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URBAN INFRASTRUCTURE FLOODS IN SOUTHERN ONTARIO: A METHODOLOGY TO DETERMINE CAUSALITY (PART ONE)

by Tanuja Kulkarni

ABSTRACT

Urban flooding can be described as floods that occur outside of floodplains and are enhanced by the extreme impermeability of city surfaces. The Supreme Court of Canada's Thunder Bay decision that in some instances municipalities are liable for urban flood damage addresses the importance of paving in a watershed.

Factors that need to be considered include the current extreme precipitation regime for southern Ontario, which is determined through literature reviews and through considering the annual maximum precipitation. The second factor that is considered is changes in land use from permeable to more impermeable surfaces, measured using aerial photos and a planimeter. The hydrological impacts of the change in land use from pervious to less pervious in the watersheds was considered through the literature. Precipitation data for southern Ontario do not follow the same trend as those in the U.S or the expected future trends for Canada. The role of climate change, sewage networks, insurers and communication between stakeholders are also considered. The main contribution of this work is the establishment of a methodology to determine causality of urban infrastructure floods, and the obstacles that exist to this type of research.

The author:

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RÉSUMÉ

Le phénomène de l'inondation urbaine peut être défini comme toute inondation survenant hors des plaines inondables, rehaussées par l'extrême imperméabilité des surfaces urbaines. L'auteure se réfère à l'affaire Thunder Bay rendue par la Cour suprême du Canada concluant que les municipalités sont responsables, dans certains cas, des dommages consécutifs aux inondations urbaines ; cette décision témoigne de l'impartance du pavement dans les zones délimitant la ligne des eaux.

Les facteurs qui doivent être considérés camprennent, d'abord, les précipitations extrêmes qui se produisent couramment dans le sud de l'Ontario, dont on peut mesurer l'ampleur dans la littérature au regard des précipitations maximum annuelles. Un second facteur à examiner réside dans les changements d'utilisation de terrain, c'est-à-dire des utilisations à l'origine dans les surfaces perméables jusqu'à celles beaucoup plus imperméables, ce qui peut être mesuré soit par des photographies aériennes soit par un planimètre. La littérature examine également les impacts hydrologiques des changements d'utilisatian des sols, des altérations perverses à moins perverses, au niveau de la ligne de partage des eaux. Les données sur les précipitations dans le sud de l'Ontario ne suivent pas les mêmes tendances que celles existantes aux États-Unis ou les tendances à venir qui sont estimées comme probables au Canada. Sont également considérés le rôle joué par les changements climatiques, les réseaux d'égouts, les impacts dans l'industrie de l'assurance et la communication entre les principaux intervenants. La principale contribution de cette recherche est d'établir une méthodologie dans le but de déterminer les causes des inondations au niveau des structures urbaines et les obstacles qui existent dans ce type de recherche.

1.0 INTRODUCTION AND PROBLEM DEFINITION

Urban infrastructure floods can be characterized as flood events from rainstorms or snowmelt that supply a large amount of water, and are enhanced by the extreme impermeability of city surfaces (Lawford et al. 1995). Urban infrastructure flooding can occur outside of floodplains, contrary to natural flooding processes.

If there is an increase of urban flooding in southern Ontario, it is important for stakeholders to recognize the impacts and attempt to mitigate them. Urban infrastructure floods can cause damage to property. Furthermore, complex insurance issues have left some homeowners who experienced urban flooding with inadequate redress. One of the main problems with compensation is the question of causality; determining if floods in urban areas were a result of overland flow, sewer back-up or a combination of the two is of

pivotal importance when establishing insurance status. Sewer back-up can be insured against, but incidences of overland flow floods are not. The 1997 Supreme Court of Canada ruling found the City of Thunder Bay negligent, and required them to compensate homeowners who were flooded. This case addressed part of the causality issue, but the complexity of issues surrounding urban infrastructure flooding is still problematic for municipalities, insurers and property owners alike, as no group has primary responsibility for collecting flood information.

Urban floods and the impacts of their damage are problems that should not persist. Appropriate watershed planning, watercourse engineering and appropriate insurance application should be effective to prevent homeowner losses due to flooding.

Lawford et al. (1995) state that "urban floods are a special case of rainstorm floods because the flood from a rainstorm supplying a large amount of precipitation is enhanced by the extreme impermeability of the city surface". Although there is no established methodology for this type of study, two variables are being explored in this paper. The first is increases in extreme rainfall as a contributing factor to urban infrastructure floods. The second is changes in land use that reduces permeability.

☐ 1.1 Goals of the Paper

The main goal of this work is to establish a methodology for studying the causality of urban floods. A number of issues are noted. First, to determine if urban floods are the result of increased precipitation. Regional rainfall literature from the United States and Canada were examined to determine if increases in extreme precipitation events have occurred in Southern Ontario. The role of global climate change and the response of the stormwater systems for handling increased volume are also addressed. The sewage systems themselves need to be considered when studying urban floods, as the increasing growth of the sewer network relative to urban development may be a key concern. The sewershed that the flooded area lies in is important to define, and its characteristics, including capacity and density need to be determined. Changes in land use are also analyzed to determine the contribution of permeable surfaces urban floods.

The final goal of this research is to determine what obstacles exist to the collection of relevant data for the study of urban floods.

□ 1.2 Variables of Consideration

■ 1.2.1 Precipitation

Changing precipitation patterns in Southern Ontario will change the flood regime. Increased incidence of extreme precipitation events will cause an increase in non floodplain, urban infrastructure floods. Bruce (1997) argues that "there is increasing evidence that future rain may come more in heavy bursts, with higher percentages of the rain running off, and with significant portions of the basin being paved, (more research is) require(d)". Increased rainfall in short periods, combined with the traditional infrastructure idea of "get the water off the land as quickly as possible" may have contributed to increased urban flood frequency. (Kinkead 1997).

■ 1.2.2 Land Use Change

Changes in local land use from permeable to impermeable will increase urban flood frequencies. For example, permeable land that surrounds a housing development that is converted to an impermeable surface will affect how water flows around that housing development. The water will be delivered to the sewer systems faster, and will contribute to urban infrastructure flooding.

■ 2.0 METHODOLOGY

Many cities experience significant urban flood events, all with similar impacts (e.g. homeowners incurring large costs, inconsistent insurance reactions, undefined causality). Although local newspapers identify areas affected by floods, few are reported in newspapers with regional or national circulation, yet urban flood events have been reported from British Columbia, Ontario, and Quebec. This paper will focus on southern Ontario, as there have been a number of incidences reported in this area in local newspapers.

Insurance archives were searched to determine incidences of urban floods, how urban flood information is archived, and where urban flooding occurs, and how it is defined according to insurers.

Global climate change may be a driving factor for increases in extreme events. Precipitation data and current literature were used to determine if a measurable increase in extreme precipitation in southern Ontario has occurred. Sewage system data, land use data, local street maps, soil maps and aerial photos were collected for

each of the three case cities to determine if land use in the area immediately surrounding flood events has changed over the last twenty years.

Current sewer networks were investigated through interviews with Municipal Works Department personnel, sewage maps and news reports.

2.1 Communication

Barriers to this type of research were discovered and documented. Phone interviews and personal meetings with water resources personnel at the appropriate Conservation Authorities were conducted, as well as with the Toronto and Region Conservation Authority. Engineers and water services personnel at the city hall of each of the case study cities and at the city of Toronto were interviewed (Appendix 1). The extent of communication and collaboration between municipal governments, insurers and Conservation Authorities was determined.

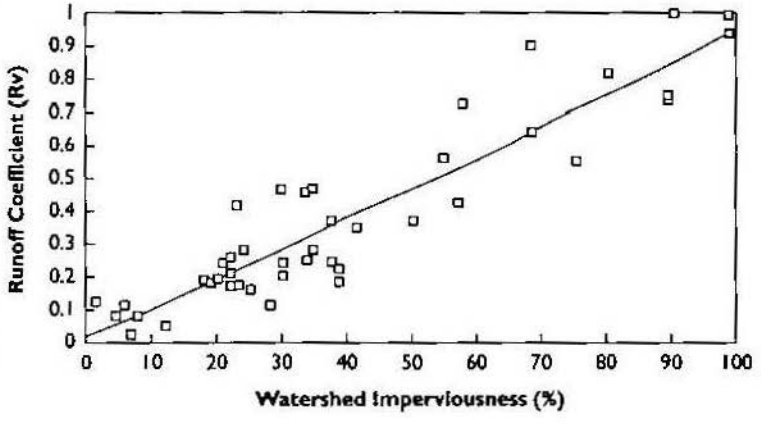
3.0 IMPLICATIONS OF URBANIZATION FOR THE HYDROLOGICAL CYCLE

Urbanization causes changes to the terrestrial phase of the hydrologic cycle. Impermeable surfaces render urban areas more vulnerable to flooding, and promote rapid runoff rates that result in large quantities of water reaching urban drainage networks (Brun 1997). There is a decrease in infiltration due to hardening of surfaces, decreased amount of depression storage available due to regrading, reduced evapotranspiration due to vegetative cover removal, and faster travel time to the receiving body of water as a result of sewer system construction. All of these changes combine to increase the volume of runoff. Pipes may replace small streams, while open channels, after urbanizing, may be dry between storm events (Snodgrass et al.1997).

Traditionally, Canadian floods are the result of heavy rainfall events; ice jams; or snowmelt. In urban areas, floods are also the result of low drainage capacity mixed with combined systems[1] inadequate rainwater removal and land cover change from vegetated to impermeable surfaces. In Canada these urban floods are most common in southern Ontario, Quebec and southern B.C. (Brun 1997).

Imperviousness is the portion of the total catchment area covered by the sum of roads, parking lots, sidewalks, rooftops and other impermeable surfaces of the urban landscape. For mature urban areas, it can be defined as the fraction of watershed that remains unvegetated (Snodgrass et al. 1997). Land development almost always involves increasing the imperviousness of the landscape. Imperviousness is a useful indicator for measuring the impacts of land development on receiving waters and their aquatic environments because the intensity of the impacts is typically a function of urbanization (Snodgrass et al. 1997). Figure 1 describes the relationship between stormwater runoff and imperviousness in a watershed, illustrating how, in highly urbanized systems, there is higher runoff. This coefficient closely tracks the percent imperviousness except at low levels, where soils and slope factors play a larger role. The runoff coefficient characterizes variables including antecedent precipitation, soil moisture, infiltration, slope, ground cover, surface and depression storage, the shape of the drainage area and overland flow velocity (Belore 1976).

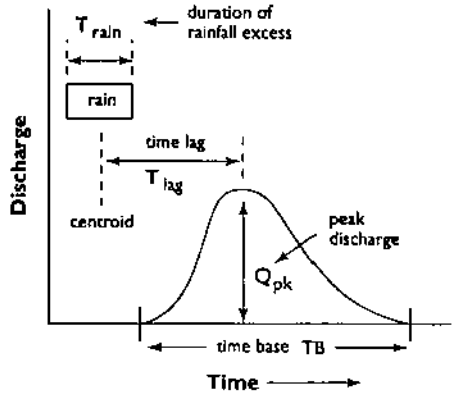
FIGURE 1
IMPERVIOUSNESS AND STORWATER RUNOFF IN A WATERSHED



Runoff coefficient (Rv) is a function of site imperviousness. Once acre parking lot is Rv = 0.95, while one acre of meadow is Rv = 0.06. (Snodgrass et al. 1997)

The hydraulic regime of urban sewer floods differs from natural streams in three basic areas. There is an increase in the magnitude and frequency of severe flood events; more of the annual flow is delivered as surface storm runoff (vs. baseflow or interflow); and the velocity of the flow during storm events increases. Urbanization increases peak flow, decreases the duration to peak and changes the volume of runoff (Figure 2).

FIGURE 2
UNIT HYDROGRAPH



Urban infrastructure flooding can result form excess precipitation entering the sewage system, but may also result from: damaged sections of the system, clogs or other barriers in the network, or repair work on one or more sections may increase the flow to other areas of the system. The hydrological cycle is important when trying to determine the causes of urban flooding, as the terrestrial and atmospheric interfaces play large roles upon incidence of urban floods. The potential of an area to "pond", that is, collect precipitation on the surface in depressions in the land is higher for area with more impermeable surfaces, is a function of the land cover and soil type. In some instances where the soil type is naturally impermeable (i.e. clay soils in Sarnia), ponding may occur naturally and frequently. Ponding also occurs in areas that are paved but not designed to drain. In Sarnia, the paving of the surface may have little effect on the drainage of the land, as it is naturally poorly drained. Urbanizing upon poorly drained land provides a more direct and faster conduit for ponded surface water to reach the sewage networks, as the area is usually designed to remove surface waters.

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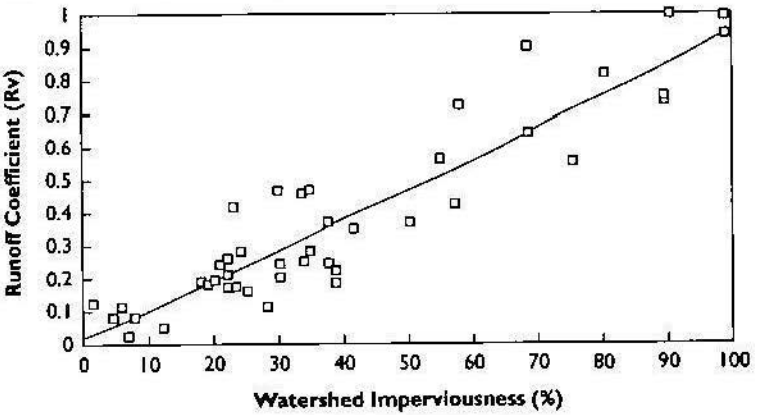

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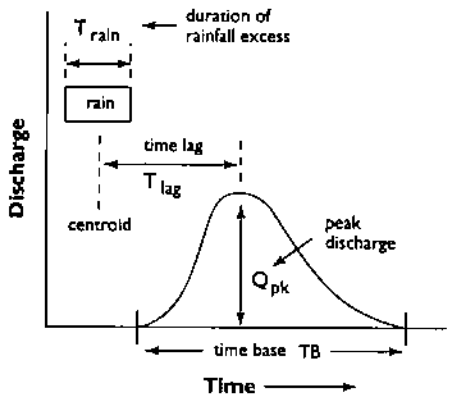

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3.1 Thunder Bay Decision

Residents in the City of Thunder Bay experienced urban flooding, related to a rainstorm event in June of 1991, and took the City to court to establish if the City was negligent and therefore, responsible for damage repair. The residents won their cases over the City of Thunder Bay in the Ontario Court of Justice, the Ontario Court of Appeals, and the Supreme Court of Canada in the fall of 1997. Two claims were based on sewer back-up, and two related to water-pipe failures. The court actions surrounding the sewer back-up cases established that the paving of streets contributed to flooding. The Municipal Engineers had published a report in 1965 that stated that the City's paving program and expansion of City drainage area for new development eliminates absorptive soils and therefore increases the quantity of runoff water and accelerates its movement towards the sewers. The overloading of the sewers was a result of the increased number of new homes, the paving of roads and private lands, and drains constructed to direct surface water to sewers. The report recommended that downspouts of homes that were connected to the sewers be disconnected, reducing the volume of water that immediately reached the sewers. Thunder Bay continued to develop new areas, increasing the area of paved land. The City did not adopt the recommendation to change its development plans or to disconnect downspouts. It maintained the direct link from downspouts to the sewer systems, allowing rainwater to directly enter the to the sewage network. The City was thereby found to be negligent.

The Thunder Bay case determined that under these specific circumstances, the City was liable. The case also addressed the more general implications of paving. Paving patterns are not considered to be problematic from the engineering perspective, as the technology currently exists to mitigate the flooding (i.e. storm water management plans, detention ponds) but the problem persists because municipalities do not necessarily apply these techniques.

3.2 Insurance

The subject of flooding poses a particular challenge to the insurance industry. MunichRe (1996) and PartnerRe (1997) have published reports that address the problem of flooding from the insurance perspective.

The question of how damage is inflicted on a property as a result of floods in urban areas is often unclear, since overland flow and sewage back-up can occur almost simultaneously. One of the key areas of misunderstanding is in the difference between sewer

back-up and overland flow. Sewer back-up occurs when the flow to the sewer system is so great that it is overloaded and the network of sewers backs up into basements. Overland flow is not covered by insurers, as damage done by this type of water inundation is by water flowing into homes through windows. Overland flow usually occurs in floodplains[2], when the river floods. Both types of floods can result from heavy precipitation, ice jams or snowmwelt, but only the damage caused by back-up is compensated for by insurers[3]. Policies can be extended to cover sewer back-up, but not for damages by surface water that entered from outside the sewage network.

The basic position of insurers is that they do not cover residential floods. They do, however, insure for the costs of sewage back-up, damage done to automobiles from floods and offer commercial flood coverage, which includes damage done to commercial property and business interruption.

Generally, the Winnipeg flood of 1997 had the industry following a concurrent causation principle, where insured property owners who were affected by sewer back-up and flood water damage were compensated (Canadian Insurance 1997). There were instances where some companies honoured all sewer back-p claims, and some did not, claiming that overland flow flood damage had occurred, and sewer back-up damage did not worsen the situation (Odam 1997).

Part of the problem may lie in the insurance industry's lack of understanding of the nature of flooding. They often use arguments that involve construction within the 100 year floodplain[4], while describing it as the area that is flooded once in 100 years (ODonnell 1997). Alternatively, they do not consider floods that occur in non floodplain areas as a separate type of claim. Sewage back-up in non floodplain claims are not a result of natural hydrological cycles, but may be the result of poor planning of neighborhoods and rapid urban growth.

The role of uncertainty is critical for the insurance industry, since weather patterns largely affect it. Changes in weather patterns (i.e. increased extreme precipitation) will change the expected return periods of floods, thereby changing the distribution of risk. Insurance industry risk assessment is based on historical data (White and Etkin 1997), not on regional predictions of future weather events in the context of climate change. When increased extreme weather events occur, the payout for insurers increases. Historical data can be misleading when the future trends of climate

change are difficult to detect (Nutter 1997). The industry recognizes that climate change and continued urbanization will influence future trends, as the Insurance Council of Canada stated, (1998) "... losses (are) exacerbated by population growth, urbanization, economic expansion and climate change". More frequent extreme events may be an indication of climate change, but there has been no research on the impacts of increases in extreme precipitation on urban areas.

