = \mathbf{540}$ cents if you are subject *C*
- *Earnings*: $20\% \times (31 \times 50 - 8 \times 25) = \mathbf{270}$ cents if you are subject *B*

The amount of money you generate by undertaking the task is displayed in the second column “**My Production**” of the history table at the bottom of the screen. The total amount of money generated by all 4 members (subject *C* + 3 subjects *B*) on the task is displayed in the sixth column “**Total Production**” of the history table at the bottom of the screen.

Task – Dtables’ solutions

To solve tables with decimal numbers which are more difficult to sum up mentally, you can look up Dtables’ solutions in one or both PDF files available on your computer’s desktop. Looking up in PDF files will entail some costs that will be directly subtracted from your individual earnings at the end of the experiment. Each Dtable gets a number in the first cell (first row, first column) that you will need to look up the solution quickly. Note that PDF files contain the solutions for Dtables only. There are 2 types of PDF files:

- PDF1 with solutions which are answers of 5 cells that correspond to the sum of the 5 columns. Access to PDF1 costs 10 cents for solutions used for each table.
- PDF2 with solutions which are answers of 5 cells that correspond to the sum of the 5 columns plus the final sum. Access to PDF1 costs 20 cents for solutions used for each table.

Task – PDF files

To quickly solve the Dtables, you will be able to look up the solutions in 2 PDF files referred to as PDF1 and PDF2 on the desktop of the computer terminals at which you are seated. The PDF1 only gets the 5 columns solutions while the PDF2 gets the 5 columns solutions plus the final sum. On each PDF file, tables are laid horizontally, each line is a table, the system first goes from left to right then top to bottom, that means the first 5 numbers corresponding to the first row of the table, the 5 following numbers corresponding to the second row consecutively. The sum of the 5 columns and the final sum will be the 5 or 6 last numbers in cells at the end of each according the PDF file you will use. Several Dtables could have the same table's number, you will need to check the first row of the table to be sure that you are reading the right Dtable before to copy answers. Remember that the first five numbers of a line corresponds to the table's number plus the 4 numbers of the first row of the table.

Subject *C* will get different PDF files, the table's number will be directly follow by the sum of tables (PDF1) plus the final answer (PDF2), he won't need to check row of the table.

At the end of the experiment, a questionnaire will be given to you to report how many times you solved a Dtable by looking up or asking for a solution from each PDF file. During the experiment, you will have to use the numbered pieces of paper that you will received for helping you to remember how many times you looked up or asked for a solution and which PDF file was needful for each period. You will have to cut the part of the piece of paper corresponding to number of times you resorted to a PDF file for solving the Dtables at the end of each period.

Monitoring: only for subject *C*

If and only if you are subject *C*, you can monitor the contribution of the three subjects *B* at any time during this experiment. You can do so by clicking on the *Watch* option in the action menu. You will be faced with a monitoring screen with 3 columns, each of them corresponding to one of the subjects *B* in the experiment. The head of each column indicates the experiment ID of the subject. You can monitor or stop monitoring all *B* subjects' contributions at the same time by clicking on the buttons displayed in the top right corner of the screen.

To stop monitoring a given subject you have to click on the corresponding column header. You will be informed in real time of the production and contribution to Total production (in % terms) of the selected subject *B*.

Instructions – CT treatment

You have exactly 10 minutes to go through the instructions. You will have enough time to read the instructions carefully.

You are going to participate in an experiment about decision making. You will be paid in cash for your participation at the end of the experiment. Different participants may earn different amounts. What you earn depends on your decisions and the decisions of others. Please note that during the experiment communication is not allowed outside the software. If you have questions, please raise your hand and a monitor will come by to answer your question. If any difficulties arise after the experiment has begun, raise your hand, and someone will assist you

This experiment involves a team of 4 members and consists of 5 periods of 7 minutes each. There are *two* types of team members referred to as subject *B* and subject *C*. 3 members will be subjects *B* and *one* will be subject *C*. You will learn the type of subject you are when the experiment starts. Your individual earnings at the end of the experiment are computed as the sum of your earnings in the 5 periods.

In each period of this experiment both subjects *B* and subject *C* will be able to sum up numbers in a table (work task) or chat with subject *C* in the experiment. Subject *C* will have access to another activity that consists in monitoring other team members. To switch from one activity to another you just have to click on the corresponding option of the action menu displayed on your screen. The activities are referred to as *Task* (sum up numbers in a table), *Chat* (send/receive messages to/from Subject *C* in the experiment) and *Watch* (monitor subjects *B* contributions – only available to *C*). Each activity is undertaken separately, in a different screen.

Your experiment ID will be displayed on the top left corner of your screen once the experiment starts. It will consist of the letter *B* followed by a number if you are of type *B*. If you are the subject *C* your ID will be *C11*. The experiment will start by a practice period.

Task – summing up numbers

The task consists in summing up 25 numbers in a table with 5 rows and 5 columns. Each team member is given a different set of tables with the same level of difficulty. Before providing your final answer (the total sum of all numbers in the table) you have to fill in the 5 cells that correspond to the sums of the 5 columns. Filling in these 5 cells does not directly generate earnings but it can help you to compute the final sum. Only after filling in all these cells you will be allowed to provide a final answer (the total sum) in the box located below the table on the left. Notice that **you are not allowed** to use a calculator or any other electronic, computer-based or internet-based devices to sum up numbers.

If you do, you will be excluded and you will not be paid.

There are 2 types of tables: Itables and Dtables. Itables are tables with integers only and Dtables are tables with decimal numbers. Only the final answer (total sum of the table) is rewarded. Intermediate sums of all columns are required but are not rewarded.

Each time you answer the task correctly (your final sum is correct) you generate *50 cents* of *Total production*. This *50 cents* is not directly added to your individual earnings. Subject *C* always gets 40% of *Total production* while each subject *B* gets 20% of the total profit contributed by all members undertaking the task.

- If you sum up the numbers of a table correctly then each subject in the experiment (including yourself) gets *50 cents* times the *percentage* of *Total production* that he or she is assigned.
 - *20 cents* ($40\% \times 50$) if you are subject *C*
 - *10 cents* ($20\% \times 50$) if you are subject *B*
- If you answer the task incorrectly you generate a penalty of *25 cents* that is subtracted from *Total production*. So when you answer incorrectly your individual earnings decrease by:
 - *10 cents* ($40\% \times 25$) if you are subject *C*
 - *5 cents* ($20\% \times 25$) if you are subject *B*
- **EXAMPLE:** In the first period you provided 7 correct answers completing the task while providing 3 incorrect answers. Also, the other three team members in the experiment provided a total of 24 correct answers in the task while providing 5 incorrect answers.

Your *earnings* (“**My Period Earnings**”) for that period are equal to:

- *Earnings:* $40\% \times (31 \times 50 - 8 \times 25) = \mathbf{540 \text{ cents}}$ if you are subject *C*
- *Earnings:* $20\% \times (31 \times 50 - 8 \times 25) = \mathbf{270 \text{ cents}}$ if you are subject *B*

The amount of money you generate by undertaking the task is displayed in the second column “**My Production**” of the history table at the bottom of the screen. The total amount of money generated by all 4 members (subject *C* + 3 subjects *B*) on the task is displayed in the sixth column “**Total Production**” of the history table at the bottom of the screen.

Task – Dtables’ solutions

To solve tables with decimal numbers which are more difficult to sum up mentally, you can ask for help to subject *C* who will receive 2 PDF files with Dtables’ solutions. Asking for help to subject *C* will entail some costs that will be directly subtracted from your individual earnings at the end of the experiment. Each Dtable gets a number in the first cell (first row, first column) that you will need to request for solutions quickly. Note that PDF files contain the solutions for Dtables only. There are 2 types of PDF files:

- PDF1 with solutions which are answers of 5 cells that correspond to the sum of the 5 columns. Access to PDF1 costs *10 cents* for solutions used for each table.
- PDF2 with solutions which are answers of 5 cells that correspond to the sum of the 5 columns plus the final sum. Access to PDF1 costs *20 cents* for solutions used for each table.

Chat

If you are members *B*, you can ask for help subject *C* to provide the final sum. To do so, you have access to a chat room through which you can communicate with him in the experiment. You can access chat by clicking on the *Chat* option in the action menu.

You can send and receive messages to and from subject *C*. To send a message, you have to select first the members you want to send the message to and then click on the button *send message*. Each time you will have to rely on subject *C* to ask for help, you have to specify the table's number and the PDF file (PDF1 or PDF2) that you request the solution for to facilitate the communication and to get easily and quickly the solution that you will need.

Each time you receive a message but you are not currently on the chat screen a pop-up window will warn you about the message. You are free to discuss any and all aspects of the experiment, with the following exceptions: you may not reveal your name, discuss side payments outside the laboratory, or engage in inappropriate language (including such shorthand as 'WTF'). If you do, you will be excluded and you will not be paid.

At the end of the experiment, a questionnaire will be given to you to report how many times you solved a Dtable by looking up (subject *C*) or asking for (subject *B*) a solution from each PDF file. During the experiment, you will have to use the numbered pieces of paper that you will received for helping you to remember how many times you looked up or asked for a solution and which PDF file was needful for each period. You will have to cut the part of the piece of paper corresponding to number of times you resorted to a PDF file for solving the Dtables at the end of each period.

Monitoring: only for subject *C*

If and only if you are subject *C*, you can monitor the contribution of the three subjects *B* at any time during this experiment. You can do so by clicking on the *Watch* option in the action menu. You will be faced with a monitoring screen with 3 columns, each of them corresponding to one of the subjects *B* in the experiment. The head of each column indicates the experiment ID of the subject. You can monitor or stop monitoring all *B* subjects' contributions at the same time by clicking on the buttons displayed in the top right corner of the screen.

To stop monitoring a given subject you have to click on the corresponding column header. You will be informed in real time of the production and contribution to Total production (in % terms) of the selected subject *B*.

Instructions – ICT treatment

You have exactly 10 minutes to go through the instructions. You will have enough time to read the instructions carefully.

You are going to participate in an experiment about decision making. You will be paid in cash for your participation at the end of the experiment. Different participants may earn different amounts. What you earn depends on your decisions and the decisions of others. Please note that during the experiment communication is not allowed outside the software. If you have questions, please raise your hand and a monitor will come by to answer your question. If any difficulties arise after the experiment has begun, raise your hand, and someone will assist you

This experiment involves a team of 4 members and consists of 5 periods of 7 minutes each. There are *two* types of team members referred to as subject *B* and subject *C*. 3 members will be subjects *B* and *one* will be subject *C*. You will learn the type of subject you are when the experiment starts. Your individual earnings at the end of the experiment are computed as the sum of your earnings in the 5 periods.

In each period of this experiment both subjects *B* and subject *C* will be able to sum up numbers in a table (work task) or chat with subject *C* in the experiment. Subject *C* will have access to another activity that consists in monitoring other team members. To switch from one activity to another you just have to click on the corresponding option of the action menu displayed on your screen. The activities are referred to as *Task* (sum up numbers in a table), *Chat* (send/receive messages to/from Subject *C* in the experiment) and *Watch* (monitor subjects *B* contributions – only available to *C*). Each activity is undertaken separately, in a different screen.

Your experiment ID will be displayed on the top left corner of your screen once the experiment starts. It will consist of the letter *B* followed by a number if you are of type *B*. If you are the subject *C* your ID will be *C11*. The experiment will start by a practice period.

Task – summing up numbers

The task consists in summing up 25 numbers in a table with 5 rows and 5 columns. Each team member is given a different set of tables with the same level of difficulty. Before providing your final answer (the total sum of all numbers in the table) you have to fill in the 5 cells that correspond to the sums of the 5 columns. Filling in these 5 cells does not directly generate earnings but it can help you to compute the final sum. Only after filling in all these cells you will be allowed to provide a final answer (the total sum) in the box located below the table on the left. Notice that **you are not allowed** to use a calculator or any other electronic, computer-based or internet-based devices to sum up numbers but, you will be able to look up some solutions in 2 PDF files if you want to provide quickly the final sum of tables.

If you do, you will be excluded and you will not be paid.

There are 2 types of tables: Itables and Dtables. Itables are tables with integers only and Dtables are tables with decimal numbers. Only the final answer (total sum of the table) is rewarded. Intermediate sums of all columns are required but are not rewarded.

Each time you answer the task correctly (your final sum is correct) you generate *50 cents* of *Total production*. This *50 cents* is not directly added to your individual earnings. Subject *C* always gets 40% of *Total production* while each subject *B* gets 20% of the total profit contributed by all members undertaking the task.

- If you sum up the numbers of a table correctly then each subject in the experiment (including yourself) gets *50 cents* times the *percentage* of *Total production* that he or she is assigned.
 - *20 cents* ($40\% \times 50$) if you are subject *C*
 - *10 cents* ($20\% \times 50$) if you are subject *B*
- If you answer the task incorrectly you generate a penalty of *25 cents* that is subtracted from *Total production*. So when you answer incorrectly your individual earnings decrease by:
 - *10 cents* ($40\% \times 25$) if you are subject *C*
 - *5 cents* ($20\% \times 25$) if you are subject *B*
- **EXAMPLE:** In the first period you provided 7 correct answers completing the task while providing 3 incorrect answers. Also, the other three team members in the experiment provided a total of 24 correct answers in the task while providing 5 incorrect answers.

Your *earnings* (“**My Period Earnings**”) for that period are equal to:

- *Earnings:* $40\% \times (31 \times 50 - 8 \times 25) = \mathbf{540 \text{ cents}}$ if you are subject *C*
- *Earnings:* $20\% \times (31 \times 50 - 8 \times 25) = \mathbf{270 \text{ cents}}$ if you are subject *B*

The amount of money you generate by undertaking the task is displayed in the second column “**My Production**” of the history table at the bottom of the screen. The total amount of money generated by all 4 members (subject *C* + 3 subjects *B*) on the task is displayed in the sixth column “**Total Production**” of the history table at the bottom of the screen.

Task – Dtables’ solutions

To solve tables with decimal numbers which are more difficult to sum up mentally, you can ask for help to subject *C* who will receive 2 PDF files with Dtables’ solutions or look up directly the solution in one or both PDF files available on your computer’s desktop. Asking for help to subject *C* or looking up in PDF files will entail some costs that will be directly subtracted from your individual earnings at the end of the experiment. Each Dtable gets a number in the first cell (first row, first column) that you will need to request for solutions quickly. Note that PDF files contain the solutions for Dtables only. There are 2 types of PDF files:

- PDF1 with solutions which are answers of 5 cells that correspond to the sum of the 5 columns. Access to PDF1 costs *10 cents* for solutions used for each table.

- PDF2 with solutions which are answers of 5 cells that correspond to the sum of the 5 columns plus the final sum. Access to PDF1 costs 20 cents for solutions used for each table.

Task – PDF files

To quickly solve the Dtables, you can ask for help to subject *C* or you can look up the solutions in 2 PDF files referred to as PDF1 and PDF2 on the desktop of the computer terminals at which you are seated. The PDF1 only gets the 5 columns solutions while the PDF2 gets the 5 columns solutions plus the final sum. On each PDF file, tables are laid horizontally, each line is a table, the system first goes from left to right then top to bottom, that means the first 5 numbers corresponding to the first row of the table, the 5 following numbers corresponding to the second row consecutively. The sum of the 5 columns and the final sum will be the 5 or 6 last numbers in cells at the end of each the line according the PDF file you will use. Several Dtables could have the same table's number, you will need to check the first row of the table to be sure that you are reading the right Dtable before to copy answers. Remember that the first five numbers of a line corresponds to the table's number plus the 4 numbers of the first row of the table.

Subject *C* will get different PDF files, the table's number will be directly follow by the sum of tables (PDF1) plus the final answer (PDF2), he won't need to check row of the table.

Chat

If you are members *B*, you can ask for help subject *C* to provide the final sum. To do so, you have access to a chat room through which you can communicate with him in the experiment. You can access chat by clicking on the *Chat* option in the action menu.

You can send and receive messages to and from subject *C*. To send a message, you have to select first the members you want to send the message to and then click on the button *send message*. Each time you will have to rely on subject *C* to ask for help, you have to specify the table's number and the PDF file (PDF1 or PDF2) that you request the solution for to facilitate the communication and to get easily and quickly the solution that you will need.

Each time you receive a message but you are not currently on the chat screen a pop-up window will warn you about the message. You are free to discuss any and all aspects of the experiment, with the following exceptions: you may not reveal your name, discuss side payments outside the laboratory, or engage in inappropriate language (including such shorthand as 'WTF'). If you do, you will be excluded and you will not be paid.

At the end of the experiment, a questionnaire will be given to you to report how many times you solved a Dtable by looking up or asking for (subject *B*) a solution from each PDF file. During the experiment, you will have to use the numbered pieces of paper that you will received for helping you to remember how many times you looked up or asked for a solution and which PDF file was needful for each period. You will have to cut the part of the piece of paper corresponding to number of times you resorted to a PDF file for solving the Dtables at the end of each period.

Monitoring: only for subject C

If and only if you are subject *C*, you can monitor the contribution of the three subjects *B* at any time during this experiment. You can do so by clicking on the *Watch* option in the action menu. You will be faced with a monitoring screen with 3 columns, each of them corresponding to one of the subjects *B* in the experiment. The head of each column indicates the experiment ID of the subject. You can monitor or stop monitoring all *B* subjects' contributions at the same time by clicking on the buttons displayed in the top right corner of the screen.

To stop monitoring a given subject you have to click on the corresponding column header. You will be informed in real time of the production and contribution to Total production (in % terms) of the selected subject *B*.

PDF 1-principal

Remember that access to this file costs 10 cents for solutions used for each table. At the end of the experiment, a questionnaire will be given to you to report how many times you solved a Dtable by looking up a solution from this PDF file.

Table's number	Sum of the 5 columns				
	C 1	C 2	C 3	C 4	C 5
10	20.75	5.8	12.5	9.7	14.2
11	14.45	6.65	8.6	13.1	10.3
12	18.25	13.1	12.25	6.9	9.2
13	24	13.1	8.35	9.45	13.1
14	20	15.05	9.45	4.95	4.95
15	22.1	15.3	11.4	11.15	6.65
16	23.95	8.35	7.5	6.9	10.3
17	26.9	8.35	8.6	7.75	6.65
18	25.95	6.65	12.25	10.55	5.8
19	26.95	13.1	7.75	10.05	6.65
20	29.9	10.05	12.25	11.4	10.55
21	34.8	6.9	6.65	8.85	8.35
22	28.25	10.55	8.85	13.35	9.7
23	34.85	8.6	9.2	6.9	12.25
24	34.75	9.45	9.2	11.15	8.6
25	33.8	9.7	6.9	10.05	10.3
26	35.9	9.2	15.3	10.3	10.3
27	36.9	9.7	8.6	7.5	8.6
28	34	10.3	6.65	12.85	4.95
29	39.75	10.05	9.45	9.45	9.2
30	36	13.95	6.65	10.55	7.75
31	39.8	14.2	10.55	10.3	8.6
32	38	7.5	13.1	11.4	10.3
33	43.75	5.8	14.2	12.25	7.75
34	39.15	9.45	13.1	9.2	8.6
35	45.75	6.65	9.45	12	13.1
36	44.8	12.25	15.05	13.35	8.6
37	45.2	10.3	9.45	7.75	11.15
38	45.1	4.95	9.7	12.25	5.8
39	48.65	10.55	7.75	13.35	12
40	49.9	8.6	10.55	7.5	9.45
41	50.65	13.35	15.05	11.4	10.3
42	50.8	10.55	7.5	10.3	8.6
43	48.15	9.2	8.6	10.55	11.4
44	53.05	6.65	11.15	4.1	10.9
45	54.9	12.25	10.3	9.2	11.15
46	56.75	16.15	9.45	11.15	10.3
47	54.1	7.75	7.5	10.55	10.3
48	56.8	13.95	13.35	9.45	11.4
49	55.25	13.95	10.55	6.65	12.25

PDF 2-principal

Remember that access to this file costs 20 cents for solutions used for each table. At the end of the experiment, a questionnaire will be given to you to report how many times you solved a Dtable by looking up a solution from this PDF file.

Table's number	Sum of the 5 columns					Final sum
	C 1	C 2	C 3	C 4	C 5	
10	20.75	5.8	12.5	9.7	14.2	62.95
11	14.45	6.65	8.6	13.1	10.3	53.1
12	18.25	13.1	12.25	6.9	9.2	59.7
13	24	13.1	8.35	9.45	13.1	68
14	20	15.05	9.45	4.95	4.95	54.4
15	22.1	15.3	11.4	11.15	6.65	66.6
16	23.95	8.35	7.5	6.9	10.3	57
17	26.9	8.35	8.6	7.75	6.65	58.25
18	25.95	6.65	12.25	10.55	5.8	61.2
19	26.95	13.1	7.75	10.05	6.65	64.5
20	29.9	10.05	12.25	11.4	10.55	74.15
21	34.8	6.9	6.65	8.85	8.35	65.55
22	28.25	10.55	8.85	13.35	9.7	70.7
23	34.85	8.6	9.2	6.9	12.25	71.8
24	34.75	9.45	9.2	11.15	8.6	73.15
25	33.8	9.7	6.9	10.05	10.3	70.75
26	35.9	9.2	15.3	10.3	10.3	81
27	36.9	9.7	8.6	7.5	8.6	71.3
28	34	10.3	6.65	12.85	4.95	68.75
29	39.75	10.05	9.45	9.45	9.2	77.9
30	36	13.95	6.65	10.55	7.75	74.9
31	39.8	14.2	10.55	10.3	8.6	83.45
32	38	7.5	13.1	11.4	10.3	80.3
33	43.75	5.8	14.2	12.25	7.75	83.75
34	39.15	9.45	13.1	9.2	8.6	79.5
35	45.75	6.65	9.45	12	13.1	86.95
36	44.8	12.25	15.05	13.35	8.6	94.05
37	45.2	10.3	9.45	7.75	11.15	83.85
38	45.1	4.95	9.7	12.25	5.8	77.8
39	48.65	10.55	7.75	13.35	12	92.3
40	49.9	8.6	10.55	7.5	9.45	86
41	50.65	13.35	15.05	11.4	10.3	100.75
42	50.8	10.55	7.5	10.3	8.6	87.75
43	48.15	9.2	8.6	10.55	11.4	87.9
44	53.05	6.65	11.15	4.1	10.9	85.85
45	54.9	12.25	10.3	9.2	11.15	97.8
46	56.75	16.15	9.45	11.15	10.3	103.8

47	54.1	7.75	7.5	10.55	10.3	90.2
48	56.8	13.95	13.35	9.45	11.4	104.95
49	55.25	13.95	10.55	6.65	12.25	98.65

PDF 2-agent

Tables are laid horizontally, each line is a table, the system first goes from left to right then top to bottom, that means the first 5 numbers corresponding to the first row of the table, the 5 following numbers corresponding to the second row consecutively. The sum of the 5 columns and the final sum will be the 6 last numbers in cells at the end of the line.

Advice: Several Dtables could have the same table's number, you will need to check the first row of the table to be sure that you are reading the right Dtable before to copy answers. The first five numbers of a line correspond to the table's number plus the 4 numbers of the first row of the table.

Remember that access to this file costs 20 cents for solutions used for each table. At the end of the experiment, a questionnaire will be given to you to report how many times you solved a Dtable by looking up a solution from this PDF file.

<i>Dtables</i>	Sum of the 5 columns					Final sum
	C 1	C 2	C 3	C 4	C 5	
44,1.5,0.65,0.65,2.35,3.45,0.65,2.35,0.65,2.35,0.65,1.5,2.35,1.5,1.5,1.5,2.35,2.35,0.65,2.35,3.45,0.65,3.45,0.65,2.35	53.05	6.65	11.15	3.1	10.9	85.85
10,1.5,3.45,0.65,3.45,3.45,0.65,1.5,3.45,3.45,2.35,1.5,3.45,1.5,2.35,3.45,2.35,3.45,3.45,3.45,1.5,0.65,0.65,0.65,2.35	20.75	6.65	12.5	8.7	15.05	64.65
11,1.5,0.65,2.35,3.45,0.65,2.35,3.45,3.45,2.35,1.5,1.5,1.5,1.5,2.35,0.65,0.65,1.5,3.45,0.65,0.65,1.5,1.5,2.35,1.5	14.45	7.5	8.6	12.1	10.3	53.95
49,3.45,1.5,0.65,3.45,1.5,2.35,3.45,1.5,2.35,3.45,3.45,1.5,2.35,0.65,0.65,2.35,3.45,0.65,2.35,0.65,2.35,0.65,1.5,3.45	55.25	13.95	10.55	5.65	12.25	98.65
12,1.5,1.5,0.65,2.35,3.45,3.45,1.5,0.65,1.5,0.65,1.5,3.45,1.5,1.5,1.5,2.35,2.35,0.65,2.35,0.65,3.45,3.45,3.45,0.65	18.25	12.25	12.25	5.9	8.35	58
10,0.65,1.5,0.65,3.45,3.45,0.65,1.5,3.45,3.45,2.35,1.5,3.45,1.5,2.35,3.45,2.35,3.45,3.45,3.45,1.5,0.65,0.65,0.65,1.5	20.75	5.8	10.55	8.7	14.2	61
11,0.65,1.5,2.35,3.45,0.65,2.35,3.45,3.45,2.35,1.5,1.5,1.5,1.5,2.35,0.65,0.65,1.5,3.45,0.65,0.65,1.5,1.5,2.35,1.5	14.45	6.65	9.45	12.1	10.3	53.95
12,2.35,0.65,0.65,2.35,3.45,3.45,1.5,0.65,1.5,0.65,1.5,3.45,1.5,1.5,1.5,2.35,2.35,0.65,2.35,0.65,3.45,3.45,3.45,1.5	18.25	13.1	11.4	5.9	9.2	58.85
43,1.5,0.65,3.45,3.45,1.5,2.35,3.45,0.65,3.45,1.5,1.5,1.5,1.5,1.5,0.65,1.5,1.5,3.45,1.5,1.5,2.35,1.5,1.5,1.5	48.15	9.2	8.6	9.55	11.4	87.9
13,3.45,1.5,3.45,3.45,3.45,3.45,1.5,1.5,2.35,0.65,1.5,1.5,2.35,3.45,3.45,2.35,0.65,1.5,1.5,3.45,2.35,2.35,0.65,2.35	24	13.1	7.5	8.45	13.1	67.15
14,3.45,3.45,2.35,0.65,2.35,3.45,2.35,0.65,2.35,0.65,3.45,0.65,0.65,0.65,1.5,2.35,3.45,0.65,0.65,1.5,2.35,2.35,0.65,0.65	20	15.05	12.25	3.95	4.95	57.2
10,0.65,3.45,0.65,3.45,3.45,0.65,1.5,3.45,3.45,2.35,1.5,3.45,1.5,2.35,3.45,2.35,3.45,3.45,3.45,1.5,0.65,0.65,0.65,1.5	20.75	5.8	12.5	8.7	14.2	62.95
15,3.45,0.65,2.35,2.35,0.65,3.45,3.45,2.35,0.65,2.35,1.5,1.5,3.45,2.35,0.65,3.45,3.45,0.65,0.65,3.45,3.45,2.35,2.35,2.35	22.1	15.3	11.4	10.15	8.35	68.3
16,0.65,1.5,0.65,1.5,1.5,1.5,2.35,3.45,3.45,1.5,1.5,2.35,0.65,2.35,1.5,2.35,0.65,1.5,2.35,3.45,2.35,0.65,0.65,1.5	23.95	8.35	7.5	5.9	11.15	57.85
13,3.45,2.35,3.45,3.45,3.45,3.45,1.5,1.5,2.35,0.65,1.5,1.5,2.35,3.45,3.45,2.35,0.65,1.5,1.5,3.45,2.35,2.35,0.65,2.35	24	13.1	8.35	8.45	13.1	67.3
17,1.5,0.65,3.45,1.5,1.5,0.65,2.35,1.5,0.65,1.5,2.35,1.5,1.5,0.65,3.45,1.5,3.45,0.65,1.5,3.45,1.5,0.65,0.65,1.5	26.9	7.5	8.6	6.75	5.8	75
18,3.45,3.45,3.45,0.65,0.65,0.65,2.35,0.65,1.5,3.45,0.65,0.65,3.45,1.5,2.35,2.35,2.35,2.35,1.5,1.5,1.5,3.45,0.65,1.5	25.95	8.6	12.25	9.55	6.65	64.7
47,0.65,2.35,3.45,3.45,0.65,1.5,1.5,0.65,2.35,3.45,3.45,2.35,0.65,0.65,2.35,0.65,0.65,2.35,2.35,0.65,1.5,0.65,3.45,1.5	54.1	7.75	7.5	9.55	10.3	72.4

22,1.5,0.65,3.45,3.45,0.65,1.5,3.45,3.45,0.65,3.45,0.65,3.45,1.5,3.45,1.5,1.5,0.65,3.45,1.5,0.65,3.45,0.65,1.5,3.45	28.25	8.6	8.85	12.35	12.5	61
23,1.5,1.5,0.65,2.35,1.5,3.45,2.35,3.45,3.45,0.65,1.5,1.5,3.45,3.45,0.65,1.5,0.65,2.35,3.45,2.35,2.35,0.65,3.45	34.85	8.6	9.2	5.9	15.05	62.95
12,2.35,1.5,0.65,2.35,3.45,3.45,1.5,0.65,1.5,0.65,1.5,3.45,1.5,1.5,1.5,2.35,2.35,0.65,2.35,0.65,3.45,3.45,3.45,1.5	18.25	13.1	12.25	5.9	9.2	53.95
24,1.5,2.35,2.35,1.5,3.45,1.5,0.65,3.45,2.35,1.5,3.45,2.35,1.5,3.45,3.45,2.35,2.35,1.5,0.65,2.35,0.65,1.5,2.35,1.5	34.75	9.45	9.2	10.15	9.45	58.85
25,2.35,0.65,1.5,1.5,2.35,0.65,0.65,1.5,2.35,1.5,3.45,1.5,2.35,0.65,1.5,1.5,0.65,2.35,3.45,3.45,3.45,3.45,2.35,1.5	33.8	11.4	6.9	9.05	9.45	67.15
26,1.5,3.45,0.65,2.35,3.45,0.65,1.5,2.35,3.45,2.35,1.5,3.45,1.5,1.5,3.45,2.35,3.45,2.35,2.35,0.65,2.35,3.45,3.45,2.35	35.9	8.35	15.3	9.3	12	57.2
25,0.65,0.65,1.5,1.5,2.35,0.65,0.65,1.5,2.35,1.5,3.45,1.5,2.35,0.65,1.5,1.5,0.65,2.35,3.45,3.45,3.45,3.45,2.35,2.35	33.8	9.7	6.9	9.05	10.3	64.9
27,0.65,2.35,1.5,1.5,3.45,1.5,1.5,2.35,1.5,0.65,0.65,0.65,0.65,1.5,2.35,3.45,3.45,2.35,3.45,3.45,0.65,0.65,0.65,0.65	36.9	6.9	8.6	6.5	8.6	52.25
28,3.45,2.35,2.35,1.5,1.5,2.35,0.65,2.35,0.65,2.35,3.45,1.5,3.45,0.65,0.65,1.5,0.65,2.35,1.5,1.5,2.35,1.5,2.35,2.35	34	13.1	6.65	11.85	6.65	73.5
14,3.45,0.65,2.35,0.65,2.35,3.45,2.35,0.65,2.35,0.65,3.45,0.65,0.65,0.65,1.5,2.35,3.45,0.65,0.65,1.5,2.35,2.35,0.65,0.65	20	15.05	9.45	3.95	4.95	73.15
29,2.35,1.5,0.65,2.35,1.5,2.35,1.5,1.5,2.35,3.45,1.5,1.5,2.35,1.5,2.35,1.5,3.45,1.5,0.65,3.45,2.35,1.5,3.45,3.45	39.75	10.05	9.45	8.45	10.3	68.3
30,0.65,0.65,2.35,3.45,2.35,2.35,1.5,3.45,2.35,0.65,3.45,0.65,0.65,0.65,1.5,2.35,2.35,0.65,0.65,1.5,2.35,1.5,3.45,0.65	36	11.15	6.65	9.55	7.75	57.85
31,3.45,0.65,2.35,1.5,2.35,3.45,3.45,2.35,0.65,2.35,1.5,0.65,3.45,2.35,0.65,3.45,3.45,0.65,0.65,3.45,3.45,2.35,1.5,0.65	39.8	15.3	10.55	9.3	5.8	68
36,3.45,3.45,1.5,1.5,0.65,3.45,3.45,3.45,2.35,3.45,2.35,2.35,3.45,0.65,2.35,2.35,3.45,3.45,2.35,0.65,2.35,1.5,0.65	44.8	12.25	15.05	12.35	8.6	54.4
38,0.65,0.65,3.45,2.35,3.45,1.5,3.45,2.35,0.65,0.65,0.65,3.45,1.5,0.65,2.35,1.5,0.65,3.45,1.5,0.65,0.65,1.5,1.5,0.65	45.1	4.95	9.7	11.25	5.8	56.55
15,3.45,1.5,2.35,2.35,0.65,3.45,3.45,2.35,0.65,2.35,1.5,1.5,3.45,2.35,0.65,3.45,3.45,0.65,0.65,3.45,3.45,2.35,2.35,0.65	22.1	15.3	12.25	10.15	6.65	64
16,0.65,1.5,0.65,3.45,1.5,1.5,2.35,3.45,3.45,1.5,1.5,2.35,0.65,2.35,1.5,2.35,0.65,1.5,2.35,3.45,2.35,0.65,0.65,0.65	23.95	8.35	7.5	5.9	12.25	71.85
11,0.65,0.65,2.35,3.45,0.65,2.35,3.45,3.45,2.35,1.5,1.5,1.5,1.5,2.35,0.65,0.65,1.5,3.45,0.65,0.65,1.5,1.5,2.35,1.5	14.45	6.65	8.6	12.1	10.3	82.7
17,2.35,2.35,3.45,1.5,1.5,0.65,2.35,1.5,0.65,1.5,2.35,1.5,1.5,0.65,3.45,1.5,3.45,0.65,1.5,3.45,1.5,0.65,0.65,2.35	26.9	8.35	10.3	6.75	6.65	74.1
18,1.5,0.65,3.45,0.65,0.65,0.65,2.35,0.65,1.5,3.45,0.65,0.65,3.45,1.5,2.35,2.35,2.35,2.35,1.5,1.5,1.5,3.45,0.65,0.65	25.95	6.65	9.45	9.55	5.8	70.45
19,2.35,2.35,0.65,1.5,2.35,1.5,0.65,2.35,0.65,0.65,2.35,1.5,2.35,1.5,1.5,3.45,1.5,2.35,2.35,3.45,3.45,0.65,2.35,0.65	26.95	13.1	6.65	9.05	6.65	79
20,2.35,1.5,0.65,1.5,0.65,2.35,3.45,3.45,3.45,3.45,1.5,2.35,2.35,1.5,2.35,2.35,3.45,3.45,3.45,3.45,1.5,2.35,1.5,0.65	29.9	10.05	13.1	10.4	10.55	76.6
15,3.45,0.65,2.35,2.35,0.65,3.45,3.45,2.35,0.65,2.35,1.5,1.5,3.45,2.35,0.65,3.45,3.45,0.65,0.65,3.45,3.45,2.35,2.35,0.65	22.1	15.3	11.4	10.15	6.65	71.55
21,0.65,1.5,3.45,1.5,3.45,1.5,2.35,0.65,2.35,3.45,3.45,0.65,3.45,1.5,3.45,0.65,1.5,0.65,1.5,3.45,0.65,0.65,0.65,1.5	34.8	6.9	6.65	7.85	8.35	74.6
42,2.35,1.5,2.35,0.65,1.5,2.35,1.5,0.65,1.5,3.45,3.45,1.5,2.35,3.45,1.5,3.45,1.5,3.45,0.65,2.35,0.65,1.5,1.5,3.45	50.8	12.25	7.5	9.3	9.7	53.1
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32,0.65,1.5,3.45,1.5,1.5,1.5,2.35,2.35,3.45,1.5,1.5,2.35,3.45,2.35,0.65,2.35,3.45,1.5,2.35,2.35,1.5,3.45,0.65,0.65	38	7.5	13.1	10.4	10.3	74
44,1.5,0.65,0.65,2.35,3.45,0.65,2.35,0.65,2.35,0.65,1.5,2.35,1.5,1.5,1.5,2.35,2.35,0.65,2.35,3.45,0.65,3.45,0.65,0.65	53.05	6.65	11.15	3.1	9.2	71.6
45,2.35,3.45,2.35,2.35,2.35,3.45,2.35,1.5,2.35,0.65,2.35,1.5,2.35,2.35,3.45,2.35,0.65,2.35,0.65,3.45,3.45,2.35,0.65,0.65	54.9	13.95	10.3	8.2	8.35	81.85
33,1.5,3.45,2.35,1.5,3.45,0.65,1.5,3.45,0.65,1.5,2.35,3.45,0.65,3.45,2.35,0.65,2.35,2.35,0.65,3.45,0.65,3.45,3.45,1.5	43.75	5.8	14.2	11.25	7.75	68.5
46,1.5,1.5,2.35,0.65,3.45,3.45,2.35,3.45,3.45,1.5,3.45,1.5,1.5,1.5,2.35,3.45,0.65,2.35,2.35,3.45,3.45,3.45,1.5,1.5	56.75	15.3	9.45	10.15	9.45	73.25
47,0.65,2.35,3.45,3.45,0.65,1.5,1.5,0.65,2.35,3.45,3.45,2.35,0.65,0.65,2.35,0.65,0.65,2.35,2.35,0.65,1.5,0.65,3.45,3.45	54.1	7.75	7.5	9.55	12.25	79
37,1.5,2.35,0.65,1.5,0.65,1.5,3.45,0.65,3.45,3.45,2.35,0.65,3.45,1.5,0.65,1.5,1.5,1.5,2.35,3.45,3.45,1.5,1.5,2.35	45.2	10.3	9.45	6.75	11.15	72.1
48,1.5,3.45,1.5,3.45,2.35,2.35,3.45,0.65,1.5,3.45,2.35,3.45,1.5,0.65,2.35,3.45,1.5,3.45,3.45,0.65,3.45,1.5,2.35,3.45	56.8	13.1	13.35	8.45	12.5	81.75

