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An Econometric Analysis of Work-Related Injuries

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Abstract

Occupational health is increasingly recognized as an important public health issue in Latin American and the Caribbean (LAC). However, one of the principal problem is the absence of reliable data on its magnitude and economic consequences. The first part of the paper presents the official statistics on workplace injuries, which are usually derived from the population covered by workers' compensation schemes. These data suggest that workers in the Region are exposed to occupational risks that are significantly higher than in the established market economies. However, official statistics provide only a partial picture of occupational safety and health condition in the Region, because of the omission of the informal sector of the economy, which represents a large portion of the work force in these countries. In the empirical part of the paper, we analyze health risk associated with occupational hazard in Mexico using the 1996 Encuesta Nacional de Empleo y Seguridad Social. This analysis sheds light on the relationships between the likelihood of reporting work-related impairment, characteristics of the workers, type of occupation and contractual relationship.

1. Introduction

Occupational Safety and Health (OSH) is increasingly recognized by Latin American and Caribbean (LAC) governments and International Organizations as an important part of public health. People spend one-third or more of each day at work. Consequently, OSH conditions are a primary determinant of related health conditions. However, OSH concerns extend well beyond the obvious health consequences of work-related illnesses, accidents, and deaths. Addressing

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OSH issues is a key element in the process of social and economic development, with direct and indirect impacts on such areas as the labor market, labor productivity, household income, poverty, social security systems, international trade, and the environment.

The LAC labor force is one of the fastest growing in the world. In 1980 there were 112 million workers (IDB, 1982), by 1998 (ILO, 1998) the workforce almost doubled reaching approximately 202 million workers. Thus, in the Region, OSH has a direct impact on more than 200 million workers and their families. However, the OSH situation is far from adequate. First, there is a general lack of awareness regarding the importance of a safe and healthy work environment. Second, the Region lacks the institutional capacity and the infrastructures needed to develop and sustain a safe and healthy working environment and the Region's failure to implement or enforce appropriate safety laws translates into lost production, lost wages, medical expenses, disabilities, and deaths. Moreover, data on occupational accidents, illnesses, and deaths tend to underestimate the magnitude of the problem. Finally, the knowledge regarding the factors that affect OSH is very limited.

The aims of this paper are: first to review and briefly summarize the information available in relation to OSH in LAC; and second, to analyze the determinants of OSH. We present the preliminary results of an econometric analysis of the determinants of workplace impairment using the 1996 Mexican National Survey of Employment and Social Security (Encuesta Nacional de Empleo y Seguridad Social; ENESS). This study represents, to our knowledge, the first empirical analysis of this type in LAC.

Section 2 describes the OSH situation in the Region. Section 3 presents some aspects of the economic literature in the area of OSH. Section 4 describes the available data. Section 5 presents the results of the analysis. Section 6 concludes with a discussion of the main results.

2. Occupational Safety and Health in Latin America

The rate of occupational injury and illness in LAC is difficult to quantify. This is due, in part, to underreporting of accidents and illnesses in those firms and sectors that are legally registered and obligated to report such incidents. However, these countries also have large proportions of the economically active population employed in sectors that are not legally registered and for which few if any statistics are collected. The International Labor Office (ILO, 1998) is the principle source of statistics in this field. ILO collects and publishes occupational accident figures and rates that are based on national registration and notification systems and reliable data are obtained from the majority of LAC countries. However, comparisons are made difficult because information is not collected with consistent registration and notification systems. In most countries, the figures refer only to the number of compensated accidents; whereas in others the data refers to all reported accidents. In the majority of countries, the reporting system only covers insured workers, excluding self-employed agricultural workers, domestic servants, and casual laborers, who are known to have higher than average accident rates. In some countries, the data covers accidents and occupational diseases associated with commuting, whereas others do not. In general, it appears that inconsistencies among countries are more evident across registration of nonfatal occupational accidents than of fatal ones.

Table 1 reports the fatality rate for occupational accidents in the LAC countries for which data are available and for some non-regional countries such as Canada, USA, and Finland by way of comparison. Overall, the average rate in Latin America and the Caribbean is 0.135 per 1,000 workers, which is just between the rates experienced by the two biggest countries in the sample:

Brazil and Mexico.[1] However, there is a large variation in fatality rates across the Region, which vary from the absence of fatal accidents reported by Barbados in 1995, to the 0.33 accidents per 1,000 workers recorded in El Salvador in 1998. Table 1 also shows that in the largest countries of the Region such as Mexico and Brazil, the reporting systems monitor only one third of the workforce. In other countries such as Peru, the information available refers to only 7% of the workforce. Looking outside the Region, the occupational fatality rates in Establish Market Economies were significantly lower than the average rate for LAC. In 1997, Canada experienced a fatality rate that was almost half that of LAC, while even lower rates were recorded in Finland and the USA.

A recent survey of OSH in LAC (Giuffrida et al., 2000) suggests a number of reasons for the high level of occupational hazards in the Region. First workers in LAC are at greater risk because they tend to work longer in the presence of occupational hazards than those in more developed countries. Moreover, the profile of occupational hazards is related to the geography and natural resource endowments of the Region. For example, extraction of primary minerals and ores play a relatively large role in the Region's economies due to a significant endowment of primary commodities such as tin, cooper, gold. For certain kinds of hazards, high altitude or tropical climates may exacerbate the risk of certain injuries or contracting particular illnesses.

