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journal homepage: www.elsevier.com/locate/jeboGetting sick for profit? The impact of cumulative ICT and management changes on long term sickness absence[☆]Mohamed Ali Ben Halima^{a,b,c,e,*}, Nathalie Greenan^{a,b,c}, Joseph Lanfranchi^{a,d}^a *Employment and Labour Research Centre (CNAM – CEET), Immeuble Le Descartes 1, 29, promenade Michel Simon – 93166 Noisy Le Grand Cedex, France*^b *Interdisciplinary research laboratory in action-oriented sciences (CNAM – LIRSA), Paris, France*^c *Research federation for public policies theories and evaluation (TEPP), 5 boulevard Descartes - 77454 Marne-la-Vallée, France*^d *Laboratory of Mathematical Economics and Applied Microeconomics (LEMMA - University of Paris II), 4 rue Blaise Desgoffe 75006 Paris, France*^e *Laboratory of Modelling, Epidemiology & Surveillance of Health (CNAM – MESuRS), 292, rue Saint Martin, 75003 Paris, France*

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ABSTRACT

This article evaluates the impact of cumulative ICT and management changes on long-term sickness absences. We use a unique dataset matching a company-level survey on computerisation and organisational change with an administrative file allowing us to track health issues amongst the working population. We implement a difference-in-difference approach using two time windows: a three-year period after changes have occurred and another period corresponding to the period of implementation of changes. We identify three treatments according to the sets of tools implemented by firms and reflecting different types and degrees of organisational changes: Information and Communication technology (ICT) changes only, management changes only, and cumulative ICT and management changes.

We find the following core result: cumulative changes in ICT and management tools increase occupational risks and detrimentally affect employees' health, while management changes only reduce long-term sickness absences. However, there are gendered and occupational differences in the timing and strength of these impacts. First, when firms implement cumulative ICT and management changes, health impairments start for women during the change phase, whereas for men, they appear only afterwards. Second, while we observe the protective effects of managerial changes on their own for both genders during the change phase, these effects do not persist afterwards for women. Third, managers and professionals are protected in the change phase against the serious health consequences of cumulative ICT and management changes, and they benefit from the reduction in risks associated with management changes alone.

Hence, cumulative ICT and management changes, which are likely to yield the highest returns for firms in the presence of productive complementarities, are also associated with greater health damage. Furthermore, this social cost of organisational change is only partially borne by the firms responsible for it. We show that the most vulnerable employees are more likely to be mobile (voluntarily or involuntarily) after the implementation of changes.

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These results point to the need for public authorities assessing occupational safety and health policies to better understand the process of organisational change (its complexity, intensity, dynamics) and the social construction of health behaviours and of the uses of technology and management tools.

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1. Introduction

Standard models assume that when employers implement change, their main objective is to improve the production process to maximise profits rather than to increase employee well-being (Bloom and Van Reenen, 2007; Böckerman et al., 2012; Freeman and Kleiner, 2005). However, as they are increasingly required to meet corporate social responsibility and sustainable growth, it becomes more difficult for employers to adopt Friedman's (1970) simplistic view that 'the social responsibility of the firm is to increase its profits'. If employers do not optimise organisational change from the point of view of employee well-being, what are the likely implications for occupational health?

A closer look at available statistics shows that the orders of magnitude are potentially very high. The International Labour Organisation has estimated that the economic losses caused by occupational accidents and diseases amount to 4% of GDP. The European Commission estimates that in 2016, 1.6 working days were lost for each European worker due to work-related accidents and health problems. In France, daily benefits for accidents at work and occupational diseases have seen their highest increase in 2018. The average cost of an accident at work is €3800 or €24,000 for cumulative trauma disorders, and a day's absence due to an accident at work costs around €300 (L'Assurance Maladie - risques professionnels, 2019).

This article aims to provide empirical evidence of the relationship between organisational change and occupational health issues. To do so, it focuses on changes that primarily respond to a logic of increased economic performance. The economic and management literature on organisational change highlights the existence of different forms of productive complementarities that function as powerful incentives to jointly implement a range of changes (Brynjolsson and Milgrom, 2013). In this literature, an important distinction is made between technological changes and new concepts or management models. The former are driven by technological revolutions. We are currently in the midst of the fifth technological revolution, marked by the spread of Information and Communication Technologies (ICTs) and digital tools (Perez, 2010). Carried by these technological breakthroughs, management concepts aim to take advantage of the new opportunities they create by transforming the way work is done (Bodrožić and Adler, 2018). Therefore, we will focus on the changes that occur through the implementation of ICT on the one hand (e.g. website or enterprise resource planning) and management tools (e.g. just in time production or quality certification) on the other. A first contribution of our research is therefore to consider different intensities and levels of complexity of organisational changes by distinguishing between changes in a single type of tools (concerning only ICTs or only management tools) and cumulative changes in both ICT and management tools.

How are these changes expected to affect occupational health? First, there are questions about whether changes are going to be beneficial or harmful to health. If they enrich employees' working lives, this is likely to improve their mental and physical health. If they are merely effort biased (Green et al., 2021), they may lead to a higher incidence of illness, injury and stress. Second, even when organisational changes improve employees' control over their work, the process of introducing them can generate uncertainties leading to increased anxiety and stress. Third, are the potential health effects related to the characteristics of the changes, particularly to their intensity and complexity? An additional question concerns the duration and scale of this effect: its persistence within an organisation is debatable since those most affected might choose to leave while others are likely to adapt over time (Kahneman et al., 1999). Hence, it is important to follow the consequences of the changes over time not only from the point of view of the organisation but also from that of the workers who have been exposed. A second contribution of this research is to carefully analyse and measure, with a difference-in-difference approach and following employees through time, the impact of only ICT, only management or cumulative ICT and management changes on long-term sickness absences, a likely correlate of substantial health alterations such as work-related injuries, depression or musculoskeletal disorders.

We use a French nationally representative survey at the employer level on computerisation and organisational changes (the COI-TIC survey) linked with an administrative health insurance panel (the Hygie database). Employers provide detailed information about their adoption of a large set of ICT and management tools over a three-year time period (2003–2005). In the Hygie panel, which features a large and representative sample of employees attached to the surveyed sample of employers, we follow up in time over nine years (2000–2008)—three years before and three years after the change period. Our difference-in-difference approach combined with coarsened exact matching compares employees who faced organisational changes in their workplace (treatment group) with employees in inert firms (control group) using three subperiods: before the occurrence of changes (2000 to 2002), during their implementation (2003 to 2005) and after they took place (2006 to 2008). We break down our sample of employees according to gender and age, occupation, health status before change and date of recruitment, as these characteristics may influence access to resources, vested interest in changes, coping strategies and health-related behaviours.

We find the following core result: cumulative changes in ICT and management tools increase occupational risks and detrimentally affect employees' health, while management changes alone reduce long-term sickness absences. There are, however, gendered and occupational differences in the timing and strength of these impacts. Hence, cumulative ICT and management changes, which are likely to yield the highest returns for firms in the presence of productive complementarities, are also associated with greater health damage. We further show by observing workers along their career that this social cost of organisational change is only partially borne by the firms that are responsible for it.

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 and the measurement frame. Section 4 presents the econometric methodology. Section 5 reports baseline results and heterogeneity in the effects. Section 6 conducts robustness checks and discussion, and Section 7 concludes.

2. Organisational changes and occupational health issues

We first present the theoretical literature on synergetic effects in organisational changes on which we base our measurement framework. Then, we identify in the literature four main channels through which organisational change may touch upon occupational health issues. Finally, we survey the thin empirical literature that assesses the health consequences of organisational changes.

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, joint and coordinated adoption (Brynjolfsson and Milgrom, 2013) of a set of technologies and management tools may be the decision that yields the highest return. This is because when 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 organisations. 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 achieve 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; Ben-Ner et al., 2012; Laursen and Foss, 2003).

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

If productive complementarities play a role in the discrete choices made by firms in the fields of technology and organisation, we expect that firms will coordinate their adoption of ICT and management tools, with a preference for cumulative adoption since it is more likely to yield higher returns. However, the time frame of the sequence of decisions remains 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. Channels through which organisational changes touch upon health

Although the productive complementarity approach focuses on economic performance, when it takes into account the views of other stakeholders, particularly employees, the assumption of a win-win outcome, where both employers and employees benefit from cumulative change, generally prevails (Bloom and Van Reenen, 2006). For example, while automation

replaces tasks that involve repetition and physical strain with machines, management tools that optimise business processes increase their reliability, entailing fewer physical hazards and more safety for workers. There are also some mechanisms through which changes are designed to be beneficial to employee wellbeing. This is the case in particular when the adoption of the new tool is aligned with the needs of the employees (Demerouti, 2022): if they have been involved in the choice and the design of the use of the new tool; if it implies a direct improvement of working conditions like less tiring position of less handling of heavy loads; if it is empowering and contributes to enhanced skills and career opportunities etc.

However, other research findings in economics, industrial relations, sociology, and social psychology question the likelihood of this alignment. A first argument is that organisational change is likely to destabilise the smooth functioning of the organisation and to put its survival at risk. Theories from 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. Firms that introduce a major organisational change thus run a greater risk of failure (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 (see Dughera, 2020, for instance).

Furthermore, following March (1962), organisations can also be considered political coalitions. Hence, unresolved conflict and divergent interests are part of the everyday life of an organisation, generating complex coordination problems around production, the outcome of which is necessarily uncertain (Marengo, 2020). This conflict is likely to gain momentum in the face of organisational change. Indeed, in management studies and interdisciplinary social sciences, terms such as paradox, tensions, contradictions and dialectics have become prominent (Putman et al., 2016), and most of the time they are 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 to allow for both changes and continuity. Furthermore, Sewell et al. (2012) and Mazmanian et al. (2013) stress the duality of specific digital technologies (electronic performance monitoring and mobile email devices, respectively) 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 thus seems 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 to 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 (Caroli and Godard, 2016; Cottini and Ghinetti, 2018; Reichert and Tauchmann, 2017; 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 over how these may impact the future of their workplace or of their job.

Second, real firms are unlikely to feature homogeneous personal interests congruent with organisational interests. Godard (2004) identifies potential conflicts between organisational and employee interests in High Performance Work Systems (HPWSs). Ways of optimising organisational performance may clash with employee preferences and hamper the supportive nature of the work environment. Spurred by innovation, conflicts may also arise between interest groups within the organisation. Innovation directed at the core tasks of employees and with repercussions for the whole organisation may rally a majority against it, while more localised innovation will limit the size of the potential conflict. Bellettini and Ottaviano (2005) explore the assumption that age groups may have diverging vested interests 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 Baillien et al. (2019), organisational change may favour the perception of psychological contract breach in the workforce, which in turn could lead employees to direct bullying or hostile behaviours towards other members of the organisation. Interestingly, analysing the consequences of workplace bullying on sickness absences, Eriksen et al. (2016) find a gendered effect: only women’s long-term sickness absences increase, while men are more likely to leave the labour force in response to their poorer career prospects after exposure to bullying.

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 be lacking, and new methods are not fully mastered in the learning phase of the change process. In his stress disequilibrium model, Karasek (1979) addresses the adverse health impact of a disequilibrium between job demands and job resources. Such a disequilibrium generates both physical hazards (Niedhammer et al., 2018) and psychosocial risks (Bonde, 2008; Cottini and Lucifora, 2013). Karasek (2008) revisits this model with a 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. Empirical assessments of the health consequences of organisational changes

In a time when the feeling of an accelerated change is widely experienced, there exist both barriers to dissemination of new organisational designs and practices and scope for ill-designed ICT and management changes. It is thus useful to review the results of empirical studies that have analysed the relationship between organisational change and the 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, HPWSs and new ICT systems.

Bamberger et al. (2012) survey the impact of organisational change on mental health and argue that while exposure to such change is often cited as harmful, few studies have been published to support this assumption. In the following, we discard studies that focus on downsizing or financial restructuring. Pollard (2001) follows a sample of employees before and after a large-scale workplace reorganisation and 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 measured over the two years prior to their survey with employee-level measures of job-related anxiety and job satisfaction: changes in organisational practices, technological changes and changes of any kind. They find that only changes in organisational practices are associated with lower average employee well-being and job satisfaction, with technological changes showing no apparent interference with occupational health. Collective bargaining agreement coverage and recognised unions for pay bargaining at the workplace seem, however, to mitigate the negative impact of changes in organisational practices 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 considers the institutional context of the organisation. In private organisations, both ICT and management changes increase employees' use of skills, albeit at a decreasing rate, while management changes alone are associated with the development or at least the preservation of work involvement. Finally, Euzénat 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 such as failure mode and effects analysis and quality certification could improve physical safety in workplaces.