49,2.35,1.5,0.65,3.45,1.5,2.35,3.45,1.5,2.35,3.45,3.45,1.5,2.35,0.65,0.65,2.35,3.45,0.65,2.35,0.65,2.35,0.65,1.5,3.45	55.25	12.85	10.55	5.65	12.25	83.45
42,0.65,1.5,2.35,0.65,1.5,2.35,1.5,0.65,1.5,3.45,3.45,1.5,2.35,3.45,1.5,3.45,1.5,3.45,0.65,2.35,0.65,1.5,1.5,2.35	50.8	10.55	7.5	9.3	8.6	94.05
23,1.5,1.5,0.65,2.35,1.5,3.45,2.35,3.45,3.45,3.45,0.65,1.5,1.5,3.45,3.45,0.65,1.5,0.65,2.35,3.45,2.35,2.35,0.65,0.65	34.85	8.6	9.2	5.9	12.25	83.85
21,0.65,3.45,3.45,1.5,3.45,1.5,2.35,0.65,2.35,3.45,3.45,0.65,3.45,1.5,3.45,0.65,1.5,0.65,1.5,3.45,0.65,0.65,0.65,1.5	34.8	6.9	8.6	7.85	8.35	81.15
22,3.45,0.65,3.45,2.35,0.65,1.5,3.45,3.45,0.65,3.45,0.65,3.45,1.5,3.45,1.5,1.5,0.65,3.45,1.5,0.65,3.45,0.65,1.5,0.65	28.25	10.55	8.85	12.35	8.6	82.9
23,1.5,0.65,0.65,2.35,1.5,3.45,2.35,3.45,3.45,3.45,0.65,1.5,1.5,3.45,3.45,0.65,1.5,0.65,2.35,3.45,2.35,2.35,0.65,0.65	34.85	8.6	8.35	5.9	12.25	81.2
39,0.65,0.65,3.45,1.5,1.5,2.35,0.65,2.35,2.35,2.35,3.45,3.45,0.65,2.35,2.35,3.45,0.65,3.45,2.35,3.45,0.65,2.35,3.45,3.45	48.65	10.55	7.75	12.35	12	85.85
24,1.5,3.45,2.35,1.5,3.45,1.5,0.65,3.45,2.35,1.5,3.45,2.35,1.5,3.45,3.45,2.35,2.35,1.5,0.65,2.35,0.65,1.5,2.35,0.65	34.75	9.45	10.3	10.15	8.6	95.75
25,0.65,3.45,1.5,1.5,2.35,0.65,0.65,1.5,2.35,1.5,3.45,1.5,2.35,0.65,1.5,1.5,0.65,2.35,3.45,3.45,3.45,2.35,2.35	33.8	9.7	9.7	9.05	10.3	57
26,2.35,1.5,0.65,2.35,3.45,0.65,1.5,2.35,3.45,2.35,1.5,3.45,1.5,1.5,3.45,2.35,3.45,2.35,2.35,0.65,2.35,3.45,3.45,0.65	35.9	9.2	13.35	9.3	10.3	60.55
16,0.65,1.5,0.65,1.5,1.5,1.5,2.35,3.45,3.45,1.5,1.5,2.35,0.65,2.35,1.5,2.35,0.65,1.5,2.35,3.45,2.35,0.65,0.65,0.65	23.95	8.35	7.5	5.9	10.3	67.15
27,3.45,0.65,1.5,1.5,3.45,1.5,1.5,2.35,1.5,0.65,0.65,0.65,0.65,1.5,2.35,3.45,3.45,2.35,3.45,3.45,0.65,0.65,0.65,0.65	36.9	9.7	6.9	6.5	8.6	56.1
28,0.65,3.45,2.35,1.5,1.5,2.35,0.65,2.35,0.65,2.35,3.45,1.5,3.45,0.65,0.65,1.5,0.65,2.35,1.5,1.5,2.35,1.5,2.35,0.65	34	10.3	7.75	11.85	4.95	69.4
45,0.65,3.45,2.35,2.35,2.35,3.45,2.35,1.5,2.35,0.65,2.35,1.5,2.35,2.35,3.45,2.35,0.65,2.35,0.65,3.45,3.45,2.35,0.65,3.45	54.9	12.25	10.3	8.2	11.15	58.7
29,2.35,1.5,0.65,3.45,1.5,2.35,1.5,1.5,2.35,3.45,1.5,1.5,2.35,1.5,2.35,1.5,3.45,1.5,0.65,3.45,2.35,1.5,3.45,2.35	39.75	10.05	9.45	8.45	10.3	57.4
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20,2.35,0.65,0.65,1.5,0.65,2.35,3.45,3.45,3.45,3.45,1.5,2.35,2.35,1.5,2.35,2.35,3.45,3.45,3.45,3.45,1.5,2.35,1.5,0.65	29.9	10.05	12.25	10.4	10.55	92.3
28,0.65,2.35,2.35,1.5,1.5,2.35,0.65,2.35,0.65,2.35,3.45,1.5,3.45,0.65,0.65,1.5,0.65,2.35,1.5,1.5,2.35,1.5,2.35,0.65	34	10.3	6.65	11.85	4.95	62.05
31,2.35,1.5,2.35,1.5,2.35,3.45,3.45,2.35,0.65,2.35,1.5,0.65,3.45,2.35,0.65,3.45,3.45,0.65,0.65,3.45,3.45,2.35,1.5,3.45	39.8	14.2	11.4	9.3	8.6	66.2
30,3.45,0.65,2.35,3.45,2.35,2.35,1.5,3.45,2.35,0.65,3.45,0.65,0.65,0.65,1.5,2.35,2.35,0.65,0.65,1.5,2.35,1.5,3.45,0.65	36	13.95	6.65	9.55	7.75	76.95
31,2.35,0.65,2.35,1.5,2.35,3.45,3.45,2.35,0.65,2.35,1.5,0.65,3.45,2.35,0.65,3.45,3.45,0.65,0.65,3.45,3.45,2.35,1.5,3.45	39.8	14.2	10.55	9.3	8.6	67.45
32,0.65,1.5,3.45,3.45,1.5,1.5,2.35,2.35,3.45,1.5,1.5,2.35,3.45,2.35,0.65,2.35,3.45,1.5,2.35,2.35,1.5,3.45,0.65,0.65	38	7.5	13.1	10.4	12.25	58.95
33,1.5,2.35,2.35,1.5,3.45,0.65,1.5,3.45,0.65,1.5,2.35,3.45,0.65,3.45,2.35,0.65,2.35,2.35,0.65,3.45,0.65,3.45,3.45,1.5	43.75	5.8	13.1	11.25	7.75	59.95
22,3.45,0.65,3.45,3.45,0.65,1.5,3.45,3.45,0.65,3.45,0.65,3.45,1.5,3.45,1.5,1.5,0.65,3.45,1.5,0.65,3.45,0.65,1.5,0.65	28.25	10.55	8.85	12.35	9.7	58.4
34,1.5,2.35,1.5,3.45,0.65,3.45,2.35,2.35,0.65,2.35,2.35,3.45,2.35,1.5,1.5,1.5,1.5,2.35,3.45,0.65,0.65,3.45,0.65,0.65	39.15	9.45	13.1	8.2	9.7	63.4
35,1.5,1.5,2.35,1.5,2.35,0.65,0.65,2.35,2.35,3.45,1.5,3.45,1.5,3.45,1.5,0.65,2.35,2.35,2.35,3.45,2.35,0.65,3.45,3.45	45.75	6.65	8.6	11	13.1	75
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19,2.35,3.45,0.65,1.5,2.35,1.5,0.65,2.35,0.65,0.65,2.35,1.5,2.35,1.5,1.5,3.45,1.5,2.35,2.35,3.45,3.45,0.65,2.35,0.65	26.95	13.1	7.75	9.05	6.65	66.6
37,1.5,2.35,0.65,3.45,0.65,1.5,3.45,0.65,3.45,3.45,2.35,0.65,3.45,1.5,0.65,1.5,1.5,1.5,2.35,3.45,3.45,1.5,1.5,2.35	45.2	10.3	9.45	6.75	13.1	65.55
38,0.65,0.65,3.45,3.45,3.45,1.5,3.45,2.35,0.65,0.65,0.65,3.45,1.5,0.65,2.35,1.5,0.65,3.45,1.5,0.65,0.65,1.5,1.5,0.65	45.1	4.95	9.7	11.25	6.9	71.55
39,0.65,3.45,3.45,1.5,1.5,2.35,0.65,2.35,2.35,2.35,3.45,3.45,0.65,2.35,2.35,3.45,0.65,3.45,2.35,3.45,0.65,2.35,3.45,3.45	48.65	10.55	10.55	12.35	12	73.5
48,2.35,3.45,1.5,3.45,2.35,2.35,3.45,0.65,1.5,3.45,2.35,3.45,1.5,0.65,2.35,3.45,1.5,3.45,3.45,0.65,3.45,1.5,2.35,2.35	56.8	13.95	13.35	8.45	11.4	72.3
32,3.45,1.5,3.45,1.5,1.5,1.5,2.35,2.35,3.45,1.5,1.5,2.35,3.45,2.35,0.65,2.35,3.45,1.5,2.35,2.35,1.5,3.45,0.65,1.5	38	10.3	13.1	10.4	11.15	90.55
33,0.65,3.45,2.35,1.5,3.45,0.65,1.5,3.45,0.65,1.5,2.35,3.45,0.65,3.45,2.35,0.65,2.35,2.35,0.65,3.45,0.65,3.45,3.45,1.5	43.75	4.95	14.2	11.25	7.75	89.85

34,2.35,2.35,1.5,2.35,0.65,3.45,2.35,2.35,0.65,2.35,2.35,3.45,2.35,1.5,1.5,1.5,1.5,2.35,3.45,0.65,0.65,3.45,0.65,2.35	39.15	10.3	13.1	8.2	10.3	84.15
35,1.5,2.35,2.35,1.5,2.35,0.65,0.65,2.35,2.35,3.45,1.5,3.45,1.5,3.45,1.5,0.65,2.35,2.35,2.35,3.45,2.35,0.65,3.45,1.5	45.75	6.65	9.45	11	11.15	96.7
26,2.35,3.45,0.65,2.35,3.45,0.65,1.5,2.35,3.45,2.35,1.5,3.45,1.5,1.5,3.45,2.35,3.45,2.35,2.35,0.65,2.35,3.45,3.45,0.65	35.9	9.2	15.3	9.3	10.3	80.3
36,3.45,3.45,1.5,1.5,0.65,3.45,3.45,3.45,2.35,3.45,2.35,2.35,3.45,0.65,2.35,2.35,3.45,3.45,3.45,2.35,0.65,2.35,1.5,3.45	44.8	12.25	15.05	12.35	11.4	83.75
37,3.45,2.35,0.65,1.5,0.65,1.5,3.45,0.65,3.45,3.45,2.35,0.65,3.45,1.5,0.65,1.5,1.5,1.5,2.35,3.45,3.45,1.5,1.5,3.45	45.2	12.25	9.45	6.75	12.25	102.1
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38,1.5,0.65,3.45,2.35,3.45,1.5,3.45,2.35,0.65,0.65,0.65,3.45,1.5,0.65,2.35,1.5,0.65,3.45,1.5,0.65,0.65,1.5,1.5,0.65	45.1	5.8	9.7	11.25	5.8	105.2
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41,3.45,2.35,3.45,1.5,2.35,3.45,2.35,3.45,1.5,1.5,3.45,3.45,1.5,3.45,3.45,0.65,3.45,2.35,2.35,2.35,2.35,3.45,0.65,1.5	50.65	13.35	15.05	10.4	10.3	97.8
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34,1.5,2.35,1.5,2.35,0.65,3.45,2.35,2.35,0.65,2.35,2.35,3.45,2.35,1.5,1.5,1.5,1.5,2.35,3.45,0.65,0.65,3.45,0.65,0.65	39.15	9.45	13.1	8.2	8.6	69.6
41,3.45,3.45,3.45,1.5,2.35,3.45,2.35,3.45,1.5,1.5,3.45,3.45,1.5,3.45,3.45,0.65,3.45,2.35,2.35,2.35,2.35,3.45,0.65,1.5	50.65	13.35	16.15	10.4	10.3	76.2
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49,3.45,3.45,0.65,3.45,1.5,2.35,3.45,1.5,2.35,3.45,3.45,1.5,2.35,0.65,0.65,2.35,3.45,0.65,2.35,0.65,2.35,0.65,1.5,3.45	55.25	13.95	12.5	5.65	12.25	73.55
17,2.35,0.65,3.45,1.5,1.5,0.65,2.35,1.5,0.65,1.5,2.35,1.5,1.5,0.65,3.45,1.5,3.45,0.65,1.5,3.45,1.5,0.65,0.65,2.35	26.9	8.35	8.6	6.75	6.65	79.05

PDF 1-agent

Tables are laid horizontally, each line is a table, the system first goes from left to right then top to bottom, that means the first 5 numbers corresponding to the first row of the table, the 5 following numbers corresponding to the second row consecutively. The sum of the 5 columns and the final sum will be the 6 last numbers in cells at the end of the line.

Advice: Several Dtables could have the same table's number, you will need to check the first row of the table to be sure that you are reading the right Dtable before to copy answers. The first five numbers of a line correspond to the table's number plus the 4 numbers of the first row of the table.

Remember that access to this file costs 20 cents for solutions used for each table. At the end of the experiment, a questionnaire will be given to you to report how many times you solved a Dtable by looking up a solution from this PDF file.

<i>Dtables</i>	Sum of the 5 columns				
	C 1	C 2	C 3	C 4	C 5
44,1.5,0.65,0.65,2.35,3.45,0.65,2.35,0.65,2.35,0.65,1.5,2.35,1.5,1.5,1.5,2.35,2.35,0.65,2.35,3.45,0.65,3.45,0.65,2.35	53.05	6.65	11.15	3.1	10.9
10,1.5,3.45,0.65,3.45,3.45,0.65,1.5,3.45,3.45,2.35,1.5,3.45,1.5,2.35,3.45,2.35,3.45,3.45,1.5,0.65,0.65,0.65,2.35	20.75	6.65	12.5	8.7	15.05
11,1.5,0.65,2.35,3.45,0.65,2.35,3.45,3.45,2.35,1.5,1.5,1.5,1.5,2.35,0.65,0.65,1.5,3.45,0.65,0.65,1.5,1.5,2.35,1.5	14.45	7.5	8.6	12.1	10.3
49,3.45,1.5,0.65,3.45,1.5,2.35,3.45,1.5,2.35,3.45,3.45,1.5,2.35,0.65,0.65,2.35,3.45,0.65,2.35,0.65,2.35,0.65,1.5,3.45	55.25	13.95	10.55	5.65	12.25
12,1.5,1.5,0.65,2.35,3.45,3.45,1.5,0.65,1.5,0.65,1.5,3.45,1.5,1.5,1.5,2.35,2.35,0.65,2.35,0.65,3.45,3.45,3.45,0.65	18.25	12.25	12.25	5.9	8.35
10,0.65,1.5,0.65,3.45,3.45,0.65,1.5,3.45,3.45,2.35,1.5,3.45,1.5,2.35,3.45,2.35,3.45,3.45,1.5,0.65,0.65,0.65,1.5	20.75	5.8	10.55	8.7	14.2
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10,0.65,3.45,0.65,3.45,3.45,0.65,1.5,3.45,3.45,2.35,1.5,3.45,1.5,2.35,3.45,2.35,3.45,3.45,1.5,0.65,0.65,0.65,1.5	20.75	5.8	12.5	8.7	14.2
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28,3.45,2.35,2.35,1.5,1.5,2.35,0.65,2.35,0.65,2.35,3.45,1.5,3.45,0.65,0.65,1.5,0.65,2.35,1.5,1.5,2.35,1.5,2.35,2.35	34	13.1	6.65	11.85	6.65
14,3.45,0.65,2.35,0.65,2.35,3.45,2.35,0.65,2.35,0.65,3.45,0.65,0.65,0.65,1.5,2.35,3.45,0.65,0.65,1.5,2.35,2.35,0.65,0.65	20	15.05	9.45	3.95	4.95
29,2.35,1.5,0.65,2.35,1.5,2.35,1.5,1.5,2.35,3.45,1.5,1.5,2.35,1.5,2.35,1.5,3.45,1.5,0.65,3.45,2.35,1.5,3.45,3.45	39.75	10.05	9.45	8.45	10.3
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31,3.45,0.65,2.35,1.5,2.35,3.45,3.45,2.35,0.65,2.35,1.5,0.65,3.45,2.35,0.65,3.45,3.45,0.65,0.65,3.45,3.45,2.35,1.5,0.65	39.8	15.3	10.55	9.3	5.8
36,3.45,3.45,1.5,1.5,0.65,3.45,3.45,3.45,2.35,3.45,2.35,2.35,3.45,0.65,2.35,2.35,3.45,3.45,3.45,2.35,0.65,2.35,1.5,0.65	44.8	12.25	15.05	12.35	8.6
38,0.65,0.65,3.45,2.35,3.45,1.5,3.45,2.35,0.65,0.65,0.65,3.45,1.5,0.65,2.35,1.5,0.65,3.45,1.5,0.65,0.65,1.5,1.5,0.65	45.1	4.95	9.7	11.25	5.8
15,3.45,1.5,2.35,2.35,0.65,3.45,3.45,2.35,0.65,2.35,1.5,1.5,3.45,2.35,0.65,3.45,3.45,0.65,0.65,3.45,3.45,2.35,2.35,0.65	22.1	15.3	12.25	10.15	6.65
16,0.65,1.5,0.65,3.45,1.5,1.5,2.35,3.45,3.45,1.5,1.5,2.35,0.65,2.35,1.5,2.35,0.65,1.5,2.35,3.45,2.35,0.65,0.65,0.65	23.95	8.35	7.5	5.9	12.25
11,0.65,0.65,2.35,3.45,0.65,2.35,3.45,3.45,2.35,1.5,1.5,1.5,1.5,2.35,0.65,0.65,1.5,3.45,0.65,0.65,1.5,1.5,2.35,1.5	14.45	6.65	8.6	12.1	10.3
17,2.35,2.35,3.45,1.5,1.5,0.65,2.35,1.5,0.65,1.5,2.35,1.5,1.5,0.65,3.45,1.5,3.45,0.65,1.5,3.45,1.5,0.65,0.65,2.35	26.9	8.35	10.3	6.75	6.65
18,1.5,0.65,3.45,0.65,0.65,0.65,2.35,0.65,1.5,3.45,0.65,0.65,3.45,1.5,2.35,2.35,2.35,2.35,1.5,1.5,1.5,3.45,0.65,0.65	25.95	6.65	9.45	9.55	5.8
19,2.35,2.35,0.65,1.5,2.35,1.5,0.65,2.35,0.65,0.65,2.35,1.5,2.35,1.5,1.5,3.45,1.5,2.35,2.35,3.45,3.45,0.65,2.35,0.65	26.95	13.1	6.65	9.05	6.65
20,2.35,1.5,0.65,1.5,0.65,2.35,3.45,3.45,3.45,3.45,1.5,2.35,2.35,1.5,2.35,2.35,3.45,3.45,3.45,3.45,1.5,2.35,1.5,0.65	29.9	10.05	13.1	10.4	10.55
15,3.45,0.65,2.35,2.35,0.65,3.45,3.45,2.35,0.65,2.35,1.5,1.5,3.45,2.35,0.65,3.45,3.45,0.65,0.65,3.45,3.45,2.35,2.35,0.65	22.1	15.3	11.4	10.15	6.65
21,0.65,1.5,3.45,1.5,3.45,1.5,2.35,0.65,2.35,3.45,3.45,0.65,3.45,1.5,3.45,0.65,1.5,0.65,1.5,3.45,0.65,0.65,0.65,1.5	34.8	6.9	6.65	7.85	8.35
42,2.35,1.5,2.35,0.65,1.5,2.35,1.5,0.65,1.5,3.45,3.45,1.5,2.35,3.45,1.5,3.45,1.5,3.45,0.65,2.35,0.65,1.5,1.5,3.45	50.8	12.25	7.5	9.3	9.7
43,1.5,0.65,3.45,3.45,1.5,2.35,3.45,0.65,3.45,1.5,1.5,1.5,1.5,1.5,0.65,1.5,1.5,3.45,1.5,1.5,2.35,1.5,1.5,3.45	48.15	9.2	8.6	9.55	13.35
32,0.65,1.5,3.45,1.5,1.5,1.5,2.35,2.35,3.45,1.5,1.5,2.35,3.45,2.35,0.65,2.35,3.45,1.5,2.35,2.35,1.5,3.45,0.65,0.65	38	7.5	13.1	10.4	10.3
44,1.5,0.65,0.65,2.35,3.45,0.65,2.35,0.65,2.35,0.65,1.5,2.35,1.5,1.5,1.5,2.35,2.35,0.65,2.35,3.45,0.65,3.45,0.65,0.65	53.05	6.65	11.15	3.1	9.2
45,2.35,3.45,2.35,2.35,2.35,3.45,2.35,1.5,2.35,0.65,2.35,1.5,2.35,2.35,3.45,2.35,0.65,2.35,0.65,3.45,3.45,2.35,0.65,0.65	54.9	13.95	10.3	8.2	8.35
33,1.5,3.45,2.35,1.5,3.45,0.65,1.5,3.45,0.65,1.5,2.35,3.45,0.65,3.45,2.35,0.65,2.35,2.35,0.65,3.45,0.65,3.45,3.45,1.5	43.75	5.8	14.2	11.25	7.75
46,1.5,1.5,2.35,0.65,3.45,3.45,2.35,3.45,3.45,1.5,3.45,1.5,1.5,1.5,2.35,3.45,0.65,2.35,2.35,3.45,3.45,3.45,1.5,1.5	56.75	15.3	9.45	10.15	9.45
47,0.65,2.35,3.45,3.45,0.65,1.5,1.5,0.65,2.35,3.45,3.45,2.35,0.65,0.65,2.35,0.65,0.65,2.35,2.35,0.65,1.5,0.65,3.45,3.45	54.1	7.75	7.5	9.55	12.25
37,1.5,2.35,0.65,1.5,0.65,1.5,3.45,0.65,3.45,3.45,2.35,0.65,3.45,1.5,0.65,1.5,1.5,1.5,2.35,3.45,3.45,1.5,1.5,2.35	45.2	10.3	9.45	6.75	11.15
48,1.5,3.45,1.5,3.45,2.35,2.35,3.45,0.65,1.5,3.45,2.35,3.45,1.5,0.65,2.35,3.45,1.5,3.45,3.45,0.65,3.45,1.5,2.35,3.45	56.8	13.1	13.35	8.45	12.5

49,2.35,1.5,0.65,3.45,1.5,2.35,3.45,1.5,2.35,3.45,3.45,1.5,2.35,0.65,0.65,2.35,3.45,0.65,2.35,0.65,2.35,0.65,1.5,3.45	55.25	12.85	10.55	5.65	12.25
42,0.65,1.5,2.35,0.65,1.5,2.35,1.5,0.65,1.5,3.45,3.45,1.5,2.35,3.45,1.5,3.45,1.5,3.45,0.65,2.35,0.65,1.5,1.5,2.35	50.8	10.55	7.5	9.3	8.6
23,1.5,1.5,0.65,2.35,1.5,3.45,2.35,3.45,3.45,3.45,0.65,1.5,1.5,3.45,3.45,0.65,1.5,0.65,2.35,3.45,2.35,2.35,0.65,0.65	34.85	8.6	9.2	5.9	12.25
21,0.65,3.45,3.45,1.5,3.45,1.5,2.35,0.65,2.35,3.45,3.45,0.65,3.45,1.5,3.45,0.65,1.5,0.65,1.5,3.45,0.65,0.65,0.65,1.5	34.8	6.9	8.6	7.85	8.35
22,3.45,0.65,3.45,2.35,0.65,1.5,3.45,3.45,0.65,3.45,0.65,3.45,1.5,3.45,1.5,1.5,0.65,3.45,1.5,0.65,3.45,0.65,1.5,0.65	28.25	10.55	8.85	12.35	8.6
23,1.5,0.65,0.65,2.35,1.5,3.45,2.35,3.45,3.45,3.45,0.65,1.5,1.5,3.45,3.45,0.65,1.5,0.65,2.35,3.45,2.35,2.35,0.65,0.65	34.85	8.6	8.35	5.9	12.25
39,0.65,0.65,3.45,1.5,1.5,2.35,0.65,2.35,2.35,2.35,3.45,3.45,0.65,2.35,2.35,3.45,0.65,3.45,2.35,3.45,0.65,2.35,3.45,3.45	48.65	10.55	7.75	12.35	12
24,1.5,3.45,2.35,1.5,3.45,1.5,0.65,3.45,2.35,1.5,3.45,2.35,1.5,3.45,3.45,2.35,2.35,1.5,0.65,2.35,0.65,1.5,2.35,0.65	34.75	9.45	10.3	10.15	8.6
25,0.65,3.45,1.5,1.5,2.35,0.65,0.65,1.5,2.35,1.5,3.45,1.5,2.35,0.65,1.5,1.5,0.65,2.35,3.45,3.45,3.45,3.45,2.35,2.35	33.8	9.7	9.7	9.05	10.3
26,2.35,1.5,0.65,2.35,3.45,0.65,1.5,2.35,3.45,2.35,1.5,3.45,1.5,1.5,3.45,2.35,3.45,2.35,2.35,0.65,2.35,3.45,3.45,0.65	35.9	9.2	13.35	9.3	10.3
16,0.65,1.5,0.65,1.5,1.5,1.5,2.35,3.45,3.45,1.5,1.5,2.35,0.65,2.35,1.5,2.35,0.65,1.5,2.35,3.45,2.35,0.65,0.65,0.65	23.95	8.35	7.5	5.9	10.3
27,3.45,0.65,1.5,1.5,3.45,1.5,1.5,2.35,1.5,0.65,0.65,0.65,0.65,1.5,2.35,3.45,3.45,2.35,3.45,3.45,0.65,0.65,0.65,0.65	36.9	9.7	6.9	6.5	8.6
28,0.65,3.45,2.35,1.5,1.5,2.35,0.65,2.35,0.65,2.35,3.45,1.5,3.45,0.65,0.65,1.5,0.65,2.35,1.5,1.5,2.35,1.5,2.35,0.65	34	10.3	7.75	11.85	4.95
45,0.65,3.45,2.35,2.35,2.35,3.45,2.35,1.5,2.35,0.65,2.35,1.5,2.35,2.35,3.45,2.35,0.65,2.35,0.65,3.45,3.45,2.35,0.65,3.45	54.9	12.25	10.3	8.2	11.15
29,2.35,1.5,0.65,3.45,1.5,2.35,1.5,1.5,2.35,3.45,1.5,1.5,2.35,1.5,2.35,1.5,3.45,1.5,0.65,3.45,2.35,1.5,3.45,2.35	39.75	10.05	9.45	8.45	10.3
30,3.45,3.45,2.35,3.45,2.35,2.35,1.5,3.45,2.35,0.65,3.45,0.65,0.65,0.65,1.5,2.35,2.35,0.65,0.65,1.5,2.35,1.5,3.45,0.65	36	13.95	9.45	9.55	7.75
20,2.35,0.65,0.65,1.5,0.65,2.35,3.45,3.45,3.45,3.45,1.5,2.35,2.35,1.5,2.35,2.35,3.45,3.45,3.45,3.45,1.5,2.35,1.5,0.65	29.9	10.05	12.25	10.4	10.55
28,0.65,2.35,2.35,1.5,1.5,2.35,0.65,2.35,0.65,2.35,3.45,1.5,3.45,0.65,0.65,1.5,0.65,2.35,1.5,1.5,2.35,1.5,2.35,0.65	34	10.3	6.65	11.85	4.95
31,2.35,1.5,2.35,1.5,2.35,3.45,3.45,2.35,0.65,2.35,1.5,0.65,3.45,2.35,0.65,3.45,3.45,0.65,0.65,3.45,3.45,2.35,1.5,3.45	39.8	14.2	11.4	9.3	8.6
30,3.45,0.65,2.35,3.45,2.35,2.35,1.5,3.45,2.35,0.65,3.45,0.65,0.65,0.65,1.5,2.35,2.35,0.65,0.65,1.5,2.35,1.5,3.45,0.65	36	13.95	6.65	9.55	7.75
31,2.35,0.65,2.35,1.5,2.35,3.45,3.45,2.35,0.65,2.35,1.5,0.65,3.45,2.35,0.65,3.45,3.45,0.65,0.65,3.45,3.45,2.35,1.5,3.45	39.8	14.2	10.55	9.3	8.6
32,0.65,1.5,3.45,3.45,1.5,1.5,2.35,2.35,3.45,1.5,1.5,2.35,3.45,2.35,0.65,2.35,3.45,1.5,2.35,2.35,1.5,3.45,0.65,0.65	38	7.5	13.1	10.4	12.25
33,1.5,2.35,2.35,1.5,3.45,0.65,1.5,3.45,0.65,1.5,2.35,3.45,0.65,3.45,2.35,0.65,2.35,2.35,0.65,3.45,0.65,3.45,3.45,1.5	43.75	5.8	13.1	11.25	7.75
22,3.45,0.65,3.45,3.45,0.65,1.5,3.45,3.45,0.65,3.45,0.65,3.45,1.5,3.45,1.5,1.5,0.65,3.45,1.5,0.65,3.45,0.65,1.5,0.65	28.25	10.55	8.85	12.35	9.7
34,1.5,2.35,1.5,3.45,0.65,3.45,2.35,2.35,0.65,2.35,2.35,3.45,2.35,1.5,1.5,1.5,1.5,2.35,3.45,0.65,0.65,3.45,0.65,0.65	39.15	9.45	13.1	8.2	9.7
35,1.5,1.5,2.35,1.5,2.35,0.65,0.65,2.35,2.35,3.45,1.5,3.45,1.5,3.45,1.5,0.65,2.35,2.35,2.35,3.45,2.35,0.65,3.45,3.45	45.75	6.65	8.6	11	13.1
36,3.45,2.35,1.5,1.5,0.65,3.45,3.45,3.45,2.35,3.45,2.35,2.35,3.45,0.65,2.35,2.35,3.45,3.45,3.45,2.35,0.65,2.35,1.5,0.65	44.8	12.25	13.95	12.35	8.6
19,2.35,3.45,0.65,1.5,2.35,1.5,0.65,2.35,0.65,0.65,2.35,1.5,2.35,1.5,1.5,3.45,1.5,2.35,2.35,3.45,3.45,0.65,2.35,0.65	26.95	13.1	7.75	9.05	6.65
37,1.5,2.35,0.65,3.45,0.65,1.5,3.45,0.65,3.45,3.45,2.35,0.65,3.45,1.5,0.65,1.5,1.5,1.5,2.35,3.45,3.45,1.5,1.5,2.35	45.2	10.3	9.45	6.75	13.1
38,0.65,0.65,3.45,3.45,3.45,1.5,3.45,2.35,0.65,0.65,0.65,3.45,1.5,0.65,2.35,1.5,0.65,3.45,1.5,0.65,0.65,1.5,1.5,0.65	45.1	4.95	9.7	11.25	6.9
39,0.65,3.45,3.45,1.5,1.5,2.35,0.65,2.35,2.35,2.35,3.45,3.45,0.65,2.35,2.35,3.45,0.65,3.45,2.35,3.45,0.65,2.35,3.45,3.45	48.65	10.55	10.55	12.35	12
48,2.35,3.45,1.5,3.45,2.35,2.35,3.45,0.65,1.5,3.45,2.35,3.45,1.5,0.65,2.35,3.45,1.5,3.45,3.45,0.65,3.45,1.5,2.35,2.35	56.8	13.95	13.35	8.45	11.4
32,3.45,1.5,3.45,1.5,1.5,1.5,2.35,2.35,3.45,1.5,1.5,2.35,3.45,2.35,0.65,2.35,3.45,1.5,2.35,2.35,1.5,3.45,0.65,1.5	38	10.3	13.1	10.4	11.15
33,0.65,3.45,2.35,1.5,3.45,0.65,1.5,3.45,0.65,1.5,2.35,3.45,0.65,3.45,2.35,0.65,2.35,2.35,0.65,3.45,0.65,3.45,3.45,1.5	43.75	4.95	14.2	11.25	7.75