Second, occupational health and safety is a new field in the Region and there are fewer experts available, less safety equipment, less monitoring equipment, fewer inspectors and less enforcement than in developed nations (Delclos et al., 1999). Furthermore, OSH research is probably under-funded in the Region since estimates show that only about 5% of occupational health research in the world takes place in developing countries (Partanen et al., 1999). This clearly demonstrates a severe imbalance, if we compare this share of the population and the severity of occupational safety problems in these countries.

Third, in 1998 around 48% of the economically active population on LAC worked in the informal sector of the economy (Lora and Marquez, 1998; ILO, 1999), which is composed of micro-enterprises, domestic services, and self-employed workers. In the formal sector, employment in small enterprises of 6-20 workers represent 25% of the total (ILO, 1999). It is argued that exposure to occupational hazards in these sectors is higher because when firms are small, the fixed costs of reducing occupational hazards may be prohibitive since the firm cannot benefit from scale economies. Moreover, economic activities in the informal sector may be in sectors that are particularly hazardous (such as construction, agriculture and small-scale mining). Monitoring of work conditions is also particularly problematic for informal workplaces that, often by definition, operate outside formal legal standards and regulation.

Fourth, labor markets in LAC are characterized by elevated unemployment and underemployment rates and by a general absence of unemployment insurance, social security insurance and income maintenance for the unemployed and for those working in unregulated sectors of the economy. Therefore, many of the Region's workers may tolerate hazardous working conditions rather than risk losing their jobs. This makes it difficult for workers to undertake collective action to improve working conditions, including limiting the ability to mobilize strikes.

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[1] Since we have weighted the national rate by the number of workers covered, the importance of the outliers is reduced.

Fifth, unions in LAC have been hampered in their ability to promote safer working conditions. In more developed countries occupational health has been promoted through a long struggle by workers against employers who have sought to deny or limit liability. However to play this active role, unions had to be independent organizations that speak for the interests of their rank and file (Framkin, 1999; Laurell, 1989). By contrast, unions in LAC have a checkered history. They have faced severe repression under numerous dictators and military governments. In other cases or times, unions have been co-opted to serve political interests that do not necessarily reflect the best interests of the membership. In many cases, unions have represented only a minority share of workers – those employed in formal workplaces – and have not been immune to the corruption that exists in all spheres of political and economic life. For these and other reasons, unions in the Region have not been able to have the same positive impact on improving working conditions, as have their counterparts in higher income countries.

Finally, in healthy people, some occupational health hazards may occur without apparent effects because the human body has the capacity to deal with such challenges. However, many people can be vulnerable because of poor hygiene and sanitation, poverty and illiteracy or because they are malnourished or already chronically ill. For such people, exposure to occupational hazards can markedly heighten the risks of serious illness or death. The population in LAC contains a large proportion of people who are less healthy and therefore more vulnerable to occupational exposure to toxic chemicals or biological agents.

3. Occupational Safety and Health in the Economic Literature

The determinants and consequences of workplace safety have been an important issue in the economic literature since the end of the 1960. Various theoretical and empirical studies have been inspired by the introduction of workplace safety regulations in the US, notably the Coal Mine Health and Safety Act (CMHSA) of 1969, and the Occupational Safety and Health Act (OSHA) of 1970. The theoretical literature mainly focused on the justification of government interventions on the market for workplace safety. Empirical work on workplace accidents have mainly concentrated on the effect of CMHSA and OSHA regulations on the frequency and severity of workplace injuries, the relationship between workers' compensation and job safety, as well as the impact of unionization. However, the empirical evidence for the consequences of government safety regulation is mixed. Whereas Viscusi (1986), McCaffrey (1983) and Lanoie (1992) found no or little impact of government safety regulations, the empirical results of Gray and Jones (1991a, 1991b) and Well (1996) indicate a significant positive influence of OSHA inspections on workplace safety.

The economic literature suggests that occupational safety is related to the presence of workers' compensation for occupational accidents and diseases and the nature of the contractual relationhip with the employer. Some authors have argued that in a world of perfect markets and complete information the presence of wage differentials for risky jobs implies that public regulation of occupational safety and worker compensation for occupational accidents are unnecessary. Thaler and Rosen (1976) presented a hedonic model where the labor market is perfectly competitive, workers are risk averse and have perfect information about risks of accidents and are also perfectly mobile between jobs, while firms differ in terms of certain intrinsic risks of accidents but can influence the probability of accidents through undertaking safety expenditures. Under this assumption, workers' compensation insurance is unnecessary and harmful.

However, in incomplete markets or with incomplete information non-optimal situations can occur. As noted by Rea (1981), there are at least five possible types of imperfect information that may affect this market.

First, employers and insurers may not be able to identify workers who are accident-prone. This type of misinformation leads to a problem of adverse selection. One solution (or a partial solution) is to restrict the range of choice the insured is allowed, i.e. to impose compulsory insurance to prevent lower risks individuals or firms opting out.

Second, employees and employers may be incorrect in their estimates of occupational risk and of their influence on the level of risk. Under the assumption that workers underestimate risks, Diamond (1977) and Oi (1974) argued that mandatory insurance and safety regulation are justified because they raise the expected utility of risk adverse workers.

