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ORGANISATIONAL CHANGES AND LONG-TERM SICKNESS ABSENCE AND INJURY LEAVE : A DIFFERENCE IN DIFFERENCE APPROACH

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Organisational changes and long-term sickness absence and injury leave: a difference in difference approach*

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Abstract

The article evaluates the impact of organisational changes on long-term sickness absence. We use a unique dataset matching a company level survey on computerisation and organisational changes with an administrative file allowing to follow up health issues in the working population. We implement a difference in difference approach using two time windows: a three years' time period after changes have occurred and another one during the implementation of changes. Guided by the perspective that organisations change through the implementation of new tools and practices, we consider Information and Communication Technologies (ICTs) on one hand and management tools on the other. This allows to identify three treatments according to the sets of tools implemented by companies: ICT changes only, management changes only, both ICT and management changes.

We find the following core result: changes in the management dimension alone reduce long-term sickness absences when joint changes in ICT and management tools increase occupational risks. There are however gendered differences in the timing and strength of impacts as women are mainly impacted during the period when changes are implemented and impacts are stronger while men are impacted afterwards. Also, older employees seem protected against the serious health consequences of any form of changes. These results point to the need to better understand the process of organisational change (its complexity, intensity, dynamics), the gendered construction of health behaviours as well as that of technology and management tools uses in devising occupational safety and health policies targeted at evolving work environments.

Key words: organisational change, information and communication technologies, long-term sickness absence, gender and age behaviour

JEL classification: O33, I12, J28

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1. Introduction

Standard models assume that employers make adjustments to the production process to maximise profits, rather than employee wellbeing (Bloom and Van Reenen, 2007; Freeman and Kleiner, 2005). However, complexity, divergent interest among stakeholders and bounded rationality make it difficult for collective entities like business organisations to act as perfectly rational agents. Furthermore, as they are held more accountable for corporate social responsibility and sustainable growth, it becomes more difficult for employers to share the simplistic view of Friedman (1970) saying that "The social responsibility of business is to increase its profit".

Indeed, from the society point of view, the social consequences of poorly managed changes at work appear as quite serious. The International Labour Organisation estimated that the economic losses created by work accidents and occupational diseases amounts to 4% of GDP. In 2016, for each European worker, the European Commission estimates that respectively 1.6 working days are lost because of work accidents and work related health problems. In France, the daily benefits for work accidents and occupational diseases experienced the fastest increase in 2018. The average costs of a work accident amounts 3800 euros, 24000 euros for cumulative trauma disorders and a day's absence due to work accident costs around 300 euros (L'Assurance Maladie – risques professionels, 2019).

If organisational changes are not optimised from the point of view of employee well-being, what are their consequences on occupational health issues? There are first some uncertainties about the impact of organisational changes on employees' health. If they enrich employees' working lives, this is likely to improve their mental and physical health. If they are simply effort biased (Green et al., 2021), they may lead to a higher incidence of illness, injury, absence and stress. Second, even if organisational changes enhance workers' control over their job, the process of their introduction can generate uncertainty leading to increased anxiety and stress. An additional question is about the length of this alleged effect on employees' health: its persistence is questionable since those worst affected could choose to leave their organisation while the remainder are liable to adapt over time (Kahneman et al., 1999). A first contribution in this paper is to carefully analyse and measure with a difference in difference approach the impact of organisational changes on long term sickness absence, a likely correlate of substantial health impairments like work accidents, depression or cumulative trauma disorder.

Furthermore, the economic and management literature on organisational changes describes the existence of different forms of productive complementarities which work as powerful incentives to jointly implement a whole array of changes (Brynjolsson and Milgrom, 2013; Dughera, 2020; Kay et al., 2018). This is likely to increase potential adverse impacts in terms of employee outcomes. An important distinction in this literature is between technological changes on one hand and new management concepts or models on the other one. The first changes are fuelled by technological revolutions. We are today in the midst of the fifth technological revolution, marked by the diffusion of Information and Communication Technologies (ICTs) and digital tools (Perez, 2010). The second changes, prompted by technological breakthroughs intend to take advantage of the new opportunities they bring about by transforming the way work is done (Bodrožić and Adler, 2018). Hence we will consider changes through the implementation of ICTs on one hand, of management tools on the other. A second contribution of our research is to better grasp the various dimensions of the process of organisational change: its complexity, its intensity, its dynamics.

We use a French nationally representative survey at the employer level on computerisation and organisational changes (COI-TIC survey) linked with an administrative health insurance panel (Hygie

data base). Employers give detailed information about their adoption of a large set of ICT and management tools over a three years' time period (2003-2005). In the panel Hygie, we follow up in time over nine years (2000-2008), three years before and three years after the change period, a large and representative sample of employees attached to the surveyed sample of employers. Our difference in difference approach compares employees that faced organisational changes in their workplace (treatment group) with employees in inert companies (control group) using three sub-periods: before the occurrence of changes (2000 to 2002), during their implementation (2003 to 2005) and after they took place (2006 to 2008). We breakdown our sample of employees according to sex and age as these characteristics may influence access to resources, vested interest in changes, coping strategies and health related behaviours.

The rest of the paper is structured as follows. Section 2 reviews theoretical and empirical results on organisational changes and occupational health issues. Section 3 describes the data, the measurement frame and the econometric model. Section 4 presents the results and section 5 concludes.

2. Organisational changes and occupational health issues

2.1 Synergetic effects in organisational changes

Firms change their organisation to maintain their competitive advantage in increasingly competitive market conditions or to gain from new technological opportunities. The economic literature stresses the existence of synergetic effects in the spectrum of potential changes through the concept of productive complementarities. Indeed, the joint and coordinated adoption (Brynjolsson and Milgrom, 2013) of a set of technologies and management tools may be the decision that yields the highest return. This is because, when the tools are complementary, their joint use brings an additional productive gain to the performance generated by the independent use of each of them. Hence, there is a strong economic incentive to opt for a radical organisational change involving evolutions in several dimensions rather than for an incremental one.

In the economic and management literature empirical studies have targeted three different systems of joint decisions within organisation. The first system relates to the managerial concept of high performance or high involvement work systems. These forms of work organisation typically combine and integrate Human Resource Management (HRM) and work practices to reach superior organisational performance. The idea that there are synergistic effects in the bundle of chosen practices is core in this field of research (Bloom and Van Reenen, 2001; Jackson et al., 2014).

The innovation literature has also identified and investigated complementarities between technological and organisational innovations (Van Oorschot et al., 2018). As argued by Damanpour (2014), the development of measures on non-technological innovation in the Community Innovation Survey has contributed to provide empirical evidence on these complementarities (Ballot et al., 2015; Battisti and Stoneman (2010); Evangelista and Vezzani, 2010; Hervas-Oliver et al., 2014; Sapprasert and Clausen, 2012). This literature also deals with the timing of innovations with a debate between those who advocate synchronous or simultaneous adoption (Damanpour, 2014) and those who describe a sequential complementarity where organisational innovation tends to follow technological adoption (Battisti et al., 2015).

The coordination of decisions about the use of ICTs and of new management practices is the topic of another strand of literature that started from the concern about the *productivity paradox*, that is the fact

that even though computers are pervasive in the economy since the 1990s, significant productivity impacts are slow to show up in empirical studies. The complementarity between ICT investments and other intangible investments in organisational capital were identified at the turn of the millenium as one of the explanation of this puzzle (Brynjolfsson and Hitt, 2000; Greenan, 2003) and this view remained accurate with the evolution of ICTs in the digital age (Bocquet et al, 2007; Brynjolfsson and McElheran, 2016; Corrado et al., 2017). Bodrožić and Adler (2018) argue that management tools associated with the business process model are those that have been predominantly adopted by organisations in the computer age. They aim at rationalising business processes up and down the value chain and bridging internal and external boundaries.

If productive complementarities play a role in the discrete choices made by companies in the fields of technology and organisation, we expect that companies will coordinate their adoption of ICTs and management tools with a preference for cumulative adoption as it is more likely to yield higher returns. The time frame of the sequence of decisions remains however uncertain as arguments in favour of simultaneous and sequential adoption coexist while it is difficult to address this timing precisely in statistical surveys.

2.2 Organisational changes and employees' work experience

Although the productive complementarity approach focuses on economic performance, when it takes into account the views of other stakeholders and in particular employees, a win-win assumption where both employers and employees benefit from cumulative change generally prevails. For example, while automation replaces tasks that involve repetition and physical strain with machines, the optimisation of business processes increases their reliability, entailing less physical hazards and more safety.

