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The Impact of Working Conditions on Sickness Absence : A Theoretical Model and an Empirical Application to Work Schedules

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A Theoretical Model and an Empirical Application to Work Schedules

Cédric AFSA * and Pauline GIVORD *

Abstract

This paper explores how poor working conditions impact sickness absence through their effect on health. Our contribution is two-fold. First, we develop a static theoretical model based on the concept of health capital, wherein poor working conditions are partially compensated by higher wages. According to our model, the effect of working conditions on sickness absence is ambiguous. Second, we apply our model to the case of working time arrangements and test the effect of working irregular schedules or shift work on sickness absence, using data from the French Labor Force Survey on a specific population (male manual workers in the private sector). As observed and unobserved heterogeneity may lead to severe bias, we use propensity score matching methods. Our estimates show that working irregular schedules has a significant impact on sickness absence. The results are more mitigated for shift work. In any case, the extent crucially depends on age.

Résumé

Cette étude s'intéresse à l'impact des conditions de travail sur l'absence pour maladie. Notre contribution est double. Tout d'abord, nous proposons un modèle théorique statique fondé sur le concept de capital santé, dans lequel des conditions de travail pénibles peuvent être au moins partiellement compensées par des salaires plus élevés. Selon notre modèle, l'effet des conditions de travail sur l'absence pour maladie est ambigu. Ensuite, nous étudions l'impact spécifique de l'organisation du temps de travail sur l'absence pour maladie, en utilisant les données de l'enquête Emploi sur une population particulière (les hommes ouvriers travaillant dans le secteur privé). Pour réduire les biais liés à la présence d'hétérogénéité individuelle, nous utilisons des méthodes de matching sur le score de propension. Nous obtenons un impact significatif du fait de travailler avec des horaires de travail irrégulier sur l'absence au travail. Les résultats sont moins clairs pour le travail en équipe. Dans tous les cas, les résultats dépendent nettement de l'âge.

Keywords: working conditions; health demand; sickness absence; work schedules; matching estimator.
JEL Classification: I12; J22; J28; J81

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Introduction

The impact of working conditions on sickness absence is an issue of particular relevance for public policy. In an aging society, the painfulness of a job may not be sustainable. In this respect, improving the quality of jobs in order to raise the participation rate in Europe is a key policy objective fixed by the Lisbon Council (2000) [1]. In addition, the increase in the amount of sickness benefits paid by the public health insurance system constitutes a recurring source of concern in France as well as other European countries. A better understanding of the determinants of sickness absence is thus essential.

Economists have been reluctant to insert this topic on their research agenda for two main reasons, however. First, working conditions are not an economic concept and consequently cannot be handled easily by a textbook economic model. Second, from an empirical point of view, working condition variables are subject to measurement error.

Our contribution is two-fold. First, we propose an economic framework linking working conditions, health, and absenteeism and develop a simple theoretical model wherein poor working conditions[2] affect sickness absence through their effect on health. Our model shows that if bad working conditions are compensated even partially by pay premiums, their impact on sickness absence is ambiguous. Consequently, the question of how poor working conditions impact sickness absence becomes an empirical one.

We then test the predictions of our model with a specific example of working conditions, working time arrangements. We claim that this working condition is more “objectifiable”, and thus less prone to measurement error, than other working conditions. The empirical question is to what extent shift work or irregular schedules, as opposed to regular schedules (on a weekly basis), affect sickness absence. One of the major difficulties in this empirical analysis is dealing with the observed and unobserved heterogeneity of employees relating to their working time arrangements. In order to reduce the heterogeneity bias, we use propensity score matching methods. Furthermore, we restrict our sample to the population of male manual worker in private sector: this population is of reasonable size for the quality of estimate, and relatively

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[1] See for example : “Adapting to change in work and society : A new Community strategy on health and safety at work 2002–2006”, European Commission (2002).

[2] Poor working conditions are, e.g., exposure to noise, to high temperatures, to smokes or fumes, carrying heavy loads, working in painful positions, working on shift work (see, e.g., the European Working Conditions Survey for a comprehensive list of working conditions items generally used in surveys on this topic).

homogeneous in terms of qualification, standard of leaving and habits (all characteristics linked with health and propensity of leaving).

Our results suggest that irregular schedules significantly increase the sickness absence rate of male manual workers; the effect is increasing with age. On the other hand, we do not observe a significant impact of shift work on absence rates, apart from older workers. Note that as those who were prone to the adverse consequences of poor working conditions left employment prior to the beginning of the study (the so-called "healthy worker effect"), bias selection can lead to underestimating the true effect of working schedules on absence.

The rest of the paper is organized as follows. In section 1 we make a short review of literature on the topic. Section 2 presents the theoretical framework. Section 3 stresses the empirical problems posed by the measure of working conditions and their impact on health. Section 4 describes the econometric strategy and gives the empirical results. Section 5 concludes.

1. Health, work, and absence: A review of literature

As underlined by Brown and Sessions (1996), little attention has been paid in the economic literature to the question of absence and its causes. A first trend of the literature in the late 1970s and early 1980s was based on the neoclassical labor supply model, wherein the propensity for an employee to be absent depends on the difference between his or her desired hours – those which maximize his utility – and the contracted hours (e.g., Allen, 1981). The model predicts that an increase in contracted hours will increase the tendency to be absent.

A second trend of the literature is based on the shirking model of Shapiro and Stiglitz (1984), where the problem is posed in terms of moral hazard. In these models absence is supposed to reveal the employee's level of effort. In this line several authors examined how to limit moral hazard. Most often the variable of interest is the replacement rate, *i.e.*, the ratio between the wage rate and the sick-leave compensation. Johansson and Palme (2002, 2005), Bolduc *et al.* (2002) and Andrén (2005), for example, confirmed the disincentive effect of low replacement rates on sickness absence.