Third, there are serious monitoring constraints. Employers may not be able to monitor whether employees are taking proper precautions. The insurers may be unable to monitor precautions taken by either employers or employees. These two types of misinformation involve a particular type of moral hazard, *ex ante* injury hazard, which refers to the effect of the insurance on the choice of self-protective activities taken by the insured when the insurer cannot observe or enforce these activities. Typically, ex ante moral hazard leads to an under-provision of self-protection activities by the insured. In the market place for accidents, this problem is compounded with the possibility of ex ante "double moral hazard" (Lanoie, 1991): a workplace accident not only depends on the precaution levels of the worker but also on those of the firm. Insurers have adopted a number of devices to reduce this problem based on incentive mechanisms, which share the cost between the insured and the insurer. For instance, the insured worker may have to pay a fraction of any claim or the insurance premiums paid by the employer may be based on its previous safety record. However, in general insurance for work-related accidents gives opposite incentives to both parties, at least when the employer is experience-rated by the insurance. It decreases the cost of an accident to the worker, inducing less precaution, while increases the cost of an accident to the firm, inducing more precaution. The result is that ex ante double moral hazard does not necessarily lead to an underprovision of precaution by both parties. Whether or not it does depends on the substitutability or complementary of the precautions levels of the two parties and on the chosen level of insurance and intensity of the experience rating.

The final reason because imperfect information affects the insurance market is that the insurer may not be able to monitor the nature of the injury. This type of misinformation concerns *ex ante casualty hazard* and *ex post duration hazard.* When the insurer is not perfectly informed about the state of the world, an insured worker may take action in order to increase the level of his benefits. For instance, he may be encouraged to simulate injuries or to file a claim that occurs off the job, especially in the case of hard to diagnose injuries. He may also attempt to obtain a longer period of recovery compensated by the social security by exaggerating the severity of his injury.

The above discussion suggests that, due to partial information concerning the risk of accidents and the presence of a variety of informational asymmetries, workers' insurance for work-related accidents and diseases generates potential problems of moral hazard and other adverse incentives. Thus, it is important to analyze empirically the impact of workers' compensation on the frequency and the duration of work-related accidents.

The empirical evidence for the consequences of workers' compensation benefits is mixed and limited to USA data. Chelius (1982) and Neumann and Nelson (1982) conclude that high compensation benefits result in less serious injuries since employers invest more in safety. Ruser's (1991, 1993) results, on the other hand, indicate that increased workers' benefits lead to more lost workdays and more severe accidents at work since employees behave less careful.

Empirical evidence from LAC has not been generally available. Using recent Mexican survey data and the fact that a large share of Mexico's workforce is in the informal sector of the economy, where workers' compensation is not provided, it is possible to estimate the effect of such types of insurance on occupational accidents and illness.

4. Data

The empirical analysis is based on the 1996 Mexican National Survey of Employment and Social Security (Encuesta Nacional de Empleo y Seguridad Social; ENESS).[2] The 1996 edition of the ENESS is extremely valuable because included a special module on work safety and access to social security. This data set can be used to evaluate the determinants of OSH in Mexico as well to shed light on some of the issues presented in the previous sections.

In the survey 12,235 households were interviewed. After eliminating observations with missing values to at least one of the used variables, a final sample of 14,850 observations remained. The details of the variables used in the analysis are showed in Table 2.

Dependent Variable

In the survey there are different questions that relate to the occurrence of work-related accidents and diseases. The first relevant question refers to whether or not the individual suffered from a work-related impairment. This variable (*Impairment*) is a dichotomous variable taking the value of one if the individual suffers from a work-related impairment and zero otherwise. Thus, it can be analyzed using a probit statistical model. Table 2 shows that the percentage of the individuals in the sample that reported work-related impairment is very small, representing approximately 1% of the sample.

Moreover, the survey distinguishes between *temporary impairment* and *permanent impairment*. Table 2 shows that permanent impairments are more frequent, representing approximately 61% of all impairments reported. One could proceed modeling these two variables separately and estimating an appropriate model for each kind of impairment. This, however, is problematic since the two variables can be expected to be closely related, representing a competing risk of accidents for an individual. Joint estimation of these equations using a bivariate probit model is desirable, because takes this interdependence into account and increases the efficiency of the estimation.

The questionnaire also asks to report the number of days of work lost due to work-related impairments. Table 2 shows that on average the 14,850 workers in the sample reported losing 1.35 days out of work. Conversely, workers that suffered work-related impairments lost, on average, 121.07 days of work. Statistical problems may arise, because the event we want to model is a non-negative count event with a skewed distribution and the OLS estimator is inappropriate for this type of data (see Cameron and Trivedi, 1998; Winkelmann 1997).[3] The empirical analysis can be improved by the use of statistical models that recognize that the dependent variable is a non-negative integer count event, such as the Poisson and Negative Binomial (NB) count data models. Moreover, in the data we observe a very large number zeros, which is a common feature of count data events. An alternative approach is the estimation of Zero-Inflated (ZI) models, which allow for systematic differences in the statistical processes governing observations with zero and observations with one or more counts.

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[2] The ENESS is a national survey administrated by the Secretaría del Trabajo y Previsión Social and the Instituto Mexicano del Seguro Social together with the Instituto Nacional de Estadística, Geografía e Informática.

[3] For a review of count data models with specific emphasis to applications in health care, see Jones (2000).

Explanatory variables

As explanatory variables we use variables related to workers' characteristics, aspects of the occupation, and features of the contractual relationship.

