A methodological proposal to evaluate the cost of duration moral hazard in workplace accident insurance

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Abstract

The cost of duration moral hazard in workplace accident insurance has been amply explored by North-American scholars in both the USA and Canada. Given the current context of financial constraints in public accounts and particularly in the Social Security system, we feel that the issue merits inquiry in the case of Spain. The present research also posits a methodological proposal using the econometric technique of stochastic frontiers, which allows us to break down the duration of work-related leave into what we term "economic days" and "medical days". Our calculations indicate that during the seven-year period spanning 2005 to 2011, the cost of sick leave amongst full-time salaried workers amounted to 5,830 million Euros (in constant 2011 Euros). Of this total, and bearing in mind that "economic days" are those attributable to duration moral hazard, over 2,500 million Euros might be linked to workplace absenteeism. It is on this figure where economic policy measures might prove more effective.

JEL Classification: J28, J32, I13.
Key words: workplace accident insurance, moral hazard, stochastic frontiers.

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1. INTRODUCTION

The present work seeks to gauge the financial cost of sick leave subsequent to a workplace accident, and which is exclusively due to worker opportunistic behavior. One initial point worth highlighting is that the financial cost linked to workplace accidents is extremely high. In this sense, a report by the *Comisiones Obreras* trade union (CC.OO., 2004) estimates that the cost of workplace accidents in Spain amounted to 11,988 million year 2002 Euros, 1.72% of said year's Gross Domestic Product. However, it should be pointed out that this covers a wide array of situations and categories[1] in the costs associated to workplace accidents.

In the economic literature addressing work related accidents, one common theme has been to explore the problems of moral hazard posed by the regulation of workplace health and safety, a topic dealt with for instance by Fortin and Lanoie (2000). Said work points to four kinds of moral hazard related to workplace accident insurance. Firstly, *ex ante* injury hazard, which involves workers exercising less care and precaution due to the insurance guaranteeing them an income should they suffer an accident. The second type is termed *ex ante* causality hazard and emerges because of the difficulty in identifying which accidents have actually occurred at work. The third case is so-called *ex post* duration hazard, and leads to the number of days off extending beyond what is justifiable. The fourth type is known as insurance substitution hazard and may encourage workers to seek a more generous payout through accident insurance than they would otherwise obtain through unemployment insurance, which might prove less lucrative. The present research focuses particular attention on the third type of moral hazard, although we believe that the fourth kind may also be operating to a certain extent.

Sick leave duration is a far more complicated topic than would appear at first glance. Comparing different groups reveals that said measure is highly

[1] From a more limited standpoint, yet nonetheless one which also reflects the enormity of the costs associated to occupational accidents, and in what is now considered a classical quote in the literature in this field, Krueger (1990) estimates that in a typical year in the USA, for every day lost due to strikes 50 days are lost to work accidents.

sensitive to the number of minor accidents reported. As a result, microdata, which allow the nature and seriousness of the injury to be considered, are felt to provide key insights. Another point to be taken account of is that sick leave duration involves two clearly different features: one which is mainly medical, and concerns a person's natural recovery time following an injury, and another that is mainly financial, and which relates to an individual's capacity to choose, and possibly indulge in opportunistic or strategic behavior. The latter of these has received most attention in the economic literature, particularly vis-à-vis the issue of absenteeism, and has been rationalized in terms of "moral hazard" when workers' compensation systems are involved.

In our view, the two components differ, which is why we consider they merit being approached differently. From an econometric standpoint, we use stochastic frontier techniques to distinguish between the two factors. Estimating a lower or "cost" frontier, which is primarily determined by medical factors, enables us to measure minimum sick leave duration, interpreted here as an indicator of the unavoidable period required for a worker to return to work after regaining an acceptable state of health. Actual sick leave duration will exceed said minimum. The difference will be attributable to behavior based on the rational decisions of the "homo economicus" of microeconomic theory. We therefore model said difference, namely the "inefficiency" term, within stochastic frontier literature, through what are essentially economic variables such as the type of contract, worker compensation while absent from work, which sector of the economy workers are involved in, etc.

The economic literature dealing with sick leave duration from the standpoint of work absenteeism and work accidents has tended to treat all the days taken off equally. We believe that differentiating between "medical days off" and "economic days off" will allow us to explore the issue at hand more accurately. Our main interest lies in "economic days off". The Spanish Royal Academy of Language (in its first and closest definition to the employment context) defines work absenteeism as: "*Deliberate absence from work*". The Oxford English dictionary defines said concept as: "*The practice of regularly staying away from* *work or school without good reason*". These two definitions clearly show that interpreting work absenteeism as the days required for adequate medical recovery is a conceptual error. The main contribution of the present work lies precisely in the methodological proposal of breaking down sick leave duration into two components and attributing the financial cost of absenteeism to purely "economic days off".