These models, combined with bargaining models, provide a theoretical framework to explain the contra-cyclical fluctuations of sickness absence: Higher unemployment weakens the worker's bargaining power and consequently his propensity to claim sickness leave for fear of being laid off. Similarly, Arai and Thoursie (2005) documented the negative correlation between sickness absence and temporary contracts.

In their comparative study on absence in twelve European countries, Frick and Malo (2005) introduced the determinants mentioned above. They calculated national indicators, characterizing for each country the degree of the wage compensation system's generosity for sickness absence, the level of unemployment, and the degree of job protection. In their empirical models, the effects of these institutional variables conform to what is generally found in the literature but are likely to be less important than those produced by individual characteristics such as the existence of health-related problems in the workplace.

This very last point illustrates one of the criticisms addressed to theoretical models, which generally ignore the individual's health status even though they deal with sickness absence (Brown and Sessions, 1996). Doing this, these models implicitly assume that absence never results from the employee's incapacity to work but reveals his choice not to work. To rule out this type of limitation, Barmby, Sessions and Treble (1994) enriched the theoretical framework based on moral hazard and incorporated an index of sickness as a preference parameter into the utility function. For their part, Marmot *et al.* (1995) pointed out that there is a strong association between health and sickness absence. They went a step further and examined whether job satisfaction (as a measure of job quality) might determine absence, too. Empirical evidence made them suggest that the effect of working conditions on long spells of absence might be related to the effect of work on health.

Taking working conditions into account to explain absence behavior is not a natural way of thinking for economists, at least for those who rely on the theory of equalizing differences (Rosen, 1974). The theory predicts that the pecuniary and non-pecuniary advantages and disadvantages of a job must be equalized. Thus, activities that offer unfavorable working conditions must pay premiums as compensation in order to equalize the workers' utilities.

However, some economists, besides Marmot *et al (ibid)*, have included work environmental issues in their studies on absenteeism. In his empirical analysis, Allen (1981) introduced work hazards (i.e., the probability of becoming ill or getting injured on the job) as control variables. The results point out a strong positive relationship between work hazards and absenteeism. In the same vein, Drago and Wooden (1992) based their theoretical analysis on the labor-leisure choice model. Their empirical results confirm the predictions of the model that employees on shift work are more prone to be absent.

Other analysis derived from the model of moral hazard (Shapiro and Stiglitz, 1984). In this respect, Grignon and Renaud (2004) distinguished the so-called claim reporting moral hazard, which corresponds to the "pure" ex post moral hazard, and the risk-bearing moral hazard, which may be connected with the preventive behavior of both the employer and the employee and is the variable of interest when studying working conditions and their impact on behavior. On this basis their empirical work consists of disentangling these two potential effects. More importantly, Ose (2005) developed the model of Shapiro and Stiglitz and tried to separately identify voluntary absence (shirking) on the one hand and involuntary absence for health-related problems due to bad working conditions on the other. One of the main predictions of her model is that a poor work environment implies higher sickness (involuntary) absence even if the worker is fully compensated to avoid shirking. Her estimation approach consists of separating short-term absence (spells lasting up to three days, which are supposed to measure shirking) and long-term absence (sickness spells) into different models. In line with the theory, long-term absence for men is related to work environment.

This paper is related to a third branch in the literature on absenteeism and working conditions, which derives theoretical frameworks from the concept of health capital. Cropper (1977) developed a long-term model of occupational choice wherein bad working conditions affect the individual's utility by decreasing his probability to be alive. This model is shown to be formally analogous to a conventional model of health capital so that choice of occupation is considered an investment in health. The worker chooses his path of employment in the risky occupation optimally over the life cycle, between unsafe but higher-paying jobs and an increased probability of dying. Case and Deaton (2005) proposed an intertemporal model of health based on Grossman (1972). Differently from Cropper, they assumed that health capital enters directly into the individual's utility function. They found some empirical evidence to support the hypothesis that bad working conditions affect the rate at which health capital depreciates with age.

2. Theoretical framework

We develop a simple theoretical framework based on Grossman model of investment in health (Grossman, *ibid.*). Let H_0 be the initial stock of health and *H* the stock of health at time *t* (we omit the index *t* of *H* for sake of simplicity). Grossman model assumes that net investment in the stock of health equals gross investment *I* minus depreciation:

$$H = I + (1-\delta)H_0 , \qquad (1)$$

where δ is the rate of depreciation ($0 < \delta < 1$). We adapt the model to deal with working conditions and sickness absence.

First, as Sickles and Taubman (1986) do, we endogenize the rate of depreciation and assume that δ depends on environmental characteristics such as working conditions. Suppose then that it were possible to rank jobs according to an index κ, strictly positive, which measures the degree of hardness of the job. We assume a positive relationship between κ and δ: health depreciates more rapidly when the employee is exposed to bad working conditions. This assumption relies on findings duly reported in medical and ergonomic literature (see section 1). Moreover we assume that the longer the time of exposure to bad working conditions, the higher the rate of depreciation. Consequently an employee may be willing to reduce his time of exposure for health reasons and decide to be (temporarily) absent from work. Let *s* be the duration of sickness absence and $\bar{h}$ the contractual working time of the employee, with $s \leq \bar{h}$. We make then δ depend on *d* - the time of exposure to bad working conditions - besides κ. We pose the following relationship:

$$\delta = \delta(\kappa d) = \delta[\kappa(\bar{h} - s)] .$$

The rate of depreciation is supposed to increase with *d* ($\partial\delta / \partial d > 0$) and even more rapidly when *d* is high ($\partial^2\delta / \partial d^2 > 0$).