The problem is often misunderstood by victims who believe that they should be compensated for their losses through insurance or through government assistance in a timely and comprehensive manner. Households and businesses may be insured, but when the causality of the events is unclear, the redress, if any, may not cover costs, and may not be from the insurance companies.

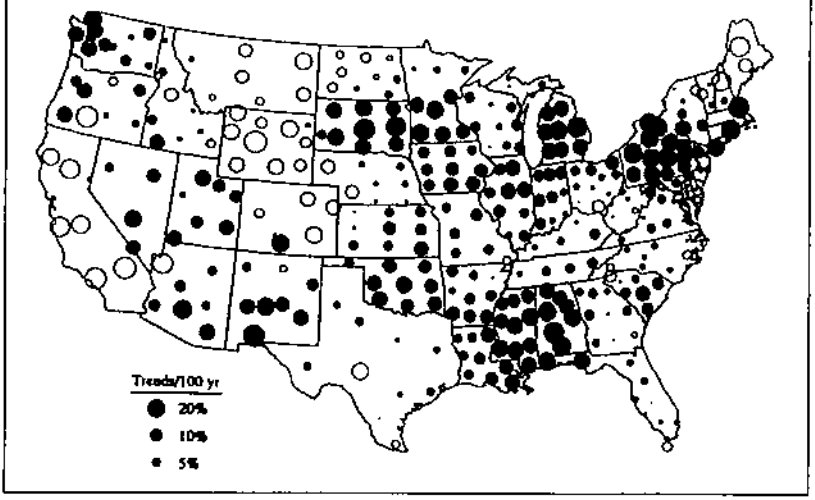
4.0 PRECIPITATION TRENDS IN SOUTHERN ONTARIO

The Canada Country Study is a national assessment of the social, biological and economic impacts of climate change for Canada (Mayer and Avis 1998). It determined that "an increase in flooding events is expected due to more intense rainfall and snowfall over localized areas in some regions..." However, existing meteorological definitions of flooding are narrow in scope, and cannot necessarily be applied to predict local urban flood events. For example, they do not consider the functions of soil permeability, topology or land use.

One determinant of infrastructure flooding, to be evaluated this study is increased extreme precipitation in the region. Karl et al. (1996) have measured an increasing trend in annual precipitation in the United States over the last century (Figure 3). Karl et al. (1996) defined extreme precipitation as an event where two or more inches (50.8 mm) of precipitation fall over one day. Their study shows that since 1970, the precipitation trend has remained above the 20th century mean, and averaged more than 5% greater than the previous seventy years (Karl et al. 1996). Karl et al. (1995, 1996) state that there is a clear increase in the areas of the United States affected by extreme precipitation (Figure 4). The increase in extreme precipitation occurs in all seasons in all regions of the continental United States, except for the west and southeast. This increase is equivalent to one additional extreme precipitation event

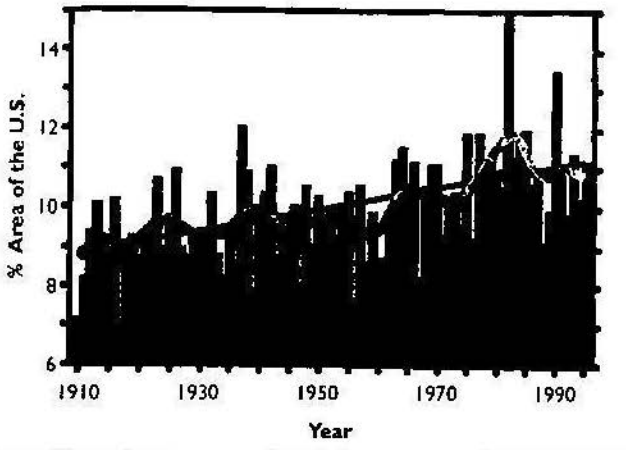
occurring every two years. The National Ocean and Atmospheric Administration (NOAA) has stated, with 90% probability, that the United States is experiencing more extreme weather events (Nutter 1997). Shriner et al. (1998) stated that, "annual precipitation amounts from 1901 to 1995 over North America *as a whole* show evidence of a gradual increase since the 1920's, reaching their highest levels in the past few decades".

FIGURE 3
ANNUAL PRECIPITATION TRENDS



Annual precipitation trends (1900-1994 converted to percent per century) centered within state climatic divisions are reflected by the diameter of the circle centered within each climatic division. Solid circles represent increases and open circles represent decreases. (Karl et al. 1996)

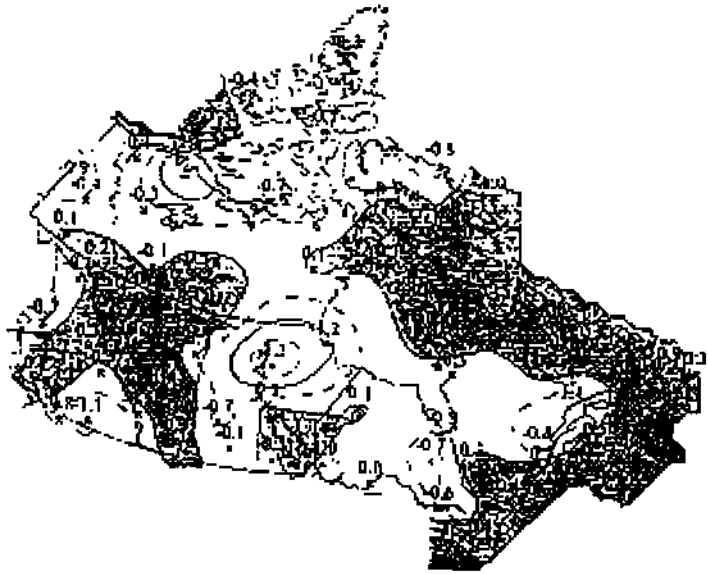
FIGURE 4
PERCENTAGE OF THE CONTERMINOUS U.S. AREA



Percentage of the conterminous U.S. area with a much above normal proportion of total annual precipitation from 1-day extreme events. (Karl et al. 1996)

If such a trend exists for extreme events in southern Ontario, increases in infrastructure flood events may occur. However, Hogg and Swail (1997) applied the methodology of Karl et al. (1996) to a Canadian study and came to a different conclusion. The Canadian extreme event was characterized as one half of the American extreme, (i.e., the American "heavy rainfall equivalent of 25 mm), but despite this reduction in threshold, there was no significant trend in Canada (Figure 5). In Canada, the 65 stations that were available for extreme value analysis were insufficient to determine the ratios of greater than normal values, so linear ratios were mapped. Hogg (1995) found no systematic increase in daily rainfall in Canada and no evidence of regional frequency increases of extreme rainfall. Hogg and Swail (1997) state that "The proportion of rain falling in events exceeding 25 mm has decreased, between 1910 and the present, at the majority of the 65 stations analysed. This doesn't mean that the area affected by above normal values is necessarily decreasing, but it certainly doesn't support Karl's finding in the United States". The regional trend for southern Ontario was a slight increase (0.1 mm), but was not statistically significant (Hengeveld pers. comm.).

FIGURE 5
MAP OF TREND



Map of trend of the fraction of annual precipitation falling in events greater than 25 mm/day. Units of trend are change/year 1000. Shaded area are increases, non-shaded areas are decreases. (Hogg 1997)

The precipitation literature supports different conclusions for extreme precipitation analysis. The international community (MunichRe 1997, Shriner et al. 1998) has suggested that the number of extreme precipitation events has been increasing. In addition, American studies have indeed measured an increase (Karl et al. 1996). However, Environment Canada (Hogg and Swail 1997) has not measured a change in extremes in Canada, and elsewhere it is reported that Canada expects to discover an increase in the future (Maxwell, Mayer and Street 1998, Francis and Hengeveld 1998).

Canadian weather stations are not as spatially concentrated as they are in the United States because the land mass is large, and the density of observation stations is low (Hogg et al. 1998). The spatially inhomogeneous nature of extreme events compounds the uncertainty in Canada. It is assumed that *changes* in extreme precipitation are "more spatially consistent than extreme precipitation itself, making it possible to describe changes in extreme precipitation conditions based on regionalized extreme indices or homogenous regions of extreme precipitation variation" (Hogg et al. 1998).

4.1 Climate Change

More frequent extreme weather events are predicted to accompany global warming, in part as a consequence of projected increases in convective activity (Shriner et al. 1998). More intense rainfall accompanying global warming is expected to increase the occurrence of floods in floodplains as well as the incidence of urban floods in non-floodplain areas.

The Canada Country Study (Maxwell, Mayer and Street 1998) considered how Canada will be affected by climate change and determined that "an increase in flooding events is expected due to more intense rainfall and snowfall over localized areas in some regions...".

There is a growing interest in softer approaches to stormwater management, including encouraging infiltration, and wet/dry ponds (Kinkead 1997). In the face of climate change, these soft approaches need to be more widespread in order to mitigate some impacts.

Francis and Hengeveld (1998) agree that weather extremes are becoming an increasingly serious problem, and that there is a reasonable possibility that climate change will intensify it. The extent of the exacerbation due to climate change is unclear at present, because the role of the natural fluctuations of extremes has not been determined. Severe weather as a feature of climate has not been adequately studied, and there are three key areas where further study is warranted: (i) there is a need for a better grasp of emerging trends, as the frequency of extreme weather needs to be more throughly examined; (ii) the use of historical records brings forth the questions of quality of the records and their comparability; and (iii) there needs to be a better understanding of natural variability. The extremes that are measured may or may not be part of the natural flux of climate and this should be further studied before policy can be made. The link between climate change and weather extremes is not clear because we lack complete understanding of the natural phenomenon (Francis and Hengeveld 1998). Global circulation models do not produce output at the appropriate scale to determine this relationship.

Extreme precipitation events are an indicator of climate change, and although the climate change—extreme events link is still emerging, if the trend can be determined for southern Ontario, urban infrastructure flooding may he partially explained. Once extreme precipitation trends for southern Ontario are resolved, than definitive policy decisions can be made, and appropriate mitigation and adaptation strategies can be developed.

4.2 The Intensity, Duration and Frequency of Rainfall Events

Stream flow information is not always available for all areas, so to determine sewage capacity needs, engineers turn to rainfall data to determine the peak flows over an area (Hogg and Carr 1989). The use of this data is based on the assumption that precipitation usually varies in a regular manner (Hogg and Carr 1989). The peak flow estimates can be determined using computer models, but the engineer must determine the maximum duration of the rainstorm that the system should be built to sustain and they must determine the frequency with which the capacity of the structure can be exceeded (or the return period of the storm) (Hogg and Carr 1989). Lawford et al. (1995) outlined that, "for a given rainfall amount, the runoff generated is dependent on the distribution of the city's permeable surfaces. Urban flood models can be calibrated for specific cities to account for this factor in infrastructure design. For most design applications, rainfall statistics are obtained from intensity, duration frequency curves using durations equal to or greater than the time for runoff from the farthest reaches of a river basin to reach the rivers mouth".

5.0 CONCLUSION

The phenomenon of urban infrastructure floods may be attributable to many factors. This paper considered the role of precipitation, land cover and to a lessor degree, sewage networks. Although the variables considered were simple, they could not be pursued to their fullest degree due to the limited data available. Single urban infrastructure flood events in a city do no indicate a pattern of floods, or establish the frequency of them, but this work considers the potential causes of flooding, rather than determining if a pattern exists. To determine if a pattern of urban infrastructure floods is emerging, a content analysis approach would be needed.

The detected extreme precipitation data in Canada is inconsistent with that measured in United States studies. The differences may lie in the different extreme value calculation, the different sample sizes or in latitude effects. The trends in the United States are not expected to be identical to those of Canada, but there should be a gradation of extreme precipitation over the border, not abrupt shifts (Hogg 1999 pers. comm.). The difference in the values over the border may be a latitude effect for the more western stations; the southern Ontario precipitation is expected to be similar to that of Michigan and New York.

The precipitation literature has not laid out a clear picture of whether extreme precipitation in southern Ontario is increasing. A regional study done for southern Ontario does has different results than the national study for the northeastern U.S. (Hogg and Swail 1997, Karl et al. 1996). This could be the result of a number of factors, but the geographical limits to both studies indicates that political boundaries determined the limits of the analysis. For a more comprehensive analysis, a North American climate zones study may prove to be more useful and may indicate the true trend of extremes. If the studies were conducted from a continental perspective, one that included data stations from the U.S and Canada, perhaps more harmonious conclusions can be drawn.

Climate change has implications for urban flooding, as expected increases in volume of flow, due to increases in rainfall, in urban areas will be carried by the sewage networks. This increase in flow may decrease the return period for the sewage pipes, causing more frequent infrastructure back-up and damage to homes. This can be alleviated if sewers were designed for expected trends in volume, but to date, there are no plans to expand sewer services to include the expected impact of climate change.

The insurance issues can only be resolved when the causality of urban floods is determined. This paper outlines a potential methodology to begin the process of discovering the origin of urban floods, and as it is refined, the causality will emerge. Causality remains to be determined, only then can homeowners be fairly compensated.

Upstream and downstream land users should co-ordinate on drainage and land use issues, as the behaviour of upstream land users will directly impact those downstream.

One of the obstacles to obtaining complete data sets of the land cover, sewage networks, floodplain and precipitation data was the lack of communication among the stakeholders. There are two sets of non-communicating stakeholders; insurers, homeowners and municipal governments, who do not share information on urban floods; and municipal governments and conservation authorities, who do not coordinate efforts when confronted with urban flood events. There is clearly value in establishing communication lines for municipal engineers and conservation area managers, if only to collect the appropriate data sets for studying urban floods. This lack of communication may contribute to the lack of integrated watershed management and the lack of preventative approaches to planning. If communication between these stakeholders was more

structured and information about land use was exchanged more readily, land use analysis and urban flood causality research could be more easily facilitated.

The gaps in the environmental management of Canadian cities have left no institution with primary responsibility for urban floods or their prediction. Urban floods need to be recognized as an important issue for insurers, municipalities and conservation authorities, because their impact can be massive. With proper planning and municipal responses, however, they should be avoidable.

The primary product of this paper is the development of the methodology and the determination of where gaps in resources exist. The next steps to further this research include filling the data gaps; which may take considerable resources, and further refinement of the methodology.

APPENDIX I
LIST OF INTERVIEWEES

Jeff Caden – Water Resources, St. Claire Conservation Authority

Barbara Gray – Regulations Officer, Rideau Valley Conservation Authority

Don Haley – Coordinator, Floodplain Management, Resource Science Section, Watershed Management Division, Toronto and Region Conservation Authority

Bill Hogg – Chief, Climate Monitoring and Data Interpretation Division, Climate Research Branch, Atmospheric Environment Service, Environment Canada

Grant Kelly – Institute for Catastrophic Loss Reduction

Chris Kocot – Atmospheric Environment Service, Environment Canada

Kevin Loughborough – Engineering, City of Toronto Public Works

Reg McMichael – Engineering Division, Works Department, City of Sarnia

Laurie Mennaman – Water Resources Planner, Ontanabee Conservation Authority

Don Poof-Engineering Department, City of Ottawa

Sandra Rakovac – Insurance Council of Canada

City of Peterborough Engineering Department, City Works

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☐ Notes

1. Combined sewage systems are those that carry both sanitary sewage and storm water. They were the first system to be used in Canada, and are slowly being replaced with separate sewer systems that carry the sanitary flow and the storm water in different pipes.

2. The relatively flat land stretching from either side of a river to the bottom of the valley walls. Floodplains are periodically inundated by the river water, and is defined by municipalities as the furthest extent of the one in one hundred year flood.

3. Compensation is only available to residential and commercial buildings in Ontario.

4. Municipally defined floodplains are areas which have a 1/100 probability of flooding, independent of flood events the previous year.

PRÉVISION DU RISQUE ET TARIFICATION : LE RÔLE DU BONUS-MALUS FRANÇAIS

par Michel Grun-Réhomme

RESUME

Le bonus-malus intervient dans la prime payée par l'assuré et permet aux assureurs de conserver une information sur les assnrés, disponible pour l'ensemble des acteurs du marché. On se propose, dans cet article, de faire le point sur cette question. Les données présentées ici proviennent d'une mutuelle française d'assurance automobile et sont représentatives de la situation que l'on rencontre en France dans les autres grandes assurances mutualistes sans intermédiaires ou dans les compagnies traditionnelles.

Mots clés : variables observables et non observables, tarification, risque, bonus-malus.

ABSTRACT

The « bonus-malus » is a factor of the insurance premium paid by policyholders nnd it allows insurers to store information on policyholders, that becomes available for all the actors of the market. We propose in this article to review this issue. Data presented here come from a French mutual automobile insurance company and are representative of the situation in France in other large mutual insurance companies or in traditional companies.

***Keywords**: observable and not observable variables, tariffing, risk, bonus-malus.*

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INTRODUCTION

Le coefficient réduction majoration (le bonus-malus) est un mécanisme qui permet d'ajuster la prime d'assurance automobile payée par l'assuré, en fonction de sa conduite observée au cours des périodes antérieures (cf. Petit Dictionnaire de l'économie de l'assurance, 1994). Il permet donc à la compagnie d'assurance d'intégrer le niveau de risque réel de l'assuré (évaluation incertaine de ce niveau de risque) dans la tarification comme élément de crédibilité de l'historique individuel. C'est alors un outil de tarification a posteriori à l'intérieur de chaque classe de tarification, basée sur d'autres facteurs explicatifs du risque liés au conducteur, au véhicule et à la zone géographique (Dionne et Vanasse, 1992 et Henriet et Rochet, 1991).

