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OPTIMAL SICKNESS BENEFITS IN A PRINCIPAL-AGENT MODEL

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Optimal sickness benefits in a Principal-Agent Model

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Abstract

This paper studies the optimal design of sickness benefits in a repeated principal-agent model, where the fraudsters are not observed by the principal. Sickness compensation protects workers against the income fluctuations implied by the risk of illness and its provision is limited by the presence of fraudsters using this protection to temporarily adjust their labour supply. We show that the slope of the optimal contract depends on the dynamics of the rate of fraudsters over time. When the duration of temporary shocks on the disutility of work is shorter than the average duration of diseases, the sickness benefits must increase over time. In addition, A tax dependent on the length of the sick leave makes it possible to minimise the cost for a given promise-keeping constraint. Contrary to intuition, this tax must be decreasing because the necessity to penalise the shortest sick leave to deter agents from cheating.

Keywords: Sickness benefits, Absence rate, Recursive contracts.
JEL: I13; I18; J24

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1 Introduction

In this paper, the design of optimal sickness benefits is analysed using a repeated principal-agent model, where the fraudsters are not observed by the principal. This optimal contract minimises a principal's cost under a given promise-keeping constraint. Sickness compensations protect workers against the income fluctuations implied by the risk of illness. However the presence of fraudsters using this protection to react to a temporary variation of their work disutility limits the level of the benefits. Thus, we explore the optimal provision of sickness benefits when a risk-neutral agency (the principal) cannot observe[1] the fraud behaviours of risk-averse workers (the agents). We focus on two tools: sickness benefits and a tax dependent on the length of the sick leave. Indeed, there is considerable evidence that sickness benefits can increase sickness absence (De Paola et al. (2014), Johansson and Palme (2005), Pettersson-Lidbom and Thoursie (2013), Puhani and Sonderhof (2010), Ziebarth and Karlsson (2014)). Even if work absence is mainly due to illness (*e.g* epidemics, cancers, cardiovascular diseases, diabetes, mental health disorders,...), the impossibility of observing and sanctioning abuses of sick leave involve a risk of moral hazard. Thus, the principal must make a trade-off between protecting workers and reducing the fraud rate.

According to our review of the literature, no researchers have analysed absenteeism with a principal-agent model. The economic literature has provided several explanations for the work absence. Ehrenberg (1970) in a seminal theoretical paper argues that absenteeism is linked to overtime and extended work weeks. According to Ose (2005), sickness absences are the consequence of health degradation. Thus, bad working conditions in firms increase the absence rate. Thus, the cost of absences must be transferred from the government and workers to firms to provide incentives to improve work conditions. Allen (1981) suggests another explanation based on the traditional income leisure trade-off. Notably, labour supply and labour demand are not constant over time, and job contracts have fixed working hours. In this framework, sickness benefits allow adaptations to change in labour supply, labour demand, or work disutility. Shapiro and Stiglitz (1984) and Barmby and al. (1994) have presented models with moral hazard and efficiency wages. In these papers, the wage level has influenced the absence rate and productivity. Coles and Treble (1996) and Chatterji and Tilley (2002) have also been interested in productivity-absence rate links.

These theoretical works have highlighted the significant role of the gap between wages and sickness benefits in absence rate. A large part of the literature on this topic had been empirical and focused on determinants of the absence rate (Barmby, Orme and Treble (1995); Brown and Sessions (1996)). Many individual characteristics have demonstrated to affect the duration of sick leave: gender (Bridges and Mumford (2001)), age (Barmby and Stephan (2000)), seniority, number of children or income (Chaupain-Guillot and Guillot (2007)). Firms' characteristics and, in particular, working conditions also affect employees' health (Valssenko and Willard (1984), Strauss and Thomas (1998), Kuhn, Lalive and Zweimuller (2009) and Browning, Dano and Heinesen (2006)). Afsa and Givord (2009), with data from France, show that irregular working hours increase the absence rate and, a correlation between economic activity and absence rate. According to Arai and Skogman Thourise (2005) and, Askildsen, Bratberg and Nilsen (2005) the absence rate is pro-cyclical in Norway and Sweden.

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[1] If a pathology is perfectly observable by the principal, there is no moral hazard and the result is trivial: the replacement ratio is constant over time.

The level of sickness benefits is also a determinant of work absence. Johansson and Palme (1996) and, Henrekson and Persson (2004) provide evidence that an increase in the differential between wages and sickness benefits decreases the absence rate. A worker decides to take a sick leave when the increase in welfare associated with leisure offsets the reduction in income. Notably, a possibility is to limit the negative effects of sickness benefits by introducing the monitoring of absent workers. However, the monitoring of fraudsters is difficult. Firms do not have the skills to assess workers' health. Moreover, international standards of individual rights protect the doctor-patient relationship. In most OECD countries, medical confidentiality protects doctors and patients from interference by firms and governments: health is private information. Thus, health monitoring is imperfect, illegal, and costly.

To limit sickness benefits expenditures, firms and governments provide incentives through offering sickness benefits lower than wages that vary over time. To limit moral hazard, firms and governments can provide incentives by offering sickness benefits lower than wages and that vary over time. Thus, the introduction of waiting days deprives workers of income during the first days of their absence, after which the level of benefits increases with the sick leave duration. This compensation scheme creates an entry cost that reduces the moral hazard risk. The French healthcare system pays benefits from the fourth day of sick leave, amounting to 50% of the wage. However, more than two thirds of firms (usually medium and large firms) choose to complete these benefits. In France, the sickness benefits expenditures increased by 7.6% by year between 1997 and 2003. These expenditures were 5.3 billion euros in 2005 for a total of 200 million days of absence (Chaupain-Guillot and Guillot (2007)). To these direct costs, we can add the cost associated with the labour disorganisation in firms (e.g. temporary employment, overtime, loss of production). Work absences in the European Union imply a loss equivalent to 1% of GDP. With U.S. data, Szucs (1999) estimates the cost of the influenza: between USD 10 and 15 billion. According to Levy (1996), this cost is 2.5 billion dollars for France.

Table 1 presents the European legislation on compensation for sick leave. The second column corresponds to the duration of the waiting period, and the third column corresponds to the level of sickness benefits. The benefits are from 50% (France and Italy) to 70% (Netherlands) of the wage. In general, the level of benefits is indexed to wages. Only Ireland and England offer a lump sum. In Germany and Belgium, employees are compensated from the first day of illness. In the other countries, a waiting period is required. In France, Spain and Italy, workers are compensated only after 3 days absence. The waiting period is equal to 1 week in England. Thus, in most countries, the compensation profile is increasing. In the case of Spain and England, benefits also increase after several weeks of sickness. Compensation schemes for English and Irish workers are the least generous, whereas Belgian workers benefit from the most favourable systems. The fourth column reports whether there is an entitlement to full wage continuation[2]. Sometimes, employees have contracts that provide them with the right to sick pay the first day of illness. Nevertheless, ceteris paribus, waiting days increase the cost of the absence. Thus, Chaupain-Guillot and Guillot (2017) show that the workers are more likely to take sick leave in

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[2] The counterpart of the full wage continuation can be the annualization of the working time, ie the obligation to recover later the hours not made during the days of absence. Another justification is precisely to reduce absenteeism by avoiding the spread of contagious illness within the firm. In Italia, there is no waiting period for tuberculosis (MISSOC).

countries where there is an entitlement to full wage continuation, and where there is no a waiting period. The first column of the second table shows the share of employees absent for at least one day in the last month, and the second column shows the average length of absence per worker. Italy and France are the countries with the lowest rates of absence, that is, respectively 9.7% and 8.3%. Belgium and the Netherlands have the highest rates. However, French workers have the longest absence (12 days), and the Irish are absent on average 4 days.

