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**Effects of Workers'
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Effects of Workers' Compensation: A Survey^{*}

Bernard Fortin[†], Paul Lanoie[‡]

Résumé / Abstract

Cette étude couvre un grand nombre des travaux théoriques et empiriques réalisés sur les effets incitatifs de l'existence d'indemnisation pour les accidentés du travail (IAT) dans le contexte nord-américain. Nous analysons d'abord la rationalité économique de l'indemnisation obligatoire des accidentés du travail. Nous étudions ensuite l'impact de l'IAT sur le comportement. On peut distinguer trois types d'effets : 1) l'IAT peut influencer la fréquence, la durée et la nature des réclamations à travers une variété d'effets incitatifs. Dans le cas d'information asymétrique sur les activités de prévention des accidents, l'IAT peut affecter les activités préventives des employés et des employeurs, ainsi que le niveau de risque sur le marché. Dans le cas d'information asymétrique sur la véritable nature des accidents du travail, les travailleurs assurés peuvent tenter de déclarer de faux accidents, ou des accidents survenus à l'extérieur de leur lieu de travail. Ils pourront aussi entreprendre certaines activités afin de bénéficier d'indemnisations plus élevées, particulièrement dans le cas de blessures difficiles à diagnostiquer. De plus, on peut observer une substitution entre l'IAT et d'autres programmes d'assurance. La décision de déclarer un accident du travail peut également être affectée par la générosité des prestations. 2) L'IAT peut modifier le taux de salaire des travailleurs et 3) l'IAT peut affecter la productivité de la firme. Jusqu'à présent, les écrits ont mis l'accent sur le premier type d'effets. Les principaux résultats montrent qu'une hausse de l'IAT est associée à une augmentation de la fréquence des blessures (élasticités entre 0.4 et 1), et à une hausse de la durée moyenne des réclamations (élasticités entre 0.2 et 0.5). Par ailleurs, on peut constater une relation positive entre l'accroissement de l'IAT et le nombre de blessures difficiles à diagnostiquer. Et, dans le même ordre d'idées, les études ont montré (du moins au Canada) qu'il s'effectue une substitution entre l'assurance chômage et l'assurance contre les accidents du travail. Enfin, des résultats empiriques ont montré que la présence de l'assurance contre les accidents du travail conduit à d'importantes réductions du taux de salaire, tandis qu'une nouvelle vague d'études suggère que les changements de l'assurance contre les accidents du travail peuvent également exercer un effet négatif sur la productivité.

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This survey covers extensively the theoretical and the empirical work that was done on the incentive effects related to the existence of workers' compensation (WC) in the North American context. It first analyzes the economic rationale for compulsory WC. Then it studies the impact of WC on behavior. Three types of effects can be distinguished: 1) WC may influence frequency, duration and nature of claims through a variety of incentive effects. Under asymmetrical information about accident prevention activities, WC may affect safety behavior of both employers and employees and the risk level in the market place. Under asymmetrical information about the true nature of workplace injuries, insured workers may attempt to report false or off-the-job accidents and to undertake activities in order to obtain higher WC benefits, especially in the case of hard-to-diagnose injuries. Moreover, substitution between WC and other insurance programs may be observed. The decision of reporting a workplace accident may also be affected by the generosity of WC benefits. 2) WC may induce changes in occupational wages rates and 3) WC may affect firms' productivity. So far, the literature has focused mainly on the first type of effects. The main results show that increases in WC insurance are associated with an increase in the frequency of injuries (elasticities ranging from 0.4 to 1), and with an increase in the average duration of claims (elasticities ranging from 0.2 to 0.5). Furthermore, increases in WC are associated with more reporting of injuries that are hard-to-diagnose and, in the same line, there are some evidence (at least in Canada) of substitution between unemployment insurance and WC insurance. Lastly, there are empirical results showing that the presence of WC insurance induces important reductions in wage rates, while an emerging literature suggests that changes in WC insurance may also have negative productivity effects.

Mots Clés : Assurance, accidents du travail, sécurité du travail, incitation, salaires, productivité

Keywords : Insurance, workers' compensation, occupational safety and health, incentives, wages, productivity

1. Introduction

The social cost of workplace accidents is important. In a typical year in the United States, more than 50 times as many working days are lost to work injuries than to labor strikes, and from one-half to one-third as many working days are lost to work injuries than to unemployment (Krueger, 1988). Not surprisingly, policy makers have been concerned by this phenomenon and workers' compensation (WC) insurance has been made compulsory in most North American jurisdictions, covering more than 90 percent of the workforce.

WC insurance is a form of no-fault insurance in case of a workplace accident, where workers give up the right to sue their employer in exchange for a right to compensation. Firms are considered liable for workplace accidents and pay insurance premiums as a percentage of their total payroll to a Workers' Compensation Board (WCB), which compensates accident victims and pays for their medical expenses related to workplace injuries. In most jurisdictions, insurance premiums are adjusted to reflect the past claim records of firms (experience-rating). WC claims result from work injuries that produce an impairment that can be classified by duration (temporary or permanent) and severity (total or partial). Most claims are for temporary total impairment, where the injured worker returns to work with no residual impairment. Claimants then receive a percentage of their pre-injury wage throughout the duration of the claim (typically 66 % of gross wage in the U.S. and 90 % of net wage in Canada)¹.

It is important to consider the implications of the WC system since it operates in a market context. The system may have a variety of effects on employees and employers. Three types of effects can be distinguished². First, WC may influence frequency, duration and nature of claims through a variety of incentive effects. In particular, WC insurance may lead to moral hazard problems which arise when informational asymmetries are used for personal gains³. The first is that of *ex ante* injury hazard. Since insurance covers the financial and medical losses associated with the injury, workers' incentive to exercise care will diminish with increases in coverage. Moreover, because employers fund WC benefits through premiums linked at least in part to their firm's safety record, there is an incentive to increase the investment in health and safety capital when there is an increase in WC insurance coverage. These

¹ In both countries, benefits are not taxable.

² This classification is similar to that adopted by Moore and Viscusi (1991).

³ The description that follows uses Viscusi's (1992) classification.

pressures may result in changes in risk or, more precisely, in the frequency or the duration of injuries.

A second form of moral hazard, termed *ex ante* causality hazard, arises because it is sometimes difficult to identify which accidents are caused by the job. Therefore, workers may file claims for accidents that have not occurred, or for off-the-job accidents. A third form might be termed *ex post* duration hazard. With an increase in the insurance coverage, injured workers may be tempted to take action in order to prolong the duration of the period over which benefits are paid out.

A final form of moral hazard, termed *insurance substitution* hazard, may arise, given that WC is in general more generous than unemployment insurance (UI). Workers may be tempted to undertake activities in order to benefit from WC instead of UI, when they are confronted with a lay-off. For instance, they may report false or off-the-job accidents or, given that they have been injured on the job, they may try to increase the duration of their period of recovery compensated by WC.

The decision to file an accident report may also be affected by the level of WC benefits (reporting incentives) since, in some circumstances, an injured worker may have some discretion over whether to ignore an injury and to continue working or to report the injury and to receive WC benefits.

Second, the change in risk described above may in turn affect workers' wage through changes in compensating differentials, or simply because social insurance for job injuries will increase the attractiveness of risky employment to workers, thus reducing the required compensating differential. Third, WC benefits may lead to more absenteeism and the loss of firm specific human capital, which in turn may induce productivity effects.

To our knowledge, the present survey is the first to cover all these aspects related to the existence of workers' compensation. As will be shown, the literature has focused on the first type of effects described above and is mainly North American. Section II discusses the theoretical rationale for government regulation of WC insurance and presents the theoretical arguments which relate changes in WC insurance coverage to changes in certain outcomes (frequency, duration and nature of claims, wage and productivity). Section III provides a survey of the empirical work that was done on these issues. Section IV presents some concluding remarks and discusses the lessons to be learned by policy makers from this literature.

2. Theoretical work

2.1. Economic rationale for WC insurance

1) A model with no market imperfection

Some authors, such as Thaler and Rosen (1976), allege that the presence of both wage differentials for risky jobs and private insurance markets implies that WC is unnecessary. In their hedonic model based on Rosen (1974), the labor market is perfectly competitive, workers are risk averse and have perfect information about risks of accidents. They are also perfectly mobile between jobs. Firms differ in terms of certain intrinsic risks of accidents but can influence the probability of accidents through undertaking safety expenditures. Moreover, the marginal cost of reducing risks varies across firms.

The model also assumes a perfect insurance market: the cost of insurance against injuries equals its actuarial value and insurers know the true probability of accident in each firm. Conditional upon facing a given accident probability, each worker will choose an optimal amount of insurance coverage. This level of insurance will equate his (ex post) marginal utility in all states of the world (that is, with and without injury). Workers will move to firms whose wage rate-risk of injuries combination maximizes their well-being. If all workers are identical, firms with higher risk of accident will have to pay a higher wage rate to attract workers. This is the case even if workers are perfectly insured against accidents, since the insurance premium is increasing with the level of risk prevailing in a firm.