The remainder of the work is organized as follows. The second section offers a review of the literature exploring the determinants of sick leave duration resulting from workplace accidents. Commonly used econometric procedures are referred to as are some of the chief conclusions to emerge. Section three describes the methodology employed to obtain the main results. As already mentioned, these are econometric procedures based on so-called "stochastic frontiers". The fourth section presents and describes the database used in the present work: Statistics of Accidents at Work (SAW). This section also provides some descriptive information prior to the subsequent and more rigorous econometric analysis. Section five discusses the principal findings to emerge, and comprises two sub-sections: the first considers the estimated parameters based on multivariate regression analysis, and the second compares the estimations of the "medical days off work" and "economic days off work", calculating the purely financial cost of workplace absenteeism. The final section presents the main conclusions.

2. STATE OF THE QUESTION

From an economic standpoint, the literature exploring sick leave duration resulting from workplace accidents first emerged several decades ago. In the 1980s and 1990s, much of the scholarly inquiry addressing these topics commenced in the USA and in Canada. A thorough review of all of this literature may be found in chapter 16 of the Handbook of Insurance (Butler et al., 2013).

All of these works were grounded on the fact that, as a result of the health compensation insurance that covered part of their lost salary, employees could vary the moment they returned to work following a workplace accident. Yet, the way in which this matter has been analyzed in econometric terms has varied enormously. Some early studies used aggregated databases (industry or state/province) to draw their conclusions. Two works representative of this type of research are Curington (1986) and Lanoie (1992). As a result of the composition effects caused by aggregated data, some researchers have more recently resorted to using microdata. One standard technique involves taking the duration logarithm as a dependent variable and estimating through ordinary least squares (Krueger 1990; Meyer et al. 1995; Campolieti and Hyatt 2006). However, when faced with censored data, the most appropriate approach adopts duration models. Two seminal works exploring sick leave duration through proportional risk models are those of Butler and Worrall (1985), and Johnson and Ondrich (1990).

Many of these works examine the effect which more generous health insurance has on sick leave duration. Meyer et al. (1995) or Butler and Worrall (1985) report that a 10% increase in compensation leads to a rise in sick leave of close to 4%. Yet, others such as Krueger (1990) or Johnson and Ondrich (1990) estimate the impact on duration to be over 10%. Nevertheless, many of these works also state that this finding is not evident a priori. Better compensation may also spark an increase in the number of minor accidents reported, thereby causing a reduction in the mean duration (Meyer et al., 1995; Butler et al., 1997).

For the case of Spain, several previous works explore sick leave duration following occupational illness. Although adopting a common approach based on duration models, Corrales et al. (2008), Moral et al. (2012) and Martin-Roman et al. (2013) analyze sick leave from different perspectives. Corrales et al. (2008) study differences in duration amongst the various regions in Spain. Moral et al. (2012) compare the time men and women are absent from work, whilst Martin-Román et al. (2013) focus their analysis on the recovery periods from injury of self-employed workers, with particular attention on the economic cycle.

The most similar work from the econometric perspective is that of Martín-Román and Moral (2014), which uses the stochastic frontier technique to compare the working conditions of national and immigrant workers through the duration of their sick leave. The present study, however, takes one step further by enabling the days to be reflected in monetary terms so as to clearly identify the cost associated to duration moral hazard.

3. METHODOLOGY

As explained in the introductory section, the current work seeks to measure the cost of compensation associated to duration moral hazard. To achieve this, sick leave duration must be broken down into two parts. The first is linked to purely medical aspects and the other is the result of workers' opportunistic behavior. To carry out these decompositions, the literature has employed a number of techniques such as linear decomposition on ordinary least square models or non-linear decomposition on duration or count models.

The approach taken in the current work differs and follows that of Martín-Román and Moral (2014). The starting point is to assume a standard sick leave duration (D_i^s), which is purely medical and which marks the lower boundary. This minimum period of recovery from illness or injury prior to returning to work may be represented by the following expression:

$$d_i^s = X_i\beta + v_i \qquad (1)$$
$$with\ d_i^s = ln(D_i^s)$$

X_i being a vector of individual characteristics, β a vector of coefficients and v_i a random error of mean 0 and variance σ_v^2.

