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# Risk and Insurance Economics 25 Years After

by Henri Loubergé*

**Abstract**

The paper is written on the occasion of the 25th anniversary of the International Association for the Study of Insurance Economics, known as "The Geneva Association". It reviews the evolution of insurance economics, by first recalling the situation in 1973, then presenting the developments and new approaches which flourished since then. The paper argues that these developments were only possible because steady advances were made in the economics of risk and uncertainty and in financial theory. Insurance economics has grown in importance to become a central theme in modern economics, providing not only practical examples to illustrate new theories, but also inspiring new ideas of relevance for the general economy.

## 1. Introduction

When the International Association for the Study of Insurance Economics – "The Geneva Association" – started operations in 1973, the economics of risk and insurance was embryonic. Indeed, one of the main goals of the founding fathers of the Association was to promote the development of risk and insurance education in economics curricula, in order to widen and deepen the contacts between the insurance industry and its economic partners. To reach these goals, four actions were initiated:

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- the creation of the Ernst Meyer prizes and scholarships;
- the organization of annual meetings for insurance economists, which started in 1974, and which became later known as the seminars of the "European Group of Risk and Insurance Economists"[1];
- the creation of *The Geneva Papers on Risk and Insurance* (January 1976), which were intended to be an immediate vehicle for the dissemination of insurance research sponsored by the Association, and to become a future source of reference studies for the benefit of risk and insurance education;
- and the first survey on the teaching of risk and insurance economics in Europe (Loubergé, 1976), which was not only intended to provide a description of the existing situation, but also (and more fundamentally) a plea for a certain course of development in risk and insurance research.

The "interface philosophy", which was strongly asserted in the statements of goals of the Geneva Association (see, e.g., Barre, 1974)[2], implied that the development of risk and insurance education in general economics and management programs was more important – in a long term view – than the development of specialized insurance and/or risk management programs at the academic level. Specialized programs already existed in some countries (Germany, Austria, Switzerland and the USA). There was a clear need to extend them to other countries, but the most urgent task seemed to make economists aware of the growing importance of risk and uncertainty issues in the modern society. This would lead to the development of the economics of risk as a main foundation of general economic theory, and this would imply much wider interest for the institutions especially designed for the coverage of risks, i.e. insurance institutions. In other words, the primary goal was not to promote the education of future insurers and managers with an economic background[3]. The goals were rather to develop an understanding for risk and insurance issues among the future partners of the insurance industry, and to attract the attention to risk and insurance as a stimulating and important field for economic research.

As an illustration of this approach, the above-mentioned survey listed existing courses and programs under seven headings. These were :

1. Risk and society
2. Theory of risk and uncertainty
3. (Macro) Economics of risk and insurance
4. Financial institutions and markets (Money, banking and insurance)
5. Social policy / Social insurance
6. Insurance company management
7. (Corporate) Risk management

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[1] The first meeting was organized on the suggestion of the Geneva Association's president, Professor Raymond Barre. It gathered, in Geneva, nine professors of risk and insurance economics in European universities (R.L. Carter, G. Dickinson, D. Farny, M. Haller, E. Helten, D.C. Lambert, J.J. Rosa, L. Selleri, and J.L. Vila), and three representatives of The Geneva Association (R. Barre, O. Giarini, and H. Loubergé). In 1976, the third meeting gathered already some thirty participants.

[2] See also Giarini (1975) and Loubergé (1981).

[3] This was rather seen as the responsibility of the national insurance associations.

In contrast, a Huebner Foundation survey of risk and insurance instruction in American colleges and universities (1972) made a distinction between courses according to the branches of insurance (life, liability, property/casualty, etc.).

In the early seventies, some attempts to link insurance to general economic theory had already been made, but they were still scarce. The books written by Pfeffer (1956), Mahr (1964), Greene (1971) and Carter (1972), or the one edited by Hammond (1968), tried to bridge the gap. (Corporate) risk management started, at least in the United States, to be considered seriously as a branch of study – see Mehr and Hedges (1963) and Greene (1973) as early references. The main obstacle was obvious: traditional economic theory was based on the assumption of perfect knowledge – with some *ad hoc* departures from this assumption, as in the theory of imperfect competition or in keynesian macroeconomics. In order to witness an integration of risk and insurance issues into general economics, the theory of risk had to develop and to gain a position at the heart of economic theory. The foundations were already at hand: the von Neumann-Morgenstern (1947) and Savage (1954) theory of behaviour under uncertainty, the Friedman-Savage (1948) application to risk attitudes, Pratt's (1964) analysis of risk aversion, and the Arrow (1953) and Debreu (1959) model of general equilibrium under uncertainty. These approaches had already started to bring about a first revolution in the study of finance, with the Markowitz (1959) model of portfolio selection and the Sharpe (1964) – Lintner (1965) – Mossin (1966) model of equilibrium capital asset pricing (the CAPM). With the benefit of hindsight, we know now that they did provide the starting point for the accomplishment of one of The Geneva Association's long term objectives: the integration of risk and insurance research into the mainstream of economic theory.

The purpose of this paper is to remind the reader of the situation of insurance economics in 1973 (section 2), and to summarize its main development since then (section 3). A fourth section is devoted to the new approaches which emerged with the growing integration of insurance and finance. The fifth section concludes. Due to limitations in space and time, two important related topics were omitted from this survey: health economics and social security. In addition, life insurance is only partially covered in the fourth section. The discussion is mainly concentrated on risk and insurance economics issues as they relate to property-liability insurance.

## 2. Insurance economics in 1973

When the Geneva Association started operations in 1973, the economic theory of insurance had already begun to develop on the basis of five seminal papers: Borch (1962), Arrow (1963), Mossin (1968), Ehrlich and Becker (1972) and Joskow (1973)[4]. Following these papers, and more particularly the first two, a bunch of important papers were published. They were a signal that the elaboration of an economic theory of risk and insurance was under way.