However, other research results from economics, industrial relations, sociology or social psychology challenge this perspective. The main argument is that organisational changes are likely to destabilise the smooth functioning of the organisation and to put its survival at threat. Theories that are part of an evolutionist-ecologist perspective, maintain that the selection process within populations of firms tends to favour stabilised organisations, relying on standardised routines, at the price of a high level of inertia. Companies that introduce major organisational changes thus run a greater risk of failure or mortality (Nelson and Winter, 1982). The conflicting theoretical perspectives on the relationship between organisational routines and organisational changes show at least that organisational change is not a process that is likely to be spontaneously virtuous for the stakeholders of an organisation (Kay, 2018). Modern theories of evolution do not postulate that adaptive processes always reach a stable, optimal and unique equilibrium (Dughera, 2020 for instance).

Furthermore, following March (1962), organisations can also be considered as political coalition. Hence unresolved conflict and divergent interest is part of the everyday life of an organisation, generating a complex coordination problem around production, which outcome is necessarily uncertain (Marengo, 2020). This conflict is likely to gain momentum in face of organisational change. Indeed, in management studies and interdisciplinary social sciences, terms like paradox, tensions, contradictions and dialectics have become prominent (Putman et al., 2016) and they are most of the time connected with organisational transformation. Contradiction is often seen as a driving force of organisational change and organisational actors often deal with tensions and contradictions by opening options to align opposite forces in order to allow for both changes and continuity. Furthermore, Sewell et al. (2012) and Mazmanian et al. (2013) stress the duality of digital technologies (respectively electronic performance monitoring and mobile email devices) and show how they generate paradoxical work experiences for their users.

Putnam et al. (2016) define tensions as "stress, anxiety, discomfort, or tightness in making choices, responding to, and moving forward in organizational situations" (p.69). Although it is not so common in the economic and management literature, it seems thus essential to address the work experience of employees facing organisational change in increasingly turbulent organisational environments. Four main sources of risk may jeopardise their health and wellbeing by imposing physiological, psychological and behavioural threats: uncertainty, conflict, violence and disequilibrium between constraints and resources.

First, increased uncertainty related with organisational change has an impact on psychological exhaustion (Bordia et al., 2004) and on the feeling of job insecurity which has been consistently linked with detrimental mental health effects (Sverke et al., 2002). If cost-cutting reorganisations or financial restructuring are more directly linked with increased job insecurity, other forms of organisational change may also increase the feeling of insecurity if employees have no information and control on how these may impact the future of their workplace or of their job.

Second, there is no tale of homogeneous personal interest congruent with organisational interest. Godard (2004) identifies potential conflicts between organisational and employees' interests in high performance work systems. Ways of optimising organisational performance may clash with employee preferences and hamper the supportive nature of the work environment. Conflicts may also happen between interest groups within the organisation, spurred by innovation. Innovation, directed to the core tasks of employees and with repercussions for the whole organisation may rally a majority against it when more localised innovation will limit the size of the potential conflict. Employees' diversity also plays a role in the emergence of conflicts between interest groups. Bellettini and Ottaviano (2005) explore the assumption that age groups may have diverging vested interest pushing junior employees to support radical change while senior employees prefer improvements to existing processes.

Third, violence is likely to derive from conflicts (Salin, 2003). Organisational change may feed hostility and competition within the organisation, leading to counterproductive behaviours to hinder or eliminate competitors. According to Ballien et al. (2019), organisational change may favour in the workforce the perception of psychological contract breach which in turn could lead employees to direct bullying or hostile behaviours to other members of the organisation. Interestingly, analysing the consequences of workplace bullying on sickness absence, Eriksen et al. (2016) find a gendered effect: only women's long term sickness absence increases, men being more likely to leave the labour force in response of reduced career perspectives in case of exposure.

Finally, organisational changes foster some disequilibrium between constraints and resources: new demands and obligations impose additional constraints on employees in a change process where everything cannot be planned in advance; resources are not instantly reallocated, some skills may lack and new methods are not fully mastered in the learning phase of the change process. In his stress disequilibrium model, Karasek (1979) has addressed the adverse health impact of a disequilibrium between job demands and job resources. It generates both physical hazards (Niedhammer et al., 2018) and psychosocial risks (Bonde, 2008; Cottini and Lucifora, 2013). Karasek (2008) revisited this model with new stress physiological theory to describe how low social control can contribute to the development of chronic disease through the deregulation of physiological systems.

2.3 Review of empirical results

In a time when the feeling of an accelerated change is widely experienced, barriers to dissemination of new organisational designs and practices as well as scope for ill-designed ICT and management changes exist in workplaces with growing workforce diversity. It is thus useful to review the results of empirical

studies that have analysed the relationship between organisational change and health and well-being of employees. It is noticeable that empirical research on this topic is scarce. We will organise our review according to the measurement frame for organisational change: direct measures of organisational changes, High Performance Work Systems (HPWS) and new ICT systems.

Bamberger et al. (2012) survey the impact of organisational change on mental health and argue that if organisational change is often cited as a harmful exposure, few studies only have been published to support this assumption. Reviewed organisational changes take most of the time the form of cost cutting reorganisations like downsizing or financial restructuring. They conclude that more studies of long term effects are required to strengthen the negative evidence. Østhus (2007) finds that downsizing or internal reorganisations increase demands on employees to exert more efforts, without any positive counterparts in terms of task discretion, job security or job satisfaction. The results further suggest negative effects on work related health problems which are stronger for internal reorganisations than for downsizing. Pollard (2001) was able to follow a sample of employees before and after a large scale workplace reorganisation. She concludes that it caused significant increases in distress and in systolic blood pressure and that uncertainty reinforced these effects. Bryson et al. (2013) relate three change indicators over the two years prior to the survey: any kind of change, labour changes (working time arrangements, organisation of work, work techniques or procedures, initiatives to involve employees) and capital change (upgrading of computers, upgrading of other types of new technology, introduction of technologically new or significantly improved product or service) with measures of job related anxiety and job satisfaction measured at the employee level. They find that only labour changes are associated with lower average employee well-being and job satisfaction, therefore showing that technological changes may not interfere with health at work. Collective bargaining agreement coverage and recognised union for pay bargaining at the workplace seem however to mitigate the negative impact of such innovation on employee well-being. Bigi et al. (2018) address the human sustainability of organisational change driven by the adoption of ICT and new management tools in the private and public sectors and find that it depends on how intense the changes are and on how their implementation takes into account the institutional context of the organisation. In private organisations, both ICT and management changes increase employees' use of skills but at a decreasing rate while only management changes are associated with the development or at least the maintenance of work involvement. Finally, Euzenat and Mortezapouraghdam (2016) consider the impact of the implementation of a large set of management tools on the rate of work accidents. Their findings suggest that the implementation of quality management techniques like failure mode and effects analysis (FMEA) and quality certification could improve physical safety in workplaces.

As summarised by Kalmi and Kauhanen (2008) empirical results on the impact of HPWS on employee outcomes have been somewhat conflicting with a view arguing on mutual gains and another one, more critical. The mutual gain literature emphasises the increase in discretion and the resulting monetary and psychological benefits when the critical view argues that the limited gains accruing to employees are outweighed by increased stress, intensification and work injury (Askenazy, 2001; Brenner et al, 2004; Fairris and Brenner, 2001). Bockerman et al. (2012), however do not find any robust evidence that HPWS impact sickness absence when they instrument their measure. Taking a dialectical view based on the findings of the management literature, Han et al (2020) elaborate several propositions regarding why HPWS have negative effects from the perspective of employees and when they occur. Interestingly, one of their propositions is that there is an inverted U-shape relationship between how extensively HPWS are implemented and the reaction of employees. They label it a "too much of a good thing effect". They also stress that time is crucial because when HPWS systems are reinforced, health impacts do not

immediately occur. This calls for longitudinal studies and a measurement frame for HPWS that allows to investigate cumulative impact through interaction effects and intensity measures.