However, the insurer only perceives a real duration (D^r) which tends to be longer than the standard duration ($D^r \geq D^s$). Within this actual duration, as well as the medical or physiological aspects already mentioned, the worker's ability to prolong their period of recovery plays a major role. This leads us to assume a problem of asymmetric information associated to monitoring workers which insurance companies need to engage in while employees are absent from work. As a result, the actual duration is the sum of the standard duration plus a random non-negative disturbance as shown by the following expression:

$$d_i^r = d_i^s + u_i \tag{2}$$

$$with\ d_i^r = ln(D_i^r)$$

Where u_i is another error term with a positive mean and variance σ_u^2. Consequently, the standard duration constitutes a lower frontier[2] explained on the basis of personal traits such as age and gender, as well as the particular nature of the injury and how serious it is or which part of the body is affected. All of these variables determine the recovery period based on strictly medical considerations. As a result, d_i^r may also be expressed as follows:

$$d_i^r = X_i\beta + v_i + u_i \tag{3}$$

Having a compound disturbance means that the most appropriate method of calculation is maximum likelihood estimation using the stochastic frontier technique and assuming a distribution determined for u_i[3]. Provided the disturbances and regressors remain independent, estimating least squares gives non-biased, consistent, and efficient estimators. Yet, there is inconsistency in the constant term and the variances of the two disturbances cannot be separated[4].

Furthermore, the stochastic frontier technique also allows the disturbance differentiating between real and standard durations to be modeled. Consequently, we can identify which variables might influence the duration that is not justified for medical or physiological reasons. In line with Battese and Coelli (1995), the effects of inefficiency might be explained based on a vector Z of variables, applying the following expression (4):

[2] Within the methodological framework of the present paper, this lower frontier would be associated to what the literature has termed as the cost frontier.

[3] Aigner et al (1977) use a semi-normal distribution, Meeusen and Van den Broeck (1977) opt for an exponential distribution, Stevenson (1980) uses a normal truncated distribution, and Green (1980a and 1980b) choose a gamma distribution.

[4] Not being able to estimate the value of the variances separately means that the corresponding tests cannot be carried out to validate inefficiency.

$$u_i = Z_i\varphi + \omega_i \tag{4}$$

$$with\ \omega_i \geq -Z_i\varphi$$

In (4), φ is the vector of parameters to be estimated and ω_i is a set of random variables assumed to be independent and equally distributed which come from the distribution chosen for u_i. In this case, although estimating the maximum likelihood proves more complex, β, φ, σ_v^2 and σ_u^2 may be obtained jointly.

Finally, the estimations of u_i can also be obtained through the mean or the mode of $f\ (u_i/\varepsilon_i)$, knowing that $\varepsilon_i = v_i + u_i$ (Jondrow et al., 1982), and for each subject the value of their efficiency can be calculated in costs by calculating the following expression:

$$EF = \frac{f(X_i\beta)exp(v_i + u_i)}{f(X_i\beta)exp(v_i)} = exp(u_i) \tag{5}$$

Once the duration logarithms have been decomposed, in order to calculate the financial cost, the days need to be reconstructed. Using a logarithmic specification for the estimations requires a transformation which corrects prediction underestimation, shown in the following expression:

$$D^r = exp^{d^r} > exp^{(\widehat{d_i^s})} \cdot EF \tag{6}$$

Following on from Wooldridge (2010), underestimating equation (6) may be corrected by an accessory regression which gives predictions that are biased but nonetheless consistent and not subject to error normality.

$$D^r = \widehat{\alpha_0} \cdot exp^{(\widehat{d_i^s})} \cdot EF \tag{7}$$

Using $\widehat{\alpha_0}$, and undoing the logarithmic transformation, the equivalence in days of each component may be calculated.

$$D^r = \widehat{\alpha_0} \cdot exp^{(\widehat{d_i^s})} EF = \widehat{\alpha_0} \cdot exp^{(\widehat{d_i^s})} + \widehat{\alpha_0} \cdot \left(exp^{(\widehat{d_i^s} + \widehat{u_i})} - exp^{(\widehat{d_i^s})} \right) = \widehat{D^s} + \widehat{D^i} \qquad (8)$$

where $\widehat{D^i}$ refers to the duration linked to inefficiency.

4. DATABASE

When calculating the cost of workplace accidents in terms of paid compensation, the variable which emerges as key is sick leave duration. As a result, the database offering the best information is the Statistics of Accidents at Work (SAW) published by the Ministry of Labor and Social Security. This is a register of all the accidents which lead to absence from work each year in Spain, and which also includes information concerning the workers, the accidents, injuries, and the particular job in question.