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35,1.5,2.35,2.35,1.5,2.35,0.65,0.65,2.35,2.35,3.45,1.5,3.45,1.5,3.45,1.5,0.65,2.35,2.35,2.35,3.45,2.35,0.65,3.45,1.5	45.75	6.65	9.45	11	11.15
26,2.35,3.45,0.65,2.35,3.45,0.65,1.5,2.35,3.45,2.35,1.5,3.45,1.5,1.5,3.45,2.35,3.45,2.35,2.35,0.65,2.35,3.45,3.45,0.65	35.9	9.2	15.3	9.3	10.3
36,3.45,3.45,1.5,1.5,0.65,3.45,3.45,3.45,2.35,3.45,2.35,2.35,3.45,0.65,2.35,2.35,3.45,3.45,3.45,2.35,0.65,2.35,1.5,3.45	44.8	12.25	15.05	12.35	11.4
37,3.45,2.35,0.65,1.5,0.65,1.5,3.45,0.65,3.45,3.45,2.35,0.65,3.45,1.5,0.65,1.5,1.5,1.5,2.35,3.45,3.45,1.5,1.5,3.45	45.2	12.25	9.45	6.75	12.25
29,2.35,1.5,0.65,2.35,1.5,2.35,1.5,1.5,2.35,3.45,1.5,1.5,2.35,1.5,2.35,1.5,3.45,1.5,0.65,3.45,2.35,1.5,3.45,2.35	39.75	10.05	9.45	8.45	9.2
38,1.5,0.65,3.45,2.35,3.45,1.5,3.45,2.35,0.65,0.65,0.65,3.45,1.5,0.65,2.35,1.5,0.65,3.45,1.5,0.65,0.65,1.5,1.5,0.65	45.1	5.8	9.7	11.25	5.8
39,0.65,0.65,3.45,1.5,1.5,2.35,0.65,2.35,2.35,2.35,3.45,3.45,0.65,2.35,2.35,3.45,0.65,3.45,2.35,3.45,0.65,2.35,3.45,2.35	48.65	10.55	7.75	12.35	10.9
40,1.5,1.5,1.5,1.5,3.45,0.65,3.45,2.35,1.5,1.5,2.35,0.65,1.5,2.35,3.45,0.65,1.5,0.65,3.45,1.5,3.45,3.45,1.5,0.65	49.9	8.6	10.55	6.5	9.45
41,3.45,2.35,3.45,1.5,2.35,3.45,2.35,3.45,1.5,1.5,3.45,3.45,1.5,3.45,3.45,0.65,3.45,2.35,2.35,2.35,2.35,3.45,0.65,1.5	50.65	13.35	15.05	10.4	10.3
40,1.5,1.5,1.5,1.5,3.45,0.65,3.45,2.35,1.5,1.5,2.35,0.65,1.5,2.35,3.45,0.65,1.5,0.65,3.45,1.5,3.45,3.45,1.5,1.5	49.9	8.6	10.55	6.5	10.3
41,1.5,2.35,3.45,1.5,2.35,3.45,2.35,3.45,1.5,1.5,3.45,3.45,1.5,3.45,3.45,0.65,3.45,2.35,2.35,2.35,2.35,3.45,0.65,1.5	50.65	11.4	15.05	10.4	10.3
40,1.5,2.35,1.5,1.5,3.45,0.65,3.45,2.35,1.5,1.5,2.35,0.65,1.5,2.35,3.45,0.65,1.5,0.65,3.45,1.5,3.45,3.45,1.5,0.65	49.9	8.6	11.4	6.5	9.45
34,1.5,2.35,1.5,2.35,0.65,3.45,2.35,2.35,0.65,2.35,2.35,3.45,2.35,1.5,1.5,1.5,1.5,2.35,3.45,0.65,0.65,3.45,0.65,0.65	39.15	9.45	13.1	8.2	8.6
41,3.45,3.45,3.45,1.5,2.35,3.45,2.35,3.45,1.5,1.5,3.45,3.45,1.5,3.45,3.45,0.65,3.45,2.35,2.35,2.35,2.35,3.45,0.65,1.5	50.65	13.35	16.15	10.4	10.3
42,0.65,3.45,2.35,0.65,1.5,2.35,1.5,0.65,1.5,3.45,3.45,1.5,2.35,3.45,1.5,3.45,1.5,3.45,0.65,2.35,0.65,1.5,1.5,2.35	50.8	10.55	9.45	9.3	8.6
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46,2.35,3.45,2.35,0.65,3.45,3.45,2.35,3.45,3.45,1.5,3.45,1.5,1.5,1.5,2.35,3.45,0.65,2.35,2.35,3.45,3.45,3.45,1.5,2.35	56.75	16.15	11.4	10.15	10.3
46,2.35,1.5,2.35,0.65,3.45,3.45,2.35,3.45,3.45,1.5,3.45,1.5,1.5,1.5,2.35,3.45,0.65,2.35,2.35,3.45,3.45,3.45,1.5,2.35	56.75	16.15	9.45	10.15	10.3
47,0.65,3.45,3.45,3.45,0.65,1.5,1.5,0.65,2.35,3.45,3.45,2.35,0.65,0.65,2.35,0.65,0.65,2.35,2.35,0.65,1.5,0.65,3.45,1.5	54.1	7.75	8.6	9.55	10.3
48,2.35,2.35,1.5,3.45,2.35,2.35,3.45,0.65,1.5,3.45,2.35,3.45,1.5,0.65,2.35,3.45,1.5,3.45,3.45,0.65,3.45,1.5,2.35,2.35	56.8	13.95	12.25	8.45	11.4
49,3.45,3.45,0.65,3.45,1.5,2.35,3.45,1.5,2.35,3.45,3.45,1.5,2.35,0.65,0.65,2.35,3.45,0.65,2.35,0.65,2.35,0.65,1.5,3.45	55.25	13.95	12.5	5.65	12.25
17,2.35,0.65,3.45,1.5,1.5,0.65,2.35,1.5,0.65,1.5,2.35,1.5,1.5,0.65,3.45,1.5,3.45,0.65,1.5,3.45,1.5,0.65,0.65,2.35	26.9	8.35	8.6	6.75	6.65

Chapter II: Influence costs: An experimental evidence⁹

⁹ This chapter has given rise to a paper entitled *On the Merit of Equal Pay: Influence Activities & Incentive Setting* with Brice Corgnet, Ludivine Martin and Angela Sutan. This submitted paper contains some sections that we did not have opportunities to include in this chapter.

III. Introduction

The use of technologies in the workplace has considerably increased in the last decades; several firms were quick to adopt new technologies in the production, management and communication process (Colombo and Delmastro, 1999; Ariss, 2002). The diffusion of Informational and Communication Technologies (ICT) has engendered some organizational changes regarding structures and work practices of firms (Black and Lynch, 2001). Empirical evidence suggests that the implementation of ICT in the firm have to be combined with organizational changes to realize the greatest benefits from these technologies (Milgrom and Roberts, 1990; Brynjolfsson and Hitt, 2000). These organizational changes have encompassed several issues such as employee involvement in decision making, compensation, teamwork, flattening hierarchies, information sharing, ERP use, scheduling and etc. (Bertschek and Kaiser, 2004; Falk, 2005). Even though technological and organizational changes facilitated by these technologies contribute to the increase of firms' productivity (Black and Lynch, 2001; Bresnahan et al., 2002; Brynjolfsson and Hitt, 2000), these changes also incurred substantial costs (Colombo and Delmastro, 2004; Bertschek and Kaiser, 2004). Some of these costs are generated by workers' behaviors who are reluctant to these organizational changes (Schaefer, 1998) or which could attempt to influence these changes in favor of their own interests (Milgrom, 1988; Milgrom and Roberts, 1988, 1990b). So, the adoption of new technologies engendered some organizational changes that could imply important costs with some consequences on workers' productivity and organizational performance.

The manager must solicit information on the value of organizational changes from workers in order to select the appropriate form of change (Schaefer, 1998; Matejka and De Waegenaere, 2005). However, agency theory assumes that the interests of the agent may not coincide with those of the principal (Acemoglu et al., 2007) so, this situation may generate incentives for the former to provide biased information to the latter. Indeed, "Where different parts of the organization have responsibility for different pieces of information relevant to a decision, we would expect some biases in information transmitted due to perceptual differences among the subunits and *some attempts to manipulate information* as a device for manipulating the decision." (Cyert and March, 1963, 2013, page 67).

The issue of the manipulation of information is worthwhile for studies on impacts of ICT use at workers' level since empirical evidence has shown that firms have to adopt technologies and organizational changes that push decision-making at the agent level for more efficiency

(Black and Lynch, 2001; Bresnahan et al., 2002; Brynjolfsson and Hitt, 2000; Garicano, 2000; Garicano and Rossi-Hansberg, 2006; Bloom et al. (2014). This is consistent with the evidence that a decentralized work organization positively impacts the agent's performance (Aghion et al., 2013; Charness et al., 2012; Sliwka, 2001). However, a decentralized work environment which enables more autonomy for employees as they have a greater voice in decision making could also generate more opportunities and incentives for workers to manipulate information. By reducing communication costs, ICT allows an increase of direct interactions between principal and agents. Thus, agents could rely more on the principal and have more opportunities to influence the decision making. So, the implementation of ICT opens more channels of communication and means for the agent to influence the principal's decision. Indeed, "in reality a worker doesn't always need to produce more than her rival to win a promotion tournament, but rather can create an impression well founded or otherwise, that she has." (Carpenter et al., 2010). The selfish reasons that lead the agent to maximize his interest rather than the firm's interest may entail important costs.

The literature on influence costs has highlighted the substantial costs generated when the agent manipulates the information for selfish reasons. According to Milgrom (1988) and Milgrom and Roberts (1988, 1990b), influence costs are costs induced by individuals' activities to provide information which makes them look good relative to others and to affect others' decisions to their benefit. Milgrom and Roberts (1988) develop an economic approach to influence activities in organizations which may bring benefits but also entail influence costs with negative overall effects. One of the hypotheses of influence costs theory is that when the information is only available for the agent and if the principal has discretion about the distribution of resources, there are high incentives for a rational agent to manipulate the information in order to increase his benefits¹⁰. The use of subjective information for the evaluation of the performance may also generate influence activities. "A more pertinent problem with subjective assessments in large firms may be the danger of rent seeking activities, which refers to any actions that agents carry out that are designed to increase the likelihood of better ratings from supervisors, but that have less value on surplus than some other activity that they could carry out" (Prendergast, 1999, p.31). The competitions between

¹⁰The typical worker operates in a setting where efforts are exerted in the hope of a promotion, salary revision, or bonus, which are typically at the discretion of superiors. (Prendergast, 1999)

departments in the firm for the budget allocation, competition between workers for a promotion for examples are some cases that could lead individuals to manipulate information.

The manipulation of the information by the agent can take many forms, “ranging from conscious lies concerning facts, through suppression of unfavorable information, to simply presenting the information in a way that accentuates the points supporting the interested party’s preferred decision and then insisting on these points at every opportunity” (Milgrom and Roberts, 1988, p.156). The costs for the firm are twice: first because the agent misuses the resources by attempting to affect the principal's decision making and secondly because that leads the principal to make inefficient decisions. Milgrom and Roberts (1988) present three solutions that the organization should adopt to lower the impact of influence activities. The first is to close communication channels for certain decisions. The limitation of the principal’s discretion and the restriction of his ability to respond to information supplied by agents are the second option. The last option is that, the principal may build the incentives system in such a way that the interests of the agent coincide with his interests.

In our knowledge, there are some theoretical papers which studied influence activities, most of them focus on the relationship between influence activities and changes in the organization. Employees may engage in influence activities if they expect that the firm will be reorganized (Schaefer, 1998). The firm may not implement some organizational changes even if it’s required because the change of formal and informal rules or procedures in an organization is a high incentive to influence activities (Matejka and De Waegenaere, 2005). If a good decision is not implemented by the agents, it can be costly for the organization then, influence activities don’t only degrade the quality of decision making but it could also undermine the returns of a good decision. Influence activities generate a distortion of the allocation of resources within the organization (Inderst et al., 2005). Most recently, Corgnet and Rodriguez-Lara (2013) showed that influence activities increase the cost of implementing the high level of effort and the principal may not deliberately monitor the agent in equilibrium. Our contribution is to investigate some crucial elements of this theory by using the experimental methodology which enables us to provide a direct test in a controlled real work environment. This methodology is indispensable to provide data with key variables which are often unobservable in other methodological frameworks.

The costs of influence activities depend on how the information is gathered and whether the principal’s decision impacts the reward system in the organization. In this chapter, our aim is

to test some features of the influence costs theory. More precisely, we focus on the willingness of agents to engage on timewasting activities and on the impact of these influence activities on the principal's discretion regarding the allocation of rewards. For this purpose, we use the virtual organization software that embeds key features of real workplace environment such a long, repetitive and effortful task (e.g. Dohmen and Falk, 2011; Eriksson et al., 2009; Niederle and Vesterlund, 2007), an on-the-job leisure activities (internet browsing) and real-time monitoring (Corgnet et al., 2014). Our workplace environment considers organizations with one principal and three agents which can separately complete a work task and browse the web. To mimic the influence activities, we allow agents to falsely increase their level of production instead of work to generate value to organization in order to have the higher piece of cake. We conducted a 2×2 design in which influence activities were either available or not. Depending on the treatment, agents received a fixed pay (*Equal pay*) or a variable pay (*Discretionary pay*) allocated by the principal at the end of each session. We have measured influence activities by analyzing the time spent by agents on an activity which enables them to artificially increase their performance. The study of the allocation of rewards made by the principal will also has enabled us to evaluate the efficiency of his decision (influence costs).

According to influence costs theory, we found that agents are willing to expend resources to influence the principal's decision and that the principal's discretion represents a higher incentive for agents to engage on timewasting activities. We report that agents who engaged in influence activities spent an average of 9.28 % of their time to artificially increase their level of production by 45.25% as observed by the principal. As the consequence, the individual production is around \$3 lower on average when influence activities are available compared to when they are not under *Discretionary pay*. Unexpectedly, we also find that agents engaged on influence activities in the fixed pay reward system. This result is consistent with the findings of Charness et al. (2014) that status seeking may lead agents to engage in costly actions. Regarding the influence costs, we find that influence activities lead principals to make more inefficient decisions by giving the higher pay to the wrong agent or by weakening incentives in presence of influences activities. Indeed, the pay of the best performers is around \$1 lower on average per period under *Discretionary pay*. The remainder of the chapter is structured as follows. Section 2 describes the used software and the experimental design. Section 3 presents our main behavioral hypotheses. The results of the experiment are provided and discussed in section 4. Section 5 concludes.

II2. Experimental design and procedures

We used the Virtual organization software¹¹ to run our experiment because this software reproduces some relevant features of real work environment. Indeed, participants can undertake a real effort task, monitor each other, cheating and browsing internet during the experiment (Corgnet et al., 2014). This software enables us to record time spent on each activity by each participant and also when and how many times they switch from one activity to another one.

II2.1. Game design

Our virtual workplace environment considers organizations with two levels of hierarchy referred to subject B as agent at the lower level and subject C as principal on the top of the hierarchy. Each organization consisted of one principal and three agents, they learned about their role at the beginning of the experiment. Participants kept the same role and the same partners that they were randomly assigned and matched for the whole duration of the experiment. All participants were able to undertake three different activities separately in a different screen by choosing the corresponding option from a drop-down menu at the bottom-right of their screens. The activities consisted to *work* (*Task* option) and *browse the web* (*Internet* option) for both principal and agents. Agents had an additional activity that consisted to *influence* (*boost* option) the principal while the later was able to *monitor* (*watch* option) then. The workplace environment and activities are described in detail below.

II2.1.1. The work task

The work task consists in summing up 36 numbers in a table with 6 rows and 6 columns. It is a long, repetitive and effortful task already used in others studies (Corgnet et al., 2015a; 2015b). This task was designed to reduce as much as possible the intrinsic motivation derived from performing the task just for its sake. Each participant is given a same set of tables generated randomly with the same level of difficulty. Before providing the total sum of all numbers in the table, they have to fill in the 6 cells that correspond to the sums of the 6 columns of randomly-generated integers between zero and three (see Figure II.1).

¹¹ <https://sites.google.com/site/corgnetb/virtual-organizations>.

Participants were not allowed to use a calculator or any other electronic, computer-based or internet-based devices to sum up numbers. Each correct completed table provided 60 cents of individual production while 30 cents were subtracted if the answer was incorrect. Penalties did not apply when individual production was equal to zero¹².

Figure II. 1: Task screen

Subject: B12							Time Remaining: 02:54
	Column1	Column2	Column3	Column4	Column5	Column6	
	0,00	0,00	3,00	0,00	3,00	3,00	
	0,00	1,00	3,00	3,00	2,00	1,00	
	3,00	1,00	2,00	3,00	2,00	3,00	
	3,00	3,00	1,00	0,00	0,00	0,00	
	1,00	1,00	3,00	0,00	2,00	3,00	
	2,00	3,00	0,00	1,00	2,00	2,00	
Sum Column:							

II2.1.2. Leisure activity (Internet)

Our computerized firm environment enables participants to undertake a leisure activity. The first window displayed on the computer screen of each participant at the beginning of a given period was a Google page embedded in the software. Both agents and principal were able to browse the internet at any time during this experiment. Participants were informed about the confidentiality of their usage of internet, they were free to consult their email or visit any web page. Participants can access the internet screen by clicking on the *Internet* option in the drop-down menu; they were unable to undertake another activity while they were browsing the web. This activity enables us to implement a real leisure activity at the workplace.

II2.1.3. Monitoring activities

Only the principal was allowed to use the *watch* option during the experiment. This activity enabled him to observe the production of all agents at any time during the experiment by accessing a separate window with a monitoring screen. By using the *watch* option, the principal was informed in real time of the amount of individual production in cents of all agents. He was also informed of their relative production to the total production of the organization in percentage terms. The principal was able to observe one or all agents' production at the same time. However, he was unable to undertake another activity during this time. The principal was also unable to know the activities completed by agents. The principal

¹² The individual production can never be negative thus could not decrease the total team's production.

received a monitoring summary at the end of each period with information about the individual and the relative productions of each agent and the last time he used the *watch* option. We have to notice that information about agents' production as observed by the principal could be false if one or several agents were manipulating their production. However, the principal could deduce that there is wrong information¹³.

II2.1.4. Influence activities

In order to implement influence activities, we gave to agents the ability to manipulate information about their performances by pretending that they produce more than they really do. This activity which was referred to as *boost* in the experiment allowed agents to exaggerate their amount of production as observed by the principal at any time during the experiment. To do so, they just had to select the *boost* option in the action menu and enter the amount by which they wanted to increase their production as observed by the principal. After clicking on a confirmation button, agents were unable to complete any other activity during 30 seconds. By using the *boost* option, agents reduce by 5% the time they should dedicate to work. The amount by which agents exaggerated their production was recorded in the history panel at the bottom of their screen while the amount of their actual production remains unchanged. So agents were able to keep track of their influence activities and evaluate their impacts at the end of the session. This *boost* option has two aspects which will enable us to measure influence activities: the time spent by agents and the total amount they entered to artificially increase their production.

The monitoring summary of the principal also reflected this exaggeration but, as the result of influence activities, the sum of agents' production he observed differed from the actual total production. So, the principal was able to know whether one or several agents had artificially increased their production. However, the principal was unable to know neither the one who exaggerated his production nor by which amount his production had increased if he didn't monitor them in real time. This is the case because the monitoring screen does not give information about the activities completed by each subject. But, by monitoring on real time, the principal could be able to detect influence activities if someone was entering an amount different of 60. Also, by observing on real time or by reading the monitoring summary at the

¹³ By observing agents, principals were able to deduce if they used the *boost* option when they entered an amount different of 60.

end of the period, the principal was able to realize whether someone increased his production if his individual production was not a multiple of 30.

II2.1.5 Payment schemes

There are two types of payment schemes. Participants were rewarded a share of the total production which is the sum of the individual production of the principal and the three agents at the end of each period. The principal always gets 40% of the total production regardless the payment scheme. Agents get the remaining 60% of Total production at the end of each period as follow: In the *Equal pay* reward system, each of them always received 20% of the total production while in the *Discretionary pay* reward system; principal has to divide the remaining 60% of total production among the 3 agents according to his discretion¹⁴. In the last row of the monitoring summary, principal decided upon the allocation by entering numbers in the corresponding green cells. Once principal has entered the shares allocated to each agent, all agents were informed about their pay of the total production as well as the pay they received in the history panel at the bottom of their screen.

II2.2. Treatments

We ran a 2 x 2 experimental design resulting in four treatments. Payment schemes and influence activities were the parameters which varied between treatments. The treatments are outlined in the table below (Table II.1). In each treatment, participants were randomly matched with 3 others at the beginning of the experiment and kept the same partners for the whole duration of the experiment. In the baseline treatment also called *NIEP* treatment (*No influence + Equal pay*), all participants are able to work, browse internet but only the principal was able to use the *watch* option. The payment scheme for this treatment is *Equal pay*, each agent of the same organization always has the same pay at the end of each period. The *NIDP* treatment (*No Influence + Discretionary pay*) is the second treatment of our experiment, this treatment differs from the first one in the payment scheme. Indeed, *Discretionary pay* is the reward system for this treatment, the pay of each agent depends of the discretion of the principal. The third treatment, *IEP* treatment (*Influence + Equal pay*) is similar to the first one but agents have the *boost* option, and thus are able to artificially

¹⁴ Each subject B can be allocated a different percentage of the total production and this percentage can be changed by subject C at the end of each period.

increase their production. The *IDP* treatment (*Influence* + *Discretionary pay*) is the last treatment, it is similar to the third one because agents had the *boost* option but the reward system is the *Equal pay*.

Table II. 1: Summary of treatments

		Payment schemes	
		<i>Equal pay</i>	<i>Discretionary pay</i>
Influence activities	Influence	<i>IEP</i> treatment (16 groups)	<i>IDP</i> treatment (16 groups)
	No Influence	<i>NIEP</i> treatment (15 groups)	<i>NIDP</i> treatment (15 groups)

In treatments *IEP* and *IDP*, agents are able to artificially increase their production as perceived by the principal; we will refer to these treatments as *Influence* treatments. Treatments *NIDP* and *IDP* will also be called *Discretionary* treatments because in these 2 treatments, the pay received by agents depends on the principal's discretion.

II2.3. Procedures

The experiment took place in March and April 2014 at the Economic Science Institute (ESI) of Chapman University, we recruited 252 students (51.61% females) from this university. We conducted 21 sessions with 63 groups of 4 students each but, one student left the experiment because of a headache, so we lost the data of one organization. So, we just collected data from 62 groups (248 students). Between 12 and 24 individuals who were invited through the ESI recruiter software participated in each session. Each session lasted around one hour and half with 5 periods of 10 minutes. Participants' earnings at the end of the experiment were computed as the sum of the earnings of the 5 periods. Regardless their role, participants earned on average \$32.5¹⁵ including a show-up fee of \$7.

Participants had 20 minutes to read the instructions displayed on their computer screen. A timer that indicates the remaining time to read the instructions was displayed on the laboratory screen. A printed copy of the summary of the instructions was given to each

¹⁵ This amount also includes the earnings of the first stage in which participants were asked to sum five one-digit numbers.

subject two minutes before the end of the instructions round. The experimenter closed the instructions file after the time required for the instructions reading. We noticed that participants finished reading the instructions in less than 20 minutes. We gave the ability to participants to require assistance if they had any questions during the instruction round or if any difficulties arose after the experiment has begun by raising their hand, but none of them asked questions during the instructions round. When the instructions file was closed, a pop up inviting the subject to type their name was displayed on their computer screen.

Table II. 2: Summary of the experimental design

	248 participants were matched in organization of 4 members : one principal and three agents			
Treatments	<i>IEP</i>	<i>NIEP</i>	<i>IDP</i>	<i>NIDP</i>
	<i>Equal pay</i>		<i>Discretionary pay</i>	
	Influence	×	Influence	×
First stage	Ability test			
Second stage	Session (5 periods of 10 minutes each)			
Third stage	×		Allocation stage (at the end of each session)	
Fourth stage	Payment stage (at the end of the experiment)			
END				

The experiment started with an ability test. Before receiving instructions, participants were invited to sum as many five one-digit numbers as they could during two minutes. Each correct answer was rewarded 10 cents and the total earnings of this stage were added to the individual earnings of the participants at the end of the experiment. The number of correct answers is what we refer to as “*Ability*” in the rest of this chapter. A google page was displayed on the computer screen of each subject when the experimenter launched the session, they were able to browse internet or switch to another activity. Participants were able to get access of information about all previous periods through the history table at the bottom of the screen.

II3. Behavioral hypotheses

Before formulating the behavioral hypotheses that we expect in our treatments, we have to notice that our objective is to test the influence costs theory. The main prediction of this theory is that influence activities arise when the principal has discretion over decisions with some distributional implications (Milgrom and Roberts, 1988). We focus on the time wasting activities and on the impact of influence activities on the principal's decision making.

II3.1. Influence activities

The influence costs theory assumes that agents will engage on time wasting activities in order to manipulate the information required for the principal to make decisions. If agents spend time on influence activities, they will spend less time on productive activities. In our design, when a participant undertakes an influence activity which helps him to artificially increase his production, he is unable to switch to another activity during 30 seconds. This time is subtracted from the time available for a given period which could be spent in productive or leisure activities. According to Milgrom (1988) and Milgrom and Roberts (1988, 1990b), the principal's discretion is the most powerful incentive on influence activities. When the principal's making decision can impact the distribution of payoffs, individuals are more willing to spend time and resources to engage on influence activities. In *Discretionary* treatments, the principal has to allocate 60% of the total production between three agents that is how we implement the principal discretion. Therefore, agents in *IDP treatment* should be more willing to provide information which makes them look good relative to others in order to get the higher pay.

Hypothesis 1: When influence activities are available, we expect that agents will devote time to these activities and unduly overstate their productivity indicate. The highest level of influence activities will be reached in *IDP* treatment.

Hypothesis 2: When influence activities are available, we expect that agents will spend less time on productive activities. The lowest percentage of time will be reached in *IDP* treatment under *Discretionary* treatments and *Influence* treatments.

II3.2. Influence costs

The costs for the firm are twice: first because the agent misuses time and resources by attempting to affect the principal's decision making and secondly because that leads the principal to make inefficient decisions (Milgrom, 1988; Milgrom and Roberts, 1988, 1993). We will measure the individual production of each member of the organization since the time devoted by agents to influence activities will reduce their time spent on productive activities and may affect their performance. The analysis of the allocation of rewards made by the principal will also enable us to evaluate the costs generated by the influence activities.

II3.2.1. Productivity

The agency theory assumes that agents will exert the minimum effort in order to maximize their payoff if they receive a flat wage and if there is any monitoring and penalty for shirking. Several studies in economics showed that individuals' performance is higher in tournament system than in other pay systems (Gneezy et al., 2003; Carpenter et al., 2010). According to the influence costs theory, the principal's discretion should create high incentives to influence activities and therefore weaken the strength of this payment scheme. Therefore, the production of the team may be lower because agents will engage on influence activities and principals may spend more time on monitoring activity.

Hypothesis 3: We expect the individual production to be lower in *IDP* treatment under *Discretionary* treatments.

II3.2.2. Decision making

The study of the allocation of rewards made by the principal will enable us to evaluate the efficiency of his decision. More precisely, we define efficient decision as the allocation of the highest pay by the principal to the best producer and so on. Influence activities lead the principal to make inefficient decisions regarding the allocation (Milgrom, 1988; Milgrom and Roberts, 1988, 1993). Therefore, if an agent uses the *boost* option, he may receive a higher pay than he deserves. Indeed, by trusting the information on the summary screen at the end of the session, the principal may not reward the meritocracy if a given agent artificially increased his level of production. The *watch* option may be helpful for the principal to detect some influence activities. Indeed, by monitoring on real time, the principal could detect influence activities if an agent was entering an amount higher or different than 60 even if this amount is

a multiple of 30 or 60¹⁶. Also, by observing on real time or by reading the monitoring summary at the end of the period, the principal can deduce whether someone increased his production if his individual production was not a multiple of 30. In order to have the right information to make the right decision, the principal in *IDP* treatment should face this dilemma: either he increases the size of the cake by producing himself or spends more time on monitoring activity.

Hypothesis 4: Under *Discretionary* treatments, we expect: *i)* Principals in *IDP* treatment to make more inefficient decisions regarding the allocation of pay. *ii)* Principals in *IDP* treatment to spend more time on monitoring activity and less time on productive activity. *iii)* Principals to identify and punish some influences activities in *IDP* treatment.

II4. Results

This section includes descriptive statistics and econometric analysis of experimental data. We thus consider a total of 320 observations for each of the *influence* treatments and 300 observations for each treatment without influence activities. These observations are related for the 5 periods, three fourths correspond to data on agents while the remaining observations correspond to principals. We start the section by comparing agents' time dedication on each activity across treatments; we also report p-values of the clustered t-tests (Wilcoxon rank-sum test) on the difference of means. The second part of this section presents an econometric analysis of the effect of influence activities on principals' decisions by using linear panel regressions with random effects and clustered standard errors to consider the fact that observations may not be entirely independent.

II4.1. Descriptive statistics of time dedication on each activity per treatments

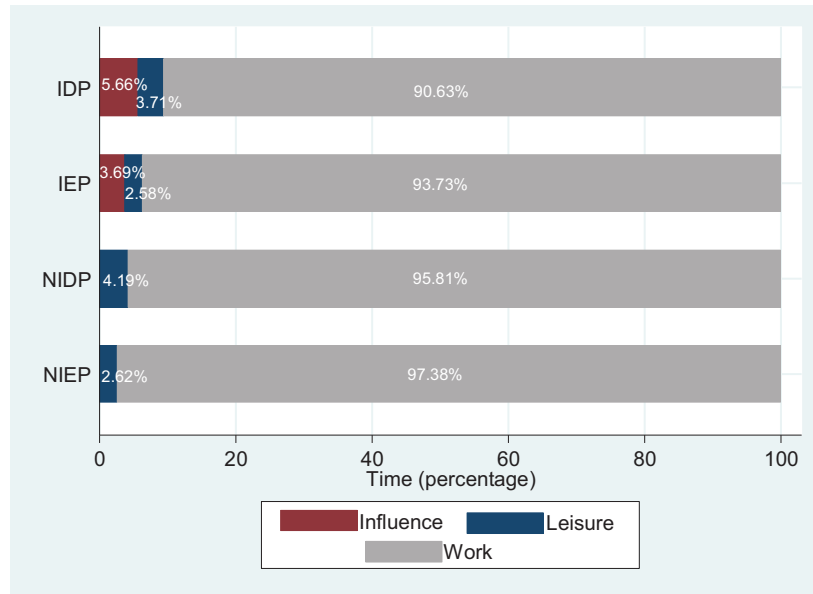
We provide descriptive statistics regarding influence activities as well as work and leisure activities.

