

Risk regulation, liability and insurance

Literature review of their influence
on safety management

Eric Marsden

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THEME

Human and
organizational factors
of safety

THE *Foundation for an Industrial Safety Culture* (FonCSI) is a french public-interest research foundation created in 2005. It aims to:

- ▷ undertake and fund research activities that contribute to improving safety in hazardous organizations (industrial firms of all sizes, in all industrial sectors);
- ▷ work towards better mutual understanding between high-risk industries and civil society, aiming for a durable compromise and an open debate that covers all the dimensions of risk;
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Titre Risk regulation, liability and insurance : literature review of their influence on safety management

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Ce document propose une revue de la littérature sur la complémentarité (et les antagonismes) existants entre responsabilité civile (“liability” en anglais), réglementation et assurance et leur impact sur la gestion de la sécurité. Le document couvre les travaux de plusieurs disciplines scientifiques, principalement l’analyse économique du droit et la théorie de la régulation. Certaines des questions discutées sont complexes ; ce document vise à proposer des explications simples accompagnées de références à la littérature professionnelle et académique permettant au lecteur intéressé d’approfondir ses lectures. Certaines questions sont l’objet de débat entre chercheurs ; dans ces situations, nous avons cherché à présenter les différents points de vue en présence.

Le document fournit des informations de contexte sur les questions qui ont été débattues au cours du workshop NeTWork’2012, et s’appuie sur les contributions de certains participants ainsi que la riche discussion de ces trois journées.

Le premier chapitre s’intéresse à la **réglementation**, à commencer par la justification économique classique pour l’intervention de l’état (présence d’externalités, de défaillances informationnelles et d’aléa moral). Un certain nombre d’obstacles à l’efficacité de la réglementation en matière de sécurité sont présentés. Enfin, quelques alternatives ou compléments à la réglementation classique, comme l’autorégulation, sont discutés brièvement. Le chapitre 2 présente une synthèse de la **loi en matière de responsabilité civile**, en commençant par des définitions introductives. Des facteurs qui affaiblissent l’efficacité de la loi en matière de responsabilité civile en tant qu’incitation à investir en matière de prévention sont discutés, ainsi que les effets négatifs de la responsabilité civile sur la gestion de la sécurité. Un certain nombre d’études de cas illustrant la responsabilité des régulateurs sont brièvement présentés. Le chapitre 3 discute de l’impact de l’**assurance** et la réassurance sur la manière dont la sécurité est gérée par les entreprises et les individus. Enfin, le dernier chapitre discute les sources de motivation d’entreprises et d’individus pour éviter les dommages aux tiers et à l’environnement.



À propos des auteurs

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This document provides a short **literature review** on the complementarity (and antagonisms) between liability rules, safety regulation and insurance and their effect on safety management. It draws on a range of disciplines, with a focus on economic analysis of law and regulation theory. Some of the issues discussed are rather complex; this document attempts to provide simple explanations together with references to the professional literature for the interested reader. Some issues are the subject of ongoing debate between scholars; in such situations, we have attempted to present the various points of view.

The document provides background information concerning the topics discussed during the NeTWork'2012 workshop, and draws on some of the contributions of workshop participants and the rich discussion which took place during the three days.

The first chapter presents issues related to **regulation**, starting with the classical economic justifications for state intervention (presence of externalities, information failures and moral hazard). A number of obstacles to the effectiveness of safety regulation are presented. Finally, some alternatives or complements to regulation, including self-regulation, are briefly discussed. Chapter 2 presents an overview of **liability law**, starting with some introductory definitions. Factors which weaken the effectiveness of liability as an incentive to invest in prevention are discussed, as are negative effects of liability regimes on safety management. A number of case studies illustrating the liability of regulators are briefly presented. Chapter 3 discusses the impact of **insurance** and reinsurance on firms' and individuals' safety management. The last chapter briefly analyzes firms' and individuals' sources of motivation to take care.



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Introduction

Context

A variety of institutional mechanisms are used by society to control the risks generated by hazardous activities:

- ▷ **Regulation**, in which the state imposes restrictions on hazardous activities which are intended to improve safety. This regulation may be prescriptive, imposing specific technological or organizational requirements (the literature refers to “command-and-control” regulation), or more goal-oriented (outcome-based), in which the regulator specifies a number of safety goals and allows firms to choose the best methods to attain them.
- ▷ **Liability regimes**, which attempt to ensure that firms have appropriate incentives to avoid accidents by requiring them to compensate victims of their activity. Liability laws are sometimes combined with obligatory **insurance** to ensure that compensation is available even for firms whose activities may lead to damages which exceed their ability to pay.
- ▷ **Soft law** and self-regulation approaches, which aim to establish voluntary standards of behavior or codes of conduct which improve safety, associated with social sanctions for firms which do not engage in the process.
- ▷ **Insurance**, a risk-sharing mechanism which ensures that victims are compensated for the monetary component of a loss. The ability of insurance companies to put a financial price on certain facets of industrial risks (making it easier to integrate in firms’ decision-making), combined with insurers’ safety management expertise, tend to offset the moral hazard associated with insurance, in which firms’ incentive to take care is reduced by the provision of coverage.

The advantages and disadvantages of these different policy instruments, for different types of hazardous activities, have been widely studied in the legal studies and economics literature. Command-and-control regulation tends to be effective in limiting risks, but also hinders technological innovation and the use of novel safety mechanisms; its enforcement is relatively expensive. Liability regimes are not fully effective in encouraging firms to take sufficient care to avoid harm, since the causal link between industrial activity and damage is sometimes difficult to establish, or can be triggered many years after the harm-causing event, which leads to many complications. Furthermore, when firms also purchase insurance for damages caused by their activity, the deterrent effect of liability regimes may be significantly weakened. Soft law approaches to safety management are not always effective in limiting risks, and hinder public participation in the debate on safety management, due to a lower degree of transparency of the decision-making process.

A number of factors make it difficult to assess the **relative performance** of these different frameworks:

- ▷ Different types of industrial activity lead to differing requirements. Influencing the design process of products involving complex new technologies, for which significant uncertainty about future behaviours exists, differs from the problems raised by a more traditional industrial sector where risks are well-known and little innovation is present.
- ▷ Relative performance should be assessed along several dimensions. The dimension most often studied in economic analysis of law is that of reducing risk to the “socially optimal” level, in which spending on safety corresponds to society’s willingness to pay for risk reduction. This viewpoint adopts a *utilitarian* viewpoint on ethics, in which the aim is to provide the greatest good for the greatest number. However, other ethical frameworks and criteria exist, such as the moral obligation to avoid harm (“duty ethics”), and the right for victims to seek compensation.
- ▷ Regulation, liability, insurance and soft-law are often simultaneously applicable, which leads to potential for interference or complementarity.

These subjects were debated by researchers and practitioners during the NeTWork'2012 workshop, which was held over three days in the Sorèze abbey near Toulouse, France. The topic of the workshop was *Liability and Insurance and their Influence on Safety Management of Industrial Operations and Products*. It was organized by Michael Baram (Boston University Law School) with the assistance of Ernst Zirngast (Swiss Reinsurance Company) and Stefan Müller (Technical University Berlin), and primarily funded by the *Foundation for an Industrial Safety Culture* (FonCSI)¹.

The workshop served as a forum for presentations and discussion based on knowledge gained from working experience and empirical research with regard to the influence of liability law and insurance/reinsurance on safety management of existing types of industrial operations and products. The present document provides a review of the background to some of the discussions during the NeTWork workshop.

Objectives of this document

This document provides a short **literature review** on the complementarity (and antagonisms) between liability rules, safety regulation and insurance and the effect that they have on safety management. It draws on a range of disciplines, with a focus on economic analysis of law and regulation theory. Some of the issues discussed are rather complex; this document attempts to provide simple explanations together with references to the professional literature for the interested reader. Certain issues are the subject of ongoing debate between scholars; in such situations, we have attempted to present the various points of view.

Whilst primarily intended to provide background information on the topics discussed during the NeTWork'2012 workshop, primarily from the economics literature, the document also draws on some of the contributions of workshop participants and the rich discussion which took place during the three days. It has benefited from useful feedback from some workshop participants.

The prospectus [Baram 2014] and several of the papers presented at the workshop were published in a special issue of the *Journal of Risk Research* in 2014 (volume 17, issue 6). The prospectus and workshop agenda are available at the NeTWork website, www.network-network.org.

Document structure

This document is structured as follows:

- ▷ Chapter 1 presents issues related to **regulation**, starting with the classical economic justifications for state intervention (presence of externalities, information failures and moral hazard). A number of obstacles to the effectiveness of safety regulation are presented. Finally, some alternatives or complements to regulation, including self-regulation, are briefly discussed.
- ▷ Chapter 2 presents an overview of **liability law**, starting with some introductory definitions. Factors which weaken the effectiveness of liability as an incentive to invest in prevention are discussed, as are negative effects of liability regimes on safety management. A number of case studies illustrating the liability of regulators are briefly presented.
- ▷ Chapter 3 discusses the impact of **insurance** and reinsurance on firms' and individuals' safety management. It explains techniques used by insurance companies to limit the effects of moral hazard, discusses areas of activity for which insurance is obligatory of where strong incentives to obtain coverage exist, and describes structural sources of instability in insurance markets.
- ▷ Chapter 5 analyzes firms and individuals' sources of motivation to take care and concludes the document.

¹ For more information on the NeTWork expert group and its long tradition of bridging the gap between scholarly thought and practical applications, see www.network-network.org.

We are interested in your feedback! Please send any comments or suggestions for improving this document via email to cahiers@FonCSI.org.

Issues related to regulation

Regulation² has been the subject of significant amounts of research over the past decades, concerning the evaluation of different regulatory instruments and regulatory processes, the extent of regulation (and reliance on other mechanisms such as self-regulation and liability law), and the distribution of benefits and costs among the population which results from regulation in different areas [den Bergh and Paccos 2012]. In this document we focus on “risk regulation”, concerning the prevention of major accident hazards, the prevention of occupational accidents, the protection of the environment and product safety. Related areas include food safety [Henson and Caswell 1999] and patient safety. These are areas where the body of regulation has grown significantly over the last 40 years in most developed nations, becoming a significant responsibility of governments [Moss 2002; Hutter 2006].

This chapter opens with a discussion of the theoretical justification for regulation, from a classical economics perspective, including the presence of externalities (§ 1.1.1), incomplete information (§ 1.1.2), and consumer misperceptions of product quality. In § 1.2, a number of factors that reduce the effectiveness of classical safety regulation are presented, including technological innovation, regulators’ lack of information on risks, costs and benefits, and regulatory capture. The chapter concludes in § 1.3 by a description of alternatives to classical regulation, in particular self regulation.

1.1 Theoretical justification for regulation

Classical economics theory is based on a model of actors who have clearly defined preferences, are rational and act in their self-interest. Much of the literature on economic analysis of law is based on these assumptions, which simplify mathematical modelling of human behaviour, even if they are imperfect explanations for the behaviour of real people³. Analysis based on more complex and realistic models of behaviour is presented in § 4.1.

homo economicus
and economic
analysis of law

In some situations, investment in safety (or precaution) is worthwhile for the entity making the investment, and self-interest ensures that risks are controlled. In other situations, safety regulation is necessary to ensure that risk-takers do not unduly expose society to harm.

² Regulation refers to obligations imposed by public law designed to induce individuals and firms to outcomes which they would not voluntarily reach, but are in the public interest. Regulation is enforced by public officials and compliance is aided by the threat or imposition of some sanction.

³ Certain strands of research challenge these assumptions, arguing that the presumption in law and other institutions that people are self-interested creates powerful self-fulfilling expectations, situations and behaviours [Hanson and Jost 2012].

Self-interest and the need for safety regulations

Suppose that I own a house with a fireplace, and that there is a 1% chance that a spark from my chimney will set the roof of my house on fire in the following year. If my roof burns, I would suffer 10 000€ in damage. The *expected cost*⁴ of the fire is the value of damages if it occurs multiplied by the probability that it will occur, in this case 100€. Suppose that a spark-catching device on my chimney would cost 80€ to install.

Installation of the device would be both wise from my standpoint (the cost of reducing the risk is less than its expected value) and socially efficient (its social benefits outweigh its costs). Suppose, instead, that the device costs 200€. In that case, installation would be both unwise from my standpoint and socially inefficient. (I would be better off — and society would be better off — if instead of purchasing the device, I bought fire insurance.) In both cases, the self-interest of the affected person and the collective interest of society at large coincide, so it may not be necessary for the law to intervene (assuming that I am fully informed and capable of calculating expected cost correctly). I will, without any guidance from the state, voluntarily take the socially optimal level of precaution⁵.

Let us now assume that sparks emitted by my chimney may be carried by the wind and land on my neighbor's roof instead of on mine. Suppose that the loss to the neighbor in such a case would be 10 000€; there is a 1% chance of the accident occurring; and the cost (to me) of the spark-catching device would be 80€. Here, self-interest and the interests of society diverge. It would be socially efficient for me to install the device. But if I am not obliged to pay for damage to my neighbor's roof, I may not take the socially-efficient precaution. In such situations, legal intervention (in the form of regulation or tort liability) becomes necessary.

In economic theory, the classical justification for regulation (in which the government restricts the rights of individuals) comes from various types of **market failure**: externalities, incomplete information, and consumer misperceptions of product quality and moral hazards. Externalities and informational considerations are discussed in the following two sections. The moral hazard problem is discussed in § 3.1.