The data used in this work correspond to full-time workers whose sick leave commenced between 2005 and 2011. Filtering out the figures corresponding to self-employed workers and removing the injuries which lead to worker fatalities leaves a total of 5 431,693 workplace accidents. Of these, 931,184 correspond to 2005, 949,208 to 2006, 977,151 to 2007, 823,723 to 2008, 643,852 to 2009, 487,085 to 2010 and 519,490 to 2011.

Table 1 offers an initial review of the data concerning the length of each period of sick leave broken down into the year it occurred as well as a range of characteristics regarding the accident or the person involved. The first two groups of characteristics deal with purely medical aspects such as the nature of the injury, its severity, or the place where medical attention was first provided. The longest periods can be seen to correspond to accidents involving a heart attack, or those leading to traumatic amputation, or a fracture. Other features to emerge are that serious injuries lead to periods of sick leave which are five times longer than non-serious injuries or that cases dealt with in primary care centers last half as long as those treated in hospital.

The other groups of variables deal with other characteristics such as gender, the type of contract, or nationality. Broadly speaking, women tend to have longer periods off than men, workers with open-ended contracts have longer sick-leave periods than workers on temporary contracts, and national workers tend to take longer sick leave than immigrant workers. This is particularly true when comparing with workers from developing countries.

(table 1)

A further aspect worth taking into account concerns the year when sick leave was taken. Broadly speaking, sick leave can be seen to grow over the years, increasing from 24 days in 2005 to 29.5 in 2011. Yet, this rise is by no means constant over the period. After some years of stability, which even witnessed a slight fall up to 2008, there was a sharp increase in 2009 which remained steady with slight variations in 2010 and 2011. This evolution over time has also led to a change in the differences in duration between certain characteristics. For instance, the final year of the sample reveals how differences in duration in terms of the type of contract diminished substantially. The same was also true amongst immigrants from developed countries and Spanish nationals. The most striking case emerges in the case of gender, where differences in duration are inverted. Whereas in 2005, female sick leave was days two longer than male sick leave, in 2011 it was slightly shorter.

Finally, and from the standpoint of costs, a reduction in the aggregated cost of accidents over time can be seen. This result might be linked to the financial crisis and to the loss of jobs which has also led to a drop in the number of those subject to risk. Nevertheless, a noticeable increase in the cost per accident is also in evidence due to longer sick leave periods in the final years of the sample.

5. RESULTS

Based on the above descriptors, the question to be answered concerns to what extent said cost and its evolution is the result of purely physiological or medical aspects and to what extent it may be triggered by duration moral hazard. To answer this question, the following steps are taken: firstly, the duration logarithm is decomposed by applying stochastic frontier estimation, and secondly the logarithms are transformed into days and multiplied by the daily compensation in order to obtain the value of the costs.

5.1. Decomposing the duration logarithm.

When calculating how much compensation expenditure is associated to duration moral hazard, it is necessary to identify which part of the sick leave is the result of purely medical aspects and which part might be attributed to individual behavior. As already mentioned in the methodological section, one way of distinguishing between these two components is to estimate stochastic frontiers in terms of costs. By applying this technique, the dependent variable may be decomposed into a minimum value (minimum cost) and a one-sided error term linked to inefficiency (unjustified excess costs). We link the first part to the duration which would be expected due to purely physiological or medical aspects (minimum duration), and the second to questions concerning worker behavior and to duration moral hazard (non-justified excess duration).

The first question to be resolved when specifying the frontier model is to pinpoint which variables form part of the frontier and which are to be included in inefficiency. Since the frontier represents a minimum duration, we feel that it can only be due to medical and physiological reasons. As a result, the variables chosen were the type of injury (12 dummies), the injured part of the body (7 dummies), a variable measuring whether the accident is serious, another indicating whether the injury was initially treated in hospital, another reflecting whether the patient needed to be admitted to hospital, and another indicating whether the injury was a recurrence of a previous injury. Two personal variables were also included which might impact the length of the period off work. The first of these is age, as it might well affect the worker's recovery[5]. The second is a dummy which takes the value 1

[5] This variable is also included squared to reflect possible non-linear effects of injured worker ageing.

if the worker is male and is included in order to reflect physiological differences between men and women which might affect convalescence[6].