1. LA SINISTRALITÉ

Si le risque d'accidents menace tous les individus, seule une partie d'entre eux sera atteinte. Du point de vue de l'assuré, la solidarité en matière d'assurance automobile a ses limites. Les assurés n'ont pas des véhicules équivalents et les coûts de réparation d'un véhicule diffèrent selon la valeur marchande du véhicule et de ses pièces détachées. En général, les assurés ne veulent pas payer pour les autres, estimant aussi qu'un comportement riscophobe et que la responsabilité reconnue d'un conducteur lors d'un sinistre ne sont pas le fruit du hasard (conduite en état d'ivresse, vitesse excessive, non respect de la signalisation).

Les assureurs conscients de cet opinion proposent des tarifs ajustés au risque. Pour obtenir un versement préalable d'un montant raisonnable, destiné à couvrir les futurs sinistres, il est nécessaire de pouvoir estimer avec suffisamment de précision la charge totale des sinistres, à partir d'une classification des risques du portefeuille. La première étape consiste donc à élaborer des classes « homogènes » de risque pour les différentes garanties : responsabilité civile, dommages au véhicule, vol.

L'homogénéité d'une classe de risque est définie à l'aide de caractéristiques liées aux conducteurs (âge, catégorie socioprofessionnelle, sexe, ...), aux véhicules (puissance, groupe, ...) et à la zone géographique (cf. Grun-Réhomme, 1998). Si on considère un

contrat extrait d'une classe homogène de risques, cette classe est donc caractérisée par cette composante observable (âge, véhicule, ...), mais aussi par une variable inobservable résiduelle individuelle qui prend en compte la variété des comportements face au risque. Dans les approches économétriques paramétriques de l'analyse du risque, on suppose que cette composante inobservable suit une loi gamma de paramètre a, de moyenne 1 et de variance 1/a. D'autres modèles utilisent une approche semi-paramétrique basée sur une estimation des moments des effets aléatoires.

L'homogénéisation des risques est une condition nécessaire à la mutualisation des risques, qui conduit, selon un premier ordre d'approximation, à une valeur équitable d'une prime uniforme. Mais une individualisation insuffisante de la prime peut aussi conduire à une surtarification des « bons risques » au profit des « mauvais risques », induisant notamment un phénomène d'antisélection. D'autre part, on montre qu'il existe un équilibre de Nash où les « mauvais » risques choisissent la couverture totale et les « bons » risques, une couverture partielle (Rothschild et Stiglitz, 1976).

Il est nécessaire de faire une distinction entre risque individuel et risque collectif. Plus précisément, l'idée consiste à calculer une prime individuelle comme somme pondérée d'une composante collective et d'une composante strictement individuelle. La composante collective est la prime actuarielle destinée à compenser le risque collectif de la classe homogène à laquelle est rattaché l'assuré. La composante individuelle, mesurée par le coefficient réduction majoration (crm ou bonus-malus), est destinée à corriger la première composante pour tenir compte de l'écart entre le risque individuel et le risque collectif (de sa classe). La prime individuelle étant, par exemple, une combinaison convexe des deux composantes :

$$y = (1 - \alpha)\, c + \alpha x$$

où c est la prime actuarielle collective et une composante individuelle basée sur le crm ou sur la moyenne temporelle des montants des sinistres subis par l'assuré dans le passé et α, compris entre 0 et 1, est un facteur de crédibilité qui permet d'appréhender le risque propre avec une confiance suffisante. La prime peut aussi être calculée selon une règle de compensation fondée sur l'espérance conditionnelle $E(C/\Delta)$, où C est la variable représentative du risque collectif et Δ les facteurs de risques inobservables. Le crm intervient comme un élément de crédibilité de l'intégration du risque dans la tarification.

2. LA TARIFICATION

Tout assureur cherche à estimer au mieux ses sociétaires ou sa clientèle et à offrir des contrats différenciés par classes de risques. Si un assureur proposait le même contrat, un contrat indifférencié, il attirerait les mauvais risques dans une situation concurrentielle, où un autre assureur proposerait des contrats différenciés avec une plus faible prime mais une franchise plus élevée (principe de l'antisélection).

Dans la pratique, le passage d'une modélisation du risque (responsabilité civile, dommages au véhicule, vol) à la tarification n'est pas immédiat. Certes des considérations liées à la politique de la direction de l'entreprise et à l'analyse de la concurrence peuvent intervenir pour moduler l'adéquation du risque aux cotisations, mais nonobstant ces considérations, des difficultés proviennent de l'application de la réglementation sur le bonus-malus.

Deux stratégies sont possibles dans l'utilisation du coefficient réduction majoration (bonus-malus) pour la tarification :

- La première consiste à utiliser le bonus a priori. On considère le bonus comme une variable de tarification, explicative du risque, identique aux autres. Le bonus participe donc à la prévision du risque pur. Ensuite il faut trouver une démarche qui respecte la hiérarchisation des classes de risque et la législation.
- La seconde consiste à utiliser le bonus a posteriori. Le modèle de prévision est le même que dans le cas précédent, mais on calcule une prime de référence pour chaque classe de risque après suppression de l'effet résiduel « perturbateur » du bonus. La cotisation payée alors par l'assuré fait intervenir cette prime de référence et le coefficient de réduction majoration (Pinquet, 1999). C'est, en général, cette seconde stratégie qui est mise en place.

La tarification a priori, basée uniquement sur la composante collective, présente donc des imperfections et le système bonus-malus vient affiner a posteriori les estimations. Une modélisation de la tarification a priori est proposée par Henriet et Rochet, 1991. Par ailleurs, on sait que le kilométrage parcouru et le nombre d'accidents responsables et non responsables que l'assuré a eus dans le passé (qualité de la conduite) sont de bons indicateurs du comportement du conducteur, qui peuvent pallier l'antisélection, mais ces variables sont, en général, inobservables. On peut rendre cette variable observable par la lecture du compteur kilométrique ou par la mise en place d'un autre compteur, mais une telle disposition

pose un problème de fiabilité et rencontre des obstacles commerciaux. En effet cette mesure est, en général, mal perçue par l'assuré. On peut aussi intervenir au niveau de la franchise. La tarification a posteriori a les mêmes effets que la franchise obligatoire imposée dans certains contrats. Les franchises rachetables constituent une autre alternative.

La démarche généralement adoptée par les assureurs consiste à utiliser des variables observables plus ou moins corrélées à cette variable inobservable du kilométrage parcouru et le bonus-malus pour traduire le passé du conducteur.

Une enquête de l'I.N.S.E.E. auprès des ménages sur l'utilisation de l'automobile en 1990 met en évidence des corrélations et la pertinence des facteurs explicatifs retenus.

La moyenne estimée pour l'ensemble de la population du kilométrage annuel parcouru est de 12 800 km, avec bien sûr des variations selon l'âge, le sexe et la profession. Cette moyenne est de 13 400 pour les hommes et de 11 600 pour les femmes. Les personnes âgées parcourent moins de kilomètres que les autres, 9 900 km pour les 60 à 65 ans et seulement 7 900 km pour les plus de 65 ans. Les cadres supérieurs (17 400) et les professions libérales (16 800) roulent plus que les autres catégories professionnelles et, à l'opposé, les exploitants agricoles parcourent moins de km (10 200) que les autres. La moyenne annuelle de kilomètres parcourus est une fonction décroissante de l'ancienneté du véhicule ou de l'ancienneté d'acquisition du véhicule.

La fréquence des sinistres déclarés par les ménages est une fonction croissante du coefficient de réduction majoration et une fonction logarithmique croissante du kilométrage annuel parcouru.

La tarification doit retenir suffisamment de facteurs explicatifs du risque sans pour autant retenir de l'information redondante. Le stockage de l'information a un certain coût et la liaison entre deux facteurs peut produire des estimateurs de mauvaise qualité et des effets de surpondération dans le risque. De plus, pour obtenir une certaine stabilité dans le temps des indicateurs de risque (fréquence, coûts) dans chacune des classes, il est nécessaire d'avoir un effectif suffisamment grand (cf. Grun-Réhomme, 1998), ce qui donne un avantage aux assureurs qui possèdent un portefeuille important.

Dans les mutuelles sans intermédiaires, les tarifs sont simplifiés car ils s'adressent en général à des segments du marché plus homogènes, alors que les compagnies traditionnelles ont souvent des modèles plus complexes, des segments plus différenciés et des tarifs plus divers.

Une segmentation très fine des différents risques semble illusoire, comme le montre la modélisation (cf. Henriet et Rochet, 1991); il s'agit toutefois de mettre en évidence les bons risques, les très mauvais risques et d'avoir une échelle de comparaison entre les risques.

D'autre part, l'utilisation du coefficient de réduction majoration doit inciter le conducteur à la prudence pour réduire la fréquence des sinistres, et à ne pas déclarer les petits sinistres.

3. QUELQUES PROPRIÉTÉS DU BONUS-MALUS FRANÇAIS

La clause française du bonus-malus a été adoptée en 1984 et c'est le seul système européen multiplicatif. En effet, à chaque sinistre dans l'année, la prime est multipliée par un coefficient de majoration fixe et à l'inverse par un coefficient inférieur à 1 en cas de non sinistre.

Le coefficient réduction majoration ne fait intervenir que la fréquence des sinistres survenus, ainsi que leur distribution dans le temps, et non le coût de ces sinistres. Besson et Partrat (1992) ont utilisé les lois Poisson-Gamma et Poisson-inverse gaussienne pour modéliser la fréquence des sinistres.

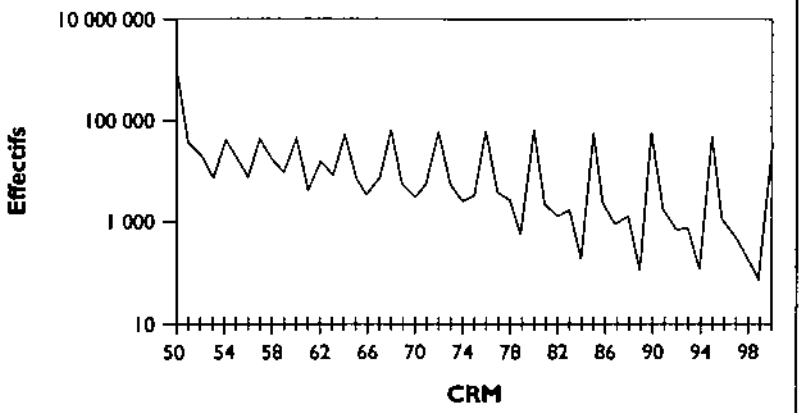
Rappelons que la première année d'assurance, le coefficient réduction majoration est égal à 1,00, et qu'il est réévalué chaque année. Si l'assuré n'a eu aucun sinistre responsable, le coefficient est multiplié par 0,95 avec une règle pour les arrondis en utilisant la partie entière, il est multiplié par 1,25 pour chaque sinistre 100 % responsable et par 1,125 pour les sinistres à torts partagés. En aucun cas, le coefficient ne pourra dépasser 3,50 ou passer en dessous de 0,50. Dans un portefeuille, on trouve, en général toutes les valeurs entre 0,50 et 1,70 (ou 2,00); après, la population étant moins importante, on constate une discontinuité dans cette suite. Si l'assuré reste deux ans sans sinistre, il ne peut avoir un coefficient supérieur à 1 (cf. lignes 4 et 6 du tableau suivant). Si l'assuré reste trois ans avec un bonus égal à 0,50, le premier sinistre 100 % responsable peut ne pas affecter le coefficient. Sans sinistre, le bonus passe de 1,00 à 0,50 en 13 ans.

Quelques exemples de la valeur du bonus-malus, sur 5 ans, en fonction de la sinistralité :

Situation	1	2	3	4	5
Aucun sinistre	1,00	0,95	0,90	0,85	0,80
Aucun sinistre sur 10 ans	0,76	0,72	0,68	0,64	0,60
Aucun sinistre sur 15 ans	0,57	0,54	0,51	0,50	0,50
1 sinistre 100 % responsable la 1re année	1,00	1,25	1,18	1,00	0,95
1 sinistre 100 % responsable la 3e année	1,00	0,95	0,90	1,12	1,06
1 sinistre la 1re année à torts partagés	1,00	1,12	1,06	1,00	0,95
2 sinistres 100 % responsables aux dates 2 et 4	1,00	0,95	1,19	1,03	1,29

Les résultats présentés maintenant sont également valables pour les autres assureurs dont le portefeuille a une taille suffisante pour qu'il soit possible de se situer dans un contexte de loi des grands nombres.

GRAPHIQUE 1
DISTRIBUTION DES EFFECTIFS (ÉCHELLE LOGARITHMIQUE) SELON LE BONUS-MALUS (ENTRE 50 ET 100)

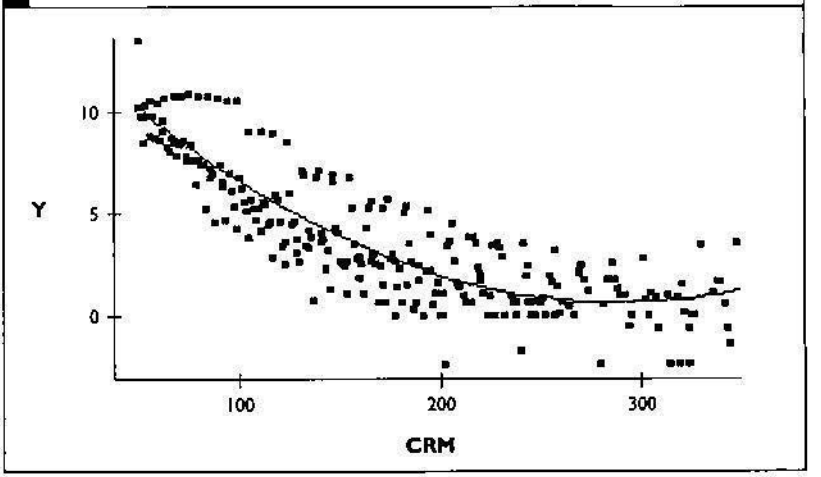


Bien évidemment, certaines valeurs du crm sont plus fréquentes que d'autres. Il est fréquent de trouver un crm égal à 50 (ou 0,50) pour plus de 50 % des assurés d'une compagnie d'assurance. D'autre part, la proportion d'assurés dont le crm est compris, au sens large, entre 0,50 et 1,00 se situe aux alentours des 97 %, voire 98 %. Le crm moyen est de l'ordre de 0,62.

Comme le montre le graphique précédent, la répartition des assurés (en réalité, le nombre de véhicules années assurés) selon le crm présente une périodicité qui varie avec le crm. Vu la règle des 5 % de baisse relative des crm en l'absence de sinistres, une « période » de 3 correspond au bonus absolu des conducteurs dont le crm est compris entre 0,53 et 0,60, une « période » de 4 correspond au bonus absolu des conducteurs dont le crm est compris entre 0,61 et 0,80, etc. Les valeurs modales correspondent aux trajets les plus courants : retour au bonus maximum des conducteurs qui viennent d'être responsables d'un sinistre (d'où une valeur moyenne à 0,62), et trajet vers le bonus maximum pour les jeunes conducteurs. Pour des malus supérieurs à 2,00, l'effectif devient relativement faible.

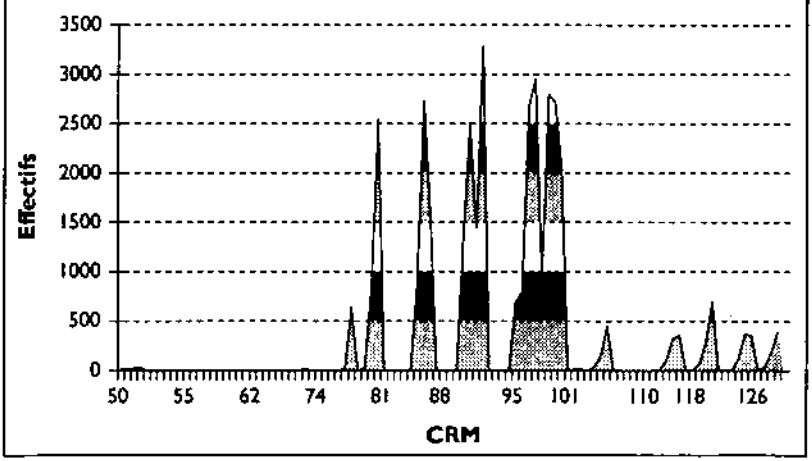
Le graphique suivant représente l'ensemble du portefeuille. L'axe des abscisses correspond au coefficient réduction majoration et l'axe des ordonnées au logarithme du nombre de véhicules années assurés. Une modélisation log-quadratique permet d'expliquer les $^3/_4$ de la dispersion du portefeuille.

GRAPHIQUE 2
DISTRIBUTION DE L'ENSEMBLE DU PORTEFEUILLE (ÉCHELLE LOGARITHMIQUE) EN FONCTION DU BONUS-MALUS



Bien sûr, le bonus-malus n'est pas indépendant de l'ancienneté de permis et de l'âge du conducteur, et ceci est particulièrement vrai pour les jeunes. Il est globalement une fonction décroissante de l'ancienneté de permis et de l'âge du conducteur. Entre l'âge et l'ancienneté de permis, le coefficient de corrélation linéaire varie autour de 0,85 selon les compagnies d'assurance.

GRAPHIQUE 3
DISTRIBUTION DES EFFECTIFS DES 18-22 ANS SELON LE CRM



On constate, pour les jeunes, des pics non négligeables au dessus de 1,00. Pour eux, la proportion de malus est plus importante que dans l'ensemble de la population, avec un net avantage pour les filles. Les jeunes filles sont dans l'ensemble meilleures conductrices que les jeunes garçons. Grosso modo, le risque est multiplié par 3 pour les jeunes garçons et par 2 pour les jeunes filles.

■ CONCLUSION

Les graphiques précédents permettent d'effectuer des comparaisons entre différentes mutuelles ou compagnies d'assurance. Ainsi chacune peut quantifier son portefeuille au niveau des bons et des mauvais risques. Même s'il nous a été possible d'effectuer quelques comparaisons, le respect de la confidentialité des résultats ne nous permet pas de présenter ces comparaisons.