As summarised by Kalmi and Kauhanen (2008), the empirical results on the impact of HPWS on employee outcomes have been somewhat conflicting with the view arguing for mutual gains and another, more critical, perspective. The mutual gain literature emphasises the increase in discretion and the resulting monetary and psychological benefits, while the critical view argues that the limited gains accruing to employees are outweighed by increased stress, work intensification and work injuries (Askenazy, 2001; Brenner et al., 2004; Fairris and Brenner, 2001). Böckerman et al. (2012), however, do not find any robust evidence that HPWSs impact sickness absences when they instrument their measure, and Bryson et al. (2012) find that exposed employees have more short absence spells but higher subjective well-being and fewer accidents than comparable non-exposed employees. However, these studies most of the time consider the use of HPWSs, not their implementation phase. Taking a dialectical view based on the findings of the management literature, Han et al. (2020) elaborate several propositions regarding why HPWSs have negative effects from the perspective of employees and when these effects occur. Interestingly, one of their propositions is that there is an inverted U-shape relationship between how extensively HPWSs are implemented and the reaction of employees. The authors label this a “too much of a good thing effect”. They also stress that time is crucial because when HPWSs are reinforced, health impacts do not immediately occur. This calls for longitudinal studies considering the implementation phase, when the most harmful impacts may occur, and a measurement frame for HPWSs that allows to investigate their 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 amply studied the positive outcomes of ICT use, negative employee outcomes are considered less often and have not yet been systematically reviewed. They provide a meta-analysis of 52 studies covering negative outcomes such as workload, stress, anxiety and burnout. It supports the link between the various forms that ICT use has taken through time and negative outcomes. ICT uses are related to working conditions characterised by workload, role ambiguity and role conflict, which increase 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 amongst ICT users. This is surprising because autonomy usually tends to mitigate negative employee outcomes.

Both positive and negative employee outcomes from organisational changes, use of HPWSs and ICT uses are found in the literature; rationalising these diverging results calls for further research on the forms of change processes that contribute to securing a balance in the working life of exposed employees.

3. Data

The objective of this study is to evaluate the impact of changes in uses of ICT and management tools, and in particular of cumulative ICT and management changes on long-term sickness absences. We use a French representative survey at the employer level on computerisation and organisational changes (the COI-TIC survey) linked with an administrative health insurance panel (the Hygie database). 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 followed individuals

Table 1
Organisational changes within firms.

| 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 | 13,697 | 100 |

Source: COI-TIC survey 2006.

Coverage: Private firms with 10 and more employees.

Reading note: 68.59% of the 13,697 COI firms remained unchanged, corresponding of 9395 firms.

over 2000–2008 with precise measures of health issues: sick leave, work accidents, occupational diseases, and medical consumption.

3.1. Organisational change and computerisation (COI-TIC survey)

The COI-TIC survey was carried out by the National Institute of Statistics and Economic Studies (INSEE), while the scientific guidance for its development took place at the *Centre d'Etudes de l'Emploi* (CEE). A random sample of private firms in the non-agricultural market sector with 10 employees or more was selected. The data were stratified by industry and firm size with a comprehensive layer beyond 500 employees. The survey received a high response rate of 85%, leading to a sample of 13,687 firms (Greenan et al., 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. The underlying logic of the COI-TIC survey is to hypothesise that the implementation of new tools reflects the intentions of business leaders to change productive organisations. Thus, the questionnaire grounds the measurement of organisational changes in the dynamics of diffusion of these new tools. The questions are based on a thorough review of professional journals and on field work. This preparatory phase led to the selection of a list of tools in the middle of their diffusion phase in the population of firms at the time of the survey, for instance, quality certifications or enterprise resource planning. In addition, the number of tools adopted in a given period reflects the intensity of the organisational changes implemented.

We distinguish two families of tools because they affect two complementary systems within organisations: management tools that support the production system and ICTs that equip the information system. We select a list of tools that impact the work situations of employees: 13 management tools and 15 ICT tools (Appendix Table A1). Following the method developed in previous studies, we use multiple correspondence analysis (MCA) to obtain a continuous scale index measuring the extent of the changes in each system¹ (Greenan and Mairesse, 2006; Bigi et al., 2018). The higher the firm value on this scale, the more intense are its organisational changes in the given system. However, in our empirical analysis, we restrict ourselves to binary measures of the changes. We consider a firm to have experienced a significant change in each dimension when the value of the change index is superior to 0.20.² We code firms with index values below this threshold as having experienced marginal changes or no change.

The combination of these two binary variables leads to the identification of four cases of companies implementing (1) ICT changes only, (2) management changes only, (3) both ICT and management changes or (4) no change or marginal changes.

Table 1 shows the breakdown of the population of firms by type of organisational changes implemented over 2003–2005. We find that 68.6% of firms remained inert, 17.2% implemented ICT changes only, 7.4% implemented management changes only and 6.8% implemented ICT and management changes jointly. The fact that firms' implementing only ICT changes is the more frequent form of organisational change points to the fact that the period under coverage corresponded to the midst

¹ Because no single tool or type of equipment can represent by itself the heterogeneity in observed management strategies, we have to find a way to capture the diversity in the uses of modernising tools by firms. We therefore apply MCA to produce a synthesis of the information contained in the large frequency table with dummies recording whether the firm uses each of the listed tools. The MCA generates quantitative scores, called dimensions, which are the linear combinations of these dummy variables that maximise the average correlation between them. We run two MCAs describing, respectively the use of ICTs and management tools in 2006. We retain the first dimension of each MCA, which captures the largest share of the total inertia in the data (respectively, 28% and 26%). On this first dimension, organisations that use several tools jointly are opposed to organisations that do not use them or that use only a few of them. The most advanced tools that are at the beginning of their diffusion curve in the population of organisations obtain a higher score in the composite index. Thus, a composite index with a higher value indicates that the organisation uses a broader set of more advanced ICT or management tools. We report the vector of coefficients in the linear combination of dummy variables along the first dimension of each MCA in the last column of Table A1 in Appendix 1, labelled "baseline metric". We use this to compute composite indices describing the use by firms of each family of tools in 2003. The differences between the 2006 and 2003 composite indices measures changes in ICT and management tools.

² This corresponds to approximately one standard deviation of the continuous scale indices. Indeed, the ICT change index has a mean of 0.11 and a standard deviation of 0.22; the management changes index has a mean of 0.06 and a standard deviation of 0.18.

of the web 2.0 revolution with the development of mobile ICT, social networks and new generations of software equipment for firms such as groupware, enterprise resource planning and workflow software (Greenan et al., 2010).

Table A2 in Appendix 1 examines these four groups. It gives the share of firms that introduced each tool between 2003 and 2006 within each of our organisational change categories. The tools are ranked according to the frequency of their introduction within each system in the population of firms undergoing change (Column 3). The table confirms that inert firms adopted none or a marginal number of tools, with the highest frequency for ICT and, in particular, websites and EDI. Firms with only ICT changes adopted a marginal number of management tools (most frequently CRM), and each ICT tool is adopted more frequently in this group than in the overall population of changing firms. We observe the same pattern, but reversed, for firms that introduced only management changes, with the diffusion of ICT being low, just slightly above that of inert firms. Firms that introduced ICT and management changes clearly have a higher intensity of changes because they implemented both types of changes at the same time and because they implemented more tools than firms that introduced changes in one system only. While the changes are higher on the intensity scale, we do not observe a very different configuration of tools within each system for these firms. Indeed, the Spearman rank correlations of the shares of firms adopting each tool between firms with changes in one system only and firms with cumulative changes are positive; the correlation is stronger and more significant for information system tools (0.96, $p < 0.001$) than for production system tools (0.50, $p < 0.0819$). The only noticeable difference is that the share of quality certifications and of environmental or ethical certification are slightly more frequent in the firms that implemented management changes only (respectively 36.71% and 19.18%) than in the firms with cumulative ICT and management changes (respectively 33.08% and 15.87%). Quality certification is also the most widespread management tool in the group of firms with management changes only.

3.2. Hygie administrative database

The Hygie database describes career and sick leave 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 nonfarm 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 absences for health reasons and provides information on medical consumption. In contrast to most data sources, which provide only the annual number of sick days, this file provides individualised data with a 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, and age upon entering the labour market. The second one (CAREER) is a panel that traces careers registered to calculate pensions from the date of entry into the labour market. For instance, it gives employment spells, wages, employer identification numbers, validated quarterly period contributions to the general social security scheme (related to employment, unemployment, long-term sickness absences, maternity leaves, and work-related accidents), and retirement dates.

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 firms that 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 sick leave has been validated for pension calculation. Such long-term sickness absences may be linked to significant disabling events such as a serious work injury, an occupational disease, depression or pregnancy. Indeed, survey evidence in France has shown that the top three reasons for long-term sick leave are an accident or trauma (28%), musculoskeletal disorders (19%) and psychological disorders (14%) while for shorter episodes the main cause is ordinary sickness. Furthermore, according to interviewed employees, 45% of sick leaves lasting more than one month are work-related.³ These long-term sick leaves accounted for 12% of all sick leaves in 2020, with a very high average duration of 94 days of absence. Finally, more than 60% of firms experienced at least one long-term sick leave during the survey year.

Considering the likely channels by which organisational changes may deteriorate workers' health (Section 2.2), studying long-term sickness episodes appears appropriate from both the employer's and society's points of view. It is nevertheless unfortunate that short-term sick leaves before 2003 are not also recorded in our database, as Böckerman et al. (2012) find opposite relations between the use of HPWSs and short and long absence spells.

³ These figures come from the *Baromètre annuel Absentéisme* designed by Malakoff-Humanis covering a representative sample of 3000 private sector employees in 2022. The presentation of the results of this survey is available at <https://newsroom.malakoffhumanis.com/actualites/malakoff-humanis-presenteles-resultats-2020-de-son-barometre-annuel-absenteisme-maladie-545f-63a59.html>.

Table 2A
Sequence of presence in the same company over 2003–2005, 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 |
| Entering | 4236 | 16.16 | 57.60 | 19.07** | 12.35 | 10.98* |
| Exiting | 5959 | 22.73 | 58.05 | 21.09 | 10.72*** | 10.14 |
| Mobile | 1402 | 5.35 | 58.28 | 22.11 | 9.77*** | 9.84 |
| Continuous presence | 14,620 | 55.77 | 56.24 | 20.67 | 13.00 | 10.09 |

Sources: COI-TIC survey matched with Hygie data.

Coverage: Employees from private sector firms with 10 employees or more.

Note: Entering: 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 Columns (4) to (7), we compute the frequency difference tests between entering, exiting or mobile employees and employees with a continuous presence: *** significant at 1%, ** significant at 5%, * significant at 10%.

We do not know the precise duration of the sickness absence because of the nature of our administrative database. Employees validate a quarterly period as a qualifying period on sick leave when they receive sickness benefits over sixty consecutive days within a maximum spell of 4 quarters per calendar year. We thus have annual information about long sickness absences and injury leaves before, during and after the implementation of organisational changes by the firms responding to the COI-TIC survey.

3.3. Sample and descriptive statistics

Our goal is to assess the consequences of organisational changes for long-term sickness absences amongst employees who experienced the period when changes were implemented in the company. Our study sample is constructed in two steps. First, we select in Hygie the individuals with working information over the period 2000–2008. This selection leads to a sample of 477,250 individuals employed in the whole private sector. Second, matching of the COI-TIC survey with the Hygie database allows us to describe the career path of 26,321 individuals affiliated with a firm from the COI-TIC sample for at least a year from 2003 to 2005. These workers were employed in 12,366 COI-TIC firms, corresponding to 90% of the total number of firms in the COI-TIC sample. This sample is representative of non-farm employees from private sector firms with 10 employees or more. Because we want to be sure that these employees experienced the changes implemented by firms in 2003, 2004 or 2005, we select those with a continuous presence in the company during these three years. They represent 55.8% of the initial sample of employees.

In [Table 2A](#), we compare the distribution of changes in this subsample and in the subsamples of individuals who entered the company (Entering), exited (Exiting) it or did both (Mobile) during the change period. Hence, we are able to assess whether this sample selection is likely to create any bias coming from the fact that individuals with a continuous presence would work in firms slightly more or less prone to changes than entering, exiting or mobile employees. In fact, we do not observe a higher renewal of the workforce in changing firms during the period when changes were implemented, and our focus on continuous presence does not lead to neglect the health consequences of such a phenomenon.

Furthermore, in [Table 2B](#), we assess the extent to which excluding workers with a non-continuous presence from the overall sample during the change period could alter the structure of the workforce by type of organisational change. For example, the removal of non-continuous workers reduces the percentage of women in our sample but in a more or less similar way across the four categories of firms. It also reduces the percentage of young workers since they are more mobile, without biasing the impacts of the forms of change on the health of the workforce, since this percentage decreases in a comparable way in the four categories of firms. Finally, this observation of an almost identical change in the distribution of the workforce within change categories holds when we compare the distributions of occupations in the initial and research samples.