Paradoxically, countries with a low absence rate have longer average lengths of absence. This phenomenon can be explained as follows: for France and Italy, the 3 day waiting period dissuades workers not seriously ill from taking sick leave. They can also have a deterrent effect on fraudsters. This phenomenon implies that workers taking a sick leave are on average more sick than in countries without a waiting period. Therefore, the average duration of a sick leave is longer.

Table 1: Sickness benefit: An international comparison

Country	A medical certificate from the 1^{st} day of absence	Day of Waiting period	Level of sickness benefit	Full wage continuation
Belgium	No	0	60% of wage	Yes
France	Yes	3	50% of wage	Yes
Germany	No	0	70% of wage	Yes
Ireland	Yes	6	196 euros by week	No
Italy	Yes	3	50% of wage	Yes
The Netherlands	Yes	2	70% of wage	No
Spain	No	3	60% of wage during the first 3 weeks, then 75%	No
UK	No	7	81 euros during the first 28 weeks, then 95 euros	No

Country	Share of employees absent at least on day in the last month	Average duration of sick leave
Belgium	15.1%	9
France	9.7%	12
Germany	10.5%	9
Ireland	12.6%	4
Italy	8.3%	9
The Netherlands	18.8%	7
Spain	11.5%	-
UK	-	5

Data: MISSOC (January 2019), Chaupain-Guillot and Guillot (2017)

Accordind to our review of the literature, waiting days or/and sickness benefits in a principal-agent framework have not been investigated. Our model is similar to the principal-agent models by Arrow (1963) and Holmstrom (1979). The closest models are those of Shavell (1979) and Hopenhayn and Nicolini (1997), but they are interested in the optimal profile of unemployment benefits. Our goal is to determine the optimal consumption profile to provide to an agent who does not commit fraud. For this, we assume that the principal is able to perfectly control the consumption level of the agent[3]. Thus, the

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[3] Obviously, taking into account precautionary savings or the full wage continuation would reduce the share of sickness benefits. However, this does not modify the result according to which the dynamics of the total consumption depends on the dynamics of the fraud rate.

principal must design an incentive scheme to minimise an expected cost subject to a given intertemporal utility. We develop a dynamic principal-agent model in which disutility of work is affected in each period by idiosyncratic shocks. A temporary increase in disutility encourages workers, sick or healthy, to leave work. Therefore, absent workers may be sick or healthy. We determine the optimal sickness benefits according to the sick leave duration by using a dynamic principal-agent model (Spear and Srivastava (1987) and Phelan and Townsend (1991)). We show that the slope of the optimal contract depends on the dynamics of the rate of fraudsters over time. If the duration of temporary shocks on the disutility of work is shorter than the duration of diseases, the sickness benefits must increase over time. By contrast, if the duration of temporary shocks on the disutility of work is greater than the duration of diseases, the sickness benefits must decrease over time. We also analyse the introduction of monitoring. In this case, at first, the introduction of monitoring increases the slope of the contract by reducing the rate of fraud in the long term. In a second step, the monitoring makes it possible to propose a flat compensation profile when no agent cheats. Indeed, by definition, if no worker cheats, the fraud rate is constant over time and equal to zero. The remainder of this paper is presented as follows. Section 2 presents the model, section 3 presents the numerical results, and section 4 concludes.

2 The basic model

2.1 The environment

In this subsection, we present a simple model to describe the properties of the optimal design of sickness benefits . We consider an economy where the labour supply can be temporarily modified by shocks to the workers' utility. We distinguish two types of shock. *(i)* First, temporary variations of the disutility of work ε_t independent of the agents' health , for instance, spouse's work, children' health, colleagues' productivity or weather can influence the decision to work (Connolly (2008), Bradley, Green and Leeves (2007)). *(ii)* Second, shocks on workers' health α_t. Obviously, diseases affect utility whatever the status in the labour market. However, for notational convenience, we normalise to zero the effects of shocks for agents on sick leave. Thus, α_t corresponds to the loss of utility for an individual who remains at work despite her/his illness. In other words, α_t can be interpreted as a variation in the work disutility following a shock on workers' health. This variation can be real or the consequence of a change in the perception of the work disutility in the particular case of mental health concerns such as depression or burn out. In this paper, we assume that the value of α_t is still sufficiently high to force the worker to take a sick leave.

Notably, j represents the health status with $j = h, s$ (healthy or sick). The disease is not the only cause of absence at work. Agents can use sick leave to adjust labour supply to the changes in the disutility of work. This phenomenon is possible because insurers cannot perfectly observe health status. Indeed, insurers do not have the skills to assess workers' health. In addition, the medical confidentiality between doctor and patient makes health private information. Thus, agents must choose between two states in the labour market: work ($i = e$) or sick leave ($i = n$). The existence of moral hazard implies a trade-off between incentives and protection of sick agents. To characterise the optimal design of sickness benefits, we consider a principal-agent model (Shapiro and Stiglitz (1984)) in which workers are risk-averse and the insurer (The principal) is risk-neutral. The preferences of the worker are:

$$E\sum_{t=0}^{\infty}\beta^t[u(c_t)-\varepsilon_t-\alpha_t] \tag{1}$$

where $0<\beta<1$ and $c_t>0$ are the intertemporal discount factor and consumption at time t. E is the expectation operator. $u(.)$ is a CRRA utility function, increasing, twice differentiable and strictly concave with $u'(0)=+\infty$:

$$u(c_t)=\frac{c_t^{1-\sigma}}{1-\sigma} \tag{2}$$

with σ as the risk aversion. All jobs are identical and paid by a constant wage w. On the other side, the sickness benefits are not necessarily constant over time. Workers on sick leave receive benefits equal to $b(t)$, where t is the duration of sick leave. We assume that the agent does not have access to the financial market. Workers cannot borrow or lend and hold no assets. This assumption means that the agent cannot use precautionary savings to insure against illness risks and against shocks of disutility at work. Therefore, the principal controls the consumption of the agent. In the presence of precautionary savings, the effects of switching from a flat compensation profile to the optimal contract depend on the wealth of the agents when they enter sick leave. Obviously, agents whose savings stock is zero cannot smooth their consumption during the waiting days ($b=0$) and therefore are strongly penalised by a growing profile of sickness benefits. Thus, solving the programme without precautionary savings is equivalent to assuming that the principal has a Rawlsian behaviour: She or he minimises the expected cost subject to a promise-keeping constraint for a sick worker with no precautionary savings.

To characterise the properties of the optimal contract analytically, we first assume that shocks to the work disutility are always sufficiently high to induce agents to take sick leave. This means that in this basic model, the probability to take sick leave is exogeneous. In the next section, by simulating the model numerically, we introduce an endogenous probability of cheating. We note the probability of being sick π and the probability of having a shock on the disutility of work q. In the second case, the agents stop work because they are not sick. The principal's objective is to limit the cost of this fraud without reducing the protection of truly sick agents.

Beyond the level of sickness benefits, the principal can limit the fraud by modifying the future welfare of the agent; to do this, an insurer can modulate the level of taxes based on the duration of sick leave. Similarly, firms can delay wage promotion. Schon (2015) argues that the impact of taking sick leave on future employment prospects affects workers' sick leave decisions in Germany. To consider this possibility of limiting fraud by modifying the level of future welfare of agents, we introduce the possibility for the principal to tax the worker according to the duration of her/his last sick leave. This tax θ_t is paid only once when returning to work. Thus, agents have no incentive to return sick leave to manage the level their tax. Notably, all tools to manipulate the future utility of agents have the same effects as this tax.

Several situations can lead to the end of sick leave. We denote the probability of cure ϕ and the probability of no longer experiencing an increase in the disutility of work ψ. In both cases, the sick leave stops, and the agent returns to work. Moreover, medical counter-expertise can be performed to identify fraudsters. The probability of detecting fraudulent behaviour is denoted as η. This parameter captures the frequency and the effectiveness of the controls. These probabilities follow a Poisson processes and are independent of the duration of the sick leave. If a healthy agent is sanctioned for sick leave at the period t, the benefits are suspended, and the agent returns to work and pays the tax θ_t.