1.1.1 Externalities

Externalities (a concept from economics) are a cost or benefit of an activity which are not transmitted through prices. For example, industrial activity sometimes generates pollution whose cost is primarily borne by people living near the plant or using water downstream, rather than by the company which owns the plant. In determining whether running the plant is profitable, the company compares only its costs (raw materials, labour, *etc.*) with the product's selling price, ignoring the negative externality⁶. This leads to *market inefficiency*, since goods are produced despite their total social cost (including the pollution) being greater than their value to society. It also leads to an inefficiently low level of pollution control. Indeed, the producer may be able to reduce the amount of pollution relatively cheaply, at a lower cost than the damage caused by the pollution to people in the surroundings. However, the producer has no economic incentive to reduce pollution, so may not make the necessary investment.

Externalities are one of the justifications for regulation, in which the government imposes technological standards (for instance diesel vehicles must be equipped with a particle filter) or limits on pollution. Another solution is the use of **emission fees** (called *Pigouvian taxes* by economists): the government charges the company for the damage caused by its pollution, converting the external cost into an internal one. The company will now include the cost of pollution (paid as an emission fee) in the selling cost of its product, leading to efficient decisions on the level of production and the amount of pollution control⁷. Note that the government

⁴ The mathematical *expectation* of a random variable is what one would “expect” to find if one could repeat the random variable process an infinite number of times and take the average of the values obtained (to be more formal, it is a weighted average of all possible outcomes).

⁵ See the definition of “optimal level of prevention” on page 19 for the rather narrow meaning used here for the term “socially optimal”.

⁶ Note that externalities may also be positive: a person who is vaccinated against a disease protects themselves, but also other people surrounding them.

⁷ The principle of emission fees (green taxes and the polluter pays principle) is contested on moral grounds by some environmentalists and scholars, who compare them to **indulgences in the Middle Ages** (in which the Roman Catholic Church allowed people to pay in order to forgive sins) [Goodin 1994]. Indeed, by putting God's

market inefficiency

emission fees

imposing the emission fees must be able to measure the social cost of the pollution to determine the level of the fees, but does not need to measure the cost of prevention (this will be done by the company, acting in its own best interest).

In many cases, negative externalities result from the interaction between decisions made by more than one party. Consider the impact of airport noise on homeowners under the flight path. Airports were generally built far from urban zones, but urban growth has led to the construction of homes in areas impacted by the noise. Responsibility for the negative impact of noise is shared by the airlines and by homeowners who purchased houses at attractive prices, knowing that they would be exposed to aircraft noise; it is a “reciprocal cost”. According to an argument developed by Nobel prize-winning economist Ronald Coase, the cost for any sound-control measures (for instance, requiring quieter engines on airplanes, or installing soundproofing in houses) should be borne by both parties, and not the “polluter” alone. Otherwise, reducing the level of noise (as a result of emission fees imposed by the regulator) would encourage more people to build houses under the flight path, leading to a higher social cost of the noise, and thus to higher emission fees; the airport would be “punished” for its noise-reduction investment. An implication is that a system based on emission fees only leads to a social optimum if the regulator knows enough about the costs of controlling the negative externality to determine which party should be considered the polluter (and thus be taxed) and which the victim.

mutual nature of
harm

Ronald Coase pointed out that if all parties involved can **negotiate** and organize payments to compensate each other for their actions, then a social optimum can be reached without government intervention. Consider the case of a steel plant whose activity produces dust which is carried into the garden of a person living nearby, preventing them from growing lettuce. The negative externality is the combined effect of the plant’s activity and the lettuce growing. If the cost to the company which owns the plant of reducing dust levels is greater than the value of lettuces to the downwind homeowner, a social optimum may be reached by the company agreeing to pay the exposed homeowner a little more than the value of his lettuces. All parties would be better off, producing a market solution to the problem without the need for intervention of a regulator. Symmetrically, if the value of lettuces to the homeowner is greater than the cost of pollution control, the homeowner may pay the company to install the pollution control.

compensatory
payments

If however the dust affects a hundred homeowners, the situation becomes more complicated. If 90 of them agree to contribute to the cost of pollution control and ten refuse, those who refuse will get a “free ride”, being able to grow their lettuce without having contributed to the pollution reduction. Each homeowner has an incentive to avoid paying, hoping that his neighbors will bear the cost. The problem becomes increasingly complicated to resolve as the number of parties involved increases. Economists call this issue **transaction costs**: the cost of reaching and enforcing mutually beneficial private contracts. Coase’s observation is that the presence of negative externalities (which have not been resolved by negotiation between the affected parties) implies that some form of transaction cost prevents private bargaining from eliminating the problem.

free-riding

From an economic point of view, transaction costs explain the need for regulation to reach a socially optimal level of prevention⁸.

Note that transaction costs in hypothetical bargaining concerning the prevention of major accidents are very high, since it is in general very difficult to determine the set of potentially affected parties *ex ante* and because it is difficult for all parties to acquire the necessary

graces on auction, indulgences were selling what some critics (notably, Protestant clerics) thought should be God’s alone to exercise, in the same way as it can be seen as being presumptuous to forgive “attacks on Mother Nature”. Indulgences were also criticized for selling that which cannot be sold, for allowing people to buy their way out of immoral behaviour, and for their socially regressive nature (only the rich can purchase the indulgence or the right to damage the “common good”, the environment). This criticism of emission fees is based on an interpretation of pollution as harm done to nature, contrasting with economists’ view of damage done to a common good, requiring compensation.

⁸ See the definition of “optimal level of prevention” on page 19 for an explanation of the rather narrow meaning of “socially optimal” which is adopted here.

information on levels of risk (indeed, information on technological risk tends to be complex and difficult for non-specialists to understand; it is also well known that people's perception of small probabilities, such as that of a major accident, is biased).

1.1.2 Incomplete information

There is a significant body of research in economics concerning the effect of incomplete or asymmetric information on peoples' decisions. The interest of economists dates back to a famous paper in 1970 on the "market for lemons" [Akerlof 1970], for which George Akerlof won a Nobel Prize⁹.

Asymmetric information and the "market for lemons"



Suppose that there are 100 second-hand cars for sale in a town: 50 well-maintained cars that are worth 10 000€ each, and 50 "lemons" worth 2 000€. The sellers know which is which, but the buyers don't. What will the market price of a second-hand car be? You might think it would be the *expected value* of a second-hand car, or 6 000€, but at that price no-one will propose a high quality car for sale. The market price will therefore be close to 2 000€ (the market fails to establish a fair price for buyers and sellers).

This mechanism causes a "race to the bottom" in markets where buyers cannot determine the true quality of goods or services for sale. Two factors make this body of research on the effects of asymmetric information relevant to the regulation of safety:

- ▷ Some attributes of safety can be thought of as a "quality" of products which is often difficult for consumers to assess¹⁰.
- ▷ Regulation of behaviour requires information, since a regulator – or the courts – must examine a person or firm's decisions and their consequences, and determine their legal implications. Firms generally have access to better information concerning risks than do regulators¹¹, so mechanisms which produce incentives ensuring that they use this information to improve their decisions regarding safety will in general be socially beneficial.

information
regulation

A form of regulation which can help to resolve the "safety as a quality" issue¹², whilst still preserving consumers' freedom of choice, is **information regulation** (also known as mandatory disclosure regimes). Firms can be required to disclose information concerning the risks associated with their product (the most familiar example being warnings concerning side effects on medicines), or concerning the environmental impact of their activities [Case 2001].

⁹ Beyond its scientific importance, this paper is remarkable in illustrating deficiencies in the scientific review process. Akerlof first submitted the paper to *The American Economic Review*, whose editor rejected it on the grounds that it was trivial. A second journal, *The Review of Economic Studies*, then rejected the paper on the grounds that the journal did not public papers on topics of such triviality. The *Journal of Political Economy* then rejected the paper with a referee comment that the paper was wrong in its reasoning: if it were right, economics would be different. The fourth journal to which the paper was submitted, the *Quarterly Journal of Economics*, finally accepted it for publication.

¹⁰ A consumer purchasing a new car, for example, may have neither the technical expertise nor the information necessary fully to evaluate the risk of injury related to a particular design feature. It could also be difficult for the consumer to obtain complete information on every key aspect. Likewise, a patient purchasing a medical procedure, for example, may be unlikely fully to understand the complex risks, costs and benefits of that procedure relative to others.

¹¹ However, depending on the size of the company and on the level of novelty of the process, the regulator may have better information concerning risk prevention than the firm. This is particularly true for smaller firms, which have less capability to develop internal competency in risk management, and for "mature" processes or technologies, where the regulator may have developed historical skill.

¹² At least for examples of consumer choice including the selection of products on a market (product safety issues) or the choice of transportation method.

The toxics release inventory program

The toxics release inventory (TRI¹³) program run by the U.S. EPA¹⁴ requires firms and federal government facilities to make data available to the public concerning releases of toxic substances and waste management activities. Such regulations have been shown to have some empirical impact on the stock market value of polluting firms, and subsequently on their level of emissions [Konar and Cohen 1997].

The Hazard Communication Standard

Regulation in the USA and the EU requires companies that use hazardous chemicals to provide their workers with access to information on the identities and the hazards of the chemicals that they work with, along with advice on appropriate handling and safe use. The *Hazard Communication Standard*¹⁵ was implemented by OSHA¹⁶ in 1983. It requires “upstream” manufacturers and importers of hazardous chemical products to furnish their “downstream” customer companies with labels and informative data sheets for each chemical sold. Downstream firms, as employers, are then required to provide this information to their employees, and to provide training to help them avoid harmful exposure and use the chemicals safely. Similar requirements have been integrated into EU legislation in the context of the REACH regulation¹⁷. These hazard communication regulations are often claimed to be the most effective workplace safety regulation [Baram 1986; Baram and Dillon 1992].

Standards and labels. The state can encourage firms to invest in reducing the impact of their activities or improving product quality by creating standards [Brunsson and Jacobsson 2000] or labels [Bergeron et al. 2014]. These non-binding instruments are designed as an information signal to consumers, and rely on voluntary adherence by firms, which hope to obtain an economic advantage from their investment. The label creates incentives for innovative firms to improve their performance with respect to the target criteria (assuming that the state invests sufficiently in publicity to ensure that consumers identify the label as a positive feature of goods), and over time is assumed to have an impact also on less innovative firms, by modifying consumer expectations. Over time, they generate a definition of good practice and can be seen as an indirect form of governance of firms’ activities.

An example of successful application of these instruments is environmental impact labelling schemes such as the Blue Angel in Germany and the Nordic Swan in the Nordic countries.

The government may also use **public information campaigns** to attempt to influence public behaviour, for example encouraging road safety and promoting energy efficiency, or can publicize “league tables” that rank the performance of firms with respect to specific indicators, or can “name and shame” firms that are convicted for regulatory violations¹⁸.

However, several factors limit the effectiveness of information regulation [Magat and Viscusi 1992]:

- ▷ people are known to have difficulties in appreciating information related to low probability events, and to use heuristics in decision-making which can lead to divergences from decision-theoretic optimality¹⁹;
- ▷ for products or services which are very complex (for instance, involving new technologies), it may be difficult for consumers to understand the associated risks;

¹³ cf. epa.gov/tri/.

¹⁴ EPA: the U.S. Environmental Protection Agency.

¹⁵ cf. <https://www.osha.gov/dsg/hazcom/>.

¹⁶ OSHA: the U.S. Occupational Safety and Health Administration.

¹⁷ The US and EU hazard communication regulations are being harmonized with the UN-developed Globally Harmonized System of Classification and Labelling of Chemicals (GHS).

¹⁸ For example, the UK Health and Safety Executive’s Prosecutions Database, available online at <https://resources.hse.gov.uk/convictions/>, provides details of cases successfully prosecuted by the state regulator.

¹⁹ For instance, people tend to overestimate small mortality risks such as the risk of dying from botulism, and underestimate very large risks, such as the lifetime risk of heart disease from all causes.



- ▷ the **information overload** issue means that consumers are not able to digest the large amounts of information which may be necessary to make an informed choice as to the level of risk to which they might be exposed.

1.2 Limits of classical safety regulation

Regulators can adopt various approaches to creating and enforcing safety requirements [CNRA 2014; Durbin 2013]:

- ▷ **Classical command-and-control:** this prescriptive, “one size fits all” approach means that the regulator sets specific requirements for regulated activities, including specific technological measures, and ensures (for instance using regular inspections) that the prescriptions are implemented in a satisfactory manner. This approach allows fairness and clarity in the requirements, but suffers from a number of problems which are described below.
- ▷ **Goal-based or outcome-based:** the regulator establishes specific outcomes or goals for regulated activities, but does not specify how they must be reached. This approach allows flexibility in allowing regulated firms to select the most effective measures to reach the objective, but there are difficulties in certain cases in identifying observable outcomes that are not “too late” in an accident sequence.
- ▷ **Process-based:** the regulator identifies key processes that are expected to lead to safe performance (such as the establishment of a safety management system), and require regulated firms to implement these processes effectively. This approach allows the regulator to observe and discuss management-level activities in regulated firms, but is not necessarily effective in ensuring good safety performance.
- ▷ **Self-assessment:** regulated firms are required to establish self-assessment programmes and identify areas of their activities and their safety management that require extra attention, and implement improvement programmes. This approach promotes continuous improvement of safety management, but is ineffective if used as the sole regulator requirement.

The most common approach adopted by safety regulators remains the command-and-control approach, possibly in combination with other approaches. The effectiveness of this prescriptive approach is limited by a number of factors:

- ▷ **Technological innovation leading to outdated regulations.** Regulation is generally static in nature, and quickly becomes outdated in areas affected by rapid technological change. It may inhibit innovation in safety mechanisms by requiring firms to implement techniques that are less effective than the state of the art²⁰.

