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Economics for occupational safety and health

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The aim of the article is to show how economics can help in decision making in occupational safety and health. Different methods and concepts used in economics have been described. In addition, examples have been given of how regulation and incentives have been used to promote occupational safety and health.

Key terms economic evaluation; incentive; regulation.

Occupational safety and health is perhaps the most commonly promoted through ethical arguments (1, 2). Decisions about safety and health measures have usually been negotiated as part of the general conditions of employment and, therefore, have been implemented without any economical considerations, for example, codes (3). Economics entered the field of occupational health and safety in the same way as it did in many other publicly provided or regulated services. Efficient utilization of resources to reach objectives was added to previously used arguments [eg, cost–benefit analysis of occupational health and safety regulations in the United States (4)].

Our objective in this article was to show how economics can help to promote occupational safety and health and how to make optimal choices regarding priorities. We also aimed both at offering ideas for researchers applying economics in their studies and at providing tips or "reading instructions" for practicing professionals.

The main body of the article consists of different methods used in economics. We also clarify the basic concepts used in economic analysis. In addition, we describe how the economy affects choices for or against occupational health and safety.

Categorization of economic evaluation

Drummond (5) has classified evaluation methods for health care on two bases. First, a distinction must be made between evaluations based exclusively on (i) outcomes, (ii) costs, and (iii) evaluations involving both aspects. Moreover, the evaluation can be comparative, meaning that it must examine at least two different solutions. When there is only one intervention or program, the study is descriptive (table 1).

Cost descriptions are usually entitled cost-of-illness studies or indirect-cost studies. These studies efficiently quantify the problems and present them in monetary terms that can support decision making concerning

Table 1. Distinguishing characteristics of health care evaluations (5).

Is there a comparison of two or more alternatives?	Are costs (input) and consequences (output) examined?		
	No, examines only outcome	No, examines only costs	Yes
No	Outcome description	Cost description	Cost-outcome description
Yes	Effectiveness evaluation	Cost analysis	Full economic evaluations: cost-effectiveness, cost utility, cost minimization, cost–benefit

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policy and research funding in occupational safety and health (6). Worksite case studies often have costs declared and outcomes described.

Full economic evaluations, such as cost-effectiveness studies and cost–benefit analysis, are needed for optimal choices. The choice between the different types of full economic evaluation should be based on the objective of the intervention and the question addressed by the study. Cost-effectiveness studies measure the outcome in "natural units" (ie, health outcomes). This type of analysis is best suited for outcomes difficult to translate into monetary units, such as pain reduction. Cost-utility analyses are seldom used in workplace contexts. The outcome is measured in generic units, for example, the quality-adjusted life years (QALY) gained through the intervention. This kind of measure would enable a comparison between different projects and interventions through the cost per QALY gained. QALY measures have been developed for health care interventions, and they may not be sensitive enough to quantify outcomes in occupational safety and health. Cost-minimization is used when it is known that the same objective can be reached with at least two different interventions. Cost–benefit analyses transfer the outcome into monetary units (eg, productivity losses or gains). The results can be presented as the net benefit (loss) of one alternative over another, sometimes as a ratio between costs and benefits (cost–benefit or benefit–cost ratio), investment, or pay-back period calculations. The recommended measure is the net current value (NCV), which measures all costs and benefits of the intervention in current value by using a discount factor. The method allows for comparisons between different projects that have different durations or different timing of costs and benefits.

Cost-effectiveness studies are already common within health care, and the method has been applied to occupational health problems, for example (7). Researchers may benefit from reading the instructions given by Korthals-de Bos et al (8), and practitioners should consult the review and assessment of published studies by Tompa et al (6).

Basic elements and concepts of economic analysis

Tompa et al (6) have reviewed the literature on economic evaluations of workplace-based interventions for occupational health and safety. Their review, together with method books that are usually written for clinical settings, including that by Drummond (5), may constitute useful reading.

In general, the research design is improved by the inclusion of a comparison group. Before and after studies may provide valuable information, but it is crucial that they also account for possible confounding factors. Tompa et al give examples of published studies that accredit all productivity increases to the intervention, even though a new incentive payment scheme was being introduced in the organization at the same time.

The basic rule in economics is to define all costs and benefits and determine their value (societal point of view). This step is important also because of the many stakeholders involved in occupational health and safety issues. Assuming a wider perspective does not preclude presenting the results from the viewpoints of all relevant parties. Yet most studies in occupational safety and health are still today conducted from the employer's point of view (6).