La précédente Commission Européenne de Bruxelles avait formulé des injonctions à la France de ne plus utiliser de façon réglementaire le système bonus-malus. Les assureurs français (mutuelles et compagnies traditionnelles), pour une fois solidaires, souhaitent continuer d'appliquer le système bonus-malus tel qu'il est, l'argumentation reposant sur le désir des assureurs de garder ce coefficient comme résumé du comportement de l'assuré lorsque celui-ci

change d'assureur. Ils ont donc fait pression auprès du gouvernement et ont obtenu gain de cause, à savoir que la France soutiendra la position des assureurs. Après le changement de commission, on peut penser que le système restera encore en vigueur pendant 3 ou 4 ans.

Bien évidemment, il sera toujours possible d'utiliser le système bonus-malus en interne. La question se posera seulement pour les assurés qui changent d'assurance, mais on peut penser qu'un relevé des accidents sur les trois dernières années suivra l'assuré et que les différentes assurances se transmettront les informations.

Le rôle premier du crm n'est pas la tarification (les assureurs fixent librement la prime de base), mais la conservation d'une information sur les assurés, disponible pour l'ensemble des acteurs du marché.

À l'heure actuelle, certaines compagnies d'assurances préparent des systèmes alternatifs, dont la teneur reste secrète. Une tarification a posteriori basée sur le nombre de kilomètres parcourus semble difficile à mettre en place pour des raisons commerciales et pour le manque de fiabilité d'une telle démarche (compteur trafiqué).

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FINANCIAL RISK MANAGEMENT IN THE INSURANCE INDUSTRY

by J. David Cummins, Richard D. Phillips and Stephen D. Smith

ABSTRACT

This paper has two objectives. The first objective is to survey the finance literature on corporate hedging and financial risk management with an emphasis on how the general literature applies in insurance. We begin by reviewing the theoretical rationales for widely-held, risk-neutral, profit-maximizing firms to practice risk management and then go on to discuss the empirical literature on corporate hedging. The second objective is to develop a theoretical model to provide a new explain of why widely-held insurers manage risk. Insurers are hypothesized to invest in multiple period, private assets where the payoffs are not fully realized if the assets have to be liquidated prior to their expiration. Avoiding adverse shocks to capital that would trigger a liquidation provides the motivation for risk management in our model.

Keywords: Risk management, corporate hedging, private information, financial intermediaries, insurance.

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RÉSUMÉ

Les objectifs de cette étude sont doubles. Le premier est d'examiner la littérature financière sur la couverture des entreprises et la gestion des risques financiers avec une emphase sur l'application de la littérature générale en assurance. Nous commençons par revoir les déterminants théoriques pour que les grandes entreprises, neutres aux risques et maximisant leurs profits, entreprennent une gestion des risques. Ensuite, nous discutons de la littérature empirique sur la couverture des entreprises.

Le deuxième objectif est de développer un modèle théorique fournissant un nouveau déterminant pour que les grands assureurs gèrent leur risque. Les assureurs sont supposés investir sur des horizons sur plusieurs périodes, dans des actifs privés pour lesquels les payoffs *ne sont pas totalement réalisés, lorsque ceux-ci doivent être liquides avant leur expiration.*

Éviter des mauvais chocs au capital qui enclencheraient une liquidation fournit une motivation dans notre modèle pour la gestion des risques.

***Mots clés** : Gestion des risques, couverture des entreprises, renseignements confidentiels, intermédiaires financiers, assurance.*

I. INTRODUCTION

This paper has two objectives. The first objective is to provide a survey of the literature on corporate hedging and financial risk management with an emphasis on how the general literature applies in insurance. We begin by reviewing the theoretical rationales for risk-neutral, profit-maximizing firms to practice risk management and then go on to discuss the empirical literature on corporate hedging. The second objective is to develop a new theoretical model to explain why the managers of risk-neutral insurance companies engage in risk management.[1] Insurers are hypothesized to invest in multiple period, private assets where the payoffs are not fully realized if the assets have to be liquidated prior to their expiration. Avoiding adverse shocks to capital that would trigger a liquidation provides the motivation for risk management in our model.

This paper draws upon three strands of modern financial theory. The first strand is perfect-markets asset pricing theory as applied to widely held firms whose shares are traded in frictionless and complete markets. This theory is based on the assumption that shares are owned by diversified investors, who eliminate non-systematic risk through their portfolio choices.[2] Investors are risk averse and choose portfolios that are optimal in terms of their taste for risk. In its simplest form, the theory envisions investors as balancing risk and return by choosing portfolios that are linear combinations of a

riskless asset (e.g., Treasury bills) and the market portfolio of risky assets. Because investors can achieve an optimal risk-return position by varying the weights placed on the riskless asset and the market portfolio, such investors do not want the individual corporations that constitute the market portfolio to manage non-systematic risk. Rather, investors want firms to maximize the market value of their net worth. In perfect markets financial theory, this generally implies that firms should be risk neutral, i.e., they should take advantage of any projects available to them that have positive net present values, without regard to non-systematic project risk.[3] Because corporate risk management is costly (e.g., because it requires the use of costly managerial resources, the payment of premia for options and other derivatives used to manage risk, etc.) and because investors can engage in "home-made" risk management, expenditures on risk management at the corporate level constitute a deadweight loss to investors.

The second strand of financial theory discussed in this paper attempts to explain the existence of corporate risk management. This theory was developed because it has been observed that corporations do manage risk, in spite of the strong proscription against this type of activity in perfect-markets financial theory. In fact, the existence of corporate risk management can be explained by reference to *imperfections* in financial markets. Financial theorists have identified two broad categories of imperfections to explain the existence of corporate risk management. One class of imperfections consists of factors that impose costs on firms that do not manage risk. Managing risk in response to these imperfections is generally value maximizing, i.e., the market value of corporate net worth will be higher if this type of risk management is carried out than if it is not. The second class of imperfections that motivate risk management are typically associated with managerial behavior, i.e., instead of maximizing the value of the firm, managers may maximize their own utility. The extent to which these behaviors is consistent with value maximization is unclear. If risk management is costless then allowing managers to hedge risk at the corporate level may be value enhancing to the extent risk averse managers demand less compensation due to the decreased likelihood that adverse outcomes will threaten their job security. However, if risk management is costly then shareholders may have to undertake certain activities, such as the development of incentive-based compensation contracts or undertake costly monitoring, to ensure the resources of the firm are devoted to the maximization of the firm's net worth and not the manager's own utility. The value maximizing and managerial risk aversion motivations for risk management are discussed in detail in section 2.

The third strand of financial theory explored in this paper deals with information asymmetries and private information, both of which are assumed away in perfect markets financial theory. This theory views insurers as financial intermediaries that borrow funds from policyholders by issuing insurance policies and then "intermediate" these funds into portfolios of invested assets. Asymmetrical information and private information can be present in both the underwriting and the investment operations of an insurer. Information asymmetries are generally present between the company and its policyholders as the policyholders typically know more about their risk characteristics than does the insurer. This information asymmetry can lead to the problem adverse selection and, in the extreme case, lead the market to fail as explained in the important article by Rothschild and Stiglitz (1976) as well as much subsequent research. The company-policyholder asymmetry also presents an opportunity for the insurer to develop *private information*, i.e., information on its policyholders that is known by the insurer but not by its competitors. By insuring a policyholder over a period of time, the insurer acquires information on the policyholder's risk characteristics that is not available to competing insurers. The insurer may be able to exploit this private information to earn economic rents from policyholders that have been with the company for a period of time (see D'Arcy and Doherty 1990).

Financial intermediaries also can acquire private information in their investment operations. Generally, this involves acquiring more information about a borrower or a complex security than is possessed by the market as a whole. For example, there is considerable evidence that banks acquire information about certain types of borrowers that is difficult for other investors to replicate (Diamond 1991). This information gives banks a competitive advantage over other banks and the capital markets in dealing with these borrowers; and banks can exploit this information to earn economic rents (Rajan 1992). Likewise, insurers have an informational advantage in investing in certain types of assets. E.g., life insurers are the major source of privately placed bonds in the U.S. capital market. Privately placed bonds are analogous to bank loans in terms of providing opportunities for insurers to gain an informational advantage.[4] Insurers also invest in structured securities and other complex long-dated financial assets where the expected return on the assets may be higher due to the level of private information they contain.

In this paper, we provide a new rationale for corporate risk management based on private information. We develop a model motivated by the observation that insurers engage in contracts

covering multiple time periods for which the payoffs on those contracts may not be fully realized until they expire. For example, D'Arcy and Doherty (1990) provide empirical evidence that insurers may be willing to underprice (take a loss on) newly issued policies based on rents they expect to earn from the subset of new policyholders who stay with the company for a period of years. The motivation for underpricing new policies is that insurers cannot fully discriminate between good and bad risks who are applicants for insurance. However, by observing policyholders over a period of time, they are able to identify the bad risks and either charge them higher premiums or eliminate them from the policyholder pool. Insurers earn a profit on the good risks that remain that more than offsets the losses created by having some bad risks in the pool at the outset. The good risks are hypothesized to remain with the insurer even though their premiums are higher than would be experienced in an informationally efficient, competitive market because competitors do not observe the private information that has been accumulated and hence cannot distinguish the good risks from the bad risks that have been eliminated from the pool. Thus, the good risks do not have an incentive to leave the insurer and go back into the market.[5]

We refer to contractual relationships in which insurers earn economic rents from private information as *private assets* – a term encompassing both insurance policy relationships as well as investments such as privately placed bonds and other opaque assets. In our model, we assume that private assets must be held for a specified period of time in order for positive rents to be realized. We make the simplifying assumption that if insurers are forced to liquidate some or all of their positions in the private assets at some intervening time period due to a shock to the capital resources of the firm, they will only collect the par value of their investment and therefore be forced to pass up the opportunity to realize the benefits of private information. In the case of insurance policies, an adverse shock to capital may lead to a ratings downgrade or regulatory intervention that causes a "flight to quality" by the insurer's profitable long-term policyholders. In the case of investments, an adverse shock may create cash flow problems that require the insurer to liquidate long-dated private investments on unfavorable terms.

Insurers can reduce the probability of having to liquidate their positions in private assets in the intervening time periods in one of two ways. First, they can reduce the level of investment they make in the private assets and hold additional levels of cash (or some other highly liquid security). The cost of adopting such a strategy is

the opportunity cost of not being able to more fully participate in a private asset with a higher expected return. This is a particularly serious problem if the private asset involves the firm's core business, as in the case of an insurer issuing insurance policies. Alternatively, insurers can engage in risk management to reduce the chance that a given shock to capital will require liquidation of the private asset. To the extent that practicing risk management is less costly than holding cash, insurers will have an incentive to transfer as much of the risk of the shock away from the firm as they can.

The theories we discuss in this article are quite general and also provide motivations for non-insurance firms to manage risk. However, there are two principal reasons why the discussion should be of particular interest to insurance economists: (1) Because of the nature of insurance enterprise, financial firms such as insurers are more susceptible to the agency costs associated with shareholder/manager and shareholder/customer informational asymmetries than are corporations in general. For example, insurers tend to invest in liquid asset classes which can be subject to rapid change. Financial firms thus can enter, exit, expand, and contract businesses rapidly, making them difficult to monitor effectively (Merton and Perold 1993, Perold 1999). In addition, financial firms are "opaque" in the sense that some of their activities are not publicly disclosed or disclosed only with significant time lags (Ross 1989). For example, insurers do not publicly report the adequacy of loss reserves and they disclose detailed data on their asset portfolios only in their annual regulatory statements. Information asymmetries are also endemic in the relationship between insurers and their customers. It is not a coincidence that Rothschild and Stiglitz (1976) and many subsequent papers on adverse selection have used insurance markets as the primary example of adverse selection. Thus, the deadweight costs of capital due to informational asymmetries are particularly severe in this industry which should lead to a higher demand for risk management by insurers. (2) As financial intermediaries, the suppliers of an insurer's debt capital are also its customers; and the customers of an insurer are particularly averse to insolvency risk (credit quality) and will strictly prefer to conduct business with highly rated firms (Merton and Perold 1993; Phillips, Cummins, and Allen 1998).[6]

The paper proceeds as follows: Section 2 provides a brief overview of the financial rationale for corporate hedging from the prior literature. Section 3 provides a summary of the empirical evidence investigating the economic factors associated with risk management and the use of derivative securities. In section 4, we present our theoretical analysis providing a new rationale for corporate hedging. Section 5 concludes the paper.

■ 2. THE RATIONALE FOR CORPORATE RISK MANAGEMENT: A SURVEY OF RECENT LITERATURE

As mentioned above, a perfect-markets approach financial theory views corporate risk management as creating deadweight costs that reduce firm value. However, because widely held corporations do engage in risk management, researchers have developed a richer set of hypotheses to explain why corporations manage risk. One set of motivations for risk management are viewed as contributing to the maximization of firm value. These factors include various market imperfections, incentive conflicts, and information asymmetries that are hypothesized to create motivations for value-maximizing corporate managers to engage in hedging activities (see, for example, Smith and Stulz 1985, Froot, Scharfstein, and Stein 1993, Stulz 1996, and Tufano 1996). However, it is also recognized that corporations may engage in risk management activities based upon objective functions other than those that are purely value-maximizing. Such activities typically arise due to managerial risk aversion and imperfectly controlled incentive conflicts between managers and owners (Smith and Stulz 1985, Stulz 1996). This section reviews the literature that explains both the value maximizing and alternative motivations for corporate hedging.

□ Value Maximizing Motivations for Hedging

One rationale for value-maximizing firms to engage in hedging activities is the avoidance of the costs of financial distress. Financial distress costs include the direct costs of bankruptcy such as legal fees and court costs. Financial distress costs also encompass indirect costs that arise even if the insurer does not enter bankruptcy, such as reputational losses and the disruption of relationships with employees, suppliers, and customers. For example, key managers may seek employment elsewhere if the firm encounters financial difficulties, suppliers may be reluctant to grant trade credit to a financially vulnerable firm, and customers may shift their business to competing firms in a "flight to quality."[7]

Financial distress costs also can arise if cash flows are adversely affected by unhedged risks that force managers to forego profitable investment projects. This is the classic under-investment problem, first identified by Myers (1977).[8] The under-investment problem arises because the presence of debt in the firm's capital structure may lead the firm to forego positive net present value projects if the

gains primarily accrue to bond holders rather than shareholders. The problem is more likely to occur in highly leveraged firms, providing a motivation for firms to hedge to avoid shocks to equity that result in high leverage ratios. A related problem, identified by Froot, Scharfstein, and Stein (1993) arises if external funds are more costly than internal funds, due to, say, information asymmetries between managers and shareholders. For example, managers are likely to be better informed about the expected cash flows from a potential project than are shareholders. Firms may hedge to reduce the volatility of their cash flows and thus help to ensure the availability of internal funds to take advantage of attractive projects.

The hypothesis that firms engage in risk management to avoid financial distress costs seems particularly applicable to the insurance industry. In the insurance industry, managers are likely to have more information about the adequacy of loss reserves than do the insurer's owners, leading to higher costs for external than for internal capital. In addition, insurers are subject to stringent state solvency regulation, enforced through regulatory site audits, detailed reporting requirements, and computerized audit ratio tests (see Klein 1995). Recently adopted risk-based capital standards require insurance commissioners to institute corrective action and ultimately to seize control of financially troubled insurers when their equity capital falls below certain thresholds. This regulatory "option" on the equity of the firm reduces the value of the owners' interest in the firm (Cummins, Harrington, and Niehaus 1993). Both corporate and personal lines policyholders are very sensitive to an insurer's financial ratings and are likely to take their business elsewhere if the insurer's financial condition begins to deteriorate.

There are a number of risks faced by insurers that may motivate them to hedge using derivatives and other risk management strategies (Santomero and Babbel 1997). Both life and property-liability insurers issue insurance contracts that create liabilities with maturities of fifteen years or more, and both types of insurers tend to invest heavily in long-term financial assets such as bonds. These long-term assets and liabilities expose insurers to interest rate risk that can adversely affect the market values of assets, liabilities, and equity. The empirical evidence suggests that both property-liability and life insurers tend to have positive equity duration gaps, with the duration of assets exceeding the duration of liabilities (Cummins and Weiss 1991, Staking and Babbel 1995), and insurers seek to hedge the resulting duration and convexity risk (Santomero and Babbel 1997).[9]

In addition to high-grade, publicly-traded bonds, insurers also invest in assets with higher default risk, higher return volatilities, and/or lower liquidity, providing a potential motivation for hedging such risks. For example, investments in real estate may expose insurers to more price and liquidity risk than they would like to retain. Many life insurers also invest heavily in privately placed bonds and mortgages, which often contain embedded options and are also subject to liquidity risk. Both life and property-liability insurers invest in collateralized mortgage obligations (CMOs), which carry similar risks. With the increasing internationalization of financial markets, insurers have begun to invest more heavily in foreign securities, either as a hedge against foreign liabilities or simply to enhance portfolio diversification and take advantage of attractive yields. Insurers thus have the motivation to reduce their exposure to foreign currencies by hedging the exchange rate risk resulting from foreign assets and liabilities. Investment in corporate equities exposes insurers to systematic risk from market fluctuations, which cannot be eliminated through diversification but can be managed through trading in derivatives such as stock options.

Various categories of liabilities also potentially expose insurers to abnormal risks. For life insurers, these include group annuities and individual life insurance and annuities. Group annuities are held by sophisticated institutional investors such as corporate pension plans, who are sensitive to both yields and insurer financial ratings. Individual life insurance and annuities are relatively long maturity contracts that contain numerous embedded options, making them particularly sensitive to interest rate and/or equity volatility risk. For example, many asset accumulation policies include minimum yield guarantees, in effect incorporating put options that are automatically exercised against the insurer when investment yields decline or, in the case of equity-linked annuities, during periods of downturns in the stock market. Life insurers also issue guaranteed investment contracts (GICs), similar to structured notes, that are purchased primarily by institutional investors. GICs are yield-sensitive and contain embedded options that are likely to be exercised in response to changes in interest rates and other economic fluctuations.