### *2.1. Borch (1962)*

In his 1962 *Econometrica* paper "Equilibrium in reinsurance markets", Karl Borch showed how Arrow's (1953) model of general equilibrium under uncertainty could be

[4] Note that two of these six authors, Kenneth Arrow and Gary Becker, received later the highest distinction for economic research - the Nobel Prize in economics.

applied to the problem of risk-sharing among reinsurers. But generations of economists later learned that this insurance application had far-reaching implications for the general economy[5]. In 1953 Arrow had shown that financial markets provide an efficient tool to reach a Pareto-optimal allocation of risks in the economy. Nine years later, Borch's theorem[6] was showing how the mechanism could be organized in practice.

The main argument is the following: in a population of risk-averse individuals, only social risks matter. Individual risks do not really matter, because they can be diversified away using insurance markets (the reinsurance pool of Borch's paper). But social risks – those affecting the economy at large – cannot be diversified: they have to be shared among individuals. Borch's theorem on Pareto-optimal risk exchanges implies that the sharing rule is based on individual risk-tolerances (Wilson, 1968). Each individual (reinsurer) gets a share in the social risk (the reinsurance pool) in proportion to its absolute risk-tolerance, the inverse of absolute risk-aversion. If all individual utility functions belong to a certain class (later known as the HARA[7] class, and including the most widely used utility functions), the sharing rule is linear. The above-mentioned CAPM, for long the dominant paradigm in finance theory, represents only a special case of this general result.

In my view, Borch's paper provides the corner stone of insurance economics. It may be conveniently used to show how the insurance mechanism of risk-pooling is part of a more global financial mechanism of risk-allocation, and how a distinction may nevertheless be made between insurance institutions and other financial institutions[8]. For this reason, it may be used to clarify ideas on a hotly-debated issue: the links between finance and insurance (see section 4 below).

In the years until 1973, Borch's seminal contribution found its main insurance economics extensions in the papers by Arrow (1970) and Kihlstrom and Pauly (1971)[9]. Arrow (1970) explicitly defined insurance contracts as conditional claims – an exchange of money now against conditional money in the future. Kihlstrom and Pauly (1971) introduced information costs in the risk-sharing model: they argued that economies of scale in the treatment of information explain why insurance companies exist.

### *2.2. Arrow (1963)*

The article published in 1963 by Arrow in *The American Economic Review* under the title "Uncertainty and the Welfare Economics of Medical Care" represents the second point of departure for risk and insurance economics. This work may be credited with at least three contributions. Firstly, the article provided, for the first time, what has become

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[5] See Gollier (1992) for a review of the economic theory of risk exchanges, Drèze (1979) for an application to human capital, and Drèze (1990) for an application to securities *and* labor markets.

[6] Actually, Borch's theorem was already present in Borch (1960), but the latter article was primarily written for actuaries, whereas the 1962 *Econometrica* paper was addressed to economists.

[7] HARA = Hyperbolic Absolute Risk Aversion. As noted by Drèze (1990), the linearity of the sharing rule follows from the linearity of the absolute risk tolerance implied by hyperbolic absolute risk aversion.

[8] The question whether or not "institutions" are needed to allocate risks in the economy was tackled later in the finance literature.

[9] The applications of Borch's theorem in the actuarial literature are reviewed by Lemaire (1990).

now the most famous result in the theory of insurance demand: if the insurance premium is loaded, using a fixed-percentage loading above the actuarial value of the policy, then it is optimal for an expected utility maximizing insured to remain partially at risk, i.e. to purchase incomplete insurance coverage. More specifically, Arrow proved that full insurance coverage above a deductible is optimal in this case. Secondly, Arrow also proved that, when the insured and insurer are both risk-averse, Borch's theorem applies: the Pareto-optimal contract involves both a deductible and coinsurance of the risk above the deductible – a result later extended by Moffet (1979) and Raviv (1979). Thirdly, the paper was also seminal in the sense that it introduced asymmetric information into the picture. Arrow noted that transaction costs and risk aversion on the insurer's side were explanations for incomplete risk-transfer, but he also realized that moral hazard and adverse selection represented major obstacles for a smooth running of the insurance mechanism. By attracting the attention of economists to these problems, he paved the way to more focused work by Pauly (1968) and Spence and Zeckhauser (1971) – on moral hazard – and by Akerlof (1970), on adverse selection.

### *2.3. Mossin (1968)*

The paper by Jan Mossin, "Aspects of Rational Insurance Purchasing", published in 1968 in *The Journal of Political Economy*, is generally considered as the seminal paper on the theory of insurance demand – although some of Mossin's results were also implicit in Arrow (1963) and explicit in another paper on insurance demand published the same year, but earlier, in the same journal (Smith, 1968)[10]. Mossin's paper is mainly famous to have shown : 1) that partial insurance coverage is optimal for a risk-averse individual when the insurance premium is such that a positive proportional loading applies to the actuarial value of the policy[11]; and 2) that insurance is an inferior good if the individual has decreasing absolute risk aversion. It was later pointed out (see below) that these strong results are respectively based on the implicit assumptions that the individual faces only one risk, and that the amount at risk is fixed (unrelated to wealth or income).

### *2.4. Ehrlich and Becker (1972)*

In the modern theory of risk management, insurance is only seen as one of the tools available to manage risk. The whole set of tools may be decomposed into subsets according to the different steps of the risk management process. Insurance belongs to the set of risk-transfer tools and represents a very powerful financial mechanism to transfer risk to the market. Another subset corresponds to risk-prevention. Broadly, risk-prevention mechanisms may be classified under two headings: mechanisms intended to modify the probability of an event; and mechanisms intended to alter the consequences of an event. Ehrlich and Becker (1972) were the first to propose a rigorous economic analysis of risk prevention. They coined the terms *self-protection* and *self-insurance* to designate the two kinds of mechanisms and studied their relationship to "market insurance". For this reason, their paper may be seen as the first theoretical paper on risk management. Briefly, the paper provides three main results :

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[10] Optimal insurance coverage using a deductible was also analyzed by Pashigian, Schkade and Menefee (1966) and by Gould (1969).