Next, let *R* be the employee's income. It allows the employee to invest in health by purchasing goods or services. In other words the investment function *I* depends on *R*: $I = I(R)$. We make the additional assumptions: $I'(R) = dI / dR > 0$ (positive impact of income) and $I''(R) = d^2I / dR^2 < 0$ (decreasing returns on investment). For simplicity we suppose that *R* consists only in wages and sick pay. Let *w* be the employee's wage rate and τ the compensation rate for sick leave. The employee's income then equals to:

$$R = w\bar{h} - w(1-\tau)s .$$

In summary (1) may be rewritten as:

$$H = I(R) + [1 - \delta(\kappa d)]H_0 \text{ with } \begin{cases} R = w\bar{h} - w(1-\tau)s \\ d = \bar{h} - s \end{cases} \quad (3)$$

Assuming that an employee seeks to maximize the stock of health *H*, he faces a trade-off: being absent (i.e. increasing *s*) slows down the rate of depreciation δ, but at the same time reduces available income and consequently investment in health. Thus the "optimal" choice of *s* is given by the first-order condition:

$$\frac{\partial H}{\partial s} = 0 \quad \Leftrightarrow \quad w(1-\tau)I'[R(s^*)] - \kappa\delta'[\kappa d(s^*)]H_0 = 0 \quad (4)$$

As shown in Figure 1, "optimal" absence corresponds then to the equality of two functions involving the marginal rate of depreciation on the one hand (hereafter "depreciation function"), and the marginal increase in health investment due to higher income on the other hand ("health investment function").

[Figure 1 around here]

We now assume that the wage rate *w* depends on κ:

$$w = w(\kappa) \text{ with } w'(\kappa) \geq 0 .$$

This assumption is in conformity with collective agreements of most firms whose employees working in bad conditions (night duty, noisy environment…) are given premiums.

Considering κ as exogenous[3] and applying the implicit function theorem to (4), the optimal absence depends on κ: $s^* = s^*(\kappa)$. Taking then the first derivative of (4) with respect to κ leads to:

$$\frac{\partial s^*}{\partial \kappa} = A.w'(\kappa) + B.H_0 ,$$

[3] We will discuss this questionable assumption later.

where: $$\begin{cases} A = \dfrac{(1-\tau)[I'(R^*) + R^*.I''(R^*)]}{w^2(1-\tau)^2 I''(R^*) - \kappa^2\delta''(\kappa d^*)H_0} \\ B = \dfrac{\delta'(\kappa d^*) + \kappa(\overline{h} - s^*)\delta''(\kappa d^*)}{w^2(1-\tau)^2 I''(R^*) - \kappa^2\delta''(\kappa d^*)H_0} \end{cases}$$

with $R^* = R(s^*)$ and $d^* = d(s^*)$. B is positive. A is positive or negative depending on the functional form of *I*. For example, if I(*R*) is isoelastic, i.e. $I(R) = R^{1-\rho}/(1-\rho)$ with $\rho < 1$, then $I'(R^*) + R^*.I''(R^*) = (1-\rho)(R^*)^{-\rho} > 0$ and A is negative. In this case if bad working conditions are compensated - even only partially - by higher wages then their impact on sickness absence may result from two opposite effects:

- a negative effect due to work incentive schemes based on higher remuneration (i.e. $w'(\kappa) > 0$);
- a positive effect due to the employee's protective behavior with respect to health depreciation.

This effect is illustrated on Figure 2 (a). Keeping s constant, the derivative with respect to κ equals to $e_1 = \delta'(\overline{s})H_0$ for the depreciation function and to $e_2 = w'(\kappa)(1-\tau)\{I'[R(\overline{s})] + R.I''[R(\overline{s})]\}$ for the health investment function. This quantity equals to $w'(\kappa)(1-\tau)(1-\rho)[R(\overline{s})]^{-\rho}$ if *I* is isoelastic. In this case, an increase in hardness of work move both curves up and the new equilibrium point s^* moves to the right or to the left depending on the magnitude of the effects e_1 and e_2.

Our simple model also predicts that the propensity to be absent increases with the employee's contractual working time $\overline{h}$ on the one hand, and with the compensation rate for sickness absence τ on the other hand, two results which have been reported in the literature (see section 1). To prove that, we apply the same reasoning as above. We take $\overline{h}$ or τ as parameters instead of κ, apply the implicit function theorem, and derive the expressions of $\partial s^*/\partial\overline{h}$ and $\partial s^*/\partial\tau$ from (4). We have thus:

$$\frac{\partial s^*}{\partial \overline{h}} = \frac{w^2(1-\tau)I''(R^*) - \kappa^2\delta''(\kappa d^*)H_0}{w^2(1-\tau)^2 I''(R^*) - \kappa^2\delta''(\kappa d^*)H_0} > 0,$$

and: $$\frac{\partial s^*}{\partial \tau} = \frac{w^2(1-\tau)I''(R^*)s^* - wI'(R^*)}{w^2(1-\tau)^2 I''(R^*) - \kappa^2\delta''(\kappa d^*)H_0} > 0\,.$$

Figures 2 (b) and 2 (c) illustrate the effects on sickness absence of an increase in $\bar{h}$ and τ respectively.

[Figure 2 around here]

3. Measuring working conditions: An empirical problem

As the impact of bad working conditions on sickness absence is theoretically ambiguous, the question must be solved empirically. Let us emphasize two points.

First, working conditions refer to various items (risk exposure, working organisation, etc). Their potential impact on sickness absence may vary depending on their potential effect on health or well-being. Consequently, although our theoretical model is general, it must be tested on a case-by-case basis. We thus focus on a particular dimension of working conditions, namely working time arrangements.

Second, we estimate the *average* impact of working conditions on sickness absence. Yet the (individual) impact may vary notably from an employee to another as, according to the model, it depends on the health status H_0, the wage rate w, and the rate of deterioration of health in case of exposure to poor or bad working conditions δ. These variables are all functions of individual characteristics such as gender, education, health-related behaviour, and so on. Thus, average impact is likely to be estimated on a (highly) heterogeneous population. This may cause aggregation bias. In order to reduce it as far as possible, we will control for individual characteristics and produce estimates on separate groups.

