

IRISS-C/I

*An Integrated Research
Infrastructure in the
Socio-economic Sciences*

**The impact of technological changes on incentives
and motivations to work hard**

by

Ludivine Martin





The impact of technological changes on incentives and motivations to work hard

Ludivine Martin

CREM-UMR CNRS 6211-Université de Rennes 1

Abstract The diffusion of Information and Communication Technologies (ICT) associated with the diffusion of new work practices since fifteen years has raised concerns about the impact of these changes on productivity. Some recent studies underline a positive impact of ICT and of new work practices on firms' productivity. But as well known in the principal-agent literature agents are predisposed to shirking, so, in order to obtain productivity gains firms need to provide workers with sufficient incentives and to encourage motivations. Our main results, obtained with data collected in Luxembourg in 2004-2005, indicate that ICT permit to create a team spirit and an enriching work environment that influences positively pure intrinsic motivations of workers. These motivations, associated with positive incentives, can be substitutes for the direct monitoring introduced usually to obtain the effort of employees, but hard to be used in a context of increasing autonomy.

Reference IRISS Working Paper 2007-15, CEPS/INSTEAD, Differdange, Luxembourg

URL <http://ideas.repec.org/p/irs/iriswp/2007-15.html>

The views expressed in this paper are those of the author(s) and do not necessarily reflect views of CEPS/INSTEAD. IRISS Working Papers are not subject to any review process. Errors and omissions are the sole responsibility of the author(s).

The impact of technological changes on incentives and motivations to work hard

MARTIN Ludivine*

CREM, Université de Rennes 1

November 2007

Abstract

The diffusion of Information and Communication Technologies (ICT) associated with the diffusion of new work practices since fifteen years has raised concerns about the impact of these changes on productivity. Some recent studies underline a positive impact of ICT and of new work practices on firms' productivity. But as well known in the principal-agent literature agents are predisposed to shirking, so, in order to obtain productivity gains firms need to provide workers with sufficient incentives and to encourage motivations. Our main results, obtained with data collected in Luxembourg in 2004-2005, indicate that ICT permit to create a team spirit and an enriching work environment that influences positively pure intrinsic motivations of workers. These motivations, associated with positive incentives, can be substitutes for the direct monitoring introduced usually to obtain the effort of employees, but hard to be used in a context of increasing autonomy.

Key words: Information and communication technologies, incentives, motivations

JEL Classification: O33, J81, L22

Résumé

La diffusion, depuis une quinzaine d'années, des Technologies de l'Information et de la Communication (TIC) associée à la diffusion des pratiques innovantes de travail a conduit de nombreux auteurs à s'interroger sur le rôle joué par les TIC dans la productivité des entreprises et à mettre en évidence un impact positif. Mais comme le soulignent les modèles d'agence, les individus sont prédisposés à "tirer au flanc". En conséquence, pour obtenir des gains de productivité, l'entreprise doit fournir les incitations suffisantes tout en encourageant les motivations des salariés. Nos principaux résultats, obtenus à partir de données collectées au Luxembourg en 2004-2005, montrent que l'usage des TIC est positivement corrélé avec le développement d'un esprit d'équipe et favorise la création d'un environnement de travail enrichissant facilitant ainsi le développement des motivations intrinsèques des salariés. Ces motivations, associées à des incitations positives, peuvent remplacer la surveillance directe introduite généralement pour obtenir l'effort des salariés mais difficile à mettre en œuvre dans un contexte d'autonomie croissante.

Mots clés : Technologies de l'information et de la communication, incitations, motivations

Codes JEL : O33, J81, L22

*CREM - Center for Research in Economics and Management - UMR CNRS 6211 - 7, place Hoche, 35065 Rennes - France - E-mail : ludivine.martin@univ-rennes1.fr

Acknowledgements

The present research was (co-)funded by the European Commission under the 6th Framework Programme's Research Infrastructures Action (Trans-national Access contract RITA 0260 40) hosted by IRISS-C/I at CEPS/INSTEAD, Differdange (Luxembourg). I thank Nicolas Poussing, Philippe Van Kerm and all the team of the CEPS/Instead for their cordial reception. I thank participants at the ZEW Summer Workshop on the Economics of Information and Communication Technologies (Mannheim, June 2007) for helpful comments.

1. Introduction

The fast diffusion of Information and Communication Technologies (ICT) in firms, allowed notably by the declining price for its use, seems to favor the productivity of the firm. Several works present evidence supporting a positive effect of ICT on productivity at the firm level (Greenan and Mairesse, 2000; Licht and Moch, 1999; Lichtenberg, 1995). However, the diffusion of ICT has been combined with changes in the organisational structure of firms with the increasing use of so called high performance work organization (Askenazy, 2004; Osterman, 2000). As these changes might be another determinant of the increase of productivity, recent empirical studies analyze the joint effects of ICT and workplace reorganization. They underline that ICT combined with workplace reorganization have positive and significant effects on productivity at the firm level (Askenazy and Gianella, 2000; Bertschek and Kaiser, 2004; Black and Lynch, 2001; Bresnahan, Brynjolfsson, and Hitt, 2002; Brynjolfsson and Hitt, 2000). Moreover, Aral, Brynjolfsson, and Van Alstyne (2007) show that ICT use furthers information diffusion in networks of workers and strengthen the productivity and the performance of individuals.

To obtain these productivity gains and to assure their competitiveness, firms need to provide the proper incentives and motivations for workers. Thanks to these incentives and motivations the firm can solve the problem of shirking and can manage the creation and transfer of knowledge. However, the problem of shirking is complicated in the context of wide technological and organisational changes. The diffusion of ICT associated with workplace reorganization involves a change from a "Tayloristic" work organization, characterized by task specialization, a pyramidal hierarchical structure, and a centralization of responsibilities, to a "Holistic" organization with multi-tasking, job rotation, the decentralization of decision-making, team work, more flexibility for the employer and greater communication between workers (Askenazy, 2004). Consequently, the relationships between employers and employees have changed. As workers became more versatile (Lindbeck and Snower, 1996, 2000) and more autonomous (Caroli, Greenan, and Guellec, 2001) the contracts became more incomplete and the evaluation of workers performance more difficult.

As well known in the principal-agent literature, since workers know their own ability levels

while employers may not, since it is costly to measure their performances, and since they prefer leisure to effort, agents are predisposed to shirk. Consequently, they can choose the actions that are not in the best interest of the employer. The firm exists in a large part to provide the proper incentives to obtain the optimal provision of workers' effort when the information on workers' performance is costly¹. In order to reduce the agency problem, the principal can use monitoring, compensations and/or promotions. This principal-agent view can be extended with the introduction of the concept of motivations, largely neglected by the economic literature. These motivations widely analyzed by organisational psychologists can be substitutes of incentives and can consequently affect effort. Building on Frey (1997), Minkler (2003, 2004) introduced both incentives and motivations in the analysis of the provision of effort at work. Moreover, Akerlof and Kranton (2005) formalize the impact of incentives and motivations in workers' utility to provide a high or a low level of effort according to their initial motivations to work in the interest of the firm.

In this paper, we seek to provide an analysis of the effects of ICT and of the changes they crystallize on the incentives and motivations the firm need to manage in order to solve the problem of shirking, and in the creation and transfer of knowledge, which are necessary for firms' productivity and competitiveness.

We perform our analysis on a representative sample of individuals working in Luxembourg surveyed in 2004-2005. Our dataset comes from the European Social Survey collected by the CEPS/Instead². A first evaluation of the consequence of ICT on different indicators of incentives and motivations to obtain the optimal effort is computed by comparing the average value of various indicators for workers who use ICT (computer, Internet) and for workers who do not. However, this benchmark estimator raises some selection problems induced by workers' and firms' heterogeneity. We choose to perform probit regressions to analyse the links between ICT use and the different incentives and motivations, including a number of controls like age, education, seniority and firm's characteristics like proxies of organisational changes. But another problem stems from the fact that the impact of ICT may not be linear. In this case, as Heckman, Ichimura, and Todd (1997, 1998) recommend, we use propensity score matching estimators. Our main results highlight, on the one hand, that the introduction of ICT is linked with the difficulty to control the work of employees. Thus, it drives firms to modify their incentives mechanisms. On the other hand, the results show that ICT use is correlated with more positives incentives, like promotions. Moreover, by offering the access to ICT to its employees, the firm creates an enriching work environment that influences positively pure intrinsic motivations of workers. These pure intrinsic motivations, associated with the positive

¹This cost can result from the costly evaluation of performance (Calvo and Wellisz, 1978), the unobservability of worker performance (Holmström, 1982) or the opportunism of team members under revenue-sharing (Alchian and Demsetz, 1972).