[Table 3](#) presents descriptive statistics for employees within changing and inert firms. First, we report the evolution of our health indicator, the probability of occurrence of a long-term sickness absence. We then split the different variables that we will use as controls in the econometric estimations into three categories. The demographic covariates include age classes in 2005, gender, annual wage upon entry into the labour market, and main occupation over the career. Two variables further measure the health status before the experimental period: the average number of long-term sickness episodes during the worker's career years before 2003 since his or her entry into the labour market and a binary indicator identifying whether the employee suffered from a chronic disease registered before 2003. The last variables control for two firm characteristics: industry (10 groups) and size (5 classes).

The results of the mean or frequency difference tests between employees within changing and inert firms are also reported in [Table 3](#). For the period before the organisational changes, there are no significant differences in terms of average long-term absence frequencies between inert firms (5.13%) 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 firms that introduced ICT changes only (5.64%) or management changes only (5.96%) than for those

Table 2B

Structure of the workforce in the research and original samples by type of change.

| | Type of organisational changes | | | | | | | |
|---|--------------------------------|--------|------------------|-------|-------------------------|-------|----------------------------|-------|
| | No significant change | | ICT changes only | | Management changes only | | ICT and management changes | |
| | Continuous | All | Continuous | All | Continuous | All | Continuous | All |
| Female | 32.31 | 34.79 | 34.91 | 36.63 | 29.84 | 31.92 | 35.86 | 40.79 |
| <i>Age classes in 2005</i> | | | | | | | | |
| [18–35 years old] | 28.79 | 39.98 | 29.75 | 40.87 | 31.74 | 39.95 | 29.76 | 41.57 |
| [36–45 years old] | 33.07 | 27.83 | 32.86 | 27.55 | 32.63 | 28.42 | 35.32 | 29.57 |
| [46–55 years old] | 29.59 | 22.22 | 29.32 | 21.72 | 27.89 | 22.26 | 26.78 | 20.51 |
| [56–65 years old] | 8.56 | 9.97 | 8.07 | 9.86 | 7.74 | 9.38 | 8.14 | 8.35 |
| <i>Occupations</i> | | | | | | | | |
| Managers and professionals | 22.44 | 22.69 | 24.95 | 25.64 | 27.89 | 27.32 | 22.44 | 23.83 |
| Technicians and associate professionals | 15.24 | 13.68 | 18.23 | 16.66 | 15.32 | 14.13 | 17.42 | 15.66 |
| Clerical, services and sales workers | 12.64 | 14.80 | 14.33 | 15.43 | 11.32 | 12.79 | 13.08 | 15.96 |
| Blue-collar workers | 37.16 | 31.15 | 32.03 | 26.22 | 35.84 | 31.42 | 37.56 | 30.43 |
| Unknown | 12.53 | 17.69 | 10.46 | 16.05 | 9.63 | 14.35 | 9.49 | 14.13 |
| Number of employees | 8 223 | 14 939 | 3 022 | 5 397 | 1 900 | 3 199 | 1 475 | 2 682 |

Sources: COI-TIC survey matched with Hygie data.

Coverage: Employees from private sector firms with 10 employees or more.

Note: In Columns (2) to (9), we compare the distributions of workers by gender, age category and occupation between the selected research sample (continuous) and the original sample (all).

in inert firms (6.57%). Finally, for the three years following those changes, these absences become significantly more frequent in firms that made changes in both dimensions (8.12%) and less frequent in those that introduced only management changes (6.02%).

Amongst the individual characteristics of the workforce, the share of women is higher in companies that experienced ICT changes, whether or not they were combined with managerial changes. In contrast, firms do not appear to have hired more workers at the beginning of the period of change, regardless of the nature of the change.

Similarly, while workers in changing firms appear to be in slightly better health on average before the changes, this difference is not significant. In terms of age, firms that adopted managerial changes have a younger workforce than other firms. These observable differences in individual characteristics across firms in different categories of organisational change may suggest a mechanism of voluntary selection into or out of the most innovative firms. We will present a matching strategy to control for selection based on observable variables in the empirical strategy section below.

Finally, with regard to the characteristics of firms, their use of different forms of change depends on their size and sectors of activity. Adoption of changes is more frequent in large firms with more than 250 employees, while certain service sectors (financial and real estate, business services) and industries (capital goods and food and beverage industries) have a more intense use of ICT and managerial changes, respectively. Such differences obviously influence the structure of occupations with, for example, more managers and professionals in changing firms.

4. Empirical strategy

4.1. Econometric model

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

The treated group is formed by employees who experienced the implementation of organisational changes in their employing firm over 2003–2005. It includes 6397 employees, of which 3022 experienced ICT changes only, 1900 management changes only and 1475 cumulative ICT and management changes. This population is compared to a control group of 8223 employees in firms where no changes were made and whose observable characteristics, regardless of the occurrence of a change, are identical.

We implement our DiD approach using three time windows capturing the development of the changes over time: 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 were implemented (2006–2008). We run two different comparisons: after versus before and during versus before. The first comparison is straightforward. As we cannot precisely date the implementation of the changes, we can be certain of their full implementation only in the after-changes window. Moreover, health consequences, both positive and negative, could take some time to develop. We run the second comparison because it is likely that some disruption happens during the 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

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 | 5.13 | 4.81 | 5.39 | 5.02 |
| Occurrence of long sickness absence and injury leave in 2003–2005 | 6.57 | 5.64*** | 5.96* | 6.87 |
| Occurrence of long sickness absence and injury leave in 2006–2008 | 6.74 | 6.29 | 6.02** | 8.12*** |
| Percentage of female workers | 32.31 | 34.9*** | 29.84** | 35.86** |
| Percentage of workers hired in 2003 | 10.73 | 10.75 | 10.37 | 10.98 |
| Occurrence of chronic disease before 2003 | 4.79 | 4.14 | 4.26 | 4.47 |
| Number of long-term absence episodes before 2003 | 0.95 | 0.94 | 0.91 | 0.91 |
| <i>Annual wage upon entry in the labour market</i> | | | | |
| -First quartile group | 25.74 | 24.55 | 22.89** | 22.58*** |
| -Second quartile group | 25.25 | 24.12 | 23.95 | 25.08 |
| -Third quartile group | 24.53 | 24.55 | 27.47** | 26.24 |
| -Fourth quartile group | 24.48 | 26.77** | 25.68 | 26.10 |
| <i>Age classes in 2005</i> | | | | |
| -[18–35 years old] | 28.79 | 29.75 | 31.74** | 29.76 |
| -[36–45 years old] | 33.07 | 32.86 | 33.63 | 35.32** |
| -[46–55 years old] | 29.59 | 29.32 | 27.89 | 26.78** |
| -[56–65 years old] | 8.56 | 8.07 | 7.74 | 8.14 |
| <i>Occupations</i> | | | | |
| -Managers and professionals | 22.44 | 24.95** | 27.89*** | 22.44 |
| -Technicians and associate professionals | 15.24 | 18.23*** | 15.32 | 17.42** |
| -Clerical, services and sales workers | 12.64 | 14.33** | 11.32 | 13.08 |
| -Blue-collar workers | 37.16 | 32.03*** | 35.84 | 37.56 |
| -Unknown | 12.53 | 10.46** | 9.63** | 9.49*** |
| <i>Firms' size</i> | | | | |
| -[10–19 employees] | 6.29 | 4.40*** | 4.10*** | 3.32*** |
| -[20–49 employees] | 8.62 | 5.29*** | 3.84*** | 3.86*** |
| -[50–249 employees] | 21.42 | 18.30*** | 20.53 | 18.10*** |
| -[250–499 employees] | 17.67 | 19.29* | 20.74** | 20.47** |
| -More than 500 employees | 46.01 | 52.71*** | 50.79*** | 54.24*** |
| <i>Industries</i> | | | | |
| -Consumer goods industry | 8.99 | 8.74 | 5.58*** | 10.31 |
| -Intermediary goods and energy | 26.58 | 19.26*** | 23.47** | 20.75*** |
| -Capital goods | 15.08 | 18.07*** | 29.79*** | 17.02** |
| -Trade | 14.13 | 9.89*** | 10.84*** | 13.36 |
| -Construction | 4.33 | 3.61** | 2.11*** | 3.32** |
| -Financial and real estate | 4.82 | 9.5*** | 5.32 | 6.92*** |
| -Food and beverage industry | 5.17 | 10.19*** | 7.74*** | 10.31*** |
| -Business services | 10.12 | 11.34** | 6.89*** | 9.42 |
| -Transportation and storage | 5.53 | 4.27** | 3.84** | 4.20** |
| -Unknown | 5.25 | 5.13 | 4.42 | 4.41 |
| Number of employees | 8223 | 3022 | 1900 | 1475 |

Sources: COI-TIC survey matched with Hygie data.

Coverage: Employees with at least three years of seniority in 2005 from private sector firms with 10 employees or more.

Note: In Columns (2) to (5), we compute mean or frequency difference tests between employees in changing firms and employees in firms with no significant changes: *** significant at 1%, ** significant at 5%, * significant at 10%.

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 absences of changing firms, we first include in the econometric model the period effect ($time = \textit{during}$ or $time = \textit{after}$). 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 both inert and changing firms. We estimate the model in a linear probability framework for ease of interpretation and because we are not trying to predict the future likelihood of long-term sickness absences:

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

The coefficients δ_1 , δ_2 , δ_3 identify the difference-in-difference estimators of the causal effects of the various types of organisational changes on long sickness absences.

The vector of covariates contains individual observable characteristics X_i (gender, age category, quartile groups of the distribution of wages upon entry into the labour market, occupational dummies, ratio of long-term absences before 2003,

dummy for chronic disease before 2003) and firm characteristics Y_{it} (industries and firm size classes). In order to better control for the type of job held during the period of change, we will also introduce into the model a set of interactions between the worker's occupation and the sector of activity of his or her firm.

Our literature review showed that employees' work experience with organisational change depended on their position in the work organisation, which is likely to vary with gender (Eriksen et al., 2016) and age (Bellettini and Ottaviano, 2005). Studies in epidemiology provide further empirical evidence of gender and age differences in exposure to physical and occupational risks and in health-related behaviours (Malard et al., 2015; Niedhammer et al., 2000, 2018, 2020). In addition, a strong link between occupations and health has been identified in a large collection of studies (see Fletcher et al., 2011, for example), which cannot be fully explained by employees' occupational choice based on their health (Ravesteijn et al., 2018). Finally, some job characteristics together with difficult working conditions may adversely affect the health of workers who are already in a fragile state, as shown in the study by de Wind, Boot et al. (2018). Thus, we investigate the heterogeneity in the effects by splitting the sample by gender, age category (over or under 45 years old), occupation (managers and professionals vs. lower-level occupations) and an indicator for health status before the organisational changes (occurrence of a long-term absence episode vs. no occurrence).

4.2. Selection issues

The question of identifying the causal effect of organisational change on workers' health is partly related to the possibility of selection of individuals into inert or changing firms. Therefore, the healthy-worker effect should be taken into account. Indeed, workers may have voluntarily chosen to be assigned to treatment, i.e., to changing firms, because they are originally more resistant to job-related ailments, which justifies their recruitment on the one hand and rationalises the firm's propensity to introduce organisational innovations that will be better endured by the workforce on the other hand.

In addition, other workforce characteristics may be correlated with both employment in changing organisations and health status. For example, workers' education level is likely to influence the evolution of work organisation (Caroli et al., 2001) and the returns to technological changes (Piva and Vivarelli, 2009) while also being positively related to their health status (see Böckerman and Maczulskij, 2016). Age is another labour force trait that affects workers' health but also their likelihood of employment in the event of technological or organisational innovations (see the study on French firms by Aubert et al., 2006).

To address this question of the random assignment of individuals to the treatment and control groups, we augment our classic DiD approach with an exact matching method. The exact matching method proposed by Iacus et al. (2011), called coarsened exact matching (CEM), 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 break down our samples of changing and inert firms by gender, age (four classes), annual wage upon entry into the labour market (four quartile groups) that may control for general education differences, and the average number of long-term sickness absence episodes before the organisational changes. The coarsened exact matching algorithm provides a very high rate of matching between treated and control individuals, superior to 90%. One valuable property of the CEM method is that it guarantees that the final imbalance between the matched control and treated groups cannot be worse than it was in the initial sample. Iacus et al. (2011) propose a multivariate imbalance measure \mathcal{L}_1 , a decrease in which after matching reflects an increase in the similarity of the distributions of the covariates in the control and treated groups.⁴ In addition, the CEM method ensures that our matched sample respects the common support hypothesis.

Individual dimensions unobservable in our data, such as workers' risk aversion or personality traits, may also influence their choice of employer. Nevertheless, we note here that several factors make it unlikely that workers make an informed choice when joining firms that later implement major changes. Indeed, these firms have no real interest in communicating with their competitors about the innovations to come. In addition, mobility barriers in the labour market may restrain the possibilities of voluntary adjustment on the part of the workforce. However, to assess the consequence of this possible unobservable selection, our analysis of heterogeneous effects below (Section 5.3) will measure the impacts of the changes for the group of individuals who joined the firms at the time of the changes' introduction in 2003.

5. Results

In this section, we will successively discuss the validity of the use of the DiD regression model, the average effects of the three treatments on the treated for our whole research sample and finally the heterogeneity in these impacts by workforce characteristics.