A related motivation for risk management by insurers and other financial intermediaries has been suggested by Allen and Santomero (1998). They point out that most investors do not actively participate directly in securities markets due to participation costs. Participation costs include the costs of learning about specific securities and continuously monitoring one's investment portfolio and trading to maintain the target level of risk. Because of these costs, a

significant amount of investment takes place through intermediaries. Allen and Santomero (1998) argue that an important role played by intermediaries is to create products with relatively stable distributions of returns that require less monitoring by investors than an actively traded portfolio. Maintaining stable return distributions (e.g., on products such an equity-linked annuities) provides another motivation for insurers to manage risk.

Another motivation to undertake corporate hedging to maximize shareholder value is provided by the convexity of the corporate income tax schedule (Smith and Stulz 1985).[10] This convexity implies that expected tax payments can be reduced by lowering the volatility of the taxable income stream through the use of derivatives or other risk management techniques. The tax schedules affecting both life and property- liability insurers have convex segments, and property-liability insurers, in particular, are known to engage in active tax management (Cummins and Grace 1994).

☐ Managerial Risk Aversion

As suggested earlier, managerial risk aversion and incentive conflicts between managers and owners provide alternative rationales for corporate hedging. behavior, i.e., instead of maximizing the value of the firm, managers may maximize their own utility. Managers may behave in a risk averse manner, taking less risk than would be optimal for the firm's owners, because their human capital and wealth are poorly diversified. Thus, they may be more concerned about losing their jobs which can lead to reductions in firm value to the extent hedging is not costless and/or it is costly for shareholders to monitor the actions of the managers. The extent to which this behaviors is consistent with value maximization is unclear. If risk management is costless, then allowing managers to hedge risk at the corporate level may be value enhancing to the extent risk averse managers demand less compensation due to the decreased likelihood that adverse outcomes will threaten their job security. However, if risk management is costly then shareholders may have to undertake certain activities, such as the development of incentive-based compensation contracts or undertake costly monitoring, to ensure the resources of the firm are devoted to the maximization of the firm's net worth and not the manager's own utility.[11] Stock option plans are considered to be especially effective in this regard.

Many firms in the insurance industry are especially susceptible to friction costs created by managerial risk aversion. A substantial

proportion of the firms in the industry are mutuals or closely-held stocks, where managers are likely to exhibit risk aversion because of suboptimal diversification of personal wealth, organization-specific capital, and/or the absence of effective mechanisms for owners to use as disciplining and incentive devices.

The mutual ownership form lacks effective mechanisms that owners can use to control, monitor, and discipline managers, such as the alienable claims, voting rights in elections for directors, and the proxy and takeover fights available to the owners of stock companies. The opportunities to align owner and shareholder interests through management compensation systems (such as stock option plans) also are more limited in the mutual ownership form. Thus, mutual managers are likely to behave in a risk-averse manner, placing a higher priority on avoiding or hedging risks that may threaten their jobs than on maximizing firm value. This reasoning suggests the hypothesis that managers of mutuals are more likely to engage in derivatives activity than comparable stock insurers.

An alternative prediction about mutuals is provided by the managerial discretion hypothesis, which suggests that mutuals will be relatively successful in less complex and less risky activities than stocks (Mayers and Smith 1988). To the extent that less complex and less risky activities give rise to less need for hedging, the managerial discretion hypothesis would predict that mutuals may be less active in the use of derivatives and other risk management techniques than stocks. Of course, these two hypotheses are not mutually exclusive, i.e., mutuals on average may be less risky and less complex than stocks, while at the same time mutual managers exhibit greater risk aversion than managers of similar stock insurers.

Another reason why mutual managers may fail to maximize value is provided by the *expense preference* hypothesis (e.g., Mester, 1989). This hypothesis holds that mutual managers are more likely to generate expenses due to excessive consumption of perquisites and other activities that are not consistent with cost minimization. Again, the rationale is that the owners of mutuals have less effective mechanisms to motivate and control managers than do the owners of stock insurers.

A final argument with regard to mutuals is that their lack of access to the capital markets may lead to rational risk averse behavior. Mutuals cannot issue new equity following an adverse shock due to higher than expected loss payments or investment losses but rather must wait for retained earnings to restore lost capital. Thus, they run the risk of having to forego attractive investment opportunities

following a shock to capital and/or losing customers due to downgrades of their financial ratings. Mutuals thus may be more active in risk management than stocks in order to avoid these adverse consequences.

■ 3. CORPORATE RISK MANAGEMENT: EMPIRICAL EVIDENCE

Corporations can manage risk using a wide variety of tools. The choice of investment projects, diversification across product lines, choices involving operating and financial leverage, and shareholder dividend strategies all can be viewed as techniques for managing risk. However, unlike some of these traditional methods for managing risk, derivative securities exist only for purposes of risk management. Consequently, empirical analyses of firms' use of derivatives provide somewhat "cleaner" results concerning why firms may choose to engage in risk management. It is also the case that the volume of activity in derivatives contracts has grown dramatically over the past two decades. Consequently, we focus the remainder of our discussion on empirical evidence on corporate risk management through the use of derivatives.

Most of the motivations for corporate hedging are generic, although they apply in varying degrees across industries. Consequently, it is informative to consider empirical evidence on risk management by both non-insurance and insurance firms. However, because we are primarily interested in the insurance industry, our discussion of non-insurance firms focuses on particularly noteworthy studies rather than trying to present a comprehensive survey.

□ Risk Management By Non-Insurance Firms

A major study investigating the question of the "motive" for risk management is by Tufano (1996), who looks at managerial compensation schemes and hedge ratios in the gold mining industry to determine whether risk management is motivated by value maximization or managerial risk aversion. Tufano argues that risk-averse managers whose compensation comes in large part through acquiring shares in the firm will want to hedge their risk. Such a policy would not necessarily benefit diversified shareholders. Tufano contrasts these managers with managers who earn a relatively large portion of their compensation through stock options. In

this situation managers can walk away from the options should the firm do poorly, but if the firm does well their positions will provide high payoffs. With this form of incentive compensation, even risk-averse managers would be more willing to tolerate gold price, and therefore earnings, volatility and thus would find hedging to be less advantageous.[12] Tufano's empirical evidence suggests that managers with high option holdings manage risk less than those with high stock holdings consistent with the managerial risk-aversion hypothesis of risk management. Tufano finds almost no evidence in favor of the various rationales that would make risk management a value-maximizing decision.

Contrary to Tufano's results, some authors have provided evidence that is more consistent with the value-maximization theories of risk management. Numerous authors have investigated whether firms engage in risk management in an effort to reduce the probability of incurring financial distress costs. An early study by Wall and Pringle (1989) found support for the hypothesis as they report that firms with lower credit ratings are more likely than higher-rated firms to use interest rate swaps.[13] Other authors have considered the more general question of whether the firm's capital structure is related to the likelihood that the firm will engage in risk management via derivatives contracting. The evidence presented in these studies is mixed. For example, neither Mian (1996) nor Nance, Smith, and Smithson (1993) report any evidence to suggest that derivatives trading is related to the capital structure of the firm. A more recent study by Geczy, Minton, and Schrand (1997) investigates the relationship between the capital structure of the firm and the decision to manage foreign currency exposures using derivatives. This study differs from its predecessors by recognizing the simultaneity of a firm's capital structure and risk-management decisions. Even after controlling for simultaneity, however, the authors conclude that there does not appear to be a relationship between a firm's capital structure and the decision to use derivatives.

Two exceptions to these studies of nonfinancial firms are Dolde (1996) and Graham and Rogers (1999). Dolde finds a significant relationship between risk management and the leverage of the firm after controlling for the firm's underlying exposure to various financial risks. Graham and Rogers (1999), like Geczy, et al., investigate the hedging and debt policy decisions of the firm using a simultaneous equations approach. They find that the use of derivatives is positively related to firm leverage. Thus, these authors find evidence to suggest highly levered firms appear more likely to use derivatives to avoid the expected costs of financial distress; or as

Graham and Rogers argue, firms that use derivatives can maintain higher leverage ratios and maximize firm value by increasing their interest-expense tax deductions.

The evidence from studies investigating the decision by non-insurance financial firms to use derivatives as a way to avoid financial distress costs is also mixed. Sinkey and Carter (1994) provide weak evidence that the capital structure and risk-management decisions of U.S. commercial banks are related. Gunther and Siems (1995), who also analyze U.S. banks, report no significant relationship between the decision to use derivatives and the capital structure of the bank. Focusing only on banks that are active in derivatives markets, Gunther and Siems find that banks reporting a higher volume of derivatives activity also have higher capital ratios. This result is in fact inconsistent with the financial distress hypothesis, at least as it is usually defined in the literature.

Mixed evidence has also been presented on the use of derivatives to lower the firm's expected tax burden. In their study of non-financial companies, Nance, Smith, and Smithson (1993) find that firms with higher investment tax credits are more likely to engage in derivative transactions. In an analysis of firms reported on Compustat, Graham and Smith (1999) conclude that approximately 50 percent of the firms in their sample face convex tax schedules and therefore have an incentive to reduce the volatility of their income stream. However, in a subsequent study, Graham and Rogers (1999) use a similar methodology to estimate the convexity of the tax schedule for a large sample of firms across many industries and are unable to find any relationship between derivative holdings and tax convexity.

A number of authors have found strong evidence documenting that firms use derivatives to reduce the variability of their income stream and thus help to ensure that adequate internal funds are available to take advantage of attractive investments. Gay and Nam (1999), for example, provide results consistent with the hypothesis that non-financial firms with both low levels of liquidity and high growth opportunities tend to hedge more. This finding is consistent with managers trying to mitigate the need to seek costly external funds to finance positive net present value projects. Other authors have found similar results. For example, Geczy, Minton, and Schrand (1997) and Nance, Smith, and Smithson (1993) both found that companies with less liquidity or companies that use less preferred stock, as opposed to using straight debt, are more likely to use derivatives to avoid shocks to the internal capital resources. A recent study by Ahmed, Beatty, and Takeda (1997) investigating 152 U.S. commercial banks also finds support for the costly external finance hypothesis.

☐ Risk Management By Insurance Firms

Cummins, Phillips, and Smith (CPS) (1997, 1998) analyze the factors that motivate both life and property-liability insurance firms to participate in derivatives markets as well as the drivers of the volume of derivatives transactions for insurers that decide to participate (see also Colquitt and Hoyt 1997). Based on 1994 data, CPS find that about 10.9 percent of life insurers and 6.9 percent of property-liability insurers use derivatives. However, usage is much more widespread in the largest size quartile, where 34.4 percent of life and 21.1 percent of property-liability insurers are active in derivatives markets. The transactions volume for life insurers far exceeds that of property-liability insurers. The transactions volume for life insurers is concentrated in bond and interest rate derivatives, as expected if insurers are using derivatives to hedge interest rate (duration and convexity) risk. Life insurers also show significant activity in foreign currency derivatives, consistent with the argument that insurers use derivatives to manage exchange rate risk. The leading categories of derivatives transactions for property-liability insurers include equity call options, foreign currency contracts, and bond and interest rate derivatives, again consistent with the management of price volatility, foreign exchange rate risk, and interest rate risk.

Following Gunther and Siems (1995), CPS (1998) conduct a multivariate probit analysis of the decision by insurers to participate in derivatives markets and a lognormal regression analysis investigating the volume of derivatives transactions by insurers. The authors investigate both decisions as they argue hedging is not costless, either in terms of fixed or variable costs. Thus, if the participation decision is driven by fixed costs, only firms with high enough levels of risk exposure, for example, due to a high tolerance for risk per unit of expected return, would find it worthwhile to enter the derivatives market. However, conditional on being active in derivatives, firms/managers with high appetites for risk will generally hedge less at the margin to the extent that each additional unit imposes marginal costs in the form of risk premiums. As evidence in support of this hypothesis, the authors report that many of the risk measures employed in the study often display exactly the opposite signs in the participation and volume regressions. This suggests that among firms having a large enough exposure to warrant participation in derivatives markets, those with the largest exposures are less willing to incur the marginal cost associated with eliminating the exposure.

The participation investigation in the CPS analysis also provides a considerable amount of support for the hypothesis that

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insurers hedge to maximize value. They present evidence consistent with the use of derivatives to reduce the expected costs of financial distress. For example, the decision to use derivatives is inversely related to the capital-to-asset ratio for both life and property-liability insurers. CPS also provide evidence consistent with the use of derivatives by insurers to hedge asset volatility, liquidity, and exchange rate risks. They find significant regression coefficients on several variables related to asset risk exposure such as the proportions of assets in privately placed bonds and collateralized mortgage obligations. Life insurers appear to use derivatives to manage interest rate risk and the risk from embedded options present in their individual life insurance and GIC liabilities. There is also some evidence that tax considerations play a role in motivating derivatives market participation decisions by insurers.

On the other hand, the CPS analysis provides little or no support for the hypothesis that corporate hedging in the insurance industry is motivated by managerial risk aversion. However, their data source did not contain several important variables that would have provided a more complete test of this hypothesis, including the proportion of an insurer's stock owned by managers and the incentive features in managerial compensation plans. The use of such variables to analyze the risk aversion hypothesis is a promising area for future research.

■ 4. CORPORATE HEDGING, MULTIPERIOD CONTACTS, AND PRIVATE INFORMATION

In this section, we provide a new rationale for corporate hedging using a simple model that provides conditions under which value-maximizing managers of insurers will find risk management desirable. Specifically, we assume that firms such as insurers invest in muti-period, private assets that have higher returns than publicly traded assets. However, the returns are not realized unless the assets are held to their maturity date. If the assets have to be liquidated prior to maturity, the firm receives only the par value of the investment and foregoes the assets' returns. The firm thus has a motivation to hedge risk in order to avoid an adverse shock to capital that may force the insurer to liquidate some or all of its holdings of the private asset. As discussed above, the private assets may be insurance policies, privately placed bonds, or some other type of complex, opaque investment. Although the model applies generally to

any firm that can invest in private assets, we believe that it is especially applicable to insurers because of the information asymmetries arising from insurance underwriting and the prominent role played by insurers in the markets for privately placed bonds and other structured securities.

To develop the theory more formally, we consider a three date model where the returns from investing in the private asset are received at date two. Assume that there are $i = 1, \ldots, N$ firms, each endowed with capital, K, and having access to two types of securities. The first security is short-term and yields a riskless yield per period, per unit of investment, of R, where $R > 0$. The other security is a long-lived private asset yielding a random gross return per unit of investment, $\tilde{\theta}_i$, at date two, $0 \leq \tilde{\theta}_i \leq \infty$. The realization of $\tilde{\theta}_i$, θ_i, is assumed to be private information with $E_0(\tilde{\theta}_i) > (1 + R)^2$, where $E_0(\bullet)$ is the expectation taken at time zero. We assume that $\tilde{\theta}_i = 0$ with positive probability, so that, absent the expenditure of costs for monitoring, firms are unable to credibly issue securities to outside claim-holders.

We will let I_i denote the level of investment in the private security at date zero, $I_i \leq K$, $\forall$ i and we assume the firm cannot add to the long-lived security at date one. In addition, if any portion is sold before maturity (date two), the portion sold returns its par value, or initial investment.[14] Absent any frictions in the capital markets, the first best solution is clearly $I_i = K$ for any-value maximizing firm *i*, and the present value of the firm at date 0 will equal

$$V_i^0 = \frac{K\,E(\tilde{\theta}_i)}{(1+R)^2}.$$

The first friction we introduce to the model involves a shock to the firm's value at time one, $\tilde{Z}_i$, with $E_0(\tilde{Z}_i) = 0$ $\forall$ *i*. The shocks are used as a summary measure for economy-wide and idiosyncratic factors that may influence the value of the firm at the intermediate date. In particular, we assume that $\tilde{Z}_i = \beta_i(\tilde{\rho} - 1) + \tilde{\epsilon}_i$ where $\tilde{\rho}$ is an observable economy-wide shock with $E(\tilde{\rho}) = 1$, $\tilde{\epsilon}_i$ is an idiosyncratic shock with $E(\tilde{\epsilon}_i) = 0$ and β_i is a sensitivity coefficient with respect to the economy-wide shock. We consider two cases regarding the support for the distribution of $\tilde{Z}_i$. In the first case, we assume the support to be bounded on the interval $[a_i, b_i]$ with $b_i = K$. Doing so ensures the firm will always be able to meet any shock equal to the firm's initial endowment, K. In the second case, shown in the appendix to this paper, we relax this assumption and assume the upper bound of the support of $\tilde{Z}_i$ can be larger than the firm's initial endowment, i.e., $b_i > K$.

Recall that the gross return on the private asset, $\tilde{\theta}_i$, is realized at date two. Given a joint distribution of $\tilde{\theta}_i$ and $\tilde{Z}_i$ at time zero, say $g(\theta_i, Z_i)$, it is possible to write this in the form $g(\theta_i, Z_i) = h(\theta_i \mid Z_i)\, f(Z_i)$, where $h(\theta_i \mid Z_i)$ is the conditional density of θ_i given a realization of $\tilde{Z}_i$, and $f(Z_i)$ is the marginal density of $\tilde{Z}_i$.

The problem facing firm i at date zero is to choose I_i to maximize the current value of its date two payoff. We use recursive programming to solve this problem. First, define ϕ_i to be the value of the firm's liquid assets at time 1. I.e., ϕ_i is

$$\phi_i = (K - I_i)(1 + R) \tag{1}$$

Then, for a given choice of I_i at date zero, if $Z_i < \phi_i$ the present value of firm i at date 1 will be

$$V_i^1 = \frac{E(\tilde{\theta}_i \mid \tilde{Z}_i = Z_i) I_i}{(1+R)} + \frac{(\phi_i - Z_i)(1+R)}{(1+R)}. \tag{2}$$

That is, the firm is able to cover its shock using only its liquid asset position. Alternatively, if the shock is greater than the liquid assets of the firm, $Z_i \geq \phi_i$, the firm will be forced to sell some or all of its investment in the private security before maturity and realizes only the par value at time 1. The present value in this case at date 1 will be

$$V_i^1 = \frac{E(\tilde{\theta}_i \mid \tilde{Z}_i = Z_i)(I_i + \phi_i - Z_i)}{(1+R)} \tag{3}$$

where $E(\tilde{\theta}_i \mid \tilde{Z}_i = Z_i) = \int \tilde{\theta}_i\, h(\theta_i \mid Z_i) d\theta_i$.