Nuclear regulation as a “quiltwork”

The U.S. Nuclear Regulatory Commission (NRC) formed a Lessons Learned Task Force to investigate the Three Mile Island accident in 1979. The task force concluded²¹ that the commission’s approach to regulation had resulted in a “quiltwork” in need of “an articulate and widely noticed national nuclear safety policy with which to bind together the narrow and highly technical licensing requirements”. After the accident at Fukushima-Daiichi, the NRC created a task force to investigate the implications for U.S. safety regulation, which concluded that the U.S. system was a “patchwork” with important gaps; it recommended reform to make the overall regulatory scheme “logical, systematic, coherent, clear and consistent”.

- ▷ **Regulators’ lack of information on risks.** In some highly technological industries, it may be very difficult for the regulator to develop a sufficient understanding of the risks of a product or activity and the effectiveness of safety barriers. For instance, the

²⁰ For instance, decades-old regulations managed by the US Department of Transport require the headlights of cars commercialized in the USA to have a high and a low beam, and nothing else. This prevents manufacturers from introducing innovative new headlight designs which detect the presence of incoming traffic and adapt the beam shape to avoid dazzling incoming drivers.

²¹ The task force’s report is available at <http://pbadupws.nrc.gov/docs/ML0614/ML061430367.pdf>.

type certification process of a new airplane is a long and complex process²², in which the regulator is, to a significant extent, dependent on risk information provided by the aircraft designer in assessing the safety of the design²³. This problem is less severe, or nonexistent, in industry sectors where the technologies are less complex and more mature.

- ▷ **Regulators' lack of information on costs and benefits.** To ensure that firms and affected parties make decisions which are compatible with the socially optimal level of prevention, regulators determine the costs of prevention for each regulated activity and the benefits of improved safety for potential victims. When firms do not experience the same costs – because of the size, the productivity or the age of the facilities – regulators should²⁴ set different standards, or some firms will be over-deterred (having to meet standards that are too costly given the benefits) whereas some firms will be under-deterred (they could meet more stringent standards at reasonable costs). As far as benefits are concerned, regulators have to obtain information on victims' preferences: some victims might accept more risks in return for lower costs of goods and services produced by hazardous activities or more production and consequently more jobs. In the absence of this information, regulators enact uniform standards that apply across the board, irrespective of specific circumstances.

- ▷ **Regulatory capture or subversion.** To cope with these informational problems, regulators have to cooperate with firms and potential victims to encourage them to reveal their costs and preferences. But these cooperative relationships may lead to the “capture of regulators”: the cooperation makes the regulatory agency vulnerable to domination by the regulated firms or by the victims [Laffont and Tirole 1991]. Regulation may also be requested by firms (and their lobbyists) as a barrier to entry to newcomers in the market [Becker 1983].

Regulatory capture of U.S. agency inspecting US offshore drilling

The failure of the BP Macondo well (Deepwater Horizon) in the Gulf of Mexico in 2010 led to a major environmental catastrophe and the death of 11 workers on the drilling rig. The regulatory agency in charge of issuing permits, collecting royalty revenue and overseeing safety of deep water oil drilling was the U.S. Minerals Management Service (MMS)²⁵. Agency incentives encouraged facilitation of the revenue-generating function, producing a disincentive to deny or delay permits based on environmental impact or safety concerns. Staffing levels did not allow agency inspectors time to undertake detailed inspections, and lack of resources meant that agency inspection equipment did not keep pace with technological development in deep water drilling [Neill and Morris 2012]. Agency inspectors were routinely invited to golf tournaments and fishing expeditions by industry representatives, and many knew each other since childhood. A “revolving door” between the regulatory agency and the industry led to significant exchanges in personnel between the regulator and oil firms²⁶.

Whilst the example of regulatory capture related to ethical lapses given above is relatively extreme, more subtle dependencies of regulators on industry standards and expertise are more common. Regulators regularly adopt voluntary industry standards, in particular in areas with a rapid pace of technological change, and tend over time to lose expertise and the ability independently to assess the risks of operations [Lindøe et al. 2013].

²² [Downer 2009] illustrates the complexity of the evaluation of the risk of a bird strike on a new turbofan engine, which depends on the identification of the most vulnerable strike point in the engine, which in turn requires deep understanding of the engine's behaviour under mechanical stress.

²³ [Downer 2009] argues that the type-certification process, as implemented by regulators such as the US FAA in civil aviation, consists to a large extent of verification of the organizational procedures implemented by aircraft manufactures and of the degree of expertise of their employees, rather than verification of an objective level of safety of the technology; it “quietly assesses the people who build aeroplanes in lieu of assessing actual aeroplanes”.

²⁴ Under the socially optimal level of prevention viewpoint.

²⁵ Later renamed the Bureau of Ocean Energy Management, Regulation and Enforcement. Other government bodies with a regulatory role in offshore drilling include the U.S. Coast Guard, OSHA, the U.S. EPA, and various state agencies.

²⁶ *Investigative report: Island Operating Company et al.*, United States Dept. of the Interior, Office of Inspector General, 2010.

When public institutions are vulnerable to **subversion** (for instance from bribery or intimidation), firms can escape fines or other penalties for regulatory non-compliance. They may also be able to subvert the legal system, and thus avoid civil liability (indeed in some situations this risk may be greater than that of subverting regulators [Glaeser and Shleifer 2003]).

Regulation of nitrate pollution from agriculture in France

Several coastal areas in France suffer from high levels of nitrate pollution due to agricultural activity, leading to the proliferation of toxic seaweed in summer and to pollution of aquifers. Though stringent regulation concerning waste management at pig farms and the use of nitrate fertilizers exists, it is under-enforced, because of the significant political pressure wielded by the French agricultural sector²⁷.

- ▷ **Cost of verification.** Regulators have to visit, control and audit regulated facilities. This activity is costly and costs are supported by society. Economists make a variety of different cost-based arguments about regulation, including that its costs exceed its social benefits [Coase 1960]; that it generates market inefficiencies and undermines economic growth. Budget limitations mean that regulators often lack the resources to monitor compliance with safety regulations [Kolstad et al. 1990]. They need significant expertise in order to assess the safety performance of firms (in particular concerning industrial safety, where issues may be more difficult to assess than for occupational safety)²⁸, and such expertise is often better rewarded in the private sector.

1.3 Alternatives to regulation

A basic requirement for regulation is that it be **equitable** (or consistent): that the same conditions be required of similar industrial operators. This sometimes leads to regulation which is detailed and prescriptive, requiring specific types of technology for instance. This form of regulation (called “command and control” in the regulation studies literature²⁹) destroys incentives for technological and organizational innovation concerning safety. An intermediate approach is based on the use of *legal standards* in law, which attempt to provide adequate levels of safety in fields which are in constant evolution by integrating expert knowledge in a form which may change more rapidly than regulation³⁰. These regimes involve industry and professionals in the formulation of rules and procedures that define what the current state of knowledge considers to be “good practice”.

legal standards

There are three main categories of alternatives to traditional command and control regulation:

1. **Liability regimes** such as the tort system, like “command-and-control” regulation, can be quite punitive and rely ultimately on the coercive power of the state. However, it is not coordinated by the state, relying instead on private citizens to recognize injuries and enforce norms on one another. This alternative (or complement) to traditional regulation is discussed in chapter 2.
2. **Market-based regulation** (incentives, markets, regulatory taxes, trading, subsidies), in which the regulator attempts to “harness the power of the market” to achieve regulatory goals. The best-known example of this approach is emissions trading, which requires regulators to create and oversee a market in pollution credits that can be freely traded

emissions trading

²⁷ cf. a report by the French auditor-general (*Cour des Comptes*), titled *La préservation de la ressource en eau face aux pollutions d'origine agricole: le cas de la Bretagne*, February 2002.

²⁸ The overuse of checklists to assess compliance with safety regulations (both by regulators and by workers within firms) is known to encourage a “compliance mentality” which is contrary to the constant vigilance and the questioning attitude required for the safety of complex socio-technical systems [Bieder and Bourrier 2013].

²⁹ This regulatory approach typically proceeds by imposing rigid standards of conduct on individual risk/pollution sources (e.g., standards requiring that firms use a specified control technology) backed up by sanctions designed to assure full compliance with such standards by each firm.

³⁰ A simplifying viewpoint on the distinction between a rule and a standard is that rules are applied *ex ante*, and standards *ex post* [Kaplow 2000]. For instance, a rule might provide a list of specific toxic substances which may not be released into the environment, whereas a standard might only ban the release of “highly toxic” substances and leave the determination of which substances are “highly” toxic to expert judgment, after the fact.

among regulated firms. Also in this category are regulatory taxes and other price-based schemes that attempt to influence the behavior of firms in existing markets by altering their incentive structure to take account of externalities (cf. § 1.1.1).

The EU Emission Trading Scheme

Established in 2005 to reduce climate change, the EU ETS “cap-and-trade” system concerns 11 000 installations which are responsible for half of the EU’s carbon dioxide emissions. A cap is set on the total emissions allowed for participating installations (typically, factories and power stations), and allowances are provided to each installation based on its initial emissions level. Installations must monitor and report their emissions, and if they exceed their allowance, must trade with other installations to obtain an extra allowance.

Since 2009, the effectiveness of the ETS in providing incentives to firms to reduce greenhouse gas emissions has been limited by a fall in the price of carbon emission permits, mostly due to a reduction in industrial activity caused by the economic slowdown.

3. **Self-regulation** (voluntary programs, “beyond compliance”, self-policing, auditing, information disclosure, contractual regulation, stakeholder participation), which shift to private parties responsibilities like standard-setting, monitoring and enforcement which have traditionally been assured by governments. This approach to regulatory policy is further described in the next section.

1.3.1 Self regulation

Certain professions such as medicine and law have long been trusted to self regulate. The assumption is that professional pride and interest for maintaining the reputation of the profession mean that one’s own peers are the strictest regulators.

Self-regulation in law

DEFINITION

Corporate and professional self-regulation refers to rules and standards enacted by an industry association for voluntary compliance by its member firms. These may include voluntary policing and reporting schemes, the use of audits, and schemes to increase the involvement of community stakeholders in the regulatory process. These kinds of programs attempt to internalize certain key aspects of the rule of law within regulated organizations.

Examples in the safety area include the American Petroleum Institute (API) standards and recommended practices for oil and natural gas firms and the chemical industry’s *Responsible Care* programme (see below) for chemical manufacturers and distributors.

Like regulation and unlike liability regimes, self-regulation acts primarily *ex ante*, before any accident has occurred. The hypothesis is that the informational advantage of industry experts (over government regulators) allows firm-specific (rather than industry-wide) standards to be set. Self-regulation regimes may also act *ex post*, for instance in punishing doctors or lawyers for malpractice.

Self-regulation has been a matter of significant debate in the legal community over the past decade (a field of research known as regulation theory), and is increasingly being adopted in the EU [Ogus 1995]. Industry self-regulation is subject to **adverse selection**: if there are no sanctions for firms which participate in the programmes but do not improve their real performance, lower “quality” firms will seek to participate to benefit from the reputational advantages, without being subjected to the costs of change (the “free-riding problem”). The primary arguments advanced by its proponents concern **efficiency**: private bodies generally have better information than a state regulator, and can therefore monitor and enforce standards more cheaply; it is also easier for them to ensure that standards of conduct are up-to-date with evolving technology.

Impact of the Responsible Care programme in the U.S. chemicals sector

The Responsible Care programme³¹ is a voluntary code of conduct adopted by the American Chemistry Council after the Bhopal accident, and which now operates in 52 countries. The chemical companies which enter the programme agree to commit themselves to improve their performance in the fields of environmental protection, occupational safety and health protection, plant safety, product stewardship and logistics, as well as to continuously improve dialogue with their neighbors and the public, independently from legal requirements.

The real impact of these voluntary programmes on pollution levels and safety is debated. Empirical studies have found some evidence that participation in the Responsible Care programme has not reduced pollution [Morgenstern and Pizer 2007; King and Lenox 2000], but does seem to be linked to a reduced likelihood of accidents [Finger and Gamper-Rabindran 2013] (reduction of 3 accidents per 100 plants in a given year, a 70% reduction).

Self-regulation of safety issues has also been criticized by a number of authors³²:

fairness criteria

- ▷ Experience since the industrial revolution suggests that it does not generally provide a sufficient assurance of social control over the hazards caused by industrial activity [Short and Toffel 2010].
- ▷ It does not constitute a means of control which meets at least two legal criteria for **fairness**:
 - predictability of what is required of companies;
 - equivalent protection for workers and other persons at risk across different sectors of society.

stakeholder involvement

- ▷ Self regulation by industry is usually an **opaque process** which protects management discretion and proprietary information. It precludes involvement of workers and the public and access to company information, especially information that would illuminate the tradeoffs made between safety and production or profit in the conduct of company activities. Thus, it permits “business as usual” in determining “how safe is safe enough” and neglects public input and interests in safety unless special safeguards are provided by government oversight and expertise. It is therefore at odds with the increasing desire (in many progressive democracies) for greater transparency, stakeholder involvement, and company **accountability in governing risks**.
- ▷ Self regulation generally involves companies adopting voluntary codes of practice or standards developed by industry or trade organizations. Several factors hinder the development of industry bodies which have sufficient **independence** from short-term pressure from their member organizations to allow them to develop high quality standards.
- ▷ Challenges for government in overseeing a self-regulatory approach to ensure the sufficiency of each company’s safety management system. Oversight can be undertaken by agency inspection, by third party inspection and certification, or by review of company self-audit reports. Effective evaluation of the degree of compliance requires agency expertise and access to company-held information.

³¹ cf. <http://www.icca-chem.org/en/Home/Responsible-care/>.

³² The discussion below is based on a presentation by Prof. M. Baram at the 2010 *Working on Safety* conference.