¹⁶The principal can observe on real time the difference in the production if an agent chooses an amount higher than 60 which the amount generated by each correct table.

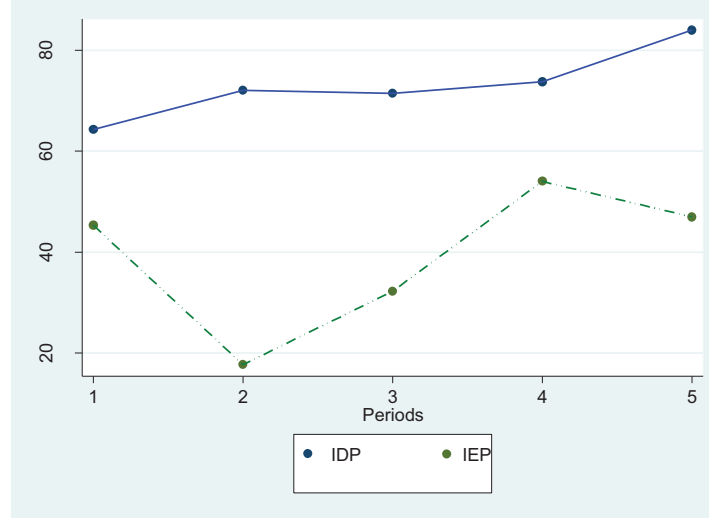
II.4.1.1. Influence activities (Time and amount)

The figure below displays the average time spent by agents of each treatment on each activity; remember that each participant could undertake separately 3 different activities in each period.

Figure II. 2: Time dedication on each activity per treatments



We can see on Figure II.2 that agents in *IDP* treatment devoted more time on influence activities on average than agents on *IEP* treatment ($5.66\% > 3.69\%$). This difference between *influence* treatments is statistically significant ($z = 2.34, p = 0.02$). Agents who engaged on influence activities in *IDP* treatment spent an average of 9.28 % of their time by using the *boost* option in a given period. It follows that the average total amount by which agents artificially increased their production was also higher in *IDP* treatment (85.72 cents) than in *IEP* treatment (52.32 cents). This result is statistically significant ($z = 2.16, p = 0.03$). Figure II.3 shows the average total amount chosen by agents in *influence* treatments to exaggerate their production. We can observe that agents in *IDP* treatment entered an amount higher than 60 cents (the equivalent of one correct table) on average. This amount was equal to 148 cents (the equivalent of 2.5 correct tables) on average for agents who used the *boost* option. These influence activities represented almost the half (45.25%) of their production level as observed by the principals and increased over time. These results confirm that the rent seeking was the reason why agents engaged on influence activities. These findings are in line with the predictions theory and with our expectations (see Hypothesis 1).

Figure II. 3: Average amount of influence activities in cents

Unexpectedly, we can also notice that agents on *IEP* treatment also engaged on influence activities even if there was no consequence on their payoffs. Figure II.3 also shows that they exaggerated their production by an amount lower than 60 cents on average. This result is consistent with the finding that status seeking could lead people to engage in costly actions (Charness et al., 2014). We also suggest that a proportion of these influence activities resulted from agents' curiosity regarding the boost option or from demand effects (Zizzo, 2010). However, the dynamic of influence activities in this treatment seems to suggest that agents were more concerned by their relative status than the satisfaction of their curiosity.

II.4.1.2. Work and internet time

We can see on Figure II.5 that on average, agents in *IDP* treatment devoted the lowest percentage of time on productive activity than others $90.63\% < 93.73\% < 95.81\% < 97.38\%$ respectively *IEP*, *NIDP* and *NIEP* treatments. We find a significant difference between the average time spent on this activity by agents under *Discretionary pay* ($95.81\% > 90.63\%$ with $z = -3.41, p < 0.01$). The percentage of time spent on productive activity by agents who used the *boost* option was equal to 86.25%. This result highlights that the competition leads agents to work hard but the influence activities weaken the strength of this reward system. We also find a significant difference when we compare agents in *influence* treatments ($z = -2.60, p < 0.01$), agents in *IDP* treatment worked less than agents in *IEP* treatment. These results are consistent with our Hypothesis 2, agents in *IDP* treatment spent less time on productive activities than others agents under *Discretionary* treatments as well as under *Influence* treatments.

Regarding internet usage, we find a significant difference between the average time spent by agents on leisure activity under *Equal pay*. Agents in *NIEP* treatment devoted more time on internet usage than agents on *IEP* treatment ($z = -2.12, p = 0.03$). The surprising part of this finding is to observe that agents on *IEP* treatment spent more time on influence activities (3.69% of their time) than on leisure activity (2.58% of their time). As discussed above, status seeking, curiosity and demand effects may explain this result. Our findings are summarized as follows:

Results 1: influence activities

- i. Influence activities (time and amount) are highest in *IDP* treatment.
- ii. Agents in *IDP* treatment spend less time on productive activity than others when we compare agents on *Discretionary* treatments as well as *Influence* treatments.
- iii. Surprisingly, agents also engage in influence activities on *Equal pay* reward system.

II4.2. Influence costs

Influence costs result from timewasting activities of agents and inefficient decisions made by principals. In order to have the right information to make the right decision, principals may spend more time on monitoring activity; thus the organizational performance may suffer because principals and agents will spend less time on productive activities. In the following sections, we present econometric analysis regarding influence costs.

II4.2.1. Productivity of the organization

The production is defined as the number of correct answers multiplied by 60 minus the number of incorrect answers multiplied by 30. We report regressions which analyze the effect of influence activities on principals and agents' production in Table II.3. We introduce dummy variables *Influence treatments* and *Discretionary treatments* that take value one if a given participant was involved in treatments with *boost* option or in treatments with *Discretionary pay* and zero otherwise. We also include a proxy of participants' summation skills which refers to the results of the summing up five one-digit numbers during two minutes.

Table II. 3: Linear panel regression for individual production for *Discretionary* and all treatments

	Production	
	<i>Discretionary</i> treatments	All treatments
	(1)	(2)
<i>Discretionary treatments</i>		46.62* (26.25)
<i>IDP treatment</i>		-77.42** (34.99)
<i>Influence treatments</i>	-67.36*** (25.89)	13.28 (22.96)
Trend	32.10*** (5.00)	30.23*** (3.39)
<i>Ability</i>	20.92*** (1.79)	20.83*** (1.81)
Male dummy	32.71 (30.26)	12.76 (19.69)
Constant	82.20** (37.81)	51.26* (29.99)
Observations	620	1220
Number of subjects	124	244
Number of teams	31	61
R ² overall	0.305	0.283
Model test chi2 (6)	208.32***	277.49***

Notes: Estimation output using robust standard errors clustered at the team level (in parentheses). Coefficients * significant at 10%; ** significant at 5%; *** significant at 1%.

In line with Hypothesis 3, we report a negative and significant effect of influence activities on teams' production (see dummy *Influence treatments* in column (1)). By contrast, the coefficient related to influence activities is not negative when considering all treatments (see dummy *Influence treatments* in column (2)). This result follows from the fact that the incentive effect of *Discretionary pay* reward system is weaker than *Equal pay* in presence of influence activities¹⁷. However, we observe a negative and significant effect of influence activities in *IDP* treatment and a positive and significant effect of *Discretionary pay* on

¹⁷ Table II.6 in appendix II also shows that the individual production was on average \$1.70 lower in the *IDP* treatment than in *IEP* treatment. But, this difference is not significant.

teams' production (see dummy variables in column (2)). Indeed, the level of production was decreased by \$2.98 under *Discretionary pay* when influence activities were available¹⁸. As principals and agents spent less time on working activity in *IDP* treatment, they were less productive than others¹⁹. We also observe that the level of production was 12.63 % higher in *Discretionary pay* compared to *Equal pay* in absence of influence activities ($z = 1.7, p = 0.09$). These results suggest that *Discretionary pay* is the most incentive reward system. This is consistent with studies of Gneezy et al. (2003) and Carpenter et al. (2010) which have shown that people are more productive in a competitive reward system. Nevertheless, our results also show that the presence of influence activities weakens the strength of this reward system. In line with learning effects (Charness and Campbell, 1988), we observe a positive trend in individual production regardless regressions. The relationship between individual production and summation skills (*Ability*) is also positive and significant in both regressions. This suggests that summation skills were driving agents' performance.

II4.2.2. Decision making

In this section, we analyze the effect of influence activities on principals' decision regarding the allocation of pay. We study the pay²⁰ received by agents from principals at the end of each period in *Discretionary* treatments. We create the variable "*Actual contribution*" which refers to the share (in percentage) of the relative agents' actual production on total production minus principals' production. We include the variable "*observed production*" which is the sum of the individual production and the amount by which agents exaggerated his level of production²¹. We also define variables *Best producer*, *Second producer* and *Least producer* which refer to the ranking agents according the *observed production* which is the production as perceived by principals during the monitoring activity and on the summary screen.

¹⁸ The individual production was 11.56 % lower on average in *IDP* treatment compared to *NIDP* treatment (see Table II.6 in appendix II); this difference is significant ($z = -1.8, p = 0.07$).

¹⁹ Principals also spent less time on working activity in *IDP* treatment (90.75%) compared to principals in *NIDP* treatment (93.19%) and principals in *IEP* treatment (93.36%). The difference is only significant when we compare the time spent on working activity by principals under *Discretionary* treatments ($z = -2.17, p = 0.03$).

²⁰ The pay is computed as the relative share on remaining 60% of the total production allocated by the principal to each agent.

²¹ The *observed production* is equal to the actual production in *NIDP* treatment.

Table II. 4: Linear panel regression for pays allocated by the principal in *Discretionary* treatments

	Pay			
	IDP (1)	NIDP (2)	IDP (3)	NIDP (4)
<i>Actual contribution</i>	0.34*** (0.093)	0.43** (0.218)		
<i>Observed production</i>	-0.00*** (0.000)	0.01 (0.005)	-0.00*** (0.000)	0.01** (0.006)
Trend	-0.07 (0.078)	-0.18 (0.176)	-0.07 (0.109)	-0.45* (0.270)
<i>Ability</i>	-0.03 (0.194)	0.51** (0.217)	0.01 (0.174)	0.28 (0.247)
Male dummy	1.35 (2.211)	-1.99 (0.314)	0.98 (1.591)	-1.09 (1.756)
Best producer			2.84 (2.095)	6.82*** (2.357)
Least producer			-7.50*** (2.164)	-5.72*** (1.403)
Constant	22.18*** (2.967)	9.78** (4.904)	34.72*** (2.830)	24.49*** (3.029)
Observations	240	225	240	225
Number of agents	48	45	48	45
Number of teams	16	15	16	15
R ² overall	0.244	0.546	0.202	0.527
Model test chi2 (4)	9613.77***	58.34***	14352.21***	115.92***

Notes: Estimation output using robust standard errors clustered at the team level (in parentheses).
Coefficients * significant at 10%; ** significant at 5%; *** significant at 1%.

The first two models of Table II.4 analyze the effect of *Actual contribution* and *observed production* on pay for *IDP* treatment (column 1) and *NIDP* treatment (column 2). The coefficient of *Actual contribution* is positive and significant in each treatment. This means that agents were rewarded according their performance but, the coefficient is higher in *NIDP* treatment. The relationship between individual production and pay is lower in treatment with influence activities ($0.43 > 0.34$). We also observe that the pay has a negative relationship with variables *observed production* and *Ability* in *IDP* treatment. The opposite is observed in *NIDP* treatment, variables *observed production* have a positive effect on agents' pay. However, these relationships are only significant for *observed production IDP* treatment and

for and *Ability* in *NIDP* treatment. We suggest that principals did not always rely on what they observed to make their decision or were negatively influenced by *observed production* in *IDP* treatment. While summation skills were driving agents' performance and pay in absence of influence activities.

Results in columns (3) and (4) study the allocation of pay by principals between three agents. We find that the *Best producer* received a significant higher pay and the *Least producer* received a significant lower pay relative to the second contributor in the *NIDP* treatment (see dummy variables in column 4). This suggests that agents were rewarded according their performance in the treatment without influence activities. In the treatment with influence activities, the *Least producer* also received a significant lower pay relative to the second contributor but, the difference between the *Best producer* and the second contributor is positive but not significant. It appears that principals seem to distrust the best contributor according to what they observed by allocating to him a lower pay proportionally to his contribution. It follows that the *observed production* is negatively related to agents' pay.

We find support of this interpretation. Indeed, the percentage of times that principals allocated the higher pay to the *Second producer* and the second pay to the *Best producer* was equal to 25.49% in *IDP* treatment compared to 12.92% in *NIDP* treatment. This result is statistically significant (proportion test, $p\text{-value} = 0.006$). More interestingly, agents' pay was \$ 2.29 lower on average than their *observed production* in *IDP* treatment. The difference between the production as observed by principals and the pay was equal to \$ 1.30 in *NIDP* treatment, this result is statistically significant ($z = 2.24, p = 0.03$). We suggest that this difference²² is so high because some principals mimicked the *Equal pay* in the *Discretionary* treatments. Consistent with our Hypothesis 4*i*, the influence activities lead principals to make more inefficient decisions regarding the allocation of pays.

Regarding the time spent by principals between working and monitoring activities, we find that on average, principals on *IDP* treatment spent less time on productive activity than principals on *NIDP* treatment, this difference is also significant ($z = -2.17, p = 0.03$). We do not find any significant result regarding the monitoring activity. Principals did not spend more time on this activity when influence activities were available. It seems that they chose to

²² The difference between the production as observed by the principal and pay could be negative if principals allocated a pay proportionally lower than the observed production. As the calculator was not allowed, we suggest that principals in both treatments did not always allocate the right pay proportionally to agents' contribution.

increase the size of cake rather than monitoring agents. This result is consistent with the finding of Corgnet and Rodriguez-Lara (2013); the principal may not deliberately monitor the agent in the presence of influence activities.

We start to test Hypothesis 4iii by creating the variable *undetectable influence* which takes the value 1 if the agent chose an amount multiple of 30 when using the *boost* option and 0 otherwise. We differentiate influences activities since each correct answer generated 60 cents while an incorrect answer implied a penalty of 30 cents. So influence activities were easily detectable whether an agent entered an amount which was not a multiple of 30.

Table II. 5: Linear panel regression for pay allocated by the principal in *IDP* treatment

	Pay	
	(1) Periods 1& 2	(2) Periods 3 to 5
<i>Actual contribution</i>	0.34*** (0.621)	0.19** (0.094)
<i>Undetectable influence</i>	5.99** (2.756)	-0.94 (2.416)
<i>Ability</i>	-0.46 (0.296)	0.12 (0.232)
Male dummy	0.92 (2.235)	2.64 (3.679)
Constant	27.28*** (4.240)	23.67*** (4.012)
Observations	44	82
Number of agents	31	33
Number of teams	31	31
R ² overall	0.506	0.08
Model test chi2 (4)	49.13***	13.60***

Notes: Estimation output using robust standard errors clustered at the team level (in parentheses). Coefficients * significant at 10%; ** significant at 5%; *** significant at 1%.

In Table II. 5, we analyze the effect of undetectable influence activities on agents' pay for the first two periods (column 1) and for the last three periods (column 2). We control for the variable *Actual contribution* as it appears to be the main driver of agents' pay. These

regressions analysis allow us to study whether principals did detect influence activities or not. We observe that the performance is better rewarded at the first two periods (see variable *Actual contribution* in Table II. 5, $0.34 > 0.19$). We also observe a positive and significant effect of *undetectable influence* at the first two periods (see dummy variable in column (1)). The *undetectable influence* seems to help in the first two periods only. Indeed, the coefficient of *undetectable influence* is negative but not significant for the last three periods. It seems that principals detected and punished the *undetectable influence* during the last periods. However, the R^2 is very low showing that the model does not explain agents' pay any more for these periods. We summarize our last finding as follows.

Result 2: Impact of influence activities

- i. The individual production is lower in *IDP* treatment under *Discretionary pay* as well as under influence activities.
- ii. Principals in *IDP* treatment make more inefficient decisions regarding the allocation of pay.
- iii. Unexpectedly, principals on *IDP* treatment do not spend more time on monitoring activity under *Discretionary pay* but they devote less time on productive activity than principals on *NIDP* treatment.
- iv. The positive effect of undetectable influence activities vanishes over time.

II5. Conclusion

The adoption of new technologies has to be combined with organizational changes for a better firm efficiency (Milgrom and Roberts, 1990; Brynjolfsson and Hitt, 2000). These changes positively affect workers' performance but also entail some costs for firms (Colombo and Delmastro, 2004; Bertschek and Kaiser, 2004). A part of these costs may be generated by workers' behaviors who are reluctant to these changes or who can try to influence changes on their interests (Milgrom, 1988; Milgrom and Roberts, 1988, 1990b; Schaefer, 1998). The investigation of these costs is worthwhile for technologies issues because the use of ICT at workplace opens more channels of communication and means for workers to influence managers' decision. Indeed, some technologies push down the decision making at the level of workers by decreasing the costs of acquiring information. So, the implementation of technologies at work may create more opportunities for employees to engage on counterproductive behaviors.

In this chapter, our contribution was to use the experimental methodology for testing some conjectures of influence costs theory which highlights the substantial costs generated by workers when they can manipulate information to influence managers' decision. According to Milgrom and Roberts (1988), managerial discretion is the most important incentive for influence activities. Our experimental design consisted of two treatments in which agents were allowed to engage on timewasting activities with and without managerial discretion regarding the allocation of pays. We also ran treatments with a fixed wage reward system to study agents' behavior regarding influence activities when there is any managerial discretion. We measured influence activities by analyzing the time spent and the amount entered by agents on an activity which enabled them to artificially increase their performance.

Our findings are consistent with the theoretical predictions of the influence costs literature. Workers wasted time on unproductive activities in order to influence managers' decision. We report that agents who engaged in influence activities spent almost 10% of their time on average to artificially increase their level of production. As the consequence, they spent less time to work and team production was 12.63% lower on average when the influence activities were available than when they were unavailable under *Discretionary pay*. Unexpectedly, we also found that workers also engaged in time wasting activities in *Equal pay* reward system. The willingness to engage on influence activities may also be driven by non-monetary incentives. This result seems to be consistent with recent research showing that status seeking may also lead people to misbehave at work.

We showed that influence activities dampen strength incentives of competition and lead managers to weaken the meritocracy. Indeed, the team production was higher in *Equal pay* than in *Discretionary pay* in presence of influence activities whereas the opposite was true when influence activities were unavailable. As influence costs, we also found that influence activities led managers to make more inefficient decisions by giving the higher pay to the wrong worker or by mimicking the *Equal pay* reward system.

Some limitations of our work should be mentioned. The virtual organization software doesn't allow for negative individual production. Indeed, penalties were not applied when individual production was equal to zero. We probably lost information about influence costs since the individual production could lower the production of the team. Our experimental design allowed participants to enter the amount they wanted to increase their production. Certainly, that enabled us to implement situation in which some employees fail to influence their

manager, but we also suggest that employees who entered a detectable amount to increase their production didn't well understand how the *boost* option worked.

According to Antonelli (2003), influence activities are self-limiting and can improve the performance of the organization. Therefore, influence activities can have some benefits which could be higher than costs and may be preferable for firms in some cases. More research is needed to address the benefits of influence activities. The implementation of Information technologies leads to a wider span of control for managers (Bloom et al., 2014); further research could assess the relationship between influence costs and the size of the span of control. Another study may investigate the relationship between influence activities and the degree of managerial discretion.

The main managerial implication is to close communication channels for certain decisions since the use of ICT allows more opportunities for workers to influence managers' decision (Milgrom and Roberts, 1988). Firms should clarify task assignment and processes of information sharing in the organizational guidelines. Another implication is that limiting managerial discretion may be optimal to deter influence activities (Milgrom, 1988; Milgrom and Roberts, 1988; Bloom and Van Reenen, 2007). However, influence activities also prevail in organizations with non-monetary incentives. We suggest that firms have to take advantage of the technology-based monitoring which provides a heightened transparency of the work process and the instant availability of indicators of workers' performance.

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Appendix II

Table II. 6: Individual production per treatment for 5 periods

Treatments		Average	Standard	P-values
	Influence activities			
Discretionary pay	Influence (<i>IDP</i>)	456.10	209.10	$z = -1.8$
	No Influence (<i>NIDP</i>)	515.5	223.65	$p = 0.07$
Equal pay	Influence (<i>IEP</i>)	489.28	213.88	$z = 1.2$
	No Influence (<i>NIEP</i>)	457.7	211.63	$p = 0.22$

INSTRUCTIONS (NIEP)

- You have exactly 20 minutes to go through the instructions. You will have enough time to read the instructions carefully. A timer is displayed on the room monitor that indicates the remaining time to read the instructions.
- After that, the experimenter will close the current document and you will be able to access the experiment. Please do not close the current document and do not access the experiment before the end of the instruction round.
- A printed copy with a short summary of the instructions will be given to you at the end of the instruction round.
- This is an experiment in decision making. You will be paid in cash for your participation at the end of the experiment. Different participants may earn different amounts. What you earn depends on your decisions and the decisions of others.
- The experiment will take place through computer terminals at which you are seated. If you have any questions during the instruction round, raise your hand and a monitor will come by to answer your question. If any difficulties arise after the experiment has begun, raise your hand, and someone will assist you.

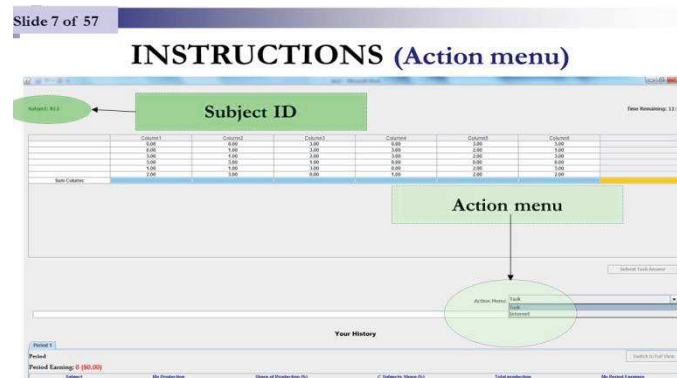
(Timing of the experiment)

- This experiment involves 4 subjects and consists of 5 periods of 10 minutes each. There are *two* types of subjects referred to as *B* and *C*.
- 3 subjects will be subjects *B* and *one* will be subject *C*. You will learn the type of subject you are when the experiment starts.
- Your individual earnings at the end of the experiment are computed as the sum of your earnings in the 5 periods.
- In each period of this experiment both subjects *B* and subject *C* will be able to: sum up numbers in a table (work task) or browse the web.
- Subject *C* will have access to another activity that consists in monitoring other subjects.
- To switch from one activity to another you just have to click on the corresponding option of the action menu displayed on your screen.
- The activities are referred to as *Task* (sum up numbers in a table), *Internet* (browse the web), *Watch* (monitor subjects *B* contributions – only available to *C*). Each activity is undertaken separately, in a different screen.

- Your experiment ID will be displayed on the top left corner of your screen once the experiment starts. It will consist of the letter *B* followed by a number if you are of type *B*. If you are the subject *C* your ID will be *C11*.

Task – summing up numbers

- The task consists in summing up 36 numbers in a table with 6 rows and 6 columns. Each subject is given a different set of tables with the same level of difficulty.
- Before providing your final answer (the total sum of all numbers in the table) you have to fill in the 6 cells that correspond to the sums of the 6 columns. Filling in these 6 cells does not directly generate earnings but it can help you to compute the final sum.



- Only after filling in all these cells will you be allowed to provide a final answer (the total sum) in the box located below the table on the left.
- Notice that **you are not allowed** using a calculator or any other electronic, computer-based or internet-based devices to sum up numbers.
- If you do, *you will be excused and you will not be paid*.
- Only the final answer (total sum of the table) is rewarded. Intermediate sums of all columns are required but are not rewarded.
- Each time you answer the task correctly (your final sum is correct) you generate *60 cents* of *Total production*. These *60 cents* is not directly added to your individual earnings.
- Each time you answer the task correctly (your final sum is correct) you generate 60 cents of *Total production*. These 60 cents is not directly added to your individual earnings.

- Subject *C* always gets 40% of *Total production* while each subject *B* gets 20% of the total profit contributed by all subjects undertaking the task.
- The amount of money you generate by undertaking the task is displayed in the second column “**My Production**” of the history table at the bottom of the screen.
- The total amount of money generated by all 4 subjects (subject *C* + 3 subjects *B*) on the task is displayed in the sixth column “**Total Production**” of the history table at the bottom of the screen.
- If you sum up the numbers of a table correctly then each subject in the experiment (including yourself) gets 60 cents times the *percentage of Total production* that he or she is assigned.
 - If you are subject *C* you get 24 cents ($40\% \times 60 \text{ cents}$).
 - If you are one of the subjects *B* you get 12 cents ($20\% \times 60 \text{ cents}$).
- If you answer the task incorrectly you generate a penalty of 30 cents that is subtracted from *Total production*. So when you answer incorrectly your individual earnings decrease by 12 cents ($40\% \times 30$) if you are Subject *C* and by 6 cents ($20\% \times 30$) if you are Subject *B*.

(Your Production can never be less than 0.)

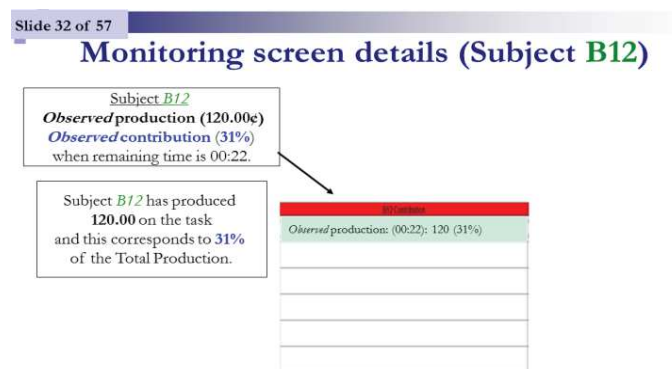
(Browsing the internet)

- Whether you are a subject *B* or subject *C*, you can browse the internet at any time during this experiment. Browsing the web is one of the basic activities that you can perform during this experiment, along with summing up numbers.
- You can access the internet screen by clicking on the *Internet* option in the action menu.
- Notice that while using the internet **you are not allowed** to download additional software. You are also expected to close pop-up windows when they appear on the screen.
- Your usage of the internet is **strictly confidential**. No one can see the web pages you are consulting (for example, your email).

Monitoring: only for subject *C*

- If and only if you are subject *C*, you can monitor the contribution of the three subjects *B* at any time during this experiment. You can do so by clicking on the *Watch* option in the action menu.
- You will be faced with a monitoring screen with 3 columns, each of them corresponding to one of the subjects *B* in the experiment. The head of each column indicates the experiment ID of the subject.

- For example, to monitor subject *B12*, you have to click on the column header “**B12**” displayed in green. The column header turns red once you click on the *Yes* button on the pop-up message: “*Ready to watch?*”
- You can monitor all subjects’ contributions at the same time by clicking on the following button displayed in the top right corner of the screen:
- You can stop monitoring all subjects *B* by clicking:
- To stop monitoring a given subject you have to click on the corresponding column header.
- You will be informed in real time of the *observed* production *and* contribution to *Total production* (in % terms) of the selected subject *B*.
- You will not know the activities completed by this subject, however.



INSTRUCTIONS (Earnings)

- Your individual earnings correspond to the following sum over the 5 periods:
 - ☐ Your *percentage* of *Total production* that has been generated by all 4 subjects (*C* subject + 3 *B* subjects) summing up numbers during the experiment.
- You will learn the exact amount of your individual earnings at the end of each *10-minute* period.

Earnings

- In the pop-up window, your individual earnings in *dollars* for the current period will be displayed.
- You will click on the OK button to continue to next period.

- Your earnings in *cents* for the current period will be also displayed in the last column of the history table at the bottom of your screen. This column is labeled “**My Period Earnings**”.
- You will also see the share of production of all other subjects at the top of your screen
- EXAMPLE: In the first period you provided 7 correct answers completing the task while providing 3 incorrect answers. Also, the other three subjects in the experiment provided a total of 24 correct answers in the task while providing 5 incorrect answers.
- Your *earnings* (“My Period Earnings”) for that period are equal to:
- *Earnings*: $20\% \times (31 \times 60 - 8 \times 30) = 324$ cents if you are a subject *B*
- *Earnings*: $40\% \times (31 \times 60 - 8 \times 30) = 648$ cents if you are subject *C*

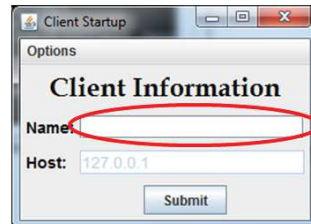
Summary

- This experiment involves 4 subjects and consists of 5 periods of 10 minutes each. There are *two* types of subjects referred to as *B* and *C*, respectively.
- 3 subjects will be subjects *B* and *one* subject will be subject *C*.
- In each period, both subjects *B* and subject *C* will be able to: *sum up numbers* in a table or *browse the web*.
- Only subject *C* will be able to monitor other subjects.
- Your individual earnings will depend on the task which consists in summing up numbers in a table.
- The total earnings generated by all 4 subjects (subject *C* + 3 subjects *B*) on the task will be divided as follows.
- Each subject *B* will get 20% of the total amount of money generated by all subjects while subject *C* always will get 40% of the total amount of money generated.

Slide 57 of 57

Please wait until the experimenter closes the current instruction screen.

- Please enter your **full name** in the following screen once the instruction screen has been closed by the experimenter.



The screenshot shows a window titled "Client Startup" with a tab labeled "Options". Inside the window, the section "Client Information" is visible. It contains two input fields: "Name:" and "Host:". The "Name:" field is currently empty and is highlighted with a red oval. The "Host:" field contains the text "127.0.0.1". Below these fields is a "Submit" button.

INSTRUCTIONS (Treatment NIDP)

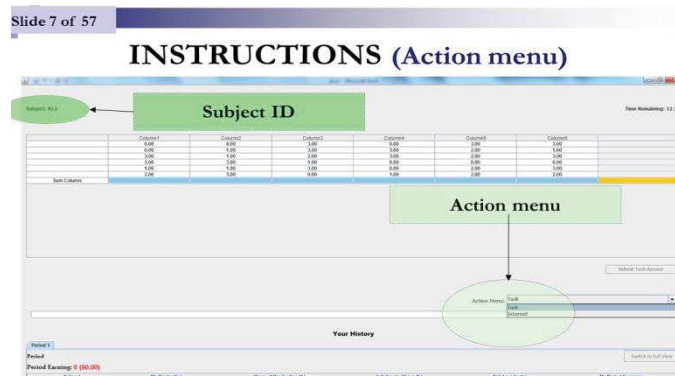
- You have exactly 20 minutes to go through the instructions. You will have enough time to read the instructions carefully. A timer is displayed on the room monitor that indicates the remaining time to read the instructions.
- After that, the experimenter will close the current document and you will be able to access the experiment. Please do not close the current document and do not access the experiment before the end of the instruction round.
- A printed copy with a short summary of the instructions will be given to you at the end of the instruction round.
- This is an experiment in decision making. You will be paid in cash for your participation at the end of the experiment. Different participants may earn different amounts. What you earn depends on your decisions and the decisions of others.
- The experiment will take place through computer terminals at which you are seated. If you have any questions during the instruction round, raise your hand and a monitor will come by to answer your question. If any difficulties arise after the experiment has begun, raise your hand, and someone will assist you.

(Timing of the experiment)

- This experiment involves 4 subjects and consists of 5 periods of 10 minutes each. There are *two* types of subjects referred to as *B* and *C*.
- 3 subjects will be subjects *B* and *one* will be subject *C*. You will learn the type of subject you are when the experiment starts.
- Your individual earnings at the end of the experiment are computed as the sum of your earnings in the 5 periods.
- In each period of this experiment both subjects *B* and subject *C* will be able to: sum up numbers in a table (work task) or browse the web.
- Subject *C* will have access to another activity that consists in monitoring other subjects.
- To switch from one activity to another you just have to click on the corresponding option of the action menu displayed on your screen.
- The activities are referred to as *Task* (sum up numbers in a table), *Internet* (browse the web), *Watch* (monitor subjects *B* contributions – only available to *C*). Each activity is undertaken separately, in a different screen.
- Your experiment ID will be displayed on the top left corner of your screen once the experiment starts. It will consist of the letter *B* followed by a number if you are of type *B*. If you are the subject *C* your ID will be *C11*.

Task – summing up numbers

- The task consists in summing up 36 numbers in a table with 6 rows and 6 columns. Each subject is given a different set of tables with the same level of difficulty.
- Before providing your final answer (the total sum of all numbers in the table) you have to fill in the 6 cells that correspond to the sums of the 6 columns. Filling in these 6 cells does not directly generate earnings but it can help you to compute the final sum.



- Only after filling in all these cells will you be allowed to provide a final answer (the total sum) in the box located below the table on the left.
- Notice that **you are not allowed** using a calculator or any other electronic, computer-based or internet-based devices to sum up numbers.
- If you do, *you will be excused and you will not be paid*.
- Only the final answer (total sum of the table) is rewarded. Intermediate sums of all columns are required but are not rewarded.
- Each time you answer the task correctly (your final sum is correct) you generate *60 cents* of *Total production*. These *60 cents* is not directly added to your individual earnings.
- Subject C always gets 40% of Total production while subjects B get the remaining 60% of Total production at the end of each period.
- At the end of each period, subject C will divide the remaining 60% of Total production among the 3 subjects B involved in the experiment. So, each subject B gets a percentage of the total profit contributed by all subjects undertaking the task.
- The amount of money you generate by undertaking the task is displayed in the second column “**My Production**” of the history table at the bottom of the screen.
- The total amount of money generated by all 4 subjects (subject C + 3 subjects B) on the task is displayed in the sixth column “**Total Production**” of the history table at the bottom of the screen.