5.1. Pretreatment trends in long-term sickness absences in the treated and control groups

Estimating the treatment effect in DiD analysis requires us to make an assumption about the trends in the control and treatment groups in the absence of treatment. A parallel trend in the outcomes is assumed, which implies that in the

⁴ Table A3 in the appendix report the differences between inert and changing firms and the multivariate imbalance measure, both before and after matching.

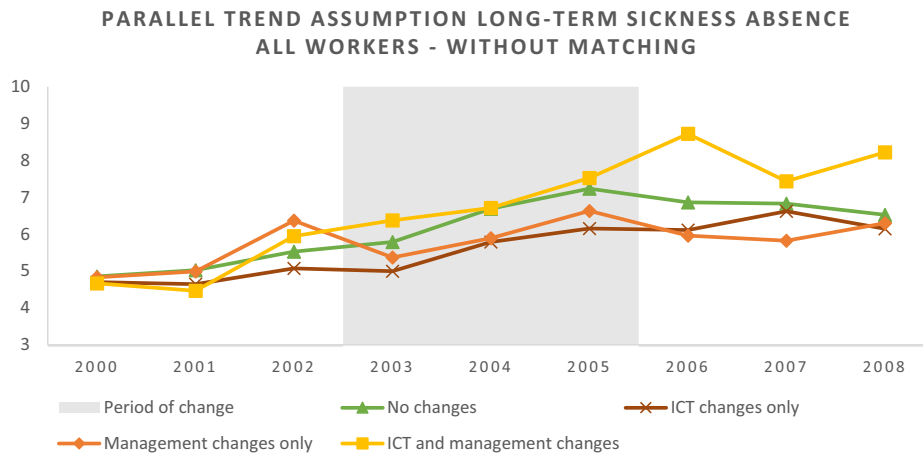


Fig. 1. Evolution of long-term sickness absences within the four groups of firms before matching.
 Notes: The Fisher common trend test checks the joint significance of all pretreatment effects obtained from the DiD estimates, controlling for individual and firm covariates and industry–occupation dummies. Null hypothesis: The pretreatment trends in long-term sickness absences are similar for the control and treated groups.
 Fisher Trend Test: $F(9, 86,834) = 1.29, P \text{ value} = 0.238$

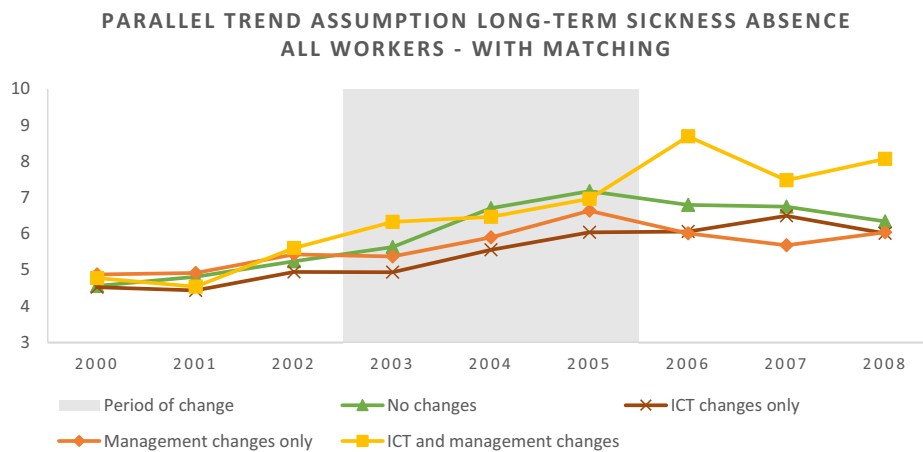


Fig. 2. Evolution of long-term sickness absences within the four groups of firms after matching.
 Notes: The Fisher common trend test checks the joint significance of all pretreatment effects obtained from the DiD estimates, controlling for individual and firm covariates and industry–occupation dummies. Null hypothesis: The pretreatment trends in long-term sickness absences are similar for the control and treated groups.
 Fisher Trend Test: $F(9, 83,018) = 1.05, P \text{ value} = 0.393$

absence of treatment, the trends in the performance variable would be similar for both the control and treated groups and time-invariant.⁵ Graphical evidence on the parallel trend assumption and the results of common trend tests are presented in Figs. 1 and 2 below, before and after matching, while the complete evolution of long-term sickness absences is reported in Tables A4 and A5 of Appendix 3 for the original and matched samples of workers.

Within the original sample, we note that the evolution of long-term sickness absences before the treatment period (2000–2002) for employees belonging to inert firms is similar to that observed for employees in firms with ICT changes only. Employees of firms adopting management changes only or cumulative ICT and management changes have a lower long-term absence incidence than employees in inert firms for the years 2000 and 2001 and a higher one for the year 2002 (5.95% and 6.37%, respectively, vs. 5.53%).

The rationale for using coarsened exact matching is that the common trends assumption necessary for the validity of the DiD estimator may be more valid for a subsample of the global population. In fact, constructing matched treatment and

⁵ The parallel trend hypothesis is tested over a time window of three years before and after the period when the changes took place. The choice of a three-year period is justified by the equality of this window with that of the period of the changes. This choice, which reduces the observation window of the period before the changes, imposes a constraint on the parallel trend test.

Table 4

Effects of significant organisational changes on long-term sickness absences and injury leaves, difference between 2006–2008 (after) and 2000–2002 (before).

| | (1) | (2) | (3) | (4) | (5) | (6) |
|-------------------------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|
| Significant ICT changes only | –0.001 (0.004) | –0.001 (0.004) | –0.002 (0.004) | –0.001 (0.004) | –0.003 (0.004) | –0.002 (0.004) |
| Significant management changes only | –0.010** (0.005) | –0.010** (0.005) | –0.010** (0.005) | –0.010** (0.005) | –0.011** (0.005) | –0.011** (0.005) |
| ICT and management changes | 0.015*** (0.005) | 0.015*** (0.005) | 0.014*** (0.005) | 0.015*** (0.005) | 0.012** (0.005) | 0.013** (0.005) |
| N | 85,408 | 85,408 | 85,408 | 85,408 | 81,746 | 81,746 |
| R ² | 0.001 | 0.031 | 0.031 | 0.032 | 0.032 | 0.032 |
| 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 firms with 10 employees or more. Note: The demographic covariates include four age dummies ([18–35], [36–45], [46–55], [56–65]), a female dummy, four dummies for the quartile groups of the distribution of the wage upon entry into the labour market and five occupational dummies. Finally, two variables measure the health situation of the respondent before 2003: number of long-term absence episodes since entry into the labour market and existence of a chronic disease. The firm covariates include 10 industry and 6 firm size dummies. Standard errors are robust to heteroscedasticity.

*** Significant at 1%, ** Significant at 5%, * Significant at 10%.

control groups ensures that all individuals share similar values on the matching variables. Hence, it is more likely that the common trends assumption holds within the subgroups characterised by the matching variables. In fact, this appears to be true in the matched sample, with the frequency of long-term sickness episodes being much more comparable across the four categories of firms. This is also very clear when we compare the evolution of absences before changes in Fig. 1 and Fig. 2.

To test the assumption of parallel trends in long-term sickness absences, we estimate a DiD model (Section 4.1) with dummy variables interacting each pre-treatment year with the different treatment dummies (ICT changes only, management changes only and both ICT and management changes). We use a Fisher joint test of equality at zero of all these estimated coefficients as a test of the null hypothesis that the pre-treatment trends in sickness absences are similar. The p value for the common trend test is higher than 0.05 for the original and matched samples (p value= 0.238 and p value=0.393 > 0.05, respectively). Our conclusion is that long-term sickness absences have a common pre-treatment trend in the control and treated groups.

5.2. Baseline estimates of the effects of organisational changes on long-term sick leaves

We present in Table 4 below our estimates of the average impact of organisational changes on long-term sickness absences in the three-year period following the changes' implementation. We can compare the differential impacts for employees in the three treated groups (those exposed to ICT changes only, to management changes only and to cumulative ICT and management changes) with employees in the control group (those with no exposure to significant organisational changes).

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 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 our preferred subsample of employees matched using *coarsened exact matching* between the control group and the treated group.

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

The size of the effects is stable regardless of the nature of the changes and the chosen specification (see Columns 1 to 4). This invariance to the inclusion of supplementary 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).⁶

⁶ A robustness exercise is performed with a two-way fixed effect (TWFE) model using time and individual worker fixed effects. The results presented in Tables A6 and A7 in statistical Appendix 4 display identical impacts under the DiD and TWFE models but naturally a much larger R². This reinforces

Table 5

Effects of significant organisational change on long-term sickness absences and injury leaves, difference between 2003–2005 (during) and 2000–2002 (before).

| | (1) | (2) | (3) | (4) | (5) | (6) |
|-------------------------------------|--------------------|--------------------|--------------------|--------------------|---------------------|---------------------|
| Significant ICT changes only | –0.006 (0.004) | –0.006 (0.004) | –0.006 (0.004) | –0.006 (0.004) | –0.008* (0.004) | –0.008* (0.004) |
| Significant management changes only | –0.009* (0.005) | –0.009* (0.005) | –0.009* (0.005) | –0.009* (0.005) | –0.010** (0.005) | –0.010** (0.005) |
| ICT and management changes | 0.004 (0.005) | 0.004 (0.005) | 0.004 (0.005) | 0.004 (0.005) | –0.001 (0.005) | –0.001 (0.005) |
| N | 86,918 | 86,918 | 86,918 | 86,918 | 83,102 | 83,102 |
| R ² | 0.001 | 0.037 | 0.038 | 0.039 | 0.036 | 0.037 |
| 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 firms with 10 employees or more.

See note on covariates and significance of the tests under Table 4. Standard errors are robust to heteroscedasticity.

These initial results illustrate strong heterogeneity in the consequences of forms of organisational changes for serious health conditions. First, note that figures from the COI-TIC survey show that during the period under review 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 firms provided that an improvement in overall productive efficiency is also observed. This first result is reminiscent of the one obtained by Bryson et al. (2013), who find no negative effects on occupational health after technological change. Moreover, management changes alone appear to be protective of health, which again appears beneficial for firms since Bigi et al. (2018) find that these forms of change in the French private sector also help maintain employees' involvement. This protective effect of management changes alone on the health of employees echoes the findings by Euzénat and Morteza-pouraghdam (2016). This may be because within the managerial practices included in our continuous index of changes, quality certifications that are likely to improve workplace safety and lower risks of occupational injuries have the highest weight.

The issue of deteriorating workforce health seems to be more topical when firms choose cumulative changes in ICT and management tools. One of the possible explanations for this finding lies in the disorders generated by the multiplicity of transformations in the work of employees. Cumulative changes represent a greater shock to the organisation of work and could 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 only one dimension because both the management board and the employees have better control over it. This explanation is consistent with Karasek's (2008) theory linking long-term disease-generating stress amongst the workforce to the disorder generated by new demands at work and the inability of individuals to exert control and implement coping strategies.

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 calls into question this return from a workforce well-being perspective.

As we said before, the organisational changes implemented in the period 2003 to 2005 may have developed over time. Nevertheless, they are also likely to have immediately changed 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 did not materialise immediately during the period of their implementation. Thus, while there is an immediate decrease in the frequency of long-term sickness absences following ICT and managerial changes on their own during the period of change (respectively –0.8 and –1 pp in the matched sample), 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

our confidence in our DiD effects, showing that controlling for unobserved static individual characteristics does not modify the nature and magnitude of the effects of the changes. We give primacy to the effects estimated by the DiD models because they can easily be compared to the effects showing heterogeneity by individual fixed characteristics.

Table 6
Dynamic effects of significant organisational change on long-term sickness absences and injury leaves between 2006–2008 (after) and 2000–2002 (before).

| | | All workers without matching | All workers with matching |
|-------------------------------------|------|------------------------------|---------------------------|
| Significant ICT changes only | 2006 | −0.004 (0.006) | −0.005 (0.006) |
| | 2007 | 0.001 (0.006) | 0.000 (0.006) |
| | 2008 | −0.001 (0.006) | −0.001 (0.006) |
| Significant management changes only | 2006 | −0.012* (0.007) | −0.012* (0.007) |
| | 2007 | −0.013* (0.007) | −0.015* (0.007) |
| | 2008 | −0.005 (0.007) | −0.007 (0.007) |
| ICT and management changes | 2006 | 0.019** (0.008) | 0.017** (0.008) |
| | 2007 | 0.007 (0.008) | 0.005 (0.008) |
| | 2008 | 0.017** (0.008) | 0.015** (0.008) |
| N | | 85,408 | 81,746 |
| R ² | | 0.032 | 0.032 |

Sources: COI-TIC survey matched with Hygie data.
Coverage: Employees with at least three years of seniority in 2005 from private sector firms with 10 employees or more.
See note on covariates and significance of the tests under Table 4. DiD estimates are reported with controls for individual and firm covariates and industry–occupation dummies. The reference period is the whole period before changes (2000–2002). Standard errors are robust to heteroscedasticity.

restricted by means of coarsened exact matching that we find that ICT changes alone have a weakly significant but protective effect against serious health impairments (−0,8 pp).