Valuation of the costs and consequences or "putting on a price tag" can be a complex task. Prices should reflect the value of the resources used. For example, the cost established for using a public health care service should equal the actual production cost, not the sum of the co-payment paid by the patient. More important in the field of occupational safety and health is the valuation of lost production—the indirect cost of ill health or occupational accidents. The calculation is usually made by the human capital method, in which the period of sickness absence is valued by multiplying daily or hourly wages by the length of the absence. In fact, this way of calculating lost production would presume a society that has reached full employment, leaving no one to compensate for the ill worker. This method has been used in estimations of the macroeconomic costs of diseases (9, 10) or an individual disease (11, 12). The human capital method estimates the potential maximums, "the benefits of the unattainable". Koopmanschap et al (13) have calculated the value of lost production more accurately, accounting for the existence of unemployment—the possibility that someone can replace an ill (or dead) employee. The length of the "friction period"—how soon the new employee is at work—varies according to the labormarket situation (unemployment) and the education needed for the job. The general rule is that the higher the qualifications, the longer the friction period. This friction-costs method provides much lower estimates about the cost of ill health at work. The costs calculated with the human capital method were almost 10-fold greater than those calculated with the friction-costs method (13).

Other factors that should be taken into account in economic analyses are (i) the time frame, (ii) relevant costs and benefits, and (iii) the possibility that it be better to use incremental costs instead of total costs.

Some interventions require a long follow-up period to show the impact; for others the impact is immediate and long lasting. The intervention itself may be continuous, and therefore the costs and benefits should be

calculated, and possibly extrapolated to the future. A good practice is to conduct a sensitivity analysis and vary the length of the period, as well as the impact and valuation of the costs and benefits in the future (adjustment for inflation and time preference, for example, discount rate).

All relevant costs and benefits should be measured. Tompa et al (6) cite studies that state the benefits of interventions in monetary terms but do not report the costs involved.

Sometimes it is better to use incremental costs instead of total costs. This possibility can be illustrated by an example in which an employer was already planning to invest in new office equipment but, due to the intervention, decided to opt for the ergonomically better and more costly alternative. In this case, the cost of the ergonomic intervention would constitute the sum exceeding the value of the originally planned investment. Similar problems can be easily avoided with the use of a comparison group.

In general, it is useful to check the assumptions used in studies. The assumptions should be well reasoned, their justification should be transparent, and their implications should be studied with a sensitivity analysis.

Markets, regulation and incentives

A competitive market is supposed to lead to the optimal allocation of resources. However, with issues in occupational safety and health, it is not necessarily the case, as employers are not always required to handle the negative externalities of production—the costs of ill health and disability—by themselves. In most developed countries, the risks of occupational accidents and diseases have been pooled, and the costs of lower than optimal occupational safety and health are covered by society. However, in developing countries, this cost is carried by individual persons and their families (10). Thus there is a need for intervention by society, by means of either regulation or incentives. Torén & Sterner (14) have classified regulation and incentives in their article [See figure 1, in which compensating wage differentials have been added.]

Negative externalities are the reason regulations exist. The effectiveness of regulations has been studied, especially in the United States and Canada. The study by Viscusi et al (4), published in 1978, did not show any significant effect of regulations issued by the Occupational Safety and Health Administration (OSHA) in the United States. Such a result has also been found in a systematic review of the construction industry (15). Regulations are usually followed by control in the form of, for instance, inspections and penalties for noncompliance. There is evidence that inspection improves occupational safety. Viscusi (16) found that, during 1973–1983, OSHA inspections reduced injury rates. Gray & Scholz (17) found that inspection and penalties in a given year led to a 22% reduction in lost-workday injuries in the following 3-year period.

The impact of regulations must be weighted against the costs. These include the costs to the administration—the public agency that formulates the standard, monitors the behavior of employers, and enforces compliance—and employers' compliance costs from adapting workplaces to the standard. Viscusi et al (4) compared the costs of various risk-reducing regulations per expected year of life saved. Workplace regulations were among the most costly ones.

Regulation may also boost the economy of an industry, as shown in the case of trichloroethylene (TCE). [Original studies by Slunge & Sterner (18) and Sterner (19), cited by Torén & Sterner (14).] Despite heavy