[11] Incomplete insurance may be obtained using a deductible or coinsurance (or both).

1) In the absence of market insurance, a risk averter will engage into self- protection and self-insurance activities, but the optimal "investment" in these activities depends on their cost. As usual, marginal benefit (in terms of higher expected utility) has to be weighted against the marginal disutility brought about by additional costs, so that complete elimination of the risk is not optimal in general.
2) Self-insurance and market insurance are substitutes: an increase in the degree of protection provided by the insurer induces a rational risk averter to reduce his investment into activities (or behaviour) aimed at reducing the consequences of the insured event. Of course, this result is also of importance for the theory of moral hazard (see section 3), but Ehrlich and Becker did not assume asymmetric information.
3) Self-protection and market insurance may be complement or substitutes, depending on the sensitivity of the insurance premium to the effects of self protection. Thus, the insurer can give to the insured an incentive to engage into self-protection activities (which reduce the likelihood of a loss) by introducing a link between the premium rate and the observation of such activities. This result is also of importance for the theory of moral hazard, and more generally for agency theory (the theory of relationships between an agent and a principal).

### *2.5. Joskow (1973)*

The paper published by Paul Joskow in the *Bell Journal of Economics and Management Science* under the title "Cartels, Competition and Regulation in the Property-Liability Insurance Industry" represents the first successful attempt to submit the insurance sector to an economic evaluation. The paper assesses competition by analyzing market concentration and barriers to entry, it measures returns to scale, and discusses insurance distribution systems and rate regulation. By providing empirical results on these issues, it has provided a reference point for subsequent research on the sector. Briefly, Joskow found that the insurance industry was approximately competitive, that constant returns to scale could not be excluded, and that the direct writer system was more efficient than the independent agency system.

## 3. Developments

The five seminal contributions presented in the preceding section prepared the ground for numerous developments. These may be grouped under three main headings: the demand for insurance and protection, economic equilibrium under asymmetric information, and insurance market structure. It is striking to realize that many of these developments are not developments in insurance economics per se. They occurred within the wider domain of general economics, insurance providing in some cases an illustration of general results, and in other cases a stimulation to search for general results[12].

### *3.1. Optimal insurance and protection*

The observation of economic life shows that individuals generally do not insist to get partial coverage when they subscribe an insurance policy. As the insurance premiums are

[12] The survey of developments presented in this section draws largely on the excellent survey of insurance economics by Dionne and Harrington (1992).

generally loaded (at least to cover insurance costs), this is however the behaviour which would be expected from them, according to Mossin's (1968) results. Moreover, insurance does not seem to be empirically an inferior good. If it was, insurance companies would be flourishing in the poorer nations and would be classified among the declining industries in the richer nations of the world. This is, again, in contradiction with Mossin's analysis (given that absolute risk aversion is, indeed, empirically decreasing). One of the seminal papers at the roots of insurance economics has thus led to two paradoxes, and it is interesting to observe how theory was reconciled with factual observation.

The second paradox (insurance is an inferior good) did not stimulate much research effort. Some scholars tried to dig into the idea by exploring the conditions under which insurance would be not only an inferior good, but also a Giffen good[13]: see Hoy and Robson (1981), and Briys, Dionne and Eeckhoudt (1989). But the interest remained limited. There are probably two reasons for that. Firstly, following Arrow (1970), it was quickly recognized among economists that insurance is a financial claim. Thus it does not seem really appropriate to apply to insurance concepts which were derived to categorize consumption goods. Secondly, it has probably been noticed by most scholars that the condition under which Mossin's result obtains is not generally met in practice. Mossin assumes that the individual's wealth increases, but that the risky component of wealth remains unchanged. In reality, changes in wealth generally imply changes in the portion of wealth exposed to a risk of loss, and this is sufficient to resolve the paradox (see Chesney and Loubergé, 1986).

The first paradox (partial coverage is optimal) has stimulated much more research effort. It has first been noticed that the result is not robust to changes in the pricing assumptions[14]: for example, full insurance is optimal if the loading is a lump sum. Some researchers pointed out that the result was either reinforced, or did not hold, if the behavioral assumptions were modified: see Razin (1976) and Briys and Loubergé (1985), or the non-expected utility developments mentioned below. But the most interesting breakthrough came from enlarging the scope of the analysis. This was made in the early eighties by deriving the logical conclusion from the observation that insurance is a financial claim. It had been recognized for long (Markowitz, 1959) that the demand for financial assets should take place in a portfolio context, taking into consideration imperfect correlations across random asset returns. The same kind of reasoning was applied to insurance by Mayers and Smith (1983), Doherty and Schlesinger (1983a)(1983b), Turnbull (1983) and Doherty (1984). In this portfolio approach, which was soon accepted as an important improvement, the demand for insurance coverage on one risk should not be analyzed in isolation from the other risks faced by the decision-maker: insurance demand is not separable, even when the risks are independent (Eeckhoudt and Kimball, 1992). When considering the demand for one risk, one has to take into account

[13] A Giffen good - a good such that the quantity demanded is an increasing function of its price - is necessarily an inferior good - a good such that the quantity demanded is a decreasing function of income. But an inferior good is not necessarily a Giffen good.