The results reported in Tables 4 and 5 are averaged over the three years after the changes took place. It is interesting to consider further when these effects are realised. For instance, does the protective or deleterious influence of organisational changes emerge in the first year and eventually wear off, or does it appear later? Hence, we also investigate dynamic responses of long-term sickness absences to the adoption of ICT and management tools. Table 6 reports these estimates.

The estimates from the original sample for one to three years after the change period systematically have the same sign as the estimated average effect, although they are not always statistically significant. What remains unchanged is the total lack of a significant impact of ICT changes on their own on long-term sickness absences. Management changes on their own appear to be health protective after their implementation period but are not significant in 2008. Finally, the detrimental impact of combined changes prevails significantly over two of the three years after the changes (2006 and 2008).

5.3. Heterogeneous effects and workforce characteristics

As mentioned above, the impacts of changes can vary according to the characteristics of the workforce. Therefore, we investigate whether the effects of organisational changes differ according to four individual features: gender, age, occupation and health status during the pre-2003 career. Thus, to estimate the heterogeneity in the effect by gender after the changes, for example, we estimate a difference-in-difference-in-differences (DDD) type of model:

$$S_{it} = \alpha + \beta Time_t + \gamma_1 Treated_{it} + \gamma_2 Female_i + \delta_1 Time_t \times Treated_{it} + \delta_2 Time_t \times Female_i + \delta_3 Treated_{it} \times Female_i + \delta_4 Time_t \times Female_i \times Treated_{it} + \varepsilon X_i + \lambda Y_{it} + u_{it}$$

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 $Female = 1$ for female workers. The coefficients of interest are δ_1 , the double difference estimator of the effect of changes on long-term sickness absences between 2006 and 2008 for male workers, and δ_4 , the triple difference estimator

Table 7

Effects of significant organisational change on long-term sickness absences and injury leaves, difference between 2006–2008 and 2000–2002 (after and before the changes), by gender and age, with matching.

| Variable | 2006–2008 vs. 2000–2002 | | 2003–2005 vs. 2000–2002 | |
|---|-------------------------|---------------------|-------------------------|----------------------|
| | Gender | Age | Gender | Age |
| <i>Double difference estimator for:</i> | | | | |
| | Male | Young | Male | Young |
| Significant ICT changes only | –0.001 (0.005) | –0.001 (0.004) | –0.008* (0.004) | –0.007 (0.004) |
| Significant management changes only | –0.016*** (0.005) | –0.013** (0.005) | –0.009* (0.005) | –0.016*** (0.005) |
| ICT and management changes | 0.017*** (0.005) | 0.013** (0.006) | –0.006 (0.006) | –0.000 (0.006) |
| <i>Triple difference estimator of differential effect for:</i> | | | | |
| | <i>Female</i> | <i>Old</i> | <i>Female</i> | <i>Old</i> |
| Significant ICT changes only | –0.003 (0.006) | –0.003 (0.006) | 0.000 (0.005) | –0.004 (0.005) |
| Significant management changes only | 0.015** (0.007) | 0.005 (0.007) | –0.003 (0.007) | 0.020*** (0.007) |
| ICT and management changes | –0.012 (0.008) | –0.001 (0.008) | 0.015** (0.008) | –0.003 (0.008) |
| F-test for joint significance of triple difference estimators [p-value] | 2.20* [0.085] | 0.31 [0.816] | 2.22* [0.081] | 2.96** [0.030] |
| N | 81,746 | 81,746 | 83,102 | 83,102 |
| R ² | 0.032 | 0.032 | 0.037 | 0.038 |

Sources: COI-TIC survey matched with Hygie data.

Coverage: Employees with at least three years of seniority in 2005 from private sector firms with 10 employees or more. See note on covariates and significance of the tests under Table 4. DiD estimates are reported with controls for individual and firm covariates and industry–occupation dummies. Standard errors are robust to heteroscedasticity.

of the supplementary effect for female workers. We also estimate the same model for the period during the changes (2003–2005).

We apply the same estimation procedure to differentiate workers under and over 45 years of age, managers and professionals from lower-level occupations and workers who did and did not experience a long-term sickness absence episode before 2003.⁷

Table 7 reports the differential impact of organisational changes by gender and age on workers' health after and during the changes.⁸ It displays the existence of gender differences in the health benefit and its timing caused by organisational transformations. On the one hand, while all workers, regardless of gender, are protected by both ICT and managerial changes on their own during the period when these changes are implemented, only women see their frequency of long sick leaves adversely affected by the combined ICT and managerial changes (+0.9 pp). On the other hand, men are also impacted after the period of changes. First, they benefit from significant management changes on their own (–1.6 pp in their frequency of long-term sickness episodes), while women are no longer significantly protected. Second, the combination of changes in the two systems is now as deleterious to male and female workers, the former suffering a post-changes increase in the frequency of long-term sickness episodes of a somewhat similar magnitude to that experienced by their female colleagues during the implementation of the changes.

Even if information is not available in the data to test their validity, we can put forward several possible explanations for why these changes affect women more severely and occur at an earlier stage. First, it could be that these gender differences relate to pregnancy decisions and maternity leaves. In Appendix 5, we discuss in detail the supplementary results by gender and age group to assess whether these differences are associated with the specific behaviours of younger women. In brief, these analyses do not suggest a systematic behaviour of women of childbearing age in response to the changes measured.

Another explanation may arise from issues of voice and power relations in organisations. A literature on the need to promote gender equality through collective bargaining to improve women's working lives has developed steadily since the late 20th century (Williamson and Baird, 2014). If men have more say on average in workplaces than women have, they would be better able to influence the content of changes and adapt them to their needs and tasks (Fana et al., 2021; Green, 2012; Greenan and Walkowiak, 2005; Howell et al., 2015). There is some form of consensus that women in negotiating positions in national and local trade unions are necessary to promote equality bargaining (Milner and Gregory, 2014). However, Kirton and Healy (2013) have documented internationally the underrepresentation of women in senior positions of unions.

⁷ We performed a joint test of Fisher to verify whether the coefficients of the triple difference estimators (DDD) for the three types of changes (ICT changes only, management changes only, and cumulative ICT and management changes) were jointly significant, showing the existence of heterogeneous effects. These tests are performed for all heterogeneity effects: gender, age, health status and occupation and for movers and stayers in the robustness section.

⁸ DiD estimators for the most complete set of covariates are reported in this table. The complete set of results is available upon request from the authors.

Table 8

Effects of significant organisational change on long-term sickness absences and injury leaves, difference between 2003–2005 and 2000–2002 (during and before changes), by occupation and health state, with matching.

| Variable | 2006–2008 vs. 2000–2002 | | 2003–2005 vs. 2000–2002 | |
|---|-----------------------------------|---------------------------|-----------------------------------|---------------------------|
| | Occupation | Health state | Occupation | Health state |
| <i>Double difference estimator for:</i> | Lower-level occupations | No long-term absence | Lower-level occupations | No long-term absence |
| Significant ICT changes only | 0.001 | 0.001 | –0.009 | –0.005 |
| | (0.005) | (0.004) | (0.005) | (0.004) |
| Significant management changes only | –0.004 | –0.007 | –0.007 | –0.010** |
| | (0.006) | (0.005) | (0.006) | (0.005) |
| ICT and management changes | 0.022*** | 0.014** | 0.005 | 0.003 |
| | (0.006) | (0.006) | (0.006) | (0.006) |
| <i>Triple difference estimator of differential effect for:</i> | Managers and professionals | Long-term absentee | Managers and professionals | Long-term absentee |
| Significant ICT changes only | –0.006 | –0.010* | 0.004 | –0.010* |
| | (0.005) | (0.006) | (0.005) | (0.005) |
| Significant management changes only | –0.016** | –0.015** | –0.008 | 0.001 |
| | (0.007) | (0.007) | (0.007) | (0.007) |
| ICT and management changes | –0.023*** | –0.0050. | –0.015** | –0.014* |
| | (0.008) | (0.008) | (0.007) | (0.008) |
| F-test for joint significance of triple difference estimators [p-value] | 4.89** | 2.48* | 2.12* | 2.20* |
| | [0.021] | [0.059] | [0.098] | [0.085] |
| N | 81,746 | 81,746 | 83,102 | 83,102 |
| R ² | 0.032 | 0.032 | 0.038 | 0.038 |

Sources: COI-TIC survey matched with Hygie data.

Coverage: Employees with at least three years of seniority in 2005 from private sector firms with 10 employees or more.

See note on covariates and significance of the tests under Table 4. DiD estimates are reported with controls for individual and firm covariates and industry–occupation dummies. Standard errors are robust to heteroscedasticity.

In France in 2001, women represented 32% of the elected officials in employee representation bodies, while they accounted for more than 40% of the electors (Amossé and Lemoigne, 2004). Our results may further be linked first to the fact that women's social capital is less valued than men's because they face problems of legitimacy and second to their more frequent part-time work, which reduces their opportunities for expression.

Third, 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; Ek, 2015; Thompson et al., 2016). This is also true in France, both in 2008 (Montaut, 2010) and in 2019 (Insee, 2022). Of course, some of these inequalities depend on the nature of the diseases. Studies on gender differences in diseases in France show that men are twice as affected by cardiovascular diseases but 40% less affected by anxiety and depression. However, when we consider all persons reporting a depressive episode in 2010, two-thirds of women reported having used a health professional, a care structure or psychotherapy, whereas only half of men reported doing so (Polton, 2016). It is possible that women treat their stress-related syndromes more rapidly whereas these symptoms are more likely to degenerate over time into cardiovascular diseases for male employees.

When considering the age of the workforce, we may expect that younger workers possess up-to-date skills to deal with innovative tools and practices while older workers benefit from greater experience of past organisational changes during their career, making them abler to find adequate coping strategies and support from their network. We find that the signs of the estimated effects for workers older and younger than 40 years old are essentially similar to those for the whole population. However, during the period of changes, we do find a significant difference between younger and older workers. If there is a decrease in the frequency of long-term sickness absences following management changes alone for younger workers (–1.6 pp), older workers experience a significantly different effect (+0.4 pp). In the three years following the changes (2006–2008), a significant increase in the likelihood of long-term sickness absences (1.3 pp) of younger workers is associated with combined implementation of new ICT and management tools, while the introduction of management innovations on their own decreases this frequency by 1.3 pp. In both cases, the health outcomes of older workers are not significantly different from those of young workers. Somehow, old and young workers appear to react identically when changes accumulate in both dimensions. When the intensity of changes increases, the health consequences are deleterious for both groups.

Table 9

Effects of significant organisational change on long-term sickness absences and injury leaves, difference between 2006–2008 (after) and 2000–2002 (before), for individuals hired before and during the organisational changes, with matching.

| | ICT changes only | Management changes only | ICT and Management changes |
|---|-------------------|-------------------------|----------------------------|
| Double difference estimator for individuals hired before the period of changes | –0.004 (0.004) | –0.012** (0.005) | 0.012** (0.006) |
| Triple difference estimator for individuals hired during the period of changes | 0.021 (0.013) | 0.005 (0.016) | 0.008 (0.018) |
| N | 81,746 | | |
| R ² | 0.033 | | |

Sources: COI-TIC survey matched with Hygie data.

Coverage: Employees with at least six years of seniority in 2006 from private sector firms with 10 employees or more.

See note on covariates and significance of the tests under Table 4. Triple difference estimates are reported with controls for individual and firm covariates and industry–occupation dummies. Standard errors are robust to heteroscedasticity.

Table 8 below reports the impact of organisational changes on workers' health according to their occupation and their health state in their previous work career, respectively, after and during the period of changes. Managers and professionals are the main beneficiaries of organisational changes in terms of health. During combined implementation of changes in both systems, this group is the only one to benefit from a decrease in long-term sick leaves (–1 pp); moreover, after the changes, when workers in lower-level occupations suffer in terms of health from these combined changes, managers and professionals are instead protected. Managerial innovations alone are also beneficial to them, decreasing their long-term absence episodes by 2 percentage points.

Additionally, the introduced innovations do not initially seem to harm workers with long absences in their past work experience. In contrast, these workers benefit from a reduction in their frequency of long-term absences, regardless of the form of the changes during their implementation. Isolated ICT and especially isolated management changes are also protective in the following three years, with only the intensity of the combined innovations proving deleterious to the health of workers, whether or not they experienced long absences in the past.