Finally, as far as ICT use at work is concerned, Karimikia et al. (2020) argue that while researchers have studied the positive outcomes of ICT use, negative employee outcomes have not yet been reviewed. They provide a meta-analysis of 52 studies covering negative outcomes such as workload, stress, anxiety or burnout. The meta-analysis supports the link between the various forms taken through time by ICT uses and negative outcomes. ICT uses are related with working conditions characterised by workload, role ambiguity and role conflict, which increases the strain, distress and work exhaustion experienced by employees, with some variations according to the different types of technology. A new finding is that a high level of autonomy tends to escalate work stress among ICT users. This is surprising because usually autonomy tends to regulate negative employee outcomes. As for HPWS, positive and negative employee outcomes of ICT uses coexist calling for further research on the forms of organisations and change processes that contribute to securing a balance in the working life of ICT users.

3. Data

The objective of this study is to evaluate the impact of organisational changes on long term sickness absence. We use a French representative survey at the employer level on computerisation and organisational changes (COI-TIC survey) linked with an administrative health insurance panel (Hygie data base). The COI-TIC survey provides company level measures on the use of a large set of ICT and management tools at the date of the survey (January 2006) and three years earlier. Hygie follows individual over 2000-2008 with precise measures of health issues: sick leave, work accidents, occupational diseases, medical consumptions.

3.1 Organisational change and computerization (COI-TIC survey)

The COI-TIC survey has been carried out by the National institute of statistics and economic studies (INSEE) while the scientific guidance of its development took place at *Centre d'Etudes de l'Emploi* (CEE). A random sample of private firms in the non-agricultural market sector with 10 employees and more has been selected. The data were stratified by industry and company size with a comprehensive layer beyond 500 employees. The survey received a high response rate of 85%, leading to a sample of about 13687 companies (Greenan et al. (coord.), 2010).

The questionnaire includes retrospective questions where the respondent describes the situation of the organisation at the date of the survey (January 2006) and three years earlier. This structure allows to measure changes that took place in 2003, 2004 or 2005. A set of questions target the use of management tools like just-in-time, quality certifications or labels and another one the use of Information and communication technologies (ICTs) such as enterprise research planning and e-commerce, among others.

The underlying logic of the COI-TIC survey is to hypothesise that company leaders' intentions to change productive organisations are reflected by the implementation of new tools and techniques. Hence, the measurement of organisational changes relies on the dynamics of the diffusion of new tools and practices. Furthermore, the intensity of the intended organisational changes is reflected by the number of new tools and equipment. The chosen tools and practices impact two complementary systems within the organisation, the production system (management tools) and the information system (ICTs).

In the COI-TIC survey, we have selected a list of tools that have an impact on the work situations of employees: 13 management tools and 15 ICTs (Appendix table A1). Following the method developed in a previous study, we used Multiple Correspondence Analysis to obtain a continuous scale index measuring the extent of the changes in each dimension (Bigi et al., 2018). The higher the firm value on this scale, the more intense is its organisational changes in the given dimension. However, in our empirical analysis, we will restrict ourselves to binary measures of the changes. We consider that the firm has experienced a significant change in each dimension when the value of the change index, between 2006 and 2003, is superior to 0,20[2]. Otherwise, firms are coded as having experienced marginal or no change. The combination of these two binary variables leads to the identification of four cases: the company has implemented (1) ICT changes only, (2) management changes only, (3) both ICT and management changes (4) no change or marginal changes.

Table 1 shows the breakdown of companies in the COI-TIC survey depending on the type of organisational changes implemented between 2003 and 2006. We find that 68.6% of companies remained inert, 17.2% implemented ICT changes only, 7.4% management changes only and 6.8% jointly implemented ICT and management changes. The fact that ICT changes only is a more frequent form of organisational change points to the fact that the period under coverage is in the midst of the web 2.0 revolution with the development of mobile ICTs, social networks and new generations of software equipment for companies like groupware, ERPs or workflow software (Greenan et al. (coord.), 2010).

Table 1: Organisational changes within companies

Type of change	Frequency	Percentage
No significant organisational changes	9395	68.59
Organisational changes	4302	31.41
- ICT changes only	2353	17.18
- Management changes only	1012	7.39
- ICT and management changes	937	6.84
Overall	13697	100

Source: COI-TIC survey 2006. Coverage: Private companies of 10 and more employees.
Lecture: 68.59% of the 13 697 COI companies remained unchanged, corresponding of 9 395 companies.

3.2 Hygie administrative database

The Hygie database describes career and sick leaves episodes for individuals insured under the French general social security system (Ben Halima et al., 2018). It relies on a random sample of 538 870 non-farm employees working in the private sector and aged 22 to 70 years in 2005 who have contributed at least once to the general pension scheme during their lifetime. It combines two administrative data files.

The first one, the French National Pension Fund administrative file (*Caisse nationale d'assurance vieillesse*, CNAV, covering the private sector) contains a wide range of variables on workers' status in the labour market and on the characteristics of their employing firms from 2005 to 2008. Individuals are followed along their career path from the time when they entered the labour market.

The second one is produced by the French Statutory Health Insurance Fund (*Caisse nationale d'assurance maladie des travailleurs salariés,* CNAMTS). It contains precise information on workers' sickness absence for health reasons and also provides information on medical consumption. Contrary to most data sources that only give the annual number of sick days, this file provides individualised data

[2] Corresponding to about one standard deviation of the continuous scale indexes.

with detailed description of each sick-leave spell and particularly the start and end dates (Ben Halima et al., 2018).

Hygie is organised with several files. We will use two of them. The first one (BENEF) is cross sectional. It features individual characteristics such as gender, age, last known occupation and employing firm, age upon entering the labour market. The second one (CAREER) is a panel that traces careers registered for the need of pension calculation since the date of entry on the labour market. For instance, it gives employment spells, wages, employer identification number, validated quarterly periods contributions to the general social security scheme (related with employment; unemployment; long-term sickness absence, maternity, and work-related accidents), retirement date.

As we want to use a difference in difference method to identify the health impact of organisational changes, we need a health indicator that we can follow up before, during and after the period of changes implemented by the companies that have responded to the COI-TIC survey. The only such health indicator available in the CAREER file is the indication that a quarterly period during which the individual was on long-term sickness absence has been validated for pension calculation. This long-term sickness absence may be linked to significant disabling event like a serious work injury, an occupational disease, a depression or a pregnancy. We do not know the precise duration of the sickness absence. Employees validate a quarterly period as a qualifying period in sick-leave when they receive sickness benefit over sixty consecutive days within a maximum spell of 4 quarters per calendar year. We thus have annual information about long sickness absence and injury leave before, during and after the companies responding to the COI-TIC survey have implemented organisational changes.

3.3 Sample and descriptive statistics

Our goal is to assess the consequences of organisational changes on long-term sickness absence for employees who experienced the period when changes were implemented in the company. Thus, we select in Hygie individuals who were working in the companies that responded to the COI-TIC survey between 2003 and 2005. This selection leads to a sample of 477 250 observations describing the career path of 26 321 individuals employed across the whole private sector. They are working in 12 366 COI-TIC respondent companies, corresponding to a matching rate of 90%. This sample is representative of non-farm employees from private sector companies with 10 employees and more.

Table 2: Sequence of presence in the same company between 2003 and 2005, by type of change

Year of presence in the company over 2003-2005	All sample		Type of organisational changes			
	N	%	No significant change	ICT changes only	Management changes only	ICT and management changes
Entrants	4 323	16.42	61.79	18.32**	10.62	9.27*
Exiting	5 960	22.64	61.88	20.40	8.98***	8.74
Mobile	1 418	5.39	63.19*	20.88	7.26***	8.67
Continuous presence	**14 620**	**55.55**	**60.70**	**19.99**	**10.88**	**8.43**

Sources: COI-TIC survey matched with Hygie data. Coverage: Employees from private sector companies with 10 employees and more.
Note: Entrants: individuals present in a COI-TIC company in 2004 and 2005 or in 2005, Exiting: individuals present in a COI-TIC company in 2003 only or in 2003 and 2004, Mobile: individuals present in a COI-TIC company in 2004 only or in 2003 and 2005. In colums (4) to (7), we compute the frequency differences tests between entrants, exiting or mobile employees and employees with continuous presence: ***significant at 1%, ** significant at 5%, * significant at 10%.

Because we want to be sure that these employees have experienced the changes implemented by companies between 2003 and 2005, we select those who have had a continuous presence in the company

during these three years. They represent 55,6% of the initial sample of employees. In table 2, we compare the distribution of changes in this sub-sample as well as in the subsamples of individuals who have entered the company (Entrants), exited (Exiting) it or done both (Mobile) during the change period. Individuals with continuous presence work in companies that are slightly more prone to changes in one dimension only than entrants, exiting or mobile employees. Hence we do not observe a higher renewal of the workforce during the time period when changes are implemented and our focus on continuous presence does not lead to neglect the health consequences of such a phenomenon.