In such a world, wage differentials across firms compensate workers for the welfare reduction associated with a risk of accident. In equilibrium, each firm's marginal cost for risk reduction equals its workers' marginal benefit from risk reduction. Moreover, wage differentials induce a social optimal allocation of workers across firms and a social optimal effort within each firm to reduce hazard. This analysis formalizes the basic insights of Adam Smith's theory of equalizing wage differentials as applied to the risk of occupational accidents.

In the case where preferences against risk of accidents vary across workers, workers with low risk aversion will choose to work in high-risk firms⁴.

⁴ This will be the case if insurance is imperfect (nonzero loading or administrative charges and hence incomplete coverage), if preferences are state dependent or if there are interpersonal differences in physical capacities to cope with job risk. In all these cases, risk-averse workers will not fully insure against accidents. Therefore their risk choice will depend on their degree of risk aversion (see Thaler and Rosen, *op.cit.*, p. 272).

Therefore, the wage premium provided by high-risk firms will understate the one required by individuals working in low-risk firms. Again, under the assumptions of the model, this sorting equilibrium will be socially optimal.

This model can also be generalized to the case where workers can influence their risk of injury through costly accident-preventing effort. As long as firms have full information about the level of effort chosen by workers, competitive equilibrium will also lead to a social optimum. In equilibrium, safety input provided by each party will be such that its marginal cost for one party will equal to its marginal benefit to both parties. This rule is analogous to the efficiency condition in public goods theory (Lanoie, 1991).

In this model, workers insure themselves in a competitive market. However, as long as firms are risk-neutral, one could argue that they are a natural source of insurance to their risk-adverse workers (see Rea, 1981). Of course, under the assumptions of the model, one should not expect this possibility to affect the injury rate at any firm and therefore the safety level and the allocation of workers across firms will still be Pareto-optimal. However, one should observe smaller compensating wage differentials in higher risk firms since a part of their workers' total compensation will include WC insurance. In such a world, the introduction of a public WC system that is perfectly experience rated and that involves no administrative costs, will lead to a safety level and an allocation of labor similar to the one observed in a competitive market. Moreover, if WC benefits are not perfectly experience rated, higher risk firms will be implicitly subsidized by the public system. Therefore they will have less incentive to undertake safety expenditures. In that case, WC insurance will lead to a sub-optimal allocation of resources (Ehrenberg, 1988).

This model shows that, in a world of complete information and perfect markets, either public WC insurance is unnecessary or is harmful. However, this result breaks down with incomplete information or imperfect markets, and the literature on accident prevention discusses such situations.

2) Problems of imperfect information

Problems of imperfect information in the "market for workplace accidents" have attracted much attention recently. As noted by Rea (1981), there are at least five possible types of imperfect information that may affect this market: 1) Employers and insurers may not be able to identify workers who are accident-prone; 2) employees and employers may be incorrect in their estimates of occupational risk and of their influence on the level of risk; 3) the employer may not be able to monitor the precautions taken by employees; 4)

the insurer may not be able to monitor employers' and employees' precautions; 5) the insurer may not be able to monitor the nature of injury. The first type of misinformation leads to what is commonly called adverse selection. The third and fourth types reflect *ex ante* injury hazard and the fifth type involves *ex ante* causality hazard or *ex post* duration hazard.

Let us first consider the case of adverse selection. This phenomenon is a manifestation in insurance markets of the more general concept of 'lemons' (Akerlof, 1970). The insured may have a much better idea than the insurer of whether he is a high- or low-risk. In the face of this asymmetric information problem, the insurance market is either inefficient or fails entirely, the ultimate outcome depending on the precise behavior of insured and insurer (e.g., see Hellwig, 1987). One solution (or a partial solution) is to restrict the range of choice the insured is allowed. A particular relevant possibility is to impose compulsory insurance to prevent lower risks opting out. It should be stressed that this policy does not necessarily require the public provision of WC insurance. The government could make WC compulsory, while not supplying insurance itself. In fact, in a number of American States, WC insurance is mandatory but is privately provided (Butler, 1994).

The second type of imperfect information concerns workers' knowledge about the safety level prevailing at different firms in the market. This problem has been analyzed by Oi (1974), Diamond (1977) and Rea (1981). Following an assumption first adopted by Adam Smith, these authors suppose that workers underestimate risk. Akerlof and Dickens (1982) have argued that the psychic costs of fear of accidents may induce a cognitive dissonance phenomenon that makes workers underestimate their perceived probability of accidents and choose a sub-optimal level of accident-preventing effort.

Under the assumption that workers underestimate risk, Diamond and Oi argue that mandatory insurance (privately or publicly provided) and safety regulation are justified because they raise the expected utility of risk averse workers. However, their analysis assumes that employees' safety precautions are not affected by the regulation of insurance. In contrast, Rea (1981) alleges that mandatory insurance and safety regulation may lead workers to undertake more risk and therefore to substitute wages for safer jobs. As a result, safety could fall even in the absence of moral hazard. Moreover, if this effect is strong enough, WC could lower workers' expected utility, evaluated with true probabilities. This analysis has some similarities with the well-known Peltzman (1975) effect, according to which automobile safety regulations such as compulsory seat belt may induce automobilists to drive less carefully. This may lead to an increase in the number and the severity of car accidents

and, if this effect is strong enough, to a reduction in total welfare.

Carmichael (1986) disagrees with the assumption that workers underestimate risk. He integrates imperfect information by exploring the role of a firm's reputation in repeated games. His model suggests that it takes time for workers to learn about changes in safety in a firm which leads, generally, to an underprovision of safety. In contrast with Rea, Carmichael is able to make unambiguous statements about the welfare-improving nature of government intervention related to occupational safety and health. In particular, he shows that a marginal increase in the level of compensation benefits leads to unambiguous improvement in welfare.

The third and fourth types of misinformation involve a particular type of moral hazard: *ex ante* injury hazard. It defines the effect of insurance on the choice of self-protection activities by the insured when the insurer cannot observe or enforce these activities (asymmetric information). Let us consider the case of individual expenditure on a preventive activity, x , which can reduce the probability of an insured event. The socially efficient level of x is that at which its marginal cost is equal to its social benefit in terms of its effect on the reduction of insured losses. But if losses are fully insured and the insurer cannot monitor individual preventive activities, the private incentive is to spend little on it. As a result, this *ex ante* moral hazard typically leads to an underprovision of self-protection activities by the insured, as far as the substitution effect is concerned (see Pauly, 1974, Holstrom, 1979, and Arnott and Stiglitz, 1988, for careful analyses of the effects of moral hazard).

Private insurers have adopted a number of devices to reduce this problem. In particular, incentive mechanisms may seek to share the cost between the insured and the insurer: frequent claimants may pay higher premiums; deductibles make the insured person pay the first \$X of any claim; with coinsurance, the insured person pays a fraction of any claim. However, none provides a complete solution to the *ex ante* moral hazard, since the root of the problem is the imperfect information of insurers about the behavior of the insured.

In the "market place for accidents", this problem is compounded with the possibility of *ex ante* "double moral hazard" (Lanoie, 1991). Indeed, a workplace accident not only depends on precaution levels of the worker but also on those of the firm. Therefore, the level of WC insurance may affect the (nonenforceable) precaution levels of the two parties. In fact, a rise of the level of insurance benefits gives opposite incentives to both parties, at least when the firm is experience-rated by the insurer or is the insurance provider. It decreases the cost of an accident to the worker (inducing less precaution),

while it increase the cost of accident to the firm (inducing more precaution). As a result, *ex ante* double moral hazard does not necessarily lead to an underprovision of precaution by both parties. Whether or not it does depends not only on the substitutability or the complementary of the precaution levels of the two parties, but also on the chosen level of insurance (Lanoie, 1991).

In such a context, can a government intervene to induce a Pareto improvement in the level of precaution? As in all cases involving misinformation problems, the answer to this question partly depends on the information the government has at its disposal. Technological constraints make the case of a government better informed than the private insurance sector unlikely. Therefore a more relevant question is whether the government, with no more information than the private sector, can improve welfare with publicly provided WC insurance. Lanoie shows, in contrast with Carmichael (1986), that the impact of a legislated increase in WC benefits does not necessarily lead to a welfare improvement. An explanation for the ambiguity is that, in Carmichael's approach, the probability of accidents depends only on the firm's safety expenditure while Lanoie's approach allows it to vary according to both workers' and firm's safety expenditure.

The last type of misinformation concerns *ex ante causality 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 WC benefits. For instance, he may be encouraged to simulate injuries (e.g. Staten and Umbeck, 1982, Butler et al., 1996a, Bolduc et al., 1997) or to file a claim that occurs off the job (e.g., Smith, 1989), especially in the case of hard-to-diagnose injuries such as sprains, strains and low back problems. He may also attempt to obtain a longer period of recovery compensated by WC by exaggerating the severity of his injury or by investing resources in order to find and convince a physician to write an appropriate medical report (Dionne and St-Michel, 1991, Fortin and Lanoie, 1992).