[14] It is obvious that the paradox may be resolved if one introduces differential information. If the insured overestimates the probability (or the amount) of loss, full insurance may be optimal, even when the premium is loaded with a fixed proportional factor.

the other risks, their correlation with the first risk, whether they are insurable or not, and under what conditions, whether some insurance is compulsory or subsidized, etc.: see, e.g., Schlesinger and Doherty (1985), von Schulenburg (1986), and Gollier and Scarmure (1994)[15]. Thus, it may be optimal to partially insure a risk which is negatively correlated with an other risk, even if the premium is actuarial. Conversely, it may be optimal to fully insure a risk in spite of unfair pricing, if this risk is positively correlated with an other uninsurable risk. In a portfolio context, incomplete markets for insurance provide a rationale for full insurance of the insurable risks. Mossin's paradox can thus be resolved by changing the perspective, instead of changing the analytical model (the expected utility model)[16].

Building on these premises, the current research program is mainly devoted to analyzing more specifically the conditions of optimal insurance demand in a portfolio context – Meyer and Ormiston (1995), Eeckhoudt, Meyer and Ormiston (1997) – or verifying the conditions under which optimal insurance demand in a portfolio context has desirable comparative statics properties, such as an increase in optimal insurance coverage when the insured or uninsured risks increase: see Eeckhoudt and Kimball (1992), Meyer (1992), Dionne and Gollier (1992), Eeckhoudt, Gollier and Schlesinger (1991) (1996), Gollier and Schlesinger (1995), Gollier (1995), Gollier and Pratt (1996), Gollier and Schlee (1997), Tibiletti (1995), Guiso and Jappelli (1997).

Research integrating joint optimal decisions on consumption, saving and insurance represents a different research program, which was addressed by Moffet (1977) and Dionne and Eeckhoudt (1984). The latter authors have shown that investing in the riskless asset is a substitute to insurance purchasing. This work was generalized by Briys (1988) using a continuous-time model.

Surprisingly, research on risk prevention (self-protection and self-insurance activities) has not benefited much from progress in the theory of insurance demand. Analysis has remained mainly circumscribed to the framework proposed by Ehrlich and Becker (1972). For example, Boyer and Dionne (1989) have shown that self-insurance leads to stronger changes in risk than self-protection (see also Chang and Ehrlich, 1985), and Dionne and Eeckhoudt (1985) obtained the surprising result that an increase in risk aversion does not necessarily result in higher self-protection, everything else constant (see also Briys and Schlesinger, 1990)[17]. Dionne and Eeckhoudt (1988) also investigated the effects of increasing risk on optimal investment in self-protection activities and found that the effect was ambiguous in general. Taking a different approach, Schlesinger and Venezian (1986) analyzed the joint production of insurance protection and loss prevention by insurers. Interestingly, they showed that consumers may be better off with monopolistic rather than perfectly competitive insurers, if the information is symmetric and the monopolistic

[15] On a related theme, see also Doherty and Schlesinger (1990) for the case where the insurance contract itself is risky, due to a non-zero probability of insurer default.

[16] These theoretical advances closely followed similar advances in the theory of risk premiums under multiple sources of risk : Kihlstrom, Romer and Williams (1981), Ross (1981).

[17] However, using a critical *switching* probability, McGuire, Pratt and Zeckhauser (1991) were able to show that the more risk-averse individual will pay more to reduce small chances of bad outcomes.

insurer has the power to alter loss probabilities before the sale of insurance. But in contrast with most other domains of risk and insurance economics, the analysis of loss prevention was not yet replaced in a broader context. A step in that direction was nevertheless made by Briys, Schlesinger and von Schulenburg (1991) with their analysis of "risky risk management".

Other work in the theory of insurance demand concerns:

1) The specific issues raised by the corporate demand for insurance: these issues will be considered in section 4 below.

2) The extension of the expected utility model to take into account state-dependent utility functions. One can thus introduce into the analysis important observations from reality. For example, the observation that the indemnity paid by the insurer cannot provide complete compensation for a non monetary loss, such as the loss of a child, or the observation that the marginal utility of wealth is different under good health and under disability: see Arrow (1974), Cook and Graham (1977) and Schlesinger (1984) for important papers along this line.

3) The replacement of the expected utility model with recent generalizations, grouped under the heading "non-expected utility analysis". This research program started recently but it has already produced several interesting papers: see Karni (1992), Doherty and Eeckhoudt (1995), Konrad and Skaperdas (1993), Machina (1995), Schlee (1995), and Schlesinger (1997). Machina (1995) submits the most important results in the theory of optimal insurance to a robustness test using generalized expected utility analysis. He concludes that most of the results are quite robust to dropping the expected utility hypothesis. The generality of his conclusion is challenged by Karni (1995). However, Schlesinger (1997) obtains the same conclusion as Machina by concentrating on two results only: Mossin's (1968) result on the optimality of partial coverage, and Arrow's (1963) results on the optimality of deductibles.

### *3.2. Economic equilibrium under asymmetric information*

The Arrow (1953) model shows that a market economy leads to a general and efficient[18] economic equilibrium – even under uncertainty – if the financial market is complete, i.e., provided the traded securities and insurance contracts make possible to cover any future contingency. This is an important result since it extends to the case of uncertainty the classical result on the viability and efficiency of a free market economy.

However, as Arrow himself noticed in his 1963 article (see above), complete coverage is not always available (or even optimal) in insurance markets due to various reasons. Among these reasons, asymmetric information has received much attention in the economic literature and has been generally discussed under two main headings: moral

[18] An economic equilibrium is efficient if it is Pareto optimal: it is impossible to organize a reallocation of resources which would increase the satisfaction of one individual without hurting at least one other individual. The first theorem of welfare economics states that any competitive equilibrium is Pareto optimal, and the second theorem states that a particular Pareto optimum may be reached by combining lump sum transfers among agents with a competitive economic system. In an efficient equilibrium, market prices reflect social opportunity costs.

hazard and adverse selection. Moral hazard exists when (1) the contract outcome is partly under the influence of the insured, and (2) the insurer is unable to observe, without costs, to which extent the reported losses are attributable to the insured's behavior. Adverse selection occurs when (1) the prospective insureds are heterogeneous, and (2) the risk class to which they belong cannot be determined *a priori* by the insurer (at least not without costs), so that every insured is charged the same premium rate. Clearly, asymmetric information is a source of incompleteness in insurance markets: e.g., a student cannot be insured against the risk of failing at an exam; a healthy old person may not find medical insurance coverage at an acceptable premium, etc. For this reason, a free market economy may not be efficient, and this may justify government intervention.