Liability and prevention

This chapter discusses the effects of liability law on firms' and individuals' motivation to take care. It starts by some introductory definitions of important terms related to tort law, civil liability and negligence. Factors which weaken the effectiveness of liability as an incentive to invest in prevention are discussed in § 2.2. The complementary nature of liability regimes and regulation is presented in § 2.3, primarily from the "optimal level of prevention" perspective developed by economists since the 1970s, but closing with a reference to corrective justice theory in law and ethics. A number of indirect benefits of liability law (information disclosure, right to justice, substitute to violent retaliation and incentive for regulators) are presented in § 2.4, followed in § 2.5 by a discussion of indirect costs of liability law, including their negative effect on innovation, the encouragement of defensive attitudes and reduction of information sharing, which inhibit learning from failure. Finally, a number of case studies illustrating the liability of regulators are briefly presented in § 2.6.

2.1 Definitions

Liability is a legal requirement to compensate another because of an unlawful injury to their person or property. The implementation of this requirement varies considerably between countries: common law jurisdictions such as the United Kingdom and the USA apply **tort law**, a body of doctrines applied by the courts to the specific facts of each case brought by a plaintiff, whereas in other countries based on civil law, legislation usually provides the doctrines to be applied by the courts or administrative bodies to determine **civil liability**. The most common form of liability arises from evidence of *negligence*: if the injured party can prove that the person believed to have caused the injury acted negligently – without fulfilling their *duty of care* – then liability law will allow compensation.

negligence

Duty of care (U.S. common law)

DEFINITION

A duty of care is a legal obligation imposed on an individual requiring that they adhere to a standard of reasonable care while performing any acts that could foreseeably harm others. Breach of duty of care is the most important element that must be established to proceed with an action in negligence.

In judging whether the duty of care was respected, certain jurisdictions ask juries to use their common sense to decide what an "ordinarily careful person" would have done under the circumstances. U.S. judge Learned Hand proposed a more instrumental approach, called the "calculus of negligence": if $B < p \times L$, where B is the cost or burden of taking precautions, p is the probability of the loss and L its magnitude or severity, then the duty of care requires the precaution.

calculus of negligence

Contributory negligence

DEFINITION

In most common-law jurisdictions, defendants to a claim based on negligence can argue that the victim, through their own negligence, contributed to the harm they suffered (thus reducing the compensation to which they are entitled). Consider a pedestrian who crosses a road negligently and is hit by a driver who was driving negligently. Since the pedestrian has contributed to the accident, they cannot sue the driver for damages; the accident would not have occurred without the pedestrian's *contributory negligence*.

The difficulty with negligence is that it still requires the plaintiff to prove that the defendant's conduct fell below the relevant standard of care. However, if an entire industry tacitly settles on a somewhat careless standard of conduct (as analyzed from the perspective of a non-specialist), then the plaintiff may not be able to obtain compensation even though he or she is severely injured, because although the defendant's conduct caused his or her injuries, such conduct was not negligent in the legal sense (everyone within the profession would testify that the defendant's conduct conformed to that of a reasonable professional in such circumstances). As a practical matter, the increasing complexity of products, injuries, and medical care (which made many formerly fatal injuries survivable), make it quite difficult and expensive to find and retain good expert witnesses who can establish the standard of care and demonstrate causation.

For this reason, the concept of **strict liability** was developed to ensure compensation for harms caused by certain activities that are useful and necessary, but that create significant risks for society.

Strict liability



In several common law jurisdictions, the doctrine of strict liability is available to the plaintiff. It makes a person legally responsible for the damage and loss caused by his or her acts and omissions, **regardless of culpability** (without a finding of fault, such as negligence or intent to harm). The claimant need only prove that the harm occurred and was caused by the defendant.

In civil law countries, violation of a statute or a rule immediately results in liability, without considering the defendant's standard of care or requiring proof of negligence.

As a general rule, the law imputes strict liability to situations that it considers to be **inherently dangerous**. It discourages reckless behavior and unnecessary losses by forcing potential defendants to take every possible precaution. It also has the effect of simplifying and expediting court decisions in these cases.

The following arguments can be made in favour of strict liability regimes:

- ▷ Concerning product liability, it causes manufacturers to internalize costs that they would normally externalize (and by passing them on to consumers, constitutes a form of **social insurance**, since compensation is paid for by all consumers). Strict liability thus requires manufacturers to evaluate the full (social) costs of their products. In this way, strict liability provides a mechanism for ensuring that a product's absolute good (to the whole of society) outweighs its absolute harm.
- ▷ It seeks to diminish the impact of **information asymmetry** between manufacturers and consumers. Manufacturers have better knowledge of their own products' dangers than do consumers, and should thus bear the burden of finding, correcting, and warning consumers of those dangers.
- ▷ It **reduces legal costs**, because a plaintiff need only demonstrate causation, not imprudence. Where causation is easy to establish, parties to a strict liability suit will most likely settle, because only damages are in dispute.

However, there are also arguments against strict liability:

- ▷ It may **over-deter** certain socially-beneficial risk-taking behaviours where uncertainty is high, in particular **innovation** and the use of new technologies. If firms bear the risk of all foreseeable and unforeseeable harms, they may be deterred from pursuing innovations whose risks are relatively unknown, resulting in under-investment in new technology.
- ▷ In situations where a risk is generated by the joint behaviour of two parties, strict liability can generate incentives for *strategic behavior* by plaintiffs.

Reduced precaution caused by strict liability

Consider the case of a farmer who knows that a railway operator will be held strictly liable for all livestock its trains run over. The farmer may let more of his livestock wander near the tracks rather than incur the expense of keeping them penned.

Another factor which distinguishes the implementation of liability law between jurisdictions is the possibility to claim *punitive damages*.

Punitive damages

DEFINITION

Common law liability regimes are said to be *balanced* when total liability payments by injurers must not exceed total harm. Certain liability regimes add the concept of punitive damages (or *exemplary damages*), which are intended to deter the defendant and others from engaging in conduct similar to that which formed the basis of the lawsuit. Punitive damages are usually reserved for when the defendant has displayed actual **intent to cause harm** or extreme disregard for the safety of others, rather than for cases of mere negligence. They are more likely to be applied when “smoking gun” evidence shows that the defendant had prior knowledge of the risk, knew of a readily available safety measure, and did not implement it, demonstrating a “conscious indifference” to public safety or the environment. The amount of punitive damages may be far in excess of compensatory damages, though some courts have sought to develop rules which prevent the award of exorbitant amounts of punitive damages.

2.2 Factors which weaken the effectiveness of liability regimes

Several phenomena reduce the effectiveness of liability, both as an incentive to invest in risk reduction and as a compensatory mechanism³³:

- ▷ **Victim’s apathy** appears when the people exposed to a hazard or pollution have no incentives to sue the injurer. When victims are not aware of the harm, or believe that the damage has natural causes, or do not know the consequences of an accident on their health or property, they will not go to trial. Injurers will therefore have no incentives to reduce risks. The prospect of involvement in lengthy and contentious proceedings with high legal costs – which may not be recoverable – may also dissuade a victim from seeking compensation.
- ▷ **Insolvency.** An injurer is called **judgment-proof** when he does not possess sufficient assets to pay fully for the damages he causes. In this case, his incentives to reduce risks by taking care may be weak, because he will not consider losses that exceed his assets³⁴. Thus, the lower the injurer’s assets, the weaker the incentives of civil liability. This is of particular importance in the case of environmental accidents such as oil spills and nuclear accidents, which may lead to high levels of damages.

Strategic restructuring by firms to avoid liability for accidents

There is empirical evidence that firms in hazardous industries view the ability to be judgment-proof as an *opportunity*, and have created separate subsidiaries or spin-offs to house their hazardous activities [van 't Veld 2006]. For instance, the introduction of the U.S. Oil Pollution Act, which increased liability for environmental damage caused by shipping accidents, coincided with the decision of some shipping companies to divide their tanker fleets into multiple single-ship companies. In another sector, [Barney et al. 1992] found that U.S. firms exposed to higher levels of liability from employee exposure to hazardous materials were less vertically integrated (and thus more likely to become bankrupt in case of a major accident, protecting them from liability) than firms not facing such risks³⁵.

This problem can be partially resolved by compulsory insurance (*cf.* § 3.2) or by special public mechanisms of compensation of victims.

- ▷ **Latency.** When the time between exposure to risk and the appearance of symptoms is very large, the deterrence effect is weakened. Indeed, countries with a common law

³³ During the NeTWork’2012 workshop, these issues were discussed by several participants, in particular Pierre Bentata and Michael Faure.

³⁴ From a historical perspective, it is worth noting that prior to the introduction of **limited liability** rules approximately 200 years ago, investors in a company were fully liable for the default of the company, and their personal assets could be seized by creditors.

³⁵ Discussing the ethical implications of their research, these researchers argue that “it is becoming increasingly important that organizational scholars become parties in the social policy dialogue that addresses such organization-based ethical issues”.

liability regime have limitation periods that prevent the initiation of a trial long after the harmful action occurred³⁶.

Latency of asbestos exposure claims

Symptoms of exposure to asbestos, such as mesothelioma, are typically contracted up to 40 years after the exposure occurs. During this period, the disease is dormant and cannot be detected by routine medical examinations. Such latency periods create problems of fact-finding in the legal system. The plaintiff generally has the burden of proving that the defendant's actions or products were a substantial cause of plaintiff's injury. Plaintiffs need to uncover records of product use or produce co-workers' testimony to demonstrate exposure to a particular defendant's product.

▷ **Causal uncertainty.** The deterrence effect of liability regimes depends upon victims' ability to demonstrate a causal link between the damages and the injurer's activities. For many technological systems, this may be difficult to demonstrate with certainty:

- Concerning environmental impacts, effects such as latency and the widespread use of a specific pollutant may complicate the demonstration of causality.
- Safety research over the past decades has shown that certain accidents, in particular in complex sociotechnical systems, have a causal structure that is both non-linear and non-deterministic. Legal investigations, in contrast, generally adopt a linear and deterministic accident model, assuming that a single root cause and clear sequence of events leads to an accident, leading to allocation of blame, and by extension liability. This legal viewpoint is encouraged by the fact that in hindsight [Rachlinski 1998], accidents often do appear to be simple, linear and deterministic, even if they were not to the people making the decisions in the context which led to harm³⁷.

hindsight bias

Impact of hindsight bias on judgment

Hindsight bias means unconsciously overestimating the likelihood one would have assigned to an event once the outcome is known. It leads observers of past events to exaggerate what other people should have been able to anticipate at the time. Hindsight bias can be reduced by training and experience. Indeed, [Viscusi 1999] ran an experiment concerning a hypothetical railway accident to measure the difference between judgments of the operating company's safety management decisions made *ex ante*, and judgments made from an *ex post* perspective (after the accident). When the facts were presented to people asked (in a laboratory setting) to act as members of a jury, they favored risk-taking behavior before the accident occurred, but after an accident occurred awarded punitive damages, because the company's decision to take risks was judged to be reckless. Presented with the same situation, a sample of state judges in the USA were better at aligning their *ex ante* judgment with a retrospective assessment of the decision.

2.3 The complementary nature of liability regimes and regulation

Liability law, or tort law, has long been advanced as a market-based alternative — or complement — to safety regulation [Calabresi 1970], which can fulfill two goals:

- ▷ **deterrence** of risk-creators, by providing an incentive to take optimal care to prevent accidents;
- ▷ **compensation** of victims when an accident actually occurs (a form of insurance for consumers³⁸).

³⁶ However, many jurisdictions now start the period of eligibility at the time the victim knew or should have known that he or she had been injured.

³⁷ This argument was presented during the NeTWork'2012 workshop by Patrick Hudson [Hudson 2014]. A more general critique of the criminal justice system's theory of culpability, based on research in social psychology, can be found in [Ross and Shestowsky 2012].

³⁸ Note however that the risk distribution features of tort liability and insurance differ in their treatment of non-monetary losses. Unlike insurance, tort damages may include compensation for pain and suffering, embarrassment and humiliation, and loss of ability to enjoy the pleasures of life.

The “optimal level of prevention”

DEFINITION

From an economic perspective³⁹, a given level of prevention is *optimal* if it minimizes the sum of the cost of accidents and the cost of prevention; *i.e.* if it leads to minimization of the whole cost of the potentially hazardous activity.

Because prevention (reducing the severity or probability of accidents) is costly, the optimal level of prevention may not be that corresponding to the lowest possible level of accidents. Indeed, that would require the highest level of prevention, which is non-optimal because the additional cost of care would be higher than the additional benefits.

In order to determine the optimal level of prevention (or of abatement, or of care), regulators must determine both

- ▷ the **cost of prevention** for each risk generator, which varies according to multiple factors such as the technology used, the age of installations, the company’s size and productivity levels (and is generally more difficult to assess for new technologies than for more established ones);
- ▷ the **benefit of lower levels of risk** to potential victims, which depend on their preferences (in terms of trade-offs between the cost of goods and the level of risk, or concerning other benefits of industrial activity, such as employment).

Incorrect estimation of these costs and benefits may lead either to *over-deterrence* (risk generators are required to attain safety levels which are more costly than their benefits to people exposed) or to *under-deterrence* (risk generators could reach a higher safety standard at a reasonable cost).

It should be noted that the “social optimum” perspective is based on **utilitarian ethics** (which aims for “the greatest good for the largest number”); most legal systems also take into account elements of **rights-based** or **duty-based ethics**, which adopt quite different rationales for judging behaviour.

The normative economic view of tort law is that the incentives it provides to firms and individuals to take account of the costs they impose on others, leads to an optimal level of prevention.