²CEPS/Instead: Centre for Population, Poverty and Public Policy Studies/International Networks for Studies in Technology, Environment, Alternatives, Development.

incentives can be substitutes for the direct supervision introduced usually to obtain the optimal effort of employees. Moreover, the results show that ICT can be a part of the management policy of the firm that affects the identification of workers with their organisation in order to obtain behaviours matched with the interest of the firm.

The paper is organized as follows. Some theoretical considerations on the relationships between incentives, motivations and the provision of effort in the context of technological and organisational changes are provided in section 2. Section 3 provides a detailed description of the database. Section 4 presents the econometric methods. Section 5 discusses the results and the last section concludes.

2. Incentives and motivations in the context of technological and organisational changes

2.1. Incentives

Incentives are widely discussed in the agency theory (Jensen and Meckling, 1976; Prendergast, 1999). Incentives are provided to workers through two options, a negative incentive (monitoring) and another one more positive (wage bonus, promotions). The principal will invest in such incentives in order to induce workers to operate in the firm's interest. An underlying assumption in this literature is that, in the absence of monitoring agents will shirk but they will respond to an incentive in the principal's interest.

The control of productivity can be objective with the pay-for-performance practice included in an explicit contract. Since it is difficult to specify all aspects of the job in an explicit contract and since it is less costly to monitor employees' effort than to measure their marginal product, the subjective monitoring option by superior is generally used (Calvo and Wellisz, 1978). To be effective the monitoring needs to be combined with penalties when it shows that the work is substandard.

The positive incentive option rewards workers for effort by means of monetary incentives like salary revision or bonus; or through promotions by acting on the career concerns of workers. Wage increases could act as a positive incentive by increasing the expected reward of effort provision by workers (Minkler, 2004). But, as workers exert effort not just to maximize their pay but also to affect future contracts, the firm can use career concerns in order to mitigate the agency problem (Fama, 1980; Holmström, 1982).

In the context of technological and organisational changes, the connectivity to Internet of workers is increasing. Consequently, it gives workers more opportunities to shirk like the use of Internet for personal purpose instead of working. To obtain optimal effort provision, firms need

to provide workers with sufficient incentives, especially in the current context of high churn rates for workers (Bauer and Bender, 2004). As technological changes influence the increase of workers' autonomy (Gollac, Mangematin, Moatty, and De Saint-Laurent, 1999), they alter the incentives schemes the firm sets up. The direct supervision becomes more difficult, so firms need to mobilize innovative modes of monitoring. In the current context of strategies like the just-in-time one, the stress of the time limit can replace the authority of the superior. If monitoring is more difficult, firms can instead use positive incentives like promotions or wage bonus to reward ex post the effort of workers and to retain workers who developed specific competences thanks to ICT use.

Hypothesis 1. *The use of ICT by workers should change the incentives schemes and should decrease the direct supervision of workers.*

Hypothesis 2. *The use of ICT in the firm should influence positively the probability of using positive incentives to obtain optimal effort of workers.*

2.2. Motivations

The standard theory of the firm does not differentiate the different sources of motivation, which are, in the economic view, just the manifestations of underlying preferences (for the reward associated with performing the task). While economists have greatly neglected these psychological effects on the level of effort, the concept of motivation has already been analyzed by organisational psychologists. Research on motivation has distinguished intrinsic and extrinsic motivation. Intrinsic motivations are influenced by the work itself. Extrinsic motivation is motivation gained by externally influenced need satisfaction. Following Deci (1971) “*one is said to be intrinsically motivated to perform an activity when one receives no apparent reward except the activity itself*” (p.105). As shown is the crowding theory (Frey, 1997), incentives can crowd out the motivations to undertake an activity and the firm does not have to neglect their effects because it will affect effort (Cools, Van Herpen, and Van Praag, 2005). The crosspollination by combining social psychology and economics is consequently necessary because the crowding out effect predicts reverse reactions of workers to the one expected in the agency theory.

2.2.1. Intrinsic motivations

In this paragraph, we will analyze both pure intrinsic motivations in the tradition of social psychologists and moral motivations introduced by Minkler (2004).

Pure intrinsic motivations come from within the person in bond with his job. Workers, who find their work interesting will enjoy it and can consequently choose to do good work for its own sake. So they are supposed to be intrinsically motivated. Following Frey (1997), external interventions, that is to say incentives, can increase or “crowd in” intrinsic motivations or quite

the opposite can diminish or “crowd out” these motivations and beyond affect the provision of effort. In the first, the worker feels that his involvement and competence is appreciated by employers (possibilities of promotions). This token of trust favours freedom of actions and so can increase intrinsic motivation and strengthen the provision of effort. In the second, the agent perceives that the external intervention like monitoring shifts the locus of control from the agent to the principal. As the worker become a “pawn” to the source of external, he responds by reducing what he has control over, *i.e.* intrinsic motivation (Deci, 1971; Minkler, 2004). Concerning the effect on effort, if the incentives schemes reduce worker’s intrinsic motivation more than they induce him to perform, effort provision will decrease.

As technological and organisational changes are associated with greater freedom in organizing one’s own work and in diversifying tasks (Caroli et al., 2001; Greenan and Walkowiak, 2005; Lindbeck and Snower, 1996, 2000), it will increase the interest of the job and it can, consequently, boost employee intrinsic motivation. The crowd in effect will be reinforced by the necessity of using reward mechanisms for employees with the competencies needed by the firm in the context of skills upgrade in organization and of high churn rate. The crowd out effect is more ambiguous. As the introduction of technological and organisational changes imply more autonomy and self-determination, workers should be more subject to control (Bradley, 2000). But the modes of control have changed and the monitoring is no more fulfilled by the supervision of superior, but more by time pressure, so the feeling of being supervised is less oppressive than the one that induce the traditional crowd out effect.

Hypothesis 3. *ICT diffusion should influence positively workers’ intrinsic motivations, and thereby their provision of effort.*

More than the work ethic embedded in intrinsic motivations, Minkler (2004) introduces *moral motivations* in the debate on workers willingness to work hard. Workers’ choices can be independent of personal welfare considerations, and commitment or duty can motivate moral actions without taking in to account incentives schemes. The integrity of workers can be a reason for moral actions (Minkler and Miceli, 2004). Integrity confers commitments to moral principles like honesty, or a “don’t lie” principle. It influences both the propensity to make promises and to keep them. People can keep their word even if it is contrary to the self-interest. Experimental repeated games provide some evidence on situations in which the standard self-interest model is refuted. According to Sally’s (1995) meta-analysis, “*language may elicit an involuntary commitment to act nonselfishly*” (p.87). If there is a commitment to work hard, as shirking is analogous to dishonesty or lying, workers may choose to provide optimal effort.

According to Bradley (2000) “*ICT should contribute to the deepening and development of true human qualities and provide time for people to develop themselves as human beings*” (p.856), the link between these changes and moral principles is however hypothetical and needs further investigations.

Hypothesis 4. *ICT can contribute to the development of human qualities but it is no sure that it will change the honesty of workers or his “don’t lie” principle. Therefore, the effect of ICT on moral motivations is quite hypothetical.*

2.2.2. Extrinsic motivations

Following Frey and Jegen (2001) extrinsic motivation comes from outside the person. So, we can include both the concept of external pressure of the group and the concept of reciprocity (Minkler, 2004) in this definition.

According to Minkler (2004) “*workers who care about the views of other workers are subject to peer pressure*” (p.870). This *external pressure* (Kandel and Lazear, 1992) most likely appears in firms that use profit sharing like in teams, because each worker’s effort affects negatively all other worker’s income or well-being (as shirking requires increased effort from others). Kandel and Lazear (1992) identify shame, as possible explanations of this external impact. For Rob and Zemsky (2002), individuals’ preference for cooperation or for team spirit can explain what encourage workers to provide a high level of effort. As external pressure can be a substitute for direct monitoring firms need to stimulate the deployment of a team spirit with the formation of groups in which members can identify with one another. Following Minkler (2004), to favour this team spirit firms can, for example, use quality circles, team meetings, inter-company sport leagues, company picnics, . . . If the firm succeeds in infusing this team spirit in the organization, the feeling of shame can replaced the use of the external penalties for substandard work to encourage effort. This feeling arise when shirkers would suffer from letting down their co-workers.

As network technologies contribute to codify tasks, knowledge, and to collect information, they stimulate electronic communications and allow workers to get more easily help from colleagues when it is needed. Moreover, a member of an organisation can easily relays to other member information concerning substandard work and it can therefore increases the feelings of shame when the effort is not high. But as the use of ICT may reduce face-to-face interactions and informal contacts, it can consequently thwart the creation of a team spirit and thus workers’ provision of effort.