In this section, we assume that any shock on the disutility of work or health always leads the agent to take sick leave with probabilities q and π. Thus, the instantaneous utility of employed workers is $u(w)$. The value functions of the employed worker (W), the sick worker (V^s), and the cheating worker (V^h) are from the solution to the following Bellman equations:

$$\begin{aligned}
W &= u(w) + \beta\Big(\pi V_1^s + (1-\pi)qV_1^h + (1-\pi)(1-q)W\Big) && (3)\\
V_t^s &= u(b_t) + \beta\Big(\phi(W - \kappa_{t+1}) + (1-\phi)V_{t+1}^s\Big) && (4)\\
V_t^h &= u(b_t) + \beta\Big((\eta + (1-\eta)\psi)(W - \kappa_{t+1}) + (1-\psi)(1-\eta)V_{t+1}^h\Big) && (5)\\
\text{with : } \kappa_{t+1} &= u(w) - u(w - \theta_{t+1}) && (6)
\end{aligned}$$

2.2 The optimal contract

We aim to analyse the properties of the optimal design of sickness benefits in a manner similar to Shavel and Weiss (1979) and Hopenhayn and Nicolini (1997). The insurer (the principal) cannot perfectly observe the behaviours of workers. Some workers may use sickness benefits to adjust their labour supply to a temporary shock of utility. Therefore, the insurer wants to design a compensation scheme that ensures a promised utility level to truly sick agents by minimising its costs. We formulate the optimal problem recursively. Notably, $C[.]$ is the expected total cost for a cohort of agents on sick leave. Because the principal cannot distinguish sick workers from cheaters, the expected cost depends on the evolution of the composition of the population on sick leave. Indeed, because the exit rates of the sick leave differ, the dynamics of these two populations differ.

Let Q^e be the number of workers in the economy. We deduce the number of sick workers ($Q_1^s = Q^e\pi$) and cheaters ($Q_1^h = Q^e(1-\pi)q$) at $t = 1$. The exit rate is ϕ for a sick worker and $\eta + (1-\eta)\psi$ for a cheater, the laws of motion are

$$\begin{aligned}
Q_t^s &= Q^e\pi(1-\phi)^{t-1}\\
Q_t^h &= Q^e(1-\pi)q[(1-\psi)(1-\eta)]^{t-1}
\end{aligned}$$

Then, the total number of agents returning to work after the period t is:

$$\Omega_t = Q^e\Big(\pi(1-\phi)^{t-1}\phi + (1-\pi)q[(1-\psi)(1-\eta)]^{t-1}(\eta + (1-\eta)\psi)\Big)$$

Therefore, the probability of observing a return to work after t period of sick leave is:

$$p_t = \frac{\pi(1-\phi)^{t-1}\phi + (1-\pi)q[(1-\psi)(1-\eta)]^{t-1}(\eta + (1-\eta)\psi)}{\pi(1-\phi)^{t-1} + (1-\pi)q[(1-\psi)(1-\eta)]^{t-1}}$$

The optimal contract consists of a sequence of unemployment benefits $B = (b_1, b_2, ..., b_t)$ and taxes $T = (\theta_2, \theta_3, ..., \theta_{t+1})$. These taxes may be negative. Then, they are interpreted as subsidies. For each contract $\{B, T\}$, there is a single value V^s and a single cost $C[.]$. The optimal contract mimimises total expenditure and provides an expected utility $V_1^s = \overline{V}$ for a newly-sick worker (the promise-keeping constraint). The total cost depends on the expected utility V^s provided to the sick agents

$$C\big[V_t^s\big] \quad = \quad \min_{b_t, V_{t+1}^s, \theta_{t+1}} \Big((Q_t^s + Q_t^h)b_t + \beta\big[C[V_{t+1}^s] - (Q_t^s + Q_t^h - Q_{t+1}^s - Q_{t+1}^h)\theta_{t+1}\big]\Big)$$

Because the exit rate and entry rate are exogenous, minimising the total cost is equivalent to minimising the average cost $\overline{C}[V_t^s] = \frac{C[V_t^s]}{Q_t^s + Q_t^h}$. Then, $\overline{C}[.]$ must satisfy the following Bellman equation

$$\begin{aligned} \overline{C}\big[V_t^s\big] \quad &= \quad \min_{b_t, V_{t+1}^s, \theta_{t+1}} \Big(b_t + \beta\big[(1-p_t)\overline{C}[V_{t+1}^s] - p_t\theta_{t+1}\big]\Big) \\ \text{subject to} \quad &: \quad V_t^s \leq u(b_t) + \beta\Big(\phi(W - \kappa_{t+1}) + (1-\phi)V_{t+1}^s\Big) \\ \text{with} \quad &: \quad \kappa_{t+1} = u(w) - u(w - \theta_{t+1}) \end{aligned}$$

We denote λ as the multiplier on the constraint. The first-order conditions with respect to b_t, V_{t+1}^s and θ_{t+1} for this principal's problem are

$$1 \quad = \quad \lambda u'(b_t) \tag{7}$$

$$(1-p_t)\overline{C}'[V_{t+1}^s] \quad = \quad \lambda(1-\phi) \tag{8}$$

$$p_t \quad = \quad -\lambda\phi u'(w - \theta_{t+1}) \tag{9}$$

And the envelope condition is:

$$\overline{C}'[V_t^s] = \lambda \tag{10}$$

Proposition 1 *If the average duration of a shocks on the disutility of work is shorter than the average duration of an illness, sickness benefits increase at the beginning of the sick leave.*

Together, the first-order condition 7 and the condition 8 allow us to conclude that $\overline{C}'[V_{t+1}^s] = \frac{1-\phi}{(1-p_t)u'(b_t)}$. With the envelope condition, we have

$$u'(b_{t+1}) = u'(b_t)\chi \tag{11}$$

with

$$\chi = \frac{1-p_t}{1-\phi} = \frac{1 + \frac{q(1-\pi)}{\pi}\left[\frac{(1-\psi)(1-\eta)}{1-\phi}\right]^t}{1 + \frac{q(1-\pi)}{\pi}\left[\frac{(1-\psi)(1-\eta)}{1-\phi}\right]^{t-1}} \tag{12}$$

This result implies that if $(1-\psi)(1-\eta) < 1-\phi$, $u'(b_t) \geq u'(b_{t+1})$. In other words, the consumption must increase over the duration of the sick leave. The explanation of this result is simple: when cheaters return to work faster than sick agents, reducing benefits at the beginning of the sick leave increases the cost of cheating. This reduction in benefits does not penalise the genuinely sick agents because it allows the financing of an increase in benefits in the long-term. Notably, the optimal profile is only influenced by the relative sick leave durations of the two types of agents.

Proposition 2 *An increase in the probability η of being monitored and punished has an ambiguous effect on the slope of the optimal contract.*

The derivative of χ with respect to η is positive if the following condition is true

$$t\Big[1-\frac{(1-\psi)(1-\eta)}{1-\phi}\Big] \geq 1+\frac{q(1-\pi)}{\pi}\Big[\frac{(1-\psi)(1-\eta)}{1-\phi}\Big]^{t} \tag{13}$$

Thus, the sign of the derivative of χ with respect to η is ambiguous. In other words, an increase in monitoring can increase or decrease the slope of the optimal contract. This result is explained by the existence of two economic mechanisms. First, a high rate of sanction eliminates long-term fraud. Thus, fraudsters are concentrated on the first days of sick leave. In this case, the optimal policy would reduce sickness benefits during the first days of sick leave and increase sickness benefits for long-term patients. Secondly, regardless of the average duration of each episode of fraud, the monitoring reduces the rate of fraud. When the fraud rate is already low, an increasing slope no longer makes it possible to significantly reduce costs. Additionally, such a contract is expensive in terms of welfare for risk-averse sick agents. In this case, the principal is interested in reducing the slope of the optimal contract. The extreme situation is $\eta = 1$ (perfect monitoring). Then, χ is equal to 1 for $t > 1$: the optimal contract is flat from the second day of sick leave. In terms of economic policy, this result implies that the introduction of monitoring makes it possible to reduce the waiting period when the average duration of the fraud episodes is short. For long periods of fraud, the first effect dominates, and the introduction of monitoring must be accompanied by a strengthening of the waiting period.