### *3.2.1. Moral hazard*

Economists make a distinction between two kinds of moral hazard, depending on the timing of the insured's action. If the latter occurs before the realization of the insured event, one has *ex ante* moral hazard, while *ex post* moral hazard exists when the insured's action is taken after the insured event[19].

*Ex ante* moral hazard was studied by Pauly (1974), Marshall (1976), Holmstrom (1979) and Shavell (1979), among others. They showed that insurance reduces the incentive to take care when the insurer is unable to monitor the insured's action. Dionne (1982) pointed out that moral hazard is also present when the insured event results in non-monetary losses, for example the loss of an irreplaceable commodity. Quite generally, partial provision of insurance is optimal under moral hazard. More specifically it was demonstrated that uniform pricing is not optimal when the insured's behavior affects the probability of a loss. The equilibrium premium *rate* is an increasing function of the amount of coverage purchased (non linear pricing): see Pauly (1974). In addition, under moral hazard in loss reduction, the optimal contract is conceived such as to make the degree of coverage a non-increasing function of the amount of losses, large losses signalling careless behavior by the insured. Small losses are fully covered, but losses exceeding a limit are partially covered (Winter, 1992, proposition 4). Shavell (1982) (1986) extended the study of moral hazard to the case of liability insurance. He showed that making liability insurance compulsory results in less than optimal care.

The existence of long-term (multi-period) contracts does not necessarily mitigate the effect of moral hazard. Under the infinite period case, Rubinstein and Yaari (1983) proved that the insurer can eliminate the moral hazard problem by choosing an appropriate experience rating scheme that provides an incentive to take care. But the result does not, in general, carry over to the finite period case (Winter, 1992). In addition, the possibility for the insured to switch to an other insurer makes a penalty scheme difficult to enforce in truly competitive insurance markets, where insurers do not share information on prospective insureds.

*Ex post* moral hazard was first pointed out by Spence and Zeckhauser (1971), and studied later by Townsend (1979) and Dionne (1984). In this case, the nature of the

[19] *Ex post* moral hazard is particularly important in medical insurance, where claimed expenses are dependent on decisions made by the patient and the physician once illness has occurred.

accident is not observable by the insurer, who has to rely on the insured's report or engage in costly verification (in the limit, the moral hazard problem becomes a fraud problem – see Picard, 1996). Mookerjee and Png (1989) showed that random audits represents the appropriate response by the insurer in this situation.

The consequences of moral hazard for the efficiency of a market economy were studied by Helpman and Laffont (1975), Stiglitz (1983), Arnott and Stiglitz (1990) and Arnott (1992), among others. They showed that a competitive equilibrium may not exist under moral hazard, and that the failure to get complete insurance coverage results at best in sub-efficient equilibrium. This is due to the fact that "moral hazard involves a trade-off between the goal of efficient risk bearing, which is met by allocating the risk to the insurer, and the goal of efficient incentives, which requires leaving the consequences of decisions about care with the decision maker." (Winter, 1992, p. 63). However, government intervention does not necessarily improve welfare in this case. This depends on government information, compared with the information at the disposal of private insurers. Arguments may be put forward in favour of a taxation and subsidization policy providing incentives to avoid and reduce losses, but public provision of insurance does not solve the moral hazard problem (Arnott and Stiglitz, 1990).

Moral hazard has become a popular theme in economics, not only because its presence in insurance markets results in less than optimal functioning of any economic system, but also because it is a widespread phenomenon. As Winter (1992) notes, moral hazard can be defined broadly as a conflict of interests between an individual (behaving rationally) in an organization, and the collective interest of the organization. Insurance markets provide the best illustration for the effect of moral hazard, but the latter is also observed in labour relationships, in finance contracts, and quite generally in all circumstances where the final wealth of *a principal* is both uncertain and partially dependent upon the behavior of an *agent* whose actions are imperfectly observable: for example, in a corporation, the wealth of the firm's owners (stockholders) is partly dependent upon the actions of the manager; in judicial procedure, the final outcome is partly dependent upon the efforts of the lawyers; in a team, the success of the team is partly dependent on the individual effort of the members, etc. All these situations were studied in the economic and financial literature under the headings *of principal-agent relationships* or *agency theory*, with close connections to the literature on moral hazard in insurance: in both cases, the objective is to define the optimal "incentive contract" to mitigate the effect of asymmetric information, and to study the consequences of different arrangements on deviations from efficiency: see Ross (1973), Radner (1981) and Grossman and Hart (1983) for canonical references. Similarly, the consequences for general economic equilibrium of market incompleteness brought about, among other causes, by moral hazard has become a central theme of research in economics: see, e.g., Polemarchakis (1990). On the moral hazard issue, at least, developments in insurance economics were closely related to developments in general economic theory.

*3.2.2. Adverse selection*

A central development in the study of adverse selection was the paper by Rothschild and Stiglitz (1976). This paper assumed two classes in the insured population: "good risks" and "bad risks". The two classes differ only with respect to their accident probability. The

authors showed that a competitive insurance market does not necessarily reach an equilibrium under adverse selection, and that, if it does, the "good risks" suffer a welfare loss. More specifically, under the assumptions of the model, equilibrium can be obtained if the proportion of good risks in the economy is not "too large". The equilibrium situation involves the supply of discriminating contracts providing full insurance at a high price to the bad risks and partial coverage at a low price to the good risks[20]. Compared to the symmetric information case, the bad risks get the same expected utility, but the good risks suffer a welfare loss. The policy implication of the model is that, in some circumstances, insurance markets may fail, and monopolistic insurance (under government supervision) may be justified as a second best[21].