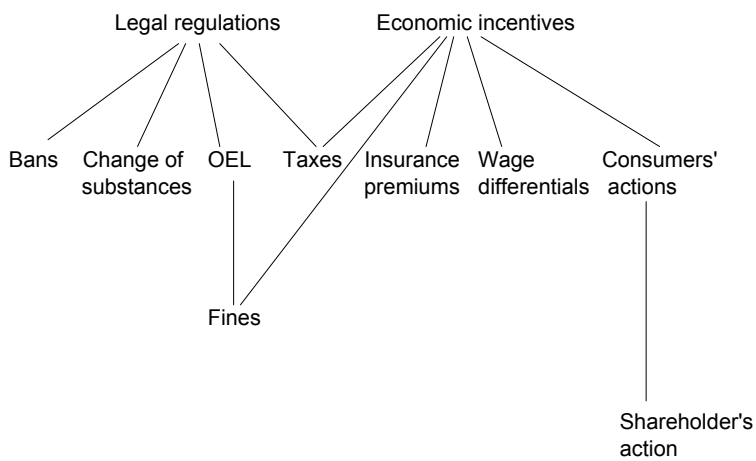

Figure 1. Regulation and incentives for occupational safety and health (14). OEL = occupational exposure limit)

opposition from industry, Norway, Sweden, and Germany all adopted different strategies for lowering the use of TCE. Sweden set a ban. Later the regulation was ruled too tight by the Court of the European Union. But use had decreased in the meantime. Some small-scale firms closed down. Most firms continued business in Sweden with improved technology. There were firms that moved their production units to other countries, but they did it for lower wage costs, not because of the regulation.

Taxing risky substances forces employers to internalize the costs of using the substances. This was the policy chosen in Norway, where a heavy tax was levied for the use of TCE. Half of the tax revenues were refunded to the industry for research in alternative methods and new technology. Germany chose a policy of strict and detailed regulations for the use, storage, and transport of TCE. This procedure led to a decline in the use of TCE. As a byproduct, highly advanced technology for using TCE was developed and exported to other countries that only later started regulating the use of TCE.

The risks at work also have an impact on the labor market. If employees are aware of the risks involved in their work and the labormarket situation allows them to place demands on employers (no unemployment, big share of working-aged population employed), they may request higher wages for risky or unpleasant jobs. Therefore, employers are required to pay a "compensating wage differential". Viscusi [(20), cited Viscusi et al (4)] has studied wage differentials in the United States. He used industry injury rates for workers and their wages and found that the wage differentials were the highest, about 12–15%, in food and allied products, furniture and fixtures, lumber, and wood product industries. More recently, Lalive (21) had the opportunity to use firm-specific risk information instead of industry risk. He found that wages were higher in risky jobs, but the differential was about 40% lower than in Viscusi's study.

Employers do face costs of ill health in disability pensions and in premiums for sickness absences, occupational diseases, and accidents. These costs can all be shared collectively, or they can be totally or partly employer-based (experience rating). For example, in the Netherlands, employers cover the costs of sickness absence for 24 months. Employers' possibility to insure themselves for the costs of sick leaves can be limited by legislation (22). In Finnish workplaces with more than 1000 employees, the employer pays the complete costs of each disability pension. Premium differentiation and "no claims" bonuses are widely used in member states of the European Union.

Employers may receive subsidies for promoting occupational safety and health at work. For instance, in Norway, companies were eligible for funding to develop new technologies to diminish the use of TCE. In Finland, employers are reimbursed for the costs of occupational health services (60% of preventive services and 50% of medical services). The funds for subsidies can be collected from industry or from the taxpayers. For example, in British Columbia, investments in ceiling lifts in institutional care were funded by the workers' compensation funds. In Ontario, it was the provincial government that subsidized the investments, and the money was raised from taxpayers (23).

Consumers' actions or shareholders' values could also act as incentives for improving occupational health and safety. However, so far, they have been rare. The regulation for chlorine was actually initiated because of consumers' environmental concerns, not for safety and health at work. Still, among its consequences were improved work conditions. If the "responsible employer" image brings in increased sales of products and services, and therefore profits, then consumers' choices also have important potential as an engine for improvements in work conditions.

Concluding remarks

Economics can support decision making on different levels. In general, politics concerning occupational safety and health are well justified on economic grounds. A very high proportion of the true costs of occupational injury and disease fall on parties external to the firm. According to Mustard (20), the following three types of instruments for influencing firms are available to prevention authorities: (i) regulation, inspection and enforcement, (ii) insurance incentives, and (iii)) information and consultation (including the sponsorship of research investments) (20). The effectiveness of the policy should always be considered when the instruments to be used are selected. Usually there are different options, out of which the most efficient one should be chosen—the option that achieves the most with the least costs. Regulation has proved to be an expensive tool, and sometimes even inefficient.

Politicians, practitioners, and workplaces need information on "what works" in promoting occupational safety and health. The task of finding out "what works" is usually researchers' task. When they are designing their studies, and if they are interested in economic evaluation, they should regard economic evaluation as an integral component of a workplace-based intervention study, rather than as an add-on. First of all, an economic evaluation should build on the effectiveness evaluation.

Practitioners and workplaces can use cost–benefit analyses as a tool to judge different options for improving safety and health at work. Tools already exist to aid such calculations.

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