We thus need a data source with precise information on working conditions but also on individual characteristics of workers. This point raises many difficulties.

The first difficulty is that employees' descriptions of their working conditions may reflect both the reality of their work and the perception they have of it (Gollac, 1997). Second, employees' answers to questions about their working conditions in the past may be severely biased due to errors of memory (Molinié, 2003). Moreover, the biases are much higher when the working conditions are subject to personal perception or interpretation (such as moving heavy loads or being exposed to noise). We choose to focus our study on working time arrangements. This variable is more objective than other working condition variables and consequently less prone to measurement error. Besides, working time arrangements are likely to affect health: Few people can adapt completely to shift work and irregular working hours due to disturbances in their "biological clock" and in their daily lives (for a general review of health effects, see U.S. Congress, 1991; Wedderburn, 2000).

Another difficulty is to include health status in a causal chain linking working conditions to observed behaviour. Generally speaking, self-reported health status is a subjective variable and thus poses problems similar to those raised by indicators of working conditions. Moreover, these problems accumulate in the sense that, for example, individuals who declare themselves in bad health are induced to report their work environments as being harder than they really are. In addition, the effects of working conditions on health may appear in the long term. In order to avoid memory biases, information must be collected by resurveying the same individuals over time and by limiting retrospective questions.

To our knowledge, there does not exist any French data source that fulfills these requirements satisfactorily. The few panels available are too short or do not contain enough information either on working conditions or other characteristics of the job, health status, and sickness absence. More importantly, the compensation rate in case of sickness absence (the τ parameter of the theoretical framework) is not available in any survey.

For lack of a better alternative, we used the French "Labour Force Survey" (hereafter LFS). The LFS is conducted quarterly by the French National Institute for Statistics and Economic Studies (*Insee*). The survey sample is representative of the French population aged 15 and over. One over 600 persons are selected in the sample, and the number of respondents is about 75,000 each quarter. The large sample size is one decisive advantage of this data source, as there will be enough observations even in groups defined by age, gender, and occupation (see below).

Standard information such as educational attainment, occupation, age, job tenure, labour market status (employed, unemployed, not in the labour force), and industry is available each quarter. The LFS also contains information on working time arrangements. It is then possible to compare employees working a regular schedule (i.e., whose schedules do not vary from week to week) to those doing shift work, which account for 21.4 % of the sample, or those working irregular schedules (i.e., with schedules varying from week to week), which account for 15.1% of the sample.

One of the limitations of the LFS is that it does not contain information on health status or actual replacement rate, which may lead to biased estimates as stated before. In order to reduce the biases, we restrict our sample to male manual workers in the private sector, aged 18 to 59[4]. Male manual workers compose a rather homogenous population with similar levels of education and standards of living. Moreover, manual workers represent more than one third of the male working force in France. We have thus a large (sub)sample available: pooling LFS samples from the first quarter 2002 to the fourth quarter 2006, the total sample size is 17,874 observations. Smaller samples will provide less precise estimates, more sensitive to small sampling errors (this point is important, as sickness absence is rare in our data; see below). Moreover, we are able to estimate the impact of poor working conditions separately on four groups defined by age. As age is a (rough) proxy of health, it may reduce the heterogeneity bias.

Obviously, these sample restrictions will not eliminate all potential heterogeneity or the selection bias due to the "healthy workers" effect, well reported in ergonomic literature: Those working irregular schedules or shift work are probably the healthiest ones. They are thus probably less sensitive to poor working conditions. Moreover, working irregular schedules could give workers the opportunity to find time to exercise and rest for longer periods than others, thus decreasing their probability of sickness absence.[5] However, this selection bias is not so important for our subject, as it probably underestimates the impact of working schedules on sickness absence.

Here an employee is considered as having been absent for sickness reason if he declared not having worked due to illness during the entire "reference week," that is the calendar week before the interview. In France, all sickness absences—even short-term absences—have to be approved by a physician (see Appendix A). Thus, there is no theoretical reason to distinguish

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4 The retirement age is 60 in France. Legal working age is 16, but in our data workers under 18 are scarce.

5 Note, however, that in our case manual workers with irregular schedules could not choose convenient working times: According to the French survey on working times in 2001, 92% of male manual workers in the private sector with varying schedules have no choice to change their schedules.

short- and long-term absences. However, we only consider sickness absence of one week or more. There are two reasons for this. The first and principal reason is that sickness absences of less than one week are badly measured in our survey. Second, as our subject of interest is how bad or poor working conditions affect health, we prefer to ignore (very) short absences, for example, those due to colds or influenza, which are less likely to be directly dependent on working regular or irregular schedules.

That said, our variable of absence remains a choice variable. Of course, absence of a week or more is partly deterministic. When seriously ill, the worker has no other choice than to stop working. However, in many cases the worker keeps some freedom and may decide to continue working or not, depending on his resistance to disease or his aversion to lost wages in case of absence from work.

With this only measure on one “reference” week, the absence rate is very low. This may influence the robustness of the estimates. We then use information from the second interview that takes place three months later. In short, our indicator of sickness absence measures absence during the whole current reference week, or/and during the whole reference week of the next quarter. It thus captures, even very partially, the delayed impact of working conditions on health. The drawback is that we have to restrict the sample to those who answered twice and were still employed at the second time. We checked that excluded and selected individuals have on average similar observed characteristics, but we cannot exclude that selection bias may occur if they have different unobserved characteristics. We will return to this point below. On average, the rate of sickness absence is roughly 5.6 %.

Table 1 gives descriptive statistics of the sample. The wages of employees working irregular schedules or shift work are, on average, 11 % higher than those working regular schedules. This is in line with previous results on French data, which report wage differentials of roughly 16 points between shift and day workers (Lanfranchi *et al.*, 2002). Thus, the effect of irregular schedules on absence could be theoretically ambiguous (see section 2).