Extensions of the basic Rothschild-Stiglitz model are due to Wilson (1977), Spence (1978) and Riley (1979), who dropped the assumption of myopic behavior by insurers[22]. Then, a separating equilibrium exists always, provided insurers are able to monitor total insurance purchases by individuals on a given risk, or share information on customers' purchases (Hellwig, 1988).

Experience rating and risk categorization may be used as substitutes or complements to discriminating contracts. Dionne (1983) and Dionne and Lasserre (1985) on one hand, and Cooper and Hayes (1987) on the other hand extended Stiglitz's (1977) monopoly model to multi-period contracts, respectively with an infinite horizon and a finite horizon, and with full commitments by the insurer to the terms of the contract. Hosios and Peters (1989) extended the finite horizon case to limited commitment. In this case, contract renegociation becomes relevant, as information on the risk types increases over time. In addition, strategic use of accident underreporting becomes an issue.

Cooper and Hayes (1987) also extended the Rothschild-Stiglitz (1976) model to a two-period framework. They were able to demonstrate the beneficial effect of experience rating under full commitment by insurers. A different model, without commitment and assuming myopic behavior by insureds, was proposed by Kunreuther and Pauly (1985) and empirically supported by D'Arcy and Doherty (1990) and Dionne and Doherty (1994)[23].

Risk categorization, which uses statistical information on correlations between risk classes and observable variables (such as age, sex, domicile, etc.), was studied by Hoy (1982), Crocker and Snow (1986) and Rea (1992). Their work shows that risk categorization enhances efficiency when classification is costless, but its effect is ambiguous when statistical information is costly (see also Bond and Crocker, 1991). These results are of utmost political importance, given the ethical critics on the use of observable personal attributes, such as sex and race, in insurance rating.

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[20] Insurance contracts are defined in terms of price *and* quantity, instead of price for any quantity. Insureds reveal their class by their choice in the menu of contracts. There is no "pooling" equilibrium, but a "separating" equilibrium.

[21] Stiglitz (1977) studied the monopolistic insurance case.

[22] See Dahlby (1983) for empirical evidence on adverse selection in the Canadian automobile insurance markets, Crocker and Snow (1985) for a review of these models and Dionne and Doherty (1992) for a survey of adverse selection.

[23] See Dionne and Doherty (1992) for a comparison of the models.

Like moral hazard, but to a lesser extent, adverse selection is an important problem beyond the domain of insurance. It is mainly encountered in labour markets, where the employers are uninformed about the productivity of the prospective employees, and in financial markets, where banks and finance companies lack information on the reimbursement prospects of different borrowers. The insurance economics literature on adverse selection reviewed above has thus led to applications to other economic domains: see, e.g. Miyazaki (1977) for an application to the labour market and Stiglitz and Weiss (1981) for an application to credit markets. Note, however, that in these cases, quality signalling by the informed agents represents a feasible strategy to circumvent the asymmetric information problem (Spence, 1973). For example, education and dividend payments find an additional justification in these circumstances. In contrast, signalling does not generally occur in insurance markets: insureds do not engage in specific activities to signal that they are good risks.

### *3.2.3. Moral hazard and adverse selection*

As Arnott (1992) notes, only limited progress has been made in analyzing moral hazard and adverse selection together, and this has considerably hindered empirical investigation in the economics of insurance, since both problems combine in actual insurance markets. First attempts were made by Dionne and Lasserre (1987) in the monopoly case and by Eisen (1990) in the competitive case. More recently, Bond and Crocker (1991) pointed out that risk categorization may be endogenous if it is based on information on consumption goods that are statistically correlated with an individual's risk (*correlative products*). Thus, adverse selection and moral hazard becomes related. If individual consumption is not observable, taxation of correlative products by the government may be used to limit moral hazard and reduce the need for self-selection mechanisms as an instrument for dealing with adverse selection. New developments along this line may be expected.

## *3.3. Insurance market structure*

Numerous studies on the insurance sector have followed the lead provided by Joskow (1973). The availability of data and better incentives to perform economic research explain that most of these studies pertain to the US market.

- Insurance distribution systems were mainly analyzed by Cummins and VanDerhei (1979)[24].
- Returns to scale in the insurance industry were submitted to empirical investigation by numerous authors, e.g., Doherty (1981), and Fecher, Perelman and Pestieau (1991).
- The various forms of organizational structure in the insurance industry – stock companies, mutuals, Lloyds' underwriters – were analyzed in an agency theory framework by Mayers and Smith in a series of papers: (1981), (1986) and (1988) among others. They verified that conflicts of interest between owners, managers and policyholders affect the choice of organizational form for different insurance branches (see also Hansmann, 1985).

[24] See, however, Zweifel and Ghermi (1990) for a study using Swiss data.

- The effects of rate and solvency regulation were scrutinized in numerous researches, such as Borch (1974), Ippolito (1979), Munch and Smallwood (1980), Danzon (1983), Finsinger and Pauly (1984), Pauly, Kleindorfer and Kunreuther (1986), Harrington (1984), Cummins and Harrington (1987), D'Arcy (1988). These studies were stimulated by the traditional government regulation of insurance activities, a general trend towards deregulation over the recent decades, and the consumer pressures for re-regulation (mainly in California) since the end of the 1980s. Dionne and Harrington (1992) conclude their survey of research on insurance regulation by noting: firstly, that "not much is presently known about the magnitude of the effects of regulatory monitoring and guaranty funds on default risk" (p. 32); and secondly, that rate regulation seems to have produced a variety of effects. It favored high risk groups, increased market size and encouraged insurers' exits, but nonetheless reduced the ratio of premiums to losses and operating expenses.