Theoretical models that take into account not only the standard *ex ante* injury hazard but also the *ex post* duration hazard and the *ex ante* causality hazard, show that usual WC insurance contracts are suboptimal when the last two types of moral hazard are present (e.g., Mookherjee and Png, 1989, Dionne and St-Michel, 1991). In particular, partial insurance coverage alone is not optimal. Selective auditing procedures have also to be introduced. Reports should be audited more extensively in the case of injuries that are hard-to-diagnose, since *ex post* duration and *ex ante* causality hazards are likely to be more severe in that case.

The above discussion suggests that, due to partial information concerning the

risk of accidents and to the presence of a variety of informational asymmetries, the private labor and insurance markets are likely to fail to provide the optimal level of safety and the optimal allocation of workers across occupations. Moreover, our analysis of adverse selection suggests that compulsory WC insurance is likely to improve welfare. However, this does not imply that publicly provided WC is necessarily Pareto-improving. While the goal of this social insurance may be to ameliorate the potential market failures, our analysis suggests that it is not clear that it is necessarily the case. In publicly provided WC, there is also a potential for moral hazard problems and other adverse incentives. It is thus important to analyze both theoretical and empirical impact of WC on variables such as 1) the frequency, duration and nature of claims; 2) the level of occupational wage rates and 3) the level of labor productivity.

2.2. Theoretical Effects of WC Insurance

1) Effect on the frequency, duration and nature of claims

This section analyses the theoretical impact of WC insurance on both the occurrence (frequency and duration) of claimed accidents and their nature. These effects are certainly those that have been most studied in the economic literature on WC. Moreover, we pay a particular attention to the impact of other social insurance programs such as unemployment insurance (UI) on these variables. Indeed, recent literature has shown that one is likely to observe a substitution between UI benefits and WC compensation.

- Effect on the frequency of claims

A change in parameters of a WC program, such as the level of benefit coverage, will affect the frequency of WC claims through a number of incentive effects. Thus, for a given wage rate and a given level of safety expenditures by the firm, an increase in the level of WC benefits will induce workers to reduce their accident-preventing efforts and it may lead them to report false accidents or accidents that occurred off the job. These factors will tend to raise the number of reported accidents. Moreover, not all workers who are injured on the job report their accident to the WC Board, since there are various costs associated with filing for WC benefits. These costs include the value of time and resources needed to see a doctor and to fill up requested forms, the costs associated with the probability of being controlled and to have to undertake other medical examinations. An injured worker will do so only as long as the expected marginal benefits of filing a claim exceed its

marginal cost. Therefore, one should expect incentives to report workplace accidents to be positively related with the WC benefit level, especially in the case of minor injuries (Krueger, 1990a).

On the other hand, as long as WC benefits are at least partially experience rated at the firm level, an increase in benefit coverage will raise a firm's costs associated with its own accident experience. Therefore, employers will have more incentive to spend resources on safety prevention, for a given level of accident-preventing effort from its employees. Moreover, higher benefits will increase employers' incentive to challenge claims. These effects will reduce the number of (accepted) claims.

From this analysis, it is clear that the impact of a change in WC benefits on the frequency of claims is ambiguous since, *ceteris paribus*, it creates safety and reporting incentives working in opposite directions for employers and employees. Moreover, the net result depends on the degree of complementary or substitutability between safety efforts of each party as well as on the nature of the labor contract (Ehrenberg, 1988, Krueger 1990a, Lanoie, 1992a). Empirical analyses are required to resolve this ambiguity.

- Effect on the duration of claims

Behavior of employers and employees not only influence the rate of reported injuries but also their duration. As discussed earlier, following an increase in the level of WC benefits, workers may have incentives to take action in order to obtain a longer period of recovery compensated by WC (ex post duration hazard). Indeed, a higher benefit level generates both substitution and income effects that induce an injured worker to increase his leisure (assumed to be a normal good) by prolonging his period on WC. Of course, this possibility is limited by the level of resources required to obtain the needed medical report. These costs reflect the probability of contestation and rejection of the physician's report. This may involve a costly and stressful process of examinations by other physicians, of testimony in arbitrage, and possible delays in WC benefits payments (Fortin and Lanoie, 1992). Moreover, through their negative effect on the level of workers' safety efforts, higher benefits will also raise the duration of claims, as long as lower safety efforts increase not only the probability but also the expected severity of injuries.

On the employers' side however, higher partially experience rated WC benefits will play in the opposite direction, by encouraging them to increase their safety expenditures and by increasing their incentives to challenge claims. Again the net impact of higher benefits on the duration of claims is

ambiguous and empirical studies are needed to shed light on this issue.

- Effect on the nature of the claims

As discussed above, higher benefits may induce a worker to simulate injuries, to file a claim for injuries that occur off the job (as long as benefit coverage is more generous under WC than under disability insurance) or, given that he had a workplace accident, to obtain a longer period compensated by WC. However, the costs of these actions for the worker will depend on the nature of accidents. Thus one should expect these costs to be smaller for accidents that are harder to diagnose. Therefore, higher benefits should not only influence the frequency and the duration of claims but also the nature of injuries compensated by WC. In particular, they should increase the relative importance of reported hard-to-diagnose injuries.

This suggests one way to isolate ex post duration hazard and ex ante causality hazard on the one hand, from ex ante injury hazard (effects on safety behavior) and from effects on reporting injuries occurring on the job, on the other. The idea is to verify whether higher benefit coverage induces more important effects, in terms of frequency and duration, on injuries that are hard-to-diagnose, such as back-related problems, in comparison with injuries such as contusions, friction burn or fractures, than are much easier to diagnose (Dionne and St-Michel, 1991, Fortin et al. 1995, Bolduc et al. 1997).

- Effect of unemployment insurance on occurrence and nature of claims (insurance substitution hazard)

Many reasons may suggest the existence of a potentially strong interdependency in the effects of UI and WC programs. The basic reason is that, as emphasized by Ehrenberg (1988), the structure of both programs are quite similar. In particular, both provide insurance against an adverse consequence (workplace injury or unemployment) that leads to time away from work. Therefore, as long as the risk of these events is partially determined by employer and employee behavior, one could expect behavior in the labor market to be affected interactively by the characteristics of both systems. Thus as long as the worker's net wage replacement ratio provided by UI is smaller than the corresponding WC benefit ratio, some workers suffering from a workplace injury may, *ceteris paribus*, have incentives to take action in order to prolong their period of recovery, especially in industries where the level of unemployment is relatively high. Indeed, in these industries, many injured workers may expect to be unemployed and to

received UI benefits after their period of recovery. Moreover, workers who expect a period of unemployment (e.g. in seasonal industries) may have incentive to use fewer resources in attempting to prevent workplace accidents. In addition, some workers may be encouraged to shirk in order to increase their chances of receiving WC rather than UI benefits.

Fortin and Lanoie (1992) and Bolduc et al. (1997) have provided theoretical models that shows, under plausible assumptions, lower UI benefits will raise both frequency and duration of WC claims, especially in the case of hard-to-diagnose injuries.

2) Effect on wage rates

A number of studies have theoretically analyzed the impact of WC on the wage rates (Ehrenberg 1988, Lanoie, 1990). As shown above, in a world of perfect competition with perfect information and public WC, higher benefits that are perfectly experience rated would reduce wage rates so as to offset the new WC costs. Total workers' remuneration (including the value, for workers, of more generous WC insurance) would thus not be affected by the policy. In other words, the downward shift in the labor demand curve in a given industry would be offset by the downward shift in the corresponding labor supply curve.

As long as the WC system is not perfectly experience rated, the reduction of wage rates in high-risk industries or occupations would be larger than the increase in firms' WC liability, while the contrary would be observed in low-risk industries. This will be the case if one takes into account the required increase in the portion of costs that are not dependent on firms' own accident experience to fund higher benefits (cross-subsidizing effect). Therefore, the level of compensating wage differential would be reduced in favor of high-risk industries.

Moreover, under asymmetrical information, workers in high-risk industries will have incentives to reduce precaution levels and to prolong the duration of their compensated accidents. On the firms' side, incentives will play in the opposite direction. Therefore, the impact of moral hazard and reporting behavior is ambiguous on reported injuries and therefore on the wage rates.

3) Effect on labor productivity

A theoretical and empirical literature is recently emerging on the effects of WC insurance on labor productivity and available papers have not been

published yet. Butler et al. (1997), and Butler and Gardner (1994) present a model of management in which managers tend to use the disability system as a mean of getting rid of the less productive employees. They show that workers receiving disciplinary notices (i.e., those with «management» problems) are more likely to enter in disability status. Furthermore, Butler et al. (1996b) argue that, as WC benefits increase, work absenteeism increases and firm specific human capital will be lost (holding labor and physical capital constant) and output will fall.