- If you sum up the numbers of a table correctly then each subject in the experiment (including yourself) gets *60 cents* times the *percentage* of *Total production* that he or she is assigned.
- If you are subject *C* you get *24 cents* ($40\% \times 60 \text{ cents}$).
- If you are subject *B* you get a *percentage* (allocated to you at the end of the period by subject *C*) of the *60 cents*.
- If you answer the task incorrectly you generate a penalty of *30 cents* that is subtracted from *Total production*. So when you answer incorrectly your individual earnings (as well as other subjects' earnings) decrease.

(Your Production can never be less than 0.)

(Browsing the internet)

- Whether you are a subject *B* or subject *C*, you can browse the internet at any time during this experiment. Browsing the web is one of the basic activities that you can perform during this experiment, along with summing up numbers.
- You can access the internet screen by clicking on the *Internet* option in the action menu.
- Notice that while using the internet **you are not allowed** to download additional software. You are also expected to close pop-up windows when they appear on the screen.
- Your usage of the internet is **strictly confidential**. No one can see the web pages you are consulting (for example, your email).

Monitoring: only for subject C

- If and only if you are subject *C*, you can monitor the contribution of the three subjects *B* at any time during this experiment. You can do so by clicking on the *Watch* option in the action menu.
- You will be faced with a monitoring screen with 3 columns, each of them corresponding to one of the subjects *B* in the experiment. The head of each column indicates the experiment ID of the subject.
- For example, to monitor subject *B12*, you have to click on the column header "**B12**" displayed in green. The column header turns red once you click on the *Yes* button on the pop-up message: "*Ready to watch?*"
- You can monitor all subjects' contributions at the same time by clicking on the following button displayed in the top right corner of the screen:
- You can stop monitoring all subjects *B* by clicking:

- To stop monitoring a given subject you have to click on the corresponding column header.
- You will be informed in real time of the *observed* production *and* contribution to *Total production* (in % terms) of the selected subject *B*.
- You will not know the activities completed by this subject, however.

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Monitoring screen details (Subject B12)

Subject *B12*

Observed production (120.00€)

Observed contribution (31%)
when remaining time is 00:22.

Subject *B12* has produced
120.00 on the task
and this corresponds to **31%**
of the Total Production.

81 centimes
Observed production: (00:22): 120 (31%)

INSTRUCTIONS (Earnings)

- Your individual earnings correspond to the following sum over the 5 periods:
 - Your *percentage* of *Total production* that has been generated by all 4 subjects (C subject + 3 B subjects) summing up numbers during the experiment.
- You will learn the exact amount of your individual earnings at the end of each *10-minute* period.

Earnings

- In the pop-up window, your individual earnings in *dollars* for the current period will be displayed.
- You will click on the OK button to continue to next period.
- Your earnings in *cents* for the current period will be also displayed in the last column of the history table at the bottom of your screen. This column is labeled “**My Period Earnings**”.
- You will also see the share of production of all other subjects at the top of your screen

Allocation of *Total production*

- At the end of each of the 5 periods subject *C* allocates a percentage of *Total production* to each *B* subject. Given that subject *C* gets a fixed percentage of 40% of *Total production* at the end of each period, there is 60% of *Total production* to divide among the 3 subjects *B*.
- Notice that each subject *B* can be allocated a different *percentage* of *Total production*. Also, this *percentage* can be changed by the *C* subject at the end of each period.
- *B* subjects do not know this *percentage* until the end of a given period.
- In the last row of the monitoring summary, subject *C* will decide upon the allocation of *Total production* among the 3 subjects *B* by entering numbers in the corresponding **green cells** in the last row of the summary screen.
- **EXAMPLE:** subject *C* allocates the remaining 60% of *Total production* among subjects *B* as follows:
 - B11 gets 15%, B12 gets 25%, B13 gets 20%,
 - Notice that all percentages sum up to 60%.
 - Once subject *C* has entered the *percentages* allocated to each subject *B*, all subjects *B* are informed about their share of *Total production* in the history panel at the bottom of their screen.
 - **EXAMPLE:** In the first period you provided 7 correct answers completing the task while providing 3 incorrect answers. Also, the other three subjects in the experiment provided a total of 24 correct answers in the task while providing 5 incorrect answers.
 - Also, imagine that you are subject *B12* and that subject *C* has allocated to you 25% of *Total production* at the end of the first period. Your earnings (“**My Period Earnings**”) for that period are equal to:

Earnings Calculation

- **EXAMPLE:** In the first period you provided 7 correct answers completing the task while providing 3 incorrect answers. Also, the other three subjects in the experiment provided a total of 24 correct answers in the task while providing 5 incorrect answers.
- Also, imagine that you are subject *B12* and that subject *C* has allocated to you 25% of *Total production* at the end of the first period. Your earnings (“**My Period Earnings**”) for that period are equal to:
 - *Earnings:* $25\% \times (31 \times 60 - 8 \times 30) = 405 \text{ cents}$ if you are subject *B12*
 - *Earnings:* $40\% \times (31 \times 60 - 8 \times 30) = 648 \text{ cents}$ if you are subject *C11*

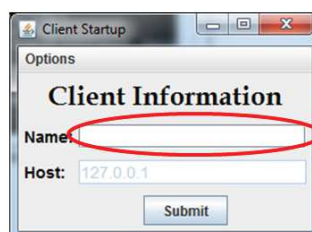
Summary

- This experiment involves 4 subjects and consists of 5 periods of 10 minutes each. There are *two* types of subjects referred to as *B* and *C*, respectively.
- 3 subjects will be subjects *B* and *one* subject will be subject *C*.
- In each period, both subjects *B* and subject *C* will be able to: *sum up numbers* in a table or *browse the web*.
- Only subject *C* will be able to monitor other subjects.
- Your individual earnings will depend on the task which consists in summing up numbers in a table.
- At the end of each period, subject *C* always gets 40% of the total amount of money generated by all 4 subjects (*C* subject + 3 *B* subjects) and decides how to allocate the remaining 60% among the 3 subjects *B*.

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Please wait until the experimenter closes the current instruction screen.

- Please enter your **full name** in the following screen once the instruction screen has been closed by the experimenter.



The screenshot shows a window titled 'Client Startup' with a sub-header 'Options'. Below this is the 'Client Information' section. It contains two input fields: 'Name:' and 'Host:'. The 'Name' field is currently empty and is circled in red. The 'Host' field contains the text '127.0.0.1'. At the bottom of the form is a 'Submit' button.

INSTRUCTIONS (IEP)

- You have exactly 20 minutes to go through the instructions. You will have enough time to read the instructions carefully. A timer is displayed on the room monitor that indicates the remaining time to read the instructions.
- After that, the experimenter will close the current document and you will be able to access the experiment. Please do not close the current document and do not access the experiment before the end of the instruction round.
- A printed copy with a short summary of the instructions will be given to you at the end of the instruction round.
- This is an experiment in decision making. You will be paid in cash for your participation at the end of the experiment. Different participants may earn different amounts. What you earn depends on your decisions and the decisions of others.
- The experiment will take place through computer terminals at which you are seated. If you have any questions during the instruction round, raise your hand and a monitor will come by to answer your question. If any difficulties arise after the experiment has begun, raise your hand, and someone will assist you.

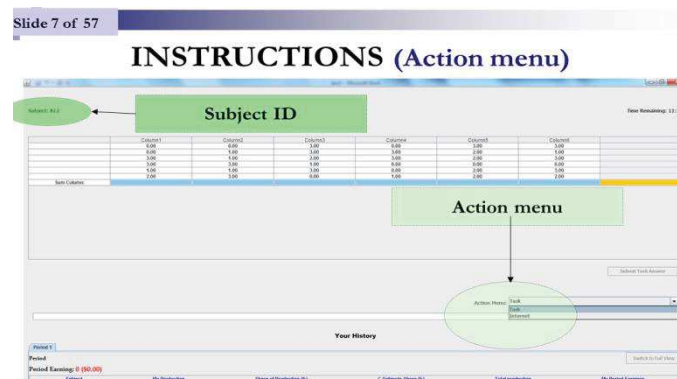
(Timing of the experiment)

- This experiment involves 4 subjects and consists of 5 periods of 10 minutes each. There are *two* types of subjects referred to as *B* and *C*.
- 3 subjects will be subjects *B* and *one* will be subject *C*. You will learn the type of subject you are when the experiment starts.
- Your individual earnings at the end of the experiment are computed as the sum of your earnings in the 5 periods.
- In each period of this experiment both subjects *B* and subject *C* will be able to: sum up numbers in a table (work task) or browse the web.
- Subject *C* will have access to another activity that consists in monitoring other subjects.
- Subjects *B* will have access to an activity in which they will be able to exaggerate their performance on the work task.
- To switch from one activity to another you just have to click on the corresponding option of the action menu displayed on your screen.
- The activities are referred to as *Task* (sum up numbers in a table), *Internet* (browse the web), *Watch* (monitor subjects *B* contributions – only available to *C*) and *Boost* (exaggerate task production as *observed* by subject *C* – only available to *Bs*). Each activity is undertaken separately, in a different screen.

- Your experiment ID will be displayed on the top left corner of your screen once the experiment starts. It will consist of the letter *B* followed by a number if you are of type *B*. If you are the subject *C* your ID will be *C11*.

Task – summing up numbers

- The task consists in summing up 36 numbers in a table with 6 rows and 6 columns. Each subject is given a different set of tables with the same level of difficulty.
- Before providing your final answer (the total sum of all numbers in the table) you have to fill in the 6 cells that correspond to the sums of the 6 columns. Filling in these 6 cells does not directly generate earnings but it can help you to compute the final sum.



- Only after filling in all these cells will you be allowed to provide a final answer (the total sum) in the box located below the table on the left.
- Notice that **you are not allowed** using a calculator or any other electronic, computer-based or internet-based devices to sum up numbers.
- If you do, *you will be excused and you will not be paid*.
- Only the final answer (total sum of the table) is rewarded. Intermediate sums of all columns are required but are not rewarded.
- Each time you answer the task correctly (your final sum is correct) you generate *60 cents* of *Total production*. These *60 cents* is not directly added to your individual earnings.
- Subject *C* always gets *40%* of *Total production* while each subject *B* gets *20%* of the total profit contributed by all subjects undertaking the task.

- The amount of money you generate by undertaking the task is displayed in the second column “**My Production**” of the history table at the bottom of the screen.
- The total amount of money generated by all 4 subjects (subject *C* + 3 subjects *B*) on the task is displayed in the sixth column “**Total Production**” of the history table at the bottom of the screen.
- If you sum up the numbers of a table correctly then each subject in the experiment (including yourself) gets 60 cents times the *percentage* of *Total production* that he or she is assigned.
- If you are subject *C* you get 24 cents ($40\% \times 60 \text{ cents}$).
- If you are one of the subjects *B* you get 12 cents ($20\% \times 60 \text{ cents}$).
- If you answer the task incorrectly you generate a penalty of 30 cents that is subtracted from *Total production*. So when you answer incorrectly your individual earnings decrease by 12 cents ($40\% \times 30$) if you are Subject *C* and by 6 cents ($20\% \times 30$) if you are Subject *B*.

(Your Production can never be less than 0.)

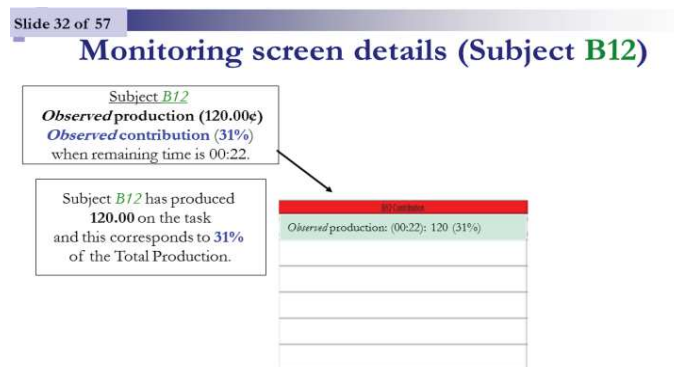
(Browsing the internet)

- Whether you are a subject *B* or subject *C*, you can browse the internet at any time during this experiment. Browsing the web is one of the basic activities that you can perform during this experiment, along with summing up numbers.
- You can access the internet screen by clicking on the *Internet* option in the action menu.
- Notice that while using the internet **you are not allowed** to download additional software. You are also expected to close pop-up windows when they appear on the screen.
- Your usage of the internet is **strictly confidential**. No one can see the web pages you are consulting (for example, your email).

Monitoring: only for subject *C*

- If and only if you are subject *C*, you can monitor the contribution of the three subjects *B* at any time during this experiment. You can do so by clicking on the *Watch* option in the action menu.
- You will be faced with a monitoring screen with 3 columns, each of them corresponding to one of the subjects *B* in the experiment. The head of each column indicates the experiment ID of the subject.

- For example, to monitor subject *B12*, you have to click on the column header “**B12**” displayed in green. The column header turns red once you click on the *Yes* button on the pop-up message: “*Ready to watch?*”
- You can monitor all subjects’ contributions at the same time by clicking on the following button displayed in the top right corner of the screen:
- You can stop monitoring all subjects *B* by clicking:
- To stop monitoring a given subject you have to click on the corresponding column header.
- You will be informed in real time of the *observed* production *and* contribution to *Total production* (in % terms) of the selected subject *B*.
- You will not know the activities completed by this subject, however.



INSTRUCTIONS (Boost)

- If and only if you are subject *B*, you can exaggerate your production, as *observed* by subject *C*, at any time during this experiment.
- To do so, you just have to select the *Boost* option in the action menu.
- To exaggerate your *observed* production, you have to enter the amount by which you want to increase it.
- After clicking on *OK*, you will not be able to complete any other activity for 30 seconds. This is how your screen will look like during these 30 seconds:

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INSTRUCTIONS (Boost)

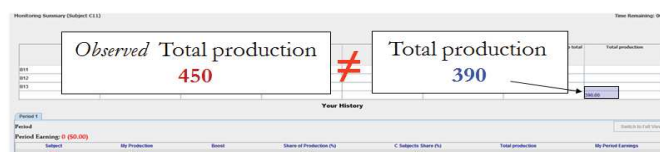
- After clicking on *OK*, you will not be able to complete any other activity for 30 seconds. This is how your screen will look like during these 30 seconds:

- The amount by which you boosted your *observed* production will appear in the Boost column at the bottom of your screen.
- The My Production column will remain unchanged, however.
- For example, consider the situation in which the production of subject *B12* is 120¢ while the other three subjects have produced a total of 270¢ . In that case, *Total production* is equal to 390¢ and subject *B12* contribution to *Total production* is equal to 31% ($120\text{¢}/390\text{¢}$).
- Consider now that subject *B12* exaggerates his or her *observed* production by 60¢ using the boost option.
- As a consequence, the production of subject *B12* as *observed* by subject *C* will immediately increase from its current level of 120¢ to 180¢ . Also, the *observed* contribution of subject *B12* will increase from 31% to 38% ($180\text{¢}/390\text{¢}$) and the *observed* contributions of subjects *B11* and *B13* will decrease.
- The monitoring screen of subject *C* will reflect this increase in *observed* production and contribution of subject *B12*.
- As a result of subject *B12* boosting his or her *observed* production, the sum of subjects' *observed* productions will be different from the actual *Total production* in the monitoring summary.

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Monitoring and Boost

- As a result of subject *B12* boosting his or her *observed* production, the sum of subjects' *observed* productions will be different from the actual *Total production* in the monitoring summary.



- The monitor will be able to know whether one or several subjects *B* have boosted their *observed* production. However, the monitor will not know which subject(s) exaggerated their *observed* production and by which amount.
- This is the case because the monitor will not be informed of the activities completed by each subject.
- Instead, the monitor will be informed of the *observed* production and contribution of the monitored subjects *B* at that moment in time.

INSTRUCTIONS (Earnings)

- Your individual earnings correspond to the following sum over the 5 periods:
 - Your *percentage* of *Total production* that has been generated by all 4 subjects (*C* subject + 3 *B* subjects) summing up numbers during the experiment.
- You will learn the exact amount of your individual earnings at the end of each *10-minute* period.
- In the pop-up window, your individual earnings in *dollars* for the current period will be displayed.
- You will click on the OK button to continue to next period.
- Your earnings in *cents* for the current period will be also displayed in the last column of the history table at the bottom of your screen. This column is labeled “My Period Earnings”.
- You will also see the share of production of all other subjects at the top of your screen
- **EXAMPLE:** In the first period you provided 7 correct answers completing the task while providing 3 incorrect answers. Also, the other three subjects in the experiment provided a total of 24 correct answers in the task while providing 5 incorrect answers.
- Your *earnings* (“My Period Earnings”) for that period are equal to:
 - *Earnings:* $20\% \times (31 \times 60 - 8 \times 30) = 324$ cents if you are a subject *B*
 - *Earnings:* $40\% \times (31 \times 60 - 8 \times 30) = 648$ cents if you are subject *C*
- Note that the amount displayed in the Boost column increased your production as *observed* by subject *C* without changing either the value of the My Production and Total production columns.

Summary

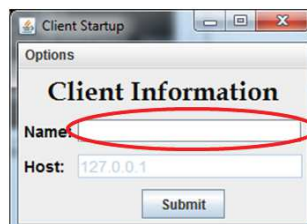
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- 3 subjects will be subjects *B* and *one* will be subject *C*.
- In each period, both subjects *B* and subject *C* will be able to: *sum up numbers* in a table or *browse the web*.
- Only subjects *B* will be able to exaggerate their production and contribution as *observed* by subject *C* by using the *boost* option.
- Only subject *C* will be able to monitor other subjects.
- Your individual earnings will depend on the task which consists in summing up numbers in a table.
- The total earnings generated by all 4 subjects (subject *C* + 3 subjects *B*) on the task will be divided as follows.
- Each subject *B* will get 20% of the total amount of money generated by all subjects while subject *C* always will get 40% of the total amount of money generated.

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Please wait until the experimenter closes the current instruction screen.

- Please enter your **full name** in the following screen once the instruction screen has been closed by the experimenter.



The screenshot shows a window titled 'Client Startup' with a sub-header 'Options'. Below this is the 'Client Information' section. It contains two input fields: 'Name:' and 'Host:'. The 'Name' field is currently empty and is circled in red. The 'Host' field contains the text '127.0.0.1'. At the bottom of the form is a 'Submit' button.

INSTRUCTIONS (IDP)

- You have exactly 20 minutes to go through the instructions. You will have enough time to read the instructions carefully. A timer is displayed on the room monitor that indicates the remaining time to read the instructions.
- After that, the experimenter will close the current document and you will be able to access the experiment. Please do not close the current document and do not access the experiment before the end of the instruction round.
- A printed copy with a short summary of the instructions will be given to you at the end of the instruction round.
- This is an experiment in decision making. You will be paid in cash for your participation at the end of the experiment. Different participants may earn different amounts. What you earn depends on your decisions and the decisions of others.
- The experiment will take place through computer terminals at which you are seated. If you have any questions during the instruction round, raise your hand and a monitor will come by to answer your question. If any difficulties arise after the experiment has begun, raise your hand, and someone will assist you.

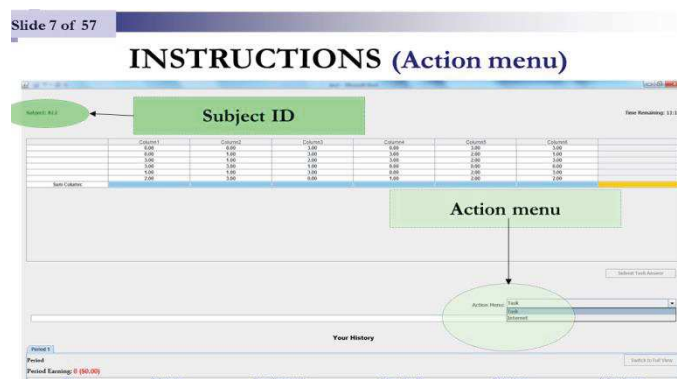
(Timing of the experiment)

- This experiment involves 4 subjects and consists of 5 periods of 10 minutes each. There are *two* types of subjects referred to as *B* and *C*.
- 3 subjects will be subjects *B* and *one* will be subject *C*. You will learn the type of subject you are when the experiment starts.
- Your individual earnings at the end of the experiment are computed as the sum of your earnings in the 5 periods.
- In each period of this experiment both subjects *B* and subject *C* will be able to: sum up numbers in a table (work task) or browse the web.
- Subject *C* will have access to another activity that consists in monitoring other subjects.
- Subjects *B* will have access to an activity in which they will be able to exaggerate their performance on the work task.
- To switch from one activity to another you just have to click on the corresponding option of the action menu displayed on your screen.
- The activities are referred to as *Task* (sum up numbers in a table), *Internet* (browse the web), *Watch* (monitor subjects *B* contributions – only available to *C*) and *Boost* (exaggerate task production as *observed* by subject *C* – only available to *Bs*). Each activity is undertaken separately, in a different screen.

- Your experiment ID will be displayed on the top left corner of your screen once the experiment starts. It will consist of the letter *B* followed by a number if you are of type *B*. If you are the subject *C* your ID will be *C11*.

Task – summing up numbers

- The task consists in summing up 36 numbers in a table with 6 rows and 6 columns. Each subject is given a different set of tables with the same level of difficulty.
- Before providing your final answer (the total sum of all numbers in the table) you have to fill in the 6 cells that correspond to the sums of the 6 columns. Filling in these 6 cells does not directly generate earnings but it can help you to compute the final sum.



- Only after filling in all these cells will you be allowed to provide a final answer (the total sum) in the box located below the table on the left.
- Notice that **you are not allowed** using a calculator or any other electronic, computer-based or internet-based devices to sum up numbers.
- If you do, *you will be excused and you will not be paid*.
- Only the final answer (total sum of the table) is rewarded. Intermediate sums of all columns are required but are not rewarded.
- Each time you answer the task correctly (your final sum is correct) you generate *60 cents* of *Total production*. These *60 cents* is not directly added to your individual earnings.
- Subject *C* always gets 40% of *Total production* while subjects *B* get the remaining 60% of *Total production* at the end of each period.

- At the end of each period, subject C will divide the remaining 60% of Total production among the 3 subjects B involved in the experiment. So, each subject B gets a percentage of the total profit contributed by all subjects undertaking the task.
- The amount of money you generate by undertaking the task is displayed in the second column “**My Production**” of the history table at the bottom of the screen.
- The total amount of money generated by all 4 subjects (subject C + 3 subjects B) on the task is displayed in the sixth column “**Total Production**” of the history table at the bottom of the screen.
- If you sum up the numbers of a table correctly then each subject in the experiment (including yourself) gets 60 cents times the *percentage* of *Total production* that he or she is assigned.
- If you are subject C you get 24 cents ($40\% \times 60 \text{ cents}$).
- If you are subject B you get a *percentage* (allocated to you at the end of the period by subject C) of the 60 cents.
- If you answer the task incorrectly you generate a penalty of 30 cents that is subtracted from *Total production*. So when you answer incorrectly your individual earnings (as well as other subjects’ earnings) decrease.

(Your Production can never be less than 0.)

(Browsing the internet)

- Whether you are a subject B or subject C, you can browse the internet at any time during this experiment. Browsing the web is one of the basic activities that you can perform during this experiment, along with summing up numbers.
- You can access the internet screen by clicking on the *Internet* option in the action menu.
- Notice that while using the internet **you are not allowed** to download additional software. You are also expected to close pop-up windows when they appear on the screen.
- Your usage of the internet is **strictly confidential**. No one can see the web pages you are consulting (for example, your email).

Monitoring: only for subject C

- If and only if you are subject C, you can monitor the contribution of the three subjects B at any time during this experiment. You can do so by clicking on the *Watch* option in the action menu.

- You will be faced with a monitoring screen with 3 columns, each of them corresponding to one of the subjects *B* in the experiment. The head of each column indicates the experiment ID of the subject.
- For example, to monitor subject *B12*, you have to click on the column header “**B12**” displayed in green. The column header turns red once you click on the *Yes* button on the pop-up message: “*Ready to watch?*”
- You can monitor all subjects’ contributions at the same time by clicking on the following button displayed in the top right corner of the screen:
- You can stop monitoring all subjects *B* by clicking:
- To stop monitoring a given subject you have to click on the corresponding column header.
- You will be informed in real time of the *observed* production *and* contribution to *Total production* (in % terms) of the selected subject *B*.
- You will not know the activities completed by this subject, however.

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Monitoring screen details (Subject **B12**)

Subject **B12**

Observed production (120.00€)

Observed contribution (31%)

when remaining time is 00:22.

Subject **B12** has produced 120.00 on the task and this corresponds to 31% of the Total Production.

Contributions
Observed production: (00:22): 120 (31%)

INSTRUCTIONS (Boost)

- If and only if you are subject *B*, you can exaggerate your production, as *observed* by subject *C*, at any time during this experiment.
- To do so, you just have to select the *Boost* option in the action menu.
- To exaggerate your *observed* production, you have to enter the amount by which you want to increase it.
- After clicking on *OK*, you will not be able to complete any other activity for 30 seconds. This is how your screen will look like during these 30 seconds:

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INSTRUCTIONS (Boost)

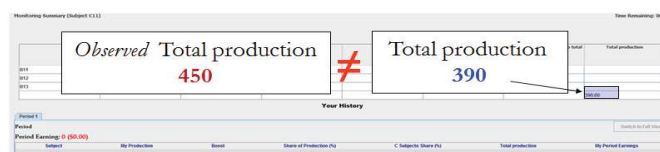
- After clicking on *OK*, you will not be able to complete any other activity for 30 seconds. This is how your screen will look like during these 30 seconds:

- The amount by which you boosted your *observed* production will appear in the Boost column at the bottom of your screen.
- The My Production column will remain unchanged, however.
- For example, consider the situation in which the production of subject *B12* is 120¢ while the other three subjects have produced a total of 270¢ . In that case, *Total production* is equal to 390¢ and subject *B12* contribution to *Total production* is equal to 31% ($120\text{¢}/390\text{¢}$).
- Consider now that subject *B12* exaggerates his or her *observed* production by 60¢ using the boost option.
- As a consequence, the production of subject *B12* as *observed* by subject *C* will immediately increase from its current level of 120¢ to 180¢ . Also, the *observed* contribution of subject *B12* will increase from 31% to 38% ($180\text{¢}/390\text{¢}$) and the *observed* contributions of subjects *B11* and *B13* will decrease.
- The monitoring screen of subject *C* will reflect this increase in *observed* production and contribution of subject *B12*.
- As a result of subject *B12* boosting his or her *observed* production, the sum of subjects' *observed* productions will be different from the actual *Total production* in the monitoring summary.

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Monitoring and Boost

- As a result of subject *B12* boosting his or her *observed* production, the sum of subjects' *observed* productions will be different from the actual *Total production* in the monitoring summary.



- The monitor will be able to know whether one or several subjects *B* have boosted their *observed* production. However, the monitor will not know which subject(s) exaggerated their *observed* production and by which amount.
- This is the case because the monitor will not be informed of the activities completed by each subject.
- Instead, the monitor will be informed of the *observed* production and contribution of the monitored subjects *B* at that moment in time.

INSTRUCTIONS (Earnings)

- Your individual earnings correspond to the following sum over the 5 periods:
 - ☐ Your *percentage* of *Total production* that has been generated by all 4 subjects (*C* subject + 3 *B* subjects) summing up numbers during the experiment.
- You will learn the exact amount of your individual earnings at the end of each *10-minute* period.
- In the pop-up window, your individual earnings in *dollars* for the current period will be displayed.
- You will click on the OK button to continue to next period.
- Your earnings in *cents* for the current period will be also displayed in the last column of the history table at the bottom of your screen. This column is labeled “My Period Earnings”.
- You will also see the share of production of all other subjects at the top of your screen

Allocation of *Total production*

- At the end of each of the 5 periods subject *C* allocates a percentage of *Total production* to each *B* subject. Given that subject *C* gets a fixed percentage of 40% of *Total production* at the end of each period, there is 60% of *Total production* to divide among the 3 subjects *B*.
- Notice that each subject *B* can be allocated a different *percentage* of *Total production*. Also, this *percentage* can be changed by the *C* subject at the end of each period.
- *B* subjects do not know this *percentage* until the end of a given period.
- In the last row of the monitoring summary, subject *C* will decide upon the allocation of *Total production* among the 3 subjects *B* by entering numbers in the corresponding **green cells** in the last row of the summary screen.

- **EXAMPLE:** subject *C* allocates the remaining 60% of *Total production* among subjects *B* as follows:
- B11 gets 15%, B12 gets 25%, B13 gets 20%,
- Notice that all percentages sum up to 60%.
- Once subject *C* has entered the *percentages* allocated to each subject *B*, all subjects *B* are informed about their share of *Total production* in the history panel at the bottom of their screen.
- **EXAMPLE:** In the first period you provided 7 correct answers completing the task while providing 3 incorrect answers. Also, the other three subjects in the experiment provided a total of 24 correct answers in the task while providing 5 incorrect answers.
- Also, imagine that you are subject *B12* and that subject *C* has allocated to you 25% of *Total production* at the end of the first period. Your earnings (“**My Period Earnings**”) for that period are equal to:

Earnings Calculation

- **EXAMPLE:** In the first period you provided 7 correct answers completing the task while providing 3 incorrect answers. Also, the other three subjects in the experiment provided a total of 24 correct answers in the task while providing 5 incorrect answers.
- Also, imagine that you are subject *B12* and that subject *C* has allocated to you 25% of *Total production* at the end of the first period. Your earnings (“**My Period Earnings**”) for that period are equal to:
- *Earnings:* $25\% \times (31 \times 60 - 8 \times 30) = 405$ cents if you are subject *B12*
- *Earnings:* $40\% \times (31 \times 60 - 8 \times 30) = 648$ cents if you are subject *C11*

Summary

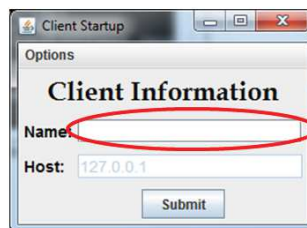
- This experiment involves 4 subjects and consists of 5 periods of 10 minutes each. There are *two* types of subjects referred to as *B* and *C*, respectively.
- 3 subjects will be subjects *B* and *one* will be subject *C*.
- In each period, both subjects *B* and subject *C* will be able to: *sum up numbers* in a table or *browse the web*.
- Only subjects *B* will be able to exaggerate their production and contribution as *observed* by subject *C* by using the *boost* option.
- Only subject *C* will be able to monitor other subjects.

- Your individual earnings will depend on the task which consists in summing up numbers in a table.
- The total earnings generated by all 4 subjects (subject *C* + 3 subjects *B*) on the task will be divided as follows.
- At the end of each period, subject *C* always gets 40% of the total amount of money generated by all 4 subjects (*C* subject + 3 *B* subjects) and decides how to allocate the remaining 60% among the 3 subjects *B*.

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Please wait until the experimenter closes the current instruction screen.

- Please enter your **full name** in the following screen once the instruction screen has been closed by the experimenter.



The screenshot shows a window titled 'Client Startup' with a sub-header 'Options'. Below this is the 'Client Information' section. It contains two input fields: 'Name:' and 'Host:'. The 'Name' field is currently empty and is circled in red. The 'Host' field contains the text '127.0.0.1'. At the bottom of the form is a 'Submit' button.

Chapter III: On the impact of technology-based monitoring on workers' behavior: An experimental investigation²³

²³ This chapter has given rise to a paper entitled *Surveillance informatique versus surveillance classique : une expérience d'effort réel* with Brice Corgnet, Ludivine Martin and Angela Sutan. This paper which has been accepted in the *Revue économique* contains some sections that we did not have opportunities to include in this chapter.

III1. Introduction

The introduction of Information and Communication Technologies (ICT) at workplace has generated new ways to create, collect and share information as well as a growing use of technological tools by firms to monitor employees (Ariss, 2002; Bloom et al., 2014; West and Bowman, 2014). According to the American Management Association study (AMA, 2007), 73% of US organizations have engaged on technology monitoring. Indeed, the advancement in ICT has led to the ease of the monitoring of employees by technologies (Ariss, 2002; Alder and Ambrose, 2005; Sarpong and Rees, 2014; West and Bowman, 2014). The technology-based monitoring system (*IT monitoring*) allows firms to automatically record indicators of employees' effort and performance (Aral et al., 2012; Bloom et al., 2014; Gallie et al., 2001). Therefore, managers can easily access this performance data for rewarding or for sanctioning employees.

Although more than 80% of organizations inform employees that they monitor keystrokes, time spent on keyboard and review computer files, at least 28% of employers have fired workers for e-mail and internet misuses (AMA, 2007). One can think that employees are not really aware of the extent of the technology-based monitoring system (Ariss, 2002). These misuses of computer systems and technology resources have a negative impact on productivity of the firm (Koch and Nafziger, 2015). According to Sarpong and Rees (2014), the misuse of e-mail by employees accounts more than \$2 billion in losses annually. A better understanding of how technology monitoring affects workers' performance might be useful to minimize the misuse of technologies at work and make workers perform at their peak. The purpose of this chapter is to investigate in lab how technologies monitoring affect the workers' behaviors.