Hypothesis 5. *Technological changes stimulate electronic communications. On the one hand ICT uses increase the interdependence of workers, but on the other hand they reduce face-to-face interactions. Consequently, the global impact of ICT changes on the setting up of a team spirit and thus on external pressure is quite ambiguous.*

Another extrinsic motivation comes from the *reciprocity* between employers and workers. An agent is expected to, at least partly, determine his level of motivation considering the behaviours of others, particularly the employer. In addition to purely self-interested people, there are a

fraction of people who are also motivated by fairness or reciprocity considerations. According to experimental economics and the work of Fehr and Gächter (2000) people cooperate more than predicted by the self-interested model in response to friendly actions and less in response to hostile actions. According to Akerlof and Yellen (1990), in the context of work, reciprocity implies that a fair worker will be honest with an honest employer and will shirk with a dishonest employer (one that fails to provide a good working environment or a good salary), that is to say the worker will reduce drastically the level of effort.

With the introduction of high performance work systems and ICT, according to Colvin (2006) firms place greater value on employees developing firms' specific competencies. Consequently, firms will try to keep such workers in a context characterized by high churn rates for workers (Bauer and Bender, 2004). Furthermore, to obtain optimal effort of workers who develop ICT competences, the firm can choose to reward them by providing good working conditions.

Hypothesis 6. *Technological changes should influence positively the relationships between employers and employees.*

2.3. Identity

Akerlof and Kranton (2005) build a principal-agent model in which they include both incentives mechanisms and motivations and introduce the concept of identity. Identity in organisation embodies the extent to which workers identify with their firm and want to achieve its goal. Thus we can distinguish “outsiders” who think of themselves as not a part of the firm and “insiders” who think of themselves as a part of the firm. The cost to obtain high level of effort is smaller when the worker identifies with the firm. Therefore, It can be profitable to invest in “motivational capital” in order to try to change a worker’s identity from an outsider to an insider.

They take standard hypotheses concerning the behaviours of workers. The utility is increasing in income, the agent is risk averse and her actions affect the profit of the firm while the principal can't observe them. The worker can take the action A at a cost of effort e_A or the action B at a cost of effort e_B , with $e_A \succ e_B$. Firm's revenues are random but conditional on the choice of action by the worker. When the agent chooses the action A , revenues are high (π_H) with a probability of $1/2$ and low (π_L) with a probability of $1/2$. When the agent chooses action B , revenues are always low. The principal observe realized revenues and pay the worker according to the level of revenues, a high salary (w_H) when revenues are high (π_H) and a low salary (w_L) when revenues are low (π_L). The overall agent's utility is $u(y) - e$ with $u(y)$ the utility from income and e the effort.

Then, they introduce utility from identity. Insiders (N) should act in the firm's best interest and their ideal effort is e_A and outsiders (O) should choose the least cost action so their ideal

effort is e_B . The utility the worker derives from belonging to the category $c = \{N; O\}$ is I_c . Thus the utility the agent loses from diverging from the ideal effort level of her category is $t_c|e^*(c) - e|$ où t_c , where t_c is the importance of living up to the ideal.

Linked with the notion of motivations, we can consider that pure intrinsic motivations contribute to the utility from identity of the agent and that t_c is influenced by moral motivations and extrinsic ones. The utility the agent gains from her identity depends on unpaid gratifications she gets from her job. An agent intrinsically motivated by an enriching work will have a bigger utility than an agent not intrinsically motivated especially when her identity is the identity of the firm. t_c represents the unease of a worker when her actions fail to live up to her ideal. It can be a function of the predisposition of the worker to feel guilty when her level of effort is insufficient in bond with her moral motivations, of the degree of cooperation between the employees, of the feeling of belonging to a team (Rob and Zemsky, 2002) which develops a feeling of shame³ and finally of the reciprocity existing between the employer and the employee. Those moral and extrinsic motivations will positively influenced t_c and drive workers to provide the level of effort of her category. Then $t_c|e^*(c) - e|$ represents the disutility of the agent when her effort differs from the optimal effort of her social category.

The overall utility of the worker is: $U(y, e, c) = u(y) - e + I_c - t_c|e^*(c) - e|$

Akerlof and Kranton (2005) assume that the principal wants to obtain the action A whichever the social category is. Thus the firm's expected profits are : $\Pi(c) = \frac{1}{2} [\pi_H + \pi_L] - \frac{1}{2} [w_H^c + w_L^c]$

The firm maximises the profit subject to an incentive constraint (1) which is the condition that the worker prefers to do the high-effort action A than the low-effort one B , and a participation constraint (2) to give the worker at least as much utility as she could obtain in another firm (\bar{u}).

$$u(\frac{1}{2} [w_H^c + w_L^c]) - e_A + I_c - t_c|e^*(c) - e_A| \geq u([w_L^c]) - e_B + I_c - t_c|e^*(c) - e_B| \quad (1)$$

$$u(\frac{1}{2} [w_H^c + w_L^c]) - e_A + I_c - t_c|e^*(c) - e_A| \geq \bar{u} \quad (2)$$

Consequently, if the worker has the insider identity, the presence of the identity utility reduce the wage differential needed to obtain the high-effort level of the action A because the agent maximises her utility by providing the action A . On the contrary, if the worker identifies as an outsider, the presence of the identity utility increase the wage differential needed to compensate her for the utility lost when she provides the high-effort level needed to do the action A . The monetary incentive and motivation by identity are, this way, substitutes, but positive incentives can be used by the firm to keep insiders in the firm in the context of high churn rate.

³“Shame exists when others observe non performance and then exert external pressure. In contrast, guilt arises as internal pressure even when one's actions are unobservable”, Minkler (2004, p. 870).

As the firm prefers a worker with an insider identity, it's in the interest of the firm to invest in "motivational capital" in order to change a worker's identity from an outsider to an insider. ICT use, as we saw before, should modify the motivations of the agents and consequently, should reinforce the provision of effort by positively influencing the utility the agent obtains with her work. It can also appear as a token of trust that can reinforce the feelings of shame and culpability when the ideal of the group is not reached. So we can formulate a last hypothesis we will test in our empirical analysis.

Hypothesis 7. *Giving workers the use of ICT should appeared as an investment in motivational capital which result in changing outsiders in insiders.*

3. Data

The data used in this study relates to individuals working and living in the Grand Duchy of Luxembourg. They were collected within the framework of a European project called: European Social Survey (ESS). This European project was conducted in over 20 countries of the European continent on nationally representative samples of individuals. It contains information on a wide range of attitudinal and socio demographic characteristics of individuals. In Luxembourg, an additional questionnaire was inserted. It provides items on the use of new technologies, both at home and at work. The data were collected, using face to face interviews, by the CEPS/Instead thanks to the financial support from the Luxembourg National Research Fund. The survey⁴ was twice realized in 2002-2003 and in 2004-2005, but here, we use the data of the second round. As we want to analyze the links between ICT and motivations at work, we focus our attention on the working population and more specifically to employees who are aged between 16 and 65. The numbers of workers interviewed is 706.

3.1. Dependant variables

To obtain productivity gains and to assure their competitiveness, firms need to provide workers with sufficient incentives and motivations.

To analyse the links between, on the one hand ICT use and, on the other hand firms' incentives schemes and workers' motivations, we constructed proxies of the different incentives and motivations from perception of workers about their working conditions⁵. In order to test our hypothesis 1, we analyse a proxy of monitoring defined by a work closely supervised. To test our hypothesis 2, we consider a variable that measure the use of wage bonus by the firm and a variable that measure the promotion possibilities defined by good opportunities of advancement. As we said before, to study motivations we can distinguish intrinsic motivations

⁴In Appendix A we provide descriptive statistics of the survey data.

⁵The details of the ESS questions and the variables constructed are contained in Appendix B.

from extrinsic ones. On the one hand, the intrinsic are caught by a proxy of good job in order to test the hypothesis 3 and a proxy of moral motivations defined by the fact of following rules even when no one is watching in order to test the hypothesis 4. On the other hand, for the extrinsic motivations we test the hypothesis 5 by capturing external pressure with the use of two variables, the need of colleagues' gratitude and a proxy of team spirit. Finally, we test our hypothesis 6, the reciprocity between employers and workers, with a dummy characterising the security of the job offered by the firm to the workers.

3.2. Distinction between insiders and outsiders

To test the hypothesis 7, we seek to distinguish insiders and outsiders to see if offering the use of ICT to employees has a different connection with incentives and motivations depending on the social category of workers.