Proposition 3 *If the average duration of shocks on the disutility of work is shorter than the average duration of illness, sickness benefits become constant in the long run.*

By considering equation 12, we observe that if $(1-\psi)(1-\eta) < 1-\phi$, $u'(b_t) = u'(b_{t+1})$ when $t \to +\infty$. When cheaters return to work faster than sick workers, the number of cheaters tends to zero for the long-term sick leave. In this case, the principal no longer has incentives to offer increasing sick benefits.

Proposition 4 *If the average duration of a shock on the disutility of work is less than the average duration of an illness, the tax deacreases over time.*

The first-order condition 9 implies

$$\frac{u'(w-\theta_{t+1})}{u'(w-\theta_{t+2})} = \frac{p_t u'(b_t)}{p_{t+1}u'(b_{t+1})}$$

with the equation 11, we have

$$\frac{u'(w-\theta_{t+1})}{u'(w-\theta_{t+2})} = \frac{1+[\eta+(1-\eta)\psi]\left[\frac{(1-\pi)q}{\pi\phi}\right]\left[\frac{(1-\psi)(1-\eta)}{1-\phi}\right]^{t-1}}{1+[\eta+(1-\eta)\psi]\left[\frac{(1-\pi)q}{\pi\phi}\right]\left[\frac{(1-\psi)(1-\eta)}{1-\phi}\right]^{t}} \tag{14}$$

This result implies that if $(1-\psi)(1-\eta) < 1-\phi$, $u'(w-\theta_{t+1}) > u'(w-\theta_{t+2})$. Thus, the level of consumption when the agent returns to work increases with the duration of the sick leave. In other words, the tax decreases with the duration of the sick leave. Notably, when cheaters return from of sick leave more quickly than sick workers, a degressive tax makes it possible to transfer financial resources to sick agents. Thus, the principal can guarantee the promise-keeping constraint by reducing the cost of fraud.

Note that the assumption of no precautionary savings does not change our result that the slope of the sickness benefits depends on the dynamics of the fraud rate over time. In the presence of precautionary savings, the principal could fully transfer the cost of fraud to agents by not taking care of workers during the first days of sick leave. In return, the promise-keeping constraint would be ensured by an increase in sickness benefits in the medium and long term. Thus, taking precautionary savings into account would strengthen our results concerning the slope of the optimal contract [4]. For sick agents, this steeper slope could be interpreted as a reimbursement in the medium term of the costs incurred during the waiting days.

In this section, we have shown that whether sickness benefits increase or not depends on the relative duration of a period of fraud and a period of sickness. However, we assumed that sick leave entry and exit rates were exogenous and did not depend on the compensation scheme. In the next section, we introduce endogenous probabilities and then calibrate the model to estimate the expected gains from the introduction of the optimal contract.

3 Numerical model

The compensation scheme can change the behaviour of the agents. In particular, the reduction of benefits during the first days of sick leave reduces the number of frauds and encourages agents to remain in employment. In this section, we assume that entry rates to sick leave are endogenous. Because the promise-keeping constraint is constant for the sick workers, the optimal contract can only change the entry rate of fraudsters. In other words, the optimal contract cannot affect the presenteeism rate. Then, the optimal contract depends on the endogenous distribution of agents in different states of the economy. Therefore, the analysis of the optimal contract must be solved numerically.

3.1 Endogenous probability

Similar to Allen (1981), we assume that the decision to work is the result of a trade-off between labour income and the disutility of work. In this section, q is no longer exogeneous. We assume that the probability of shock on the disutility of work is ψ. Then, a new value of disutility is drawn in a distribution,

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[4] In the case of utility shock longer than the average duration of an illness, the slope would also be stronger in order to mobilize the precautionary savings of cheaters in the long term.

and the agent can use sickness benefits to adjust labour supply according to the changing value of disutility. The disutility of work is drawn from a known distribution $F(\varepsilon)$ with support $(0,+\infty)$ and density $f(\varepsilon)$. This assumption implies that the disutility of work is not constant through time. Let x denote the reservation value of disutility of work. The probability of cheating is now $q=\psi(1-F(x))$. When an agent is on a sick leave the probability of shock is also ψ, but we assume that the value of ε is always zero and implies returning to work. In other words, $\frac{1}{\psi}$ is average duration for a fraud sequence. The probabilities of becoming sick π and to cure ϕ remain unchanged.

Let $W(\varepsilon)$ denote the expected value for workers at time t, and V_t^j denote the expected value for workers on sick leave with a health state $j=s,h$, after t period. The Bellman equations are

$$\begin{aligned}
W(\varepsilon) &= u(w)-\varepsilon+\beta\Big(\pi V_1^s+(1-\pi)\psi\int_0^{+\infty}\max\left(W(\varepsilon'),V_1^h\right)\mathrm{d}\varepsilon'+(1-\pi)(1-\psi)W(\varepsilon)\Big) && (15)\\
V_t^s(\varepsilon) &= u(b_t)+\beta\Big(\phi(W(0)-\kappa_{t+1})+(1-\phi)V_{t+1}^s\Big) && (16)\\
V_t^h(\varepsilon) &= u(b_t)+\beta\Big(\eta(W(\varepsilon)-\kappa_{t+1})+(1-\eta)\psi(W(0)-\kappa_{t+1})+(1-\eta)(1-\psi)V_{t+1}^h\Big) && (17)\\
\text{with : }\kappa_{t+1} &= u(w)-u(w-\theta_{t+1}) && (18)
\end{aligned}$$

For each contract $\{B,T\}$, these Bellman equations allow us to determine the optimal rules of entry into sick leave.

3.2 Equilibrium of flows

Agents maximise their welfare by choosing the reservation value of the disutility of work below which they work. Let x denote the reservation value of disutility of work. x is given by the equality between the expected discounted value of an agent at work and the expected discounted value of a healthy agent on sick leave (a fraudster), $W(x)=V_1^h$. Therefore, when a worker has a shock on her/his disutility, the probability of remaining at work is $F(x)$. Thus, in the steady state, the equilibrium of flows for the workers is:

$$Q^e\left[\pi+(1-\pi)\psi(1-F(x))\right] = \sum_{t=1}^{+\infty}Q_t^h(\eta+(1-\eta)\psi)+\sum_{t=1}^{+\infty}Q_t^s\phi$$

For the agents on sick leave, the equilibrium of flows is

$$\begin{aligned}
Q_1^h &= Q^e(1-\pi)\psi(1-F(x))\\
Q_1^s &= Q^e\pi\\
Q_{t+1}^h &= Q_t^h(1-\psi)(1-\eta)\\
Q_{t+1}^s &= Q_t^s(1-\phi)
\end{aligned}$$

A contract is characterised by a vector $B = [b_1, b_2, ..., b_t]$ and a vector $T = [\theta_2, \theta_3, ..., \theta_{t+1}]$. Given this contract, agents maximise their expected discounted utility by choosing reservation values. Then, we can deduce the vector for the stationary distribution of population consistent with the decision rules of the agents.