In relation to workers' characteristics we include the age of the worker (together with its squared term), gender and whether or not the person is *married*. We also construct a series of variables regarding the educational level. The estimated models take as a baseline an individual with secondary level education (either complete of incomplete) and include dummy variables indicating whether the person did not receive any formal education (*Education 0*), received primary level education (either complete of incomplete) (*Education 1*), or had a higher degree (*Education sup*).

We constructed a dummy variable indicating whether or not the worker is affiliated to a social *security institute* and therefore has the right to receive compensation in case of occupational accidents or diseases. Estimating of the coefficient of this variable is particularly interesting because tests for the effects of moral hazard and other adverse incentives in the insurance system. However, caution is required in this interpretation because there may be differences in the likelihood of reporting accidents between the two groups of worker. Moreover, it could be argued that the decision of participating in the informal sector of the economy and not having social security protection is jointly determined and the variable endogenous.

The data set provides detailed information on the characteristics of the principal occupation of the respondents. In the regression model, we include the weekly remuneration in the principal occupation (*Remuneration*). To some extent, the inclusion of this variable tests the hypothesis of the hedonic wage model formulated by Thaler and Rosen (1976). If the labor market is perfectly competitive and there is perfect information about the risk of accidents, we would expect that the likelihood of work-related impairment were *ceteris paribus* associated with higher wages in order to compensate for occupational hazards.

We also include a series of dummy variables indicating the industry sector to test if there are differences in their occupational hazards. Thus, taking as a baseline the public sector and defense, we used dummy variables to indicate agriculture and farming, manufacturing, mining and electricity, communication and transport, construction and services.

Moreover, using an employees with a permanent written contract for a baseline, we distinguished the cases when the worker had a fixed term written employment contract (*Temporary*) or a verbal employment contract (*Verbal*). We also distinguished the cases when the person interviewed was *self-employed*; working without salary, a co-operative worker or family worker (*No salaried*); and whether the individual is working in a different location than the rest of the family (*Migration*). Economic theory is an uncertain guide when it comes to predicting the impact of these "atypical" contractual arrangements on the level of OSH. If the majority of workers regard these characteristics (e.g. the uncertainty of temporary jobs and self-employment) as disamenities, then in a competitive market there would be an increase in other components of the compensation package relative to that given to permanent workers. This may take the form of increased wages for temporary workers of equal skill. However, it is unlikely that temporary workers will be compensated by being offered a safer environment than that one provided to permanent workers. Foley (1998) argues that higher hazard for atypical workers arises from both the demand and the supply sides of the labor market. On the supply side, temporary workers may place a greater emphasis on wages relative to other elements in the compensation package than permanent workers. In this case the theory would predict that they would forgo some safety in favor of increased wages. Moreover, temporary workers may regard their tenure at any particular work site to be of such a short duration that they would be less exposed to hazards than their counterparts and would reap less benefits from investments to improve these conditions. This reasoning, while rational at the level of each individual workplace, is likely to result in greater exposure to hazard when aggregated over many employment experiences. From the supply side, the temporary workers are usually viewed as short-term resources. Employers are less likely to make significant investments in training temporary workers and to improve their work environment. In general, temporary workers will be considered as being less likely to provide a return on any investment in safety.

Moreover, taking as baseline group employees working in an establishment with between 16 and 50 workers, we included dummy variables to distinguish the cases when the establishment was larger or smaller and whether the individual was a street vendor, or in general a worker without a specific premises (*No premises*). We have discussed in section 2 that the size of the enterprise may be related to OSH. Finally, we include a dummy variable that indicates if the worker has a second occupation (*2 Occupation*). We expect that persons having more than one job may be exposed to higher occupational hazards and therefore more likely to report work-related impairments.

5. Estimation Results

In the regression analysis, we included all the individuals that were between 16 and 65 years of age and were employed at the time of the surveys. After eliminating all observations with any missing values for the variables discussed above, we retained 14,850. The baseline in all of the regressions is a male worker, single, working in the public sector or defense, with secondary education, employed with a written permanent contract, not affiliated with a social security institute, working in an enterprises with 16-50 employees and living with the rest of the household. In all the estimations we adjusted the standard errors for the clustered design of the survey, and we used appropriate weights to control for the differences in the probability of selection in the sample. Thus the sample can be considered as representative of the Mexican population.

Probit model

Table 3 reports the estimated coefficients together with the estimated marginal effects from a probit model of whether or not the worker reported a work-related impairments. Even if the estimated pseudo-R^2 is relatively low (0.1048), the RESET test suggests that the model does not suffer from miss-specification.

The results suggest that there is a strong inverse "U" shaped relationship between occupational accidents and age. The highest probability of reporting work-related accidents or diseases is among individuals whose age is 50 years. In the literature, we found some evidence suggesting that the probability of incurring in occupational accidents decreases with age (Root, 1980). However, the dependent variable used in the analysis includes also occupational diseases, and a positive relationship with age is likely to exists because the probability of developing a disease depends on the exposure to the hazard. Thus, it seems sensible that the combined effect of age on work-related impairment takes the form of an inverse "U" shaped relationship.

Among the other variables included in the regression model, we note that female workers and employees with higher education are less likely to report occupational accident or disability. Thus, after controlling for the type of economic activity and other factors, women and highly educated workers are more likely to be employed in positions that are less exposed to occupational hazards. These results probably reflect the fact that women are over-represented in low risk clerical jobs and that highly educated workers are disproportional employed in low risk occupation such as management.