According to Akerlof and Kranton (2005), we can distinguish the two social categories of employees by using the degree of loyalty of workers towards their firm or how much they are proud to be working for their firm. Despite the shortcomings of the concept because “[...] *these responses do not tell us why workers feel this way. Perhaps firms invest in identity. Perhaps workers select organizations that share their values. Perhaps workers adopt their firms' values to minimize cognitive dissonance*” (p. 22), it corresponds to the framework they build where identity is a part of workers' utility.

From this point of view, in order to distinguish the two populations of workers, we use the following question: “Thinking about the organisation you work for, how much do you agree with the following statement? I would turn down another job with higher pay in order to stay with this organisation”. If the employee agrees or strongly agrees with the statement, he's considered as an insider, otherwise the employee is considered as an outsider. In our data, nearly 40% of employees can be considered as insiders and so 60% as outsiders.

3.3. Independent variables

Our measures of ICT use at work concerns computer and Internet use. They are constructed has dummy variables that takes the value one when the individual use the ICT at the workplace and zero otherwise.

Even if we have no information on firms' choice of organisation and of the possible organisational changes implemented in the last years, we have variables relating to the characteristics of occupied job. On the one hand, we use information on the diversity of the tasks carried out in the job to have an idea of employee's versatility (“*multi-tasking*”). On the other hand, the data give information about the flexibility of the work schedule *i.e.* the fact that the worker is

often informed at short notice before having to work overtime for the needs for the firm, which gives us an idea of flexibility in the organisation of the production (*“flexibility”*).

The different control variables introduced in our empirical analyses concerns numerous aspects of workers, of their job and of the firm. The ESS survey provides information on the worker, that is to say the gender, the age, the highest level of education attained. The survey also provides information on each worker’s job and on the firm in which he works. More precisely, we have information on the occupation (5 groups: unskilled workers; skilled workers; clerks and services workers; technicians; professionals and high level management), if the employee weekly work more or less than the legal limit (40 hours), the seniority. Concerning the characteristics of the firm, we introduce the sector as well as the size of the firm.

Table 1 displays the characteristics of workers who use a computer and/or Internet at work. In the sample there are 59% of workers who use a computer in the workplace and 45% who use Internet. ICT users stand out from those who do not use, by individual or job characteristics. Qualified workers employ more widely new technologies than others. Thus, 81.66% of workers with college graduate use Internet at work against 22.57% of workers with only 0-13 years spent at school. Near than 90% of professionals and high level management employees use a computer at work and 80% use Internet. It is the case for less than 30% of skilled workers for the computer use and 16% for Internet. The proportion of individuals who uses ICT in the sectors of industry or construct is less important than in the other sectors. Concerning the size of the firm, it appears that more than 65% of individuals working in firms employing more than 25 persons use a computer and 50% Internet against less than 50% for computer use and 35% for Internet use in smaller firms.

Table 1: Characteristics of ICT users

	Computer users	Internet users
Mean in the sample	58.54%	45.18%
Individual characteristics		
Man	59.52%	47.44%
Woman	56.98%	41.67%
15-29 ans	62.18%	49.08%
30-44 ans	59.87%	46.15%
45 ans et plus	54.22%	41.13%
0-13 years at school	36.80%	22.57%
High School graduate	69.44%	54.55%
College graduate	90.48%	81.66%
Occupation		
Working hours \geq 40h	61.27%	47.69%
Working hours < 40h	47.41%	35.42%
Job tenure < 3 years	59.09%	44.51%

	Computer users	Internet users
Job tenure ≥ 3 years	58.70%	45.68%
Professionals, high level management	89.47%	80.39%
Technicians	83.93%	67.25%
Clerks and services workers	55.24%	35.95%
Skilled workers	26.97%	16.30%
Unskilled workers	15.79%	8.03%
Firm characteristics		
Size less than 10 employees	41.23%	34.17%
Size between 10 and 24 employees	47.15%	33.33%
Size between 25 and 99 employees	67.41%	52.55%
Size between 100 and 499 employees	67.31%	55.35%
500 employees and more	67.12%	48.67%
Industry, construct	37.74%	26.54%
Trade, transport, financial services, property business	68.70%	47.23%
Education, civil services, health services	61.77%	55.56%

Note: 67.12% of workers who work in a firm employing more than 499 persons use a computer at work and 48.67% use Internet.

4. Econometric method

A first estimate of the links between ICT and the different mechanisms of incentives and motivations (Y) can be obtained with Chi-square tests. We compare the average value of Y for workers who use the ICT ($T = 1$) and for the workers who do not ($T = 0$). This benchmark estimator is generally called “naïve”. However, this benchmark estimator raises some selection problems induced by workers’ heterogeneity (due to age, occupation, education,...) and firms’ heterogeneity (size, organisation,...), because we can’t introduce control variables with this methodology.

To handle this problem, in a second estimate, we choose to perform probit regressions of the different incentives and motivations variables on ICT use, including the control variables concerning the worker and the firm. For each incentives and motivations we have a dummy variable (Y_i) which is ascribed the value 1 if the worker ($i = 1, \dots, n$) announces that his work shows the characteristic, 0 if not.

We consider the carrying out of the binary dependent variable as the result from a rule of decision. This rule is a mechanism associating the exogenous variables x_i with the observation of the event $\{Y_i = 0\}$ or $\{Y_i = 1\}$. Thus, $Y_i = 1$ if $y_i^* > 0$ and $Y_i = 0$ if $y_{ie}^* \leq 0$, with the latent variable $y_i^* = \beta'.x_i + \epsilon_i$ where x_i is the vector containing the exogenous variables and β the vector of parameters that captures the influence of the exogenous variables. We assume that the error term ϵ_i is distributed as a normal i.i.d. variable. The probability that the work shows

a particular characteristic is written as follows:

$$\begin{aligned} \text{Prob}(Y_i = 1) &= \text{Prob}(\beta'.x_i + \epsilon_i > 0) \\ &= 1 - F(-\beta'.x_i) \end{aligned}$$

And the probability that the work doesn't show a particular characteristic is:

$$\text{Prob}(Y_i = 0) = F(-\beta'.x_i)$$

The likelihood function can be written as:

$$L = \prod_{i=1}^n [1 - F(-\beta'.x_i)]^{Y_i} \cdot [F(-\beta'.x_i)]^{(1-Y_i)}$$

And the log-likelihood function is:

$$\log L = \sum_{i=1}^n [Y_i \log(1 - F(-\beta'.x_i)) + (1 - Y_i) \log(F(-\beta'.x_i))]$$

But another problem stems from the fact that the impact of ICT may not be linear. The effect, indeed, can be different for distinct groups of workers.

That's why, in a third estimates, we use propensity score matching estimators, as Heckman, Ichimura, and Todd (1997, 1998) recommend. We can formalize the access to ICT in the workplace by a random variable T , which takes value 1 if the individual reaches the program (*i.e.* has the access to an ICT) and 0 if not. The variable of interest (Y) which denotes the fact that the worker i has such or such incentives or motivations to provide the optimal effort is described by two probabilities ($\hat{P}(Y_i = 1); \hat{P}(Y_i = 0)$) conditional on the access to the "treatment" (T). For a worker i , we do not observe at the same time the fitted probability of having an incentive or a motivation $\hat{P}_1(Y_i = 1)$ if the worker use the ICT ($T_i = 1$) and the fitted probability $\hat{P}_0(Y_i = 1)$ if the worker do not use the ICT ($T_i = 0$).

In the data, we only observe:

$$\hat{P}(Y_i = 1) = T_i \hat{P}_1(Y_i = 1) + (1 - T_i) \hat{P}_0(Y_i = 1)$$

For each worker, the "causal effect" (Rubin, 1974) of the treatment C_i is defined by the difference between what would be the situation of the individual if she were treated (*i.e.* if she used ICT at work) and what it would be if she were not treated: $C_i = \hat{P}_1(Y_i = 1) - \hat{P}_0(Y_i = 1)$

Given that our data are not experimental, we do not observe for a same individual the two fitted probabilities and consequently this parameter cannot be identified. So, we need to

estimate the average effect of treatment on the treated (ATT):

$$\begin{aligned}
ATT &= E(\hat{P}_1(Y = 1) - \hat{P}_0(Y = 1)/T = 1) \\
&= E(\hat{P}(Y = 1) - \hat{P}_0(Y = 1)/T = 1) \\
&= E(\hat{P}(Y = 1) - E(\hat{P}_0(Y = 1)/X, T = 1)/T = 1) \\
&= E(\hat{P}(Y = 1) - E(\hat{P}_0(Y = 1)/X, T = 0)/T = 1) \\
&= E(\hat{P}(Y = 1) - E(\hat{P}(Y = 1)/X, T = 0)/T = 1)
\end{aligned}$$

In order to obtain an estimation of the ATT we use information available on the workers to build, for each individual using ICT, a “counter-factual” *i.e.* an estimate of what would be his situation if he had not used the ICT.