Working backwards and taking expectations at time zero and discounting, we have that the time zero value of firm i, V_i^0, is given by

$$V_i^0 = \frac{E_0(\tilde{\theta}_i) I_i}{(1+R)^2} + \int_{a_i}^{\phi_i} \frac{(\phi_i - Z_i) f(Z_i)}{(1+R)} dZ_i + \int_{\phi_i}^{b_i} \frac{(\phi_i - Z_i) E(\tilde{\theta}_i \mid \tilde{Z}_i) f(Z_i)}{(1+R)^2} dZ_i. \tag{4}$$

We now consider the firm's investment decision under two alternative assumptions regarding the joint distribution of $\tilde{\theta}_i$ and $\tilde{Z}_i$.

Case 1 – Firm level endowment shocks, $\tilde{Z}_i$, at date 1 reveal no information regarding the realization of the return on the private technology asset, $\tilde{\theta}_i$, at date 2.

In Case 1, we assume that $E(\tilde{\theta}_i \mid \tilde{Z}_i) = E_0(\tilde{\theta}_i)\ \forall\ Z_i$. This assumption is weaker than assuming independence but stronger than the assumption that $\tilde{\theta}_i$ and $\tilde{Z}_i$ are uncorrelated. In this case the first order condition is given by

$$\frac{\partial V_i^0}{\partial I_i} = \frac{E_0(\tilde{\theta}_i)}{(1+R)^2} - \frac{E_0(\tilde{\theta}_i)}{(1+R)}\ [1 - F(\phi_i)] - F(\phi_i) = 0 \tag{5}$$

where $F(\phi_i) = \int_{a_i}^{\phi_i} f(Z_i)\, dZ_i$. Notice that in this case the second order condition for a maximum is satisfied since

$$\frac{\partial^2 V_i^0}{\partial I_i^2} = -f(\phi_i) E_0(\tilde{\theta}_i) + f(\phi_i)\,(1+R) < 0 \tag{6}$$

since, by assumption, $E_0(\tilde{\theta}_i) > (1 + R)^2 > (1 + R) > 0$.

Let $I_i = I_i^*$ solve equation (5). Our focus on the demand for risk management revolves around examining the difference in the value of the firm in the absence of shocks, $V_i^0(K) = K\, E_0\,(\tilde{\theta}_i)/(1 + R)^2$, and the second best value of the firm, given by (4) and evaluated at $I_i = I_i^*$. Call this $V_i^0(I_i)$. Define D_i to be this difference

$$D_i = V_i^0\,(K) - V_i^0\,(I_i^*). \tag{7}$$

We argue that anything making D_i larger will encourage value maximizing firms to be more likely to engage in risk management activities to the extent that these contracts can be used to reduce D_i by mitigating the influence of the shocks. To the extent that the shocks contain some macroeconomic component, traded off-balance-sheet contracts can be effective in minimizing (7).

To investigate changes in the difference function, equation (7), first note that for any factor, call it x, we know that

$$\frac{\partial D_i}{\partial x} = \frac{\partial D_i}{\partial I_i^*}\frac{\partial I_i^*}{\partial x} + \frac{\partial D_i}{\partial x}. \tag{8}$$

However, we also note that at I^*

$$\frac{\partial D_i}{\partial I_i} = \frac{\partial V^{i^0}(K)}{\partial I_i^*} - \frac{\partial V^{i^0}(I_i^*)}{\partial I_i^*} = 0. \tag{9}$$

This last result follows from the fact that $\frac{\partial V^{i^0}(I_i^*)}{\partial I_i^*} = 0$ and $V_i^0(K)$ is not a function of I_i^*. Equations (8) and (9) demonstrate that we only need to consider the direct effect of changes in any of the underlying factors on the difference between the first best value of the firm, $V_i^0(K)$, and the second best value of the firm $V_i^0(I_i^*)$.

Given this result, consider changes in expected return on the private technology asset, $E_0(\tilde{\theta}_i)$. Using the definition of $V_i^0(K)$ and equation (4), we have

$$\frac{\partial D_i}{\partial E_0(\tilde{\theta}_i)} = \frac{K - I^*}{(1+R)^2} - \int_{\phi_i}^{b_i} \frac{(\phi_i - Z_i) f(Z_i)}{(1+R)^2} dZ_i > 0. \qquad (10)$$

So, our first result is that the demand for risk management will be higher by firms with more valuable private, but illiquid securities.

Our next result concerns the demand for risk management as a function of the distribution of shocks. This can be easily analyzed by re-writing equation (4) (recalling $E_0(\tilde{Z}_i) = 0$) as

$$V_i^0 = \frac{E_0(\tilde{\theta}_i | \bar{Z}_i) I_i^*}{(1+R)^2} + \frac{(K - I_i^*) E_0(\tilde{\theta}_i)}{(1+R)} + \int_{a_i}^{\phi_i} \frac{F(Z_i) dZ_i}{(1+R)} \left(1 - \frac{E_0(\tilde{\theta}_i)}{(1+R)}\right) \qquad (11)$$

where the last term is obtained by integrating by parts. Consider an alternative shock, call it $\tilde{Y}_i$, with distribution function G, and $E_0(\tilde{Y}_i) = 0$. If $\tilde{Y}_i$ is also confined to the closed interval $[a_i, b_i]$, then Rothschild and Stiglitz (1970) have shown that if "$\tilde{Y}_i$ has more weight in its tails than $\tilde{Z}_i$" and both have the same mean, then

$$\int_{a_i}^{Y_i} [G(Z_i) - F(Z_i)] dZ_i = T(Y_i) \geq 0 \text{ and } T(a_i) = T(b_i) = 0.$$

It follows immediately from the fact that $E_0(\tilde{\theta}_i) > (1 + R)$ and equation (11) that, for any value of I_i^*, equation (11) is lower if the firm faces the riskier shock $\tilde{Y}_i$ when compared to $\tilde{Z}_i$. Thus, our second result is that, ceteris paribus, firms who face a riskier distribution of shocks will have more incentive to engage in risk management. Stated alternatively, firm value will be higher for those firms who can reduce the riskiness of the distribution of shocks they face, all other things held equal.

To explore this result, note that since $\tilde{Z}_i = \beta_i(\tilde{\rho} - 1) + \tilde{\epsilon}_i$, any risk management contract whose payoff is tied to can $\tilde{\rho}$ be used to reduce the weight in the tails of the distribution of $\tilde{Z}_i$. For example, consider a forward contract that pays off $\tilde{\rho}$ at date one. Define H_i to be the number of forward contracts held short at a forward price of ρ_f. With H_i forward contracts, the net shock the firm now faces, $\tilde{Z}_i^h$, is

$$\tilde{Z}_i^h = -H_i(\tilde{\rho} - \rho_f) + \tilde{Z}_i \,. \tag{12}$$

If we assume costless hedging, i.e., $\rho_f = 1$, then

$$\begin{aligned} \tilde{Z}_i^h &= (\beta_i - H_i)(\tilde{\rho} - 1) + \tilde{\epsilon}_i \\ &= \tilde{x}_i^h + \tilde{\epsilon}_i \,. \end{aligned} \tag{13}$$

Appealing to the Rothschild and Stiglitz once again, $\tilde{Z}_i^h$ is more risky than $\tilde{\epsilon}_i$ if $\tilde{x}_i^h$ is a mean zero random variable and $E(\tilde{x}_i^h \mid \epsilon_i) = 0 \; \forall \epsilon_i$. Thus, choosing $H_i = \beta_i$ will eliminate the firm's exposure to the economy-wide risk, (i.e. $\tilde{x}_i^h = 0$) and therefore reduce the riskiness of the firm's shock to include only its idiosyncratic component. It follows, therefore, given the Rothschild and Stiglitz result, that the value of the firm is maximized by eliminating the economy-wide portion of the firm's risk exposure and reducing the riskiness of the shocks that the firm faces. Moreover, when hedging is costless, no other terms in the firm valuation equation (equation 11), are affected since $E_0(H_i(\tilde{\rho} - 1)) = H_i(E_0(\tilde{\rho}) - 1) = 0, \; \forall \; H_i$. We also note the obvious point that if the amount of idiosyncratic risk and market risk are inversely related, firms with high levels of idiosyncratic risk will tend to have smaller positions in risk management contracts (e.g., H_i will be smaller).

Case 2 – Firm level endowment shocks, $\tilde{Z}_i$, at date 1 reveal new information regarding the realization of the return on the private technology asset, $\tilde{\theta}_i$, at date 2.

The second case we consider involves relaxing the assumption that $E(\tilde{\theta}_i \mid Z_i) = E_0(\tilde{\theta}_i) \; \forall \; Z_i$. I.e., we allow for the possibility that the size of the shock to the firm's endowment may be correlated with the return the firm can expect on its private technology asset. For example, an unexpected strengthening in the foreign currency exchange rate between the U.S. and Korea may also signal that the underlying credit worthiness of a fixed income asset issued by a Korean corporation may also have changed. In this case, the value of the firm at date 0, using equation (4) and the fact that covariance is a linear operator, we have that

$$V_i^{0'} = V_i^0 \frac{\mathrm{Cov}_0\left[\left(E(\tilde{\theta}_i)\,|\,Z_i\right), Z_i \,|\, b_i \geq Z_i \geq \phi_i\right]}{(1+R)^2} \qquad (14)$$

where V_i^0 is the value of the firm if $E(\tilde{\theta}_i \,|\, Z_i) = E_0(\tilde{\theta}_i)\ \forall\ Z_i$ and Cov(•) is the covariance operator. Notice that, for a given level of I_i, the value of the firm will be lower if the conditional (on Z_i) time one value of the private asset is increasing in Z_i. This result contrasts with the standard portfolio theory idea that one would want to minimize the variance of terminal wealth by seeking out assets whose value would be high when other, negative, shocks to endowment are high (i.e., Z_i is large).

The intuition for our result can be seen by recognizing that, for $\phi_i \leq Z_i \leq b_i$, some of the private security must be liquidated. Consider two private assets, with the same unconditional expectation. Suppose that for the first asset $E(\tilde{\theta}_i^1 \,|\, Z_i)$ is increasing in Z_i, while, for the second, $E(\tilde{\theta}_i^2 \,|\, Z_i)$ is decreasing in Z_i. Then value will, ceteris paribus, increase by choosing the second asset since the opportunity cost of liquidation $[E(\theta_i \,|\, Z_i) - (1 + R)]$ is low when the security must be liquidated. For example, if negative endowment shocks are being caused by a poor overall economy, value would be enhanced by holding private securities whose value, conditional on the economy, is also low. That is, the opportunity cost of having to liquidate the private asset at time 1 is lower when the size of the shock and the expected return are negatively related. Re-interpreting the shocks to be interest rate related changes in liability values, it is straightforward to show that firms may increase value by acquiring assets whose values are less, rather than more, sensitive to decreases in interest rates, e.g., mortgage backed securities.

Thus, we would argue that firms for which asset values and endowment shocks are positively dependent are more likely to utilize risk management tools, while those in the opposite position will tend to have built in insurance against the realizations of these opportunity cost.

We have not yet considered the case where the shocks to capital may result in bankruptcy. While we provide a brief set-up of this problem in the Appendix to this paper, we note that many of the results obtained here remain. However, it is no longer the case that an increase in the riskiness of cash flows will always result in a higher demand for hedging since bankruptcy provides an option to the firm which increases in value with increases in the riskiness of cash flows. Therefore, a mean preserving spread in the distribution

of shocks may increase value to the extent the increases in the value of the limited liability option may partially or totally offset the additional demand for risk management that arises from the desire to avoid liquidating the valuable private asset.

To summarize, the model yields three main predictions:

a. The demand for risk management will be higher for firms with more valuable private but illiquid investments.

b. Firms that face riskier random shock distributions will have a greater demand for risk management than firms facing less risky random shocks.

c. Firms for whom private asset returns and random endowment shocks are positively correlated are more likely to engage in risk management, whereas firms in the opposite position have a natural hedge against the costs of random shocks.

To test these propositions, one would need to have data on the composition of insurer investment portfolios in order to determine the volume of private investments, the relative rates of return on these investments, and the correlation between private investment returns and random shocks. Life insurers hold substantial amounts of privately placed bonds and mortgages, which are likely to reflect private information. Both life and property-liability insurers hold structured securities and collateralized mortgage obligations, which also can be considered to have some characteristics of private assets.

Considering insurance policies as an insurer's projects or "assets," evidence presented in D'Arcy and Doherty (1990) is consistent with the argument that insurers accumulate private information by insuring drivers over a period of time and that this private information allows them to charge relatively higher prices the longer the driver has been with the company. The amount of private information on corporate insurance buyers, on the other hand, is likely to be relatively less because the commercial insurance market is more price competitive, commercial buyers are more sophisticated than personal lines policyholders, and commercial buyers tend to have statistically credible loss data that can be easily be provided to competing insurers. Thus, we might expect personal lines insurers to have more valuable private information than that possessed by commercial lines insurers. This provides some indication of the types of hypotheses that might be testable based on our model.

Evidence presented in Cummins, Phillips, and Smith (1997, 1998) is also consistent with the main predictions of our model. For example, the probability that both life and property-liability insurers will engage in derivatives transactions is positively related to the ratio of stocks to total assets, consistent with firms with riskier random shock distributions having a greater demand for risk management. In addition, for life insurers, participation in derivatives markets is positively related to the percentage of reserves in individual life insurance and annuity products and in GICs. Both individual life and annuities and GICs are relatively illiquid, multiple period contracts on which insurers are likely to acquire private information. Property-liability insurers with higher ratios of products liability reserves to total liabilities are more likely to participate in derivatives markets, as expected if products liability is a line with relatively high volatility. These findings are intriguing, and it is hoped that they will motivate additional research in this area.

■ 5. CONCLUSION

This paper provides a review of the rationales that are often advanced to explain why corporations manage risk. Because the pure theory of finance views expenditures on corporate hedging as dead-weight costs that destroy firm value, the financial rationales for hedging usually involve the existence of market frictions and transactions costs that can be mitigated through corporate hedging. Firms may have a motive to hedge to reduce the expected costs of financial distress, including the disruption of relationships with key employees, suppliers, and customers. Another set of reasons for corporate hedging include the avoidance of shocks to internal capital that may force the firm to forego profitable investment opportunities and the reduction of expected taxes due to the convexity of the corporate income tax schedule. An alternative, and non-mutually exclusive, hypothesis is that hedging is motivated by managerial risk aversion, i.e., by the desire of managers to maximize their own utility rather than to maximize firm value.

The paper also reviews the empirical literature on a specific type of hedging activity undertaken by firms – the trading of financial derivatives. For non-financial firms and banks, the evidence on the use of derivatives to maximize firm value is rather mixed. One prominent paper (Tufano, 1996) finds that risk management by gold mining firms seems to be driven primarily by executive compensation plans, i.e., by managerial utility maximization. The evidence

from research on the relationship between the use of derivatives and firm capital structure and, more generally, the use of derivatives to reduce financial distress costs also has been mixed. Stronger evidence has been found that firms use derivatives to lower their expected tax payments and to reduce the variability of their cash flows to help ensure adequate internal funds. Cummins, Phillips, and Smith (1997, 1998) present convincing evidence that insurers use derivatives to reduce financial distress costs and to hedge risks resulting from investment return volatility, liquidity, and exchange rate risk. They also find evidence supporting the hypothesis that insures use derivatives to hedge risks affecting the value of liabilities. We expect corporate hedging through derivatives and other devices to become increasingly important in the years to come and to provide numerous research opportunities for economists.

The paper also provides a theoretical analysis that leads to a new rationale for corporate hedging. We postulate a firm that has the opportunity to invest in a long-lived investment project which has an especially attractive return due to private information or other factors. However, the return is realized only if the project is held until maturity. The firm is subject to random shocks that may necessitate the liquidation of part or all of the project prior to maturity. If liquidation occurs, the firm receives only the par value of the investment and must forgo the attractive return that could have been realized at maturity. The potential loss of this return motivates the firm to engage in hedging. The theory leads to the predictions that the demand for hedging will be positively related to the expected return on the long-lived investment project and also positively related to the riskiness of the random shocks faced by the firm. A counterintuitive prediction is that the demand for hedging will be greater if the random shock and the return on the long-lived project are positively correlated. The intuition behind this result is that the firm will be more averse to liquidating the project due to a shock in states of the world where the payoff is higher. We conclude the theoretical discussion with some suggestions for testing our hypotheses.