We also estimate a strong positive relationship with the variable measuring the affiliation to public or private social security. This result may represent evidence that workers and employers' moral hazard (e.g. the fact that both workers and employers may take fewer precautions because they know they are injured) is stronger than employers' incentive to reduce occupational risks because the insurance premium is based on their safety record. However, we have to consider that there may be also other contributing factors. For example, if the worker has the right to social security benefits, he or she may be more likely to report occupational injuries or disease in the survey.

In relation to the type of economic activity we found that, compared with the public sector and defense workers in other economic sectors show a higher probability of suffering from occupational accidents. In particular, the likelihood of reporting work-related impairment is highest among workers in the transport and communication industry, followed by manufacturing, mining and electricity. In third place, we have the service sector, followed by agriculture and farming. Only the construction sector does not statistically differ from the baseline group.

Moreover, workers who have a second occupation are more likely to report work-related health problems. This could be due to longer exposure to occupational hazards, the effect of stress or fatigue, or correlated with particular hazard occupations.

Finally, workers that reside in a different location than the rest of the household (*Migration*) have a higher and statistically significant likelihood of reporting an occupational impairment. On the other hand, remuneration, size of the enterprise, whether the work relationship is based on a temporary or verbal agreement, being self-employed, without a specific premises, and without a salaried work do not appear to be significantly associated with OSH.

Bivariate probit model

We have distinguished between temporary and permanent work-related impairments and we have estimated the two regressions jointly using a bivariate probit model. The results from the estimation are presented in Table 4. The hypothesis that the two regression models are independent ($r = 0$) is rejected. Therefore, the bivariate probit model produces estimates that are more efficient than estimating the two models separately.

Even if the estimates are altogether quite similar to the previous model, we can notice some differences between the determinants of temporary and permanent impairments. First of all, the effects of age are quite different. In the case of temporary impairment the maximum is at 41 years of age, while permanent impairments are more likely to be reported at a much older age of 57.

In the regression estimating permanent impairments, *Migration* has a positive and statistically significant impact as well as the variable measuring the case of a verbal contact. On the other hand these two variables are not significant in the regression estimating temporary impairments.

Finally, another difference refers to the variable that indicates the case of a worker without salary, co-operative worker or family worker. In the regression estimating temporary impairments, the variable shows a statistically significant positive coefficient, while in the case of permanent impairments the estimated coefficient is again statistically significant, but negative.

Count data models

We have also used as dependent variable the number of days out of work due to work-related impairments. Since this variable take the form of positive count, we have first estimated the Poisson and the NB models, which are presented in Table 4.

The estimates of the Poisson model, presented in the first part of Table 5, are broadly in line with the previous estimates, but the extreme significance of the goodness of fit statistic (c^2 (14819) = 142493) indicates that the Poisson model is not appropriate and that we should try the NB model.[4] The Poisson model is a special case of the NB. In order to test the restriction that a = 0, we perform a likelihood-ratio test. The very large c^2 (1) value of 141000, asserts that the probability that we would observe these data conditional on the process being Poisson, is virtually zero.

The presence of overdispersion, although consistent with the NB specification, does not necessarily imply that the NB specification is the best model. Plausible alternatives to the models estimated so far are the Zero Inflated (ZI) models.

To explain why the ZI model may be suitable in our case, consider the possibility that the decision of not going to work requires some fixed costs. These costs may include the value of time and resources needed to see a doctor and to fill requested forms. Therefore, there may be systematic differences in the statistical process governing the decision about taking days off from work and the process governing the number of days out of work. Zero Inflated (ZI) Poisson or NB models allow for systematic differences in the statistical processes governing observations with zero and observations with one or more counts. This is achieved by combining a dichotomous model governing the binary outcome of the count being zero or positive and a truncated-at-zero model for strictly positive outcomes.

Table 6 presents the estimate of the ZI model, in which the probability of a nonzero count is modeled as a logit function and the number of positive counts is assumed to follow a NB distribution.[5] The Likelihood ratio tests presented at the bottom of Table 5 show that the ZI NB is preferred over the NB model, the ZI Poisson model and the Poisson model.

In relation to the issue of the interpretation of the regression coefficients, we note that the coefficients on the variables can be interpreted as semielasticity. In other words, the coefficient b_j equals the proportionate change in the conditional mean if the *j*-th regressor changed by one unit.

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[4] The c^2 goodness of fit test compares the fitted probability with actual frequencies, where the fitted frequencies distribution is computed as the average over observations of the predicted probabilities fitted for each count (Cameron and Trivedi, 1998; p. 155).

[5] Since the ZI model assumes the correlation between the two regressions to be zero, the covariate lists of the two models can be identical.

The logit function, which models the probability of observing zero days out of work, shows a "U" shaped relationship with the age of the worker.[6] The minimum is among individuals whose age is 53 years. The ZI NB model for the non zero outcomes shows the same pattern and a maximum at the age of 44.

Interesting differences appear in relation to the educational level. Higher education is a significant factor in the probability of taking no days out from work, but does not affect the number of days. On the other hand, workers without education tend to have fewer days out of work.

Among the other variables, we observe that *Migration* has a negative and statistically significant impact on the likelihood of observing a zero, while it is not significant in the number of days out of work. Workers who are affiliated with a social security system are both less likely to have zero outcomes and to have more days out of work.