[Table 1 around here]

4. Econometric strategy and results

Among male manual workers working irregular schedules (resp. shift work), 6.2 % (resp. 5.9 %) were absent for illness reason during at least one of the two "reference" weeks (Table 2, columns (1a) and (1b)). This rate varies from 4.2 % (resp. 3.9 %) for workers aged 18-29 years to 8.4 % (resp. 7.9 %) for workers aged 50-59.

In order to first estimate the effect of working irregular or shift work on absence rates, we compare absence rates according to work schedules. In Table 2, the column (2a) shows the raw differences in absences rates of workers in irregular schedules with workers in regular schedules, while column (2b) presents differences in absence rates of workers doing shift work with those in regular schedules. These "naive" estimators exhibit very a small positive, insignificant effect of working irregular schedules or shift work on sickness absence.

However, these naive estimators are likely to be biased, as employees working irregular schedules or shift work could be selected according to characteristics also related to sickness absence. For example, as shift work is more frequent in industrial firms where workplace hazards are also more frequent naive estimation will result in spurious correlation between shift work and being absent for sickness reason.

As the Labour Force Survey is a (rotating) panel, one could first think of using repeated observations to reduce potential heterogeneity bias. However, panel data methods have several drawbacks in our case. First, the length of the panel is very short (one year and one quarter only). Individuals who change working time arrangements over this short period are scarce (roughly 2.5%). Identification thus would rely on a very tiny population. Second, attrition in the "Labour Force Survey panel" is quite large. As our outcome is the absence at work, we need to observe individuals at work during the whole period of the panel. Attrition could thus lead to serious biases here: As poor working conditions have a detrimental effect on the employee's health, it could affect his productivity and therefore the probability to continue working. This effect is observable in our data, as attrition appears correlated with the fact of being absent for illness reason at the time of the first interrogation (but not on work schedules). Finally, as our variable of interest is a dichotomous one, dealing with heterogeneity with panel estimates is strenuous. Fixed effects models could not be used as directly as in a linear case (as the probability of illness absence is close to zero, linear approximation does not stand here). Results would crucially depend on the assumptions on the parametric form.

For all these reasons, we thus prefer to rely on propensity score matching methods. We briefly present these methods in the next section.

4.1. Propensity Score Matching (*PSM*)

The general principle of matching methods can be quickly summarized as follows (for a comprehensive presentation, see Smith and Todd, 2005).

Let I be the "treatment variable", e.g., working with irregular schedules or doing shift work. Matching consists of (a) pairing each employee who works an irregular schedule ($I = 1$) with one (or more) employee(s) working a regular schedule ($I = 0$) and having the same (or roughly the same) observable characteristics, (b) comparing their respective propensities to be absent.

It is worth emphasizing here that the usual PSM method refers to a binary case. In our case, we have in principle two "treatments": working irregular schedules or shift work. Although we could easily extend the methodology to a multi-treatment case (see, e.g., Lechner, 2002), we prefer here to look separately at the effect of each treatment we consider. In each case the "control group" consists of employees working regular schedules.

Let us thus denote S_1 (resp. S_0) the propensity to be absent conditionally on working irregular schedules[6]. For each person, only one of the two outcomes S_0 and S_1 is observed. We are interested in estimating the average effect of working irregular schedules (instead of regular schedules) on sickness absence for employees working irregular schedules (*Average Treatment Effect on the Treated*)[7]:

$$\Delta = \mathrm{E}(S_1 - S_0 \mid I = 1) \qquad (5)$$

The difficulty arises from the fact that we observe here only S_1 but not S_0. To circumvent this difficulty, PSM methods rely on the so-called "unconfoundness assumption." It states that the outcome S_0 is independent of the type of schedules I, conditionally on a set of observables X:

$$S_0 \perp I \mid X \qquad (6)$$

6 We present the method for those working irregular schedules. Of course, it could be transposed directly to shift work.

7 The Average Treatment Effect (ATE) is also a parameter of interest. It needs a more stringent identificational assumption, as we need the--non observed--counterfactuals sickness absence rates not only for the individuals of the treatment group (workers in irregular schedules or shift work) but also for invidivuals of the control group (workers in regular schedules).

As shown by Rosenbaum and Rubin (1983), if (6) holds, then the following holds:

$$S_0 \perp I \mid b(X) \qquad (7)$$

for any “balancing” function of X, $b(X)$, i.e., such as:

$$X \perp I \mid b(X) \qquad (8)$$

In particular, the propensity score $p(X) = \Pr(I = 1 \mid X)$ is a balancing function of X. PSM methods consist of matching on this propensity score. They eliminate bias due to observable heterogeneity by balancing the observed covariates between the treatment group (irregular schedules) and the control group (regular schedules).

In practice, the propensity score is unknown and must be estimated. We follow the usual practice and estimate $p(X)$ by using a standard probit model (estimates are given in Appendix B). Our set of variables includes job characteristics that are likely to be linked simultaneously to different schedules and to the rate of sickness absence: branch of industry, occupation, firm size, or type of contract (permanent or temporary). It also contains individual characteristics such as age and qualification, which are closely related to health status. We include interactions between branch industry and firm size variables so that the property (8) is satisfied[8]. We use a radius matching estimator (each treated is matched with all untreated having the same value of propensity score, or propensity score within a small calliper around this value) and check that different specifications gives similar results.

Finally, in order to deal with heterogeneous effects related to age, estimation was carried out separately for workers aged 18-29, 30-39, 40-49, and 50-59.

4.2. Results

Columns (3a) and (3b) of Table 2 give the propensity score matching estimation results of the impact on illness absence of respectively working irregular schedules versus regular schedules and working shift work versus regular schedules.