Table 3: Descriptive statistics about stable employees in inert and changing firms

Variables	No significant changes (%)	Significant ICT changes only (%)	Significant management changes only (%)	Significant ICT and management changes (%)
Occurrence of long sickness absence and injury leave in 2000-2002	5.12	4.95	5.24	5.04
Occurrence of long sickness absence and injury leave in 2003-2005	6.52	5.75**	5.78**	7.01
Occurrence of long sickness absence and injury leave in 2006-2008	6.75	6.47	5.75**	8.05***
Female	32.37	34.72**	30.01*	35.96**
Hired in 2003	10.77	10.71	11.13	9.74
Chronic disease before 2003	4.80	4.17	4.03	4.38
Ratio of long term absence before 2003	0.94	0.96	0.91	0.93
Annual wage upon entry in the labour market				
- Quartile 1	25.69	24.12*	23.46*	21.83***
- Quartile 2	25.22	23.91	23.77	25.57
- Quartile 3	24.63	24.97	26.79*	26.46
- Quartile 4	24.46	26.99***	25.97	26.14
Age classes in 2005				
- [18-35 years old]	28.83	30.04	31.82**	29.63
- [36-45 years old]	32.85	33.05	33.27	35.96**
- [46-55 years old]	29.70	29.11	26.67**	27.03*
- [56-65 years old]	8.62	7.80	8.24	7.39
Occupations				
- Managers and professionals	22.92	24.60*	27.23***	22.24
- Technicians and associate professionals	15.22	18.10***	16.16	17.45**
- Clerical, services and sales workers	12.59	14.78***	10.51**	13.31
- Blue collar workers	36.83	32.57***	35.35	38.64
- Unknown	12.44	9.96***	10.75*	8.36***
Firms' size				
- [10-19]	6.09	4.24***	4.40***	3.49***
- [20-49]	8.35	5.58***	3.21***	3.57***
- [50,249]	21.46	18.41***	18.81**	18.59**
- [250,499]	18.11	18.47	21.26***	20.05*
- More than 500	45.99	53.30***	52.33***	54.30***
Number of employees	8 875	2 923	1 590	1 232

Sources: COI-TIC survey matched with Hygie data. Coverage: Employees with at least three years of seniority in 2005 from private sector companies with 10 employees and more.
Note: In colums (2) to (5), we compute mean or frequency differences tests between employees in changing firms and employees in firms with no significant changes: ***significant at 1%, ** significant at 5%, * significant at 10%.

Table 3 presents descriptive statistics for employees within changing and inert companies. First, we report the evolution of our health indicator, the probability of occurrence of long-term sickness absence. The different variables that we will use as controls in the econometric estimations are split into three categories. First, the demographic covariates include age classes, gender, annual wage upon entry in the labour market, and occupation. Second, two variables measure the health status before the experimental period: the proportion of career years before 2003 with at least a quarter in sick leave since the entry in the labour market and a variable identifying whether the employee suffered from a chronic disease registered before 2003. Third the firm characteristics are described by industry dummies (10 industries) and size classes (5 groups).

The results of the mean or frequency differences tests between employees within changing and inert companies are also reported in table 3. Before the organisational changes, there are no significant differences in terms of average long-term absence frequencies between inert companies (5.12%) and changing ones. On the other hand, during the period of implementation of the changes (2003-2005), the frequencies of long-term sick leave are on average significantly lower for employees belonging to companies that have introduced ICTs only (5.75%) or management changes only (5.78%) compared to inert companies (6.52%). Finally, in the three years following those changes, these absences become significantly more frequent in companies that have made changes in both dimensions (8.05%) and less frequent in those that have introduced only management changes (5.75%).

3.4 Econometric Model

We develop a difference in difference approach (DiD) with an exact matching method where we compare long term sickness absence of employees in changing and inert firms before and after the changes period. Identifying the causal effect of changes requires controlling for any systematic shocks to the health outcomes (work accidents, occupational disease, stress…) of employees in changing firms that are correlated with, but not due to, organisational changes.

The exact matching method proposed by Iacus et al. (2011), called *Coarsened Exact Matching* is based on the idea of assigning matching weights that reflect differences in observable characteristics between the control group and the treated group. Hence we breakdown our samples of changing and inert firms according to gender, age (four categories), annual wage upon entry in the labour market (four categories), chronic disease before 2003, and the ratio of long term sick absence before 2003. The coarsened exact matching algorithm provides a very high rate of matching between treated and control individuals, superior to 90%. We then compute the average treatment effect for the treated using a classic difference in differences estimator.

The treated group is formed by employees who experienced the implementation of organisational changes in their employing firm between 2003 and 2005. It includes 5 745 employees of which 2 923 experienced ICT changes only, 1 590 management changes only and 1 232 joint ICT and management changes. This population is matched to a control group of 8 875 employees in firms where no changes have been made and whose observable characteristics, regardless of the occurrence of a change, are identical.

As changes develop over time, we implement our DiD approach using three-time windows: the three years before the changes took place (2000-2002), the three-years during which changes took place (2003-2005) and the three years after the changes (2006-2008). We run two different comparisons: after versus before and during versus before. The first comparison is straightforward. As we cannot date precisely the changes, we can be certain of their full implementation on the after changes window only.

Moreover, health consequences, both positive and negative could need some time to develop. We run the second comparison because it is likely that some disruption happens during the time period when the changes are implemented, raising physical and psychological occupational risks. Indeed, if the changes are not carefully planned, uncertainty, conflicts, violence and disequilibrium between constraints and resources are expected to reach momentum during the period when the changes materialise in the information and production systems.

To capture any trend in the long term sickness absence of changing firms, we first include in the econometric model the period effect ($time = during\ or\ time = after$). Second, change dummies (ICT for ICT changes and MC for management changes) control for the time-invariant characteristics of the treatment groups. Finally, we include firm-by-period effects, to control for changes over time for the treatment groups. We estimate the model in a linear probability framework for ease of interpretation and because we are not trying to predict future likelihood of long term sickness absence:

$$S_{it} = \alpha + \beta\ Time\ (During\ or\ after)_{it} + \gamma_1\ Treated\ (ICT\ only)_{it} + \gamma_2\ Treated\ (MC\ only)_{it} + \gamma_3\ Treated\ (ICT\ and\ MC)_{it} + \delta_1(Time\ \times ICT\ only\ )_{it} + \delta_2(Time \times MC\ only\ )_{it} + \delta_3(Time \times ICT\ and\ MC)_{it} + \varepsilon\ X_{it} + \lambda\ Y_{it} + u_{it}$$

Coefficients $\delta_1, \delta_2, \delta_3$ identify the difference in difference estimators of the causal effects of the various types of organisational changes on long sickness absence.

The vector of covariates contains individual observable characteristics X_{it} (gender, age category, the quartiles of the distribution wages upon entry in the labour market, the occupational dummies, ratio of long term absence before 2003 , the dummy for chronic disease before 2003) and firm characteristics Y_{it} (industries and firm size classes).

Our literature review showed that employees' work experience with organisational change depended on position in the work organisation, which is likely to vary with gender (Eriksen et al., 2016) and age (Bellettini, G., & Ottaviano, 2005). Studies in epidemiology give further empirical evidence of gender and age differences in exposure to physical and occupational risks as well as health related behaviours (Malard et al., 2015; Niedhammer et al., 2000, 2018, 2020)-. We thus investigate the heterogeneity of our results by splitting the sample by gender and age category (over or under 45 years old).

4. Results

4.1 Consequences of organisational changes on long-term sick leave

We present in Table 4 below our estimates of the average impact of organisational changes on long-term sickness absence, in the three-year period following their implementation. We can compare the differential impacts for employees in the three treated groups (exposed to ICT changes only, to management changes only and to ICT and management changes) with employees in the control group (no exposition to significant organisational change). Each successive column after the basic specification (1) includes controls, beginning with individual worker covariates (2) and adding firm covariates (3). Then, Column 4 reports the estimates further controlling for heterogeneous effects between types of jobs with a set of industry-occupation dummies. Finally, the specifications estimated in columns 3 and 4 are repeated in columns 5 and 6 respectively for a subsample of matched employees between the control group and the treated group using *coarsened exact matching*.