Following Rosenbaum and Rubin (1983), we can matched individuals who take part in the treatment and those who not, according to the estimation of the probability to be involved in the use of ICT, the propensity score: $S(X) = Pr(T = 1/X)$. Furthermore, they show that the propensity score summarizes enough information to compute the estimation of the ATT.

The propensity score provides a comparability criterion between the “treated” group and the “untreated” or control one. If the score tends to be high for the people treated and weak for the untreated, it implies that the treated and the untreated people show different individual characteristics. There is, thus, a selection bias in so far as the treated use ICT because of their individual characteristics.

Following Heckman et al. (1997, 1998), we can thwart the selection bias, and construct a group of treated and a group of untreated workers comparables in accordance to their propensity score⁶. In practice, it implies that the sample has to be restricted to a common support of the empirical distributions of the scores respectively for observations such as $T_i = 1$ and for observations such as $T_i = 0$.

Then, we use the following non parametric Kernel matching estimator which under some regularity assumptions is convergent and asymptotically normal:

$$\widehat{ATT}_K = \frac{1}{N_1} \sum_{i \in I_1} \left\{ \hat{P}_1(Y = 1) - \sum_{j \in I_0} \frac{K\left(\frac{S(x_j) - S(x_i)}{h}\right)}{\sum_{j \in I_0} K\left(\frac{S(x_j) - S(x_i)}{h}\right)} \hat{P}_0(Y = 1) \right\}$$

Where K is a normal kernel function, h is the bandwidth parameter of the estimation, I_1 denotes the treated group, I_0 the untreated or control group, N_1 the number of individuals in I_1 .

⁶This methodology is classically used by authors analyzing the impact of organisational change on working conditions or wages. See for example, Askenazy and Caroli (2006); Diaye, Greenan, and Urdanivia (2006).

As we use the Kernel methodology, the right term inside the brackets is a weighted average of the observations in the control group. Consequently each individual j in the untreated group takes part in the construction of a counter-factual of i in the treated group. And the importance of $j \in I_0$ in this construction varies as the distance between his propensity score and that of $i \in I_1$.

5. Results

In the following subsections, we analyse the links between incentives, motivations and ICT use at work using three methods: naïve estimates, probit regressions and the propensity score method. As the uses of computer and of Internet are highly correlated and it makes difficult the implementation of the matching estimators, so we choose to make distinct analyses. The computer use is seen here as a tool allowing tasks codification and the transfers of information and knowledge between the different departments of the firm in a short time. The Internet use is seen here as a tool promoting communications with the outside, information research, and consequently can improve tasks execution. But, as the access to Internet is linked with the use of a computer, the results will therefore include at the same time the use of computer software and of communication tools offered by the Web as e-mail and bulletin boards, for example⁷.

The first column of the results reports naïve estimates for computer use (respectively the fourth column for Internet use) *i.e.* the difference in the percentage of workers who have such or such incentives or motivations to work hard, between workers who use the ICT and workers who do not. To go further, we estimate probit equations for the probability of being motivated by such or such incentives or motivations. The second column for computer use (respectively the fifth for Internet use) presents the marginal effects⁸ associated with the coefficient obtained in the probit regressions. Our third analyze concern the use of a propensity score method⁹. The third column for computer use (respectively the sixth for Internet use) reports the ATT estimated with the Kernel matching method.

With the results from the analysis of ICT use on the incentives and motivations to work hard, it seems that heterogeneity biases are quite large. The coefficients estimated either using the probit methodology or using the propensity score method are quite different from the naïve estimates. The effects of the ICT use on incentives or motivations to work hard are increasingly small when we correct for the heterogeneity of workers and firms. Moreover, for some incentives

⁷Details concerning the results of the different estimators are available on request.

⁸Each line in the second column or in the fifth one corresponds to a different probit.

⁹The first step in the method is to estimate a model Probit explaining the probability for an individual to have an access to the use of computer or the Internet according to the ICT considered, in order to perform the computation of propensity scores. To match our individuals, we retain a limited number of variables among the control variables included in the standard Probit. Non-significant variables in the estimation of the access to an ICT are, indeed, removed.

or motivations, the positive link with ICT use disappears when we introduce more and more corrections of the heterogeneity bias *i.e.* when we use the probit methodology and then the propensity score.

5.1. ICT and incentives

Table 2 presents the results of the tests of the hypotheses concerning the links between ICT and negative and positive mechanisms of incentives. We analyze the results obtained from the whole sample and on the two subpopulations of workers with or without the identity of the firm in order to see if the effects are more present for the population of outsider than for the population of insider in order to test our final hypothesis on an investment in motivational capital permitted by the investment in ICT.

Table 2: ICT use and incentives^a

		Computer use			Internet use		
		χ^2 test	Probit	ATT	χ^2 test	Probit	ATT
<u>Hypothesis 1</u> Monitoring	Whole sample	-8.71%**	-0.04 (0.052)	-0.004 (0.015)	-13.56%***	-0.108** (0.049)	-0.021 (0.015)
	Insider	3.66%	0.104 (0.082)	0.022 (0.048)	-6.19%	-0.042 (0.081)	0.032 (0.025)
	Outsider	-17.9%***	-0.148** (0.070)	-0.009 (0.027)	-18.97%***	-0.177*** (0.064)	-0.031 (0.024)
<u>Hypothesis 2</u> Wage bonus	Whole sample	6.43%*	0.081* (0.043)	0.032** (0.013)	6.94%**	0.085** (0.043)	0.012 (0.110)
	Insider	9.32%*	0.128* (0.066)	0.03* (0.018)	12.58%**	0.19*** (0.071)	0.023 (0.024)
	Outsider	4.32%	0.055 (0.058)	0.014 (0.023)	2.59%	0.001 (0.056)	0.006 (0.019)
Promotions	Whole sample	16.92%***	0.119** (0.052)	0.025 (0.022)	13.52%***	0.092* (0.050)	0.023 (0.017)
	Insider	18.77%***	0.184** (0.085)	0.009 (0.037)	13.74%**	0.196** (0.085)	0.053* (0.031)
	Outsider	13.6%***	0.066 (0.069)	0.032 (0.026)	10.73%**	0.006 (0.064)	0.032** (0.016)

^a For the probit, the marginal effects are provided. Standard errors are in parentheses, in the Kernel estimates they are computed using bootstrap. *, **, *** indicate statistical significance at the 10%, 5% and 1% level, respectively.

The use of ICT at work has no or little link with the negative incentive tested. The ATT is, indeed, non significant for all samples. However, the probit estimates underline that the use of ICT and in particular the joint use of the computer and the Internet (caught by right columns in table 2) appears to reduce the likelihood of the resort by the employer to the direct control

of the work of employees. When the two subpopulations of employees are distinguished, we can see that this effect appears only for the subpopulation of outsider.

The results of the test of hypothesis 2, concerning the links between ICT use and positive incentives mechanisms, show that at the level of the whole sample, ICT are associated with greater use of positive incentives. This effect is underlined by “naive” comparisons and by probit estimates, but not, however, by matching models. When we distinguish insiders from outsiders, it appears that the use of ICT is correlated with monetary rewards only for the workers with the identity of the firm. Through these monetary rewards, theoretically less used for insiders (Akerlof and Kranton, 2005), in the context of skills acquisition *via* the use of ICT, the firm can recognize the value of these skills in order to retain insiders and to promote the development of pure intrinsic motivation (crowd in effect). At the level of promotions, the results of the ATT show that, for the two subpopulations studied, the joint use of a computer and Internet is correlated with a feeling of having opportunities for advancement. Thus, for insiders, the ICT users have a 5.3 points higher probability of thinking that they can get a promotion than non users against 3.2 points for outsiders. Therefore, the results substantiate for the most part hypothesis 1 and hypothesis 2.

5.2. ICT and intrinsic motivations

The results on the links between the ICT use and intrinsic motivations of employees are shown in table 3.