Organizational changes due to ICT have considerably led firms to use technologies for their protection but also for the monitoring of the firm's production (Sarpong and Rees, 2014). Consequently, managers have access to a new way to monitor employees' performance thanks to technological advances in technologies. Indeed, the use of technologies to monitor workers' performance is not new but the technology monitoring system is ever more sophisticated and still in constant innovation (Sarpong and Rees, 2014; West and Bowman, 2014). Software like ERP (Enterprise Resource Planning) or CPM (Computer Monitoring performance) continuously and instantaneously keep details about workers' attendance (log-in account), time coded log of all activities performed from their computer terminal, time and

length of time website visited, overtime, and break time (Ariss, 2002; Alder and Ambrose, 2005; Pierce et al. 2015; West and Bowman, 2014). More precisely, "...any action performed on a company computer may subject to monitoring even if it is not transmitted over a network nor stored in a file" (Ariss, 2002, p.554).

The technology-based monitoring provides a heightened transparency of the work process and instant availability of employees' performance indicators (Sarpong and Rees, 2014). Thereby, reliable and fair information on employees' productivity generated by technology monitoring is objective for both employees and managers to reward their performance. However, some studies on organizational changes shed light on the potential of the ICT to produce serious stress and health problems (Ariss, 2002; Aubert et al., 2004; Alder and Ambrose, 2005; Sarpong and Rees, 2014). Employees often feel stressed, and distrusted because their privacy is violated by being closely monitored (Ariss, 2002). The technology monitoring invades worker privacy, increases work pressure, creates an atmosphere of mistrust, and undermines employees' loyalty (Alder and Ambrose, 2005).

Therefore, the *IT monitoring* system could negatively impact workers' performance and consequently the productivity of the firm. According to Falk and Kosfeld (2006), the decision to control agents significantly reduces their willingness to act in the principal's interest if they believe that their employer mistrusts them. If agents perceive they have become 'pawns' of the principal, they reciprocate by reducing their effort: this is known as the crowding out effect (Deci, 1975; Fehr and Gächter, 2001; Frey, 1993; Frey and Oberholzer-Gee, 1997; Van Herpen and al., 2005). So, the invasive and pervasive monitoring system led by the advance in technologies could fail to increase agents' effort and reduce shirking behaviors at the workplace.

The investigation of the technology-based monitoring system is also interesting since evidence suggests that firms should promote the use of technologies which provide greater information access to agents (Black and Lynch, 2001; Bresnahan et al., 2002; Brynjolfsson and Hitt, 2000; Garicano, 2000; Garicano and Rossi-Hansberg, 2006; Bloom et al., 2014); while influence costs theory assumes that agents will not perform at their peak because they will waste time by trying to manipulate information as a device to influence the manager's decision (Milgrom 1988; Milgrom and Roberts, 1988, 1990b). Individuals who have opportunities to cheat can create the impression that they are the best performers instead of actual hard work (Carpenter et al., 2010). This willingness to manipulate information will lead

to substantial costs for the firm (Milgrom 1988; Milgrom and Roberts, 1988, 1990b; Schaefer, 1998; Corgnet and Rodriguez-Lara, 2013; Inderst et al., 2005). So, technologies that allow more autonomy for agents may entail a costly loss of control for the principal since agents and the principal's interests are not perfectly aligned (Acemoglu et al., 2007). Nevertheless, the implementation of ICT at the workplace has enabled more agility for agents to make autonomous decisions as well as a higher control by the principal and (Bloom et al., 2014). Therefore, the firm may not face a tradeoff between loss of control by the principal and more autonomy for the agent (Aghion and Tirole, 1997) by taking advantage of the *IT monitoring*.

This is consistent with the agency theory which states that agents will not perform at their peak without constant monitoring. In fact, monitoring is effective to increase agents' effort and productivity because they will work hard to avoid the sanction if they get caught shirking: this is known as the disciplining effect (Alchian and Demsetz, 1972; Calvo and Wellisz, 1978; Dickinson and Villeval, 2008; Jung, 2014; Nagin et al., 2002; Prendergast, 1999). Therefore, the technology-based monitoring system could be effective to increase agents' effort and reduce shirking behaviors at the workplace. The *monitoring* software may also be crucial since some technologies devices provide several leisure options like games or internet access to social networks which could lead the agent to misbehave at workplace (West and Bowman, 2014). Schnedler and Vadovic (2011) reported that about 78% of agents accessed the internet for unproductive purposes such as personal use or entertainment while at work according to the 2005 Internet Usage Study. Despite the fact that every employee signs the IT charter of the hiring firm, some cases of firing because of internet abuse or misuse suggest that they are unaware about the extent of the technology monitoring system²⁴.

So far, existing literature on the impact of the technology monitoring on workers suggests that this monitoring system is neutral and offers a profitable situation for both managers and workers since it is embedded in ICT (Alder and Ambrose, 2005; Sarpong and Rees, 2014; West and Bowman, 2014). Indeed, *IT monitoring* allows managers to evaluate more easily agents' performance; therefore, they could detect shirking behaviors more effortlessly. On the employees' side, *IT monitoring* might not lead to stressful conditions since it is embedded in the technology tool. So, this monitoring system could overcome the constraints of traditional monitoring and decrease the hidden costs of monitoring. However, Pierce et al. (2015)

²⁴Engel, (2010) reports a story of Toquir Choudhri, a 14-year veteran worker of the New York City Department of Education who got fired for using the internet for personal matters.

showed that the technology monitoring is likely to reduce cheating behaviors and to improve workers' productivity. This finding is inconsistent with the idea that stressful conditions due to *IT monitoring* will lead workers to decrease their effort. So, the technology-based monitoring may have several effects which could generate opposite results. So, some questions arise as: how *IT monitoring* impacts workers' behaviors? What is the overall effect of technology monitoring on workers' productivity?

Our main contributions to the literature are twofold. First, we investigate the technology monitoring on the lab. Second, we investigate monitoring in setting with three activities that workers can undertake in a real workplace environment to disentangle the effect of *IT monitoring* on working, cheating and web browsing activities. Existing experimental studies on monitoring focused on the control of the output by the principal and designed the monitoring system as a probability or a frequency chosen by the principal to audit agents' output (Dickinson and Villeval, 2008; Engel, 2010; Jung, 2014; Nagin et al., 2002). Thereby, the agent performs the task after being informed about this monitoring rate, there is no monitoring while the task is being performed and only the output is monitored. The agent perceives the monitoring level as a signal of trust or distrust and reciprocates. During the experiment, the principal does not have any information about activities undertaken by the agent. Although firms resort to *IT monitoring* which provides detailed information about workers' activities, this form of monitoring has not hitherto been studied in the literature. Unlike previous experiments which study the impact of monitoring, our experimental design embeds both real leisure and cheating alternatives into the workplace environment.

The aim of this chapter is to use a controlled laboratory experiment to analyze the impact of the technology-based monitoring on agents' behaviors through working, web browsing and cheating activities. While principal behavior is largely neglected in existing literature, we also investigate how the principal's behavior is impacted by the *IT monitoring* system. For this purpose, we conducted an experiment using virtual organization that includes on-the-job shirking activities into the work environment (Corgnet et al., 2014). This software enables us to introduce a real-effort work task (e.g. Dohmen and Falk, 2011; Eriksson et al., 2009; Niederle and Vesterlund, 2007) as well as technology monitoring and real-time access to leisure and cheating activities. We design a workplace environment which consists of organizations with one principal and three agents which can simultaneously complete a work task and browse the internet. Only agents are allowed to falsely increase their level of production as observed by the principal (cheating activity). Depending on the treatment, the

principal could monitor agents' level of production only (Traditional monitoring) or all agents' activities on top of their production level (*IT monitoring*). We conducted a 2x2 design in which we varied the monitoring system and the payment scheme (*equal* pay or *discretionary* pay). The *discretionary* pay is an incentive since the principal can reward (punish) agents according to his discretion by allowing a higher (lower) pay.

According to previous experimental studies, we find that the IT monitoring system also implies a disciplining effect as agents on *IT monitoring* treatments are more productive and spend less time on cheating activity compared to agents on treatments without *IT monitoring*. However, the disciplining effect of *IT monitoring* is evanescent since the workers' productivity which was 11.42% higher on average during the first three periods in the treatment with *IT monitoring* compared to the treatment without, decreased to 2.5% the last two periods under *discretionary* pay. Also, agents on *IT monitoring* treatment cheated less during the first three periods and more for the last two periods compared to agents on treatment without *IT monitoring* when the sanction was available. Unexpectedly, we also find that the average time spent by agents on the internet was 97.67% higher in treatment with *IT monitoring* than the time devoted to this activity by agents on treatment without *IT monitoring* when the sanction was unavailable. Nevertheless, these agents were more productive on average than agents in other treatments. This result is consistent with the finding of Koch and Nafziger, (2015) and Martin and Omrani, (2015) that workers are willing to work harder when internet access is available without any sanction for using it. The remainder of the chapter is structured as follows: Section 2 presents our behavioral hypotheses. Section 3 describes the software that we used and the experimental design. Results of the experiment are presented in section 4. Section 5 concludes.

III2. Behavioral hypotheses

The aim of this chapter is to investigate the effect of the technology-based monitoring on agents and principals' behaviors. We derive our behavioral hypotheses from the agency theory and the literature on the technology-based monitoring. We put forward hypotheses based on working, cheating and leisure activities that workers can undertake at the workplace. We also formulate hypotheses about time spent by principals on monitoring activity and principals' production.

III2.1. Agents' behaviors

We are interested on how the *IT monitoring* system affects agents' willingness to work, cheat or browse the web at the workplace. Contrary to a monitoring system in which only the agents' outputs are audited, this monitoring system provides detailed information about agents' activities. We expect that both monitoring systems may lead to the disciplining effect. We also expect that this effect should be more pronounced under *IT monitoring* system, particularly when the sanction is available.

III2.1.1. Working activity

According to Frey (1993) and Falk and Kosfeld (2006), the principal's decision to tightly monitor agents can be perceived as a signal of distrust and may be counterproductive. But, evidence suggests that the disciplining effect occurs when the principal's monitoring is considered legitimate by agents (Schnedler and Vadovic, 2011; Dickinson and Villeval, 2008; Nagin et al., 2002). The fact that the *IT monitoring* is embedded in the computer-based systems of the firm may legitimize its use by the principal. Also, agents might not feel stressed and distrusted since the technology-based monitoring is invisible (Alder and Ambrose, 2005; Sarpong and Rees, 2014; West and Bowman, 2014). According to the agency theory literature, the principal's monitoring should lead agents to raise their level of effort to avoid the sanction resulting from counterproductive behaviors (Calvo and Wellisz, 1978). Consequently, the disciplining effect should be more pronounced when the sanction is available. Because agents know that all their activities are monitored, the *IT monitoring* should be more effective to discipline agents than the monitoring system in which only the agents' outputs are monitored. We formulated our hypotheses as follow:

Hypothesis 1: We expect that agents will be more productive and will spend more time on working in presence of *IT monitoring*. The disciplining effect will be more pronounced in the presence of the sanction.

III2.1.2. Cheating activity

According to Carpenter et al. (2010), employees are able to create the impression that they are the best performers instead of working hard for rent-seeking concerns. Nagin et al. (2002) showed that agents are more likely to engage in cheating behavior when it is hard to detect. The *IT monitoring* system is more effective to reduce cheating (Pierce et al., 2015). Since the

monitoring software provides detailed information about agents' activities, agents may be less willing to cheat in presence of this monitoring system. Also, when the principal only monitors agents' outputs, it can be hard to detect cheating. We also suggest that if agents are punished because of cheating, they will work harder at the following period.

Hypothesis 2: We expect that: i) Agents will cheat less in presence of *IT monitoring*. ii) Sanctioned cheaters will be more productive at the next period.

III2.1.3. Leisure activity

Numerous leisure activities exist at the workplace, e.g. coffee and cigarette breaks, personal calls. Some technological devices also provide options like games or internet access which could lead the agent to misbehave at the workplace. Individuals spend time on browsing the web when internet access is available (Corgnet et al., 2014). Schnedler and Vadovic (2011) reported findings of the Internet Usage Study of 2005 which show that about 78% of employees browse the web for unproductive purposes such as personal use or entertainment during working time. So, agents will spend time on leisure activities regardless the monitoring system. But, if they know that all their activities are monitored, they may spend less time on leisure compared to the situation in which only outputs are monitored.

Hypothesis 3: We expect that agents will spend less time on leisure activity in presence of *IT monitoring* compared to when *IT monitoring* will be unavailable.

III2.2. Principal's behaviors: monitoring and working

The monitoring is costly for the principal (Dickinson and Villeval, 2008). Nevertheless, the technology-based monitoring eased the detection of shirking behaviors. Consequently, the principal may devote a larger portion of time on monitoring activity if they can monitor all agents' activities. Moreover, if the principal has a discretionary power regarding agents' pay, they will be more willing to collect the right information for decision making. This may negatively affect their level of production. The monitoring software enables principals to clearly know if a given agent is working or cheating. So, principals may be less productive in presence of *IT monitoring*.

Hypothesis 4: We expect that principals will spend more time to monitor agents and may be less productive in presence of *IT monitoring*. This effect should be more pronounced whether they are able to sanction agents or not.

III3. Experimental design

We used the virtual organization software (Corgnet et al., 2014) to run our experiment. This software enabled us to reproduce some relevant features of a real work setting. The virtual organization software also allowed us to record time spent by participants on each activity that they are able to undertake and how many times they switch from one activity to other. We designed organizations with one principal denoted *Subject C* and three agents denoted *Subjects B*. Participants learned about their role at the beginning of the experiment and kept the same role and the same partners that they were randomly assigned and matched for the whole duration of the experiment.

III3.1. Design of the activities

Our experimental design allowed participants to undertake three different activities separately in a screen by choosing the corresponding option from a drop-down menu at the bottom-right of their screen. These activities²⁵ consisted of a real effort task (work task) in a limited time and browsing the internet (leisure activity) that all participants can undertake by clicking on the *Task* or *Internet* options respectively. Agents had an additional activity that consisted of increasing their level of production artificially (cheating activity)²⁶ by using the *boost* option, while the principal was able to monitor agents' activities (monitoring activity) by using the *watch* option. These activities are described in detail below.

III3.1.1. The work task

The task is a long, repetitive and effortful one (Dohmen and Falk, 2011; Ericksson et al., 2009; Niederle and Vesterlund, 2007). This task was designed to reduce as much as possible the intrinsic motivation derived from performing the task just for its sake (Corgnet et al., 2014). Participants had to sum up several tables of 36 numbers without using pens, scratch paper, calculators or any other electronic devices. Each table had six rows and six columns of randomly-generated integers between zero and three. Before providing the final answer in the bottom-right cell, participants had to provide a separate subtotal for all of the 6 columns. Each correct completed table provided 60 cents of individual production while 30 cents were

²⁵ These activities are similar to those activities in the experimental design of chapter II. We set up a new monitoring system which is the added value in this chapter.

²⁶ This activity is the same that the influence activities in chapter II.

subtracted if the answer was incorrect. Penalties did not apply when individual production was equal to zero²⁷.

III3.1.2. The cheating activity

To implement the cheating activity, our experimental design allowed agents to pretend that they were more productive than they really were. Agents were able to exaggerate their level of production at any time during the experiment. To do so, agents just had to select the *boost* option in the action menu and entered the amount by which they wanted to falsely increase their production as observed by the principal. The cheating activity came with a cost in terms of time as agents were losing 5% of the time they should dedicate to work or leisure activities by using the *boost* option. Indeed, after clicking on OK, agents were unable to undertake any other activity for 30 seconds.

The amount by which they artificially increased their level of production appeared in the *boost column* at the bottom of their screen. However, the column with information about their real production remained unchanged. The monitoring summary of the principal also reflected this exaggeration but, the principal was able to realize that the sum of agents' production was different from that of real total production at the end of the period. Indeed, the cheating activity and the work task led to similar results as the production of the agent increased while the level of production of others decreased. But, the cheating activity did not increase the total production of the group that is how it differs from the work task.

III3.1.3. The leisure activity

The leisure activity encompassed in the virtual organization software is the internet browsing. The first window displayed on the computer screen of each participant at the beginning of each period of our experiment was the Google page. All participants were able to browse the web at any time during the experiment. They could also access the internet screen by clicking on the *Internet* option in the action menu; they were unable to undertake another activity while they were browsing the web. Participants were informed about the confidentiality of their usage of internet, they were free to consult their email or visit any web page.

²⁷ The individual production can never be negative thus could not decrease the total team's production.

III3.1.4. The monitoring activity

The experimental design of this chapter differs from that of chapter 2 by the new monitoring system that we set up. Indeed, there were two types of monitoring systems in this design: the *traditional monitoring* and the technology-based monitoring (*IT monitoring*). The *traditional monitoring* system was similar to the monitoring system used in previous experimental studies as the principal was only able to monitor agents' outputs (Dickinson and Villeval, 2008; Engel, 2010; Jung, 2014; Nagin et al., 2002). The *IT monitoring* system collected and recorded information about all activities undertaken by each agent at any time during the experiment when the principal used the *watch* option. In both monitoring systems, the principal was informed in real time of agents' production in cents and of their relative production to the total production of the organization in terms of percentage. However, the principal was able to monitor all subjects' activities at the same time with the *IT monitoring* system only. So, the principal with the *IT monitoring* was informed in real time of the activity undertaken by all agents and also when they switched from one activity to another at any time (see Figure III. 1).

Figure III. 1: Example of principals' screen for IT monitoring and Traditional monitoring

IT monitoring	Traditional monitoring
B12 Activities	B12 Contribution
Switched to Internet Observed production(00:34): 180.00(40%)	Observed production: (00:22): 120 (31%)
Boost Observed production(00:34): 180.00(40%)	
Inactive Observed production(01:04): 180.00(40%)	
Switched to Boost Observed production(01:08): 120.00(31%)	
Switched to Internet Observed production(01:16): 120.00(31%)	
Answer Task2 Observed production(01:19): 120.00(31%)	
Sum Column, #6 Observed production(01:24): 60.00(18%)	
Current State Task2 Observed production(01:40): 60.00(18%)	

As the consequence of the *IT monitoring* system, the principal was distinctly able to know if a given agent was cheating or browsing the web by observing agents on real time. The principal was also able to deduce the amount by which the agent had falsely increased his level of production. Conversely, the principal with the *traditional monitoring* system was able to detect the cheating activity only if a given agent was entering an amount different of 60 by monitoring agents on real time. By reading the monitoring summary at the end of the period, the principal with both monitoring systems was able to deduce if someone increased his level of production when the individual production was not a multiple of 30 with²⁸. Nevertheless, the principal was unable to know which one(s) exaggerated his observed production and by which figures if he didn't monitor them on real time.

III3.2. Treatments

We ran a 2 x 2 experimental design resulting in four treatments (see Table III.1). Reward systems and monitoring systems were the parameters which varied between treatments. Our experimental design allowed for the same payment schemes of chapter 2. The principal was still rewarded 40% of the total production regardless the payment scheme while agents received the remaining 60% of the total production. In the *equal pay* reward system, each agent received 20% of the total production at the end of each period. The principal decided how to allocate the whole remaining 60% of total production among the three agents²⁹ at the end of each period in the *discretionary pay* reward system. Each agent was informed of his *pay*, once the principal validated the percentage allocated to him at the end of each period. The principal in the *discretionary pay* reward system was able to mimic the *equal pay* reward system by giving 20% of the total production to each agent.

The baseline treatment named *TMDP* treatment implemented the *traditional monitoring* and *discretionary pay*. The *TMEP* treatment (*traditional monitoring* + *equal pay*) was the second treatment. These two treatments were similar to *Influence* treatments in chapter 2. The third treatment, *ITDP* treatment (*IT monitoring* + *discretionary pay*) was similar to the first one but differed from the monitoring system. The *ITEP* treatment (*IT monitoring* + *equal pay*) was the

²⁸ Each correct answer generates 60 cents of individual production while 30 cents is subtracted from individual production for each incorrect answer. So, by cheating with an amount equals to 60 or multiple of 30, agents may not be caught by the principal.

²⁹ Each subject B can receive a different or a same percentage of the total production according to the discretion of subject C.

last treatment. We will refer to treatments with *IT monitoring* system and *discretionary pay* as *IT treatments* and *discretionary treatments* respectively. The figure below summarizes these treatments.

Table III. 1: Summary of treatments

Treatments (Numbers of participants)	Reward systems	
	<i>Equal pay</i>	<i>Discretionary pay</i>
<i>traditional monitoring</i>	<i>TMEP</i> (64)	<i>TMDP</i> (64)
<i>IT monitoring</i>	<i>ITEP</i> (60)	<i>ITDP</i> (60)

III3.3. Experimental procedures

Our experiment took place at the laboratory of the Economic Science Institute (ESI) at Chapman University in the city of Orange (California). A total of 248 students (52.42% females) divided in 62 organizations of 4 individuals each participated to this experiment. We conducted 24 sessions in spring 2014. Each session lasted almost one hour and half with 5 periods of 10 minutes. The whole experiment consisted of three stages. The first stage was the summation skills test, participants were asked to sum as many five one-digit numbers as they could during two minutes. Each correct answer was rewarded 10 cents and the total earnings of this stage were added to the individual earnings of participants at the end of the experiment. The number of correct answers of each participant at this stage is what we will refer to as *Ability* in our regressions.

The second stage was the instructions round; the instructions were displayed on participants' computer screens. Participants had 20 minutes to read the instructions carefully on the computer screen. A timer that indicated the remaining time to read the instructions was displayed on the laboratory screen. A printed copy of the summary of instructions was given to each subject, two minutes before the end of the instructions round. The instructions file was closed after the countdown was finished. We have to notice that participants have finished reading the instructions in less than 20 minutes. Participants were able to require assistance if they had any questions during the instructions round or if any difficulties arose after the experiment had begun, but none of them asked questions. In the third stage, participants were

able to undertake one of the three activities mentioned above. Participants learned about their role in this stage.

The individual earnings were computed as the sum of the earnings for five periods added up to the earnings of the summation skills stage. The exact amount of individual earnings in dollars for a given period was displayed in a pop-up window at the end of the period. Participants were able to access information about their earnings of previous periods through the history table on their screen at any time during the experiment. Regardless their role, participants earned on average \$26.5 including a show-up fee of \$7.

Table III. 2: Summary of the experimental design

	248 participants were matched in organization of 4 members : one principal and three agents			
Treatments	<i>ITEP</i>	<i>TMEP</i>	<i>ITDP</i>	<i>TMDP</i>
Parameters	<i>Equal pay</i>		<i>Discretionary pay</i>	
	<i>IT monitoring</i>	TM monitoring	<i>IT monitoring</i>	TM monitoring
First stage	Summation skills test			
Second stage	Session (5 periods of 10 minutes each)			
Third stage	×		Allocation stage (at the end of each session)	
Payment of participants				

III4. Results

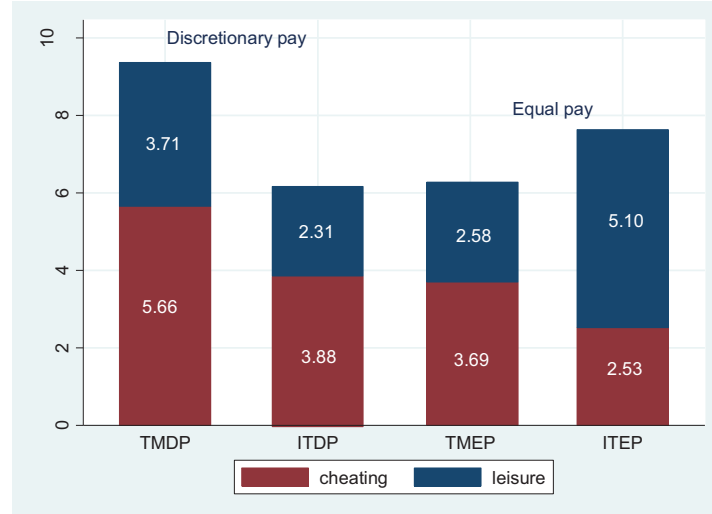
We start this section by presenting descriptive statistics on how agents devoted their time among shirking activities across treatments; we also report p-values for significance tests (clustered version of the Wilcoxon rank-sum test) on the observed mean differences. The second part of this section presents an econometric analysis of the impact of *IT monitoring* system on agents' and principals' behaviors towards working, leisure, cheating and

monitoring activities. We use linear panel regressions with random effects and clustered standard errors at the organization level to analyze our data. This allowed us to take into account the fact that the performance of subjects in the same team may be correlated. We consider a total of 300 observations (60 participants \times 5 periods) for each of the *IT treatments* and 320 observations (64 participants \times 5 periods) for each treatment without *IT monitoring*. Three fourths of these observations correspond to data on agents while the remaining observations correspond to principals.

III.4.1. Descriptive statistics

We present descriptive statistics for cheating and leisure activities regarding 90 agents of *IT treatments* and 96 agents of treatments without *IT monitoring* across the five periods. The software we used enabled us to collect data about the time dedicated by each participant on each activity. We report the average proportion of time spent (in percentage) by agents on each of shirking activities per period and per treatment.

Figure III. 2: Time dedication by agents on shirking activities per treatments



Descriptive statistics show that the time spent by agents on cheating activity is lower in treatments with *IT monitoring* compared to treatments without. Under *discretionary (equal) pay*, agents allocated on average 3.88% (2.53%) of their time to cheating activity in presence of *IT monitoring* compared to 5.66% (3.69%) when *IT monitoring* was unavailable. Nevertheless, these differences are not statistically significant. In line with hypothesis 2, a lower proportion of agents (40.22%) engaged at least once on cheating activity when *IT*

monitoring was available compared to 45.83% in absence of *IT monitoring* (proportion test, p-value = 0.08)³⁰.

The time spent by agents on leisure activity is also lower in presence of *IT monitoring* than the time spent on this activity when it is unavailable, but only under *discretionary pay*. Surprisingly and in contrast with our hypothesis 3, a higher proportion of agents (21.11%) browsed the web at least once in *IT treatments* compared to 15% in treatments without *IT monitoring* (proportion test, p-value = 0.02). However, the proportion of agents who browsed the web at least once is equal to 17.77% in treatment with *IT monitoring* compared to 17.50% in treatment without under *discretionary pay* (proportion test, p-value = 0.47). Indeed, under *equal pay*, 24.44% of agents engaged at least once on leisure activity in treatment with *IT monitoring* compared to 12.5% in treatment without *IT monitoring* (proportion test, p-value = 0.001). The time spent by agents on leisure activity in treatment with *IT monitoring* is about twofold higher compared to the time spent on this activity by agents in treatment without under *equal pay*³¹. This difference is statistically significant ($z = -1.73$, $p = 0.08$). This result shows that *IT monitoring* may have different effects according to the availability of the sanction. When the sanction is available, agents spend less time on internet because they could get caught and punished in the meantime. Nevertheless, when the sanction is unavailable, they are more willing to spend time on internet even if they could get caught.

Another interesting finding is that agents in treatment with *IT monitoring* and *equal pay* who spend more time on internet are more productive compared to agents on other treatments³². It seems that employees are more willing to perform at their peak when they could enjoy internet. This finding is consistent with recent evidence showing that agents are willing to work harder when they have internet access without any sanction for using it (Koch and Nafziger, 2015; Martin and Omrani, 2015). In absence of *IT monitoring*, we also surprisingly observe that agents spent more time on cheating activity than on leisure activity (3.69% > 2.58%) under *equal pay*. It is surprising because agents may enjoy browsing the web rather

³⁰ The effect of *IT monitoring* is more pronounced under *discretionary pay*, 43.55% of agents engaged at least once on cheating activity when *IT monitoring* was available compared to 55.42% in absence of *IT monitoring* (proportion test, p-value = 0.01).

³¹ Agents on treatment with the *IT monitoring* system devoted more than 5% of their time on average to browse the internet under *equal pay*.

³² Agents on *ITEP* treatment produced on average 503.47 > 500.67 (*ITDP*) > 497.63 (*TMEP*) > 459.25 (*TMDP*) however, they devoted less time on productive activity (91.87 %) than agents on *TMEP* (93.36%) and *ITDP* (93.73%) only. So they produced more than others by spending less time on working activity than they do.

than waste time on cheating activity since there are no incentives to cheat. It may be due to their curiosity or/and the demand effect may also explain this result (Corgnet et al., 2015).

III4.2. Econometric results

We report regression estimates for the impact of the *IT monitoring* on agents' and principals' behaviors. We create dummy variables *IT treatments* and *discretionary treatments* that take value one if a given participant was involved on treatments with *IT monitoring* or treatments with *discretionary pay* or zero otherwise. The production is defined as the total number of correct tables completed by a given participant discounted by the number of incorrect tables. We also include a proxy of participants' summation skills named *Ability*. This variable refers to the results of the summing up of five one-digit numbers during two minutes that participants were asked for before reading the instructions.

III4.2.1. Working activity

Table III.3 presents the results of five panels for regressions which analyze the effect of *IT monitoring* on agents' behaviors regarding the working activity. To assess the impact of *IT monitoring* on agents' performance, we create the variable *Productivity*. This variable is computed as the percentage of correct tables on total tables completed by a given agent. We define the variable "*Working_time*" as the time devoted by agents to working activity.

The first two models of Table III.3 are related to agents' productivity in *discretionary treatments* for the first three and the last two periods respectively. Under *discretionary pay*, the productivity is higher in the treatment with *IT monitoring* compared to treatment without (see dummy *IT treatments* in columns [1] and [2]). The relationship between *IT monitoring* dummy and agents' productivity is higher and significant for the first three periods only. Indeed, agents' productivity was 11.42% higher on average in the treatment with *IT monitoring* than in treatment without for these periods ($z = -2.6, p = 0.04$). During the last two periods, the productivity was also higher in the treatment with *IT monitoring* compared to treatment without, but the difference decreased to 2.5% ($z = -0.9, p = 0.32$). This result is consistent with our hypothesis 1. We observe that the relationship between the productivity and the variable *Ability* is positive for the first three periods and negative for the last two periods. It seems that agents' ability was not driving their performance during the second part of the experiment.

Conversely, agents on treatment with *IT monitoring* seem to be less efficient than others under *equal pay* (see variable *IT treatments* in third column of Table III.3). This result is surprising since we observed that the average production of agents was slightly higher on treatment with *IT monitoring* compared to treatment without (see Table III.10 in appendix III). When looking at the productivity as the ratio of correct tables on the time spent on working activity, agents on treatment with *IT monitoring* produced on average more than others although they spent less time on average than them on this activity ($\$5.04/8\text{min}07\text{s}$) > ($\$4.98/8\text{min}27\text{s}$). Consequently, agents on treatment with *IT monitoring* were more efficient under *equal pay*. However, when we compared the productivity as the percentage of correct tables on total tables summed by each agent, the productivity was lower on the treatment with *IT monitoring* (80.46%) compared to treatment without (81.43%)³³. The explanation of this result is as that under *equal pay*, agents in the treatment with *IT monitoring* summed more tables in less time compared to agents on the treatment without *IT monitoring*; but they also made more mistakes. Nevertheless, as hypothesized, the agents' production was higher on average in presence of *IT monitoring* with a lower productivity however. We observe that the time devoted on working activity is significantly positive related to the productivity as expected.

We observe a negative trend in productivity regardless the payment scheme; the coefficient is only significant under *equal pay*. This observation suggests that the number of incorrect tables increased over time even if agents were summing more tables. Agents may have been tired (Corgnet et al., 2014) or just less focused on their task by summing tables repeatedly. We also observe a positive trend in production regardless the payment scheme (see Figure 3 in appendix III). This is consistent with learning effects (Charness and Campbell, 1988); the dynamics of production differed across payment scheme, however.

The time spent on working activity is the dependent variable of the last two columns in Table III.3. Agents in *IT treatments* spent more time on working activity under *discretionary pay* and less time under *equal pay* compared to agents on treatments without *IT monitoring* (see dummy *IT treatments* in the last two columns in Table III.3). We observe a negative trend in time spent on working activity, the coefficient is higher and significant for *discretionary treatments*. This suggests that agents were spending more time on cheating activity to increase their production or on leisure activity to enjoy the internet browsing over time. It appears that

³³ Under *discretionary pay*, the percentage of correct tables on total tables summed by each agent was higher in treatment with *IT monitoring* (83.50%) on average compared to treatment without *IT monitoring* (79.35%).

the positive effect of *IT monitoring* was lower over time. The relationship between the variable *working_time* and the agents' ability is negative regardless the payment scheme; the coefficients are higher and significant for *discretionary treatments*.

Table III. 3: Linear panel regression assessing the impact of the *IT monitoring* on agents' behavior for working activity.

	<i>Productivity</i>			<i>Working_time</i>	
	<i>Discretionary treatments</i>		<i>Equal.</i>	<i>Discretionary.</i>	<i>Equal.</i>
	Periods 1-3	Periods 4-5	Periods 1-5	Periods 1-5	Periods 1-5
	(1)	(2)	(3)	(4)	(5)
<i>Working_time</i>	0.09*** (0.02)	0.06** (0.03)	0.07*** (0.02)		
<i>IT treatments</i>	4.28* (2.48)	0.83 (3.11)	-0.38 (2.61)	1.87 (12.62)	-14.48 (11.77)
Trend	-0.69 (1.09)	-1.75 (1.64)	-1.04*** (0.47)	-7.12** (3.14)	-3.21 (2.91)
<i>Ability</i>	0.38** (0.18)	-0.04 (0.22)	0.19 (0.15)	-2.29* (1.22)	-0.10 (0.88)
Male dummy	-2.09 (2.29)	0.16 (2.61)	-0.61 (2.76)	-2.04 (10.67)	-9.11 (12.52)
Production				0.31*** (0.05)	0.24*** (0.04)
Constant	33.72*** (11.42)	61.92*** (15.48)	47.62*** (12.59)	390.96*** (23.16)	394.10*** (21.28)
Observations	279	186	465	465	465
Number of agents	93	93	93	93	93
Number of teams	31	31	31	31	31
R ² overall	0.226	0.250	0.179	0.370	0.335
Model test chi2 (5)	24.35***	5.76	11.49**	83.78***	92.04***

Notes: Estimation output using robust standard errors clustered at the team level (in parentheses).