The second part of the specification process involves selecting the variables to be introduced in the model as explanatory factors of inefficiency. These are variables which have often been taken into account in the economic literature addressing workplace absenteeism and "moral hazard" in work accident compensation insurance. In the present work, two models are estimated specifying inefficiency. The first includes controls for the occupation (9 dummies)[7], for the region where the accident occurred (17 dummies)[8], for the year the leave was taken (6 dummies), and the origin of the injured worker (2 dummies). Apart from these, a further dummy is also included reflecting whether the worker has an open-ended contract[9] as well as another variable detailing the amount of compensation involved[10].

In the second model, in addition to all the previously mentioned variables, a variable reflecting gender is included as is another indicating whether the accident led to an injury classed as "difficult to diagnose"[11]. This latter regressor is included since the literature has reported that the injuries most likely to induce opportunistic behaviour by workers are so-called "difficulty to diagnose" injuries (Fortin and Lanoie, 2000), easy to conceal injuries (Smith, 1990) or "soft tissue" injuries (Butler et al., 1996). These injuries are basically sprains and lumbago.

As already mentioned, in the present work a cost frontier is estimated[12] where inefficiency is modeled and where the residuals are assumed to follow an

[6] Martín-Román and Moral (2008) report higher numbers of lower back pain (lumbago) and sprains amongst Spanish women. Moral et al. (2012) report differences in duration between Spanish men and women once medical and physiological causes are controlled for.

[7] Even though there are two classifications of different occupations (CNO94 and CNO11), ten homogenous groups are constructed.

[8] Corrales et al (2008) find significant differences in sick leave duration resulting from workplace accidents in the various regions in Spain.

[9] The literature has often stressed the importance of the type of contract on workplace accident rates (Hernanz and Toharia, 2006, Amuedo. 2002 and Guadalupe. 2003).

[10] For a review of the effects of compensation on workplace accident rates, consult the review conducted by Fortin and Lanoie, (2000).

[11] Moral et al (2010) describe differences in the percentage of difficult to diagnose accidents reported by national and immigrant workers.

[12] The logarithm likelihood ratio tests find a cost frontier with significance level of 1%. However, when positing a production frontier, this does not prove significant.

exponential distribution. Table 2 shows the results of these estimations for three specifications. In the first, only those affecting the frontier are included as explanatory variables. The other two specifications include the modeling of inefficiency referred to in previous paragraphs.

(table 2)

The first two blocks in Table 2 reflect the values of the variables which affect the frontier. Irrespective of the specification chosen, all the coefficients can be seen to be highly significant and display the expected sign. Furthermore, the effect of the variables emerges as stable in the three models regardless of whether inefficiency is modeled or not. It can thus be seen that the longest standard durations correspond to accidents leading to fractures traumatic amputation, to serious injuries, and those which require hospitalization, as well as recurrences of previous injuries. As regards personal variables not related to the injury, standard durations are seen to increase with injured worker age, and recovery times are seen to be shorter in the case of males.

The last two blocks shown in Table 2 reflect the coefficients of the variables included to model inefficiency. As occurs with the variables at the frontier, all of the variables prove to be highly significant and display stable signs and values in the two models. It should also be pointed out that, apart from the variables shown in Table 2, *dummies* have been included to control possible spatial and occupational effects when calculating inefficiency. Nevertheless, it can be seen that the regions which display the lowest levels of inefficiency are the Balearic Islands, Catalonia, Madrid, La Rioja, and Navarra, and that the occupations exhibiting the highest levels of moral hazard correspond to managers, senior consultants and support staff as well as skilled workers in the primary sector[13].

Overall, it can be seen that the years prior to the crisis, together with 2008, evidence the lowest levels of duration moral hazard. However, over the last three

[13] The full estimations with the coefficients not included in table 2 are available to those interested upon request from the authors.

years of the sample period the situation was the opposite and there was a substantial rise in inefficiency. With regard to injured worker nationality, lower rates of absenteeism are apparent amongst foreign workers, particularly those from less developed countries. It can also be seen that unjustified duration is longer in the case of workers who have an open-ended contract and that it grows in relation to the size of the compensation received. Finally, as regards the variables added in the last specification, inefficiency increases when the injured party is male and when the reported injury is classified among those deemed as difficult to diagnose.

It may therefore be concluded that all the variables included in the specification of inefficiency evidence signs that are consistent with the results reported in the literature, which would appear to bear out the robustness of the estimation carried out.

5.2. Reconstructing duration and calculating the financial cost.

Preliminary frontier estimation allows the value of the inefficiency to be calculated and separated from the so-called standard duration for each of the injured parties. As a result, the following step is to reconstruct the values of the durations based on the decomposition obtained for the logarithm of the days off work. This reconstruction will provide a calculation of the compensation costs associated to the standard duration and to the duration moral hazard cost.