3.3 The principal's problem

The objective of the principal is to minimise the cost of providing a promise-keeping constraint $V_1^s = \overline{V}$ for a newly-sick worker on sick leave. Insurers cannot observe reservation values of the disutility of work, but the economic environment is public information. Therefore, the principal knows the distribution $F(.)$ and the probabilities to become sick and be cured. Insurers choose the optimal sick leave compensation scheme, which is characterised by a sequence of sickness benefits, $B = [b_1, b_2, ..., b_t]$ and a sequence of taxes, $T = [\theta_2, \theta_3, ..., \theta_{t+1}]$. We assume that workers cannot smooth consumption through time by using precautionary savings. Thus, the principal perfectly observes and controls the agents' consumption.

For each contract, $\{B, T\}$, there is a single vector of the distribution of the population $D = [Q^e, Q^s, Q^h]$. The equilibrium of flows ensures the stationarity of the distribution. Consequently, the optimal contract is a contract that minimising the total cost $C[.]$ for all t under the promise-keeping constraint. Thus, $C[.]$ must satisfy the following program:

$$\begin{array}{rcl} C\big[V_t^s\big] & = & \displaystyle\min_{b_t, V_{t+1}^s, \theta_{t+1}, x} \Big((Q_t^s + Q_t^h) b_t + \beta \big[C[V_{t+1}^s] - (Q_t^s + Q_t^h - Q_{t+1}^s - Q_{t+1}^h) \theta_{t+1} \big] \Big) \\ \text{subject to} & : & V_t^s(\varepsilon) \leq u(b_t) + \beta \Big(\phi (W(0) - \kappa_{t+1}) + (1 - \phi) V_{t+1}^s \Big) \\ \text{with} & : & \kappa_{t+1} = u(w) - u(w - \theta_{t+1}) \\ \text{and} & : & Q_t^s = Q^e \pi (1 - \phi)^{t-1} \\ & & Q_t^h = Q^e (1 - \pi) \psi (1 - F(x)) [(1 - \psi)(1 - \eta)]^{t-1} \end{array}$$

Several contracts provide the promise-keeping constraint $V_1^s = \overline{V}$ but with different costs for the insurer. The optimal contract is a contract that minimises the expected discounted cost for the insurer. We observe that the program of our basic model has, in addition, a quantity effect. Now, we can manipulate the incoming flow of fraudsters by modifying the slope of sickness benefits. Indeed, the principal minimises its costs for a given level of welfare. Thus, in our model, the welfare provided to sick agents is given and identical regardless of the compensation profile chosen. Therefore, the decision to take sick leave for sick agents is never affected by the form of the contract. In other words, the optimal contract cannot affect presenteeism[5]. This case is not the case for fraudsters. Indeed, when the average duration of a shock of disutility is shorter than the average duration of illness $((1 - \psi)(1 - \eta) < 1 - \phi)$, then all increasing profiles providing $V_1^s = \bar{V}$ imply a reduction of the level V_1^h. This mechanism reduces the influx of fraudsters into sick leave.

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[5] This is the reason why we can assume that the probability to take a sickness absence π is exogenous.

The presence of sick individuals at work is a major fact often underestimated in the public debate. Recent literature shows that presenteeism has significant consequences on the productivity of firms and on public finances (Johns (2010)). Barmby and Larguem (2009) provide evidence that some diseases involve contamination risks reducing productivity in the firm. In other words, the risk of illness is not always an individual risk. It is also a collective risk which justifies sick leave for contagious workers and/or the obligation to be vaccinated. For Bergström and al. (2009), presenteeism has medium and long-term effects on workers' health conditions, and thus on their employability. This point is particularly important in the context of pension system reforms that postpone the retirement age. Hemp (2004) argues that the cost of presenteeism is greater than the cost of absenteeism and medical treatment. However, our analytical framework ignores the issue of presenteeism. As the principal programme shows, the optimal contract is the sequence of sickness benefits which minimises the expected cost subject to the promise-keeping constraint ($V_1^s = \bar{V}$) for a newly-sick worker. In other words, whatever the outcome of the principal's programme, a sick agent who stops work has an expected utility equal to $\bar{V}$. By definition, for a sick worker, the value associated with employment and the value associated with sick leave are never affected by the design of the optimal contract. This is the reason why the optimal contract cannot change the decision to take (or not take) sick leave when the worker is really sick. Therefore, the sequence of sickness benefits is neutral on presenteeism. This is not the case for a worker who suffers a shock of disutility as long as the expected duration of shocks on the disutility is different of the expected duration of diseases. Thus, the principal's programme acts on the rate of fraud for a given presenteeism.

4 The optimal sick leave compensation design

The model has only a few parameters to calibrate. Therefore, this section does not claim to be a quantitative forecasting exercise. Our goal is to numerically illustrate the qualitative characteristics of the model. Indeed, the need to consider the dynamics of the population prevents us from studying the properties of the optimal contract analytically. In this section, after a calibration of our model, we compare the perfect information case to the imperfect information case with constant sickness benefits. Next, we study the optimal contract when sickness benefits vary by the duration of the sick leave. Finally, we discuss the effects of monitoring.

4.1 Calibration

The model is calibrated from the French insurance compensation system. The reference period is the day. Following the economic literature on optimal contracts, we set the coefficient of relative risk aversion σ to 2. The discount factor β is equal to 0.9999, which implies an annual discount rate of 4%. The wage is normalised to 1, and there is no monitoring and no tax for the benchmark calibration ($\eta = 0$ and $\theta_t = 0$).

The French healthcare system is based on two pillars: a public insurance system financed by obligatory social contributions based on wages, and a private insurance system used by patients and their employers. In most situations, the replacement ratio exceeds 90% after a benefit waiting period of 3 days. On average, a blue-collar worker receives 50% of his/her wage per episode of sick leave ($b = 0.5$). According to DARES[6] (2013), in France, the absence rate of blue-collar workers is 4.2%. This rate is similar to rates observed in other European countries: the average for Canada, Czech republic, France, Luxembourg, Slovenia, Spain, Sweden, Switzerland, and United Kingdom is 4% (see Barmby, Ercolani and Treble (2002). The average duration of a sick leave is slightly greater than 6 days. Assuming, as in our model, that the probability of healing follows a Poisson distribution, we set $\phi = \frac{1}{6}$. Thus, to reproduce the absence rate of 4%, the probability of becoming sick must be calibrated to $\pi = 0.007$.

Individual characteristics play an important role in explaining the absence rate. However, this paper analyses the incentives provided by the sickness benefits profile. We assume the individual characteristics given. The calibration of the model reproduces the elasticity of the number of sick leave less than 2 days compared with the average level of sickness benefits. This strategy allows us to capture the effects of the compensation scheme. In practice, the generosity of the contract should also take individual characteristics even if the slope of the contract and the economic mechanisms at work remain the same for all agents. By definition, no data is available on the number of fraudsters. However, we observe that recent variations in the amount of compensation reduced the number of sick leave cases significantly. In 2012, the addition of a 1-day waiting period reduced the number of sick leaves less than 2 days by 45%. Thus, with the French healthcare system, a reduction of 1% of the average replacement ratio (for one episode of sick leave) reduces the number of sick leaves less than 2 days by 3%. We do not claim that this result is due to a decrease in fraud because some sick workers likely also gave up taking sick leave. Thus, our goal is to replicate the effects of reduced benefits on the number of sick leaves less than 2 days and not a fraud rate. To reproduce this elasticity, we set $\psi = \frac{1}{2}$ (the duration of an episode of fraud is on average 2 days) and calibrate $F(.)$. Then, the distribution $F(.)$ is log-normal with a mean equal to 0.1 and a standard deviation equal to 1.