APPENDIX A

In this appendix we consider the case where the shocks to capital may result in bankruptcy – i.e., where $b_i > K$ under the assumption that the shock $\tilde{Z}_i$ conveys no information about the realization of the return on the private asset $\tilde{\theta}_i$. In this case the insurer will be insolvent for $Z_i > I_i + (K - I_i)(1 + R) = I_i + \phi_i$. Reworking the programming problem, we have that V_i^1 is still given by either equation (1) (if $Z_i \leq \phi_i$), equation (2) (if $\phi_i < Z_i < \phi_i + I_i$) or $V_i^1 = 0$ (if $Z_i \geq \phi_i + I_i$). In this case, assuming that $\tilde{\theta}_i$ and $\tilde{Z}_i$ are independent and dropping the "i" subscript for notational convenience, the time zero value of firm i is given by

$$V^0 = \int_a^{\Phi} \left[\frac{IE_0(\tilde{\theta}) + (\phi - Z)(1+R)^2}{(1+R)^2} \right] f(Z)dZ + \int_{\Phi}^{\Phi+I} \left[\frac{E_0(\tilde{\theta})(I + \phi - Z)}{(1+R)^2} \right] f(Z)dZ. \tag{A.1}$$

Equation (A.1) can also be written, after some manipulation, as

$$V^0 = \int_a^{\Phi} \left[\frac{(\phi - Z)((1+R) - E_0(\tilde{\theta}))}{(1+R)^2} \right] f(Z)dZ + \frac{E_0(\tilde{\theta})(I+\phi)}{(1+R)^2} - \int_{\Phi+I}^{b} \left[\frac{E_0(\tilde{\theta})(I+\phi-Z)}{(1+R)^2} \right] f(Z)dZ. \tag{A.2}$$

In this case the first order condition can be written as

$$\frac{\partial V^0}{\partial I} = 0 = \left[\frac{E_0(\tilde{\theta}_i) - (1+R)}{(1+R)} \right] F(\phi) - \left[\frac{E_0(\tilde{\theta}_i)R}{(1+R)^2} \right] F(\phi + I). \tag{A.3}$$

Checking the second order conditions, we have that

$$\frac{\partial^2 V_0}{\partial I^2} = -[E_0(\tilde{\theta}_i) - (1+R)] f(\phi) + \frac{R^2}{(1+R)^2} E_0(\tilde{\theta}_i) f(\phi + I). \tag{A.4}$$

Using equation (A.3), it is straightforward to show that the second-order condition will hold (i.e., equation (A.4) will be negative) if Z is drawn from a distribution that is log concave, i.e., if $\frac{\partial^2 \ln[F(Z)]}{dZ^2} \leq 0$. To see this, note that equation (A.4) will be negative if and only if

$$\frac{f(\phi)}{f(\phi+I)} > \frac{R^2 E_0(\tilde{\theta}_i)}{[E_0(\tilde{\theta}_i)-(1+R)]\ (1+R)^2} = \frac{R\,F(\phi)}{(1+R)\,F(\phi+I)} \qquad \text{(A.5)}$$

where the last equality follows from setting equation (A.3) equal to zero and solving for $E_0(\tilde{\theta}_i) - (1 + R)$. It follows that a sufficient condition for equation (A.5) to hold is that $\frac{f(\phi)}{F(\phi)} \geq \frac{f(\phi+I)}{F(\phi+I)}$ (since $R < 1 + R$). Log concavity of F guarantees that this inequality will hold.

Some of the earlier comparative statistics go through even in the case where bankruptcy is possible. The analog to equation (7) is given by

$$\frac{K\,E_0(\tilde{\theta})}{(1+R)^2} - \int_a^{\phi} \left[\frac{I E_0(\tilde{\theta}) + (\phi - Z)\ (1+R)^2}{(1+R)^2}\right] f(Z)dZ$$
$$- \int_{\phi}^{\phi+I} \left[\frac{E_0(\tilde{\theta})\ (I+\phi-Z)}{(1+R)^2}\right] f(Z)dZ. \qquad \text{(A.6)}$$

It is straightforward to show that, as before, $\frac{\partial D}{\partial E_0(\tilde{\theta}_i)} > 0$, so that firms with more valuable private assets will choose to engage in risk management. To see this, recall that

$$\frac{\partial D}{\partial E_0(\tilde{\theta})} = \frac{K}{(1+R)^2} - \frac{I F(\phi+i)}{(1+R)^2} - \int_{\phi}^{\phi+I} \frac{(\phi-Z)}{(1+R)^2}\, dF(Z). \qquad \text{(A.7)}$$

It follows immediately that (A.7) is non-negative since $IF(\phi + I) < K$ and $Z > \phi$ over the range ϕ to $(\phi + I)$.

It is less straightforward to determine whether or not firms facing more risky distributions for their shocks will be more inclined to engage in risk management since limited liability provides shareholders with an option whose value is increasing in the volatility of the shocks. Therefore, a mean preserving spread in the distribution of shocks increases firm value and this may partially or totally offset the additional demand for risk management that arises from the desire to avoid liquidating the valuable private asset. Finally, while we omit details, the desire to hold assets whose conditional values are inversely related to shocks will still be in place.

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Notes

1. We follow the standard practice in the insurance economics literature in referring to insurance companies as "insurers" throughout our discussion. Insurers are assumed to be owned by shareholders who hire managers to operate the firm.

2. Financial theory divides risk into two major types – *non-systematic risk*, which can be eliminated by investing in a diversified portfolio, and *systematic risk*, which cannot be eliminated through diversification. Non- systematic risk is considered to be firm or industry specific, whereas systematic risk affects the entire market and thus cannot be diversified away.

3. Systematic project risk is recognized through the discount factor used to calculate the net present value of the project, i.e., it is recognized in the cost of capital. See Brealey and Myers (1996) for further discussion.

4. Such private information would not arise for widely traded, standardized securities such as Treasury bonds and corporate equities. For private information to develop, the investor must have a unique opportunity to obtain information that is not available to others. The relationship between banks and their borrowers and between insurers and the issuers of privately placed bonds may give rise to such information.

5. Implicit in this discussion is the assumption that the price charged to new policyholders is higher than the price the good risks have to pay if they remain with the insurer, which in turn is higher than the price the good risks would pay in an informationally efficient, competitive market. Recall that the price charged to new risks is a pooled price applying to both bad risks and good risks. Consequently, insurers could lose money on the pooled price when selling to both bad and good risks and still have sufficient slack in pricing to earn positive rents when insuring only the good risks. Another issue, discussed by D'Arcy and Doherty (1990), is that the insurer's competitors could adopt the strategy of offering insurance at favorable rates to policyholders who can present a valid renewal offer from another insurer; and, in fact, at least one major company has based a marketing campaign on this approach. In effect, by making the renewal offer, the insurer has revealed some of its private information, which can potentially be captured by competitors. D'Arcy and Doherty suggest various ways that the insurer could protect its private information by "scrambling" the renewal signal.

6. Investors are willing to supply capital to firms with various levels of insolvency risk as long as they are appropriately compensated. Customers of insurers have a greater concern about credit quality because they have purchased insurance in most cases to reduce their exposure to unfavorable contingencies that threaten their financial security. A bond investor can protect against bond defaults by specific issuers by investing in a diversified portfolio. An insurance policyholder, on the other hand, cannot diversify by purchasing numerous small insurance policies from a large number of insurers. Thus, credit risk acquires greater significance to buyers of insurance than to investors in corporate debt.

7. See Andrade and Kaplan (1998) for one attempt to measure the costs of financial distress.

8. See also Mayers and Smith (1987).

9. Duration and convexity risk refer to the risk of changes in the market values of assets and liabilities due to changes in interest rates. The market values of assets and liabilities equal the present value of their cash flows. If interest rates increase, the present value of the cash flows decline. If assets have longer durations than liabilities, for example, an interest rate increase will reduce the market value of assets by more than it reduces the market value of liabilities, leading to a decline in the market value of equity that can create financial distress costs. Insurers are more susceptible to duration and convexity risk than are other financial intermediaries such as banks because both the assets and liabilities of insurers have unusually long maturities.

10. The tax schedule is convex if its slope is increasing in income (i.e., if it has positive first and second derivatives). For convex tax schedules, the expected value of the tax payment is increasing in the risk of the income stream.

11. Another managerial motivation for hedging involves the use of risk management to signal managerial skill in the presence of asymmetric information (Breeden and Viswanathan 1996, DeMarzo and Duffie 1995).

12. It is well-known that the value of a stock option is increasing in the risk of the underlying stock. Intuitively, this is because the holder of the option benefits from upside fluctuations in the stock price but loses nothing beyond the option premium in the event of downside fluctuations (see Hull 1993).

13. For a discussion of the various types of derivative securities, see Hull (1993).

14. In this model we assume the firm will recoup its initial investment in the private technology asset. However, the finance literature modeling distressed asset sales predicts that firms forced to liquidate some or all of their investment in private technology assets will often be forced to accept price discounts. For a theoretical discussion, see Schleifer and Vishny (1992). Pulvino (1998) provides some recent empirical support for this prediction. The benefits of risk management would be even greater for insurers if they were forced to liquidate a portion of their investment in the private technology assets at a discount.

LE DÉVELOPPEMENT DES ASSURANCES EN EUROPE JUSQU'AUX DÉBUTS DE L'INDUSTRIALISATION

par Alain Plessis et André Straus

RÉSUMÉ

Durant l'Antiquité et le haut Moyen Âge européens, les hommes ont cherché divers moyens de se prémunir contre les dangers qui les menaçaient, mais ils ne sont pas parvenus à mettre au point des pratiques relevant véritablement de l'assurance.

Ce sont les marchands des villes de l'Italie du Nord, et d'abord ceux de Gênes, qui ont inventé l'assurance maritime. Celle-ci s'est ensuite répandue dans l'ensemble de l'Europe. D'abord dans la péninsule ibérique et l'actuelle Belgique aux XV^e^-XVI^e^ siècle, puis durant les deux siècles suivants en France, dans les pays germaniques, bien plus encore en Hollande et surtout en Angleterre. Au XVIII^e^ siècle, Londres est déjà le pôle dominant dans ce secteur.

Dans le même temps, d'autres formes d'assurances, l'assurance Incendie et l'Assurance Vie ont commencé à se développer. Ces assurances, qui au début étaient de pures activités spéculatives, sont devenues des affaires commerciales reconnues, pratiquées par de véritables entreprises de diverses natures (compagnies privées, mutuelles, établissements publics).

À la fin du XVIII^e^ siècle, les Européens ont donc une pratique déjà longue des assurances et de leurs techniques.

Mots clés : assurance incendie, assurance maritime, assurance vie, capitalisme commercial, histoire de l'assurance, pays européens, risque, sécurité.

ABSTRACT

The search for ways to guard against danger goes back to Antiquity and the High Middle Ages, but it never resulted in the practice of insurance.

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Maritime insurance was invented by the merchants of the cities of Northern Italy, primarily those of Genoa. It then spread to the rest of Europe, first to the Iberian Peninsula and present-day Belgium in the fifteenth and sixteenth centuries, then, in the next two centuries, to France and the German states, and especially to the Low Countries and England. London became the hub of maritime insurance in the eighteenth century.

In the meantime, fire insurance and life insurance developed. They were purely speculative at first but they grew into recognised commercial activities, practiced by genuine business (private companies, mutual societies, public institutions).

By the end of the eighteenth century, European had considerable experience in insurance audits techniques.

***Keywords**: fire insurance, marine insurance, life insurance, commercial capitalism, history of insurance, European countries, risk, security.*

INTRODUCTION

On relève un nombre relativement restreint d'ouvrages de caractère historique dans la volumineuse bibliographie internationale recensant chaque année l'ensemble des publications concernant les assurances. Quant aux historiens qui s'intéressent à l'histoire des assurances, ils sont peu nombreux, et plus rares encore ceux qui font de ce domaine de recherche leur spécialité[1].

Les publications portant sur l'histoire des assurances consistent en quelques livres commandés par des compagnies (certains sont d'un grand intérêt)[2], et en des articles et des ouvrages portant sur des points particuliers, étudiés très généralement dans un cadre national[3]. Au total, le champ de l'histoire des assurances est très inégalement défriché, selon les pays (les études sur la France sont bien moins nombreuses que celles qui portent sur l'Angleterre ou sur l'Allemagne), selon les époques aussi : ainsi les débuts de l'histoire de l'assurance et ses premiers développements du XIV^e^ au XVIII^e^ siècle paraissent avoir suscité plus de travaux historiques que le grand essor de ce secteur et sa profonde transformation durant les deux derniers siècles[4].

Aussi personne n'a-t-il entrepris récemment de dresser une synthèse de l'histoire des assurances comme celle qu'avait proposée Jean Halpérin en 1946[5]. Cet auteur avait placé explicitement son oeuvre dans la lignée de l'Ecole des Annales : Marc Bloch, à la mémoire duquel était dédié cet ouvrage, et Lucien Febvre incitaient en effet depuis 1929 les historiens à s'intéresser à de nouveaux sujets relevant de l'histoire économique et sociale entendue au sens

large, parmi lesquels l'assurance avait évidemment sa place. En 1956 encore Lucien Febvre a montré son intérêt pour l'histoire de l'assurance (et plus généralement celle de l'évolution du « besoin de sécurité ») en commentant les travaux d'Halpérin. Mais ces initiatives ont été finalement peu suivies. Fernand Braudel lui-même, qui se voulait le continuateur des fondateurs de l'École des Annales, et qui avait consacré aux assurances de nombreux passages de sa thèse sur *La Méditerranée et le monde méditerranéen à l'époque de Philippe II* (1re édition 1949), n'en parle pratiquement pas dans la vaste synthèse proposée trente ans plus tard sous le titre *Civilisation matérielle, Économie et Capitalisme, XVIe-XVIIIe siècle.*

Ce relatif et persistant désintérêt de la plupart des historiens pour des activités liées si intimement au temps et aux incertitudes de l'avenir surprend. On peut en attribuer la responsabilité au manque d'intérêt des dirigeants de nombreuses compagnies : soucieux avant tout d'innover, et oubliant que leurs activités se basent sur le calcul actuariel qui implique une connaissance approfondie du passé, ils se sont détournés de leur histoire ou n'ont cherché dans leurs livres anniversaires que de faciles occasions de faire valoir leur image. Par souci de préserver le secret des affaires, et en particulier le secret des affaires de leurs clients, ils ont longtemps, peut-être plus encore que les banquiers, refusé aux chercheurs l'accès à leurs archives, qui souvent n'avaient même pas été classées par des archivistes. Les sources primaires, indispensables à la recherche historique, font donc souvent défaut.

Mais, assurément, les historiens eux-mêmes sont aussi responsables de ce relatif retard de l'histoire des assurances. Ils paraissent avoir été effrayés par la technicité des opérations d'assurances, par les difficultés de compréhension et d'interprétation de la comptabilité des compagnies, par la complexité d'un secteur se divisant en de multiples branches disparates et comprenant des entreprises de type très divers.

Quoi qu'il en soit, ces lacunes de notre connaissance historique sont regrettables, puisqu'elles touchent une activité qui, au fil du temps, a dû jouer un rôle considérable dans toute l'histoire économique et sociale du capitalisme. En effet, le progrès de l'humanité est le fruit d'une chaîne de grandes innovations; or chacune d'elles a fait surgir de nouveaux risques, que la plupart des individus n'auraient pas osé affronter, s'ils n'avaient pas eu la possibilité de se garantir contre eux efficacement. C'est là qu'il faut chercher à saisir le rôle historique primordial de l'assurance : elle a dû être une condition de l'essor du grand commerce international d'abord, un des préalables de la révolution industrielle ensuite, et,

bien plus généralement, un rouage indispensable à l'accomplissement des grands progrès de la civilisation. Imaginons un moment que le développement de l'assurance n'ait pas accompagné les grandes inventions et les grandes découvertes, comment les hommes auraient-ils osé se lancer sur des mers lointaines, spécialiser leurs productions agricoles, construire des immeubles qui pouvaient être la proie des flammes, se servir de la machine à vapeur, utiliser le chemin de fer ou plus tard l'automobile...? C'est ce qui explique que nos sociétés soient devenues de plus en plus des « sociétés assurantielles ». L'objet de ce chapitre est donc de mettre en parallèle le développement des assurances et celui du capitalisme occidental au fil du temps. Cette forme d'économie de marché est apparue comme on le sait d'abord en Europe méridionale pour gagner ensuite une grande partie du continent à l'époque de « l'Europe des marchands » et de s'y affirmer pendant la révolution industrielle. L'espace concerné par notre étude s'étend donc progressivement à mesure que ce processus conquiert de nouveaux territoires : l'Europe des banquiers et des industriels déborde celle des marchands et son influence grandissante s'exerce sur d'autres continents.

Ceci explique que dans leur développement historique les assurances ont dû emprunter des formes diverses, étroitement liées au système de fonctionnement de la société où elles se déploient, et donc révélatrices de ses caractéristiques. Les acteurs en ce domaine peuvent être, successivement ou simultanément, dans des combinaisons diverses, des capitalistes, simples individus ou associés en compagnies, des sociétés mutuelles, et aussi l'État, qui peut soit se contenter de poser des règles, soit se charger lui-même d'assurer certains risques.

En définitive, l'objet de cette étude est de suivre l'expansion de l'assurance au fil de l'histoire, en la considérant comme un facteur essentiel du développement économique, mais aussi comme le résultat de tout un ensemble de pressions et de contraintes exercées par son environnement, lui-même en constante évolution. Elle provient d'un besoin constant de sécurité qui traduit une tendance profonde de l'esprit humain, mais qui se diversifie et s'amplifie à mesure que l'homme est confronté à de nouveaux dangers ou qu'il les perçoit de manière nouvelle. La réponse à cette demande d'une meilleure sécurité, qui peut devenir particulièrement pressante à la suite d'une grande découverte ou d'un événement majeur, dépend largement des contraintes et des obstacles, des opportunités et des moyens aussi qu'apportent, à un moment donné, tout le contexte économique, social et politique, ainsi que l'outillage mental dont disposent alors les hommes. C'est dans ce cadre contraignant que

des hommes ont réussi à faire progresser l'assurance, selon des rythmes différents et sous des formes diverses, dans les pays européens.

En étudiant ainsi l'assurance tout à la fois comme un rouage actif de l'histoire, comme un ensemble de phénomènes dont il convient de définir les caractéristiques essentielles, et enfin comme le résultat des contraintes du milieu et des réponses trouvées par les hommes[6], nous tenterons de cerner d'abord les premières phases de son histoire. Mais il convient de reconstituer la préhistoire de l'assurance, avant de saisir l'invention de l'assurance, et de suivre enfin ses principaux développements dans le cadre de l'essor du capitalisme commercial jusqu'à la fin du XVIII[e] siècle.

LA PRÉHISTOIRE DE L'ASSURANCE

L'assurance répond au besoin de sécurité éprouvé par des hommes, qui se sont toujours sentis vulnérables dans leurs personnes comme dans leurs biens, mais ils ont utilisé longtemps à cette fin d'autres moyens que l'assurance proprement dite pour se prémunir contre les périls et les dommages qui les ont toujours menacés. Ils pouvaient faire appel à des formes de prévoyance, et surtout à des institutions d'entraide, de solidarité ou d'assistance, destinées à secourir les victimes d'un malheur. Même si les assurances ont un objectif proche de ces lois ou de ces associations ayant pour vocation la protection des individus contre divers malheurs, elles s'en distinguent par des traits spécifiques, qu'il convient de rappeler.