Durations are reconstructed based on the auxiliary estimation shown in equation (7) and the decomposition in equation (8). Table 3 provides a summary of the results obtained for days off and for the cost of compensation. The three first rows refer to standard duration, duration linked to moral hazard, and the sum of the two, both in terms of the mean and in aggregated terms. The last three show the cost of compensation associated to each of the previous durations.

(table 3)

The results in Table 3 show that of the 25.4 days which the mean sick leave period lasts, just over 14 are due to purely physiological aspects and represent what we term standard duration. The remaining 11 days constitute the part of sick leave linked to duration moral hazard. In aggregated terms, it can be seen that sick leave associated to purely medical reasons entail a loss of 7.76E+07 working days, whereas 6.05E+07 days are the result of discretional worker behavior.

If we translate these figures into money, the mean cost of sick leave in compensation paid to workers comes to 1071 Euros. Of this total, almost 600 Euros may be accounted for by purely medical or physiological reasons, whereas 475 Euros are the result of worker behavior. Following on from this, the total expenditure on compensation over the period 2005-2011 resulting from full-time worker sick leave comes to 5,820 million Euros. Of this total, over 3,000 million is due to days which come under the umbrella of standard recovery, whereas over 2,500 million are linked to work absenteeism.

The final part of the work is devoted to studying the evolution of the cost of sick leave and its composition over the period analyzed. To perform this analysis, Graph 1 was constructed, where the composition of the mean cost over time is shown.

(graph 1)

The results in Graph 1 show an increase in mean sick leave cost over the sample period studied, particularly in the three last years linked to the financial crisis. This increase occurs both in the part associated to medical aspects as well as in the part corresponding to duration moral hazard. However, whereas the cost of compensation linked to standard duration increases smoothly and in a more or less sustained manner, the cost of inefficiency rose sharply in 2009, and remained stable in 2010 and 2011 after having fallen in 2008. These data underline the fact that the rise in the mean cost is due mainly to the increase associated to duration moral hazard. One final point worth highlighting is that this result might also be due to insurance substitution hazard. This kind of moral hazard means that, when faced with possible lay off, injured workers deliberately prolong the time they are absent from work so as to take advantage of accident benefit payment which is more lucrative than unemployment insurance.

6. CONCLUSIONS

Duration moral hazard in sick leave occurs when workers prolong the time they are off work thanks to compensation insurance which covers their loss of earnings. The cost of this in economic terms merits detailed study and an accurate calculation so that economic policy measures aimed at minimizing its impact may be taken. With this purpose in mind, the present work proposes a method that allows the economic cost of workplace accidents to be split into two components which we feel to be highly contrasting in nature: the amount associated to the worker's period of recovery, and the other which reflects injured workers' opportunistic behavior.

An initial exploratory analysis of the data reveals that during the period spanning 2005 to 2012 expenditure on full-time salaried worker compensation fell by around 30%. Said reduction is due exclusively to a fall in the number of accidents given that the unit cost of each accident has grown by over 35%. This evolution in the costs bears out the importance of analyzing which part of the increase in the unit cost is due to accidents being more serious and which part is due to duration moral hazard.

The stochastic frontier analysis carried out in the present research reveals that of the twenty-five and a half days average sick leave period arising from an accident, over eleven are the result of worker opportunistic behavior. Translated into costs, these figures mean that of the total amount spent on compensation, close to 44% is attributable to duration moral hazard (or perhaps insurance substitution hazard). As a result, during the seven-year period analyzed, over 60 million working days are lost because of worker behavior, representing an expenditure of over 2,500 million constant 2011 Euros.

The time pattern observed in the cost of each accident reveals the key role played by the financial crisis. After 2009, the cost of sick leave increases substantially, a rise which was particularly in evidence in the part associated to moral hazard. These findings do not seem to point to any notable rise in the severity of the accidents, yet do seem to indicate an attempt by workers to profit from accident compensation insurance.