3. Empirical Work

3.1. Studies on frequency, duration and nature of claims

This section will present the empirical work that was done to investigate the different effects of workers' compensation insurance. We will follow the same outline as in the preceding section. A first group of studies has examined the impact of changes in WC benefits on the frequency, duration and nature of claims, and the potential interaction between social insurance programs.

Claim frequency study

Recall that, theoretically, the effect of WC benefits changes on injury rates is ambiguous; it depends on the relative magnitude of employee and employer responses to such changes. This question has been studied extensively in the North American context. Typically, the authors estimate an equation which relates the injury rate to a variable capturing the generosity of WC benefits and a set of control variable for aspects such as demographic characteristics of manpower, industrial sector, or unionization. All reported studies in **Table 1** are either American or Canadian, many of them were actually performed by a team of researchers surrounding Richard J. Butler and John D. Worrall. Table 1 reports the authors, the data used, the definition of the dependent variable, the definition of the benefit variable and representative benefits elasticities obtained for each study.

A variety of **data sources** has been used in these studies : aggregate data at the state level (Chelius 1977, 1982, 1983 ; Worrall and Appel, 1982; Butler and Worrall, 1983 ; Ruser, 1985 ; Butler, 1994), data at the industry level (Butler, 1983 ; Bartel and Thomas, 1985 ; Curington, 1986 ; Worrall and Butler, 1988, 1990 ; Lanoie 1992a, 1992b ; Lanoie and Streliski, 1996), data at the firm level (Chelius and Kavanaugh, 1988 ; Ruser, 1991) and micro data

at the individual level (Leigh, 1985 ; Krueger, 1990a ; Moore and Viscusi, 1990, Thomason, 1993, Thomason and Pozzebon, 1995).

Most authors take the total number of claims to construct the injury rate used as the **dependent variable**, while some of them are interested in certain categories of injuries: most of the studies by Butler and Butler and associates distinguish between temporary total, permanent partial and permanent total disabilities ; Moore and Viscusi (1990) distinguish between fatal and nonfatal injuries; Lanoie, (1992a), and Lanoie and Streliski (1996) distinguish between temporary and permanent disabilities, and Thomason (1993) only considers the permanent partial disability cases. These distinctions are often advocated to control for «reporting effects ». Indeed, permanent disabilities or death cases are likely to have always been reported in the same fashion to WCBs through time, so that any detected effect of WC benefits would not be attributable to changes in the reporting behavior.

The **measure of benefits** also varies across studies. American studies performed with data at the state level often use the wage replacement ratio prevailing for temporary total disability cases. Butler, Worrall and associates use a measure of the wage replacement ratio expected on the basis of the wage distribution in each state (which accounts for the minimum and maximum insurable income)⁵. Studies with data at the industry level use the industry wage and the maximum insurable income to define a wage replacement ratio per industry (Curington, 1986, Lanoie, 1992a, 1992b, Lanoie and Streliski, 1996). Since they include data on people who had an accident and on people who had not, studies with micro-level data involve the calculation of potential workers' compensation benefits for each individual (instead of a representative or « averaged » individual, as the aggregated analyses do).

Virtually all these empirical analyses, which use conventional regression techniques, find that claims frequency increases as workers' compensation increases. This implies, in line with our theoretical discussion, that employee responses are stronger than employer responses. The **results** suggest that a 10 percent increase in benefits is associated with a 4 to 10 percent increase in claims frequency (with an average elasticity of about 0.6 across the various studies). These results do not seem to be influenced by the type of data used, and findings in Canadian studies, especially in Thomason and Pozzebon (1995) and in Lanoie (1992b), are in the same order of magnitude. Interestingly, Butler (1983), Butler and Worrall (1983) and Worrall and Butler (1990), who consider three types of disability cases (temporary total,

permanent partial and permanent total), all show that the estimated elasticity increases with the injury duration.

The only study to report a negative and significant relationship between benefits and frequency is Moore and Viscusi (1990)⁶. They find that benefits increases do tend to decrease the number of fatal injuries. This result is not necessarily surprising since, for this category of claims, it is plausible that the employee response to benefits changes, as described above, may be dominated by employer responses.

Among the limitations of these studies, one should first note that the use of aggregate data at the state level in many American studies is debatable since it is probably difficult to account for all unobservable or difficult-to-quantify differences in state laws and program administration. This estimation strategy was probably appropriate in early studies when no other data source was available, but recently, most authors have turned themselves to more disaggregated data. Second, most of these studies fail to consider in their specification other institutional aspects that could influence workplace safety like experience rating and safety regulation. There are some exceptions: Ruser (1985) controls for experience rating, Bartel and Thomas (1985), and Curington (1986) account for OSHA⁷ activities, while Lanoie (1992a, 1992b) and Lanoie and Streliski (1996) control for both experience rating and «OSHA-type» safety regulations. Interestingly, Ruser (1985), Bartel and Thomas (1985), and Lanoie (1992a) find lower elasticities than in the rest of the literature : 0.35 for Ruser and non-significant results for Bartel and Thomas (1985) and Lanoie (1992a)⁸. Third, as discussed in the theoretical section, from a policy point of view, it is important to distinguish between legitimate changes in injury rates following increases in WC coverage (the reporting effect), and changes that could reflect an abusive use of the system. Therefore, the question of moral hazard is crucial in this debate.

Duration studies

Generally, the severity of injuries is proxied by the duration of claims (average duration at the state or at the industry level, and actual duration at the

⁵ This measure is fully described in Butler (1983).

⁶ Such a result is also present in a simulation exercise of Kniesner and Leeth (1989).

⁷ OSHA : Occupational Safety and Health Agency.

⁸ Lanoie (1992b)'s results are in the range of the rest of the literature, while Curington does not report his elasticity estimates.

individual level). Theoretically, the impact of benefits changes on severity rates is ambiguous for the same reasons given at the beginning of the preceding section and because, at the aggregate level, changes in benefits may result in a change of the mix of injuries, leading to a different average duration. For instance, if higher benefits lead to an increase in the reporting of small injuries that would otherwise have gone unreported, the average severity in a state, or in an industry, may decline without any real improvement in workplace safety.

As one can see from Table 2, again, the research on this question has been mainly done in North America. Fewer studies are available than for claim frequency, and they tend to be more recent. This could partly explain why most of them have been performed with individual data. Certain studies examine the duration of all claims as their **dependent variable** (Krueger, 1990b, Lanoie, 1992a, 1992b, and Lanoie and Streliski, 1996, Meyer et al., 1996), but a number of them are based on specific categories of claims: Butler and Worrall (1985); Worrall and Butler (1985); and Butler and Worrall (1991a) consider low-back injury claims, while Johnson and Ondrich (1990), Curington (1994) and Johnson et al. (1995) are using permanent partial disability claims. The rationale for focusing on different types of injuries is not always clear. For instance, Butler and Worrall (1991a) choose the low-back claims « in order to minimize the impact of unobservable heterogeneity due to differences in the type of claim, or in the administration of a claim » (p. 164). Curington (1994) chooses permanent partial disabilities to complete the picture since most studies are based on temporary total claims. The **measures of WC benefits** used in these studies are very similar to those in the claim frequency studies.

Concerning the **estimation technique**, certain authors have based their analysis on « natural experiments » (Curington, 1994, Meyer et al. 1996) and use difference in means estimates and conventional regression analysis, while the others use hazard models. As explained in Kiefer (1988), these models are based on conditional probability (e.g., the probability of an individual leaving WC in the tenth week, given that he has been absent nine weeks). Without entering in all the technical details, it is commonly accepted (e.g., see the discussion in Meyer, 1990) that hazard models are superior to regression analysis to investigate spells duration, especially when time-dependent covariates are relevant (changing benefits over the duration of a claim) and when there is censoring in the data (spells that are not completed).

The principal **finding** of these studies is that the duration of disabilities varies directly with WC benefits. The benefit elasticity in these studies is about 0.2

to 0.5, with certain outliers (Johnson and Ondrich find an elasticity around 1, while Krueger's results are in the 1.5-2 range).

Among the methodological issues and possible limitations related to this work, one should note again that most of these studies fail to consider in their specification other institutional aspects that could influence safety. Another more technical issue is the assumed parametric form of the baseline hazard in studies using hazard models. Most previous work in this area has relied on parametric methods which assume, despite a lack of theoretical support, a specific form for the baseline hazard (e.g., Weibull). Only Fortin et al. (1995) (to be discussed in details in the next section) use the mixed proportional hazard model devised by Meyer (1990) that does not impose a parametric form on the baseline hazard. Another important issue is related to unobserved heterogeneity. As is well known, ignoring unobserved heterogeneity may lead to a dynamic selection bias in the parameter estimates and in the estimate of the baseline hazard. For example, as time goes by, it is possible that workers who do not return to the labor market after an accident are those with an intrinsic bad health condition. If one does not account for this unobserved heterogeneity, one may end up with the false impression that the hazard declines through time. A convenient and commonly used distribution for the random variable reflecting unobserved heterogeneity is the gamma, but there is no consensus on the best distribution to adopt.