Finally, we also consider 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, if some workers with specific capacities to endure the hardship or stress attached to organisational change were hired at the time of its implementation, they may benefit in terms of health. Additionally, 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 improving existing production processes. Newly hired employees do not have work habits specific to the firm and therefore are more likely to easily and less reluctantly become accustomed 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. These workers have not yet created work routines that innovations may challenge, and they are less likely to suffer a 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 social network support to endure conflict in the company or voice power to discuss the way in which changes are implemented. Finally, in the case of an economic downturn, they are under the threat of the *last-in-first-out* 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 the employees in the treatment and control groups. amongst these junior employees, women are overrepresented (36.4% versus 32.8% in the overall sample), as are younger workers (83% versus 69.4%). Because the size of the junior group is not large enough to perform a difference-in-difference estimation within this sample, we estimate once again a difference-in-difference-in-differences (DDD) type of model.

The first three rows of Table 9 show that the impacts of the various forms of change on the long-term absences of employees hired before 2003 are consistent with the findings for the overall workforce. This is probably due to their high proportion in the workforce. Although the frequency of long-term absence episodes for the most recently hired workers increases regardless of the nature of the changes, this rise is not significant, and the health state of these junior entrants does not signal a specific comparative advantage. It is therefore very unlikely that these workers would have self-selected into changing firms for health benefits.

6. Robustness and discussion of results

We perform three robustness checks. First, we test different thresholds for our definition of significant changes. Second, instead of comparing an average computed over three years before and after the changes, we compare 2006 with 2002.

Table 10

Effects of significant organisational changes on long-term sickness absences and injury leaves, during and after the changes, under different values defining significant change.

| | During changes 2003–2005 | | | After changes 2006–2008 | | |
|-------------------------------------|--------------------------|--------------------|-------------------|-------------------------|--------------------|-------------------|
| | cut-off 0.2 | cut-off 0.3 | cut-off 0.4 | cut-off 0.2 | cut-off 0.3 | cut-off 0.4 |
| Significant ICT changes only | –0.008* (0.004) | –0.007* (0.004) | –0.005 (0.005) | –0.002 (0.004) | 0.004 (0.004) | 0.005 (0.005) |
| Significant management changes only | –0.010** (0.005) | –0.002 (0.006) | –0.010 (0.008) | –0.011** (0.005) | –0.004 (0.007) | 0.002 (0.008) |
| ICT and management changes | –0.001 (0.005) | 0.001 (0.007) | –0.009 (0.011) | 0.013** (0.005) | 0.018** (0.007) | 0.021* (0.011) |
| N | 83,102 | 83,102 | 83,102 | 81,746 | 81,746 | 81,746 |
| R ² | 0.032 | 0.031 | 0.030 | 0.032 | 0.032 | 0.031 |

Sources: COI-TIC survey matched with Hygie data.

Coverage: Employees with at least six years of seniority in 2006 from private sector firms with 10 employees or more.

See note on covariates and significance of the tests under Table 4. Double difference estimates are reported with controls for individual and firm covariates and industry–occupation dummies. Standard errors that robust to heteroscedasticity.

Finally, we distinguish the health impacts on the workers who left the firm after the period of change (movers) from those on workers who stayed in the firms (stayers).

In our baseline model, the threshold value at which we define a significant change is 0.2, corresponding to approximately one standard deviation of the distribution of the composite indicators capturing the intensity of changes. In fact, by increasing this threshold, we define as significant changes situations where firms adopted a larger set of new tools and practices. Hence, the intensity of the modifications in the work environment grows and, according to our hypothesis, so do the possible deleterious effects on the health of the workforce. In Table 10 below, we report the baseline estimates for effects during and after the changes with the threshold values for significant changes set successively at 0.2, 0.3 and 0.4.

In summary, when the threshold at which we define a significant change is increased, the higher intensity of the measured transformation goes hand in hand with a less favourable situation for workers, who tend to take long-term sick leaves more often after the changes. The protective effect of management changes on their own diminishes until it completely vanishes for all employees, while the deleterious aspect of cumulative ICT and management changes is exacerbated, albeit at the cost of less precisely estimated effects. Note that the decrease in the significance of the coefficients may be due to a problem of precision linked to the reduction in the number of employees in the treated groups reported in Table A10 of statistical Appendix 6. The logic is somewhat similar for the effects measured *during the changes*: the protective effects of changes in ICT and managerial systems alone become insignificant as the intensity of change is increased. We find no significant modification in the effect estimated for the combined changes.

In our baseline estimates, we assessed the effects of the changes over the widest window that we could use in our database, i.e., over the three years before and after the implementation of the organisational changes. However, as shown in Fig. 1 above and in Table A4 in the appendix, workers in firms that implemented managerial changes saw a significant increase in the frequency of long-term absences in the last year before implementation. The CEM has already mitigated this increase (Fig. 2 and Table A5). Nevertheless, to assess the extent to which the measured effects may be sensitive to significant modification in long-term sick leave frequencies in the year prior to the implementation of the treatment, we estimate our baseline models between the year immediately preceding the changes, 2002, and the year immediately following these changes, 2006. The results reported in Table 11 confirm that the new estimated results are qualitatively in line with those obtained over the three-year average before and after the changes. The same set of results obtained before CEM is available in Appendix 7, Table A11, and displays the same pattern of effects.

As we explicitly mentioned in our introduction, one of the main objectives of our study was to assess the extent to which the changes implemented by companies contribute to preserving the health of their employees. This question seems important to us for at least two reasons. The first concerns the sustainability for the workforce of the growth fuelled by technological and managerial changes. The second relates to the social responsibility of companies for the well-being of their employees and the social costs associated with a possible impairment of their health.

For these reasons, we have focused on analysing the impacts of the changes for all workers who experienced them, without distinguishing between those who changed employers in the years following the changes and those who did not. In this way, these impact estimates approach the full causal impact of ICT and management change on workforce health. Nevertheless, two observations lead us to question this assessment. In addition, we may wish to examine the consequences of the changes solely from the perspective of the employers who implemented them.

First, our use of an administrative database on only active employees makes it impossible to monitor the long-term health consequences for employees who become inactive. Therefore, we cannot identify whether the changes led to health impairments for some workers that caused them to withdraw from the labour force. Second, the information available in our database does not allow us to measure the presence of any new organisational changes in firms between 2006 and 2008. Here again, our data do not allow us to precisely quantify the extent of this bias. The fact that we measure significant changes that are likely not to recur over a short time horizon already mitigates this issue. Indeed, since the implementation

Table 11
Effects of significant organisational changes on long-term sickness absences and injury leaves, difference between 2006 (after) and 2002 (before).

| Variable | Workforce | Gender | Age | Occupation | Health state |
|---|---------------------|---------------------|---------------------|-----------------------------------|---------------------------|
| <i>Double difference estimator for:</i> | | | | | |
| | All workers | Male | Young | Lower-level occupations | No long-term absence |
| Significant ICT changes only | −0.005 (0.007) | −0.004 (0.008) | −0.004 (0.008) | −0.008 (0.008) | 0.004 (0.008) |
| Significant management changes only | −0.018** (0.009) | −0.023** (0.009) | −0.020** (0.009) | −0.015 (0.010) | 0.005 (0.009) |
| ICT and management changes | 0.016* (0.009) | 0.022** (0.010) | 0.027*** (0.010) | 0.026** (0.011) | 0.023** (0.010) |
| <i>Triple difference estimator for:</i> | | | | | |
| | | <i>Female</i> | <i>Older</i> | <i>Managers and professionals</i> | <i>Long-term absentee</i> |
| Significant ICT changes only | − | −0.012 (0.010) | −0.002 (0.010) | 0.007 (0.009) | −0.012 (0.010) |
| Significant management changes only | − | 0.027** (0.012) | 0.007 (0.013) | −0.008 (0.012) | −0.026** (0.012) |
| ICT and management changes | − | −0.005 (0.014) | 0.008 (0.014) | −0.034** (0.013) | −0.011 (0.014) |
| F-test for joint significance of triple difference estimators [p-value] | | 2.49* [0.058] | 1.59 [0.196] | 2.47* [0.057] | 2.13* [0.081] |
| N | 27,712 | 27,712 | 27,712 | 27,712 | 27,712 |
| R ² | 0.037 | 0.037 | 0.037 | 0.037 | 0.037 |

Sources: COI-TIC survey matched with Hygie data.

Coverage: Employees with at least six years of seniority in 2006 from private sector firms with 10 employees or more.

See note on covariates and significance of the tests under Table 4. Triple difference estimates are reported with controls for individual and firm covariates and industry–occupation dummies. Standard errors are robust to heteroscedasticity.

of many new tools is necessary to cross the threshold of significant change, such a degree of change is less likely to be repeated in subsequent years.

To assess the impacts of organisational changes on the workforce that remained in the firm during 2006–2008, it is necessary to distinguish between those who stayed and those who left. By focusing on the first group, we can assess the extent to which the transformation damaged the health of the workforce that remained employed in the changing firms. It is clear that if movers are amongst the employees most adversely affected by the changes, they are likely to resign or be dismissed by their employer. In this case, the measured impact would be subject to selection bias but would illustrate the health status of the workers who took part in the organisational changes and stayed in the firm.

Table 12 below shows the estimates of a triple difference model in which we distinguish stayers and movers. Workers who remain employed in the same firm appear protected against the health impairments of changes. Hence, after the period of changes, stayers do not experience more long-term sickness episodes than they did before the changes. Stayers in firms implementing ICT changes on their own show fewer absences (−0.8 pp) on average after the changes than stayers in inert firms. From the viewpoint of the employer, this evidence appears to be good news. To some extent, these results remind us of the lack of influence of the use of innovative workplace practices on long absence spells for the employed workforce found in Böckerman, Bryson et al. (2013).

Given the estimated impacts on the entire workforce, these estimates also imply, as a counterpart, that workers who have seen their employment relationship interrupted have either benefited from this departure (minus two percentage points for workers who left firms that initiated managerial changes only) or are in worse situations (plus 1.9 and 2.6 pp, respectively, for workers leaving firms that changed their ICT system or both systems simultaneously). Unfortunately, our database does not record the reasons for departure, and it is therefore impossible to distinguish voluntary departures from dismissals. Indeed, the administrative database used to track the situation of workers is organised in such a way as to record accumulated social rights in terms of health protection and retirement. It is therefore not feasible to provide practical evidence of the pathways by which workers left the firms. However, we are able to highlight how the changes specifically influenced future movers and stayers during their implementation phase (2003–2005). In the first column of Table 12, we report these impacts and thus the evolution of the health of movers before they left and of that of stayers. The latter experienced a decrease, but not a significant one, in the frequency of long-term absence episodes, regardless of the form of the changes, confirming the absence of deterioration in their health during the period of change. Movers also did not experience a significant increase in the frequency of long-term absences.

In addition, we carry out a descriptive analysis to characterise the differences between stayers and movers (Table 13). First, it appears that movers had a 66% higher frequency of long-term absences during the changeover period than stayers (8.37% versus 5.24%). Moreover, these movers are more frequently young, female and in occupations below the rank of managers and professionals. These last two categories of workers are also the least protected in terms of long-term absences during the change phase, particularly when they face cumulative ICT and management changes (see Section 5.3). To some

Table 12

Effects of significant organisational change on long-term sickness absences and injury leaves for stayers and movers, during and after the changes, with matching.

| Variable | During changes 2003–2005 | After changes 2006–2008 |
|---|-----------------------------|----------------------------|
| Double difference estimator for: | | |
| | Stayers | Stayers |
| Significant ICT changes only | –0.008 (0.005) | –0.009* (0.005) |
| Significant management changes only | –0.008 (0.006) | –0.005 (0.006) |
| ICT and management changes | –0.004 (0.006) | 0.005 (0.007) |
| Triple difference estimator of differential effect for: | | |
| | Movers | Movers |
| Significant ICT changes only | 0.003 (0.008) | 0.019** (0.009) |
| Significant management changes only | –0.002 (0.010) | –0.020* (0.011) |
| ICT and management changes | 0.014 (0.011) | 0.026** (0.012) |
| F-test for joint significance of triple difference estimators [p-value] | 0.53 [0.658] | 4.42*** [0.004] |
| N | 83,102 | 81,746 |
| R ² | 0.039 | 0.033 |

Sources: COI-TIC survey matched with Hygie data.

Coverage: Employees with at least three years of seniority in 2005 from private sector firms with 10 employees or more.

See note on covariates and significance of the tests under Table 4. Triple difference estimates are reported with controls for individual and firm covariates and industry–occupation dummies. Standard errors are robust to heteroscedasticity.

Table 13

Characteristics of stayers and movers.

| Descriptive Statistics Movers/Stayers | Stayers | Movers |
|---|---------|--------|
| Occurrence of long sickness absence and injury leave in 2000–2002 | 4.84 | 5.57 |
| Occurrence of long sickness absence and injury leave in 2003–2005 | 5.24 | 8.37 |
| Occurrence of long sickness absence and injury leave in 2006–2008 | 6.56 | 6.89 |
| Female | 31.92 | 34.71 |
| [18–35 years old] | 27.64 | 32.89 |
| Managers and associate professionals | 40.32 | 38.67 |
| N | 9551 | 5069 |
| % | 65.33 | 34.67 |

Sources: COI-TIC survey matched with Hygie data.