Coefficients * significant at 10%; ** significant at 5%; *** significant at 1%.

We decide to deeply examine results about the agents' ability by performing 4 regressions reported on Table III.10 (see appendix III). We create the variable *Low_Ability* which takes the value one if the production of a given agent at the summation skills stage was in the bottom 30% of the distribution or zero otherwise. The dependent variable of the first two columns in Table III.10 is the agents' production in *IT treatments* and treatments without *IT*

monitoring respectively. This table also reports results from regressions with controls for low-ability agents, agents' production, trend and gender about the agents' pay for *discretionary treatments*. We can see that low-ability agents were more productive on *IT treatments* and significantly less productive on treatments without *IT monitoring* (see variable *Low_Ability* in the first two columns in Table III.10). Indeed, the production of low-ability agents was 7.77% higher than the production of high-ability agents on *IT treatments*. On treatments without *IT monitoring*, the production of low-ability agents was 37.57% lower than the production of high-ability agents ($z = 4.92, p = 0.000$). It seems that *IT monitoring* led low-ability agents to work harder, but we did not predict such a disciplining effect. The coefficient associated to the relationship between pay and low ability dummy is positive and significant on *IT treatments* and negative for treatments without *IT monitoring*. These findings suggest that low-ability agents were more productive and more rewarded on *IT treatments*.

Our results are consistent with the evidence from previous experiments and suggest that the two monitoring systems lead to a disciplining effect (Dickinson and Villeval, 2008; Nagin et al., 2002; Engel, 2010). However, this effect is more pronounced under *IT monitoring* system³⁴. We showed that agents on *IT treatments* produced more than agents in treatments without *IT monitoring* system. Also, regardless the payment scheme, there were less free-riders³⁵ in *IT treatments* (3.11%) compared to treatments when *IT monitoring* was not available (3.95%). But, contrary to many of the results in lab experiments, we find that the disciplining effect appears to be more pronounced in the first part of the experiment and under *discretionary pay* only. This disciplining effect of the *IT monitoring* was mitigated under *equal pay* since agents spent less time on working activity in presence of *IT monitoring* compared to treatment without. Also, the proportion of free-riders was higher (4.44%) in treatment with *IT monitoring* compared to treatment without (3.33%) under *equal pay*³⁶. These results are partly inconsistent with our hypothesis 1. It appears that the monitoring system requires the imposition of the punishment to be more effective (Calvo and Wellisz, 1978). We summarize our findings related working activity as follows:

³⁴We observe on Table III.2 that agents on *IT monitoring* treatments were more productive than others regardless the payment scheme *ITEP* (503.47) > *TMEP* (497.63) and *ITDP* (500.67) > *TMDP* (459.25). We notice that subjects in *ITEP* treatment were the best producers.

³⁵ We define free-rider as the agent which spent less than 50% of his time on working activity.

³⁶ The proportion of free-riders was lower (1.77%) in treatment with *IT monitoring* compared to treatment when *IT monitoring* was unavailable (4.58%) under *discretionary pay* (proportion test, p-value = 0.09).

Results 1: Working activity

- i) Agents in *IT treatments* were more productive and spent more time on working activity than others under *discretionary pay*. This effect was more pronounced for the first three periods.
- ii) Agents in treatment with the *IT monitoring* were more productive but spend less time on working activity than agents in treatment without *IT monitoring*.
- iii) *IT monitoring* system led low ability skills agents to perform better than high ability skills agents.

III.4.2.2. Cheating activity

Next, we investigate the impact of *IT monitoring* on cheating activity for *discretionary treatments* only. Remember that by using the *boost* option, agents were unable to undertake another activity during 30 seconds but could artificially increase their production by one or several tables at the same time. We examine the amount by which agents increased their performance and the time they spent to cheat. We also analyze the pay received by cheaters on treatment with *discretionary pay* and *IT monitoring* only³⁷. We define variables "*cheating_time*" and "*cheating_amount*" which respectively refer to the time spent by a given agent on cheating activity and to the amount entered by agents to increase their apparent production respectively. We also created the variable "*caught_cheating*" which takes the value one if a given agent was caught while using the *boost* option or zero otherwise.

The effect of *IT monitoring* on agents' behaviors under *discretionary pay* seems to change over time (see dummy *IT treatments* of the first 2 columns in Table III.4). The fact that the coefficient of *IT treatments* is positive and significant for the last two periods relates to the fact that agents on treatment with *IT monitoring* cheated more than others at the second part of the experiment. Indeed, for the first three periods, agents who used the *boost* option on *IT monitoring* treatment increased their production by an amount equals to \$1.16 on average compared to \$1.44 for agents on treatment without *IT monitoring*. Conversely, this average amount was equal to \$2.69 in treatment with *IT monitoring* compared to \$1.68 in treatment without *IT monitoring* for the last two periods. Figure III.4 (see appendix III) perfectly reflects this change; these results are not significant however.

³⁷ The principal was able to clearly detect a shirking behavior on *ITDP* treatment. So, we decide to study this treatment only.

Table III. 4: Linear panel regression assessing the impact of *IT monitoring* on agents' and principals' behaviors regarding cheating activity for *discretionary treatments*.

	<i>Cheating_amount</i>		Pay	Production
	<i>Discretionary treatments</i>		<i>ITDP</i>	
	Periods 1-3	Periods 4-5	Periods 1-5	
	(1)	(2)	(3)	(4)
<i>IT treatments</i>	-13.99 (20.46)	54.41* (32.78)		
<i>Cheating_time</i>	2.20*** (0.19)	2.34*** (0.80)		
<i>Cheating_amount</i>			0.01** (0.01)	
Production	-0.03 (0.04)	-0.11 (0.09)	0.02*** (0.00)	
Pay _(t-1)	0.33 (0.79)	2.15* (1.32)		7.03*** (1.26)
Trend	19.85* (12.04)	6.62 (25.17)	-1.21*** (0.24)	10.16 (7.06)
<i>Ability</i>	1.69 (2.90)	2.18 (4.52)	-0.45** (0.18)	4.01 (5.36)
Male dummy	-4.32 (19.11)	-18.04 (40.03)	1.04 (1.61)	-36.54 (42.75)
<i>Caught_cheating</i>			-12.24*** (3.89)	
<i>caught_cheating</i> _(t-1)				164.32*** (37.95)
Constant	-46.16 (91.80)	-36.98 (156.84)	30.63*** (2.36)	199.40** (90.42)
Observations	186	186	225	180
Number of agents	93	93	45	45
Number of teams	31	31	15	15
R ² overall	0.455	0.215	0.418	0.254
Model test chi2	175.54***	18.20***	92.68***	64.43***

Notes: Estimation output using robust standard errors clustered at the team level (in parentheses). Coefficients * significant at 10%; ** significant at 5%; *** significant at 1%.

We can notice that the amount by which agents increased their production was more than twice as high during the two last periods in treatment with *IT monitoring* (compared to the first three periods), and exceeded by \$ 1.01 the amount in treatment without *IT monitoring*³⁸. This result echoes our finding that the disciplining effect of the *IT monitoring* is more effective during the first periods. The relation between *cheating_time* and *cheating_amount* is significantly positive; the coefficient is higher for the last two periods. This observation supports the finding that agents cheated more during the last periods. As the results, the relationship between the variable *cheating_amount* and the pay for previous period is higher and significant for the last two periods. These results show the positive effects of cheating on agents' pay. However, we observe a positive trend in *cheating_amount* but the coefficient is higher and only significant for the first three periods. It seems that as there was more cheating during last periods, more agents were caught cheating since principals were clearly and easily able to detect cheaters with *IT monitoring*. Consequently, the implementation of sanction by principals (by allocating a lower pay) was dampening the agents' willingness to cheat.

Results in the last two tables of Table III.4 provide support for this explanation. Indeed, the cheating was punished by principals and agents caught on this activity produced more than others after the sanction as predicted in our hypothesis 2ii (see dummies *Caught_cheating* and *L1.Caught_cheating* in the last 2 columns of Table III.4). Actually, the average pay for agents who got caught was equal to \$2.35 compared to \$3.99 for agents who did not get caught on cheating activity. Nevertheless, the average production as observed by principals for agents caught on cheating activity was higher (\$7.29) compared to \$6.36 for agents who were not caught. So, agents caught on cheating activity received a lower pay than others although their average production as observed by principals was higher. These results confirm that principals punished cheating behavior by allocating a lower pay to agents. We notice that the proportion of agents who get caught by using the *boost* option is equal to 12.24%. Production and *cheating_amount* have a positive relation with pay; the relationship with production is higher however. This shows that the incentive to cheat was not large enough to sidestep the positive effect of *IT monitoring*. This observation also suggests that agents' performance was more profitable than cheating (see dummy $\text{pay}_{(t-1)}$ in the last column compared to first two columns of Table III.4). We also observe a negative trend in pay; we suggest that principals offer

³⁸ We notice that a lower proportion of agents (50%) cheated at least once in presence of *IT monitoring* compared to 62.5% of agents in treatment without *IT monitoring* for the last 2 periods (proportion test, p-value = 0.09).

lower-powered incentives to decrease cheating behavior (Corgnet et al., 2015). The relationship between agents' ability and the pay is negative and significant (see dummy *Ability* of the third column in Table III.4). This result supports the finding that low-ability agents received a higher pay than others as we showed previously. We can conclude that *IT monitoring* was useful to detect a cheating activity and to lead agents to work at their peak. The *IT monitoring* is quite successful at reducing shirking (Engel, 2010) but, it could fail to increase agents' effort since its disciplining effect lessens over time.

Results 2: Cheating activity

- i) Agents in *IT treatments* engaged less on cheating activity.
- ii) The amount by which agents falsely increased their production was lower on treatment with *IT monitoring* for the first periods only.
- iii) For the last two periods, agents on *IT monitoring* treatment cheated more (amount) than others under *discretionary pay*.
- iv) The *IT monitoring* was useful to detect cheating behaviors and to lead agents to increase their level of effort after the sanction.

III4.2.3. Leisure activity

The regressions in Table 5 provide the impact of *IT monitoring* on agents' behaviors regarding leisure activity. We create the variable *Internet_time* which refers to the time spent on leisure activity by participants. We also create the variable "*caught_internet*" which takes the value 1 if the subject got caught on internet (0 otherwise) in the treatment with *IT monitoring* and *discretionary pay*. Results on the first two columns of the table below confirm our findings in descriptive statistics (see dummy *IT treatments* in the first two columns of Table III.5). The time spent by agents on leisure activity was lower on treatment with *IT monitoring* compared to treatment without *IT monitoring* under *discretionary pay*. Agents spent more time on leisure activity when *IT monitoring* was available compared to agents in treatment when it was not under *equal pay*. As expected, the relationship between *Internet_time* and time spent on others activities is negative; these coefficients are higher for *discretionary treatments*. We also observe a positive trend in time spent on internet; however the coefficient is higher and only significant for *discretionary treatments*. It appears that the gap of time spent on internet between periods is higher *on discretionary treatments*. This may suggest that the willingness to take a break increased since the task was effortful or simply

agents were forgetting the extent of *IT monitoring* with time. The disciplining effect of the *IT monitoring* is effective under *discretionary pay* only. We notice that 30% of agents were getting caught while browsing the web.

Table III. 5: Linear panel regression assessing the time spent on internet by agents and agents' pay in *ITDP* treatment.

	<i>Internet_time</i>		Pay
	<i>Discretionary.</i>	<i>Equal.</i>	ITDP
	(1)	(2)	(3)
<i>IT treatments</i>	-0.39 (4.50)	10.72** (4.70)	
<i>Working_time</i>	-0.59*** (0.13)	-0.46*** (0.09)	
<i>Cheating_time</i>	-0.68*** (0.13)	-0.36*** (0.13)	
Production	0.01 (0.01)	-0.00 (0.01)	0.02*** (0.00)
Trend	4.25** (1.85)	2.61 (2.18)	-1.05*** (0.25)
<i>Ability</i>	0.07 (0.51)	-0.13 (0.37)	-0.42** (0.19)
Male dummy	7.79 (5.13)	-3.11 (3.51)	1.59 (1.71)
<i>Caught_internet</i>			-2.31 (2.75)
boostamount			0.01 (0.01)
Constant	295.41*** (60.23)	241.81*** (39.19)	29.22*** (3.02)
Observations	465	465	225
Number of agents	93	93	45
Number of teams	25	25	15
R ² overall	0.578	0.480	0.343
Model test chi2 (7/6)	53.26***	88.54***	42.14***

Notes: Estimation output using robust standard errors clustered at the team level (in parentheses). Coefficients * significant at 10%; ** significant at 5%; *** significant at 1%.

The last panel regression of Table III.5 shows that the pay of agents which were got caught on internet was lower compared to the pay of others in treatment with *IT monitoring* and *discretionary pay* (see dummy *Caught_internet* in the last column of Table III.5). Nevertheless, when looking at the production as observed by the principals, we observe that agents' production was 28.01% lower on average for agents who got caught on internet

compared to those who were not. Also, the actual production of agents who get caught by using the *Internet* option was 38.75% lower on average compared to those who were not caught. Consequently, agents caught on internet received a lower pay (\$2.58) on average compared than others (\$3.72). These results are not significant however.

Results 3: Internet use

- i) Agents in *IT treatments* spent less time on internet than others under *discretionary pay*.
- ii) Agents in *IT treatments* spent more time on internet than others under *equal pay*.
- iii) Agents caught on internet were less productive and received a lower pay compared to others in treatment with *IT monitoring* and *discretionary pay*.

The table below summarizes the main effects of *IT monitoring* on agents' behavior. The impact of the technology-based monitoring is clear for the production and the time spent on cheating but mitigated regarding the time spent on productive and leisure activities and cheating (amount).

Table III. 6: Main effects of *IT monitoring* on agents' behavior.

IT vs TM	Work		Cheating		leisure
	Time	production	time	amount	time
<i>Discretionary pay</i>	+ ³⁹	+	-	- ⁴⁰	-
<i>Equal pay</i>	-	+	-	+ ⁴¹	+
global	?	+	-	?	?

³⁹ Symbols + and – refer to the effect of technology monitoring agents' behaviors compared to the traditional monitoring.

⁴⁰ The cheating (amount) was lower on average for the five periods in presence of IT monitoring. More precisely, the cheating was only lower during the first three periods but higher for the last 2 periods when *IT monitoring* was available compared to when it was not under *discretionary pay*.

⁴¹ The cheating (amount) was higher on average during the five periods in presence of IT monitoring under *equal pay*.

III4.2.4. Principal's behavior

We start by presenting summary statistics regarding principals' behaviors. Under *discretionary (equal) pay*, principals on *IT treatments* devoted 81.59% (92.56%) of time on average to working activity compared to principals without *IT monitoring* 90.74% (93.19%). Principals on *IT treatments* also spent less time on average (at least half) on leisure activity than others. Indeed, the average time spent on internet was equal 0.58% (0.40%) under *discretionary (equal) pay* for principals with *IT monitoring* compared to 1.41% (0.81%) for principals in treatments without *IT monitoring*. We notice that principals' pay was 5.30% (6.25%) higher on average under *discretionary (equal) pay* for principals in *IT treatments* compared to principals' pay on treatments without *IT monitoring*. These results are not statistically significant.

We report regressions analyzing the effect of *IT monitoring* on monitoring activity and principals' production in Table III.7. We define the variable "*monitoring_time*" which is the time devoted on monitoring activity by principals. Consistent with our hypothesis 4, principals on *IT treatments* spend more time on monitoring activity compared to principals in other treatments (see dummy *IT treatments* in last first columns of Table III.7). The regression coefficient is higher and significant for *discretionary treatments* (see dummy *IT treatments* in the first two columns of Table III.7). Indeed, under *discretionary pay*, principals allocated 17.83% of their time to monitor agents in presence of *IT monitoring* compared to 7.85% when *IT monitoring* was unavailable ($z = -1.89$, $p = 0.06$). As expected, the relationship between principals' production and *monitoring_time* is negative regardless of the payment scheme; the coefficient is only significant under *equal pay*. We observe a negative trend on time spent by principals on monitoring activity regardless the reward system; the relationship is higher under *equal pay*. However, these results are not statistically significant.

Table III. 7: Linear panel regression assessing the effects of *IT monitoring* on principals behavior regarding production and monitoring.

	<i>Watching_time</i>		Production	
	<i>Discretionary.</i>	<i>Equal.</i>	<i>Discretionary.</i>	<i>Equal.</i>
	(1)	(2)	(3)	(4)
Production	-0.1 (0.07)	-0.08*** (0.02)		
<i>IT treatments</i>	49.05** (20.51)	12.85 (10.01)	-2.74 (39.68)	53.94 (49.81)
<i>Working_time</i>			0.57*** (0.12)	0.82*** (0.12)
Pay			0.39*** (0.06)	0.66*** (0.12)
Trend	-2.18 (4.45)	-3.02 (2.14)	14.65* (8.16)	-10.29 (8.34)
<i>Ability</i>	1.72 (2.22)	0.64 (1.17)	4.50 (0.30)	1.26 (6.55)
Male dummy	-23.64 (21.83)	5.99 (12.01)	37.52 (45.06)	-21.45 (47.25)
Constant	75.28* (43.42)	61.56*** (18.94)	-230.23*** (71.47)	-421.61*** (117.31)
Observations	155	155	155	155
Number of principals	31	31	31	31
Number of teams	31	31	31	31
R ² overall	0.265	0.181	0.479	0.477
Model test chi2 (5/6)	13.79**	38.88***	177.77***	138.82***

Notes: Estimation output using robust standard errors clustered at the team level (in parentheses). Coefficients * significant at 10%; ** significant at 5%; *** significant at 1%.

Results on the last two panels of the table above show that principals with *IT monitoring* are more productive compared to principals in treatments without, under *equal pay* only (see variable *IT treatments* on first two columns of Table III.7)⁴². Indeed, the principals' production was 18.56% higher under *equal pay* and 2.29% lower under *discretionary pay* when *IT monitoring* was available compared to treatments without. The coefficients of relationships between variables *working_time*, pay and principals' production are positive and significant regardless the payment scheme. These coefficients are higher on *equal pay* (see dummies *working_time* and pay in the last two columns of Table III.7). These observations

⁴² On average, principals on *IT treatments* devote less time (87.23%) to working activity compared to 91.97% for principals on treatments without *IT monitoring* but their production is 8.34% higher on average.

suggest that principals on *discretionary treatments* spent on average less time on working activity and received a lower pay compared to the principals on treatments with *equal pay* reward system. These observations also shed light on the power of the *IT monitoring*. Indeed, principals on *IT treatments* were spending less time on productive activity compared to principals on treatments without *IT monitoring* while their pay was higher on average compared to those of principals without *IT monitoring* regardless the payment scheme. We observe a positive trend in production under *discretionary pay*; this relation is negative under *equal pay*⁴³. It appears that the gap of principals' production between periods was higher under *discretionary pay* since they devoted less time to monitoring activity. We also observe that the relationship between principals' production and the variable *Ability* is positive. Conversely to agents, it seems that principals' ability was driving their performance. This relationship is higher under *discretionary pay*; these results are not statistically significant.

Results 4: The principal's behavior

- i) Principals on *IT treatments* spent more time on monitoring activity.
- ii) Principals on *IT treatments* were less productive than principals in treatments without *IT monitoring* under *discretionary pay*.
- iii) Principals on *IT treatments* were more productive than others under *equal pay*.

The table below summarizes the main effects of the technology-based monitoring on principals' behavior. The impact of *IT monitoring* is clear for the time spent on activities but mitigate regarding the production.

Table III. 8: Main effects of *IT monitoring* on principals' behavior.

IT vs TM	Work		monitoring	leisure
	Time	production	time	time
<i>Discretionary pay</i>	- ⁴⁴	-	+	-
<i>Equal pay</i>	-	+	+	-
global	-	?	+	-

⁴³ The trend of principals' production under *equal pay* is positive until the fourth period.

⁴⁴ Symbols + and – refer to the effect of technology monitoring agents' behaviors compared to the traditional monitoring.

III5. Discussion and Conclusion

The technology-based monitoring continuously and instantaneously keeps details about workers' attendance, time coded log of all activities performed from their computer terminal, time and length of time website visited, overtime, and break time. So, this monitoring system could seriously impact workers' performance. Although the diffusion of ICT at workplace has generated a widespread use of technological tools to monitor employees, the technology monitoring has never been really studied in the economic literature. Also, some cases of firing because of computer systems and technology resources misuses suggest that workers may not really be aware of the extent of the technology monitoring system, even if they signed the IT charter of the firm.

In this chapter, our first contribution to the agency theory literature was to investigate the impact of the technology monitoring on agents' and principals' behaviors in the lab. We believe that a better understanding of how technology monitoring affects workers' performance might be useful to minimize costs of technologies misuses at work. While previous experimental works studied the monitoring rate chosen by the principal to audit agents' output; the principal was able to monitor agents' output (Traditional monitoring) or all agents' activities on top of their output (*IT monitoring*) depending on the treatment, in our experiment. We designed a workplace environment in which agents were able to complete a work task, browse the internet and cheat; we addressed the effect of *IT monitoring* on agents' behaviors through these three activities. We conducted a 2x2 design in which we varied the monitoring system and the payment scheme (*equal pay* or *discretionary pay*). The *discretionary pay* was an incentive system as the principal was able to reward or punish agents according to his discretion by giving higher or lower pays.

Consistent with previous studies, we found that the disciplining effect occurs in presence of the technology monitoring when the sanction is available. But, the most important finding is that this effect varies over time. Indeed, when the technology monitoring was available, agents produced more compared to treatment without this monitoring system. But, the gap between the productions of two treatments was 4 times lower in the last two periods compared to the first three periods. Moreover, agents cheated more in presence of the technology monitoring compared to the situation without during the last two periods. Since the technology monitoring is invisible, it seems that employees forgot the extent of this monitoring system over time. This could explain why there are several cases where agents get

fired because of internet abuse or misuse despite the fact that they know the IT charter. Nevertheless, the disciplining effect of the technology-based monitoring reappears after a sanction.

The disciplining effect of the technology monitoring differed whether the sanction was available or not. Indeed, this effect was mitigated in absence of sanction. Although agents produced more and spent less time on cheating in presence of the technology monitoring, they spent less time on productive activity and more time on leisure activity compared to others. These results mostly stand in contrast to our hypotheses. Nevertheless, the most productive agents were those who spent more time on internet. In our experimental design, the availability of internet did not depend on the principal's discretion (Koch and Nafziger, 2015). So, we cannot conclude that agents reciprocated by working hard. We suggest that the moral cleansing effect (performing a good deed after doing a bad one) could explain this result (Sachdeva et al. 2009, Branas-Garza et al. 2012). Indeed, by browsing the web, the moral capital of agents was debited and they work hard after by crediting their moral capital to compensate.

We found two others surprising results regarding the impact of the monitoring software. The first is related to agents with low summation skills. We found that they were more productive compared to others with high skills. It seems that the technology monitoring system lead agents to work harder. The second result is related to cheating, agents were more effective to cheat when the technology monitoring was available. Indeed, regardless of the payment scheme, agents spent less time to cheat but they entered a higher amount on average to increase their production compared to others. We suggest that they were trying to reduce the probability to get caught as it was easy to detect the cheating with the monitoring software. It appears that agents were adapting to the technology.

The second contribution of our paper concerns principal's behavior that is often neglected in the literature. We found that the technology monitoring is costly in terms of time as principals spent more time to monitor agents in presence of this monitoring system compared to others. As the result, principals spent less time to work but also on leisure activity compared to others. However, the overall effect of the technology monitoring is positive since the production of the organization as well as principals' pay are higher when *IT monitoring* is available than when it is not. The monitoring software is also more effective in terms of time to clearly detect and punish shirking behaviors at work.

One managerial implication of this chapter is that managers should use detailed information provided by the monitoring software in order to get workers aware of the extent of this monitoring system. For example, give some feedbacks about workers' productivity or internet use should be better to get them motivated and focused on their work. Another implication is that the use of technology tools to monitor agents need to be adapted to a specific payment scheme in order to reap more potential benefits from the use of ICT. In this chapter we examined the effect of technology monitoring compared to the classic monitoring system but we did not design a treatment in which principals could give a monitoring rate to agents. Also, our design of the monitoring software was imperfect as principals were unable to have information about workers' activities without monitoring them in real time. The technology-based monitoring records continuously and instantaneously data about workers even if the principal is absent. Further researches could focus on the threshold in which the disciplining effect of technology monitoring lessens. The frequency and type of feedbacks that principals can give to agents in order to constantly get them aware of the extent of the technology-based monitoring could be studied also.

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Appendix III

Table III. 9: Comparison of agents' production over payment scheme.

Treatments		Average	Median	Standard deviation	P-values Ranksum test
<i>Equal pay</i>	Traditional (<i>TMEP</i>)	497.63	495	216.49	$z = -0.51$ $p = 0.60$
	IT (<i>ITEP</i>)	503.47	480	262.50	
<i>Discretionary pay</i>	Traditional (<i>TMDP</i>)	459.25	450	220.70	$z = -1.18$ $p = 0.23$
	IT (<i>ITDP</i>)	500.67	510	224.59	

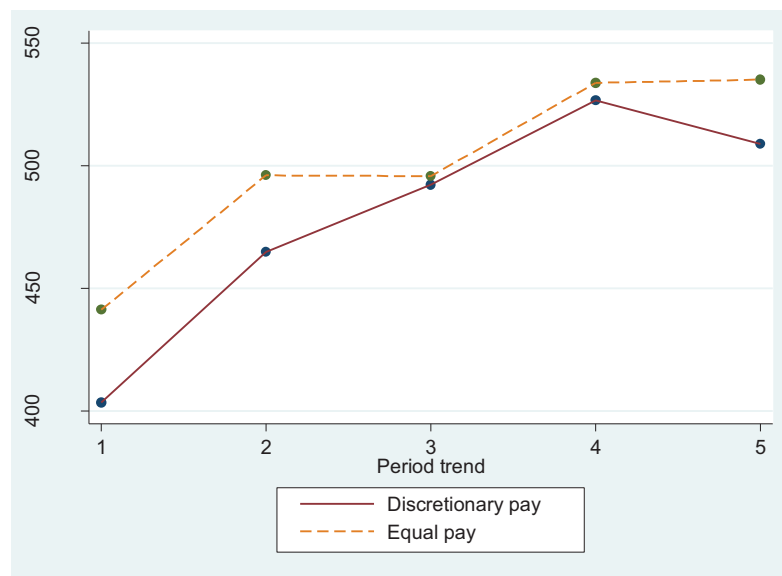
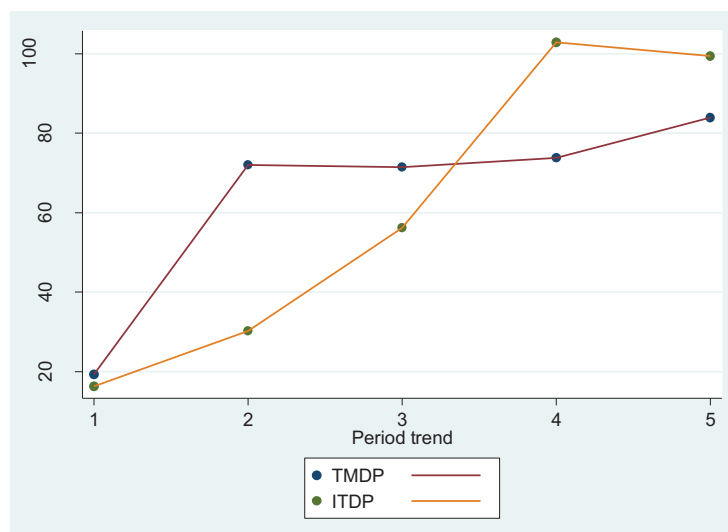
Figure III. 3: Agents' production on average over payment scheme in cents

Table III. 10: Linear panel regression with regarding production and pay for low ability agents.

	Production		Pay	
	<i>IT treatments</i>	<i>TM treatments</i>	<i>ITDP</i>	<i>TMDP</i>
	(1)	(2)	(3)	(4)
<i>Working_time</i>	1.06*** (0.02)	1.08*** (0.06)		
<i>Discretionary treat.</i>	-13.95 (36.67)	-10.77 (25.42)		
<i>Low_Ability</i>	36.11 (42.62)	-163.24*** (28.56)	5.61** (2.73)	-2.78 (2.44)
Trend	22.58*** (4.35)	23.52*** (3.85)	-1.02*** (0.26)	-0.54** (0.27)
Male dummy	-41.43 (39.46)	-9.36 (23.07)	1.79 (1.94)	0.88 (1.95)
Production			0.02*** (0.00)	0.02*** (0.00)
<i>Cheating_amount</i>			0.01 (0.01)	0.00 (0.01)
Constant	-67.50 (46.33)	-71.92* (39.71)	21.37*** (2.76)	26.78*** (3.11)
Observations	450	480	225	240
Number of agents	90	96	45	48
Number of teams	30	32	15	16
R ² overall	0.348	0.475	0.349	0.172
Model test chi2 (6/5)	144.33***	394.96***	38.76**	38.16***

Notes: Estimation output using robust standard errors clustered at the team level (in parentheses). Coefficients * significant at 10%; ** significant at 5%; *** significant at

Figure III. 4: Agents cheating (amount in cents) on average over *discretionary treatments*

INSTRUCTIONS of TMEP and TMDP treatments are the same than those of IEP and IDP in Chapter II. We just reported instructions related to ITEP and ITDP in this section.

INSTRUCTIONS (*ITEP*)

- You have exactly 20 minutes to go through the instructions. You will have enough time to read the instructions carefully. A timer is displayed on the room monitor that indicates the remaining time to read the instructions.
- After that, the experimenter will close the current document and you will be able to access the experiment. Please do not close the current document and do not access the experiment before the end of the instruction round.
- A printed copy with a short summary of the instructions will be given to you at the end of the instruction round.
- This is an experiment in decision making. You will be paid in cash for your participation at the end of the experiment. Different participants may earn different amounts. What you earn depends on your decisions and the decisions of others.
- The experiment will take place through computer terminals at which you are seated. If you have any questions during the instruction round, raise your hand and a monitor will come by to answer your question. If any difficulties arise after the experiment has begun, raise your hand, and someone will assist you.

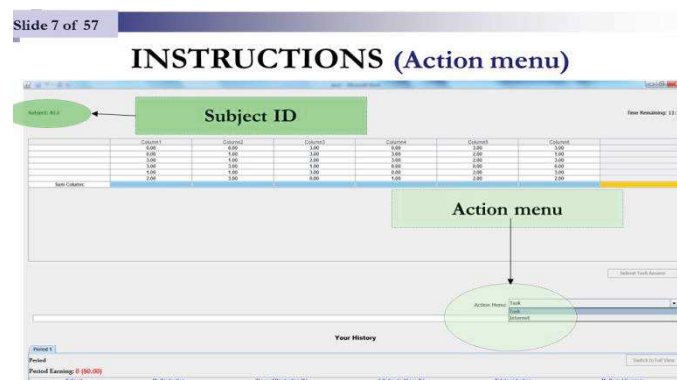
(Timing of the experiment)

- This experiment involves 4 subjects and consists of 5 periods of 10 minutes each. There are *two* types of subjects referred to as *B* and *C*.
- 3 subjects will be subjects *B* and *one* will be subject *C*. You will learn the type of subject you are when the experiment starts.
- Your individual earnings at the end of the experiment are computed as the sum of your earnings in the 5 periods.
- In each period of this experiment both subjects *B* and subject *C* will be able to: sum up numbers in a table (work task) or browse the web.
- Subject *C* will have access to another activity that consists in monitoring other subjects' activities.
- Subjects *B* will have access to an activity in which they will be able to exaggerate their performance on the work task.
- To switch from one activity to another you just have to click on the corresponding option of the action menu displayed on your screen.

- The activities are referred to as *Task* (sum up numbers in a table), *Internet* (browse the web), *Watch* (monitor subjects *B* contributions – only available to *C*) and *Boost* (exaggerate task production as *observed* by subject *C* – only available to *Bs*). Each activity is undertaken separately, in a different screen.
- Your experiment ID will be displayed on the top left corner of your screen once the experiment starts. It will consist of the letter *B* followed by a number if you are of type *B*. If you are the subject *C* your ID will be *C11*.

Task – summing up numbers

- The task consists in summing up 36 numbers in a table with 6 rows and 6 columns. Each subject is given a different set of tables with the same level of difficulty.
- Before providing your final answer (the total sum of all numbers in the table) you have to fill in the 6 cells that correspond to the sums of the 6 columns. Filling in these 6 cells does not directly generate earnings but it can help you to compute the final sum.



- Only after filling in all these cells will you be allowed to provide a final answer (the total sum) in the box located below the table on the left.
- Notice that **you are not allowed** using a calculator or any other electronic, computer-based or internet-based devices to sum up numbers.
- If you do, *you will be excused and you will not be paid*.
- Only the final answer (total sum of the table) is rewarded. Intermediate sums of all columns are required but are not rewarded.
- Each time you answer the task correctly (your final sum is correct) you generate *60 cents* of *Total production*. These *60 cents* is not directly added to your individual earnings.