Studies related to the nature of claims

As discussed above, problems of moral hazard, which arise when informational asymmetries are used for personal gain, are of different types. First, Butler and Worrall (1991b) develop an approach that allows one to distinguish between certain of these types (the studies presented in this section are summarized in Table 3). Their approach can be summarized in the following way: Assume that all workers receiving WC are being paid the maximum weekly benefit for wage replacement. If the WCB raises this maximum by 10 percent, the total value of benefits will increase, *ceteris paribus*, by 10 percent (the actuarial effect). If, instead of a 10 % increase, we observe a 15 % increase in total benefits paid, the extra 5 % might be expected to have arisen from two effects: workers and firms may have changed their level of prevention (the «risk bearing effect» which is equivalent to the ex ante injury hazard we defined earlier), and /or workers may have made more claims, for longer periods etc. (the «claims reporting effect», which is a combination of the ex post duration hazard, the ex ante causality hazard and the claims reporting effect we defined earlier).

Butler and Worrall argue that evidence concerning the relative impacts of these two effects can be obtained by investigating the responsiveness of WC payments to changes in the wage-replacement benefit rate. If it is assumed that there is no claims reporting effect on medical expenses –workers have no reason to claim medical expenses, so an increase in wage-replacement should not produce additional medical claims- any change in medical claims which follows an increase in wage-replacement must have arisen from the risk-bearing effect.

They tested this hypothesis using data from 33 states during the period 1954-1981 and found that a 10 percent increase in benefits led to a 13.2 percent increase in total benefits paid for wage replacement and to a 3.6 percent decrease in medical expenses. They conclude from this that the risk bearing effect was -3.6% and that the claim reporting effect was $+6.8\%$ (if total claims increased by 3.2% more than the actuarial effect, when the risk bearing effect suggested that they should have decreased by 3.6% , then the claim reporting effect must have been $3.2 + 3.6 = 6.8$). This is an interesting approach. However, it depends crucially on the assumption that the claims reporting effect (as they define it) has no impact on medical claims, which could be debatable, especially if this effect leads to a change in the mix of injuries that are reported (this point will be discussed in more details below).

Other authors have used more directly the nature of claims to detect the presence of moral hazard problems. A group of researchers has investigated how difficult-to-diagnose injuries evolve with changes in benefits (ex ante causality hazard and ex post duration hazard). Given that each study has adopted a different approach, we have to discuss them in turn.

Staten and Umbeck (1982) are the first to present evidence of moral hazard from the behavior of air traffic controllers. In the 1970s, these workers were covered by a disability program which, in case of a work-related claim, was providing them with a compensation equal to a fixed percentage of their pay (around 75% non-taxable) for the duration of the claim. Given the type of job of these people, an injury did not need to be physical ; stress-related disorders that prevented the employees from working would qualify. Certain changes in the 1970s in the rules governing disability claims made claiming disabilities more attractive for controllers. The 1974 rule changes made monitoring false claims generally more complicated and made catching a fake stress-related claim especially difficult.

A controller who wanted to fake a claim for stress-related disability needed to show the disability was job-related to collect, and the examiners were directed to look for specific events that could have contributed to the stress. This

created the incentive to manufacture on-the-job incidents that could have caused the stress. The natural candidate here was a « separation violation », in which planes for which the controller was responsible came too close to one another. Two sorts of separation violations are recorded : System Errors and Near Mid-Air Collisions. The former represent any violations of the standard separation requirements ; the later are much more serious and directly life threatening. Because either sort of violation would do equally well for the purposes of filing a claim, a controller who did not want to cause unnecessary danger would be more willing to generate a minor violation than a near collision. And, in fact, the authors show that the number of System Errors jumped significantly after the 1974 change, but there was only a small, statistically insignificant change in the number of Near Mid-Air Collisions.

Smith (1989) raised the possibility that workers' compensation may be paying for some off-the-job injuries. He argues that these injuries reported as work-related would probably be difficult to diagnose, relatively easy to conceal, and tend to be reported early in the shift, especially on Mondays. From a sample of about 57 000 injury cases that occurred in 1978 and 1979 in seven states⁹, Smith finds that of the three largest categories of claims, strains and sprains are reported earlier in the day. Moreover, the propensity to report strains and sprains earlier in the day is significantly increased on Mondays and on days following a three-day weekend. Smith estimates that 4 % of strains and sprains are misrepresented as having occurred on the job.

Card and McCall (1996) reexamine this question with a 10 percent random sample of «first reports» of injury filed with the Minnesota Department of Labor and Industry between 1985 and 1989. Combining these administrative data on workplace injury claims with CPS data on medical insurance coverage, and using different estimation technics, they are not able to show that workers with low medical coverage rates are more likely to report a Monday injury than other workers. They conjecture that the «Monday effect» may be a consequence of the return to work after a «week end hiatus» (p.20).

In a recent paper, Derrig (1997) proposes a more direct test of the «Monday effect» in light of recently available data from the Insurance Fraud Bureau (IFB) of Massachusetts. Summarizing WC claims and taking accepted IFB fraud referrals as proxies for fraud claims, he finds no significant difference in the distributions of each day of the week, even adjusting for days after holidays. Similar empirical distributions are consistent with the hypothesis of elevated true claim injuries on Mondays, and their accompanying fraud level.

⁹ These states are: Colorado, Delaware, Montana, New York, North Carolina, Virginia and Wisconsin.

Similar distributions are not consistent with the off-the-job injury explanation of the Monday effect.

Dionne and St-Michel (1991) investigate the presence of moral hazard by looking at the variation in days on WC for injuries with difficult-to-diagnose conditions relative to those with less difficult-to-diagnose conditions. They split injuries into two dimensions based on injury severity (minor versus major injuries) and whether the condition was easy or more difficult to diagnose. Like Smith, they reason that moral hazard responses will be greatest for the difficult-to-diagnose injuries: lower back pain (minor injury) and spinal disorder (major injury). Their analysis is based on a change in Quebec coinsurance parameters occurring in 1979. They consider a sample of about 5000 injury cases (half before the change and half after). Their OLS estimates show that, as insurance coverage increased in 1979, days spent on difficult-to-diagnose claims rose significantly more than did claims with easy diagnosis. They also find that, once the interaction with diagnosis difficulty was controlled, the 1979 shift had no independent effect on the average duration of claims. This means that most of the impact of the increasing generosity of the regime on durations came through an increase in days by those with difficult-to-diagnose injuries.

Workers are not the only parties in the disability process that are sensitive to financial incentives. In this perspective, Butler et al. (1996a) analyze the existence of behaviors associated with moral hazard from health care providers in U.S. HMOs (Health Maintenance Organization). HMOs are per capitated payment programs in which physicians contract to meet all the health care needs of an individual (or a family) for an annual fee. However, they get paid on a fee-for-service basis for workers' compensation injuries, on top of their per capitated fees, and so are financially better off when they classify as many of their treatments as work related as possible. Physicians outside HMOs face different payment systems: fee-for-service doctors get paid the same for treating a broken bone arising from an accident at home as they do for the same type of break occurring on the job.

This leads to the hypothesis that, as HMO coverage expands, relatively more sprains and strains are expected because these are difficult-to-diagnose injuries. To test this hypothesis, they use a database on the types of WC claims across states and over time (15 states for the time period 1980-1989). Estimations are done with a multinomial logit model in which they assume that the typical worker may experience one of five states : 1) no injury; 2) sprains and strains (including low back); 3) lacerations and contusions; 4) fractures and crushing injuries; and 5) all other types of injuries. The

elasticities for the replacement ratio indicate that a 10 % increase in benefits leads to a 1.25 % increase in sprains and strains. A 10 % increase in the proportion of the population covered by HMOs leads to about a 0.8 % increase in the proportion of strains and sprains.

Interaction between social insurance programs

Fortin and Lanoie (1992) examine indirectly the presence of moral hazard behaviors (insurance substitution hazard) through the interaction between WC and unemployment insurance (UI). In particular, they argue that, since WC is in general more generous than UI (which is the case in most industrialized countries, see Lanoie, 1994), workers about to be laid-off may have incentives to reduce their prevention efforts so as to benefit from WC instead of UI. Workers suffering from a workplace accident may also be tempted to take action in order to obtain a longer period of recovery compensated by WC, especially if they know that they would be laid-off when returning on the labor market. These arguments lead to the following theoretical predictions: 1) an increase in the wage replacement rate under WC should lead to a higher frequency and/or longer duration of claims; 2) an increase in the wage replacement rate under UI should have the converse effect.