Coverage: Employees with at least three years of seniority in 2005 from private sector firms with 10 employees or more.

extent, these observations may confirm that these more intense changes led to a reallocation of some of the workforce most severely affected by the new work systems. However, this line of reasoning is not especially valid for young workers, who, on the contrary, did not suffer deleterious changes but rather benefitted from managerial changes only. These health-promoting changes may have opened up new career opportunities for young workers by providing them with valued work experience in the labour market.

7. Conclusion

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

To this end, we use an original database resulting from matching 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 leave episodes of a sample of people insured under the general social security system, while the second describes the changes implemented in firms over three years in their uses of ICT and management tools.

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

We find the same core results in all our regressions: cumulative changes in ICT and management tools increase occupational risks and detrimentally influence employees' health, while management changes on their own reduce long-term sickness absences. Hence, it appears that when changes simultaneously influence several dimensions of the work environment, the workforce may suffer from the scope of work environment renewal. The changes likely to yield the highest returns for firms in the presence of productive complementarities are also associated with larger health damages. Changes that take place in one dimension only, appear health protective, and especially when they occur in the management system. There are two potential explanations. Firstly, because the change is less complex, its scope is likely to be more limited and its consequences easier to monitor. Secondly, quality certifications play a prominent part in management changes only and by contributing to setting standards in the production process, it may reduce occupational risks. Interestingly, recent research has shown that companies seeking radical innovation tend to disengage from quality certification, reflecting, from another angle, the trade-offs between economic and social performance (Clougherty and Grajek, 2023).

Using a difference-in-difference-in-differences (DDD) model with matching, we investigate the presence of heterogeneity in the effects of organisational changes by workforce characteristics (gender, age, and occupation) and by health status. Our estimates reveal gendered and occupational differences in the timing and strengths of the impacts. First, when firms implement cumulative ICT and management changes, health impairments start for women during the change phase, whereas for men, they only appear afterwards. Second, while we observe protective effects of managerial changes on their own for both genders during the change phase, these effects do not persist afterwards for women. Third, managers and professionals are protected in the change phase against the serious health consequences of cumulative ICT and management changes, and they benefit from the reduction in risks associated with management changes on their own. When we look at age differences, the only effect heterogeneity that we find is that younger workers start to be protected by management changes alone during the change phase, which is not the case for older workers. In addition, workers who experienced a major health shock in the past appear more protected against health damage during the change phase, but they are as exposed as their colleagues to the negative consequences of cumulative ICT and management changes after their implementation.

To assess the impacts of organisational changes on the workforce that remained in the firm during 2006–2008, it is necessary to distinguish between those who stayed and those who left. By focusing on the first group, we can assess the extent to which the transformation damaged the health of the workforce that remained employed in the changing firms. Our results show that these workers are protected against the health impairments of cumulative ICT and management changes. Thus, the group of workers who left a changing company after the period of change is particularly vulnerable in terms of health problems. This is the case both when they were exposed to cumulative ICT and management changes and when they were exposed to ICT changes only. An important consequence for public policies is that the social cost of the most profitable organisational changes is only partially borne by the firms responsible for it.

These findings highlight the need for public authorities assessing occupational safety and health policies to better understand the process of organisational change (its complexity, intensity and dynamics), the social engineering of the uses of technology and management tools and the social construction of health behaviours. This is of critical importance in the era of data-driven and intelligent technologies that are likely to enter many different functions within organisations (Bailey, 2022). Indeed, the chances that firms will opt massively for cumulative ICT and management changes are high. Effective occupational risk prevention policies at firm level and effective public monitoring of these policies are therefore essential to mitigate the social impact of future changes.

One way of safeguarding employee welfare would be to require companies to organise the appointment and consultation of workforce representatives on major changes in the organisation. While this study lacks information on the effectiveness of successful employee representation, one avenue for future research would be to assess the extent to which negotiation is an effective means of managing change, as appears to have been the case in the UK in the 2000s (see Bryson et al., 2013).

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Declaration of Competing Interest

None.

Appendix 1: Measuring ICT and Management changes

Table A1
% of firms using ICTs and management tools in 2003 and 2006.

| | % of firms | | 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: Firms 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
% of firms having introduced a tool between 2003 and 2006 according to change categories.

| | Inert | Changing | ICT only | Man only | ICT&Man |
|--|-------|----------|----------|----------|---------|
| ICTs | | | | | |
| Website | 6.97 | 34.46 | 38.40 | 12.45 | 49.09 |
| Intranet | 1.83 | 26.53 | 33.40 | 2.89 | 35.78 |
| Electronic data interchange system (EDI) | 4.28 | 19.02 | 20.40 | 4.42 | 31.76 |
| Tools for data analysis | 1.76 | 23.14 | 26.36 | 5.34 | 34.89 |
| Local Area Network | 1.27 | 19.01 | 23.95 | 2.59 | 25.02 |
| Tools for interfacing databases | 1.10 | 18.48 | 18.60 | 3.93 | 34.20 |
| Extranet | 0.84 | 16.05 | 18.74 | 3.40 | 23.43 |
| Tools for automated data archiving or research | 1.36 | 13.83 | 15.48 | 1.73 | 23.13 |
| Tools for collaborative work (groupware) | 0.21 | 13.80 | 17.58 | 0.15 | 19.60 |
| ERP | 1.18 | 8.77 | 9.25 | 2.49 | 14.50 |
| Databases for HRM | 0.42 | 10.89 | 11.70 | 1.72 | 19.04 |
| Databases for R&D | 0.60 | 9.07 | 9.36 | 1.37 | 16.85 |
| Software or firmware for R&D | 0.50 | 8.43 | 8.55 | 1.02 | 16.28 |
| Tools for process modelling (workflow) | 0.03 | 9.34 | 10.41 | 0.06 | 16.95 |
| Software or firmware for HRM | 0.40 | 8.00 | 8.57 | 1.04 | 14.28 |

(continued on next page)

Table A2 (continued)

| | Inert | Changing | ICT only | Man only | ICT&Man |
|---|-------|----------|----------|----------|---------|
| Management tools | | | | | |
| Satisfaction surveys of customers | 1.54 | 12.97 | 3.77 | 19.10 | 28.75 |
| Quality certifications | 0.14 | 16.19 | 0.04 | 36.71 | 33.08 |
| Customer relationship management (CRM) | 1.53 | 9.31 | 5.32 | 7.99 | 20.53 |
| Tools for tracing goods or services | 0.20 | 12.58 | 0.18 | 23.19 | 31.23 |
| Long-term relationships with suppliers | 1.05 | 9.04 | 2.36 | 13.37 | 20.63 |
| Tools for labelling goods or services | 0.83 | 9.45 | 1.64 | 17.09 | 20.12 |
| Contractual commitment to supply goods/services in limited time | 0.65 | 8.72 | 1.57 | 9.95 | 24.88 |
| Teams or autonomous work groups | 0.40 | 9.21 | 2.00 | 10.83 | 25.07 |
| Requirement for suppliers to meet tight deadline | 0.53 | 8.24 | 0.90 | 13.28 | 20.65 |
| Call or contact centres | 0.84 | 6.19 | 1.38 | 10.12 | 13.62 |
| Methods of problem solving (FMECA) | 0.15 | 8.11 | 0.11 | 16.41 | 18.53 |
| Environmental or ethical certification | 0.01 | 8.17 | 0.06 | 19.18 | 15.87 |
| Just in time production | 0.56 | 3.96 | 0.66 | 6.09 | 9.69 |

Data source: COI-TIC survey, 2006.

Coverage: Firms of 10 or more employees in the private sector. Weighted data.

Note: We have ranked ICTs and management tools in the table according to the frequency of their introduction between 2003 and 2006 in changing firms.

Appendix 2: Descriptive statistics before and after matching

Table A3

Descriptive statistics in inert and changing firms before and after matching.

| Variables | Before matching | | After matching | |
|---|----------------------------|-------------------------|----------------------------|-------------------------|
| | No significant changes (%) | Significant changes (%) | No significant changes (%) | Significant changes (%) |
| Occurrence of long sickness absence and injury leave in 2000–2002 | 5.13 | 5.03 | 4.86 | 4.90 |
| Occurrence of long sickness absence and injury leave in 2003–2005 | 6.57 | 6.02** | 6.51 | 5.87*** |
| Occurrence of long sickness absence and injury leave in 2006–2008 | 6.74 | 6.63 | 6.63 | 6.53 |
| Percentage of female workers | 32.31 | 33.63** | 32.93 | 32.93 |
| Percentage of workers hired in 2003 | 10.73 | 10.69 | 11.17 | 10.78 |
| Occurrence of chronic disease before 2003 | 4.79 | 4.25 | 3.04 | 3.04 |
| Number of long-term absence episodes before 2003 | 0.95 | 0.86 | 0.89 | 0.89 |
| <i>Annual wage upon entry in the labour market</i> | | | | |
| -First quartile group | 25.74 | 23.62** | 23.52 | 23.83 |
| -Second quartile group | 25.25 | 24.29 | 24.99 | 24.23 |
| -Third quartile group | 24.53 | 25.81** | 25.13 | 25.61 |
| -Fourth quartile group | 24.48 | 26.29** | 26.36 | 26.33 |
| <i>Age classes in 2005</i> | | | | |
| - [18–35 years old] | 28.79 | 30.34** | 31.16 | 31.13 |
| - [36–45 years old] | 33.07 | 33.36 | 33.86 | 33.47 |
| - [46–55 years old] | 29.59 | 28.31** | 27.67 | 28.10 |
| - [56–65 years old] | 8.56 | 7.99 | 7.31 | 7.30 |
| <i>Occupations</i> | | | | |
| -Managers and professionals | 22.44 | 25.25*** | 23.12 | 25.26*** |
| -Technicians and associate professionals | 15.24 | 17.18*** | 15.65 | 17.42*** |
| -Clerical, services and sales workers | 12.64 | 13.15 | 13.30 | 13.13 |
| -Blue collar workers | 37.16 | 34.44*** | 36.34 | 34.33** |
| -Unknown | 12.53 | 9.99*** | 11.59 | 9.87*** |
| <i>Firms' size</i> | | | | |
| - [10–19 employees] | 6.29 | 4.06*** | 6.35 | 4.17*** |
| - [20–49 employees] | 8.62 | 4.53*** | 8.90 | 4.56*** |
| - [50–249 employees] | 21.42 | 18.92*** | 21.47 | 18.91*** |
| - [250–499 employees] | 17.67 | 19.99*** | 17.39 | 19.85*** |
| -More than 500 employees | 46.01 | 52.49*** | 45.88 | 52.51*** |

(continued on next page)

Table A3 (continued)

| Variables | Before matching | | After matching | |
|--|----------------------------|-------------------------|----------------------------|-------------------------|
| | No significant changes (%) | Significant changes (%) | No significant changes (%) | Significant changes (%) |
| Industries | | | | |
| -Consumer good industry | 8.99 | 8.16** | 8.70 | 8.15 |
| -Intermediary good and energy | 26.58 | 20.85*** | 26.05 | 21.08*** |
| -Capital goods | 15.08 | 21.31*** | 14.97 | 21.39*** |
| -Trade | 14.13 | 10.97*** | 14.86 | 10.99*** |
| -Construction | 4.33 | 3.09*** | 4.36 | 3.12*** |
| - Financial and real estate | 4.82 | 7.66*** | 4.98 | 7.66*** |
| -Food and beverage industry | 5.17 | 9.49*** | 5.17 | 9.33*** |
| -Business services | 10.12 | 9.58 | 10.16 | 9.30 |
| -Transportation and storage | 5.53 | 4.13*** | 5.40 | 4.11*** |
| -Unknown | 5.25 | 4.75 | 5.34 | 4.87 |
| Number of employees | 8 223 | 6 397 | 7 819 | 6 161 |
| Multivariate \mathcal{L}_1 distance (Coarsened Exact Matching) | 0.733 | | 0.715 | |

Sources: COI-TIC survey matched with Hygie data.

Coverage: Employees with at least three years of seniority in 2005 from private sector firms with 10 employees and more.

Appendix 3: Evolution of long-term sickness absence before, during and after the changes period

Table A4

Frequency of long-term sickness absence episode before matching.

| Year | No changes | ICT changes only | Management changes only | ICT and management changes |
|------|------------|------------------|-------------------------|----------------------------|
| 2000 | 4.85 | 4.70 | 4.82 | 4.66 |
| 2001 | 5.02 | 4.64 | 4.98 | 4.46 |
| 2002 | 5.52 | 5.07 | 6.36 | 5.95 |
| 2003 | 5.78 | 4.99 | 5.36 | 6.37 |
| 2004 | 6.68 | 5.79 | 5.89 | 6.71 |
| 2005 | 7.23 | 6.15 | 6.63 | 7.52 |
| 2006 | 6.86 | 6.11 | 5.96 | 8.72 |
| 2007 | 6.83 | 6.62 | 5.82 | 7.43 |
| 2008 | 6.52 | 6.14 | 6.29 | 8.22 |

Sources: COI-TIC survey matched with Hygie data. 2003–2005 is the period of change.