Table 3: ICT use and intrinsic motivations^a

		Computer use			Internet use		
		χ^2 test	Probit	ATT	χ^2 test	Probit	ATT
<u>Hypothesis 3</u> Pure intrinsic motivations	Whole	24.54%***	0.092**	0.045***	22.16%***	0.043	0.018**
	sample		(0.036)	(0.017)		(0.034)	(0.007)
	Insider	26.80%***	0.165***	0.046*	22.05%***	0.089*	0.006
			(0.059)	(0.028)		(0.052)	(0.016)
<u>Hypothesis 4</u> Moral motivations	Outsider	21.62%***	0.022	0.037**	20.97%***	0.014	0.039***
			(0.042)	(0.017)		(0.043)	(0.010)
	Whole	-13.06%***	-0.041	0.01	-7.68%**	0.033	-0.005
	sample		(0.050)	(0.110)		(0.048)	(0.010)
	Insider	-3.62%	0.128	0.016	-1.84%	0.138*	-0.004
			(0.082)	(0.031)		(0.077)	(0.023)
	Outsider	-19.75%***	-0.147**	-0.012	-12.31%**	-0.049	0.006
			(0.066)	(0.013)		(0.063)	(0.013)

^a For the probit, the marginal effects are provided. Standard errors are in parentheses, in the Kernel estimates they are computed using bootstrap. *, **, *** indicate statistical significance at the 10%, 5% and 1% level, respectively.

The results highlight the fact that the use of ICT is associated with an enrichment of work. As shown by Deci (1971) or Minkler (2004), it shall promote the positive assessment by the employee of her work and therefore her pure intrinsic motivation. Pure intrinsic motivations implies the delivery of the optimal effort (e_A) without any financial compensation. Thus, for the whole population, the average treatment effect is significant and shows that workers using a computer at work have a 4.5 points higher probability of being motivated by an interesting work, and 1.8 for Internet users. In addition, the results of the ATT show that this link exists for the two subpopulations for the use of the computer and for the subpopulation of outsiders for the use of Internet (combined with a computer). Regarding the impact of ICT on moral motivations, the different methods used don't reveal a link between ICT use and the "integrity" to do the work in the interest of the firm. In conclusion, the results provide support to hypothesis 3 formulated above and display a lack of link between ICT and moral motivations. Thus the results don't permit to conclude on the ambiguity between ICT use and integrity of the agent.

5.3. ICT and extrinsic motivations

Table 4 provides the results of the tests of the hypotheses concerning the links between ICT use and extrinsic motivations.

Table 4 shows the test of hypothesis 5 on the link between ICT use and external pressures exerted by the look of the others depending on the proximity between workers in the firm. External pressures affect the level of effort thanks to the feeling of shame the employee develops when his effort diverges from the ideal. The results reveal little links between ICT and the shame feeling generated by the need for recognition. Regarding the links between ICT use and the development of a team spirit, the results of the matching method highlight a positive correlation for the whole population and for the subpopulation of outsiders. This team spirit can generate the feeling of shame recognized by Akerlof and Kranton (2005) as reducing the value of the agent when she doesn't conform to the interests of the employer. The results are used to decide on the ambiguity of links between ICT use and external pressure as formulated in the hypothesis 5 and underline a positive link between ICT use and the development of a team spirit. Moreover, the results don't support the hypothesis 6 concerning the link between ICT use and reciprocity captured by job security. However, we should noticed that this measure of reciprocity can be irrelevant in a country where the unemployment rate is less than 5%, and therefore job security is not important for an employee who knows that she can find without difficulty another job if she loses the current one.

Table 4: ICT use and extrinsic motivations^a

		Computer use			Internet use		
		χ^2 test	Probit	ATT	χ^2 test	Probit	ATT
<u>Hypothesis 5</u> Need of colleagues' gratitude	Whole	-5.07%	0.018	0.007	-3.67%	0.027	0.019
	sample		(0.053)	(0.017)		(0.050)	(0.016)
	Insider	5.63%	0.255***	-0.027	6.43%	0.242***	0.031
			(0.087)	(0.037)		(0.084)	(0.030)
	Outsider	-12.47%***	-0.118*	-0.001	-9.42%*	-0.055	-0.043***
			(0.070)	(0.013)		(0.065)	(0.017)
Team spirit	Whole	12.54%***	0.025	0.024***	10.59%***	0.014	0.028**
	sample		(0.040)	(0.008)		(0.038)	(0.011)
	Insider	9.86%**	-0.032	0.014	3.30%	-0.134***	0.036
			(0.057)	(0.034)		(0.061)	(0.028)
	Outsider	14.66%***	0.049	0.043***	16.04%***	0.094*	0.034**
			(0.055)	(0.013)		(0.050)	(0.012)
<u>Hypothesis 6</u> Job security	Whole	6.7%**	0.045	-0.002	6.23%**	0.037	0.008
	sample		(0.042)	(0.013)		(0.039)	(0.012)
	Insider	4.54%	-0.007	0.017	5.70%	0.03	0.012
			(0.039)	(0.017)		(0.040)	(0.020)
	Outsider	7.82%*	0.092	-0.003	6.11%	0.062	0.024
			(0.064)	(0.017)		(0.059)	(0.022)

^a For the probit, the marginal effects are provided. Standard errors are in parentheses, in the Kernel estimates they are computed using bootstrap. *, **, *** indicate statistical significance at the 10%, 5% and 1% level, respectively.

5.4. ICT and the investment in motivational capital

When the two subpopulations of employees are distinguished according to whether the employee has or not the firm identity, the results show that for employees' motivations, the links between ICT and intrinsic or extrinsic motivations are more present and/or more important for the subpopulation of outsiders than for the subpopulation of insiders. Thus, this result provides support to the hypothesis 7. Consequently, ICT use can appear as an investment in motivational capital that can ultimately transform outsiders into insiders.

Finally, even if the monetary rewards are theoretically less used for insiders (Akerlof and Kranton, 2005), the results highlight that positive incentive mechanisms are linked to ICT use especially for the population of insiders. It seems that as firm obtains easily the high level of effort with insiders, which in turn provides high incomes, the firm chooses monetary rewards or promotions to retain those employees in the context of high churn rate and the search of skilled workers by firms. Especially in a country where the unemployment rate is low and consequently the opportunities of finding a better job higher for high skilled workers.

6. Conclusion

The large diffusion of ICT associated with the diffusion of high performance work practices since the early 1990s has raised concerns about the impact of these changes on productivity. Some recent studies underline a positive impact of ICT and innovative practices of work on individuals' and firms' productivity. In this context of wide changes, our work seeks to study how the firm can play on incentives and motivations through workers' access to ICT to obtain a high amount of effort and to get the productivity effects highlighted in the literature.

Grounded in the economic literature as well as in works developed in sociology and psychology, we seek to evaluate empirically, in this article, the links between ICT use and incentives, motivations. The existing works show a positive impact of technological and organisational changes on productivity without an interest in the mechanisms of incentives and motivations underlying in the getting of the optimal effort of employees for the firm. Based on works concerning incentives and motivations and works on ICT use in firms, we have formulated six hypotheses on the relationship between the use of ICT in the workplace and the mechanisms of incentives and motivations. Moreover, by mobilizing the work of Akerlof and Kranton (2005) we study the relationship of incentives and motivations in an economic model construct to study the effort of employees. These authors, by distinguishing two types of employees, holders of firm identity and the others, can understand the interest of an investment in motivational capital to get a high effort level of employees. This led us to formulate a last hypothesis on the fact that access to ICT use can be a possible investment in motivational capital.

To test the hypotheses formulated, we use a representative sample of individuals working in Luxembourg surveyed in 2004-2005. We perform three analyses. A first evaluation of the consequence of ICT on the indicators of incentives and motivations is computed by comparing the average value of the indicator for workers who use ICT (computer, Internet) and for workers who do not. However, this naïve estimator raises some selection problems induced by workers' and firms' heterogeneity. To handle this problem, we choose to perform probit regressions of the different incentives and motivations variables on ICT use, including a number of controls like age, education, seniority and firm's characteristics like proxies of the organisation of work. But another problem stems from the fact that the impact of ICT may not be linear. In this case, as Heckman et al. (1997, 1998) recommend, we use propensity score matching estimators.

The results indicate that ICT use is associated with a less use of negative incentive mechanism linked to the increasing difficulty to control workers *via* a direct supervision because of a growing autonomy permitted by the introduction of ICT and of new organizational practices. Instead of these negative incentives, firms seem to use more positive incentives such as the use of monetary rewards when the level of effort is considered sufficient by the employer. Concerning the links between ICT use (computer and/or Internet) and employees' motivations, the analyses show that by giving the possibility to use ICT at the workplace, the firm creates

an enriching work environment that influences positively intrinsic motivations of workers. In addition, the use of ICT is positively correlated with the development of a team spirit within the organisation that can generate shame if the level of effort is insufficient and thus influence positively the level of effort. Finally, with the distinction of two subpopulations according to the ownership of the firm identity or not (insider vs. outsider), ICT have more links with the motivations of outsiders, and consequently can appear and as an investment in motivational capital that can transform outsiders into insiders.