A related avenue of research, not considered by Joskow (1973), deals with cycles in the insurance industry. It has been noticed in the seventies that insurance company profits seemed submitted to more or less regular cycles, and that this phenomenon was reflected in cyclical capacity and premium rates. The Geneva Association sponsored one of the first investigations in this area (Mormino, 1979). The most often quoted papers were published later by Venezian (1985), Cummins and Outreville (1987), and Doherty and Kang (1988). The US insurance liability "crisis" of the mid-eighties stimulated research in insurance cycles (see Harrington, 1988). Briefly, this research suggests that delays in the adjustment of premiums to expected claims costs, due to regulation or structural causes, are responsible for cyclical effects.

Let us mention, finally, a topic which was not covered by Joskow (1973) and which does not seem to have concerned many researchers: the issues raised by international insurance trade. Research on this topic remained relatively limited and concentrated in Europe: see Dickinson (1977) for an early reference and Pita Barros (1993) for a more recent analysis.

## 4. New approaches: finance and insurance

Apart from the tremendous developments summarized in the preceding section, risk and insurance economics has witnessed a major re-orientation in the 1970s and 1980s: insurance has been analyzed more and more in the general framework of financial theory. This change of perspective was implicit in the definition of Arrow (1970): "insurance is an exchange of money for money". It was also foreshadowed by the recognition that insurers were financial intermediaries (Gurley and Shaw, 1960). It became soon impossible to maintain a dichotomy in the analysis of the insurance firm: insurance operations on one hand, financial investment on the other hand. As a result, insurance research became deeply influenced by advances in the theory of finance. The more so that finance underwent a major revolution in the 1970s, with the development of option theory, and that this revolution stressed the similarity between insurance products and new concepts due to financial innovation (e.g., *portfolio insurance*)[25].

[25] The similarity between option contracts and insurance policies was stressed by Briys and Loubergé (1983).

### 4.1. *Portfolio theory and the CAPM*

The influence of portfolio theory on the analysis of insurance demand was mentioned in the preceding section. But this theory had also a profound influence on the theory of insurance supply. It was soon recognized that financial intermediaries could be analyzed as a joint portfolio of assets and liabilities (Michaelsen and Goshay, 1967), and this global approach was applied to insurance company management. Under this view, insurers have to manage a portfolio of correlated insurance liabilities and investment assets, taking into account balance sheet and solvency constraints, and there is no justification for separating the operations in two distinct domains: what matters is the overall return on equity (see Kahane and Nye, 1975, and Kahane, 1977)[26].

This way of looking at insurance operations led to a theory of insurance rating, reflecting the move observed a decade earlier in finance from portfolio theory to the capital asset pricing model. Applying this model to insurance, it turns out that equilibrium insurance prices will reflect the undiversifiable risk of insurance operations. If insurance risks are statistically uncorrelated with financial market risk, equilibrium insurance prices are given by the present value of expected claims costs (in the absence of transaction costs). If they are statistically correlated, a positive *or negative* loading is observed in equilibrium. The model was developed by Biger and Kahane (1978), Hill (1979) and Fairley (1979). It was empirically evaluated by Cummins and Harrington (1985). It was also applied to determine the "fair" regulation of insurance rating in Massachussets (Hill and Modigliani, 1986)[27].

### 4.2. *Option pricing theory*

A main limitation of the capital asset pricing model is that it does not take into account non linearities arising from features such as limited liability and asymmetric tax schedules. These aspect are best analyzed using option pricing theory, since it is well known that optional clauses imply non linearities in portfolio returns. Doherty and Garven (1986) and Cummins (1988) analyzed the influence of limited liability and default risk on insurance prices, while Garven and Loubergé (1996) studied the effects of asymmetric taxes on equilibrium insurance prices and reinsurance trade among risk-neutral insurers. A major implication of these studies is that loaded premiums are not only the reflect of transaction costs and asymmetric information, or insurers' risk aversion. They reflect undiversifiable risk arising from institutional features, and they lead to prices implying risk-sharing in equilibrium, even when market participants are risk neutral.

The importance of option theory for the economics of insurance has also been recently observed in the domain of life insurance. This resulted from the fact that competition between insurers and bankers, to attract saving, has led to the inclusion of numerous optional features (hidden options) in life insurance contracts. Advances in option theory are thus currently often used to value life insurance contracts (see, e.g. Brennan and Schwartz, 1976, Ekern and Persson, 1996, and Nielsen and Sandmann, 1996), or to assess the effects of life insurance regulation (Briys and de Varenne, 1994).

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[26] See also Loubergé (1983) for an application to international reinsurance operations, taking foreign exchange risk into account, and MacMinn and Witt (1987) for a related model.

[27] Myers and Cohn (1986) extended the model to multi-period cash flows, while Kraus and Ross (1982) considered the application to insurance of the more general arbitrage pricing theory.

*4.3. Insurance and corporate finance*

The portfolio approach to insurance demand led to a paradox when applied to corporations. The latter are owned by stockholders who are able to diversify risks in a stock portfolio. If insurance risks, such as accident and fire, are diversifiable in the economy, the approach leads to the conclusion that corporations should not bother to insure them. They would increase shareholders' wealth by remaining uninsured instead of paying loaded premiums (Mayers and Smith, 1982)[28]. The paradox was solved using the modern theory of corporate finance, where the firm is considered as a nexus of contracts between various stakeholders: managers, employees, suppliers, bondholders, banks, stockholders, consumers, etc. Reduction of contracting costs provides an incentive to purchase insurance, even if the premium is loaded and the shareholders are indifferent to insurance risk: see Main (1982) and Mayers and Smith (1982)(1990). Note that asymmetric tax schedules provide another explanation for insurance purchasing by widely-held corporations: see Smith, Smithson and Wilford (1990).