They tested this hypothesis with a pooled time-series and cross-section database at the industry level (30 Quebec industries covering the period 1974-1987). They find that a raise of 1 % in WC benefits leads to an increase of the average duration of accidents in the 0.9 - 1.4 % range, while an increase in UI payments reduces the average duration of accidents with an elasticity in the 0.5 - 0.7 range. The results with respect to injury frequency are not conclusive.

The moral hazard problem described above is more likely to be important when injuries are difficult-to-diagnose (e.g., low-back injuries) and in industries where the level of unemployment is such that many workers may expect to be unemployed and to receive UI benefits after their recovery. This is the case in seasonal industries such as the Canadian construction industry, which is less active during winter because of weather constraints.

Fortin et al. (1995) estimate the effect of WC and UI benefits on the expected duration of claims using a unique panel data set allowing them to investigate more fully the issues that we just raised. The data base is composed of longitudinal WC administrative micro-data on more than 30,000 workers in the Quebec construction industry for the period 1976-1986. For the empirical work, they use a mixed proportional hazard model, devised by Meyer (1990),

that does not impose a parametric form on the baseline hazard and that takes unobserved heterogeneity into account using a gamma distribution. They find that, for hard-to-diagnose injuries, an increase of 1 % in the generosity of WC is associated with an increase of 0.71 - 1.09 % in the expected spell duration , while the elasticity with respect to UI benefits is -0.54 (a result similar to that found in Fortin and Lanoie, 1992). Furthermore, the fact that an accident occurs in December rather than in July (December corresponds to the end of the construction season for most workers) induces an increase of 21.2 % in the expected duration. This is another piece of evidence that there is substitution between WC and UI in the construction industry.

Bolduc et al. (1997) extend this work to show that WC insurance may affect the composition of reported occupational injuries. Based on an expected utility framework, their theoretical model predicts that, under reasonable assumptions, an increase in the WC wage replacement ratio (or a decrease in the UI wage replacement ratio) leads to a larger increase in the probability of reporting a difficult-to-diagnose injury than in the probability of reporting an easy-to-diagnose injury. The initial database used in this study is the same as the one used in Fortin et al. (1995). The parameters of the model are estimated using a three alternative multinomial probit framework with random effects¹⁰. Their results confirm their predictions. In particular, the impact of an increase in the WC replacement ratio on the probability of accidents ranges (in terms of elasticity) from 0.83 to 1.45 for difficult-to-diagnose injuries and from 0.72 to 1.03 for easy-to-diagnose injuries (for the period 1979-1986). Furthermore, the impact of an increase in the UI ratio ranges (in terms of elasticity) from -1.93 to -2.32 for the difficult-to-diagnose injuries, and from -1.20 and -1.47 for the easy-to-diagnose injuries. In line with these results, they also show that the probability to report a difficult-to-diagnose injury is significantly greater in winter (the dead season in the construction industry) than in other seasons.

3.2. Wage Effects

Another current of empirical literature is investigating the question: who actually pays for workers' compensation?¹¹ In particular, is it possible that the cost of workers' compensation be shifted, completely or partly, to workers through lower wages ? As discussed above, this question can be analyzed through conventional labor demand and supply curves. WC is a form of payroll tax that shifts down labor demand, resulting in a lower wage at the

¹⁰ The empirical approach is actually an extension to panel data of the approach developed in Bolduc et al. (1996) and Bolduc and Ben-Akiva (1991).

new equilibrium. The magnitude of the wage change depends on the relative elasticities of labor demand and supply. Another approach is to consider that the existence of workers' compensation has some value for workers that could lead them to accept lower wages. Specifically, the existence of WC may mean lower risk premia (or compensating wage differentials) for risky jobs, which would also entail a wage reduction. As discussed earlier, given the level of experience rating, this impact could vary across low and high-risk industries.

We have identified five empirical studies that have investigated the relationship between WC costs and wage levels. They are summarized in Table 4. In general, they use, as their **dependent variable**, a conventional measure of the wage (like the after-tax weekly male wage of production employees ; Butler, 1983). The workers' compensation variable is either a traditional measure of workers' compensation benefits, as those described above, or a measure of workers' compensation costs (e.g., Dorsey and Walzer use the rate paid for WC liability expressed in dollars per \$100 of payroll). Most authors (except Butler, 1983) have used micro data at the individual level, and some of them have focused on workers in risky jobs (e.g., Gruber and Krueger, 1991, use data from a national sample of individuals in five high-risk jobs : carpenters, truck drivers, nonprofessional hospital employees, gasoline station employees, and plumbers.)

In general, the **results** show **substantial impacts** of workers' compensation on the wage (except for Butler, 1983). Dorsey and Walzer (1983) find that, for every 1 percent increase in workers' compensation costs , wages decline by 1.4 percent. Moore and Viscusi (1990) conclude that higher compensation benefits, from the employer's perspective, more than pay for themselves. Gruber and Krueger (1991) show that 86 % of workers' compensation costs are shifted onto workers in the form of lower wages¹².

As one limitation of this literature, one should note that the authors have little to say on why the impact would be so strong. As put by Chelius and Burton (1995, p.157) « the conclusion that higher workers' compensation costs could be more than compensated by lower wage is a radical one that, undoubtedly, will be sharply contested by many members of the workers' compensation community ».

¹¹ For an excellent survey, see Chelius and Burton (1995).

¹² In the same vein, Gunderson and Hyatt (1996) present evidence on the extent to which injured workers in Ontario (1979-1988) paid, through lower wages, for « reasonable accommodation » requirements designed to facilitate their return to work after their injury.

3.3. Labor Productivity Effects

As mentioned earlier, a recent literature has focused on the effect of WC on labor productivity. In particular, Butler et al. (1997), and Butler and Gardner (1994) have tested the hypothesis that managers partly get rid of their low productivity workers through the WC program. Butler et al. (1997) show that workers receiving disciplinary notices (i.e., those with «management» problems) are much more likely to enter in disability status. A notice increases the probability of filing a claim from about 12 to 15 percent.

Moreover, Butler et al. (1996b) test the hypothesis that higher WC benefits reduce labor productivity through its impact on absenteeism and firm specific human capital. For this matter, they use a data base covering 14 U.S. manufacturing sectors from 1980 to 1991. These data include information on value added, employment, capital, WC benefits and specific human capital. These two last aspects are crucial in their analysis. Benefits are measured by the total amount of WC benefits paid in the industry divided by the total payroll, a measure which displays little variability in the sample¹³. As a proxy of firm specific capital, they use the « average job industry specific job tenure of employees » from the CPS. Assuming that output follows a Cobb-Douglas process, estimations are made in which value added is regressed on employment, capital, tenure, benefits and an interaction term between tenure and benefits. The estimated implied elasticities are ranging from 0.05 to 0.3. These results (especially those in the upper range) are a bit surprising since the benefits measure displays little variability. This suggests that the data base used is probably not the most appropriate one to study this phenomenon¹⁴.

4. Concluding remarks and policy discussion

To our knowledge, this survey was the first one to cover extensively the theoretical and the empirical work that was done on the incentive effects related to the existence of workers' compensation in the North American context. Three types of effects have been distinguished : 1) Through various incentive effects (ex ante and ex post moral hazard, substitution between WC and unemployment insurance, reporting incentives) WC may affect the frequency, duration and nature of claims; 2) WC may induce changes in the wage level and 3) WC may affect firms' productivity. So far, the literature has focused on the first type of effects. The main results have shown that

¹³ Mean : 0.03 and standard deviation : 0.0098.

¹⁴ They also tackle the question with state longitudinal data (1954-1991), but they no longer have information on the capital stock (by state) and job tenure.

increases in WC insurance are associated with an increase in the frequency of injuries (elasticities ranging from 0.4 to 1), and with an increase in the average duration of claims (elasticities ranging from 0.2 to 0.5). Furthermore, increases in WC are associated with more reporting of injuries that are difficult-to-diagnose and, in the same line, there are some evidence (at least in Canada) of substitution between unemployment insurance and WC insurance. Lastly, there are empirical results showing that the presence of WC insurance induces important reductions in wage rates, while an emerging literature suggests that changes in WC insurance may also have negative productivity effects.

For **policy makers**, our results raise the question of the appropriate rate of wage replacement provided by WC in case of workplace accident. Are the rates actually in place too high or too low? Pressure groups have their opinion which are probably irreconcilable. Unions want higher replacement rates, while business associations often criticize the great cost of workers' compensation insurance (although the results showing that WC cost is transferred to workers through lower wages put this criticism in a different perspective). Of course, it is difficult to determine theoretically or empirically what is the **optimal rate of replacement**¹⁵. The literature on moral hazard (e.g., Arnott, 1991) only tells us that the replacement rate should be less than 100 % !