The estimation also shows that remuneration is associated with a higher probability of not taking any days out of work due to work-related impairment. This result is against the expectations of Thaler and Rosen's (1976) model. However, an explanation is that workers with higher remuneration may incur larger costs if they do not go to work, thus it may reflect the higher opportunity cost of taking time to see a doctor or to process a sick leave. Finally, being self-employed is associated with more days out of work.

6. Conclusion

In this paper we have described the situation of OSH in LAC, the dimensions of the problems and some of the economics aspects related to workers' compensation for occupational accidents and diseases. In the empirical analysis we have examined the determinants of work safety in Mexico using data from the 1996 ENESS household survey.

The results presented in this paper should be considered as preliminary. However, the analysis offered a number of interesting findings. First, all the estimations showed that the probability of reporting work-related impairments and the related number of days out of work are higher among workers covered by social security compensation systems. This result suggests that workers and employers' incentive to take fewer precautions are stronger than employers' incentives to increase safety at work. An implication for policy is that a stronger experience rating system may be useful to increase precautions at work and to reduce occupational accidents and diseases. Indeed, the recent increase in the experience rating of the IMSS employers' contribution, which changed from 0.348-10.035% to 0.025-15% of payroll, went in this direction.

The second interesting result of the analysis is the absence of any positive relationship between wages and the likelihood of reporting work-related impairment. This result rejects the hypothesis of the hedonic wage model formulated by Thaler and Rosen (1976), which predicts that, *ceteris paribus*, the likelihood of suffering work-related impairment should be associated with higher wages in order to compensate for occupational hazards. Moreover, in the ZINB model wages showed a statistically significant and positive relationship with the likelihood of not reporting any day out for work due to occupational impairment. An explanation is that workers with higher remuneration have higher opportunity cost for the time needed to see a doctor or to process a sick leave.

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[6] Even if the age squared is not significant in any of the two part of the ZINB model, the variable is jointly significant (c^2 (2) = 8.68 i.e. $0.01 < p \leq 0.05$).

Third, the analysis indicated an inverted “U” shape relationship between occupational impairment and worker’s age. The peak of this relationship is different between temporary and permanent impairments, as the former are more likely to be reported by workers aged around 41 years, while permanent impairments are more frequently reported around 57 years of age. Moreover, the ZINB showed that workers of 44 years of age reported the highest number of days out of work due to occupational impairments.

Fourth, in relation to the type of economic activity we found that workers from the public sector and defense have the lowest likelihood of reporting work-related impairment. On the other hand, workers in the transport and communication industry reported the highest rate of work-related impairment followed by manufacturing, mining and electricity.

In relation to other characteristics of the contractual relationship we note that the size of the enterprise does not appear to affect occupational safety, while a second occupation and a verbal contractual agreement showed a positive impact on the likelihood of reporting permanent impairments. Moreover, self-employed and workers in enterprises with more than 50 employees reported, on average, more days out of work. However, the latter relationship was only marginally significant.

On the other hand, we have to point out some limitations of the analysis. First, the econometric analysis was based on those workers that were still at work at the time of the survey. This factor may introduce a bias in the results because of the so-called “healthy worker effect”. Those who died or were out of work because of severe disabilities at the time of the survey were excluded from the sample (Monson, 1986).

Second, since information on work-related accidents and disease as well as the occurrence of days out of work were self-reported, there may be biases due to differences in how these events were perceived. Therefore, part of the differences between workers covered and not covered by social security may be explained by differences in the perception and/or propensity of reporting work-related impairment.

Third, we have estimated the two events: the occurrence of a work-related impairment and the number of days out of work due to such impairment as independent. However, it may be possible to consider the sequential nature of the two events using more sophisticated methodologies.

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Table 1 Occupational fatality rates

Country	Fatality rate per '000 workers	Employed & covered by ILO data %	Year
Barbados [(b)]	0.000	-	95
Bolivia [(a)]	0.111	23	97
Brazil [(3, a)]	0.150	33	96
Colombia [(2, b)]	0.077	85	96
Costa Rica [(3, a)]	0.069	55	97
Ecuador [(1, a)]	0.168	35	94
El Salvador [(1, a)]	0.330	26	98
Mexico [(3, b)]	0.120	34	97
Nicaragua [(3, a)]	0.096	-	98
Panama [(1, a)]	0.140	65	98
Peru [(a)]	0.186	7	98
Trinidad & Tobago [(b)]	0.010	-	97
Venezuela [(1, b)]	0.006	60	97
Average LAC [(c)]	0.135	-	-
Canada [(2, a)]	0.071	84	97
USA [(2, b)]	0.005	-	97
Finland [(a)]	0.027	82	96
Republic of Korea [(3, a)]	0.290	38	98

Source: ILO (1998).
(1): indicates that commuting accidents are included.
(2): indicates that occupational diseases are included.
(3): indicates that both commuting accidents and occupational diseases are included.
(a): indicates compensated injuries
(b): indicates reported injuries
(c): average weighted by the number of workers covered in each country