ICT use is therefore associated with greater intrinsic motivation and can create a team spirit which can generate shame that leads to a highest level of employees' effort. ICT are also linked to a reduction in the use of negative incentive mechanisms replaced by rewards when the level of effort is known. The possible effects of crowd out created by the direct supervision of workers are pull away excluded and thus can't influence badly the provision of the effort by employees. Conversely positive incentive mechanisms used in the subpopulation of insiders can, through the crowd in effect, strengthen pure intrinsic motivations and the level of effort to work, to create and transfer knowledge. In consequence, firm can choose to reward the efforts of employees who acquired new specific skills needed by the firm to be competitive and to retain insiders in the context of high churn rates of skilled people.

Finally we need to notice that we are conscious of the difficulties to disentangle ICT and innovative work practices in studying what can encourage individuals to work in the interest of the firm. For example, it seems that even if new technologies are put at the service of organisational strategies, the impact on workers motivations mainly determined simultaneously by ICT and innovative work practice. Thus, the use of computer or Internet cannot by itself measure the possible effect of team work on external pressure while organisational changes can provide an answer. It would be necessary to investigate more the joint effect of ICT and organisational changes. Moreover, further researches should resort to other methods of matching estimators to check the robustness of the results obtained here. An alternative way of Kernel estimates concerning the matching of treated and control units can consist of taking each treated unit and searching for the control individual with the closest propensity score *via* Nearest Neighbor estimates.

Appendix

A. Descriptive statistics

	Whole sample		Computer users		Internet users	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Organisation of work						
Multi-tasking	0.7969	0.40	0.8653	0.34	0.8871	0.32
Flexibility	0.3179	0.47	0.3702	0.48	0.3961	0.49
Individual characteristics						
Sexe (Male)	0.6091	0.49	0.6234	0.49	0.6395	0.48
15-29 years	0.2309	0.42	0.2419	0.43	0.2508	0.43
30-44 years	0.4419	0.50	0.4539	0.50	0.4514	0.50
45 years and more	0.3272	0.47	0.3042	0.46	0.2978	0.46
0-13 years at school	0.4958	0.50	0.3092	0.46	0.2476	0.43
High School graduate	0.2649	0.44	0.3117	0.46	0.3197	0.47
College Graduate	0.2394	0.43	0.3791	0.49	0.4326	0.50
Employment						
Working hours	40.08	10.55	41.63	10.21	42.07	10.28
Job tenure < 3 years	0.2589	0.44	0.2594	0.44	0.2539	0.44
Unskilled workers	0.1941	0.40	0.0524	0.22	0.0345	0.18
Skilled workers	0.1303	0.34	0.0599	0.24	0.0470	0.21
Professional, high level management	0.2167	0.41	0.3392	0.47	0.3856	0.49
Technicians	0.2422	0.43	0.3516	0.48	0.3605	0.48
Clerks and services workers	0.2167	0.41	0.1970	0.40	0.1724	0.38
Firm characteristics						
Less than 10 employees	0.1727	0.38	0.1178	0.32	0.1293	0.34
10-24 employees	0.1856	0.39	0.1454	0.35	0.1356	0.34
25-99 employees	0.1971	0.40	0.2281	0.42	0.2271	0.42
100-499 employees	0.2288	0.42	0.2632	0.44	0.2776	0.45
500 employees and more	0.2158	0.41	0.2456	0.43	0.2303	0.42
Industry, construct	0.2295	0.42	0.1496	0.36	0.1348	0.34
Trade, transport, financial services, property business	0.4348	0.50	0.4514	0.50	0.4545	0.50
Education, civil & health services	0.3314	0.47	0.3940	0.49	0.4075	0.49

Note: There is 61% of man in the whole sample, 62% for computer users and 64% for Internet users.

B. Variable definitions

B.1. Negative incentives

Monitoring

My work is closely supervised - agree or strongly agree.

B.2. Positive Incentives

Wage bonus

My wage or salary depends on the amount of effort I put into my work - quite true or very true.

Promotions

My opportunities for advancement are good - agree or strongly agree.

B.3. Intrinsic motivations

Pure intrinsic motivations

Based on the answers to the following questions.

- My job requires that I keep learning new things;
- I can decide the organization of the daily work independently.

Dichotomous variables were created, with 1 representing quite true or very true. The sum of these two variables is a measure of good job content. A dummy variable was created for workers reporting positive job content for at least one aspect.

Moral motivations

"I like following rules even when no-one is watching". The variable is based on the answer of the following question. Choose the description that shows how much each person is or is not like you. He believes that people should do what they're told, he thinks people should follow rules at all times, even when no-one is watching: somewhat like me, like me, very much like me.

B.4. Extrinsic motivations

External Pressure

- Need of colleagues' gratitude
"I want people to admire what I do". The variable is based on the answer of the following question. Choose the description that shows how much each person is or is not like you. It's important to him to show his abilities, he wants people to admire what he does: somewhat like me, like me, very much like me.
- Team spirit
I can get support and help from my co-workers when needed - quite true or very true.

Fairness

Job Security : My job is secure - quite true or very true.

References

- AKERLOF, G. A. AND R. E. KRANTON (2005): “Identity and the economics of organizations,” *Journal of Economic Perspectives*, 19, 9–32.
- AKERLOF, G. A. AND J. L. YELLEN (1990): “The fair wage-effort hypothesis and unemployment,” *The Quarterly Journal of Economics*, 105, 255–283.
- ALCHIAN, A. A. AND H. DEMSETZ (1972): “Production, information costs, and economic organization,” *The American Economic Review*, 62, 777–795.
- ARAL, S., E. BRYNJOLFSSON, AND M. VAN ALSTYNE (2007): “Productivity Effects of Information Diffusion in Networks,” Working paper.
- ASKENAZY, P. (2004): *Les désordres du travail : Enquête sur le nouveau productivisme*, La république des idées, Seuil.
- ASKENAZY, P. AND E. CAROLI (2006): “Innovative work practices, information technologies and working conditions: Evidence for France,” IZA Discussion Paper 2321, Institute for the Study of Labor.
- ASKENAZY, P. AND C. GIANELLA (2000): “Le paradoxe de la productivité : les changements organisationnels, facteur complémentaire à l’informatisation,” *Economie et Statistique*, 339–340, 219–241.
- BAUER, T. K. AND S. BENDER (2004): “Technological change, organizational change, and job turnover,” *Labour Economics*, 11, 265–291.
- BERTSCHEK, I. AND U. KAISER (2004): “Productivity effects of organizational change: Microeconomic evidence,” *Management Science*, 50, 394–404.
- BLACK, S. E. AND L. M. LYNCH (2001): “How to compete: The impact of workplace practices and information technology on productivity,” *Review of Economics and Statistics*, 83, 434–445.
- BRADLEY, G. (2000): “The information and communication society: how people will live and work in the new millennium,” *Ergonomics*, 43, 844–857.
- BRESNAHAN, T. F., E. BRYNJOLFSSON, AND L. M. HITT (2002): “Information technology, workplace organization, and the demand for skilled labor: Firm-level evidence,” *The Quarterly Journal of Economics*, 117, 339–376.
- BRYNJOLFSSON, E. AND L. M. HITT (2000): “Beyond computation: Information technology, organizational transformation and business performance,” *The Journal of Economic Perspectives*, 14, 23–48.
- CALVO, G. AND S. WELLISZ (1978): “Supervision, Loss of Control, and the Optimum Size of the Firm,” *The Journal of Political Economy*, 86, 943–952.
- CAROLI, E., N. GREENAN, AND D. GUELLEC (2001): “Organizational change and skill accumulation,” *Industrial and Corporate Change*, 10, 481–506.