The results for the full sample indicate that ICT changes only have no association with variations in long-term sick leaves. However, management changes only are associated with statistically significant reductions in the likelihood of long-term sickness absences and injury leaves by about 1.1 percentage point (pp), or about 21%. Finally, when the firm jointly adopted both new ICTs and management tools, reversed impacts on the workforce health are observed, with the likelihood of long-term sickness absence increasing significantly by 1,3 pp or more than 25%.

The size of the effects is stable whatever the nature of the changes and the chosen specification (see columns 1 to 4). This invariance to new controls indicates that the variability in organisational changes between firms is not related to the worker and employer observable characteristics. Furthermore, the estimated causal impacts of the adoption of new tools and practices remain almost unchanged when we use exact matching to create comparable treated and control groups (see columns 5 and 6).

The rationale for using DiD estimator with exact matching would be that the common trends assumption necessary for the validity of the DiD estimator may be only valid for a subsample of the global population. In fact, constructing matched treatment and control groups insures that all individuals share similar values for the matching variables. Hence, it is more likely that the common trends assumption holds within the subgroups characterised by the matching variables.

Table 4: Effects of significant organisational changes on long-term sickness absence and injury leave, difference between 2006-2008 (after) and 2000-2002 (before)

	(1)	(2)	(3)	(4)	(5)	(6)
Significant ICT changes only	-0.001	-0.001	-0.002	-0.001	-0.002	-0.001
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Significant management changes only	-0.011**	-0.011**	-0.011**	-0.011**	-0.011**	-0.011**
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
ICT and management changes	0.014**	0.013**	0.013**	0.013**	0.012**	0.012**
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
R^2	0.001	0.031	0.031	0.032	0.030	0.031
N	85,408	85,408	85,408	85,408	81,402	81,402
Demographic covariates		Y	Y	Y	Y	Y
Firm covariates			Y	Y	Y	Y
industry-occupation dummies				Y		Y
Coarsened exact matching					Y	Y

Sources: COI-TIC survey matched with Hygie data.
Coverage: Employees with at least three years of seniority in 2005 from private sector companies with 10 employees and more
Note: The demographic covariates include four age dummies ([18-35], [36-45], [46-55], [56-65]), a female dummy, four dummies for the quartiles of the distribution of the wage upon entry in the labour market and five occupational dummies. Finally, two variables measure the health situation of the respondent before 2003: ratio of long term absence and existence of a chronic disease. The firm covariates include 10 industry and 6 firm size dummies.
∗∗∗ Significant at 1%, ∗∗ Significant at 5%, ∗ Significant at 10%.

To control for the validity of the common trends assumption, we have performed a supplementary regression where each group effect is interacted with a linear time index and test if all the coefficients of the group-specific linear trends are jointly null. The results of our Fisher test confirm the validity of the common trends assumption[3].

These initial results illustrate a strong heterogeneity in the consequences of forms of organisational changes on serious health conditions. First of all, it is interesting to note that during the period under

[3] These results are available upon request from the authors

review, figures from the COI-TIC survey showed that the most frequent pattern of change was ICT changes only (see table 1). These changes do not seem to have a negative impact on the health of employees, which leads us not to rule out the hypothesis of a shared benefit between employees and companies provided that an improvement in overall productive efficiency is also observed. Moreover, management changes alone appear to be protective of health, which again appears beneficial for companies since Bigi et al. (2018) have found that these forms of change in the French private sector help maintain employees' involvement. This protective effect of management changes alone on the health of employees echoes the findings by Euzenat and Mortezapouraghdam (2016). It may be due to the fact that within the managerial practices included in our index are present advanced quality management systems that may improve workplace safety and lower risks of occupational injuries.

The issue of deteriorating workforce health seems to be more topical when companies choose cumulative changes in ICT and management tools. One of the possible explanations lies in the disorders generated by the multiplicity of transformations in the work of employees. The cumulative changes represent a greater shock on the work organisation and would prevent employees from deploying health-preserving strategies because of an increase in the four threats that we have identified in our literature review: uncertainty, conflict, violence and disequilibrium between constraints and resources. There are fewer hazards when the company makes a change in one dimension only because both the management board and the employees have better control over it. This explanation is consistent with Karasek's (2008) theory, which links long-term disease-generating stress among the workforce to the disorder generated by new demands at work and the inability of individuals to exert their control and implement coping strategies.

Table 5: Effects of significant organisational change on long-term sickness absence and injury leave, difference between 2003-2005 (during) and 2000-2002 (before)

	(1)	(2)	(3)	(4)	(5)	(6)
Significant ICT changes only	-0.006	-0.006	-0.006	-0.006	-0.007*	-0.007*
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Significant management changes only	-0.009*	-0.009*	-0.009*	-0.009*	-0.009*	-0.009*
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
ICT and management changes	0.006	0.006	0.005	0.005	0.000	0.000
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
R^2	0.001	0.037	0.038	0.039	0.035	0.036
N	86,918	86,918	86,918	86,918	82,751	82,751
Demographic covariates		Y	Y	Y	Y	Y
Firm covariates			Y	Y	Y	Y
industry-occupation dummies				Y		Y
Coarsened exact matching					Y	Y

Sources: COI-TIC survey matched with Hygie data.
Coverage: Employees with at least three years of seniority in 2005 from private sector companies with 10 employees and more
See note on covariates and significance of the tests under table 4.

This result illustrates the potential contradiction between the firm's efficiency objectives and the unsustainable nature of the changes for part of the workforce. While the literature on productive complementarities and synergetic effects in the adoption of new practices and tools highlights the fact that the return associated with change is higher when the two families of changes are combined, the result obtained here questions this return from a workforce well-being perspective.

As we said before, organisational changes implemented in the period 2003 to 2005 may develop over time. Nevertheless, they are also likely to change immediately an employee's work environment. Unlike

a policy type of treatment that modifies the rules overnight, the treatment and its effects may be confused. Hence, we also implement our DiD approach by comparing the period during which the changes were implemented with the period before the changes.

The results reported in table 5 show that the effects identified for the whole sample in the three years following the changes do not materialise immediately during the period of their implementation. Thus, while there is a decrease in the frequency of long-term sickness absence following management changes alone during the period of change (-0.9 pp.), the deleterious effects of cumulative changes do not seem to be felt in the short term. The deleterious influence on health after the period of changes could be an example of a deferred version of the "too much of a good thing effect" (Pierce and Aguinis, 2013). Finally, it is only when the sample is restricted using coarsened exact matching that ICT changes alone have a weakly significant but protective effect against serious health impairments.

4.2 *Heterogeneity according to gender and age*

Among individual covariates, gender and age groups have large and significant effects on long-term sickness absence, female and older workers being more likely to suffer such episodes. Hence, we performed the same set of estimations for gender and age groups (under or over 45 years old).

Table 6: Effects of significant organisational change on long-term sickness absence and injury leave, by gender

	Difference between periods after and before changes (2006-2008 vs 2000-2002)		Difference between periods during and before changes (2003-2005 vs 2000-2002)	
	Female workers	Male workers	Female workers	Male workers
Significant ICT changes only	0.004	-0.003	-0.006	-0.007
	(0.009)	(0.004)	(0.009)	(0.004)
Significant management changes only	-0.016	-0.009*	-0.026**	-0.002
	(0.012)	(0.005)	(0.012)	(0.005)
ICT and management changes	0.009	0.016**	0.023*	-0.005
	(0.012)	(0.006)	(0.012)	(0.006)
R^2	0.025	0.036	0.031	0.040
N	28,018	57,390	28,500	58,418

Sources: COI-TIC survey matched with Hygie data.
Coverage: Employees with at least three years of seniority in 2005 from private sector companies with 10 employees and more. See note on covariates and significance of the tests under table 4. DiD estimates are reported controlling for individual, firm covariates and industry-occupation dummies.

Table 6 reports the impact of organisational changes on male and female workers' health respectively after and during the changes[4]. They display existence of gender differences in the timing and magnitude of impacts related to organisational transformations. Women are mainly impacted during the period when the changes are implemented and the impacts (both positive and negative) are stronger for them. On the other hand, men are impacted after the period of changes.