Should policy makers be worried by the empirical results showing that increases in WC are associated with increases in the level of workplace risk (duration and frequency of injuries)? Not necessarily, as discussed earlier, these results indicate that employees response to changes in WC are stronger than employer responses. This is a likely outcome if experience rating is not pervasive, which seems to be the case in most jurisdictions, especially for small firms. This could suggest that further increases in WC replacement rate should be accompanied by more intense experience rating if one wants to control total WC costs. One should recognize, however, that movements in that direction are not likely; for instance, five Canadian provinces have reduced their WC replacement rates within the last five years.

More worrying are the results of the studies related to moral hazard. In relation with these results, one should note that U.S. WC costs, as a percent of payroll, rose from 1.96 in 1980 to 2.36 in 1990, a 19 % increase in the real

¹⁵ There is some work on the optimal replacement rate provided by unemployment insurance (for instance, see Hansen and Imrohorglu, 1992). Viscusi and Evans (1990), through an estimation of state-dependent utility functions, present a calculation showing that, in the U.S., the optimal rate of income replacement under WC is 0.68 of the gross wage. However, their analytical framework does not account for moral hazard.

costs of U.S. workplace accident insurance. At the same time, real benefits increases were modest, and workplace fatalities -presumably a good proxy for job safety- fell steadily from 13 per 100,000 to 9 per 100,000 by 1990¹⁶, which means that it is unlikely that the increased costs are attributable to more dangerous workplaces. One relatively unexplored explanation of this cost trend is the change in the mix of claims reimbursed. This explanation is somewhat supported by the results indicating that increases in WC insurance are associated with more difficult-to-diagnose injuries (soft-tissue injuries and low-back pain) and longer duration of such claims.

In fact, the results presented above could suggest that more resources should be devoted to the screening of the difficult-to-diagnose claims, especially those arising on Mondays, those that are treated by an HMO physician, and those occurring in a period surrounding a lay-off. One should keep in mind, however, that if the efficiency cost of detection (medical exams, litigation etc.) is larger than the efficiency cost of moral hazard, then it may not be optimal to put more resources in detection. In fact, as long as there is no major improvement in the way physicians can detect these types of injury (especially low-back pain), it is clear that behaviors associated with moral hazard will persist.

The issue of substitution between UI and WC investigated by three Canadian studies raise the question of the optimal gap between the wage replacement rate under UI and that under WC. From the moral hazard literature, one can make the argument that, because abusing from WC (finding an accommodating physician etc.) is probably more difficult than abusing from UI, the insurance coverage should be lower for UI than for WC. However, there is no study on the optimal gap between the generosity of the two regimes. Lanoie (1994) provides a comparative analysis of the WC and UI systems in 14 OECD countries. It turns out that Canada is one of the countries (with Australia) where the gap between the generosity of the two regimes is the largest. This suggests that actions reducing this gap (reducing WC insurance coverage or increasing the generosity of UI) may be warranted.

Lastly, another worrying finding is that of Butler et al. (1996b) showing that increases in WC benefits are associated with lower productivity. However, as discussed above, more research on this issue is certainly required before we have a clear picture of the links between WC benefits and productivity.

¹⁶ These figures are taken from Butler et al. (1996a).

TABLE 1
Representative estimates of the effect of workers' compensation benefits on injury rates

STUDY	UNIT OF OBSERVATION AND SAMPLE	BENEFIT VARIABLE	DEPENDENT VARIABLE	BENEFIT ELASTICITY
Bartel and Thomas (1982)	Various industries in 22 states during the period 1972 through 1978	Expected benefit for a temporary total disability	Lost work days (for job injuries) per full-time employee	0.626
Bartel and Thomas (1985)	Three digit SIC manufacturing industries per year ; industries from 1972 to 1978 ; data are averaged over 22 states	Expected benefit for a representative wage earner who files a claim for a temporary total disability	Lost workdays per 100 full-time worker (occupational illnesses are excluded)	0.346
Butler (1983)	Manufacturing industries per year ; 15 industries over 32 years in South Carolina	Constructed by taking the average observed wages and then computing the expected benefits (accounting for minimum and maximum insurable income)	Injury rate index constructed with the principal components analysis. Includes four categories: death, dismemberment and disfiguration, permanent partial injury and temporary total injury	From 0.29* to 1.13*
Butler (1994)	Cross-section time-series data base covering 39 states during the period 1954 through 1984	Wage replacement ratio expected on the basis of the wage distribution in each state	Number of claims in non agricultural sectors per employee	0.4***
Butler and Worrall (1983)	State per year ; 35 states from 1972 to 1978	See Butler (1983)	The number of claims filed by nonself-insuring firms per thousand employees Three types of injury: temporary total minor permanent partial major permanent partial	0.352* 0.4* 1.1*
Chelius (1977)	Cross-section of industries in 18 states	Ratio of weekly WC benefits to weekly wages in a given industry, year and state compared to the same ratio for all other states	Injury rate	Positive and significant impact

STUDY	UNIT OF OBSERVATION AND SAMPLE	BENEFIT VARIABLE	DEPENDENT VARIABLE	BENEFIT ELASTICITY
Chelius (1982)	Manufacturing industries in 36 states from 1972 to 1978	Ratio of weekly WC benefits to weekly wages in a given industry, year and state compared to the same ratio for all other states	Ratio of the number of injuries per 100 full-time workers in a given industry, time period and state to the number of injuries in all other states Occupational illnesses are excluded	Positive and significant impact
Chelius (1983)	Manufacturing industries in 28 states from 1972 to 1978	Ratio of weekly WC benefits to weekly wages in a given industry, year and state compared to the same ratio for all other states	Ratio of the number of injuries per 100 full-time workers in a given industry, time period and state to the number of injuries nationwide	Positive and significant impact
Chelius and Kavanaugh (1988)	The maintenance staff at 2 New Jersey community colleges ; quarterly observations from 1979:1 to 1984:3	A dummy variable equaling 1 when WC benefits were lowered	WC claims rate for claims lasting more than 7 days	0.346***
Curington (1986)	18 manufacturing industries in New-York from 1964 to 1976	Ratio of the New-York maximum weekly benefit for temporary total disability relative to the average weekly wage for each industry	Number of compensated WC claims per 1000 full-time equivalent employees (Occupational illness cases are excluded and the injured worker must have been unable to work for seven days)	Not reported (significant positive effect)
Kniesner and Leeth (1989)	Simulation exercise calibrated to reproduce the American labor market in the early 1970s	The median after-tax income replacement rate for a married man in USA	They considered three types of injuries: non impairing injury, permanent partial disability and permanent total disability	0.21**
Krueger (1990a)	Micro-level data from current population survey ; information is available on 27,000 individuals for two consecutive years 1983-84 or 1984-85	Potential temporary total WC benefit	A 0-1 variable marking the transition into the WC program All types of industrial accidents and illness are considered	0.741**

STUDY	UNIT OF OBSERVATION AND SAMPLE	BENEFIT VARIABLE	DEPENDENT VARIABLE	BENEFIT ELASTICITY
Lanoie (1992a)	Quebec data at the industry level ; 28 industries for the period 1974-1987	The rate of wage replacement in case of a temporary total disability	Two variables: FREQUENCY: $\log [RATE_{it}/(1-RATE_{it})]$ where RATE is the total number of accidents (including diseases) with at least one workday lost divided by the number of full-time employees. PERMRATE: Same definition as FREQUENCY with the numerator of RATE being the number of permanent disability cases	Non-significant Non-significant
Lanoie (1992b)	Quebec data at the industry level covering 28 industries for the period 1983-87	The variable is based on the net wage replacement ratio obtained by a disabled worker in case of temporary total disability	$\log [RATE_{it}/(1-RATE_{it})]$ where RATE is the total number of accidents (including diseases) with at least one workday lost divided by the number of full-time employees.	0.523*
Lanoie and Streliski (1996)	Quebec data at the industry level covering 28 industries for the period 1983-90	The variable is based on the net wage replacement ratio obtained by a disabled worker in case of temporary total disability	See Lanoie (1992a))	2.38**
Leigh (1985)	11,889 American workers ; period 1977 to 1979	A proxy measure of the potential benefit a worker on WC would receive	A dummy variable which takes the value 1 if respondent receives any WC benefit	0.3*
Moore and Viscusi (1990)	1173 individual workers ; for 1982	The potential weekly benefits based on the temporary total disability	Number of fatal accidents per 100,000 workers	,0.02**
Ruser (1985)	25 manufacturing industries across a maximum of 41 states for the years 1972 to 1979	The average weekly real income benefit paid to a worker during the period of recovery from a total temporary disability	Injuries per 100 full-time workers (All types of injuries) Injuries with lost workdays per 100 full-time workers (excluding fatality cases)	0.062* 0.116***