The theory of corporate finance was also used by Garven (1987) to study the capital structure decision of the insurance firm. His paper shows that redundant tax shields, default risk, bankruptcy costs and the above-mentioned agency costs influence the insurer's capital structure decision.

*4.4. Insurance and financial markets*

When the Geneva Association started operations in 1973, the insurance/banking interface was a sensitive subject. It was generally not well-considered, in the insurance industry, to state that insurance was a financial claim and that insurers and bankers performed related functions in the economy. Twenty-five years later, and after numerous recent experiences of mergers and agreements between banks and insurers, the question is not whether the two activities are closely related, but where do they differ.

It is easy for an economist of risk and insurance to provide a general answer to this question. The answer is founded on Borch's mutuality principle (see section 2) and on subsequent work on risk-sharing. Insurance and banking, like all financial activities, are concerned with the transfer of money across the two-dimensional space of time and states of nature. Insurance deals mainly – but not exclusively (see life insurance) – with transfers across states that do not necessarily involve a change in social wealth. In contrast, banking and financial markets perform transfers across states which often involve a change in social wealth. In other words, insurance is concerned with diversifiable risk; banks and finance companies (e.g., mutual funds) are concerned with undiversifiable (social) risk.

This kind of distinction has been used before to draw a line between private and public (social) insurance. According to this view, social insurance appears on stage when the limits of private insurability are reached in the sense that the insured events are positively correlated, so that diversifiability does not obtain: epidemic diseases, losses from natural catastrophes, unemployment, etc.[29]. But, in the absence of redistributive concerns

[28] The same kind of argument was used by Doherty and Tinic (1981) to question the motivation of reinsurance demand by insurers.

[29] Public insurance is also justified on equity considerations, e.g. in medical insurance.

or market incompleteness due to moral hazard, it becomes more and more obvious that financial markets are able to perform social insurance functions, in addition to their traditional function of sharing production risk.

A case in point is the evolution in the natural catastrophes branch of insurance. As a matter of fact, since losses from natural catastrophes are correlated, they should be excluded from the private insurance area. Nonetheless, private insurance companies used to cover this risk because geographical dispersion seemed possible using the international reinsurance market. However, over the last years, the private insurability of this risk has been challenged by various developments: an increased frequency of hurricanes[30], huge losses, and a concentration of insured values in selected exposed areas of the globe: California, Florida, Texas, Japan and Western Europe. As a result, potential losses have exceeded the financial capacity of the catastrophe reinsurance market (see Kielholz and Durrer, 1987). One possible solution to the insurability problem is the traditional recourse to government insurance using increased taxation. This is the solution which was adopted in France (Magnan, 1995): a reserve fund financed by specific taxes on property-liability insurance contracts indemnifies victims from natural catastrophes. Another solution is the securitization of the risk using special purpose derivative markets: this is the solution proposed by the Chicago Board of Trade with the catastrophe options and futures contracts launched in December 1992: see D'Arcy and France (1992) and Cummins and Geman (1995) for an analysis of these contracts[31]. A third solution is the securitization of the risk using more familiar securities, such as coupon bonds, issued by a finance company (on behalf of an insurer), or by a public agency (on behalf of the State): see Briys (1997), and Loubergé, Kellezi and Gilli (1997) for a presentation and analysis of insurance-linked bonds. The marketing of these new insurance-based securities is based on the huge pool of financial capacity provided by worldwide capital markets and the prospects for risk diversification made available to investors in these securities. It illustrates the increased integration of insurance and investment banking, both activities performing a fundamental economic function, the transfer of risks.

## 5. Conclusion

When the Geneva Association started operations in 1973, it was not clear what would be the development of risk and insurance economics over the years to come. 25 years after, it is comforting to realize that considerable developments have taken place: the length of the reference list below, unconventionally divided in pre-1973 and post-1973 references gives an account of the quantitative aspects of these developments.

As this paper shows, the developments have mainly taken place along three avenues of research:

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[30] It remains to be seen whether this increased frequency is due to permanent changes (global warming of the atmosphere), or whether it represents a temporary phenomenon (with no departure from randomness in the long run).

[31] The early options and futures on four narrow-based indices of natural catastrophes were replaced in October 1995 by call spreads on nine broad-based indices. Lewis and Murdock (1996) propose to have the same kind of contract supplied by Federal authorities, in order to complete the reinsurance market.

1. The theory of risk-taking behavior in the presence of multiple risks, which encompasses the theory of optimal insurance coverage, the theory of optimal portfolio investment, and the theory of optimal risk prevention.

2. The issues raised by asymmetric information for contracts design and market equilibrium, a theme which extends beyond insurance economics and concerns all contractual relations in the economy, e.g., on labour markets, products markets and financial markets.

3. The applications of new financial paradigms, such as contingent claims analysis, to the analysis of insurance firms, insurance markets and corporate risk management, a development which links more closely insurance economics to financial economics, and insurance to finance.

Moreover, it is striking to note that one of the main objectives of the Association's founding fathers has been fully obtained: risk and insurance economics represents nowadays a major theme in general economic theory. This does not mean that risk and insurance education, *per se*, has become a predominant theme – although important developments took place also at this level. But risk and insurance issues have become pervasive in economic education, more particularly in microeconomics. To support this statement, one may verify in the second section of the following list of references that many important papers for the advancement of risk and insurance theory were published in general economic and financial journals, and not only in the leading specialized reviews. Indeed, given that this goal was reached, and that the desired result seems firmly established for the future, it may be wondered whether an other objective, the development of specialized risk and insurance education and research, which had been given less importance at the outset, should not be reevaluated today. From the experience with the tremendous research activity we have witnessed in the study of financial markets over the past years, we are allowed to infer that specialized research in insurance economics would receive a major impulse from the creation of complete, reliable and easily accessible insurance data bases.

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