Two factors contribute to making liability law more attractive than regulation under the “social optimum” perspective:

- ▷ The legal costs of managing liability are generally lower than the administrative costs of developing and enforcing regulation. This is because liability applies *ex post* (it only intervenes after the occurrence of an accident), whereas regulation intervenes *ex ante*; regulators must control all potentially hazardous activities, even those for which an accident will not occur⁴⁰.
- ▷ The regulator generally has less good information than the risk creator concerning the potential cost of accidents and the cost of prevention, and therefore is less well placed to determine the optimal level of care (as described above). Under a liability regime, each risk creator determines his optimal level of care given his private costs of prevention and the threat of being held liable by the courts.

Influential research by the economist Shavell has suggested that the choices observed to be made in the USA between liability and regulation are, when broadly viewed, socially rational with respect to the optimal level of prevention criterion described above [Shavell 1984a]. Activities that create the risk of the typical tort and that are subjected to limited regulation characteristically display features leading us to say that they ought to be controlled

³⁹ We refer to the field of **economic analysis of law**, which analyses how people react to different forms of incentives and obligations, based on assumptions that people act rationally and respond to incentives. For an overview of economic analysis of tort law, refer to [Dari-Mattiacci and Parisi 2006; Faure 2009].

⁴⁰ Note however that this efficiency argument is challenged by some empirical evidence: the tort liability system in the United States of America, the country where the system is most developed, leads to estimated direct annual costs of 1.8% of GDP, of which only 20% go to claimants [USCEA 2002].

mainly by liability, whereas activities that are heavily regulated – especially ones involving significant hazards to health or to the environment – tend to be those where liability regimes display weaknesses. Since neither measure produces optimal results alone, Shavell suggests that a combination of both strategies be used to mitigate the risk and shows that this solution is superior to a single strategy approach [Shavell 1984b].

corrective justice
theory

It is worth noting that while the economic perspective has had a significant influence on policy-makers⁴¹, particularly in the USA, it does not constitute the only normative justification for the existence of liability law. **Corrective justice theory**⁴², the most influential non-economic perspective on tort law, was originally articulated by Aristotle⁴³. Its core idea is that when a person causes wrongful harm to another, the victim has a moral right to demand, and the injurer a moral right to request, that the victim be put back in the position that they were in before the injury occurred (for example through the payment of compensation)⁴⁴. This theory sees tort law as a system of first- and second-order duties. Duties of the first order are **duties not to injure**; they establish norms of conduct. Duties of the second order are **duties of repair**; they arise when a first-order duty is breached. This view of the rationale for tort law sees this branch of private law as being exclusively concerned with justice between individuals, and not with attempting to reach public-policy goals such as encouraging or deterring certain kinds of conduct.

2.4 Indirect benefits of liability law

Liability law has a number of **indirect benefits** which go beyond the provision of incentives to prevent accidents [Herskovitz 2011]:

- ▷ **information disclosure**: tort suits generate information, which can benefit the public.
- ▷ **right to justice** (and the importance that many people attribute to the right to “speak one’s story”); there is evidence that one reason many victims file suit is that they want to hold their injurers responsible [Strawson 1974].
- ▷ torts provide a **substitute to violent retaliation** against wrongful injury.
- ▷ civil liability creates **incentives for regulators** to monitor hazardous establishments, since regulators may be held liable in case of an accident if their supervision can be demonstrated to have been wanting (see § 2.6).

More generally, to quote [Herskovitz 2011]:

“[...] tort relies on a richer conception of humanity than regulation does. Through tort law, we address each other as moral agents. We press claims and proffer defenses, offer justifications, and assert privileges. In the end, we may be held liable, but before that, we are held answerable. Tort treats us as people with rights and responsibilities, not simply as entities to be managed, handled, or “incentivized”.

and quoting from [Baram 2007]:

⁴¹ R. Posner wrote concerning the field that he helped to launch that “Economic analysis of law has grown rapidly, has become the largest, most pervasive interdisciplinary field of legal studies in the history of American law, has palpably influenced the practice of law and judicial decisions, has launched lucrative consulting spin-offs, has spawned courses and text-books in economic analysis of law, has influenced legislation (economic analysts of law played an important role in the deregulation movement), has made it *de rigueur* for law schools of the first and second ranks to have one or more economists on their faculty, has seeded a number of its practitioners in university administration and the federal judiciary, and has now crossed the Atlantic and begun making rapid gains in Europe.” [Posner 1995].

⁴² See the article *Theories of Tort Law* in the Stanford Encyclopedia of Philosophy for more details.

⁴³ Nicomachean Ethics, Book V.

⁴⁴ Note that *corrective justice* is distinct from *retributive justice*; the latter is concerned exclusively with how individuals who are morally culpable or blameworthy ought to be punished.

“... tort law is a necessary supplement to regulation for progressively reducing product and process risks and promoting the humanistic advance of technology. It represents a nation’s moral commitment to protecting each individual from those residual risks which regulation, narrowly applied and preoccupied with setting optimal levels of risks for society to bear, fails to prevent. Tort law is responsive to another regulatory limitation by assuring that individuals who suffer harm caused by a company’s negligent behaviour or dangerous activity will have access to a personal remedy. And it provides a means of social control over advancing technology which is more flexible and adaptive to meet new circumstances, and less susceptible to capture by business interests, than regulation. In these and many other ways, tort law continues to serve societal interests.

2.5 Indirect costs of liability regimes

Safety specialists often⁴⁵ criticize liability law for the negative effects it has on people’s and organizations’ behaviour:

- ▷ It may **inhibit innovation**, for fear of being exposed to liability for risks that were not anticipated during the design phase. Indeed, when judging liability for accidents in which innovative products are involved, judges’ and juries’ *ex post* assessment of the producing firm’s risk management may be affected by **hindsight bias**⁴⁶, and reach different conclusions from the firm’s *ex ante* risk assessment. Empirical evidence [Viscusi and Moore 1991] suggests that the level of product liability has a nonlinear impact on innovation: low levels of liability boost investments in new technologies and product R&D, but when product liability costs become a significant component of costs, innovation is reduced.
- ▷ It reinforces **defensive attitudes** during accident investigation, since people are concerned not to incriminate themselves or a colleague, meaning that less understanding is gained from incidents and accidents [Woods 2005], inhibiting continuous improvement of safety management. This suppression of the safety lessons which can be derived may lead to an organizational learning disability [Hopkins 2006]. The same defensive bias can affect system design and product safety decisions.
- ▷ It reinforces a **blame culture**, instead of a learning culture: during accident investigation, it produces incentives for a firm to allocate responsibility and blame to the operator at the “sharp end”, rather than identifying contributing factors at the organizational level (which shift blame to the company). Similarly, it supports the tendency of courts to prosecute the last actor in a chain of events⁴⁷, rather than taking a more global view of causation [Dekker 2003].
- ▷ It may prevent manufacturers from implementing new or improved designs in their products quickly (with the backward logic that implementing a design change might be misconstrued as an admission of faulty design).
- ▷ It **hinders sharing of information** (between divisions in a company, between operating companies and their contractors, between operating companies and regulators, *etc.*), since any uncertainty expressed may later be used to demonstrate liability.
- ▷ It causes insurers to be against the admission of fault/error, creating more frustrated victims and discouraging professionals from learning from mistakes.
- ▷ It may encourage firms to invest in lawyers instead of in risk prevention⁴⁸.

defensive bias

⁴⁵ These arguments were summarized during the NeTWork’2012 workshop by K. Visser, former head of the Dutch Safety Board.

⁴⁶ See the definition given on page 18.

⁴⁷ Following a “bad apple” view of system safety, according to which complex systems would function fine if it were not for the erratic behaviour of a few unreliable people who don’t do what they are supposed to do.

⁴⁸ Calabresi’s groundbreaking book *The Costs of Accidents* [Calabresi 1970], which defends the claim that “the principal function of accident law is to reduce the sum of the costs of accidents and the costs of avoiding accidents” notes in passing “Such incidental benefits as providing a respectable livelihood for a large number of judges, lawyers, and insurance agents are at best beneficent side effects”.

Potential for conflict between liability management and safety

Consider a hypothetical insurance company which covers private clinics against the risk of legal claims concerning nosocomial infections⁴⁹. Determining precise causality concerning these infections is sometimes complicated, since patients may arrive at the clinic with a prior infection. Given this uncertainty in terms of legal liability, the insurer can provide two forms of advice to their client:

- ▷ Hire a specialist doctor in management of infection risks, and put in place an action plan to manage the risk.
- ▷ Implement admission procedures which aim to establish a clear status of incoming patients' possible infections, in order to protect the clinic from unfounded liability claims.

These alternative strategies (which are not mutually exclusive...) may have different levels of impact on both insurance claims and on patients' health. The socially optimal strategy may differ from that which is optimal for the insurance company.

Balancing innovation risks and device safety: medical devices

New medical devices such as heart valves or pacemakers are regulated by the Food and Drug Administration in the USA, and by national competent authorities (healthcare inspectorates and notifying bodies) in the EU⁵⁰. Over the past decades, a regular debate has existed regarding the two regulatory processes for allowing the use of a new device. In the USA, the effectiveness of a device must be proven, whereas in Europe the performance is assessed in terms of a risk-benefit tradeoff (a lower burden of proof).

It is generally acknowledged that new medical device technology becomes available in Europe years earlier than in the USA.

2.6 Accountability and liability of regulators

Who regulates the regulator?

What happens if the regulatory body (or the competent authorities, or a notified body) is guilty of falling below the standard of competence imposed on those he regulates?

In a small number of cases, the responsibility of a regulatory body (and in some cases, of individuals working for a regulatory body) has been recognized after an industrial accident. A few examples are provided below.

Responsibility of the French air traffic regulator in the Concorde crash

In July 2000, a fuel leak on Air France Concorde flight 4590 led to a fire and the crash of the aircraft shortly after takeoff from Paris, causing the death of 113 people. Among other accused parties, the appeals trial in 2012 investigated the responsibility of the former head of the safety department of the French air traffic regulator. Prosecutors accused (but later acquitted) the regulator of having failed its duty to take sufficient notice of several previous incidents in which failure of the aircraft's tires led to damage to the wing structure. The acquittal statement reads:

The court considers that the duality of administrative authorities and manufacturers, the poor organization of French certification and airworthiness activities, the political balance of forces both within France and between France and Great Britain, as well as financial factors have contributed to airworthiness standards which were not up to the exceptionally high technological standard which allowed the existence of the Concorde project.

⁴⁹ Hospital-acquired infections.

⁵⁰ This illustration was described during the NeTWork'2012 meeting by Bastian de Mol [de Mol 2014].

Responsibility of the classification society after the Erika oil spill

In December 1999, the Erika oil tanker sank off the coast of Brittany, France, causing significant environmental damage. A trial in 2008⁵¹ found four parties guilty of negligence and sentenced them to pay damages in the case: the ship owner, the ship manager, the oil company which chartered the ship, and the seaworthiness classification company⁵² (found guilty for its imprudence in renewing the Erika's classification certificate, on the basis of an inspection that fell below the standards of the profession).

Responsibility of the UK Railway Inspectorate in the Ladbroke Grove accident

In October 1999, a rail accident at Ladbroke Grove (near Paddington in London) killed 31 people and injured more than 520. The installation of an automatic train protection system, which would have stopped the train after a red signal had been crossed and likely prevented the accident, had been rejected on cost grounds. The accident, which followed another two years earlier on the same railway line, damaged public confidence in the management and regulation of safety of Britain's privatized railway system. The action of the Railway Inspectorate was criticized by the public inquiry into the accident.

Maladministration by financial regulators in the Equitable Life scandal

The Equitable Life Assurance Society is a life insurance company in the United Kingdom and the world's oldest mutual insurer (founded in 1762). The company allowed large unhedged financial liabilities to accumulate over a number of years without making provision for adverse market changes and made over-generous payments to members, leading it to close to new business in 2000. In 2008, an investigation by the Parliamentary Ombudsman accused the regulators of "comprehensive failure" and found the government guilty of ten counts of maladministration.

Blameworthy deficiency of the regulator in the AZF accident

In January 2013, a French administrative appeals court recognized the responsibility⁵³ of the state regulator in the AZF accident (Toulouse, 2001). The court stated that the improper storage of waste products in the hangar believed to have been the center of the explosion:

reveals a blameworthy deficiency in the state regulator's inspection activity [...], which did not detect or impose fines for visible and long-lasting breaches of duty by the site operator despite their constituting a major accident hazard in a heavily populated urban area. [...] The state cannot exonerate itself from its own deficiencies in identifying or imposing penalties for detectable, long-lasting and severe breaches of duty by the operator of a facility which they have licensed to operate by pointing to the operator's breaches of duty, given that the objective of the state's action, and its expected outcome, was precisely to prevent such breaches of duty.

There are two significant challenges facing those who wish to call regulators to account, especially those who wish to impose strong accountability mechanisms:

- ▷ Accountability is not an absolute good (for regulators, at least). It has diminishing and, eventually, negative returns because in general it undermines other desirable attributes of a regulator, namely, independence, expertise and efficiency.

⁵¹ Whose conclusions were mostly upheld in appeal in 2012.

⁵² Classification societies establish and maintain technical standards for the construction and operation of ships and offshore structures. They also validate that construction is according to these standards and carry out regular surveys in service to ensure compliance with the standards. The system dates to the 1750s when marine insurers, based at Lloyd's coffee house in London, developed a system for the independent technical assessment of the ships presented to them for insurance cover. Classification societies take pains to specify that their certificates "do not imply, and should not be construed as an express warranty of safety, fitness for purpose or seaworthiness of the ship. It is an attestation only that the vessel is in compliance with the standards that have been developed and published by the society issuing the classification certificate".

⁵³ The two judgments are numbered 10BX02880 and 10BX02881.

- ▷ The accountability of regulators is hampered by the difficulty of effectively measuring and assessing their performance. It is very difficult to hold someone to account if you cannot determine when they have performed well and when they have performed badly.