STUDY	UNIT OF OBSERVATION AND SAMPLE	BENEFIT VARIABLE	DEPENDENT VARIABLE	BENEFIT ELASTICITY
Ruser (1991)	Longitudinal microdata set of 2,788 manufacturing establishments for the years 1979 to 1984	The average real weekly WC benefit for production worker's divided by 100	Frequency of lost-workdays injury and illness cases per 100 workers years (excluding fatalities)	From 0.2 to 0.82 (mostly significant)
Thomason (1993)	Claimants of the state WC ; 5 states for the period 1979 to 1981 (about 16,000 observations)	The weekly permanent partial benefit payment	A dummy variable that takes the value 1 if the claim was classified as a permanent partial disability and 0 if it was not	0.4***
Thomason and Pozzebon (1995)	A national sample of individual Canadian workers ; 1986-87 and 1988-89 longitudinal panels (about 52,000 observations)	A measure of worker's expected temporary total disability benefits	A 0-1 variable constructed with this question: Did you receive income from WC in past year ?	From 0.363*** to 0.410***
Worrall and Appel (1982)	The claims data, from the NCCI, include all indemnity and non-comp. medical (medical only) claims for the period 1958-1977 in the State of Texas	The average weekly indemnity benefit for temporary total disability	Temporary total disability claims divided by the medical-only claims All indemnity claims divided by the medical-only claims	0.614*** 0.465***
Worrall and Butler (1988)	15 industries from South-Carolina pooled over the period 1940-1971	The expected WC benefit for the average worker	Annual injuries per employee resulting in permanent partial injuries Annual injuries per employee resulting in temporary total injuries	2.46 0.16**
Worrall and Butler (1990)	15 industries from South-Carolina for the period 1940-1971	The expected WC benefit for the average worker	Temporary total injuries per employee Permanent partial injuries per employee Permanent dismemberment or disfigurement	1.09*** 2.79*** 1.74***

* Significantly different from 0 at the 0.10 level
0 at the 0.01 level

** Significantly different from 0 at the 0.05 level

*** Significantly different from

TABLE 2
Representative estimates of the effect of workers' compensation benefits on injury duration

STUDY	UNIT OF OBSERVATION AND SAMPLE	BENEFIT VARIABLE	DEPENDENT VARIABLE	BENEFIT ELASTICITY
Butler and Worrall (1985)	Claim for low-back injuries beginning in 1979 in Illinois	Weekly benefits under WC	Expected duration of workplace	A 10% increase in benefits increases the average claim duration by 0.23 weeks
Butler and Worrall (1991a)	Sample of low-back claims that started in 1985 from 12 states	See Butler and Worrall (1985)	Expected duration of claims	0.04*
Curington (1986)	18 manufacturing industries in New-York from 1964 to 1976	Ratio of the New-York maximum weekly benefit for temporary total disability relative to the average weekly wage for each industry	A severity index that integrates the actual days lost from work for temporary impairments with a measure of permanent impairment (Occupational illness cases are excluded and the injured worker must have been unable to work for seven days)	Not reported (non significant negative effect)
Curington (1994)	Permanent partial disability cases closed by the New-York WCB from 1964 through 1983	The weekly benefit received	Number of weeks of work absence for: minor permanent partial impairments	0.13 to 0.24

STUDY	UNIT OF OBSERVATION AND SAMPLE	BENEFIT VARIABLE	DEPENDENT VARIABLE	BENEFIT ELASTICITY
			severe permanent partial imp.	0.75 to 1.34 (mostly significant)
Johnson and Ondrich (1990)	WC clients with diverse permanent partial disabilities from Florida, New-York and Wisconsin injured in 1970	The WC benefit received	Expected duration of work absence	0.96*** to 1.16***
Johnson, Butler and Baldwin (1995)	Survey of 8690 Ontario workers with a permanent partial disability claim between June 1989 and June 1990	Benefit-wage ratio	Duration of first absences	Non-significant effect
Krueger (1990b)	Temporary total claims in Minnesota filed in 1986 and closed by July 1989 (25,446 observations)	The observed weekly benefit	Log of duration in weeks	1.67**
Lanoie (1992b)	Quebec data at the industry level covering 28 industries for the period 1983-87	The variable is based on the net wage replacement ratio obtained by a disabled worker in case of temporary total disability	Log (AWL) where AWL is the average number of workdays lost per accident. (includes all type of accidents)	Non-significant effect
Lanoie and Streliski (1996)	Quebec data at the industry level covering 28 industries for the period 1983-90	The variable is based on the net wage replacement ratio obtained by a disabled worker in case of temporary total disability	Log (AWL) where AWL is the average number of workdays lost per accident (includes all type of accidents)	0.67*
Meyer, Viscusi and Durbin	Indemnity claims beginning in 1979 in Michigan (M) and Kentucky (K) (about	The fraction of previous earning replaced by WC	The measure of duration is the number of weeks of temporary total benefits	0.29*** to 0.4*** (M)

STUDY	UNIT OF OBSERVATION AND SAMPLE	BENEFIT VARIABLE	DEPENDENT VARIABLE	BENEFIT ELASTICITY
(1995)	3,000 observations)		paid plus anticipated future weeks if the claims is still open	0.33 to 0.55** (K)
Worrall and Butler (1985)	Male workers who experiment a nonwork state due to low back temporary total injury in Illinois beginning in 1979	Replacement ratio (the wages that are replaced by WC benefits)	Expected duration of work absence	0.463***

* Significantly different from 0 at the 0.10 level

** Significantly different from 0 at the 0.05 level

TABLE 3
Studies Focusing on Moral Hazard Issues
Estimates of the effect of workers' compensation benefits on injury rate or injury duration ¹

STUDY	UNIT OF OBSERVATION AND SAMPLE	BENEFIT VARIABLE	DEPENDENT VARIABLE	BENEFIT ELASTICITY
Bolduc, Fortin, Labrecque, Lanoie (1997)	Micro data 10,000 workers in the Quebec construction industry over each month of the period 1977-1986	The level of benefits divided by the net marginal wage	A three alternative dependent variable: 1) a difficult-to-diagnose accident 2) a easy-to-diagnose accident 3) no accident	Injury rate: From 0.83** to 1.45** (1) From 0.72** to 1.03** (2)
Butler, Durbin and Helvacian (1996)	Individual claim data from 15 states for the period 1980 to 1989	Expected level of temporary total benefits in each state-year divided by wages	A multiple choice variable with four injury types: Sprains/strains Laceration/contusion Fracture/crushing All others	Injury rate: 0.164** ,0.383*** 0.25*** ,0.298***
Dionne and St-Michel (1991)	5,000 closed cases of work-related injuries which are associated to total temporary disability	Dichotomous variable representing a greater insurance coverage	In (number of days of compensation)	Injury duration: Not reported (significant positive)

STUDY	UNIT OF OBSERVATION AND SAMPLE	BENEFIT VARIABLE	DEPENDENT VARIABLE	BENEFIT ELASTICITY
Fortin and Lanoie (1992)	Quebec data at the industry level: 30 industries for the period 1974-1987	Net wage replacement ratio for a worker with a temporary total disability	Average number of workdays lost per accident (including diseases)	effect) Injury duration: From 0.9** to 1.4** Injury rate: From ,1.6 to ,1.9
Fortin, Lanoie and Laporte (1995)	Longitudinal WC administrative micro-data on more than 30,000 workers in the Québec construction industry for the period 1976-1986	The WC replacement ratio (benefits divided by pre-WC net marginal wage) calculated individually for each year	Expected duration of absence	Injury duration: 0.71 before 1979 1.09 after 1979

* Significantly different from 0 at the 0.10 level
0 at the 0.01 level

** Significantly different from 0 at the 0.05 level

*** Significantly different from

¹ Because they do not calculate benefit elasticities the studies of Butler and Worral (1991b), Staten and Umbeck (1982), Smith (1989), Card and McCall (1996) and Derrig (1997) are not reported in this Table.

TABLE 4
The impact of workers' compensation programs on the wage

STUDY	DATA	MEASURE OF BENEFITS OR WC COSTS	RESULTS
Arnould and Nichols (1983)	Sample of the 1970 population census (USA), 1/10,000 sample (≈ 1,800)	Percentage of wages recouped under state WC laws	Negative impact of WC on the wage
Butler (1983)	Fifteen industries in South Carolina, 1940-1972	Benefit index capturing the average real annual payments for injuries resulting in death, permanent disabilities and temporary total disabilities	A1\$ increase in expected benefits leads to a wage decrease between 11.5 and 14.0 ¢
Dorsey and Walzer (1983)	National sample of 5843 blue collar (May 1978)	The rate for workers compensation liability insurance expressed in dollars per \$100 of payroll	1% increase in WC costs leads to a 1.4% wage decline
Gruber and Krueger (1991)	National sample of 15,244 individuals in five high-risk jobs: carpenters, truck drivers, hospital employees, gasoline station employees and plumbers (1979, 80, 81, 87, 88)	Corresponding workers' compensation rate per \$100 of payroll	86.5 percent of WC costs are shifted on workers through lower wages
Moore and Viscusi (1990)	See Table 1	See Table 1	An increase of \$1000 in annual WC cost leads to an annual wage reduction of \$890

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