Thus, the duration of temporary shocks on the disutility of work is shorter than the duration of diseases. This calibration seems consistent with our analysis framework where the employment contracts are rigid and do not adapt to fluctuations in the labour supply of individuals: If the shock is permanent or long-term, the worker prefers to reduce her or his job offer permanently or for a long period. In this case, depending on the severity of the shock, the optimal strategy may in choosing inactivity, renegotiating the labour contract, finding a job with a lower hourly volume, or defrauding unemployment insurance. By contrast, if the shock is short, the agent prefers to reduce her or his hourly volume temporarily, but without resigning from her or his job. Thus, if the organisation of the firm does not allow the freedom to smooth the hourly volume of work over one week, one month or one year, sickness benefits can be an optimal response for the worker. Therefore, this self-selection process implies that individuals suffering from long-term shocks will necessarily have less recourse to sickness benefits fraud than those suffering from short-term shocks. Otherwise, a fraudster must choose a pathology that is difficult to observe. Then, the most effective strategy to minimise the risk of detection is to pretend to have a short pathology that leaves no visible sequel after sick leave[7]. Finally, several empirical studies have shown that a reduction

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[6] French Ministry of Labour

[7] This calls for compensation profiles adapted to the illness declared by the patient: When it is easy for the principal to

in sickness benefits had a significant effect on short-term sickness absence and the long-term effects seem more ambiguous and less powerful (Ziebarth (2013), Markussen et al. (2011), Eliason, Johansson and Nilsson (2019)). These variations may be the consequence of higher presenteeism and/or the presence of a moral hazard. In all cases, the effects are more significant in the short term. This supports the hypothesis of a higher fraud rate among short-term absences than among long-term absences.

Table 2: Benchmark calibration

Parameters		Values	Targets
Discount factor	β	0.9999	Yearly interest rate of 4% Unit of time = day
Relative risk aversion	σ	2	Cooley and Hansen (1995)
Monitoring rate	η	0	Arbitrary value
Wage	w	1	Normalisation
Return to work tax	θ	0	Arbitrary value
Sickness benefits	b	0.5	Average benefits in France
Probability of becoming sick	π	0.007	To reproduce the absence rate of blue-collar workers
Probability of healing	ϕ	0.166	Average duration for a sick leave
Probability of disutility shock	ψ	0.5	Average duration of a fraud episode

The steps of our calibration strategy are follows. Step 1: We set a compensation sequence identical to that of the French healthcare system with a waiting period of 3 days. Next, we calibrate the model to reproduce the aforementioned stylised facts. Step 2: To determine the promise-keeping value, we simulate the model by assuming constant sickness benefits equal to the average French replacement rate ($b = 0.5$). The promise-keeping value is equal to the intertemporal value of a sick worker during the first day of sick leave when the benefits are constant ($V_1^s = \overline{V}$). Let c the level of constant consumption that reproduces the intertemporal utility for a sick worker; we have $\overline{c} = [(1-\sigma)(1-\beta)\overline{V}]^{\frac{1}{1-\sigma}} = 0.813$. Finally, we estimate the cost function by the Chebyshev polynomial method (Chugunova and Pelinovsky (2009)) and find the optimal contract under the constraint $V_1^s > \overline{V}$.

4.2 The optimal contract in perfect information

What is the potential gain from introducing the optimal sickness benefits? To answer this question, we realise three numerical simulations of our model. In the first simulation, the principal never observes the fraud behaviour and the sickness benefits are constant. Therefore, the compensation profile provides no intertemporal incentive. We assume that benefits are equal to the average level observed in France ($b = 0.5$). In the second column, we assume that the information is perfect. This assumption is why the level of sickness benefits for healthy agents is $b^h = 0$. In addition, the sickness benefits of sick agents are maintained at $b^s = 0.5$. In the third simulation, we assume that the principal perfectly observes the fraud behaviour. The sickness benefits b^s and taxes θ minimise the cost of the principal $C[.]$ under the promise-keeping constraint $\bar{V}$. The results are presented in the table 3.

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check ex-post the reality of pathology, the waiting days are no longer necessary.

Table 3: Perfect information

	Imperfect information $b = 0.5$	Perfect information with $b_s = 0.5$	Perfect information Welfare constraint
$C[V_t^s]$	0.0264	0.0189	0.0183
$\bar{c}$	0.8130	0.8106	0.8130
b^h	0.5	0	0
b^s	0.5	0.5	0.54
θ	0	0	0.39
Absence rate	0.0547	0.0395	0.0395
Fraud rate	0.2880	0	0

The first column of Table 3 shows the equilibrium when information is imperfect. The principal cannot observe the causes of the absence. Therefore, sickness benefits are identical for agents who are sick and fraudsters abusing the sick leave system ($b^s = b^h$). In this simulation, the sickness benefits are constant. The principal provides no intertemporal incentive. Consequently, the absence rate and the fraud rate are higher than those of the calibration where there are 3 days of waiting: these rates are, respectively, 5.47% and 28.8%. This compensation scheme without any intertemporal incentive is our benchmark case and allows us to obtain the promise-keeping constraint $\bar{V}$. The constant consumption level $\bar{c}$ reproducing the value $\bar{V}$ is 0.813 and the average cost per sick leave episode is 0.0264. The constant level of consumption $\bar{c}$ of individuals on sick leave is higher than the level of benefits ($b = 0.5$), and this result is explained by the discounting of future wages.

In the second column, we assume that the information is perfect and the sickness benefits of sick agents are maintained at $b^s = 0.5$. Therefore, this exercise makes it possible to estimate the cost of fraud. Thus, the cost decreases by 28.4 % from 0.0264 to 0.0189, and welfare decreases from 0.8130 to 0.8106. These variations are only due to the disappearance of the healthy agents that use sickness benefits to protect themselves from disutility shocks. In other words, the decrease in welfare can also be interpreted as the cost of the disappearance of an insurance against labour disutility shocks.

In the third column, we assume that the information is perfect. Thus, the principal provides $b^h = 0$ and chooses the levels b^s and θ, which minimise its costs under the promise-keeping constraint and results in offering a welfare level $\bar{c} = 0.813$. Because the information is perfect, the fraudsters are eliminated, and offering intertemporal incentives is unnecessary. The sickness benefits are constant and equal to $b^s = 0.54$. Similarly, the principal uses a constant tax equal to $\theta = 0.39$. Thus, the income of a sick individual increases from 0.54 to 0.61 when he/she returns to work and from 0.61 to 1 after the second day of work. The use of the tax smooths income fluctuations over an additional period. In the presence of risk aversion, the smoothing of fluctuations over time makes it possible to provide an identical welfare benefit at a lower cost.

The impossibility of cheating in the future in the hypothesis that includes a major shock on the disutility of work has a negative effect on the welfare. Therefore, the principal must offset this effect by a slight increase in benefits. However, this effect is marginal compared with the reduction in cost obtained by the suppression of fraud. Thus, the cost for the principal ($C[V_1^s]$) decreases from 0.0264 to 0.0183. The last column is the best solution for the principal[8]. In the next section, we demonstrate how the use of a non-flat compensation profile makes reaching this situation in the presence of information asymmetry possible.

4.3 The optimal contract with sickness benefits no constant

To reduce the number of frauds, most compensation systems require a waiting period of a few days. Thus, the cost of the sickness is paid by the workers during the first days. This entry cost is intended to dissuade fraudsters. Table 4 reports the optimal contract when sickness benefits are not constant through time. In the first column, the principal minimises the cost under the promise-keeping constraint by using the sickness benefits. Similar to what has been observed in most countries, our simulations show a progressive compensation profile over time. However, the replacement ratio is not equal to zero from the first day: The replacement ratio is 32.3% the first day, 47.6% the second day, and 63.1% after 1 week. Providing no sickness benefits in the early days is a policy too expensive in terms of welfare for sick workers because of their risk aversion. As a result, the principal offers increasing benefits from the first day of illness. The intuition for this result is straightforward. Because shocks on the disutility of work have a shorter duration than a disease, the contract must be more generous with the longest sick leave durations. Notably, when the shock on disutility ceases, work is always preferable to sick leave regardless of the value of the benefits. For this reason, the level of benefits modifies the probability of absenteeism for an agent affected by a disutility shock but does not modify the probability of returning to employment for an agent whose disutility has returned to zero. This optimal contract reduces the absence rate to 4.22% with 6.68% of fraudsters. This mechanism allows to converge to the system with perfect information. Indeed, the introduction of progressive benefits in the case of imperfect information decreases the cost from 0.0264 to 0.0216.