Several possible explanations for these findings can be put forward. First, we verified that gender differences are not related to maternity leaves because younger women are not more absent than older ones. Another explanation may arise from issues of voice and power relations in organisations. Since men have more say on average than women in the workplace, they are abler to influence the content of

[4] DiD estimators for the most complete set of covariates are reported in this table. The complete set of results are available in the appendix (tables A2 to A5).

changes and adapt them to their needs (Green, 2012; Greenan and Walkowiak, 2005; Howell et al. 2015). This effect is partly associated with the fact that women's social capital is less valued than men's because they face problems of legitimacy and also with part-time work, which reduces employees' opportunities for self-expression. Moreover, in the elected employee representation bodies in France, women represented 32% of the elected officials in 2001, while they accounted for more than 40% of the electors (Amossé et Lemoigne, 2004). Thirdly, the health behaviours of men and women differ: when faced with comparable health problems, women appear to be more concerned about their health and consult their physicians earlier and more frequently (Courtenay, 2000). In addition, studies on gender differences in diseases in France show that men are twice as affected by cardiovascular diseases but 40% less by anxiety and depression (Polton, 2016). It is possible that women treat more rapidly their stress-related syndromes, whereas they are more likely to degenerate over time into cardiovascular diseases for male employees.

Table 7: Effects of significant organisational change on long-term sickness absence and injury leave, by age group

	Difference between periods after and before changes (2006-2008 vs 2000-2002)		Difference between periods during and before changes (2003-2005 vs 2000-2002)	
	Younger workers	Older workers	Younger workers	Older workers
Significant ICT changes only	0.002	-0.007	-0.006	-0.007
	(0.005)	(0.007)	(0.005)	(0.007)
Significant management changes only	-0.009	-0.012	-0.013**	0.001
	(0.006)	(0.010)	(0.006)	(0.009)
ICT and management changes	0.019***	0.002	0.004	0.009
	(0.007)	(0.011)	(0.007)	(0.011)
R^2	0.035	0.043	0.039	0.059
N	59,283	26,125	59,639	27,279

Sources: COI-TIC survey matched with Hygie data.
Coverage: Employees with at least three years of seniority in 2005 from private sector companies with 10 employees and more.
See note on covariates and significance of the tests under table 4. DiD estimates are reported controlling for individual, firm covariates and industry-occupation dummies.

Finally, Table 7 above reports the impact of organisational changes on younger and older workers' health respectively after and during the period of changes[5]. The signs of the estimated effects for these subgroups are essentially similar to the ones for the whole population. However, a significant influence of organisational changes was found only on younger workers' health. Hence, during the period of changes, there is a decrease in the frequency of long-term sickness absence following management changes alone but only for the younger workers (-1.3 pp). In the three years following the changes (2006-2008), a significant increase in the likelihood of long-term sickness absence (1.9 pp) of younger workers is associated with simultaneous implementation of new ICT and management tools. Somehow, the older workers appear to be more protected against changes in both dimensions. This result may seem surprising at first considering that younger workers are more likely to possess the up to date technological skills to deal with innovative tools and practices. However, older workers possess greater experience of past organisational changes during their career and therefore are abler to efficiently adapt. It is also likely that, when they remain in the company during the period of change, their position in the social network of the organisation is stronger than that of younger workers.

[5] DiD estimators for the most complete set of covariates are reported in this table. The complete set of results are available in the appendix (tables A6 to A9).

4.3. *Discussion*

The results reported in the tables 4, 6 and 7 are averaged over the three years after the changes took place. It is interesting to consider when these effects happen. For instance, does the protective or deleterious influence of organisational changes happen the first year and eventually wears off or does it appear later? Hence, we also investigated dynamic responses in long-term sickness absence to adoption of ICT and management practices. Table 8 below reports these estimates.

Table 8: Dynamic effects of significant organisational change on long-term sickness absence and injury leave between 2006-2008 (after) and 2000-2002 (before), by gender and age group

Difference between periods after and before changes (2006-2008 vs 2000-2002)						
		All worker	Female Workers	Male Workers	Younger workers	Older workers
Significant ICT changes only	2006	-0.002 (0.006)	-0.001 (0.012)	-0.003 (0.006)	-0.001 (0.007)	-0.006 (0.010)
	2007	0.001 (0.006)	0.016 (0.012)	-0.006 (0.006)	0.007 (0.007)	-0.012 (0.011)
	2008	-0.002 (0.006)	-0.003 (0.012)	-0.001 (0.006)	-0.002 (0.007)	-0.003 (0.011)
Significant management changes only	2006	-0.011 (0.007)	-0,023 (0,016)	-0.006 (0.008)	-0.012 (0.009)	-0.006 (0.014)
	2007	-0.013* (0.007)	-0,019 (0,017)	-0.010 (0.008)	-0.007 (0.009)	-0.023* (0.014)
	2008	-0.009 (0.007)	-0,005 (0,017)	-0.011 (0.008)	-0.009 (0.009)	-0.008 (0.015)
ICT and management changes	2006	0.019** (0.008)	0,021 (0,017)	0.017* (0.009)	0.025** (0.010)	0.006 (0.015)
	2007	0.006 (0.008)	-0,004 (0,017)	0.011 (0.009)	0.007 (0.010)	0.006 (0.016)
	2008	0.016* (0.008)	0,009 (0,017)	0.019** (0.009)	0.024** (0.010)	-0.006 (0.016)
R^2		0,032	0,025	0,036	0,035	0,043
N		85408	28018	57390	59283	26125

Sources: COI-TIC survey matched with Hygie data.
Coverage: Employees with at least three years of seniority in 2005 from private sector companies with 10 employees and more. See note on covariates and significance of the tests under table 4. DiD estimates are reported controlling for individual, firm covariates and industry-occupation dummies. The time reference is the whole period before changes (2000-2002)

Estimates in the whole sample for one to three years after the change period systematically keep the same sign as the estimated average effect, though it is not always statistically significant. What remains unchanged is the total lack of impact of isolated ICT changes on long-term sickness absences. This result is consistent regardless of the gender or age category of workers. Management changes alone appear health protective after their implementation period but are significant in 2007 only for the whole sample. Once again, the estimated annual effects are systematically negative for all groups by gender and age, with only one significant effect in 2007 for older workers. It should be noted that the protective dimension of managerial change decreases over time for women, confirming the immediate effect measured on average for women during the period of change. Finally, the detrimental impact of combined changes prevails significantly over two of the three years after the changes. As seen above, these effects are particularly significant for male and younger workers.

We also considered the effects of changes depending on whether workers were present in the firm before the period of change or recruited in 2003 at the beginning of the change period. Indeed, our theory

section suggests that organisational innovations may not affect these two groups of workers in the same way.

First, newly hired and senior employees might value the benefits of organisational change differently. Longer tenured employees in the company certainly prefer gradual innovation, by improving existing production processes. Newly hired employees do not have specific work habits in the firm and therefore are more likely to get used easily and with less reluctance to the most significant innovations. Second, the uncertainty associated with changes may not be perceived in the same way for the employees most recently hired by the firm. They have not yet created work routines that innovations may challenge and they are less likely to suffer the disequilibrium between old resources and new demands. As a result, they are more flexible and less stressed. In addition, new entrants are often younger and more employable in the labour market, feeling a reduced sense of job insecurity.

However, when changes generate conflicts between employees, violent behaviour can lead to deleterious health effects. The most junior workers may lack of social network support to endure conflict in the company and miss voice power to discuss the way in which changes are implemented. Finally, in case of economic downturn, they are under the threat of the *last hired first fired* rule.

The group of employees hired in 2003, at the beginning of the period of changes, consists of 8811 individuals, or approximately 10.3% of employees in the treatment and control groups. Among these junior employees, women are over-represented (36.4% versus 32.8% in the overall sample), as are younger workers (83% versus 69.4%). The size of the junior group is not sufficiently large to perform a difference in difference estimation within this sample. We chose to estimate a difference-in-difference-in-differences (DDD) type model:

$$\begin{aligned} S_{it} = \; & \alpha + \beta\, Time_{\,it} + \gamma_1\, Treated_{\,it} + \gamma_2\, Hired_{it} + \delta_1 Time_{\,it} \times Treated_{\,it} \\ & + \delta_2\, Time_{\,it} \times Hired_{it} + \delta_3\, Treated_{\,it} \times Hired_{it} \\ & + \delta_4\, Time_{\,it} \times Hired_{it} \times Treated_{\,it} + \varepsilon\, X_{it} + \lambda\, Y_{it} + u_{it} \end{aligned}$$

where *Time* =1 for the period after changes (2006-2008), *Treated =1* for each type of change ICT only, MC only and ICT and MC and *Hired =1* for each individual hired in 2003. The coefficients of interest are δ_1, the double difference estimator of the effect of changes on long-term sickness absence for the employees hired before 2003 and δ_4 the triple difference estimator of the supplementary effect for the employees hired in 2003.