Table 2 Description of the variables

Variable	Description	Mean	Std. Dev.
Impairment	Work-related impairment [a]	0.011	0.105
Temporary impairment	Temporary impairment [a]	0.0043	0.066
Permanent impairment	Permanent impairment [a]	0.0068	0.082
Days out of work	Number of days out of work due to work-related impairment (all worker in the sample)	1.352	26.733
	(only worker reporting work-related impairment)	88.610	146.842
Age	Age	34.499	12.294
Female	Female [a]	0.313	0.464
Married	Married [a]	0.553	0.497
Education 0	Without education [a]	0.081	0.273
Education 1	Primary education (primary completa y incompleta) [a]	0.438	0.496
Education Sup	Higher education (medio superior, superior, mastria y doctorado) [a]	0.199	0.400
Social Security	Affiliation to public or private social security [a]	0.462	0.499
Remuneration	Remuneration from principal occupation (last week in '000 pesos)	2.002	4.520
Agriculture	Agriculture and farming [a]	0.207	0.406
Manufacturing	Manufacturing, mining and electricity [a]	0.191	0.393
Transport	Transport and communication [a]	0.043	0.203
Construction	Construction [a]	0.052	0.222
Services	Services [a]	0.452	0.498
Temporary	Written employment contract, fixed term [a]	0.052	0.222
Verbal	Verbal employment contract [a]	0.349	0.477
Self-employed	Self-employed [a]	0.300	0.458
No Salaried	Worker without salary, co-operative worker or family worker [a]	0.003	0.051
Migration	Reside in a different location than the household [a]	0.005	0.073
Small	Enterprises with less than 16 employees [a]	0.315	0.465
Large	Enterprises with more than 50 employees [a]	0.284	0.451
No premises	Street vendor, and workers without a specific premises [a]	0.394	0.489
2 Occupation	Two or more occupations in the last week [a]	0.079	0.270

a: Dummy variable taking the value of 1 if yes, 0 otherwise.
Observations: 14,850.
Baseline: male, single, working in the public sector or defense, secondary education, salaried worker, written permanent employment contract, without social security, working in an enterprises with 16-50 employees, with a specific premises and living with the rest of the household.

Table 3 Regression results: Dependent variable *Impairment* - Probit model

Variable	Coefficient	Standard Error	Marginal Effect (dF/dx)
Age	0.0808***	0.0226	0.001364
Age^2	-0.0008***	0.0003	-0.000014
Female	-0.4981***	0.1296	-0.007214 (a)
Married	0.0684	0.0985	0.001144 (a)
Education 0	-0.1065	0.1683	-0.001605 (a)
Education 1	-0.0640	0.0982	-0.001065 (a)
Education Sup	-0.5448***	0.1460	-0.006785 (a)
Migration	0.8711***	0.2984	0.043676 (a)
Social Security	0.3717***	0.1391	0.006641 (a)
Remuneration	-0.0202	0.013	-0.000341
Agriculture	0.4066*	0.2151	0.009982 (a)
Manufacturing	0.5409***	0.1906	0.014232 (a)
Transport	0.7536***	0.2433	0.030637 (a)
Construction	0.2788	0.2575	0.006519 (a)
Services	0.4279**	0.1893	0.007576 (a)
2 Occupation	0.2636**	0.1120	0.005958 (a)
Self-employed	0.1994	0.1718	0.003759 (a)
No Salaried	0.3380	0.3540	0.008784 (a)
Small	-0.0238	0.2006	-0.000397 (a)
Large	0.0819	0.1372	0.001444 (a)
Temporary	-0.0295	0.1991	-0.000483 (a)
Verbal	0.1814	0.1542	0.003331 (a)
No premises	0.1879	0.1481	0.003373 (a)
Intercept	-4.7436***	0.5287	-
Log-likelihood	-821		
Pseudo R^2	0.1048		
RESET [c^2 (3)]	4.36		

*** indicates $p \leq 0.01$; ** indicates $0.01 < p \leq 0.05$; * indicates $0.05 < p \leq 0.1$

(a) dF/dx is for discrete change of dummy variable from 0 to 1.

Observations: 14,850

Standard errors adjusted for clustering (basic geographical statistical area).

Table 4 Regression results: Dependent variables *Temporary Impairment and Permanent impairment* – Bivariate probit model

	Temporary impairment		*Permanent impairment*	
Variable	Coefficient	Standard Error	Coefficient	Standard Error
Age	0.0946**	0.0380	0.0822***	0.0282
Age^2	-0.0012**	0.0005	-0.0007**	0.0003
Female	-0.3577**	0.1688	-0.5629***	0.1541
Married	0.0610	0.1277	0.0653	0.1143
Education 0	-0.2161	0.1908	-0.1000	0.2075
Education 1	0.0857	0.1454	-0.2164*	0.1259
Education Sup	-0.5290***	0.1990	-0.5350***	0.1700
Migration	0.4411	0.4035	1.0449***	0.3810
Social Security	0.3508*	0.1885	0.3236**	0.1404
Remuneration	-0.0158	0.0172	-0.0234	0.0147
Agriculture	0.4746	0.2934	0.3554	0.2492
Manufacturing	0.6131**	0.2593	0.4471*	0.2321
Transport	0.7568**	0.3368	0.7095***	0.2758
Construction	0.5305	0.3280	0.0107	0.3281
Services	0.4249*	0.2526	0.4100*	0.2279
2 Occupation	-0.1092	0.1674	0.4027***	0.1310
Self-employed	0.0851	0.2080	0.2990	0.2041
No Salaried	0.7392**	0.3456	-6.3432***	0.4275
Small	0.1245	0.2298	-0.2207	0.2461
Large	-0.0807	0.1828	0.2537	0.1609
Temporary	0.0223	0.2408	-0.1423	0.2358
Verbal	-0.0191	0.2118	0.3980***	0.1543
No premises	0.1193	0.1762	0.2369	0.1519
Intercept	-5.0135***	0.8798	-5.1607***	0.6646
r	-0.8226	0.1075		
Log-likelihood	-1578219			
Wald test of $r = 0$ [c^2 (1)]	12.2668***			

*** indicates $p \leq 0.01$; ** indicates $0.01 < p \leq 0.05$; * indicates $0.05 < p \leq 0.1$

Observations: 14,850.