- COLVIN, A. J. S. (2006): "Flexibility and Fairness in Liberal Market Economies: The Comparative Impact of the Legal Environment and High-Performance Work Systems," *British Journal of Industrial Relations*, 44, 73–97.
- COOLS, K., M. VAN HERPEN, AND M. VAN PRAAG (2005): "The effects of performance measurement and compensation on motivation: An empirical study," *De Economist*, 153, 303–329.
- DECI, E. L. (1971): "Effects of externally mediated rewards on intrinsic motivation," *Journal of Personality and Social Psychology*, 18, 105–115.
- DIAYE, M. A., N. GREENAN, AND M. W. URDANIVIA (2006): "Subjective evaluation of performance through individual evaluation interview: theory and empirical evidence from France," Working paper, Centre d'Etudes de l'Emploi.
- FAMA, E. F. (1980): "Agency Problems and the Theory of the Firm," *The Journal of Political Economy*, 88, 288–307.
- FEHR, E. AND S. GÄCHTER (2000): "Fairness and Retaliation: The Economics of Reciprocity," *Journal of Economic Perspectives*, 14, 159–181.
- FREY, B. S. (1997): *Not just for the money. An economic theory of personal motivation*, Edward Elgard Publishing Ltd.
- FREY, B. S. AND R. JEGEN (2001): "Motivation crowding theory," *Journal of Economic Survey*, 15, 589–611.
- GOLLAC, M., V. MANGEMATIN, F. MOATTY, AND A.-F. DE SAINT-LAURENT (1999): "A quoi sert donc l'informatique ? Revue d'études de cas," in *Innovations et Performances : Approches interdisciplinaires*, ed. by D. Foray and J. Mairesse, Editions de l'Ecole des Hautes Etudes en Sciences Sociales, 77–130.
- GREENAN, N. AND J. MAIRESSE (2000): "Computers and productivity in France: Some evidence," *Economics of Innovation and New Technology*, 9, 275–315.
- GREENAN, N. AND E. WALKOWIAK (2005): "ICT, work organisation and social interactions," Working paper, Centre d'Etudes de l'Emploi.
- HECKMAN, J., H. ICHIMURA, AND P. TODD (1997): "Matching as an Econometric Evaluation Estimator: Evidence from Evaluating a Job Training Programme," *Review of Economic Studies*, 64, 605–654.
- (1998): "Matching as an Econometric Evaluation Estimator," *Review of Economic Studies*, 65, 261–294.
- HOLMSTRÖM, B. (1982): "Moral Hazard in Teams," *Bell Journal of Economics*, 13, 324–340.
- JENSEN, M. C. AND W. H. MECKLING (1976): "Theory of the firm: managerial behavior agency costs and ownership structure," *Journal of Financial Economics*, 3, 305–360.
- KANDEL, E. AND P. LAZEAR (1992): "Peer Pressure and Partnerships," *The Journal of Political Economy*, 100, 801–817.

- LICHT, G. AND D. MOCH (1999): "Innovation and information technology in services," *Canadian Journal of Economics*, 32, 363–383.
- LICHTENBERG, F. R. (1995): "The Output Contributions Of Computer Equipment And Personnel: A Firm-Level Analysis," *Economics of Innovation and New Technology*, 3, 201–218.
- LINDBECK, A. AND D. J. SNOWER (1996): "Reorganization of firms and labor-market inequality," *The American Economic Review*, 86, 315–321.
- (2000): "Multitask learning and the reorganization of work: From Tayloristic to Holistic organization," *Journal of Labor Economics*, 18, 353–376.
- MINKLER, L. (2003): "Managing moral motivations," Working Paper 2003-06, University of Connecticut.
- (2004): "Shirking and motivations in firms: survey evidence on workers attitudes," *International Journal of Industrial Organization*, 22, 863–884.
- MINKLER, L. AND T. MICELI (2004): "Lying, integrity, and cooperation," *Review of Social Economy*, 62, 27–50.
- OSTERMAN, P. (2000): "Work Reorganization in an Era of Restructuring: Trends in Diffusion and Effects on Employee Welfare," *Industrial and Labor Relations Review*, 53, 179–196.
- PRENDERGAST, C. (1999): "The Provision of Incentives in Firms," *Journal of Economic Literature*, 37, 7–63.
- ROB, R. AND P. ZEMSKY (2002): "Social Capital, Corporate Culture, and Incentive Intensity," *The RAND Journal of Economics*, 33, 243–257.
- ROSENBAUM, P. R. AND D. B. RUBIN (1983): "The Central Role of the Propensity Score in Observational Studies for Causal Effects," *Biometrika*, 70, 41–55.
- RUBIN, D. B. (1974): "Estimating Causal Effects of Treatments in Randomized and non Randomized Studies," *Journal of Educational Psychology*, 66, 688–701.
- SALLY, D. (1995): "Conversation and Cooperation in Social Dilemmas: A meta-analysis of experiments from 1958 to 1992," *Rationality and Society*, 7, 58–92.



IRISS Working Papers

The IRISS Working Paper Series has been created in 1999 to ensure a timely dissemination of the research outcome from the IRISS-C/I programme. They are meant to stimulate discussion and feedback. The working papers are contributed by CEPS/INSTEAD resident staff, research associates and visiting researchers.

The fifteen most recent papers

Martin L., 'The impact of technological changes on incentives and motivations to work hard', IRISS WP 2007-15, December 2007.

Popescu L., Rat C. & Rebeleanu-Bereczki A., 'Self-Assessed Health Status and Satisfaction with Health Care Services in the Context of the Enlarged European Union', IRISS WP 2007-14, November 2007.

Weziak D., 'Measurement of national intellectual capital application to EU countries', IRISS WP 2007-13, November 2007.

D'Angelo E. & Lilla M., 'Is there more than one linkage between Social Network and Inequality?', IRISS WP 2007-12, November 2007.

Lilla M., 'Income Inequality and Education Premia', IRISS WP 2007-11, November 2007.

Stanciole A., 'Health Insurance and Life Style Choices: Identifying the Ex Ante Moral Hazard', IRISS WP 2007-10, November 2007.

Raileanu Szeles M., 'The patterns and causes of social exclusion in Luxembourg', IRISS WP 2007-09, August 2007.

Mussard S. & Philippe B., 'Une évaluation du rôle des déterminants du partage de la valeur ajoutée', IRISS WP 2007-08, June 2007.

Voicu B., Voicu M. & Strapkova K., 'Engendered housework. A cross-european analysis', IRISS WP 2007-07, May 2007.

Kankarash M. & Moors G., 'Heterogeneity in solidarity attitudes in Europe. Insights from a multiple-group latent-class factor approach', IRISS WP 2007-06, April 2007.

Valentova M., 'Attitudes to Family Policy Arrangements in Relation to Attitudes to Family and division of Labour between Genders', IRISS WP 2007-05, May 2007.

Valentova M., Krizova I. & Katrnak T., 'Occupational Gender Segregation in the light of the Segregation in Education: A Cross-National Comparison', IRISS WP 2007-04, April 2007.

Mussard S. & Terraza M., 'Décompositions des mesures d'inégalité : le cas des coefficients de Gini et d'entropie', IRISS WP 2007-03, April 2007.

Mussard S., 'Between-Group Pigou-Dalton Transfers', IRISS WP 2007-02, March 2007.

Van Kerm P., 'Extreme incomes and the estimation of poverty and inequality indicators from EU-SILC', IRISS WP 2007-01, February 2007.

Electronic versions

Electronic versions of all IRISS Working Papers are available for download at
<http://www.ceps.lu/iriss/wps.cfm>



IRISS-C/I is a visiting researchers programme at CEPS/INSTEAD, a socio-economic policy and research centre based in Luxembourg. It finances and organises short visits of researchers willing to undertake empirical research in economics and other social sciences using the archive of micro-data available at the Centre.

What is offered?

In 1998, CEPS/INSTEAD has been identified by the European Commission as one of the few *Large Scale Facilities* in the social sciences, and, since then, offers researchers (both junior and senior) the opportunity to spend time carrying out their own research using the local research facilities. This programme is currently sponsored by the European Community's 6th Framework Programme. Grants cover travel expenses and on-site accommodation. The expected duration of visits is in the range of 2 to 12 weeks.

Topics

The major resource offered to visitors is access to a series of internationally comparable longitudinal surveys on living conditions at the household and individual level. The anonymised micro-data provide information on wages and income, health, education, employment and professional activities, accommodation, social relations,... Comparable micro-data are available for EU countries, Central European countries, as well as the USA. These data offer opportunities to carry out research in fields such as *survey and panel data methodology, income distribution and welfare, income and poverty dynamics, multi-dimensional indicators of poverty and deprivation, gender, ethnic and social inequality, unemployment and labour supply behaviour, education and training, social protection and redistributive policies, fertility and family structures, new information technologies in households and firms, ...*

Who may apply?

All individuals (doctoral students as well as experienced academics) conducting research in an institution within the EU-25 or an FP6 Associated State. IRISS-C/I can be meeting place for groups of researchers working on a joint project. We therefore encourage joint proposals by two or more researchers.

For more detailed information and application form, please consult our website: <http://www.ceps.lu/iriss> or contact us at

IRISS-C/I, CEPS/INSTEAD
BP 48, L-4501 Differdange, G.-D. Luxembourg
Tel: +352 585855 610; Fax: +352 585588
E-mail: iriss@ceps.lu