The first three rows of Table 9 show that the impacts of the various forms of change on the long-term absence of employees hired before 2003 are consistent with the findings for the overall workforce. This is primarily due to their high proportion in the workforce: 89.7%. However, the estimations reported in the last three rows, highlight a very different, if not inverted, pattern for junior employees: ICT changes only are significantly deleterious while changes in the management dimension alone do not reduce long-term sickness absences; furthermore, the sign of the impact of joint changes in ICT and management dimensions depends on individual characteristics.

There is clearly a gendered effect of the impacts of changes on new hires. All forms of change are more deleterious for women hired in 2003 compared with more senior women in changing firms and with women hired in 2003 in inert firms, and the effect is particularly large for cumulative changes. The small sample size and the lack of information prevents us to further analyse the sources of this difference, but it is possible that these new female recruits have neither the bargaining power nor the social supports in the firm to safeguard against the tensions associated with the changes. On the contrary, male senior employees suffer more from the joint changes compared to their newly hired colleagues. It seems that

the former had created and leaned on protective routines that become outdated and did not succeed in finding new coping strategies. As a result of a combination of changes, the most experienced workers seem more vulnerable.

Newly recruited women are younger, yet there is also a deleterious effect on health for younger recruits in companies that have innovated in the ICT dimension only. This would signal an additional source of vulnerability for young and female recruits in the use of emerging technologies.

Table 9: Effects of significant organisational change on long-term sickness absence and injury leave, difference between 2006-2008 (after) and 2000-2002 (before), for individuals hired before and during organisational changes.

	All workers	Female workers	Male workers	Younger workers	Older Workers
Double difference estimator for individuals hired before the period of changes					
Significant ICT changes only	-0.004	-0.002	-0.005	-0.002	-0.010
	(0.004)	(0.009)	(0.005)	(0.005)	(0.008)
Significant management changes only	-0.011**	-0.022*	-0.007	-0.010	-0.013
	(0.006)	(0.012)	(0.006)	(0.007)	(0.010)
ICT and management changes	0.012**	-0.003	0.020***	0.017**	0.003
	(0.006)	(0.013)	(0.007)	(0.007)	(0.011)
Triple difference estimator for individuals hired during the period of changes					
Hired during significant ICT changes only	0.030**	0.059**	0.016	0.027*	0.034
	(0.013)	(0.028)	(0.015)	(0.015)	(0.030)
Hired during significant management changes only	0.004	0.068*	-0.019	0.001	0.016
	(0.017)	(0.039)	(0.017)	(0.018)	(0.045)
Hired during ICT and management changes	0.014	0.130***	-0.046**	0.017	-0.013
	(0.020)	(0.042)	(0.021)	(0.022)	(0.051)
R^2	0,032	0,026	0,036	0,035	0.043
N	85408	28018	57390	59283	26125

Sources: COI-TIC survey matched with Hygie data.
Coverage: Employees with at least six years of seniority in 2006 from private sector companies with 10 employees and more. See note on covariates and significance of the tests under table 4. Triple difference estimates are reported controlling for individual, firm covariates and industry-occupation dummies.

Altogether, these findings show a specific health fragility for individuals recruited in periods of change. These are also supported by the triple difference estimation of health effects observed during the period of change for new recruits the results of which are reported in Table A10 in the Appendix. Indeed, we find that for new female or younger recruits, changes in management tools only no longer have a protective effect but also generate a deleterious effect for female employees during the period when the changes happen.

Conclusion

This article is an innovative contribution to the evaluation of organisational changes by analysing their impact on long-term sickness absence. Rather than focusing on the efficiency gains generated by organisational changes, the analysis targets possible health impairments for the workforce.

To do so, we use an original database resulting from the matching between the Hygie panel administrative database and a large and representative company survey on organisational change and computerisation (COI-TIC). The first describes both career and sick leaves episodes of a sample of people insured under the general social security system, while the second describes the changes implemented in their company over three years through changes in the uses of ICTs and management tools.

Using a difference in difference estimator with coarse matching, we compare long-term sickness absences of employees before, during and after significant changes were implemented in their companies with that of a control group of employees in inert firms.

We find in all regressions the same core results: management changes alone reduce long-term sickness absence when joint adoption of new ICT and management tools increases risks for employees' health. Hence it appears that if companies want to obtain the best return on their modernising strategies, they need to pay particular attention to their employees when changes impact simultaneously several dimensions of the work environment.

There are however gendered differences in the timing and strength of impacts as women are mainly impacted during the period when changes are implemented and impacts are stronger while men are impacted after the period of change. Also, older employees seem protected against the serious health consequences of any form of changes.

Another important result is that employees recruited at the beginning of the change period seem to be particularly vulnerable in terms of health impairments. In particular, the long-term absences of newly recruited young women increase with the changes in management tools only during their implementation period and with all the dimensions of the changes, in particular their joint adoption, after their implementation. These results point to the need to better understand the process of organisational change (its complexity, intensity, dynamics), the gendered construction of health behaviours as well as that of technology and management tools uses in devising occupational safety and health policies targeted at evolving work environments.

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Statistical Appendix

Table A1: Diffusion of ICTs and management tools in productive units.

	% of companies		Baseline
	2003	2006	Metric
ICTs			
Website	61.2	73.3	0.065
Local Area Network	61.3	66.7	0.071
Software or firmware for HRM	63.4	65.3	0.064
Intranet	47.9	57.8	0.084
Software or firmware for R&D	47.4	49.8	0.041
Tools for data analysis	39.5	47.1	0.065
Electronic data interchange system (EDI)	36.2	45.8	0.060
Databases for HRM	34.5	38.5	0.082
Extranet	25.0	30.2	0.081
ERP	26.6	29.6	0.059
Databases for R&D	26.1	28.8	0.075
Tools for interfacing databases	21.1	28.6	0.067
Tools for automated data archiving or research	21.4	27.4	0.087
Tools for collaborative work (groupware)	15.1	21.0	0.099
Tools for process modelling (workflow)	8.8	12.7	0.111
Management tools			
Contractual commitment to provide a product or a service within a limited time	66.1	68.5	0.087
Long-term relationships with suppliers	51.7	54.7	0.076
Requirement for suppliers to meet tight deadline	51.5	53.5	0.090
Quality certifications	36.3	41.4	0.092
Satisfaction surveys of customers	32.9	38.7	0.079
Teams or autonomous work groups	30.7	33.8	0.089
Tools for tracing goods or services	28.3	32.9	0.075
Tools for labelling goods or services	28.3	30.8	0.093
Call or contact centres	25.5	28.0	0.080
Just in time production	22.9	24.3	0.071
Methods of problem solving (FMECA)	17.3	20.9	0.114
Customer relationship management (CRM)	9.7	14.3	0.072
Environmental or ethical certification	9.7	12.9	0.107

Data source: COI-TIC survey, 2006.
Coverage: Companies of 10 or more employees in the private sector. Weighted data. Note: The baseline metric comes from Multiple Correspondence Analyses applied in 2006 to each family of tools.

Table A2: Effects of significant organisational change on long-term sickness absence of female employees (difference between 2006-2008 and 2000-2002 periods)

	(1)	(2)	(3)	(4)	(5)	(6)
Significant ICT changes only	0.003	0.003	0.002	-0.002	0.004	0.001
	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)
Significant management changes only	-0.015	-0.016	-0.016	-0.021*	-0.016	-0.020*
	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)
ICT and managements changes	0.010	0.010	0.008	0.004	0.009	0.005
	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)
R^2	0.001	0.022	0.023	0.023	0.025	0.025
N	28,018	28,018	28,018	26,880	28,018	26,880
Demographic covariates		Y	Y	Y	Y	Y
Firm covariates			Y	Y	Y	Y
Industry-occupation dummies					Y	Y
Coarsened exact matching				Y		Y

Sources: COI-TIC survey matched with Hygie.
Coverage: Female employees with at least three years of seniority in 2005 from private sector companies with 10 employees and more.