Standard errors adjusted for clustering (basic geographical statistical area).

Table 5 **Regression results: Dependent variable *Days out of work* - Poisson and Negative Binomial model**

	Poisson		Negative Binomial	
Variable	Coefficient	Standard Error	Coefficient	Standard Error
Age	0.2752***	0.0993	0.4958***	0.0857
Age^2	-0.0030**	0.0013	-0.0055***	0.0010
Female	-4.8231***	0.7306	-4.4911***	0.4455
Married	-0.3158	0.3896	-0.1679	0.3926
Education 0	-1.9785***	0.6999	-3.2573***	0.7460
Education 1	-0.3541	0.5065	-2.0693***	0.5328
Education Sup	-1.7466**	0.7080	-2.5630***	0.6787
Migration	3.0231***	0.4810	1.6436***	0.4789
Social Security	2.0850***	0.4374	2.2194***	0.4871
Remuneration	-0.0476	0.0440	-0.0408	0.0383
Agriculture	1.6808*	0.9310	0.9667	0.9834
Manufacturing	2.4360***	0.7091	0.4881	0.9478
Transport	1.8295*	0.9515	2.8110***	1.0950
Construction	0.3189	1.1087	-0.6035	1.2171
Services	1.8962**	0.7882	0.1382	0.9705
2 Occupation	0.3872	0.4726	0.8458	0.6459
Self-employed	2.2544**	0.9976	2.4501***	0.9022
No Salaried	1.1959	0.8990	3.3406***	0.9298
Small	1.0282	0.9645	1.7372***	0.6014
Large	0.6493	0.6978	0.5646	0.5690
Temporary	0.2227	0.8233	-1.6334*	0.8699
Verbal	1.8633***	0.4884	0.5253	0.6679
No premises	1.0203	0.5612	1.4524***	0.5297
Intercept	-10.0122***	2.4848	-12.0499***	1.9981
ln(a)	-	-	6.4546***	0.1498
Log-likelihood		-87680		-1301
Goodness of fit test [c^2 (14819)]		174700***		
Likelihood ratio test NB vs. Poisson $a = 0$ [c^2 (1)]				173000***

*** indicates $p \leq 0.01$; ** indicates $0.01 < p \leq 0.05$; * indicates $0.05 < p \leq 0.1$

Observations: 14,850.

Standard errors adjusted for clustering (basic geographical statistical area).

Table 6 Regression results: Dependent variable *Days out of work* - Zero Inflated Negative Binomial model

	Non zero outcome		Zero outcome	
	Coefficient	Standard Error	Coefficient	Standard Error
Age	0.1823*	0.0947	-0.1481**	0.0731
Age^2	-0.0021**	0.0010	0.0014	0.0009
Female	-2.5051***	0.4168	2.0664***	0.6173
Married	-0.4051	0.3262	-0.1444	0.3359
Education 0	-1.4544***	0.4069	0.3649	0.5718
Education 1	-0.2455	0.3029	0.3245	0.3110
Education Sup	0.7458	0.5525	1.9846***	0.5403
Migration	0.2365	0.4262	-2.4627***	0.5463
Social Security	1.4008***	0.3668	-1.0789***	0.3935
Remuneration	0.0057	0.0551	0.0621**	0.0307
Agriculture	0.8278	0.6899	-1.1650	0.8139
Manufacturing	0.6695	0.6337	-1.5053**	0.7611
Transport	1.4179**	0.6700	-1.4112	0.8650
Construction	-0.2751	0.8815	-1.0675	0.8931
Services	0.8006	0.6597	-1.2285*	0.7413
2 Occupation	-0.2761	0.3744	-0.4414	0.3343
Self-employed	1.7060***	0.6586	-0.4211	0.4758
No Salaried	0.0880	1.0180	-0.9484	1.0186
Small	1.0262	0.6604	0.2672	0.6331
Large	0.9039*	0.5135	-0.0070	0.4099
Temporary	0.4694	1.0026	0.5411	0.7603
Verbal	0.9966	0.6539	-0.8816*	0.4656
No premises	0.7949	0.5779	-0.5650	0.4840
Intercept	-1.6872	2.0066	9.9552***	1.6989
Ln(a)	0.0585	0.1645	-	-

Log-likelihood	-1220
Likelihood ratio test ZINB vs. NB [Inflate = 0 c^2 (24)]	164***
Likelihood ratio test ZINB vs. ZI Poisson [a = 0 c^2 (1)]	14389***
Likelihood ratio test ZINB vs. Poisson [c^2 (25)]	172923***

*** indicates $p \leq 0.01$; ** indicates $0.01 < p \leq 0.05$; * indicates $0.05 < p \leq 0.1$

Observations: 14,850.

Standard errors adjusted for clustering (basic geographical statistical area).