Coverage: Employees with at least three years of seniority in 2005 from private sector firms with 10 employees and more.

Table A5

Frequency of long-term sickness absence episode after matching.

| Year | No changes | ICT changes only | Management changes only | ICT and management changes |
|------|------------|------------------|-------------------------|----------------------------|
| 2000 | 4.55 | 4.52 | 4.87 | 4.77 |
| 2001 | 4.80 | 4.43 | 4.91 | 4.53 |
| 2002 | 5.23 | 4.94 | 5.42 | 5.60 |
| 2003 | 5.62 | 4.93 | 5.36 | 6.32 |
| 2004 | 6.70 | 5.55 | 5.89 | 6.46 |
| 2005 | 7.17 | 6.03 | 6.63 | 6.96 |
| 2006 | 6.79 | 6.05 | 6.01 | 8.68 |
| 2007 | 6.74 | 6.49 | 5.67 | 7.47 |
| 2008 | 6.33 | 6.00 | 6.03 | 8.06 |

Sources: COI-TIC survey matched with Hygie data. 2003–2005 is the period of change.

Coverage: Employees with at least three years of seniority in 2005 from private sector firms with 10 employees and more.

Appendix 4: Two-way fixed effects estimates

Table A6

Two-way fixed effects estimates of impacts 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 |
|-------------------------------------|---------------------|---------------------|---------------------|---------------------|
| Significant ICT changes only | –0.001 (0.004) | –0.002 (0.004) | –0.002 (0.004) | –0.003 (0.004) |
| Significant management changes only | –0.010** (0.005) | –0.011** (0.005) | –0.010** (0.005) | –0.012** (0.005) |
| ICT and management changes | 0.015*** (0.005) | 0.013** (0.005) | 0.014*** (0.005) | 0.012** (0.005) |
| N | 85,408 | 81,746 | 85,408 | 81,746 |
| R ² | 0.032 | 0.032 | 0.295 | 0.294 |
| Demographic covariates | Y | Y | | |
| Firm covariates | Y | Y | Y | Y |
| Industry-occupation dummies | Y | Y | Y | Y |
| Coarsened exact matching | | Y | | Y |
| Fixed effect | | | Y | Y |

Sources: COI-TIC survey matched with Hygie data.

Coverage: Employees with at least three years of seniority in 2005 from private sector firms with 10 employees and more. See note on covariates and significance of the tests under Table 4. Two-way fixed effects estimates are reported in columns 3 and 4. Standard errors are robust to heteroscedasticity.

Table A7

Two-way fixed effects estimates of impacts of significant organisational changes on long-term sickness absence and injury leave, difference between 2003–2005 (during) and 2000–2002 (before).

| | 1 | 2 | 3 | 4 |
|-------------------------------------|--------------------|---------------------|--------------------|---------------------|
| Significant ICT changes only | –0.006 (0.004) | –0.008* (0.004) | –0.006 (0.004) | –0.008** (0.004) |
| Significant management changes only | –0.009* (0.005) | –0.010** (0.005) | –0.009* (0.004) | –0.010** (0.004) |
| ICT and management changes | 0.004 (0.005) | –0.001 (0.005) | 0.004 (0.005) | –0.001 (0.005) |
| N | 86,918 | 83,102 | 86,918 | 83,102 |
| R ² | 0.039 | 0.037 | 0.317 | 0.314 |
| Demographic covariates | Y | Y | | |
| Firm covariates | Y | Y | Y | Y |
| Industry-occupation dummies | Y | Y | Y | Y |
| Coarsened exact matching | | Y | | Y |
| Fixed effect | | | Y | Y |

Sources: COI-TIC survey matched with Hygie data.

Coverage: Employees with at least three years of seniority in 2005 from private sector firms with 10 employees and more. See note on covariates and significance of the tests under Table 4. Two-way fixed effects estimates are reported in columns 3 and 4. Standard errors are robust to heteroscedasticity.

Appendix 5: Differences in gender impacts of organisational changes and maternity leave

It is possible that differences in the evolution of long-term absences between men and women after and during the period of changes stem from pregnancy decisions and associated maternity leaves. Indeed, the quarters of absence in administrative records contain maternity leave.

To generate specific effects, it is of course necessary to consider that the maternity decision is dependant on the consequences of organisational changes. Some studies have raised the difficulties of being pregnant in the workplace. For example, the choice of motherhood is easier in an organisation that offers part-time contracts or flexible work schedules, or more difficult in a job with a high workload (Desai and Waite, 1991). If organisational changes are associated with family-friendly policies intended to support employees' needs to manage family demands and work commitments, maternity will be made easier. Also, the medical literature informs us about the negative influence of stress on physical and mental health. Hence,

psychosocial work stressors have been shown to raise the risk of pregnancy-induced hypertension (see Landsbergis and Hatch, 1996). In addition, workplace discrimination against pregnant employees has been documented in the literature and explains how pregnancy intention could be affected by organisational changes when these threaten employees' employment (Jones, 2017).

To determine whether gendered impacts of organisational changes on long-term absences are linked to maternity, we estimate our DiD model for all women and various subsamples of female employees using different age thresholds: 35, 40, 45, 50. Indeed, we know that in 2006, only 4% of French new-borns have a mother older than forty in 2006. The Tables A8 and A9 report the impacts of the three forms of changes for female employees during and after they took place.

The impacts of organisational changes on the health of female employees occur mainly during the period of the changes (2003–2005) according to the results reported in Table A8. The positive influence of cumulative changes on long-term absences becomes significant after the age of 40 and is particularly strong and for women over 50 years of age. It is therefore an effect that cannot be directly linked to maternity decisions. On the other hand, the protective nature of management changes only during this period seems to concern women under their forties, but not the youngest group of women who are less than 35. As a result, female employees under 35 are no less absent in companies implementing management only than in inert companies. A possible influence of maternity decisions on the level of absences in these changing companies could only occur for women between 35 and 40.

On the contrary, we observe in Table A9 no influence of any form of changes on long-term absences of female employees in the period after the introduction of the changes (2006–2008). First of all, the absence of a significant effect of cumulative changes is confirmed for all women, regardless of the age limits considered, and again does not seem to be linked to maternity choices. Although less significant, the same effect of managerial changes alone can be seen as in Table A8 when considering the age threshold of 35 years. Again, younger employees do not behave significantly differently in terms of absence in inert companies and those that have innovated in managerial terms.

The influence of women's maternity choices could therefore only explain the specific influence of managerial changes only for a very specific subgroup of female employees, in the form of decisions to become less pregnant when such innovations are implemented. However, it is difficult to explain such a behaviour both in relation to the existing literature on pregnancy choices and given the information available in our database.

Table A8

Effects of significant organisational change on female long-term sickness absence, difference between 2003 and 2005 (during) and 2000–2002 (before): Female by age limit with matching.

| | All | Difference between periods during and before changes (2003–2005 vs 2000–2002) | | | | | | | |
|-------------------------------------|---------------------|---|---------------------|----------------------|---------------------|----------------------|-------------------|---------------------|---------------------|
| | | age≤35 | age≤40 | age≤45 | age≤50 | age>35 | age>40 | age>45 | age>50 |
| Significant ICT changes only | −0.006 (0.009) | −0.000 (0.018) | −0.008 (0.014) | −0.012 (0.011) | −0.014 (0.010) | −0.015 (0.010) | −0.013 (0.011) | −0.005 (0.014) | 0.005 (0.017) |
| Significant management changes only | −0.026** (0.012) | −0.013 (0.022) | −0.040** (0.018) | −0.037*** (0.014) | −0.033** (0.013) | −0.039*** (0.013) | −0.020 (0.014) | −0.010 (0.018) | −0.019 (0.022) |
| ICT and management changes | 0.023* (0.012) | 0.003 (0.023) | −0.009 (0.018) | 0.002 (0.014) | 0.005 (0.013) | 0.010 (0.013) | 0.023* (0.014) | 0.045*** (0.020) | 0.058*** (0.024) |
| N | 28,500 | 8909 | 13,652 | 19,889 | 22,017 | 18,365 | 13,622 | 7386 | 5258 |
| R ² | 0.031 | 0.028 | 0.020 | 0.023 | 0.027 | 0.039 | 0.056 | 0.080 | 0.085 |

Sources: COI-TIC survey matched with Hygie data.

Coverage: Employees with at least three years of seniority in 2005 from private sector firms 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. Standard errors are robust to heteroscedasticity.

Table A9

Effects of significant organisational change on long-term sickness absence, difference between 2006 and 2008 (after) and 2000–2002 (before): Female by age limit with matching.

| | All | Difference between periods after and before changes (2006–2008 vs 2000–2002) | | | | | | | |
|-------------------------------------|-------------------|--|-------------------|-------------------|-------------------|--------------------|-------------------|-------------------|--------------------|
| | | age≤35 | age≤40 | age≤45 | age≤50 | age>35 | age>40 | age>45 | age>50 |
| Significant ICT changes only | 0.004 (0.009) | −0.002 (0.016) | −0.003 (0.012) | 0.001 (0.011) | 0.002 (0.010) | −0.001 (0.010) | 0.001 (0.012) | −0.010 (0.015) | −0.026 (0.022) |
| Significant management changes only | −0.016 (0.012) | 0.003 (0.020) | −0.012 (0.016) | −0.009 (0.014) | −0.008 (0.012) | −0.024* (0.013) | −0.014 (0.015) | −0.026 (0.019) | −0.051* (0.028) |
| ICT and management changes | 0.009 (0.012) | 0.028 (0.021) | 0.014 (0.016) | 0.015 (0.014) | 0.012 (0.013) | −0.003 (0.014) | 0.003 (0.016) | −0.008 (0.020) | −0.008 (0.029) |
| N | 28,018 | 10,629 | 15,419 | 19,741 | 23,409 | 16,256 | 11,465 | 7144 | 3476 |
| R ² | 0.025 | 0.014 | 0.016 | 0.023 | 0.025 | 0.041 | 0.053 | 0.053 | 0.066 |

Sources: COI-TIC survey matched with Hygie data.

Coverage: Employees with at least three years of seniority in 2005 from private sector firms 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. Standard errors are robust to heteroscedasticity.

Appendix 6: Distribution of the workforce according to the definition of significant change**Table A10**
Distribution of significant changes.

| Level of change | All sample N | Type of organisational changes (%) | | | |
|-----------------------|-----------------|------------------------------------|------------------|-------------------------|----------------------------|
| | | No significant change | ICT changes only | Management changes only | ICT and management changes |
| Level=0,2 | | | | | |
| Number of individuals | 14,620 | 8223 | 3022 | 1900 | 1475 |
| % | | 56.24 | 20.67 | 13.00 | 10.09 |
| Level=0,3 | | | | | |
| Number of individuals | 14,620 | 10,582 | 2257 | 934 | 847 |
| % | | 72,38 | 15,44 | 6,39 | 5,79 |
| Level=0,4 | | | | | |
| Number of individuals | 14,620 | 12,116 | 1630 | 534 | 340 |
| % | | 82,87 | 11,15 | 3,65 | 2,33 |

Appendix 7: Robustness of results by period of comparison**Table A11**
Effects of significant organisational changes on long-term sickness absence and injury leave, difference between 2006 (after) and 2002 (before), before matching.

| Variable | Workforce | Gender | Age | Occupation | Health state |
|---|---------------------|---------------------|---------------------|-----------------------------------|---------------------------|
| <i>Double difference estimator for:</i> | All workers | Male | Young | Lower level occupations | No long-term absence |
| Significant ICT changes only | −0.003 (0.007) | −0.003 (0.008) | −0.004 (0.008) | −0.007 (0.008) | 0.003 (0.008) |
| Significant management changes only | −0.018** (0.009) | −0.022** (0.009) | −0.019** (0.009) | −0.015 (0.010) | 0.003 (0.009) |
| ICT and management changes | 0.018** (0.009) | 0.027*** (0.010) | 0.028*** (0.010) | 0.027** (0.011) | 0.026** (0.010) |
| <i>Triple difference estimator for:</i> | | <i>Female</i> | <i>Old</i> | <i>Managers and professionals</i> | <i>Long-term absentee</i> |
| Significant ICT changes only | − | 0.000 (0.010) | 0.003 (0.010) | 0.009 (0.009) | −0.010 (0.009) |
| Significant management changes only | − | 0.028** (0.012) | 0.005 (0.012) | −0.006 (0.012) | −0.018 (0.012) |
| ICT and management changes | − | −0.005 (0.013) | 0.007 (0.014) | −0.032** (0.013) | −0.013 (0.013) |
| N | 28,972 | 28,972 | 28,972 | 28,972 | 28,972 |
| R ² | 0.036 | 0.037 | 0.037 | 0.037 | 0.037 |

Sources: COI-TIC survey matched with Hygie data.

Coverage: Employees with at least six years of seniority in 2006 from private sector firms 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. Standard errors are robust to heteroscedasticity.

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