Table A3: Effects of significant organisational change on long-term sickness absence leave of male employees (difference between 2006-2008 and 2000-2002 periods)

	(1)	(2)	(3)	(4)	(5)	(6)
Significant ICT changes only	-0.003	-0.003	-0.003	-0.001	-0.003	-0.001
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Significant management changes only	-0.010*	-0.010*	-0.010*	-0.007	-0.009*	-0.007
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
ICT and managements changes	0.016**	0.016**	0.015**	0.016**	0.016**	0.016**
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
R^2	0.002	0.034	0.035	0.031	0.036	0.032
N	57,390	57,390	57,390	54,521	57,390	54,521
Demographic covariates		Y	Y	Y	Y	Y
Firm covariates			Y	Y	Y	Y
Industry-occupation dummies					Y	Y
Coarsened exact matching				Y		Y

Sources: COI-TIC survey matched with Hygie.
Coverage: Male employees with at least three years of seniority in 2005 from private sector companies with 10 employees and more.

Table A4: Effects of significant organisational change on long-term sickness absence of female employees (difference between 2003-2005 and 2000-2002 periods)

	(1)	(2)	(3)	(4)	(5)	(6)
Significant ICT changes only	-0.006	-0.006	-0.006	-0.009	-0.006	-0.010
	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)
Significant management changes only	-0.025**	-0.024**	-0.025**	-0.028**	-0.026**	-0.029**
	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)
ICT and management changes	0.023*	0.023*	0.022*	0.013	0.023*	0.013
	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)
R^2	0.002	0.027	0.028	0.027	0.031	0.030
N	28,500	28,500	28,500	27,265	28,500	27,265
Demographic covariates		Y	Y	Y	Y	Y
Firm covariates			Y	Y	Y	Y
Industry-occupation dummies					Y	Y
Coarsened exact matching				Y		Y

Sources: COI-TIC survey matched with Hygie.
Coverage: Female employees with at least three years of seniority in 2005 from private sector companies with 10 employees and more.

Table A5: Effects of significant organisational change on long-term sickness absence of male employees (difference between 2003-2005 and 2000-2002 periods)

	(1)	(2)	(3)	(4)	(5)	(6)
Significant ICT changes only	-0.006	-0.006	-0.006	-0.006	-0.007	-0.006
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Significant management changes only	-0.002	-0.002	-0.002	-0.001	-0.002	-0.001
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
ICT and management changes	-0.004	-0.004	-0.005	-0.007	-0.005	-0.007
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
R^2	0.001	0.037	0.038	0.034	0.040	0.036
N	58,418	58,418	58,418	55,485	58,418	55,485
Demographic covariates		Y	Y	Y	Y	Y
Firm covariates			Y	Y	Y	Y
Industry-occupation dummies					Y	Y
Coarsened exact matching				Y		Y

Sources: COI-TIC survey matched with Hygie.
Coverage: Male employees with at least three years of seniority in 2005 from private sector companies with 10 employees and more.

Table A6: Effects of significant organisational change on long-term sickness absence of younger employees (difference between 2006-2008 and 2000-2002 periods)

	(1)	(2)	(3)	(4)	(5)	(6)
Significant ICT changes only	0.001	0.001	0.000	-0.001	0.002	0.001
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Significant management changes only	-0.010	-0.010	-0.010	-0.011*	-0.009	-0.011*
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
ICT and management changes	0.019***	0.018***	0.018**	0.017**	0.019***	0.018***
	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
R^2	0.001	0.033	0.033	0.032	0.035	0.033
N	59,283	59,283	59,283	58,339	59,283	58,339
Demographic covariates		Y	Y	Y	Y	Y
Firm covariates			Y	Y	Y	Y
Industry-occupation dummies					Y	Y
Coarsened exact matching				Y		Y

Sources: COI-TIC survey matched with Hygie.
Coverage: Employees aged between 18 and 45 with at least three years of seniority in 2005 from private sector companies with 10 employees and more

Table A7: Effects of significant organisational change on long-term sickness absence of older employees (difference between 2006-2008 and 2000-2002 periods)

	(1)	(2)	(3)	(4)	(5)	(6)
Significant ICT changes only	-0.006	-0.006	-0.006	-0.006	-0.007	-0.007
	(0.008)	(0.007)	(0.007)	(0.008)	(0.007)	(0.008)
Significant management changes only	-0.013	-0.013	-0.012	-0.009	-0.012	-0.009
	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)
ICT and management changes	0.002	0.002	0.002	-0.002	0.002	-0.002
	(0.011)	(0.011)	(0.011)	(0.012)	(0.011)	(0.012)
R^2	0.003	0.041	0.041	0.045	0.043	0.048
N	26,125	26,125	26,125	23,062	26,125	23,062
Demographic covariates		Y	Y	Y	Y	Y
Firm covariates			Y	Y	Y	Y
Industry-occupation dummies					Y	Y
Coarsened exact matching				Y		Y

Sources: COI-TIC survey matched with Hygie.
Coverage: Employees aged between 46 and 65 with at least three years of seniority in 2005 from private sector companies with 10 employees and more

Table A8: Effects of significant organisational change on long-term sickness absence of younger employees (difference between 2003-2005 and 2000-2002 periods)

	(1)	(2)	(3)	(4)	(5)	(6)
Significant ICT changes only	-0.005	-0.005	-0.005	-0.007	-0.006	-0.007
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Significant management changes only	-0.012**	-0.012**	-0.012**	-0.014**	-0.013**	-0.015**
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
ICT and management changes	0.005	0.005	0.004	0.001	0.004	0.001
	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
R^2	0.001	0.036	0.037	0.034	0.039	0.036
N	59,639	59,639	59,639	58,722	59,639	58,722
Demographic covariates		Y	Y	Y	Y	Y
Firm covariates			Y	Y	Y	Y
Industry-occupation dummies					Y	Y
Coarsened exact matching				Y		Y

Sources: COI-TIC survey matched with Hygie.
Coverage: Employees aged between 18 and 45 with at least three years of seniority in 2005 from private sector companies with 10 employees and more

Table A9: Effects of significant organisational change on long-term sickness absence of older employees (difference between 2003-2005 and 2000-2002 periods)

	(1)	(2)	(3)	(4)	(5)	(6)
Significant ICT changes only	-0.008	-0.007	-0.007	-0.008	-0.007	-0.008
	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
Significant management changes only	0.001	0.001	0.001	0.004	0.001	0.004
	(0.010)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)
ICT and management changes	0.009	0.009	0.009	-0.001	0.009	-0.001
	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)
R^2	0.003	0.041	0.041	0.045	0.059	0.061
N	26,125	26,125	26,125	23,062	27,279	24,028
Demographic covariates		Y	Y	Y	Y	Y
Firm covariates			Y	Y	Y	Y
Industry-occupation dummies					Y	Y
Coarsened exact matching				Y		Y

Sources: COI-TIC survey matched with Hygie.
Coverage: Employees aged between 46 and 65 with at least three years of seniority in 2005 from private sector companies with 10 employees and more

Table A 10: Effects of significant organisational change on long-term sickness absence and injury leave, difference between 2003-2005 (during) and 2000-2002 (before), for individuals hired before and during organizational changes.

	All workers	Female workers	Male workers	Young workers	Old Workers
	Double difference estimator for individuals hired before the period of changes				
Significant ICT changes only	-0.007	-0.009	-0.006	-0.007	-0.006
	(0.004)	(0.009)	(0.004)	(0.005)	(0.007)
Significant management changes only	-0.010*	-0.035***	0.001	-0.015**	0.001
	(0.005)	(0.012)	(0.005)	(0.006)	(0.010)
ICT and management changes	0.008	0.024*	-0.002	0.006	0.013
	(0.006)	(0.013)	(0.006)	(0.007)	(0.011)
	Triple difference estimator for individuals hired during the period of changes				
Hired during significant ICT changes only	0.008	0.026	-0.003	0.013	-0.018
	(0.013)	(0.028)	(0.014)	(0.015)	(0.029)
Hired during significant management changes only	0.013	0.098**	-0.022	0.016	0.012
	(0.017)	(0.039)	(0.017)	(0.018)	(0.042)
Hired during ICT and management changes	-0.024	-0.014	-0.025	-0.016	-0.078
	(0.019)	(0.042)	(0.020)	(0.021)	(0.049)
R^2	0,039	0,031	0,04	0,039	0.059
N	86918	28500	58418	59639	27279

Sources: COI-TIC survey matched with Hygie data.
Coverage: Employees with at least six years of seniority in 2006 from private sector companies with 10 employees and more. See notes on covariates under table 4. Triple difference estimates are reported controlling for individual, firm covariates and industry-occupation dummies.

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