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Table 1. Mean durations and costs of accidents leading to workplace absence incurred by full-time workers in terms of various characteristics and years

	2005	2006	2007	2008	2009	2010	2011	Total
				Durations				
Not specified	23.6	23.0	24.0	22.0	26.9	27.4	27.4	**24.1**
Injuries	18.2	18.4	17.7	16.9	20.1	20.9	21.5	**18.7**
Fractures	57.6	54.6	66.9	58.3	71.2	73.9	72.7	**63.8**
Sprain	22.8	22.8	23.3	21.7	26.0	27.1	27.8	**24.1**
Traumatic amputation	73.9	61.4	80.8	74.1	84.3	88.8	85.3	**76.3**
Concussion	25.0	23.9	25.1	23.8	29.4	30.5	31.0	**26.2**
Burns	18.3	18.7	18.5	16.2	19.6	20.5	19.2	**18.6**
Poisoning	16.5	15.3	14.2	13.1	16.8	16.5	16.7	**15.4**
Choking	18.5	19.8	17.6	10.5	11.4	20.2	16.0	**14.0**
Noise, heat	15.4	14.8	14.4	14.3	19.3	22.4	21.3	**17.3**
Psychological trauma	26.8	31.6	35.4	30.1	43.9	36.5	34.6	**32.9**
Multiple injuries	44.1	39.9	48.0	40.2	47.0	48.0	47.2	**44.7**
Heart attack	74.4	56.8	98.0	73.7	115.2	116.0	116.4	**91.4**
Light	23.0	22.9	23.4	21.9	26.6	27.8	28.3	**24.3**
Serious	105.6	84.7	134.0	116.5	143.3	146.8	144.1	**120.4**
Primary health center	22.2	21.6	23.3	20.9	25.5	26.6	27.0	**23.4**
Hospital	40.9	41.1	49.2	38.4	52.2	53.6	52.5	**45.7**
Female	25.7	25.3	25.7	23.9	28.5	29.4	29.5	**26.6**
Male	23.6	23.2	24.4	22.6	27.6	29.0	29.5	**25.1**
Temporary	22.4	22.2	23.2	21.8	26.8	28.2	28.9	**23.8**
Open-ended	25.8	25.2	26.1	23.7	28.4	29.5	29.8	**26.7**
Spain	24.4	24.0	25.3	23.2	28.2	29.5	30.0	**25.9**
Developed	22.3	21.9	23.3	22.5	27.7	29.3	29.3	**24.5**
Non-developed	20.2	20.5	20.6	20.4	24.3	24.9	25.7	**21.9**
Total	**24.0**	**23.6**	**24.7**	**22.9**	**27.8**	**29.1**	**29.5**	**25.4**
				Costs				
By accident	946.5	955.3	1016.7	962.2	1228.5	1286.0	1287.3	**1068.8**
Aggregated (Thousand million)	0.989	0.907	0.993	0.793	0.791	0.755	0.669	**5.81**

Source: Author's own based on SAW data.
N.B.: Costs are calculated in constant year 2011 Euros.

Table 2. Results of estimating stochastic frontiers on the logarithm of workplace sick leave duration

Log(duration)	Coefficient	Z	Coefficient	Z	Coefficient	Z
Injury (ref. Non-specified injuries)						
Injuries	-0.144	-61.6	-0.133	-57.0	-0.134	-57.7
Fractures	0.947	338.1	0.951	339.5	0.951	341.9
Sprain	0.018	7.8	0.024	10.3	-0.012	-4.9
Traumatic amputation	0.884	95.3	0.889	96.2	0.888	96.8
Concussion	0.043	15.1	0.048	16.8	0.048	16.9
Burns	-0.176	-41.5	-0.168	-39.6	-0.169	-40.2
Poisoning	-0.367	-35.6	-0.355	-34.6	-0.356	-35.0
Choking	-0.469	-40.8	-0.445	-39.2	-0.446	-39.5
Noise, heat, radiation	-0.154	-14.3	-0.153	-14.2	-0.152	-14.2
Psychological trauma	0.118	11.8	0.112	11.2	0.116	11.6
Multiple injuries	0.249	55.8	0.249	55.9	0.250	56.5
Heart attack	0.447	32	0.418	29.4	0.423	30.1
Controls for the injured part of the body have been included						
Hospital care	0.199	122.6	0.198	122.0	0.199	122.6
Hospitalization	0.600	184.3	0.592	181.7	0.594	183.1
Serious	0.928	178.8	0.934	180.4	0.933	181.4
Recurrence	0.399	168.5	0.388	163.3	0.386	162.6
Male	-0.096	-94.8	-0.095	-87.1	-0.107	-67.5
Age	0.010	41.0	0.009	33.9	0.008	33.8
Age squared	1.94·E-05	6.1	3.17·E-05	9.9	3.22·E-05	10.1
Constant	1.766	260.1	1.813	264.8	1.841	266.4
Modeling inefficiency						
Year of sick leave (ref. 2005)						
2006			-0.145	-28.4	-0.144	-28.3
2007			-0.024	-4.6	-0.024	-4.7
2008			-0.254	-47.0	-0.255	-47.1
2009			0.101	18.8	0.100	18.6
2010			0.148	27.0	0.146	26.5
2011			0.180	31.9	0.178	31.3
Nationality (ref. Spanish)						
Developed			-0.154	-9.8	-0.152	-9.7
Undeveloped			-0.291	-47.5	-0.288	-47
Open-ended contract			0.021	6.4	0.021	6.2
Compensation			0.005	42.7	0.005	40.7
Male					0.060	9.9
Difficult to diagnose					0.167	35.6
Constant			-1.493	-56.7	-1.612	-60.2
Lambda	0.69974					
Likelihood-ratio test of sigma_u=0: chibar2(01) = 7.5e+04 Prob>=chibar2 = 0.000						