- Subject *C* always gets 40% of *Total production* while each subject *B* gets 20% of the total profit contributed by all subjects undertaking the task.
- The amount of money you generate by undertaking the task is displayed in the second column “**My Production**” of the history table at the bottom of the screen.
- The total amount of money generated by all 4 subjects (subject *C* + 3 subjects *B*) on the task is displayed in the sixth column “**Total Production**” of the history table at the bottom of the screen.
- If you sum up the numbers of a table correctly then each subject in the experiment (including yourself) gets 60 cents times the *percentage* of *Total production* that he or she is assigned.
- If you are subject *C* you get 24 cents ($40\% \times 60 \text{ cents}$).
- If you are one of the subjects *B* you get 12 cents ($20\% \times 60 \text{ cents}$).
- If you answer the task incorrectly you generate a penalty of 30 cents that is subtracted from *Total production*. So when you answer incorrectly your individual earnings decrease by 12 cents ($40\% \times 30$) if you are Subject *C* and by 6 cents ($20\% \times 30$) if you are Subject *B*.

(Your Production can never be less than 0.)

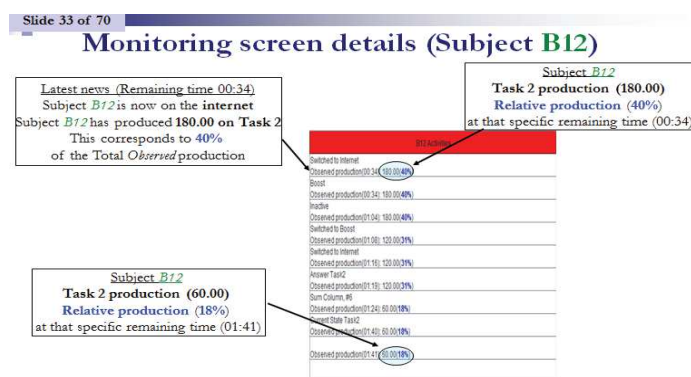
(Browsing the internet)

- Whether you are a subject *B* or subject *C*, you can browse the internet at any time during this experiment. Browsing the web is one of the basic activities that you can perform during this experiment, along with summing up numbers.
- You can access the internet screen by clicking on the *Internet* option in the action menu.
- Notice that while using the internet **you are not allowed** to download additional software. You are also expected to close pop-up windows when they appear on the screen.
- Your usage of the internet is **strictly confidential**. No one can see the web pages you are consulting (for example, your email).

Monitoring: only for subject *C*

- If and only if you are subject *C*, you can monitor the contribution of the three subjects *B* at any time during this experiment. You can do so by clicking on the *Watch* option in the action menu.

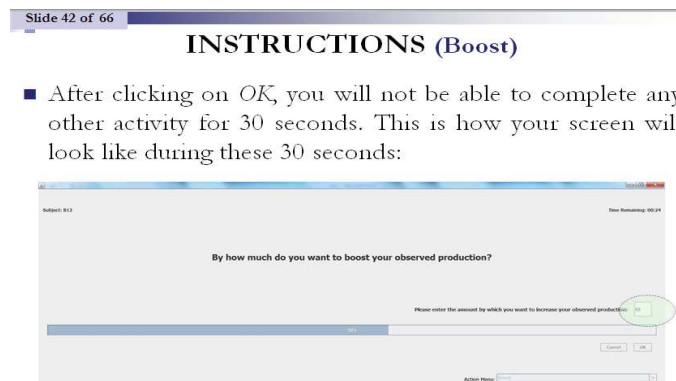
- You will be faced with a monitoring screen with 3 columns, each of them corresponding to one of the subjects *B* in the experiment. The head of each column indicates the experiment ID of the subject.
- For example, to monitor subject *B12*, you have to click on the column header “**B12**” displayed in green. The column header turns red once you click on the *Yes* button on the pop-up message: “*Ready to watch?*”
- You can monitor all subjects’ contributions at the same time by clicking on the following button displayed in the top right corner of the screen:
- You can stop monitoring all subjects *B* by clicking:
- To stop monitoring a given subject you have to click on the corresponding column header.
- At the end of each period, subject *C* will also receive a summary of his or her monitoring activities.
- You will be informed in real time of the *observed* production *and* contribution to *Total production* (in % terms) of the selected subject *B*.
- You will be informed in real time of the activities undertaken and time expended on each activity by the selected subject: *Internet* (browsing the web), *Task 2* (summing up numbers in a table) or *Boost* (exaggerating task production). All this information will be saved on the monitoring screen until you switched to another activity.
- You will be informed when a subject enter a number to sum a column before providing Task 2 final answer. This is referred to as Sum Column in the monitoring screen.
- In addition, you will be informed in real time of the observed production and contribution to Total production (in % terms) of the selected subject *B*.



INSTRUCTIONS (Boost)

- If and only if you are subject *B*, you can exaggerate your production, as *observed* by subject *C*, at any time during this experiment.

- To do so, you just have to select the *Boost* option in the action menu.
- To exaggerate your *observed* production, you have to enter the amount by which you want to increase it.
- After clicking on *OK*, you will not be able to complete any other activity for 30 seconds. This is how your screen will look like during these 30 seconds:

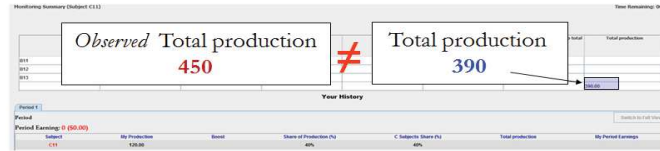


- The amount by which you boosted your *observed* production will appear in the Boost column at the bottom of your screen.
- The My Production column will remain unchanged, however.
- For example, consider the situation in which the production of subject *B12* is 120¢ while the other three subjects have produced a total of 270¢. In that case, *Total production* is equal to 390¢ and subject *B12* contribution to *Total production* is equal to 31% (120¢/390¢).
- Consider now that subject *B12* exaggerates his or her *observed* production by 60¢ using the boost option.
- As a consequence, the production of subject *B12* as *observed* by subject *C* will immediately increase from its current level of 120¢ to 180¢. Also, the *observed* contribution of subject *B12* will increase from 31% to 38% (180¢/390¢) and the *observed* contributions of subjects *B11* and *B13* will decrease.
- The monitoring screen of subject *C* will reflect this increase in *observed* production and contribution of subject *B12*.
- As a result of subject *B12* boosting his or her *observed* production, the sum of subjects' *observed* productions will be different from the actual *Total production* in the monitoring summary.

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Monitoring and Boost

- As a result of subject *B12* boosting his or her *observed* production, the sum of subjects' *observed* productions will be different from the actual *Total production* in the monitoring summary.



- The monitor will be able to know whether one or several subjects *B* have boosted their *observed* production. However, the monitor will not know which subject(s) exaggerated their *observed* production and by which amount.
- This is the case because the monitor will not be informed of the activities completed by each subject.
- Instead, the monitor will be informed of the *observed* production and contribution of the monitored subjects *B* at that moment in time.

INSTRUCTIONS (Earnings)

- Your individual earnings correspond to the following sum over the 5 periods:
 - Your *percentage* of *Total production* that has been generated by all 4 subjects (*C* subject + 3 *B* subjects) summing up numbers during the experiment.
- You will learn the exact amount of your individual earnings at the end of each 10-minute period.
- In the pop-up window, your individual earnings in *dollars* for the current period will be displayed.
- You will click on the OK button to continue to next period.
- Your earnings in *cents* for the current period will be also displayed in the last column of the history table at the bottom of your screen. This column is labeled “My Period Earnings”.
- You will also see the share of production of all other subjects at the top of your screen
- **EXAMPLE:** In the first period you provided 7 correct answers completing the task while providing 3 incorrect answers. Also, the other three subjects in the experiment provided a total of 24 correct answers in the task while providing 5 incorrect answers.
- Your *earnings* (“My Period Earnings”) for that period are equal to:
- *Earnings:* $20\% \times (31 \times 60 - 8 \times 30) = 324 \text{ cents}$ if you are a subject *B*

- *Earnings*: $40\% \times (31 \times 60 - 8 \times 30) = 648$ cents if you are subject *C*
- Note that the amount displayed in the Boost column increased your production as *observed* by subject *C* without changing either the value of the My Production and Total production columns.

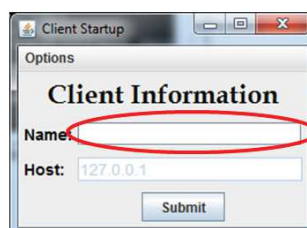
Summary

- This experiment involves 4 subjects and consists of 5 periods of 10 minutes each. There are *two* types of subjects referred to as *B* and *C*, respectively.
- 3 subjects will be subjects *B* and *one* will be subject *C*.
- In each period, both subjects *B* and subject *C* will be able to: *sum up numbers* in a table or *browse the web*.
- Only subjects *B* will be able to exaggerate their production and contribution as *observed* by subject *C* by using the *boost* option.
- Only subject *C* will be able to monitor other subjects' activities.
- Your individual earnings will depend on the task which consists in summing up numbers in a table.
- The total earnings generated by all 4 subjects (subject *C* + 3 subjects *B*) on the task will be divided as follows.
- Each subject *B* will get 20% of the total amount of money generated by all subjects while subject *C* always will get 40% of the total amount of money generated.

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Please wait until the experimenter closes the current instruction screen.

- Please enter your **full name** in the following screen once the instruction screen has been closed by the experimenter.



The screenshot shows a window titled 'Client Startup' with a sub-header 'Options'. Below this is the 'Client Information' section. It contains two input fields: 'Name:' and 'Host:'. The 'Name:' field is highlighted with a red oval. The 'Host:' field contains the text '127.0.0.1'. At the bottom right of the form is a 'Submit' button.

INSTRUCTIONS (ITVP)

- You have exactly 20 minutes to go through the instructions. You will have enough time to read the instructions carefully. A timer is displayed on the room monitor that indicates the remaining time to read the instructions.
- After that, the experimenter will close the current document and you will be able to access the experiment. Please do not close the current document and do not access the experiment before the end of the instruction round.
- A printed copy with a short summary of the instructions will be given to you at the end of the instruction round.
- This is an experiment in decision making. You will be paid in cash for your participation at the end of the experiment. Different participants may earn different amounts. What you earn depends on your decisions and the decisions of others.
- The experiment will take place through computer terminals at which you are seated. If you have any questions during the instruction round, raise your hand and a monitor will come by to answer your question. If any difficulties arise after the experiment has begun, raise your hand, and someone will assist you.

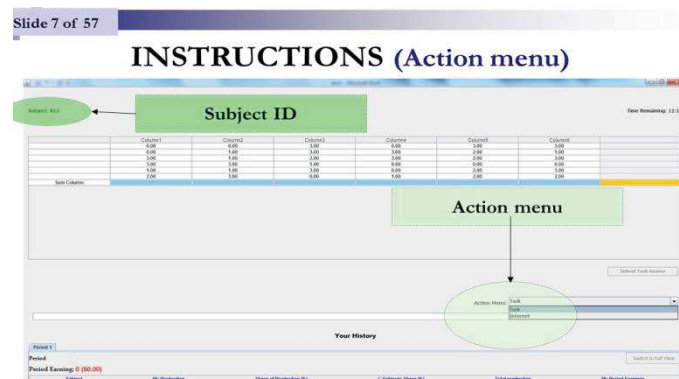
(Timing of the experiment)

- This experiment involves 4 subjects and consists of 5 periods of 10 minutes each. There are *two* types of subjects referred to as *B* and *C*.
- 3 subjects will be subjects *B* and *one* will be subject *C*. You will learn the type of subject you are when the experiment starts.
- Your individual earnings at the end of the experiment are computed as the sum of your earnings in the 5 periods.
- In each period of this experiment both subjects *B* and subject *C* will be able to: sum up numbers in a table (work task) or browse the web.
- Subject *C* will have access to another activity that consists in monitoring other subjects' activities.
- Subjects *B* will have access to an activity in which they will be able to exaggerate their performance on the work task.
- To switch from one activity to another you just have to click on the corresponding option of the action menu displayed on your screen.
- The activities are referred to as *Task* (sum up numbers in a table), *Internet* (browse the web), *Watch* (monitor subjects *B* contributions – only available to *C*) and *Boost* (exaggerate task production as *observed* by subject *C* – only available to *Bs*). Each activity is undertaken separately, in a different screen.

- Your experiment ID will be displayed on the top left corner of your screen once the experiment starts. It will consist of the letter *B* followed by a number if you are of type *B*. If you are the subject *C* your ID will be *C11*.

Task – summing up numbers

- The task consists in summing up 36 numbers in a table with 6 rows and 6 columns. Each subject is given a different set of tables with the same level of difficulty.
- Before providing your final answer (the total sum of all numbers in the table) you have to fill in the 6 cells that correspond to the sums of the 6 columns. Filling in these 6 cells does not directly generate earnings but it can help you to compute the final sum.



- Only after filling in all these cells will you be allowed to provide a final answer (the total sum) in the box located below the table on the left.
- Notice that **you are not allowed** using a calculator or any other electronic, computer-based or internet-based devices to sum up numbers.
- If you do, *you will be excused and you will not be paid*.
- Only the final answer (total sum of the table) is rewarded. Intermediate sums of all columns are required but are not rewarded.
- Each time you answer the task correctly (your final sum is correct) you generate *60 cents* of *Total production*. These *60 cents* is not directly added to your individual earnings.
- Subject *C* always gets 40% of *Total production* while subjects *B* get the remaining 60% of *Total production* at the end of each period.

- At the end of each period, subject C will divide the remaining 60% of Total production among the 3 subjects B involved in the experiment. So, each subject B gets a percentage of the total profit contributed by all subjects undertaking the task.
- The amount of money you generate by undertaking the task is displayed in the second column “**My Production**” of the history table at the bottom of the screen.
- The total amount of money generated by all 4 subjects (subject C + 3 subjects B) on the task is displayed in the sixth column “**Total Production**” of the history table at the bottom of the screen.
- If you sum up the numbers of a table correctly then each subject in the experiment (including yourself) gets 60 cents times the *percentage* of *Total production* that he or she is assigned.
- If you are subject C you get 24 cents ($40\% \times 60 \text{ cents}$).
- If you are subject B you get a *percentage* (allocated to you at the end of the period by subject C) of the 60 cents.
- If you answer the task incorrectly you generate a penalty of 30 cents that is subtracted from *Total production*. So when you answer incorrectly your individual earnings (as well as other subjects’ earnings) decrease.

(Your Production can never be less than 0.)

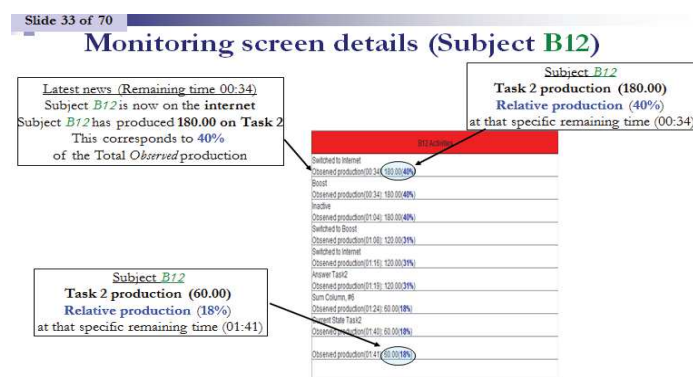
(Browsing the internet)

- Whether you are a subject B or subject C, you can browse the internet at any time during this experiment. Browsing the web is one of the basic activities that you can perform during this experiment, along with summing up numbers.
- You can access the internet screen by clicking on the *Internet* option in the action menu.
- Notice that while using the internet **you are not allowed** to download additional software. You are also expected to close pop-up windows when they appear on the screen.
- Your usage of the internet is **strictly confidential**. No one can see the web pages you are consulting (for example, your email).

Monitoring: only for subject C

- If and only if you are subject C, you can monitor the contribution of the three subjects B at any time during this experiment. You can do so by clicking on the *Watch* option in the action menu.

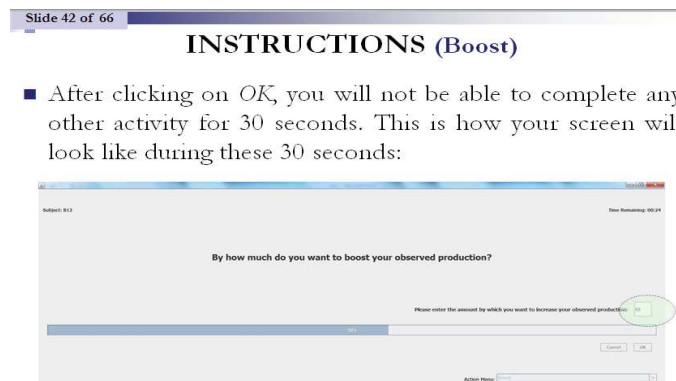
- You will be faced with a monitoring screen with 3 columns, each of them corresponding to one of the subjects *B* in the experiment. The head of each column indicates the experiment ID of the subject.
- For example, to monitor subject *B12*, you have to click on the column header “**B12**” displayed in green. The column header turns red once you click on the *Yes* button on the pop-up message: “*Ready to watch?*”
- You can monitor all subjects’ contributions at the same time by clicking on the following button displayed in the top right corner of the screen:
- You can stop monitoring all subjects *B* by clicking:
- To stop monitoring a given subject you have to click on the corresponding column header.
- At the end of each period, subject *C* will also receive a summary of his or her monitoring activities.
- You will be informed in real time of the *observed* production *and* contribution to *Total production* (in % terms) of the selected subject *B*.
- You will be informed in real time of the activities undertaken and time expended on each activity by the selected subject: *Internet* (browsing the web), *Task 2* (summing up numbers in a table) or *Boost* (exaggerating task production). All this information will be saved on the monitoring screen until you switched to another activity.
- You will be informed when a subject enter a number to sum a column before providing Task 2 final answer. This is referred to as Sum Column in the monitoring screen.
- In addition, you will be informed in real time of the observed production and contribution to Total production (in % terms) of the selected subject *B*.



INSTRUCTIONS (Boost)

- If and only if you are subject *B*, you can exaggerate your production, as *observed* by subject *C*, at any time during this experiment.

- To do so, you just have to select the *Boost* option in the action menu.
- To exaggerate your *observed* production, you have to enter the amount by which you want to increase it.
- After clicking on *OK*, you will not be able to complete any other activity for 30 seconds. This is how your screen will look like during these 30 seconds:

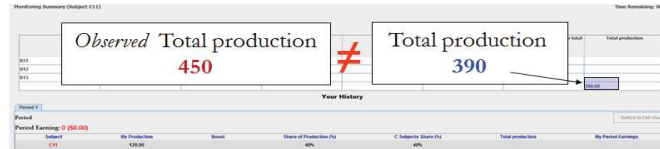


- The amount by which you boosted your *observed* production will appear in the Boost column at the bottom of your screen.
- The My Production column will remain unchanged, however.
- For example, consider the situation in which the production of subject *B12* is 120¢ while the other three subjects have produced a total of 270¢. In that case, *Total production* is equal to 390¢ and subject *B12* contribution to *Total production* is equal to 31% (120¢/390¢).
- Consider now that subject *B12* exaggerates his or her *observed* production by 60¢ using the boost option.
- As a consequence, the production of subject *B12* as *observed* by subject *C* will immediately increase from its current level of 120¢ to 180¢. Also, the *observed* contribution of subject *B12* will increase from 31% to 38% (180¢/390¢) and the *observed* contributions of subjects *B11* and *B13* will decrease.
- The monitoring screen of subject *C* will reflect this increase in *observed* production and contribution of subject *B12*.
- As a result of subject *B12* boosting his or her *observed* production, the sum of subjects' *observed* productions will be different from the actual *Total production* in the monitoring summary.

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Monitoring and Boost

- As a result of subject *B12* boosting his or her *observed* production, the sum of subjects' *observed* productions will be different from the actual *Total production* in the monitoring summary.



- The monitor will be able to know whether one or several subjects *B* have boosted their *observed* production. However, the monitor will not know which subject(s) exaggerated their *observed* production and by which amount.
- This is the case because the monitor will not be informed of the activities completed by each subject.
- Instead, the monitor will be informed of the *observed* production and contribution of the monitored subjects *B* at that moment in time.

INSTRUCTIONS (Earnings)

- Your individual earnings correspond to the following sum over the 5 periods:
 - Your *percentage* of *Total production* that has been generated by all 4 subjects (*C* subject + 3 *B* subjects) summing up numbers during the experiment.
- You will learn the exact amount of your individual earnings at the end of each *10-minute* period.
- In the pop-up window, your individual earnings in *dollars* for the current period will be displayed.
- You will click on the OK button to continue to next period.
- Your earnings in *cents* for the current period will be also displayed in the last column of the history table at the bottom of your screen. This column is labeled “My Period Earnings”.
- You will also see the share of production of all other subjects at the top of your screen

Allocation of *Total production*

- At the end of each of the 5 periods subject *C* allocates a percentage of *Total production* to each *B* subject. Given that subject *C* gets a fixed percentage of 40% of *Total production* at the end of each period, there is 60% of *Total production* to divide among the 3 subjects *B*.

- Notice that each subject *B* can be allocated a different *percentage* of *Total production*. Also, this *percentage* can be changed by the *C* subject at the end of each period.
- *B* subjects do not know this *percentage* until the end of a given period.
- In the last row of the monitoring summary, subject *C* will decide upon the allocation of *Total production* among the 3 subjects *B* by entering numbers in the corresponding **green cells** in the last row of the summary screen.
- **EXAMPLE:** subject *C* allocates the remaining 60% of *Total production* among subjects *B* as follows:
 - B11 gets 15%, B12 gets 25%, B13 gets 20%,
 - Notice that all percentages sum up to 60%.
 - Once subject *C* has entered the *percentages* allocated to each subject *B*, all subjects *B* are informed about their share of *Total production* in the history panel at the bottom of their screen.
- **EXAMPLE:** In the first period you provided 7 correct answers completing the task while providing 3 incorrect answers. Also, the other three subjects in the experiment provided a total of 24 correct answers in the task while providing 5 incorrect answers.
- Also, imagine that you are subject *B12* and that subject *C* has allocated to you 25% of *Total production* at the end of the first period. Your earnings (“**My Period Earnings**”) for that period are equal to:

Earnings Calculation

- **EXAMPLE:** In the first period you provided 7 correct answers completing the task while providing 3 incorrect answers. Also, the other three subjects in the experiment provided a total of 24 correct answers in the task while providing 5 incorrect answers.
- Also, imagine that you are subject *B12* and that subject *C* has allocated to you 25% of *Total production* at the end of the first period. Your earnings (“**My Period Earnings**”) for that period are equal to:
 - *Earnings:* $25\% \times (31 \times 60 - 8 \times 30) = 405 \text{ cents}$ if you are subject *B12*
 - *Earnings:* $40\% \times (31 \times 60 - 8 \times 30) = 648 \text{ cents}$ if you are subject *C11*

Summary

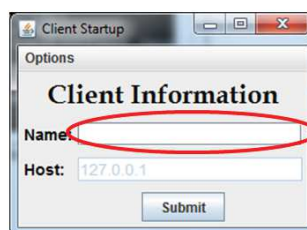
- This experiment involves 4 subjects and consists of 5 periods of 10 minutes each. There are *two* types of subjects referred to as *B* and *C*, respectively.

- 3 subjects will be subjects *B* and *one* will be subject *C*.
- In each period, both subjects *B* and subject *C* will be able to: *sum up numbers* in a table or *browse the web*.
- Only subjects *B* will be able to exaggerate their production and contribution as *observed* by subject *C* by using the *boost* option.
- Only subject *C* will be able to monitor other subjects' activities.
- Your individual earnings will depend on the task which consists in summing up numbers in a table.
- The total earnings generated by all 4 subjects (subject *C* + 3 subjects *B*) on the task will be divided as follows.
- At the end of each period, subject *C* always gets 40% of the total amount of money generated by all 4 subjects (*C* subject + 3 *B* subjects) and decides how to allocate the remaining 60% among the 3 subjects *B*.

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Please wait until the experimenter closes the current instruction screen.

- Please enter your **full name** in the following screen once the instruction screen has been closed by the experimenter.



The screenshot shows a window titled 'Client Startup' with a tab labeled 'Options'. Inside the window, the section 'Client Information' is visible. It contains two input fields: 'Name' and 'Host'. The 'Name' field is currently empty and is highlighted with a red oval. The 'Host' field contains the text '127.0.0.1'. Below these fields is a 'Submit' button.

General Conclusion

The introduction of Information and Communication Technologies at workplace has lowered information and communication costs (Milgrom and Roberts, 1990; Garicano, 2000) and has also entailed some organizational changes. These technological and organizational have positively impacted the firms' efficiency (Black and Lynch, 2001; Bresnahan et al., 2002; Brynjolfsson and Hitt, 2000) but the effects of ICT use at the level of workers are unclear. Indeed, the implementation of technologies generated several changes which can have opposite effects at the workers' level (Garicano, 2000; Bertschek and Kaiser, 2004; Garicano and Rossi-Hansberg, 2006; Bloom et al., 2014; Martin and Omrani, 2015; Sun, 2016). This dissertation explores impacts of Information and Communication Technologies (ICT) use on workers' behaviors. There are a few papers which showed positive effects of the ICT use at the level of workers but none used the experimental method. Investigating issues of ICT use regarding workers is crucial because technological and organizational changes incurred some costs for firms that should be minimized.

Our first contribution was to fill the gap of the lack of studies on ICT use at the workers' level by testing the "knowledge hierarchy" (Garicano, 2000) and influence costs theories (Milgrom, 1988; Milgrom and Roberts 1988, 1990b) in the lab. The first theory states that firms have foster investments Information technologies which provide more autonomy and lead to a higher workers' performance. While the literature on influence costs argues that workers will engage on influence activities if they have opportunities to manipulate information in order to maximize their profit. We also assessed how technologies could reduce influence costs by studying the effects of the pervasive and invasive technology monitoring on workers' behaviors.

Consistent with Bloom et al. (2014), our findings supported theoretical predictions of IT versus CT impacts on workers' performance. Information technologies users were more productive than non-users and CT users were less productive than non-users. One of our most important contributions was to investigate workers' preference between these two technologies. Employees are more willing to use Information technologies. This is consistent with the finding that when workers have a higher scope of decision making, they feel more autonomous, their sense of responsibility increases and they reciprocate by increasing their performance (Sliwka, 2001; Charness et al., 2012). Communication technologies centralize

decision making by leading agents to rely more on the principal for help. This situation is detrimental for both managers and workers. The solicitation of managers by workers to solve problems negatively impacted their production. As expected, teams with IT users were more productive than teams with CT users. However, Information technologies may provide more opportunities for workers to engage on counterproductive behaviors.

We also found support of theoretical predictions regarding influence costs. Workers are willing to manipulate information in order to influence their manager's decisions. This willingness was higher when the principal had discretion over decisions with distributional implications. We also found that influence activities led managers to make inefficient decisions and set low-powered incentives. Costs for the firm are substantial since influence activities dampen strong incentives of competition and lead the principal to weaken meritocracy. One important solution advocated by the influence costs theory is that bureaucratic rules which limit the managerial discretion may be optimal to reduce influence costs. Nevertheless, we also found that employees also engaged on time wasting activities in the fixed wage reward system; showing that influence activities are also pervasive in absence of monetary incentives.

we also showed that the IT monitoring implied a disciplining effect (Dickinson and Villeval, 2008; Nagin et al., 2002; Engel, 2010). However, our most important result was to highlight that the disciplining effect of technology monitoring is salient at the beginning and lessens over time. Since *IT monitoring* is invisible, employees seem to forget its extent. This could explain why there are several cases of employees who get fired because of internet abuse or misuse, even though they signed the IT charter of the firm. Surprisingly, we also observed that low summation skills workers were more productive than those with high summation skills regardless the payment scheme. The technology-based monitoring does not eradicate counterproductive behavior but it is quite successful to reduce cheating and internet abuse. We also found that IT monitoring was useful for the principal to detect and punish cheating behavior. IT monitoring is helpful to make more efficient decision, but it is costly in terms of time for the principal. The technology-based monitoring is also efficient for time saving because IT helps to get the right information on workers' counterproductive behaviors. This mitigates the negative effect of the monitoring costs.

Our results showed that the most productive employees were those who spent more time on Internet (Koch and Nafziger, 2015). When there is neither restriction nor sanction for

browsing the web, workers seems to reciprocate with a higher effort. The moral cleansing effect could also explain this finding.

We have to mention some limitations of our work. Our experimental designs were a little complex or incomplete. Indeed, we did not implement Communication technologies between workers and one PDF file could have been enough to reproduce Information technologies. Our design also lacked one treatment with the classic monitoring for a better comparison with the technology monitoring system. The virtual organization software did not allow for negative individual production. This led us to lose information about influence costs since the individual production could lower the production of the team. Our implementation of the monitoring software was imperfect as principals were unable to record information about workers' activities without monitoring them in real time.

Managerial implications and research avenues

Technologies are now indispensable at workplace. ICT is used at all spheres in the production process. It is crucial for managers to learn more about ICT effects on workers' behaviors in order to reap the full potential of these technologies.

This thesis draws attention on some negative consequences of Communication technologies on workers' autonomy and teams' production. The allocation of decision making in the firm may be adapted according to the technologies (Information or communication) used or vice versa in order to avoid counterproductive effects. Workers prefer Information technologies which foster their autonomy. These technologies also provide instant heightened indicators of their performance which are useful for monitoring. So, firms may prioritize the use of technologies which empower workers. However, managers may sensitize them on the extent of the technology-based monitoring in order to reduce shirking behaviors and increase their performance.

Browsing the web for personal use at workplace may have positive effect on workers' performance. When there is any restriction on internet access, employees seem to reciprocate with high effort. Nevertheless, managers have to take advantage of IT monitoring to prevent internet abuse.

Managers have to take account that status seeking may also lead workers to engage on unproductive activities in order to maintain a good reputation even if it is costly for the firm.

Therefore, the limitation of managerial discretion may not be enough to reduce influence activities.

In this work, we focused on the communication between principal and agents. Further researches could include communication between employees. Indeed, employees could share solution of problems that they already faced to help coworkers. This could increase teams' production and improve cooperation in teamwork (Isaac and Walker 1988; Sutter and Strassmair 2009; Cason et al. 2012). The negative effect of Communication technologies could be mitigated. The use of Information technologies leads to a wider span of control for managers (Bloom et al., 2014). It could be interesting to assess the relationship between influence costs and the size of the span of control.

The technology-based monitoring records continuously and instantaneously data about workers even if the principal is absent. Further researches could focus on the threshold in which the disciplining effect of technology monitoring lessens. Future researches could investigate how workers should be sensitized on the extent of IT monitoring in order to prevent technologies misuses and abuses. For example the type of feedbacks and the frequency in which these feedbacks should be provided to workers can be the object of another study. Assessing how the internet browsing could enhance workers' performance may be worthwhile.

It is also necessary to run an experiment with classic monitoring and IT monitoring in order to build a unified theory of monitoring. Although the experimental methodology enabled us to implement some features of real work environment, the use of cellphones (which provide the same leisure options than computers) at workplace shows that capturing the reality in the lab is more complex.

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L'impact des Technologies de l'Information et de la Communication sur le comportement des travailleurs : Une approche expérimentale

Cette thèse explore l'impact des technologies de l'information et de la communication (TIC) sur le comportement des employés. Alors que la théorie néoclassique de la croissance considère les TIC comme un outil utilisé dans le processus de production, nous nous sommes basés sur une théorie qui stipule que les technologies ont deux aspects différents. Les technologies de la communication centralisent la prise de décision tandis que les technologies de l'information déplacent la prise de décision au niveau de l'employé. Nous avons abordé les questions du meilleur type de technologies pour l'amélioration de la performance des employés, des coûts engendrés par l'utilisation de ce type de technologies et de l'impact de la surveillance informatique dans la réduction de ces coûts. Nous avons utilisé la méthode expérimentale pour répondre à ces questions. Nos résultats montrent que les employés préfèrent utiliser les technologies de l'information et ceux qui les utilisent sont plus productifs que les autres. Nous trouvons également que l'environnement de travail et les technologies qui poussent la prise de décision au niveau de l'employé pourraient engendrer des coûts importants pour l'entreprise. Cependant, la surveillance informatique est efficace pour réduire ces coûts mais son effet diminue au fil du temps. Nos résultats montrent que les employés les plus productifs sont ceux qui ont passé le plus de temps sur internet. Donner aux employés les informations constantes et détaillées (sur leur performance) produites par les technologies pourrait être une façon efficace de les sensibiliser sur l'ampleur de la surveillance informatique afin de les rendre plus performants.

Mots clés : Economie comportementale ; Economie expérimentale ; Technologies de l'Information et de la Communication ; Surveillance ; Performance ; Incitations

Impact of Information and Communication Technologies on workers' behavior: An experimental Investigation

This dissertation explores the impact of the use of Information and Communication Technologies (ICT) on employees' behaviors. While the neoclassical growth theory considers ICT as an input used in the production process, we relied on the knowledge hierarchy literature which states that technologies have two different key aspects. Information technologies push down the decision making at the employee level while Communication technologies centralize the decision making. We addressed the issues of the more efficient technologies for workers' performance, the costs generated by using the most efficient type of technologies and how the technology-based monitoring may be useful to reduce those costs. We used the experimental methodology since the collection of individuals and team's production is hard with survey data. Our results show that employees prefer Information technologies and those who use it are more productive than others. We also show that work organization and technologies which push down the decision making at the employee level could entail some substantial costs for the firm. However IT monitoring is quite successful at reducing those costs. Technology monitoring implies a disciplining effect at the beginning when the sanction is available but this effect lessens over time. Our results show that employees are more productive when they spend more time on internet. Giving constant heightened feedbacks (about their productivity) provided by ICT to workers should be the better way to sensitize them about the extent of technology monitoring and to increase their performance.

Keywords: Behavioral economics; Experimental economics; Information and Communication Technologies; Monitoring; Performance; Incentives

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