Columns 2 and 3 in Table 4 report the same exercise when the principal can use a wage tax. To encourage the workers to not manipulate the tax level, we assume that agent history is cleared after 2 days of work. Thus, the tax is only collected when the agent returns to work, that is, an individual absent n days has a loss of income during $n+1$ days. The introduction of this tool allows the principal to smooth the decline in income over a longer period. Table 4 reports the evolution of the sickness benefits and taxes under the same constraint that we observe in the first column. Notably, the sickness benefits always increase over time, but at a slower rate. For the first day of the sick leave, the replacement ratio is 47.1%. By contrast, in the absence of a tax, the ratio is 32.3%. Column 3 reports the tax level paid by the worker when he/she returns work. This tax decreases over time to penalise fraudsters whose absences are on average shorter than sick agents. In other words, the degressivity of the tax over time makes it possible to act differently on fraudsters and sick agents. The tax is equal to 70.6% of the wage after 1 day, 51.6% after 2 days, and 45.4% after 1 week of sick leave. An important point is as follows: all fraudsters and all sick workers necessarily receive the sickness benefits for the first day of sick leave. A second important point is as follows: the tax $\theta(2)$ is paid in most cases by the fraudsters who have shorter sick leave durations. A very high tax after 1 day of absence penalises the fraudsters, but not sick agents.

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[8] The principal observes the agents perfectly and can use all the tools (b and θ) without constraint

Table 4: Optimal contracts with sickness benefits and taxes

Period	Optimal with not tax	Optimal with tax		
	b	b	θ	w - θ
1	0.323	0.471	-	
2	0.476	0.536	0.706	0.297
3	0.566	0.575	0.518	0.482
4	0.606	0.596	0.474	0.526
5	0.622	0.608	0.460	0.540
6	0.628	0.615	0.456	0.544
7	0.631	0.618	0.454	0.546
8	0.632	0.619	0.452	0.548
9	0.632	0.620	0.450	0.550
10	0.632	0.620	0.448	0.552
$C[V_t^s]$	0.0216	0.0193		
$\overline{c}$	0.8130	0.8130		
Absence rate	0.0422	0.0404		
Fraud rate	0.0668	0.0231		

Thus, the net income after a 1 day off corresponds to 29.7% of the wage, and after 1 week off, it is 55.2%.

By taxing future wages, this optimal contract smooths the consumption over time. Because agents are risk averse, the principal can offer the same level of welfare at a lower cost. In addition, this contract discourages fraudsters. The absence rate decreases from 4.22% to 4.04%, with the rate of frauds decreasing from 6.68% to 2.31%. Then, the cost for the principal is 0.0193. Thus, the use of the two tools makes it possible to obtain a cost close to that of the case of perfect information (0.0183).

4.4 Monitoring

In this subsection, we analyse the effects of another tool: the monitoring of sick leave. Before presenting our numerical results, we want to reassert that this type of control is complex to implement, and information exchanged between a patient and a doctor is often a matter of medical confidentiality. Moreover, the counter-expertise of a second doctor necessarily intervenes after a delay of a few days, which does not allow us to detect the shortest frauds. Thus, in our simulations, we assume that fraudsters are detected and sanctioned with a probability η. However, the principal cannot detect a fraudster before the beginning of the sick leave, which implies the possibility of cheating at least 1 day before being punished. The case with monitoring is thus different from the case with the perfect information where a fraudster can be sanctioned from the period $t = 1$.

Table 5 reports our results for a value of η ranging from 0 to 0.5. As in the previous cases, the principal minimises its cost under promise-keeping constraint $\bar{V}$. Naturally, the introduction of the monitoring reduces the rate of fraud from 6.68% to 0% for $\eta = 0.5$. Removing fraud reduces the costs of the principal and smooths the consumption profile of the sick agents. Thus, the level of sickness benefits is 41.2% on the first day against 32.3% in the case without monitoring. Notably, the replacement ratio continues to

Table 5: Optimal contracts and monitoring

Period	$\eta = 0$	$\eta = 0.25$	$\eta = 0.50$
	b	b	b
1	0.323	0.371	0.412
2	0.476	0.496	0.504
3	0.566	0.549	0.537
4	0.606	0.569	0.546
5	0.608	0.575	0.549
6	0.622	0.577	0.550
7	0.628	0.577	0.550
8	0.631	0.578	0.551
9	0.632	0.578	0.551
10	0.632	0.578	0.551
$C[V_t^s]$	0.0216	0.0200	0.0195
$\overline{c}$	0.813	0.813	0.813
Absence rate	0.0422	0.0401	0.0395
Fraud rate	0.0668	0.0144	0

increase even in the absence of fraudsters. The intuition regarding this result is simple. Because the monitoring begins with the sick leave, it is not possible to avoid the presence of fraudsters in $t = 1$. Therefore, the contract must increase during the first days to discourage cheating. For $\eta = 0.5$, the cost decreases from 0.0216 to 0.0195, which is slightly less efficient than the use of the tax. By contrast with the control, the tax allows the principal to reduce its cost by taking financial resources according to the duration of the sick leave.

4.5 Rationing the number of sick leave sequences

In the United States (US), according to the US Bureau of labor Statistics (2019), the number of paid sick leave days depends on the time that a worker has worked for a firm. For instance, in private industry, a worker may be eligible for 8 sick leave days per year after 20 years of service. These days can be used at any time during the year. Rationing the number of days is a means of forcing an individual to make a trade between (i) taking a paid sick leave due to a disutility shock and (ii) not using her or his stock of days in the event of a possible future illness. To test this policy, we propose an extension of our model. Thus, we assume that the profile of sickness benefits may depend on the number of sick leave sequences taken by the worker in the past. In other words, the principal counts the number of sick leave Γ whatever the duration of the sick leave. Next, the optimal contract is the set of $b_{t,\Gamma}$ which minimises the expected cost subject to the promise-keeping constraint where t is the current duration of the sick leave and Γ the number of sick leaves. Finally, the principal can reset the agent's counter to $\Gamma = 0$. This mechanism is represented by a Poisson process with a parameter ζ, implying that the average time between two resets is $\frac{1}{\zeta}$. Now, the principal solves the following programme:

$$\begin{aligned}
C\big[V^s_{t,\Gamma}\big] \quad &= \quad \min_{b_{t,\Gamma},V^s_{t+1,\Gamma},V^s_{1,\Gamma+1},x_\Gamma} \Big((Q^s_{t,\Gamma}+Q^h_{t,\Gamma})b_{t,\Gamma} + \beta\big[C[V^s_{t+1,\Gamma}] + (Q^s_{t,\Gamma}+Q^h_{t,\Gamma}-Q^s_{t+1,\Gamma}-Q^h_{t+1,\Gamma})\bar{J}\big[W_{\Gamma+1}(.)\big]\big]\Big) \\
\text{subject to} \quad &: \quad V^s_{t,\Gamma} \leq u(b_{t,\Gamma}) + \beta\Big(\phi W_{\Gamma+1}(0) + (1-\phi)V^s_{t+1,\Gamma}\Big) \\
\text{with} \quad &: \quad \bar{J}\big[W_\Gamma(.)\big] = \beta\zeta\bar{J}\big[W_0(.)\big] \\
& \qquad +\beta(1-\zeta)\big[[(1-\pi)\psi F(x_\Gamma) + (1-\pi)(1-\psi)]\bar{J}\big[W_\Gamma(.)\big] + [\pi + (1-\pi)\psi(1-F(x_\Gamma))]\bar{C}\big[V^s_{1,\Gamma}\big]\big] \\
\text{and} \quad &: \quad Q^s_{t,\Gamma} = Q^e_\Gamma\pi(1-\phi)^{t-1} \\
& \qquad Q^h_{t,\Gamma} = Q^e_\Gamma(1-\pi)\psi(1-F(x_\Gamma))[(1-\psi)(1-\eta)]^{t-1}
\end{aligned}$$