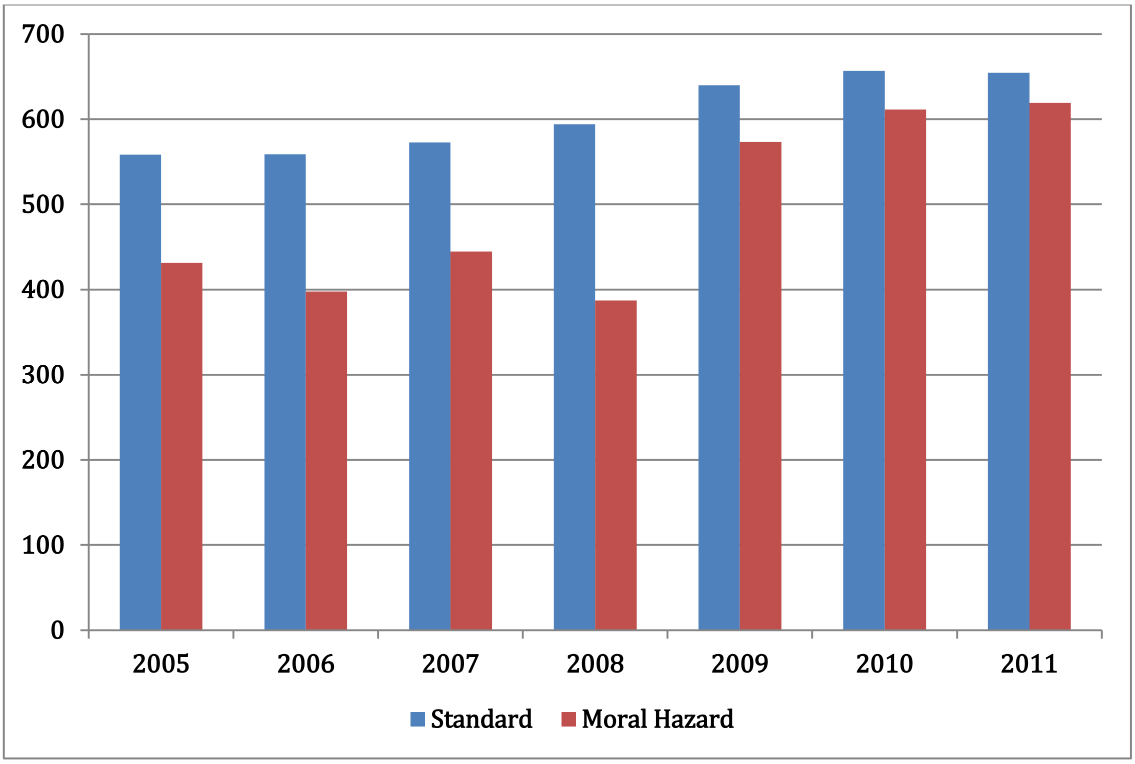
N.B.: When modeling inefficiency, nine variables have been included to control for worker occupation and 17 to control for the regions in Spain.

Table 3. Break-down of the duration and the financial cost associated to the compensation of occupational sick leave

		Mean values	Aggregated values
Days off	Standard	14.29	7.76E+07
	Inefficiency	11.15	6.05E+07
	Total	25.44	1.38E+08
Cost of compensation	Standard	595.78	3.24E+09
	Inefficiency	475.26	2.58E+09
	Total	1071.04	5.82E+09

Source: Author's own based on SAW data

Figure 1. Composition of the mean expenditure in compensation per accident and year in which sick leave was taken.



Source: Author's own based on SAW data.