Issues related to insurance

Insurance is generally thought of as a **risk-sharing mechanism** which allows after-the-fact indemnification for losses, and a mechanism for transferring the financial component of risk from risk-averse actors to larger, more risk-neutral actors. Some scholars describe it as a **social technology of justice**, providing an alternative to the retributive model (which puts the emphasis on the appropriateness of the sanctions imposed on those who are judged to be “to blame”) in which notions of cause and blame are replaced by the idea of “a distributive sharing of a collective burden” [Ewald 1991]. By determining *ex ante* the party that will provide compensation if an accident occurs, insurance promises reduced transaction costs for all involved.

risk transfer

Conditions for applicability of insurance as a social control mechanism

DEFINITION

For a risk to be insurable [Abraham 1988], and for insurance to be suitable as a form of social control over hazardous activity, a number of conditions must be met:

- ▷ The insurer is able to estimate the probability of accidents and the magnitude of the loss ⁵⁴.
- ▷ When accidents occur, the insurer is able to decide whether the loss is covered by the insurance policy.
- ▷ A sufficiently large number of insurance buyers are exposed to the same risk and are able to afford insurance coverage for this risk, allowing the insurer to spread losses over a large population.
- ▷ The risk is not *systemic*, meaning that only a small subset of the insurance buyers will be exposed to a loss at the same time (this is a problem for certain types of natural hazard such as flooding or global warming, and for risks on the financial markets).
- ▷ Accidents are *aleatory*, in the sense that they occur essentially independently of the will of the insured firm, which has taken reasonable measures to prevent them.
- ▷ There is an economic agent (a *proxy*) who seeks to be compensated for the undesired consequences of the industrial activity. This is a problem for some types of environmental damage (biodiversity, protection of landscapes) [Richardson 2002].

Insurance also has somewhat complex effects on firms’ risk prevention and risk management activities [Moss 2002; Ericson et al. 2002]. The most well-known effect, *moral hazard*, provides an incentive to insured firms to reduce their level of preventive effort [Laffont 1995; Winter 2001]. Other impacts such as the provision of safety management expertise and the indirect effects of classification and pricing of coverage tend to reinforce firms’ preventive activities [Ben-Shahar and Logue 2012].

A number of factors which affect the effectiveness of insurance as a mechanism for controlling risks are discussed in the following sections:

⁵⁴ More precisely, the loss exceedence probability curve, which represents the probability and severity of all accidents, ranging from minor to severe. This can be estimated from experience (for known risks) or using risk analysis (for novel situations).

- ▷ § 3.1 presents the **moral hazard problem**, which reduces the effectiveness of insurance as a risk control mechanism, and discusses techniques used by insurance companies to attempt to limit its effects;
- ▷ § 3.2 discusses areas of activity for which insurance is obligatory, and other factors which drive firms to obtain coverage concerning industrial risks;
- ▷ § 3.3 discusses structural sources of instability in insurance markets, which can periodically make it difficult for certain categories of industrial activity to obtain coverage;
- ▷ § 3.4 briefly discusses the complementarity of insurance with regulation and liability law.

3.1 Controlling moral hazard

The “moral hazard” problem has been identified by insurers since the 1850s.

The moral hazard problem



In economic theory, the presence of incentives for insured people or companies to act in ways that incur costs that they do not have to bear. For example, a person with insurance against automobile theft may be less cautious about locking their car, because the negative consequences of vehicle theft are now (partially) the responsibility of the insurance company. Similarly, the provision of publicly subsidized flood insurance encourages people to live in areas prone to flooding and can lead to socially inefficient decisions.

Insurers use three main classes of techniques to limit moral hazard for their clients:

- ▷ Ensuring that the insured have a financial incentive to avoid making a claim, using **deductibles** (the insured covers a certain fixed amount of any loss or damage, widely used for insurance of property damage), coinsurance (the insured pays a specified proportion of any claim, often on a graduated scale depending on the size of the loss, widely used in health insurance in the USA) or bonus systems for insured parties who make no claims.

The “bonus-malus” system for vehicle insurance

The bonus-malus mechanism is a simple technique which adjusts the premium paid by a customer according to his individual claim history. As implemented in France, the premium is the product of two factors: the “base premium” and the “bonus-malus coefficient” at the time of contract renewal. The base premium is computed at the beginning of the relationship. It can be defined freely, but can only depend on observables⁵⁵ and must be uniform over clients who have the same characteristics; it cannot be modified during the relationship unless some observable characteristic changes. The bonus-malus coefficient is multiplied by 0.95 each year without a claim, and by 1.25 for each accident where the insured party is fully or partly responsible. If one changes insurer, the bonus-malus coefficient will be transported to the new policy.

- ▷ Encouraging or requiring (via the use of **differentiated premiums**⁵⁶) the insured to implement risk-reduction measures or follow certain technical standards. (In this way, insurers play a role similar to the Pigouvian taxes described in § 1.1.1, but are strategically well-placed to collect information on firms’ risk reduction efforts⁵⁷.)

⁵⁵ Attributes of the driver and vehicle which the insurer may take into account, such as the power of the engine or the age of the driver, but not the driver’s religion.

⁵⁶ Insurers charge lower premiums to more careful policyholders, who can demonstrate that they take effective measures to reduce the insured risks. They tend to present firms with a **menu of safety options**, making explicit the link between safety investment and reduction in the premium.

⁵⁷ A series of case studies illustrating the role played by insurers in reducing the impact of flood and earthquake hazards, compiled by the Geneva Association, is described in a report *Insurers’ contributions to disaster reduction – a series of case studies*, published in May 2013, available at https://www.genevaassociation.org/media/607750/ga-2013-geneva_report-7.pdf.

- ▷ **Converting standards into rules:** through their contractual arrangements and thanks to their accumulated expertise in the prevention or mitigation of different types of risks, insurers are able to transform legal standards (which tend to be expressed in terms of principles, and are open to interpretation) into concrete requirements for various hazard categories and industrial sectors [Ben-Shahar and Logue 2012].

Role of the insurance industry in the prevention of fire risk

The insurance industry has led the development of the numerous codes and standards which govern fire prevention and building fire codes. For instance, the U.S. National Fire Protection Association⁵⁸, established by the insurance industry, has long developed standards for risk prevention which are used worldwide, in particular concerning sprinkler systems.

Insurers have a number of reasons to push their clients to implement risk-reduction measures [Ben-Shahar and Logue 2012]:

- ▷ Insurers who can identify efficient risk-reduction measures (whose benefit in reducing claims is greater than their cost to the client) can attract clients by proposing lower premiums than competing insurance firms. (Indeed, even if there is little competition between insurers, decreasing risk decreases premiums, which — assuming that insurance is not a legal requirement — increases the size of the insurance market.)
- ▷ Once the insurance contract has been signed, any loss by the client leads to a loss for the insurer.

Insurers are able to identify efficient risk-reduction measures due to their expertise in **collecting and analyzing large amounts of data** with respect to risk⁵⁹. Other factors allowing them to reduce the impact of moral hazard are:

actuarial expertise

- ▷ their ability to employ experts in certain areas where their clients may not be able to justify the cost of maintaining internal expertise;
- ▷ use of this expertise to educate their clients in risk management and provide training and guidance documents;
- ▷ onsite and documentary audits, and participation in accident and incident analysis.

There is insufficient empirical evidence to determine whether these positive effects of insurance companies on the effectiveness of firms' risk control counterbalances the detrimental effect of moral hazard.

3.2 Factors increasing insurance coverage

Some areas of activity are obliged, by national law or international treaties, to obtain insurance covering impact to third parties:

- ▷ International conventions in the **nuclear power industry**⁶⁰ require the operator to maintain insurance or other financial security for an amount corresponding to his third party liability⁶¹. These conventions provide for strict liability (allowing victims to obtain

⁵⁸ NFPA, nfpa.org.

⁵⁹ Indeed, an essential part of an insurer's activity is the assembly of large actuarial databases used to classify and price risks in the underwriting process.

⁶⁰ Including the IAEA's Vienna Convention on Civil Liability for Nuclear Damage, the OECD's Paris Convention on Third Party Liability in the Field of Nuclear Energy, and the Price Anderson Act in the USA. For an overview of current debate on the topic, consult the proceedings of the 2013 OECD Nuclear Energy Agency workshop on *Nuclear damages, liability issues and compensation schemes*, available online at <https://www.oecd-nea.org/ndd/workshops/nuclearcomp/presentations/>.

⁶¹ Note however that the operator's liability is capped at a level which is generally accepted to be far below the real level of damage generated by a major nuclear accident. The state is the insurer of last resort (the cost of nuclear accidents is socialized). In the USA, the value of the government insurance subsidy ("congressional liability") has slowly decreased from roughly 66 million USD per reactor-year in the infancy of the nuclear power industry (when the federal government wished to encourage electric utilities to produce nuclear power) to roughly 1M USD today [Dubin and Rothwell 1990; USCBO 2008].

rapid compensation) which is exclusive to the nuclear operator (who cannot attempt to share liability with suppliers and contractors, again facilitating rapid compensation of victims). It is worth noting that more than half of nuclear plants in operation or under construction (and potentially impacting more than two thirds of the world's population) are not covered by an international nuclear liability convention which is in force⁶².

- ▷ Air carriers in certain countries have mandatory accident liability insurance coverage, which is a function of the number of passengers transported and the take-off mass of the aircraft⁶³.
- ▷ The International Convention on Civil Liability for Oil Pollution Damage is an international maritime treaty concerning **oil tankers**, and requires shipowners to maintain “insurance or other financial security” sufficient to cover the maximum liability for one oil spill.
- ▷ In many countries, employers are required to take out insurance for the impact of industrial accidents and occupational diseases on their employees.
- ▷ Individuals are generally required to obtain third party insurance when they drive a motor vehicle on public roads.

In industry sectors where liability insurance is not legally mandated, a number of trends in the legal environment have led to widespread adoption of liability coverage:

- ▷ In the USA since the 1990s, a search for “deep pockets” to cover the large cost of government-mandated environmental cleanups led judges, in a number of cases, to make banks liable for the environmental impact of their borrowers. In response, banks have increasingly demanded liability insurance as a condition of financing (or, with the “bancassurance” trend towards integration of the insurance and banking sectors, insured their clients themselves), creating in effect a mandatory insurance situation for borrowers engaged in industrial activities which may impact the environment [Richardson 2002; Hooley 2001].
- ▷ **Corporate governance laws:** if a firm suffers a major loss which is uninsured, the directors and top officials of the firm are personally vulnerable to shareholder lawsuits for failing their responsibilities to protect corporate assets⁶⁴.

These obligations or incentives to obtain insurance coverage means that potential victims are more likely to receive compensation in case an accident occurs.

3.3 Structural sources of instability in insurance markets

The insurance industry is vulnerable to shocks and uncertainties, because the supply of capital is relatively inflexible (due to capital adequacy standards that require a certain ratio of premiums to equity) whereas the demand (due to unexpected sources of claims or to unforeseen changes in liability law) is variable. Furthermore, insurers invest the proceeds that they receive from their clients in the financial markets⁶⁵; the return that they obtain from these money management activities influences the policies they propose (in terms of availability and cost of coverage). The underwriting market thus tends to be cyclical, with periods where coverage is easily available at falling prices followed by periods where policies become more expensive. During the 1980s, for instance, unexpected exposure to liability claims for asbestos and hazardous waste, combined with a drop in interest rates, led to the

⁶² Presentation *Nuclear risks: are they insurable? Are they insured?* by J. Schwartz, OECD Nuclear Energy Agency, 2011 conference on Nuclear Risk and Public Decision-Making.

⁶³ For instance, EC regulation n°785/2004 on insurance requirements for air carriers and aircraft operators imposes a minimum insurance coverage of 250 000 special drawing rights (around 300 000€ at the time of writing); FAA regulations require companies operating in the USA to carry insurance of at least 300 000 USD per passenger. Note that this is significantly lower than typical compensation payouts to the families of victims of air accidents (around 1 M€).

⁶⁴ Directors may however have acquired directors' and officers' liability insurance, which reduces their incentive to adopt a prudent attitude.

⁶⁵ The size of these investments is huge: the Amsterdam Circle of Chief Economists (ACCE) estimates that the total share of insurance assets is approximately 11% of all assets worldwide.

near collapse of certain insurance companies. Insurers reacted by dropping certain categories of “high-risk” coverage, which led to the uninsurability of some companies’ activities (and to the possibility of potential victims not receiving compensation for injuries) [Baram 1988].

The Australian insurance crisis of the late 1990s

Two major Australian insurance companies collapsed in the 1990s, and insurance premiums became exorbitantly expensive or cover became unavailable. The crisis had an adverse effect on community life, with the cancellation of community festivals, sporting events, music concerts and theatre performances. One of the factors identified by a government inquiry as contributing to the crisis was unpredictability in the interpretation of the law of negligence, with a widely held view that it had become too easy for plaintiffs to obtain significant damages in personal injury cases, in particular in claims against local government bodies.

Empirical observations suggest that this instability can decrease the positive impact of insurers’ risk prevention activities, since commercial considerations may override risk considerations when insurers price their coverage.

Insurers and reinsurers must also account for the destabilizing effect of the **adverse selection** process: firms which are exposed to higher risk levels will tend to buy more insurance coverage than those with low risks. Insurance companies may be unable to adapt insurance premiums to the level of risk⁶⁶, either because of **asymmetry of information** (firms will generally have better information than their insurer on the level of risk, in particular in technological industries) or due to legislation which prevents insurers from using certain criteria to determine the insurance premium⁶⁷. This can lead to firms with low-risk activities deciding that it is cheaper to **self-insure**, meaning that only high-risk firms remain insured, leading insurers to raise premiums, in a spiral which tightens until insurance firms withdraw coverage completely⁶⁸.

adverse selection

A further threat to the stability of insurance markets is posed by correlated or **systemic risks**, in which a large proportion of an insurer’s clients are affected by a negative event, leading to claims which can overwhelm the insurer’s financial capacity. The best-known systemic risk is that affecting modern financial markets, but other threats such as large-scale natural disasters (earthquakes, flooding) and terrorist attacks⁶⁹ raise the same issues [Kunreuther and Pauly 2009].