The difference in probability of sickness absence between irregular schedules and regular schedules estimated by PSM is 1.41 and is significant at the 5 % level. Thus, working irregular

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8 We used balancing tests as a guide to specification : see Dehejia and Whaba (2002) or the contributions of Dehejia and of Smith and Todd to the special issue of the *Journal of Econometrics*, Vol. 125 (2005).

schedules plays a substantial role in absence, as it explains 1.41/6.25= 23% of total sickness absence of the concerned employees. By contrast, shift work does not seem to have a significant effect on illness absence on the whole sample. It is worth emphasizing this difference: One explanation could be that the painfulness of shift work is more acknowledged and taken into account by the employer than irregular schedule. This results in 1) higher wage (see descriptive statistics), which means, according to our model, a higher disincentive effect on absence; and 2) higher selection effect, as workers in bad health tend to be dismissed or selected from hard jobs. As we do not observe health status in our data, we could not control for this effect, and it is likely that we underestimate the true effect of shift work on absence.

[Table 2 around here]

Estimates by age also yield interesting results. First, the heterogeneity bias is strong. The difference between the "naive" estimator and the matching estimator is particularly impressive for the oldest group of workers when looking at the impact of both irregular and shift work. Shift work explains almost a third (=2.15/6.95) of the sickness absence rate for workers older than 40. Second, the impact of schedules on sickness absence is not necessarily positive, in accordance with the theoretical ambiguity. The impact of doing shift work is even negative for younger employees: -1.87 for 20-29 years old and -1.20 for 30-39 years old, although the difference is not significant.

To give some idea of the magnitude of an irregular schedule's detrimental effect on illness absence, we compare the observed absence rate of employees working irregular schedules with the "counterfactual" absence rate, i.e., the absence rates if these employees were not occupying jobs with irregular schedules or shift work. On average, the sickness absence rate of employees in irregular schedules would be 4.8 % (=6.2-1.4) if they had work in regular schedules. Not surprisingly, this counterfactual absence rate increases with age: It would be 4.7 % (=4.2+0.5) for 18-29 years old, but 6.3 % (=8.4-2.1) for 50-59 years old. It is worth noticing, however, that we do not observe this profile for employees doing shift work. An explanation relies on a dynamic "healthy worker effect" already mentioned: As times goes by, employees still in shift work are potentially the healthiest ones.

Note that matching method validity relies on the common support assumption: It states that we could find workers in regular schedules (non-treatment group) with a propensity score that is "similar" to that of almost all workers in shift or irregular schedules. In our estimates, common support is wide, as we exclude only from 0.1% to 1.5% of the "treated" individuals because of a lack of "comparable" non-treated individuals, even when we conduct estimates separately by age.

4.3. Robustness Checks

We use various matching methods to check that our results are robust: The estimated effect of working irregular schedules on sickness absence (estimates of 1.43 with radius method and probit specification for the propensity score) is 1.47 (0.53) with Kernel matching method and 1.82 (0.77) with nearest neighbour method; with logit specification for the propensity score, we obtain 1.47 (0.61) with radius method, 2.12 (0.74) with nearest neighbour, and 1.49 (0.53) with kernel matching.

More fundamentally, even if we restrict our sample to quite homogeneous workers, it aggregates unequal industries. One could ask whether the potential impact of irregular schedules or shift work is the same in different industries. As we match on the propensity score, young workers in one industry could be matched with older workers in other industries, since the age and industry dummies are only a sub-set of all available variables. As a test of robustness, we eliminate some very specific industries such as agriculture and check that the estimates remain unchanged[9]. Another way of dealing with industries' heterogeneity would have been to carry out separate estimates by industries. However, the sample size becomes too small to give reliable results.

5. Concluding remarks

We proposed a theoretical model of sickness absence based on the assumption that bad working conditions have an *indirect* impact on absence through the individual's health status. This impact turns out to be theoretically ambiguous, as it results from two opposite effects: a

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[9] E.g., when excluding agriculture, business services or personal services, impact estimates are 1.71** (0.69) for irregular schedules and 0.19 (0.66) for shift work.

disincentive wage effect and an incentive health effect. We propose an empirical test to disentangle these two antagonist effects on a particular case, working irregular schedules for male manual workers. This leads to three results. First, there is a positive significant impact of working irregular schedules on absence. Second, the sign and strength of the impact depend on age. Third, the impact varies with the nature of irregular schedules. These results call for comments.

To begin with, note that we do not ignore moral hazard phenomena. Our view is that it is very difficult, if not impossible, to separately identify “pure” health-related effects and “pure” *ex post* moral hazard. One reason is that moral hazard behaviour is largely influenced by unobserved individual characteristics. The validity of our empirical results rests on the assumption that moral hazard determinants (in particular, compensation rates) are well balanced between employees working irregular and regular schedules. The rich set of firm and individual characteristics we used gives us some confidence in our findings.

Next, the estimates by age show how much the impact of bad working conditions on sickness absence is heterogeneous. This confirms the relevance of our theoretical approach. Note also that because of this heterogeneity, one should therefore be cautious in generalizing the results beyond the study, as the sample consisted of a specific group of workers and specific working conditions.

Our empirical results may be biased, however. The PSM methods crucially depend on identifying “conditional independence assumption.” It implies that we observe all variables that jointly determine the propensity to work irregular schedules and the probability of being absent for illness reason. This is obviously not the case, as we have no information about the employee’s health status in our data. Health-related selection process (usually referred to as “healthy worker effect”) is probable: Employees suffering severe health troubles due to bad working conditions are likely to self-select or quit these jobs. As stated below, it means that our estimates are biased downwards. The real impact of working non-regular schedules is probably higher.

More generally, our model should be extended in two directions. The first one is to include the demand-side of the phenomena, particularly the risk for the employee to be laid off if he is (repeatedly) absent. Second, we ought to develop a dynamic model dealing with long-term absence. However, as already stressed, these models require demanding data sources in order to be empirically tested. As a matter of fact, these data are not yet available at least in France. This reinforces the necessity to collect them, especially as the social cost of sickness absence will probably grow in the future due to demographic trends in France as well as in other countries.