Where $\bar{J}[.]$ is the average individual expected cost for a worker and $\bar{C}[.]$ is the average individual expected cost for an agent with a sick leave. In this extension of the model, the principal must always provide the promise-keeping constraint $V^s_{t=1,\Gamma=0} = \bar{V}$. However, the principal has a new economic policy tool: It can modify the intertemporal utilities $V^s_{1,\Gamma=1}, V^s_{1,\Gamma=2}, V^s_{1,\Gamma=3}, \ldots$. In other words, the promise-keeping constraint is only respected for the first sick leave. For the following sequences, it is possible to reduce (or increase) the entry value in sick leave. Table 6 illustrates our results for $\frac{1}{\zeta} = 365$, *i.e.* for a reset of worker rights every year.

Table 6: Rationing of sick leave

Period	Optimal sickness benefits - $\frac{1}{\zeta} = 365$		
	1^{st} sequence	2^{nd} sequence	3^{rd} sequence
1	0.390	0.336	0.279
2	0.495	0.445	0.395
3	0.559	0.509	0.459
4	0.594	0.544	0.494
5	0.612	0.562	0.512
6	0.621	0.571	0.521
7	0.625	0.575	0.525
8	0.627	0.577	0.527
9	0.628	0.578	0.528
10	0.628	0.579	0.529
$C[V^s_t]$	0.0213		
$\bar{c}$	0.8130		
Absence rate	0.0417		
Fraud rate	0.0528		

The first column reports the optimal profile for the first sick leave. Sickness benefits remain progressive over time. However, on the first day, the agent perceives a replacement ratio of 39% against 32.3% in the system without rationing. Notably, on the first day of the third sick leave, the agent receives a replacement ratio of 27.9%. Thus, the higher the number of sick leaves, the lower the replacement ratio at the start of a sick leave. This compensation scheme is a means to encourage agents who suffer a disutility shock to not use any sick leave they may need in the event of future illness. The introduction of this tool improves the optimality because the cost decreases from 0.0216 to 0.0213 and the fraud rate decreases from 6.68 % to 5.28 %. Therefore, this result supports a form of rationing the number of sick leaves. However, two points are notable. First, rationing is never total. Even if the replacement ratio is low, workers still have sickness benefits: $b_1 = 0$ is never a solution. As aforementioned, this result is explained by risk aversion and because we consider an agent who does not have precautionary savings to smooth her or his consumption. Second, Rationing is a less effective solution than the tax. Notably, because the utility function is concave, the higher the income of an individual, the less the cost in terms of welfare to reduce her or his consumption.

4.6 Sensitivity analysis: Average duration of disutility shocks

We already analytically demonstrated that the slope of the optimal contract depends on the relative duration of utility shocks compared with the average duration of an illness. By definition, no data is available on the duration of disutility shocks leading agents to defraud. We calibrated our model assuming that the periods of fraud were short. Then, the slope of the optimal contract is increasing, which is similar to most OECD countries that require waiting days. In this section, we modify the average duration of utility shocks. We assume that ψ is equal to 0.1, which corresponds to an average duration of 10 days. Thus, the duration of a shock on the disutility of work is longer than the average duration of an illness. The results of the simulations are reported in the table 7 for differents values of monitoring rate η.

Table 7: Sensitivity analysis $\psi = 0.1$

Period	$\eta = 0$	$\eta = 0.25$	$\eta = 0.50$
	b	b	b
1	0.604	0.423	0.412
2	0.492	0.453	0.446
3	0.455	0.471	0.467
4	0.437	0.480	0.468
5	0.430	0.485	0.468
6	0.427	0.487	0.469
7	0.426	0.488	0.469
8	0.425	0.489	0.470
9	0.425	0.490	0.470
10	0.425	0.490	0.470
$C[V_t^s]$	0.0202	0.0179	0.0176
$\bar{c}$	0.813	0.813	0.813
Absence rate	0.0452	0.0402	0.0395
Fraud rate	0.1304	0.0164	0

The costs and replacement ratio in Table 7 cannot be directly compared with those obtained in the tables in the previous subsection. Indeed, the decrease ψ means that the shocks are less frequent but more persistent. This decrease in fluctuations allows the principal to provide the same level of welfare with slightly less generous sickness benefits than in the case $\psi = 0.5$. Thus, for a welfare $\bar{c}$ unchanged, a decrease in the cost is observed.

The sensitivity test confirms our analytical results concerning the link between the slope of the contract and the duration of shocks of disutility. Column 1 reports the optimal profile for $\psi = 0.1$ without monitoring: the slope is decreasing. Thus, when episodes of fraud are longer than episodes of illness, the principal prefers to provide welfare at the beginning of the sick leave. The reduction in the long-term replacement ratio especially penalises fraudsters whose sick leave is longer. In such a context, the introduction of monitoring modifies the slope of the optimal contract (columns 2 and 3). By excluding the fraudsters at the beginning of the sick leave, the monitoring allows us to find a situation where the sick agents are the most numerous in the long term. Therefore, an optimal benefit provides welfare after a few days rather than at the beginning of sick leave. This result suggests that monitoring and waiting periods can be complementary. When the principal is able to exert effective control, the optimal benefit introduce a waiting period to completely deprive fraudsters of sickness benefits before their exclusion. In return, sick agents can obtain a more generous sickness benefits after a few days. Thus, the level of welfare of the sick agents is unchanged and the principal reduces its costs.

Conclusion

In most OECD countries, the sick leave system provides a few days of waiting before the sickness benefits are paid. This paper provides a rational explanation for this compensation scheme. Using a repeated principal-agent model where the fraud behaviours of risk-averse workers are not observed by the risk-neutral agency, we show that the optimal contract is characterised by upward sloping sickness benefits. We explain our result as follows: workers cheat to adjust their labour supply to temporary shocks on the disutility of work. Because these shocks are shorter in duration than diseases, a growing compensation scheme makes it possible to reduce the welfare of the fraudsters without modifying the welfare of the sick agents. Notably, this result depends on only the duration of shocks. Thus, when periods of sickness are shorter than shocks on the disutility of work, sickness benefits should decrease.

We analyse two other tools: a wage tax dependent on the duration of sick leave and the monitoring. Contrary to what intuition suggests, this tax must decrease with the duration of the sick leave. As with the sickness benefits, the goal is to penalise short-term sick leave in which fraudsters are over-represented. We observe that the simultaneously increasing sickness benefits and decreasing the wage tax over time can significantly reduce the cost of the principal. This optimal contract allows an equilibrium close to the equilibrium obtained in the context of the hypothesis of perfect information. Finally, monitoring is another tool to limit fraud behaviour. We show that in the presence of control, the principal can smooth the agents' income over time.

In this paper, we consider that the risk of disease is an exogenous and individual risk. However, this risk can be partly collective, especially regarding contagious diseases such as influenza. In these cases, the principal should consider these contagious risks when characterising the optimal contract to reduce the absence rate. This type of externalities is an important argument in favour of the full wage continuation in case of sick leave. This is the case in Italy, where patients with tuberculosis have no waiting days. Thus, a possible extension of this principal-agent model consists in considering an endogenous risk of disease linked to the risk of contagion spreading in firms. Another possible extension concerns the consequences of working conditions on workers' health. Many studies have demonstrated that working conditions have a significant role in the risk of disease. Therefore moral hazard also concerns the behaviour of firms that can externalise health-related costs to social protection systems.

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