3.4 Complementarity with regulation and liability law

Over the past decade, insurance has become (in particular in North America) an increasingly important form of governance beyond the state [Barry et al. 2003], and plays a significant institutional role in the “risk society”⁷⁰ and (the insurance industry shares similar goals to the state, employs similar methodologies and is subject to many of the same social forces). By providing a framework for communicating to firms the costs of environmental risks, and

⁶⁶ In theory, a firm exposed to a higher level of risk should naturally pay a higher premium for insurance coverage against that risk.

⁶⁷ For example, in many countries, health insurers are not allowed to use pre-existing medical conditions to determine insurance rates for their clients.

⁶⁸ Note however that empirical observations suggest the existence of a negative correlation between the willingness to purchase insurance (which is related to one’s *risk aversion*) and the level of risk to which one is exposed. If risk aversion is higher among lower risk customers, adverse selection can be reduced [de Meza and Webb 2001].

⁶⁹ The 2001 terrorist attacks on the World Trade Center in New York led to damages estimated at around 80 billion USD, of which approximately 35 billion USD was insured (Wharton Risk Center), making 2001 the most costly year in the history of insurance and reinsurance up to that point. This catastrophe illustrates the high correlation of risk between different lines of insurance coverage, since the attacks affected property, caused business interruption, led to worker’s compensation claims, life insurance claims, disability claims and general liability insurance claims.

⁷⁰ The term “risk society”, coined by sociologists Anthony Giddens and Ulrich Beck, refers to a society which is increasingly occupied with debating, preventing, and managing risks that it has itself produced. It generates ubiquitous “manufactured” risks, and is partially structured by the level of exposure to these new risks (society being organized around the distribution of “bads” rather than that of “goods”). Scientific and technological development are the subject of distrust caused by losses of control (modernization becomes “reflexive” when citizens question its system of organized irresponsibility).

offering incentives to take care, it can be seen as a form of “surrogate regulation”, embodying the link between the “invisible hand”⁷¹ of private liability and the “visible hand” of regulation.

⁷¹ The *invisible hand of the market* is a metaphor conceived by the economist Adam Smith to describe the self-regulating behavior of the marketplace: individuals' attempts to maximize their own gains in a free market may benefit society even if each individual is not pushed by benevolent intentions.

Sources of motivation to take care

This chapter discusses the various sources of motivation which encourage firms and individuals to take care to avoid harm (from financial self-interest to moral duty). It also sheds some light on the effect of different policy instruments discussed in previous chapters on these sources of motivation to avoid harm, and (in § 4.2) evidence of interaction effects between these sources of motivation.

4.1 Sources of motivation to avoid harm

Firms, individuals making decisions on behalf of firms, and individuals in their daily activities, have a number of sources of motivation to take care and avoid harm to others or to the environment [Parker 2000; Winter and May 2001; Amodu 2008]:

- ▷ **Moral obligations** such as duty to follow social norms⁷² or “be a good citizen” (also called “other-regarding preferences” by economists⁷³). Socio-legal and business ethics research indicates that in democratic societies with a strong rule of law tradition, most business managers have internalized (or agree with) the social norms that underpin many regulatory rules. Such social norms include “an individual should not act in a manner that creates a foreseeable risk of serious harm to health and safety or irreversible harm to vital environmental features”. Research in institutional theory [Oliver 1991] indicates that organizations’ survival depends on their ability to conform to social norms of acceptable behaviour.

Professional **codes of ethics** and codes of practice are used by certain risk-related professions to attempt to codify moral obligations in an operational form [Davis 2002]. For instance, healthcare professionals take the Hippocratic Oath or modern variants such as the Declaration of Geneva, covering issues such as the primacy of the patient’s health (“above all, do no harm”) and medical secrecy; lawyers are required to uphold principles including the primacy of their clients’ interests, fairness towards the opposing party and confidentiality of information; engineers have a duty to “hold paramount the safety, health and welfare of the public” and “issue public statements only in an objective and truthful manner”⁷⁴. However, there is a risk of this reductionist approach to moral obligations leading to a checklist attitude to resolving dilemmas, with reactions such as “as long as it’s not illegal, it’s OK”.

- ▷ **Financial self-interest of a firm:** accidents can generate significant direct and indirect costs for a firm: material damage and lost production, damages awarded in case of liability

business case for
safety investment

⁷² In social psychology and sociology, a *social norm* is a general rule of voluntary behaviour. Examples are “treat others as they treat you” and facing the front in a crowded elevator.

⁷³ Classical economics has developed models of individual decision-making based on the assumption that people are self-interested, that their decisions are based only on their own preferences. Addressing this weakness in the models of determinants of human behaviour, a strand of research in behavioural economics over the past 20 years has investigated the role of *other-regarding preferences* in social interactions, finding evidence that a substantial percentage of people are strongly motivated by concerns for the well-being of others, for fairness (inequality aversion) and for reciprocity [Fehr and Schmidt 2006].

⁷⁴ These phrases are extracts from the “Fundamental Canons” section of the code of ethics drafted by the US Accreditation Board of Engineering and Technology.

suits, increases in the price of insurance coverage after an accident, and extra regulation (with an associated increase in operating costs) triggered by a large accident⁷⁵. Firms may also be fined or obliged to halt their activity if they do not comply with regulation (the effect of such fines is debated by economists and legal scholars, with some arguing that firms' compliance with environmental regulation is higher than that which could be predicted by the low probability of fines given the low level of enforcement and low level of fines compared with cost of compliance [Harrington 1988], and others arguing that major violations are detected and lead to credible sanctions [Nyborg and Telle 2006]). They may be obliged to follow certain health and safety standards as a result of contractual obligations or **supply-chain pressure**⁷⁶. There is some evidence [Decker 2003] that firms convicted for environmental damage later have more difficulties in obtaining permits to operate.

_____ The Porter Hypothesis: regulation as a trigger for improved competitiveness _____

DEFINITION

A controversial hypothesis raised by economist Michael Porter suggests that certain forms of environmental regulation⁷⁷ trigger innovations within firms, which not only lower the cost of meeting the required standards, but have an overall positive effect on competitiveness in the medium term [Porter and van der Linde 1995].

A number of reasons are given for this possible effect:

- pollution can be seen as inefficient use of resources, and environmental regulation can help companies to identify probable resource inefficiencies and potential technological improvements which can improve the efficiency of resource use;
- regulation focused on the collection and reporting of information can raise awareness of problems within firms;
- regulation reduces the uncertainty that investments to address the environment will be valuable, possibly overcoming organizational inertia or resistance to change from managers;
- regulation creates pressure that motivates innovation and progress.

The Porter hypothesis, which assumes that firms sometimes ignore profitable opportunities, goes against a standard assumption that firms are profit-maximizing. It remains a subject of debate more than twenty years later (see [Ambec et al. 2011] for an overview of developments since the original article and unresolved questions).

Studies of enforcement programs and their deterrent effect indicate that four factors are critical to their effectiveness:

- the likelihood of violations being detected is high
- the response to violations is rapid and predictable
- the response includes sanction
- the three above factors are perceived to be present by the regulated community

- ▷ **Reputational effect on individual decision-makers.** Individuals care about their reputation in social interaction, and violating social norms can lead to **social stigma** [Faure and Escresa 2011] (shame, embarrassment). The “naming and shaming” approach to rulemaking and – more generally – the restorative theory of justice build upon this effect.

⁷⁵ As an illustration of this effect, the spill-related expenses to BP of the Deepwater Horizon accident in the Gulf of Mexico in 2010 were estimated at 37.2 billion USD. The stock price of BP in early April 2010 was 60 USD, and dropped to 29 USD shortly after the accident, a loss of market value of 105 billion USD.

⁷⁶ For example, the chemicals and refining sectors in France require subcontracting firms to implement a safety management certification process called MASE. Certification of firms is based on external inspections by accredited organizations. A similar certification system, called VCA (for «Veiligheid-, gezondheid- en milieu- Checklist Aannemers» in Dutch), exists in the Netherlands and Belgium.

⁷⁷ The authors write “If environmental standards are to foster the innovation offsets that arise from new technologies and approaches to production, they should adhere to three principles. First, they must create the maximum opportunity for innovation, leaving the approach to innovation to industry and not the standard-setting agency. Second, regulations should foster continuous improvement, rather than locking in any particular technology. Third, the regulatory process should leave as little room as possible for uncertainty at every stage.”

Researchers argue that negative publicity has a strong impact on corporate executives, because people in high status occupations have a good deal to lose in social standing and respectability by having their reputations tarnished [Braithwaite 1989].

- ▷ **Fear of criminal prosecution by the government**, targeting individual decision-makers: accidents (in particular those which cause the death of employees) may, in some legal systems⁷⁸, lead to jail sentences for directors of firms, in particular when the firm is later found not to have complied with regulations. [Vandenbergh 2003] reviews literature showing a measurable effect of legal sanctions (fines, imprisonment, *etc.*) on the behaviour of actors declaring no commitment to social norms.
- ▷ **Reputational effect on a firm**: large accidents which are reported in the media can damage a firm's reputation or prestige, and may lead to the firm being alienated from its host community⁷⁹ and having trouble recruiting desirable employees. However, empirical evidence suggests that the financial value of the firm is mostly unaffected by the reputational effects of environmental violations.

trial by media

Consequence of environmental violations on firms' share price

[Karpoff et al. 2005] examined the consequences of 478 environmental violations by publicly traded companies between 1980 and 2000. They found that although the companies' share prices dropped measurably (by approximately 2%) when the companies were charged with such violations, the decline is fully attributable to the direct legal penalties and the remediation and compliance costs imposed on them by regulators. Because the decrease in firms' market value was not greater than the legal penalties imposed, the researchers conclude that reputational effects had a negligible impact on financial value.

As discussed in § 1.1.2, information regulation requires disclosure of the environmental impact of firms' activities, and in some cases has an impact on their market value. Reputational considerations are sometimes taken into account in firms' corporate social responsibility (CSR) programmes, though the concrete effects on level of care are debated⁸⁰.

Stock-market impact of Corporate Social Responsibility ratings

In an analysis of announcements concerning environmental CSR⁸¹ reports for U.S. publicly-traded companies from 1980 to 2000, [Flammer 2013] finds that companies reported to behave responsibly towards the environment experience a significant stock price increase, whereas firms that behave irresponsibly face a significant stock price decrease. The authors find that this external pressure on firms to behave in a responsible manner towards the environment has increased significantly during the past three decades.

[Albuquerque et al. 2014] model firms' CSR activities as mechanism to acquire customer loyalty, which leads to higher profit margins, to lower exposure to volatile economic conditions (systematic risk) and to higher market value⁸². Controlling for known determinants of systematic risk, the authors find, through an econometric analysis of the stock-market value of 2600 publicly traded US companies over the period 2003–2011, that non-corporate governance related CSR activities (as rated by an external agency) are associated with lower systematic risk and with higher stock-market value.

⁷⁸ In the US, criminal prosecution is generally limited to cases where an individual decision-maker's non-compliance with regulations is intentional or shown to be due to conscious disregard of regulation and the foreseeable harmful consequences. In the EU, mere violation of a statute or regulation is in many cases sufficient to trigger criminal prosecution. See [Faure and Heine 2005, 2000] for a detailed analysis of practices concerning criminal enforcement of environmental law in the EU.

⁷⁹ For instance, the Exxon Valdez oil spill in 1989 so angered many consumers that it triggered boycotts of Exxon's retail outlets.

⁸⁰ The rise in the number of "reputation risk management professionals" and the growth of the number of communications professionals who specialize in "litigation public relations" suggests that firms have some willingness to pay to address this issue [Yeung 2002], but does not speak to the impact of level of care.

Although it is difficult to generalize on such a complex issue, empirical research indicates that the “principled” view of regulation (moral obligations to follow social norms, to do one’s civic duty) is one of the most commonly cited reasons for compliance with safety and environmental legislation (see for instance the UK Health and Safety Executive report [Wright 1998] for results concerning firms in the UK, and [KPMG 2001] for results concerning firms in Australia).

The relative weight of these different effects will vary depending on the cultural norms within the regulated community, the economic situation of the actors involved and possibly on the values of individual decision-makers. Though few empirical studies have attempted to quantify their relative importance, [KPMG 2001] presents the results of a quantitative survey targeting more than 1000 CEOs, owners and supervisors in Australian firms in different industry sectors, aiming to identify key management motivators in health and safety. Exploratory Factor Analysis⁸³ was used on questions from a previous survey on motivations⁸⁴. Analysis of survey results identified two categories (factors) underlying both CEOs’ and supervisors’ responses. The two factors, questionnaire items and their corresponding co-relationships (factor loadings) within each category are presented in figure 4.1. In both graphs, factor 1 from the factor analysis is displayed with round markings (blue) and factor 2 with square markings (in red).

The results indicate that the most significant motivating items for CEOs are the effects of fines or prosecution for violations of safety regulations, followed by adherence to codes of practice, government requirements and company policy. For supervisors, the main motivating items declared are industry association guidelines, supply-chain pressure, advice given by government safety inspectors and the costs of legal defence if prosecuted for a violation. Many other items are rated as significant, however, with union pressure being the only item not cited as relevant. At the period concerned by this study, directors of firms in Australia were rarely prosecuted for health and safety issues, and liability for safety breaches was not strict (*cf.* § 2.1).