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Table 1. Descriptive statistics

	All	Regular Schedules	Irregular Schedules	Shift work
Mensual wage (dispersion)	1408.8 (4.6)	1355.8 (5.1)	1499.1 (14.1)	1506.4 (11.4)
Flexible annual working time agreement	20.6	16.6	29.1	26.8
Age=[18-29]	24.7	24.7	23.3	25.5
Age=[30-39]	30.2	29.4	32.8	30.7
Age=[40-49]	27.5	27.5	29.1	26.6
Age=[50-59]	17.6	18.4	14.9	17.2
Low vocational diploma	46.7	47.8	45.7	44.4
Qualification:				
Factory manual workers - highly qualified	28.8	23.7	15.4	52.5
Craft manual workers - highly qualified	25.6	34.3	18.7	5.0
Drivers	12.8	10.2	39.1	2.4
Handling and transportation manual workers	9.8	8.5	8.7	14.3
Factory manual workers – low qualification	14.4	12.5	8.2	24.1
Craft manual workers - low qualification	6.1	8.1	4.8	1.5
Farm workers	2.6	2.9	5.0	0.2
Firm Size =[1-9]	22.6	29.4	22.9	2.6
Firm Size =[10-49]	30.7	36.0	35.2	12.2
Firm Size =[50-199]	21.0	18.9	23.0	26.0
Firm Size =[200 et +]	23.0	12.9	15.7	57.3
Branch of Industry:				
Agriculture	3.4	3.9	5.3	0.3
Food industry	5.9	4.9	5.1	9.6
Consumer goods industry	4.2	3.5	1.9	7.4
Car Industry	4.9	2.8	0.8	14.1
Capital equipment goods industry	7.8	8.0	4.6	9.5
Intermediate goods industry	18.2	13.0	7.0	41.0
Construction	21.1	29.7	14.1	1.0
Trade and Repair	13.8	16.9	13.1	5.3
Transportation	12.3	8.2	36.3	7.7
Business Services	5.5	5.8	7.1	3.3
Personal Services	2.9	3.2	4.7	0.8
Sickness Absence Rate	5.6	5.4	6.3	5.9

Source: Labour Force Survey, from 1th quarter 2002 to 4th quarter 2006. Male manual workers in private sector, aged from 18 to 59.

Table 2. The effect of irregular schedules or shift work on the probability of being absent for sickness reason.

Age	Number of obs.	Irregular Schedules (vs Regular Schedules)			Shift Work (vs Regular Schedules)		
		Rate of sickness absence	"naïve" estimator	PSM estimator	Rate of sickness absence	"naïve" estimator	PSM estimator
		(1a)	(2a)	(3a)	(1b)	(2b)	(3b)
All	17,874	6.25 (0.47)	0.84 (0.50)	1.41** (0.61)	5.88 (0.38)	0.47 (0.42)	0.060 (0.63)
18-29 years	4,409	4.24 (0.81)	0.24 (0.88)	-0.47 (1.04)	3.94 (0.62)	-0.07 (0.72)	-1.87 (1.22)
30-39 years	5,397	6.47 (0.84)	1.58 (0.85)	2.51** (1.08)	5.44 (0.66)	0.55 (0.73)	-1.20 (1.09)
40-49 years	4,921	6.52 (0.89)	0.97 (0.94)	1.89* (1.19)	6.95 (0.79)	1.40 (0.85)	2.15* (1.23)
50-59 years	3,147	8.38 (1.40)	0.45 (1.49)	2.05 (1.90)	7.90 (1.04)	-0.03 (1.20)	1.76 (1.77)

Source: Labour Force Survey, from 1th quarter 2002 to 4th quarter 2006. Manual male workers in private sector aged from 18 to 59.
Standard errors in parenthesis. **: significant at the 5 % level. *: significant at the 10 % level. (1a) and (1b) is the sickness absence rates of employees working irregular schedules and shift work respectively; (2a) (resp. (2b)) is the raw difference in sickness absence rates between employees working irregular schedules (resp. shift work) and employees working regular schedules; (3a) and (3b) are the results of the PSM estimation.

Appendix A. Wage compensation for sickness absence in France

According to the French Social Security system, an employee has to justify *any* absence at work for illness reasons by providing a medical certificate to his employer within 48 hours. Otherwise he can be penalized and in some cases be laid off. In case of sickness absence the job contract is simply suspended. However if prolonged or repeated absences of the employee hinder the efficiency of the production process and make necessary the replacement of the employee, the employer can lay him off.

In case of absence an employee in private sector is entitled to sickness benefits unless she has not been working enough. The sickness benefits are paid by the Social Security system from the 4th day of absence. There is thus a waiting period of 3 days. The benefits are equal to 50% of gross wages - within a limit.

The benefits may be supplemented by employers under certain conditions fixed by collective agreements, for example by paying benefits during the first three days of absence. The employee’s seniority in the firm is an important parameter for the entitlement to supplementary benefits. Lastly private insurances can also pay a supplement.

Appendix B : Propensity score estimates (Irregular Schedules and Shift Work)