⁸¹ While the original focus of CSR was on “social” responsibility (such as paying fair wages to employees and participating in community renewal programs), more recently environmental responsibility (reduction of CO₂ emissions, use of renewable energy sources, *etc.*) issues are also reported.

⁸² This study indicates that CSR activities should not be seen as advertising, since firms with low brand capital investment rates (low advertising expenditures) have been found to have higher average stock returns than firms with high brand capital investment rates [Belo et al. 2014], which is the opposite of the effect of CSR investment.

⁸³ Exploratory Factor Analysis is an advanced multivariate statistical procedure which attempts to bring intercorrelated variables together under more general, underlying variables (called factors). It can be used to group a series of survey questions (some of which will be correlated) into latent categories, based upon the magnitude with which survey respondents endorse each survey item.

⁸⁴ The report is “Identifying effective motivational pathways for CEOs and supervisors: a report of a survey of CEOs, owners, directors and floor supervisors in Australian enterprises”, Campbell Research and Consulting, 2000. Instruction: “Other employers / supervisors have identified a range of things that influence their interest in Health and Safety. I am going to read out a number of these statements and would like you to tell me how important each of them is FOR YOU.” Question: “Can you tell me how important <specified item> is in influencing YOUR approach to health and safety?”.



Figure 4.1 – Motivational factors and the importance of specific items relating to influences upon CEOs' (top) and supervisors' (bottom) approach to occupational health and safety (from quantitative survey data, adapted from [KPMG 2001] Appendix E)

4.2 Interaction effects between different sources of motivation

The interaction between the different policy instruments described in this document (regulation, liability law and insurance), their consequences for firms and individuals involved in decision-making, and the sources of motivation to take care described above, are complex and involve many feedback loops. Figure 4.2 is an attempt by the author to present the main effects and interactions between them.

[Ayres and Braithwaite 1992] state that

“ A [compliance] strategy based mostly on punishment will undermine the good will of actors when they are motivated by responsibility. Punishment is expensive; persuasion is cheap. A strategy based mostly on punishment wastes resources on litigation that would be better spent on monitoring and persuasion. A strategy based mostly on punishment fosters an organized business subculture of resistance to regulation wherein methods of legal resistance and counterattack are incorporated in industry socialisation.

There is some evidence that these sources of motivation to take care are not independent, and in particular that they are not additive. **Motivation crowding theory**, resulting from research at the intersection of behavioural economics and social psychology, suggests that extrinsic motivators to take care, such as monetary incentives or punishments, can – under

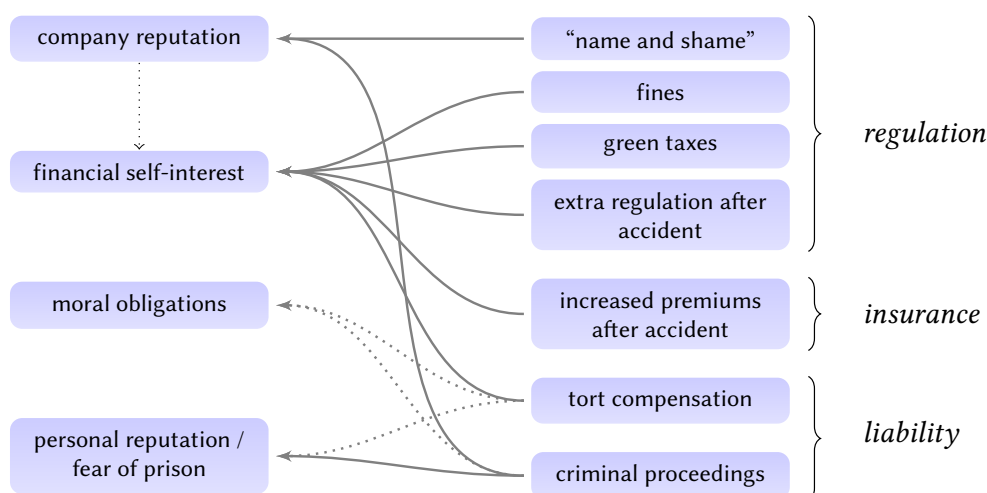


Figure 4.2 – Foreseeable post-accident consequences of various policy instruments (right) on different sources of motivation to take care (left)

certain conditions – undermine intrinsic motivation⁸⁵ [Frey 1992; Frey and Jegen 2001; Fehr and Rockenbach 2003]. For instance, regulation imposing fines for environmental damages has been shown in some cases to increase the level of prohibited behaviour, as if people react to the external motivation by reducing their effort to fulfill a certain duty. The fine is said to “crowd out” the intrinsic social disincentive to pollute, by associating the violation with a more psychologically acceptable cost.

Incentives that decrease intrinsic motivation to care for others

Concerning facility siting and NIMBY⁸⁶: in a survey of citizens in Swiss cantons in which the government was considering locating a nuclear waste repository, [Frey and Oberholzer-Gee 1997] found that the proportion of people supporting siting of the facility in their community fell by half when public compensation was offered (the rate of acceptance fell from 51% to 25%, and the level of compensation had no effect on people’s degree of acceptance). A similar effect concerning the effect of tax rebates on citizens’ willingness to accept the location of a nuclear waste facility was observed in Nevada [Kunreuther and Easterling 1990].

An experiment involving people’s willingness to restrict their collection of firewood in order to reduce the adverse environmental impact of their activity found that the implementation of regulation with limited levels of enforcement changed individuals’ behaviour to be more self-interested, “crowding out” other-regarding tendencies [Cárdenas et al. 2000]. The research suggests that policies which are intended to improve environmental quality, if weakly enforced, may do more harm than good, because their existence triggers the disappearance of socially desirable behaviours.

A comparison of the blood donor systems in the UK and USA (the former being based on voluntary donations, the latter on paid donations) [Titmuss 1970] showed that paying donors has a negative effect on their willingness to give blood. Replication of the work (which was the subject of considerable criticism by neoclassical economists) [Mellström and Johannesson 2008] has shown that the “crowding out” effect mostly disappears if the payment is replaced by a donation to charity⁸⁷.

A day-care center in Israel tried to impose fines on parents who collected their children late, forcing teaching staff to stay after closing hours. After an initial learning period, the number of parents arriving late increased significantly. One can imagine that imposing a monetary penalty emphasizes the payment-for-service aspect of the relationship between parents and teachers, “crowding out” their intrinsic motivation to respect the schedule, with the feeling that teachers are now paid for the inconvenience of staying later [Gneezy and Rustichini 2000].

⁸⁵ Intrinsic motivation is the individual’s desire to perform the task for its own sake, including factors such as morality, duty, legitimacy, fairness, loyalty and identity, whereas extrinsic motivation is linked to actions that are driven by external commands or incentives.

Further evidence of the complex relationships between intrinsic and extrinsic sources of motivation arises from the gap between what people believe motivates them *versus* what they believe motivates others. Research in psychology indicating that there is a consistent gap between the likelihood of attributing intrinsic motivation to one's own behavior and that of others. Concerning the impact of moral obligations, for instance, many studies indicate that people tend to see themselves as being more moral than others, and believe that they are more likely to engage in selfless and generous behaviour than others (this is called the "holier than thou" effect, or "I am moral, but you are deterred") [Sanderson and Darley 2002]. This misperception of others' motivations can undermine people's incentives to adopt socially desirable behaviour such as averting harm to others, due to the "sucker effect"⁸⁸.

From a legal policy viewpoint, there is evidence that the **framing** of incentives has a strong impact on the way in which they affect intrinsic motivation [Feldman 2011]. For instance, though a classical economic approach would consider fines and prices to be equivalent, tradeable emission rights have been shown to have a stronger crowding-out effect than Pigouvian taxes, and monetary incentives framed as a price reduction lead to a greater effect than when they are framed as a bonus [Fehr and Gächter 2002]. The effect of incentives is not a linear function of their magnitude: intermediate levels of incentives are the most likely to curb value-driven behavior (crowding-out effects).

⁸⁶ NIMBY: Not In My Back Yard, is a term used to describe socially desirable projects (their social benefits are larger than their social costs) that have a broad distribution of benefits but are difficult to implement because of local opposition.

⁸⁷ This work is not unrelated to the development of a large body of research on economic analysis of law which has been briefly discussed in previous chapters. See also [Havighurst 2009] for an analysis of product liability issues raised by the research.

⁸⁸ The sucker effect is a form of social loafing, leading some individuals to reduce their level of effort when working on a task in a group setting because they fear being seen as a "sucker" [Schnake 1991].

Conclusion

This document has pointed to various limitations to the effectiveness of different forms of regulation, liability regimes and insurance. It has also highlighted the multiple ways in which these instruments can affect firms' and peoples' level of precaution. The tendency in most western democracies is to use a **combination of policy instruments** in order to ensure social control over hazardous industrial activities, in the hope that the resulting combination of incentives and obligations provide adequate levels of social control of hazardous activities. Several branches of research have contributed to the analysis of the comparative performance of different combinations of policy instruments⁸⁹:

- ▷ regulatory compliance theory [Hutter 2001] and the associated empirical literature analyses the extent to which the regulated community complies with regulatory standards and its reasons for doing so;
- ▷ policy design and institutional design in political science analyse the most effective way of structuring the institutions which uphold public policy and implementing their goals [Wildavsky 1988];
- ▷ economic analysis of law applies the tools of microeconomic theory, econometrics and behavioural economics to the analysis of legal rules and institutions, primarily from an individual decision-making perspective [Kaplow and Shavell 1999].

We conclude this document by a brief analysis of the decision made in most western democracies to use multiple, overlapping policy instruments.

As illustrated in this document, regulation in its different forms, liability law and insurance mechanisms are all affected by various limitations to their effectiveness as forms of social control of hazardous industrial activity, and motivations to take care (and comply with regulation) are various and complex [May 2005b,a; Hutter 2001; Gezelius 2002; Ayres and Braithwaite 1992]. In the absence of a single optimal instrument, the tendency in most countries is to use **multiple, overlapping policy instruments** [Gravelle 1987; Gunningham and Grabosky 1998]. [Ayres and Braithwaite 1992] call this "responsive regulation", which acknowledges that different organizations, different industry sectors and different hazards will be conducive to different degrees and forms of regulation, and leads the state to search for an **optimal mix of instruments** for various risks and industrial sectors. In practice, however, the balance between different forms of regulation, insurance and liability regimes is driven as much by political calculations (in particular, in the aftermath of large accidents, by the public pressure to be seen to be enforcing change) and pressure from lobbies as by evidence of the degree of effectiveness [Haines 2011]. A few examples of risks whose social controls deviate from general principles described in this document include:

- ▷ Flood and fire risks in many countries are still handled by government compensation of victims associated with zoning laws, whereas market classification of risk via obligatory private insurance would likely be sufficient to resolve many problems.

⁸⁹ Note however that the largest part of this literature concerns compliance with environmental laws, with less focus on industrial safety and occupational safety. An overview of research on compliance with environmental laws is available at <http://www.epa.gov/compliance/resources/reports/compliance/research/>.

- ▷ Nuclear power still benefits from a state subsidy in most countries, in the form of liability caps for operators (see the discussion on page 27). This leads to unfair competition with other forms of energy production.
- ▷ Climate change risks are – to a first approximation – subject to no effective social controls.
- ▷ The risks of maritime pollution in international waters from oil tankers are subject to little regulation, liability rules and insurance requirements.

A number of case studies of the complementarity between liability and regulation were presented during the NeTWork'2012 workshop, and published in a special issue of the *Journal of Risk Research* (volume 17, issue 6, 2014):

- ▷ An analysis of 3000 cases in France's highest civil court concerning environmental accidents (between 1956 and 2010) [Bentata and Faure 2012; Bentata 2014]⁹⁰ suggests that a mutually beneficial division of labour between judges and regulators has been established over time, with different approaches to assessing compliance with the duty of care. Regulators seem to focus on monitoring technical compliance with the law and standards. Judges examine (when an accident occurs) the role of managers in allocating resources to safety management (evidence of negligence, which is more difficult to assess before the accident).
- ▷ In the fast-moving area of nanotechnology development and production, regulators have been slow to implement prescriptive regulation, and few companies have adopted “soft law” risk management programmes. Liability law (fear of lawsuits) and insurance (providing incentives for implementing risk controls) are potential drivers for participation in such programmes [Marchant 2014]⁹¹.
- ▷ The area of medical device development (pacemakers, breast implants...) is also fast-moving with high risks and benefits. The regulatory system is based on a certification process for devices, but product liability and class action suits also play a role in the social control of the risk-benefit balance [de Mol 2014]⁹².

These overlapping instruments present a number of advantages and disadvantages:

- ▷ On the positive side, overlap leads to better “coverage” of risks, since they lead to diversity in incentive structure (see § 4.1), and the weaknesses of each instrument can be compensated by the presence of complementary instruments. Since the instruments act primarily on different incentive mechanisms, they are unlikely to add together in a manner which would over-deter socially beneficial hazardous industrial activities.
- ▷ The negative aspects of overlap are a risk of inconsistency (different instruments pushing actors in different directions), for which there is little empirical evidence. The most salient issue seems to be the fact that the administrative cost and complexity of each overlapping policy instrument are cumulative, with the duplication creating inefficiencies.

Practice in most western countries suggests that the greater effectiveness attained by the overlap is seen as overriding its greater costs.

⁹⁰ This study was presented during the NeTWork'2012 workshop by Pierre Bentata.

⁹¹ This study was presented during the NeTWork'2012 workshop by Gary Marchant.

⁹² This study was presented during the NeTWork'2012 workshop by Bastian de Mol.

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