	Irregular Schedules	Shift work
Intercept	-1.17***(0.16)	-0.51*** (0.18)
Flexible annual working time agreement	0.43*** (0.03)	0.22*** (0.03)
Age=[18-29]	*Ref.*	*Ref.*
Age=[30-39]	0.02(0.04)	-0.08*** (0.04)
Age=[40-49]	0.01(0.04)	-0.21*** (0.05)
Age=[50-59]	-0.11*** (0.05)	-0.26*** (0.06)
Low vocational diploma	-0.03(0.03)	-0.02(0.03)
School Leaving age	0.02*** (0.01)	0.01(0.01)
French Nationality (=0)	-0.08(0.06)	-0.03(0.06)
Qualification:		
Factory manual workers - highly qualified	*Ref.*	*Ref.*
Craft manual workers - highly qualified	0.00(0.04)	-0.62*** (0.05)
Drivers	0.52*** (0.06)	-0.71*** (0.08)
Handling and transportation manual workers	-0.01(0.06)	0.13*** (0.05)
Factory manual workers – low qualification	-0.08(0.05)	-0.04(0.04)
Craft manual workers - low qualification	-0.02(0.06)	-0.61*** (0.09)
Farm workers	0.69*** (0.12)	-0.76*** (0.21)
Long Term contract	0.02(0.06)	-0.10(0.07)
Tenure		
[<1 year]	0.14*** (0.05)	-0.03(0.06)
[1-4 years]	0.16*** (0.04)	0.00(0.04)
[5-9 years]	0.15*** (0.04)	0.00(0.04)
[>10 years]	*Ref.*	*Ref.*
Activity :		
Production	-0.44*** (0.05)	0.45*** (0.07)
Repairing/maintenance	-0.35*** (0.06)	0.04(0.08)
Logistics/transportation	-0.32*** (0.05)	-0.02(0.07)
Others	*Ref.*	*Ref.*
Firm Size =[1-9]	-0.15*** (0.08)	-0.89*** (0.10)
Firm Size =[10-49]	-0.12(0.08)	-0.42*** (0.09)
Firm Size =[50-199]	-0.06(0.08)	0.21*** (0.09)
Firm Size =[200 et +]	0.03(0.08)	0.67*** (0.09)
Branch of Industry:		
Agriculture	-0.12(0.11)	-0.80*** (0.18)
Food industry	0.11(0.07)	-0.06(0.05)
Consumer goods industry	-0.12(0.09)	-0.16*** (0.06)
Car Industry	-0.50*** (0.12)	-0.11*** (0.05)
Capital equipment goods industry	-0.11**(0.06)	-0.61*** (0.05)
Intermediate goods industry	*Ref.*	*Ref.*
Construction	-0.14*** (0.05)	-1.70*** (0.08)
Trade and Repair	-0.07(0.05)	-0.50*** (0.05)
Transportation	0.64*** (0.05)	-0.14*** (0.06)
Business Services	0.17*** (0.06)	-0.40*** (0.07)
Nb obs.	13970	15223
LR chi2(43)	2086.94	6382.41

Source: Labour Force Survey. from 1th quarter 2002 to 4th quarter 2006. Male manual workers in private sector. aged from 18 to 59. Standard errors in parenthesis. ***: significant at the 1 % level. **: significant at the 5 % level. *: significant at the 10 % level.

Figure 1. Optimal level of absence rate.

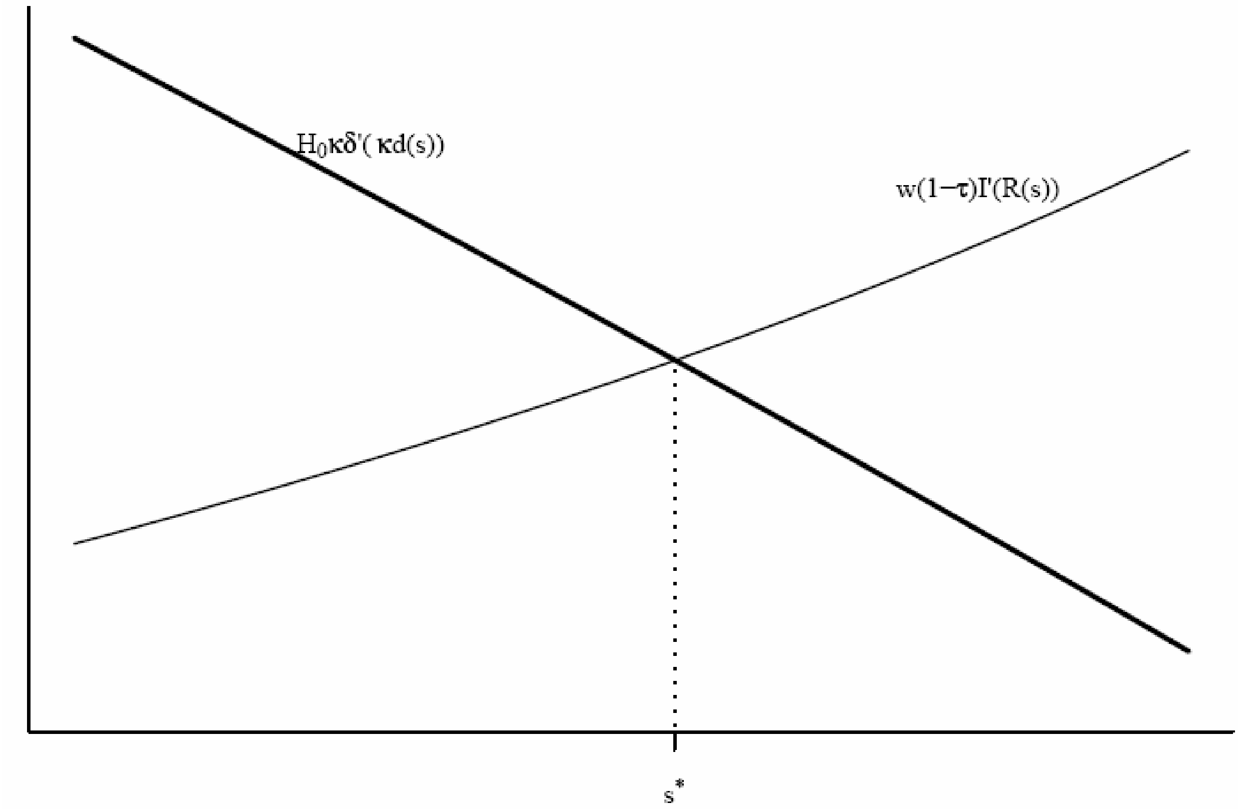

Figure 2. Impact of an increase in hardness of work (a), in contractual number of hours (b) and in compensation rate (c)