Pour qu'il y ait assurance, il faut qu'il y ait bien eu de la part d'un ensemble d'assurés le versement préalable d'une prime ou d'une cotisation, avant que ne survienne un dommage éventuel, et ce versement donne droit à ceux qui se trouvent ensuite victimes d'un dommage prévu à une compensation, et non à un simple secours. La prime est, comme l'écrit en 1881 un juriste (I. Alauzet), « l'essence du contrat d'assurance ». Tous les assurés coopèrent ainsi au dédommagement de ceux qui viennent à être frappés par le malheur, et c'est en ce sens qu'on a pu dire que l'assurance doit « compenser les effets du hasard par la mutualité » et répartir des risques incertains entre l'ensemble des assurés. Elle implique qu'interviennent, en plus de la communauté de danger constituée par les assurés, un tiers (individu ou société), un spécialiste, l'assureur et/ou le courtier, qui a en particulier la gestion des fonds collectés.

Si l'on s'en tient à cette définition stricte, on constate que les Anciens étaient fort conscients des périls qui les menaçaient, mais qu'ils cherchaient à s'en protéger en faisant appel à la solidarité familiale, professionnelle ou sociale, et non à un système assurantiel. Ainsi, d'après le Talmud, à Babylone, dès 2250 avant J.-C., l'ânier qui perdait son âne pouvait bénéficier d'un autre en remplacement, qui lui était donné par ses collègues conducteurs d'âne. Chez les Grecs, vers 600 avant J.-C., les artisans se réunissaient pour constituer grâce à leurs cotisations, souvent mensuelles, une caisse d'entraide, qui permettait de secourir ceux d'entre eux qui étaient frappés par un malheur[7].

Pour les transports maritimes, qui exposaient les marins et leurs cargaisons à des périls multiples et effroyables, longuement évoqués dans l'Odyssée, la solidarité ne pouvait suffire. Aussi les Phéniciens et les Grecs, premiers peuples à se livrer au grand commerce en Méditerranée, ont-ils inventé le prêt à la grosse aventure ou « prêt à la grosse ». Il s'agit d'une opération de crédit, dans laquelle le bailleur de fonds perd tout l'argent qu'il a avancé si le navire fait naufrage, mais si celui-ci arrive à bon port, il doit être remboursé par celui qui a entrepris le voyage et toucher un intérêt particulièrement élevé : une partie de cet intérêt, constituant la contrepartie de l'éventualité du dommage qu'il a accepté d'assumer, représente une prime perçue après coup comme compensation du risque couru. Le prêt à la grosse, d'un usage devenu fréquent dans les cités maritimes de la Grèce classique (v^e^-vi^e^ siècle avant J.-C.), notamment à Athènes, permet aux armateurs de ne pas supporter seuls la totalité de la perte d'un navire, et de partager cette perte avec le ou les banquiers qui leur ont prêté de l'argent. Mais il s'agit d'une opération très différente d'une police d'assurance, puisque celui qui cherche à diminuer ses risques ne verse aucune prime au départ, mais il bénéficie au contraire d'un prêt.

Dans cette recherche de moyens pour disposer de plus de sécurité, l'Empire Romain n'a pas réellement innové. La solidarité se traduit entre autres par la constitution d'assemblées de petites gens (*collegia tenuiorum*) fondées sous l'Empire par des artisans, des commerçants et des comédiens : ils forment en particulier des collèges funéraires, qui permettent à leurs adhérents d'avoir, grâce à leurs cotisations, la garantie de dignes funérailles, et de procurer aussi après leur décès une aide à leur veuve et aux orphelins. Et le prêt à la grosse continue à être pratiqué pour les transports maritimes, sous le nom de *nauticum foenus*, avec des taux d'intérêt élevés, allant de 24 à 36 %. Il peut concerner les esclaves embarqués sur les navires, qui sont considérés comme des biens et ne se distinguent donc pas des marchandises transportées[8].

Les Anciens, si soucieux de trouver des garanties contre l'insécurité qui les menaçait, ne sont pourtant pas parvenus à mettre en place des techniques et des institutions relevant véritablement de l'assurance. Dans les sociétés anciennes, où la richesse était avant tout foncière, et où fort rares étaient ceux qui pouvaient espérer disposer d'une épargne, la plupart des habitants étaient bien incapables de dégager une somme leur permettant de s'assurer. De plus, les dangers qui les menaçaient de tous côtés apparaissaient imprévisibles, surnaturels, et le meilleur moyen de tenter de les repousser était encore de faire des sacrifices aux dieux ou de vouer un culte aux divinités domestiques pour s'attirer leurs bonnes grâces; pour le reste, il n'y avait qu'à accepter avec fatalisme, voire avec stoïcisme, l'éventualité de ces accidents ou de ces coups du sort redoutés[9].

La période du haut Moyen Âge, et de même l'ensemble du Moyen Âge pour la plupart des contrées continentales, n'ont pas marqué de progrès annonçant l'apparition de l'assurance, bien au contraire. La prédominance de la propriété foncière, l'absence de surplus, demeurent la règle, et elles s'accentuent même. Le prêt à la grosse ne reste pratiqué que là où un commerce maritime subsiste ou renaît. Des guildes permettent seulement à leurs adhérents de bénéficier de secours en cas de maladie, de vieillesse ou d'infirmité. Les compagnons de certains corps de métiers, notamment dans les pays germaniques, s'engagent aussi par serment à s'assister mutuellement en cas d'incendie ou de destruction de leurs biens, jusqu'à ce qu'une disposition des Capitulaires de Charlemagne de 779 leur interdise de le faire[10].

Le pire des dangers qui menaçait alors les hommes, c'était d'être envoyés en enfer après leur mort, et pour contribuer à leur salut, les chrétiens devaient se conformer à la loi divine, pratiquer la charité, participer à des pèlerinages. Confrontés aux trois dangers majeurs qui menaçaient leur existence sur cette terre, la famine, l'épidémie et la guerre, ils ont cherché à mettre au point des « formes de réponse collectives » (un taux de natalité élevé, le développement de la culture du seigle, de meilleures capacités de protection militaire)[11]. Mais ils ne pouvaient songer à s'assurer contre des fléaux par nature totalement imprévisibles, puisqu'ils n'échappaient pas à la toute puissante volonté de Dieu. Aussi les notions modernes de hasard et de risque apparaissaient-elles incompatibles avec la civilisation médiévale. Jouer avec l'incertitude de l'avenir, « c'était conclure un pacte implicite avec le diable ». Plus que toute autre, la société médiévale reste éloignée de l'idée assurantielle.

L'INVENTION DES ASSURANCES MARITIMES

Pourtant, dans ce monde médiéval qui paraît longtemps immobile et hostile à toute idée d'assurance, des changements s'amorcent à partir du XIII[e] siècle. L'agriculture fait des progrès sensibles, ce qui dégage davantage de surplus à redistribuer, la monnaie d'or réapparaît dans la circulation et la richesse mobilière devient plus importante. Surtout, il se produit une poussée urbaine, qui profite principalement aux villes marchandes du nord de l'Italie. Ces villes dominantes, à vocation internationale, tirent leur richesse de la mer, et leur succès dans le commerce maritime traduit un esprit d'entreprise très développé. Mais le commerce au loin reste très dangereux, en raison des tempêtes, des pirates et des guerres, et l'expansion de ce commerce qui expose à d'énormes risques incite la sagesse des marchands à trouver de nouveaux moyens de se garantir contre d'éventuels échecs.

Ces villes sont aussi des foyers de modernité, où, comme l'a montré F. Braudel, se produit « la naissance d'une société, et plus encore d'une mentalité nouvelle, ... l'annonce d'un homme nouveau »[12]. Les marchands, en effet, veulent s'organiser pour diminuer leurs risques, maîtriser quelque peu leur avenir, au lieu de subir les catastrophes futures avec fatalisme. Ce changement de mentalité se traduit par l'apparition dans la langue italienne vers le milieu du XIII[e] siècle de termes nouveaux, superficiellement latinisés, comme *rischium, risigus, riscus* ou *riscum*, pour désigner la notion nouvelle du risque qui émerge alors[13].

Le traditionnel prêt à la grosse demeure un des moyens de se prémunir à la disposition des marchands, même s'il tombe sous la condamnation canonique du prêt à intérêt, prononcée par le pape Grégoire IX en 1234. Mais l'interdiction pontificale gêne son utilisation, et il s'agit d'un moyen de défense manquant de souplesse, qui exige des prêteurs d'énormes capitaux, qui croissent en raison même de l'expansion du grand commerce.

Les marchands divisent leurs risques, en se partageant en copropriété leurs navires, ou en créant une *societas maris*, unissant deux associés, l'un qui reste sur place, et l'autre qui embarque à bord du navire. Mais ces marchands sont en quête d'autres moyens de protection. À la fin du XII[e] siècle au plus tôt, on voit apparaître la *securitas* : ce terme, qui signifiait initialement une espèce de sauf-conduit, désigne maintenant un contrat par lequel des marchands confient des marchandises à un transporteur qui s'engage à les livrer sur un certain lieu. Au XIII[e] siècle, on mêle toujours le prêt à l'assurance, et on utilise le change maritime (*cambium trajectitium*), qui

est dérivé du prêt à la grosse : un emprunteur promet de rembourser ailleurs et dans une autre monnaie la somme reçue sur une place donnée, si le navire et sa cargaison arrivent à bon port : la prime d'assurance se trouve ainsi confondue avec le bénéfice sur le change. Par la suite, les marchands se mettent à faire des paris sur l'arrivée de leurs bateaux respectifs, celui qui verse une somme d'argent appelée *primum* en latin, ou prime, recevant en contrepartie la promesse d'être remboursé en cas de naufrage. Toutes ces pratiques apparaissent comme des tâtonnements jalonnant la voie qui mène à l'invention de l'assurance, plus spécialement destinée à se garantir contre les fortunes de mer.

Si dès 1319 on trouve mentionnés à part sur le livre d'un commerçant florentin les frais de risque de transport maritime, à notre connaissance le premier véritable contrat d'assurance, sur lequel les assureurs sont bien distincts du propriétaire du bateau, a été signé à Gênes le 13 octobre 1347; il couvrait la cargaison qu'un navire, le Santa Clara, devait transporter de Gênes à Majorque. Il n'est pas étonnant que l'assurance apparaisse ainsi d'abord à Gênes, qui était alors bien plus moderne que Venise, et cette ville va garder une place primordiale dans les assurances maritimes jusqu'au XVI^e^ siècle. Si un autre contrat de ce genre fut conclu à Palerme en 1350, c'est encore Gênes qui, en 1369, fut la première cité à régler légalement l'assurance maritime, en prévoyant la possibilité de contester après sa conclusion un tel contrat. Et le plus ancien contrat de réassurance maritime est un document fait à Gênes le 12 juillet 1370[14]...

Le contrat d'assurance maritime constituait « un progrès décisif en raison de sa souplesse d'utilisation et de l'étendue des services qu'il permettait »[15]. Aussi le succès de cette innovation a-t-il été relativement rapide : les actes de cette nature se multiplient à Gênes, mais aussi très vite à Pise (déjà en déclin), à Venise (qui établit sa primauté au XV^e^ siècle) ; et à Florence, qui pourtant n'est pas un port, on voit se multiplier les polices d'assurances, (ou *polizza*), qui sont des écrits signés par les assureurs, que les assurés exhibent pour se faire rembourser les dommages subis après un accident.

Dans tous ces contrats, trois ou quatre types d'intervenants caractéristiques sont présents. D'abord les assurés, qui sont des marchands, et les assureurs, qui appartiennent généralement au même milieu, car « il est rare de trouver un assureur qui n'apparaisse jamais, à son tour, comme assuré (et vice versa) : en somme, peu de marchands qui, entre les divers investissements possibles, négligent l'assurance, et peu d'assureurs qui ne s'occupent pas de marchandises »[16]. Si au XIV^e^ siècle le grand marchand pisan Francesco di Prato se spécialise dans ces opérations et si au début

du XV^e siècle beaucoup de marchands génois vivent exclusivement du profit des assurances qu'ils concluent, ce n'est pas le cas partout, et les assureurs n'ont pas le plus souvent d'existence autonome : F. Braudel note ainsi dans sa thèse qu'à Venise au XV^e siècle, dans le monde de la finance « tout est confusion : les Capponi, dont sont conservés les gros livres s'occupent aussi bien de transporter du vin que d'assurer des navires »[17]. Ces assureurs émiettent volontiers leurs garanties sur de nombreux risques, et chacun d'eux ne souscrit jamais une somme très forte sur un seul navire. On voit donc couramment les signatures d'un nombre important d'assureurs sur une même police. Enfin, très tôt, ceux qui s'exposent aux plus gros risques prennent l'habitude de réassurer à leur tour les capitaux qu'ils ont risqués.

Dans beaucoup de ces opérations, l'assurance est passée devant un notaire, pour qu'elle ait la forme d'un acte public, ayant un caractère d'authenticité, et le notaire est souvent ensuite pris pour arbitre en cas de litige sur le paiement des dommages à payer. Mais si à Gênes on recourt au notaire jusqu'au milieu du XV^e siècle, à Florence on traite rapidement ce genre d'affaires entre personnes privées, par l'intermédiaire des courtiers.

Les seuls intermédiaires obligés, et les seuls vrais spécialistes de cette nouvelle activité, sont les courtiers, qui démarchent les clients potentiels des assureurs, rédigent et signent les polices. À Gênes, ces courtiers deviennent très vite des professionnels spécialisés, disposant de connaissances techniques, qui forment entre eux de véritables compagnies. Ils concentrent bientôt leurs affaires dans les premières bourses, où ils peuvent comparer les risques, en collectant toutes les nouvelles qui leur parviennent sur l'éventualité d'une guerre, sur l'intensité de la piraterie, sur la valeur des cargaisons. En rassemblant ainsi, de façon empirique, un ensemble de données, ils parviennent à établir des primes moyennes, selon les destinations, les saisons, les prix des produits transportés. C'est ainsi que s'établit progressivement un marché de l'assurance, et que cette activité, au lieu d'être un pari purement aléatoire, devient l'objet d'études statistiques plus sérieuses, visant à calculer les risques au plus près.

LE PREMIER ESSOR DES ASSURANCES EN EUROPE (XIV^E- XVIII^E SIÈCLE)

L'économie de l'Europe occidentale, qui n'avait évolué qu'insensiblement durant l'Antiquité puis le haut Moyen Âge,

connaît des changements plus rapides à partir du XIVe siècle. C'est alors, du XIVe au XVIIIe siècle, que se développe le capitalisme commercial, et que s'expriment des mentalités nouvelles : de là « les initiatives prises par les hommes de l'Ouest européen pour élargir leur champ d'action, maîtriser davantage leur environnement et desserrer l'étau des forces hostiles qui les menaçaient » (J. Delumeau).

Or, comme l'a écrit Henri Sée en 1930, dans *Les progrès du capitalisme moderne*, le développement des assurances est bien « l'un des phénomènes caractéristiques » de ce capitalisme marchand et de sa modernité. La première révolution assurantielle qui s'est produite dans les villes marchandes de l'Italie du Nord s'étend progressivement dans d'autres sociétés urbaines d'Europe. La conception nouvelle du risque que les marchands veulent limiter, – une notion qui reste essentiellement cantonnée au grand commerce – , se traduit par la diffusion dans toutes les langues européennes de ce terme à l'étymologie incertaine; à partir d'un mot du latin juridique médiéval, on a forgé un terme italien (*risico*), puis des vocables très proches en catalan et en provençal, parce que les ports du littoral méditerranéen travaillaient ensemble; puis il apparaît en français, en allemand, en anglais, et même en serbo-croate et en russe. « Cette communauté d'adoption d'un même terme renvoyant à un même concept s'explique par le fait qu'il appartient d'abord à un même cercle professionnel et fermé, voué au grand commerce maritime »[18].

Désormais les assurances tiennent une place distincte et essentielle dans l'activité des cités marchandes, et les plus grands des capitalistes du temps, les Médicis ou les Fugger, s'y intéressent, les hommes politiques les plus puissants, comme Philippe II ou Colbert, s'en préoccupent, les premiers économistes, et au premier chef Adam Smith, l'étudient.

Cette montée en puissance de l'assurance en Europe s'est faite dans trois directions principales. Les assurances maritimes se sont d'abord propagées essentiellement dans les cités marchandes liées directement au grand commerce méditerranéen du XIVe au XVIe siècle, puis elles se sont étendues, tout en se transformant, dans l'Europe du Nord-Ouest, essentiellement aux Provinces-Unies et en Angleterre durant les XVIIe et XVIIIe siècles, enfin, à la même époque, on voit émerger de nouvelles formes d'assurance, qui ne se développeront largement que par la suite.

☐ La propagation des assurances maritimes dans l'aire méditerranéenne et ses prolongements

L'extension des assurances suit étroitement les flux dominants du commerce maritime. Au XIV^e^ et au XV^e^ siècle, c'est la Méditerranée qui demeure l'économie-monde par excellence, un univers en soi, qui a son unité économique, « construite d'en haut, à partir des villes dominantes de l'Italie du Nord »[19]. Aussi voit-on les assurances, de mieux en mieux proportionnées au risque couru, se développer dans ces villes d'Italie et aussi dans les cités qui sont en rapports étroits (et parfois en compétition) avec elles. Ce sont d'ailleurs généralement des colonies de marchands italiens, Génois, Toscans ou Vénitiens, qui essaiment dans d'autres cités et y acclimatent les assurances maritimes, dont ils sont les « véhicules » selon le terme utilisé par Halpérin. Les assurances y ont été importées, avant d'y être imitées par des marchands locaux.

L'assurance maritime, qui continue à prospérer dans ses lieux de naissance, en Italie du Nord, s'implante ainsi à Raguse (Dubrovnik)[20], qui connut une grande prospérité au XV^e^ siècle. A l'ouest, le Portugal, où la navigation tient de bonne heure une place importante, vit se créer dès la fin du XIII^e^ siècle une bourse d'assurance pour la navigation vers les ports étrangers, qui travaillait selon le principe de la mutualité et était soumise au contrôle de fonctionnaires royaux; et ce pays a fait, de 1367 à 1383, l'expérience éphémère d'une assurance obligatoire des propriétaires de navires, sous l'égide du roi. Mais c'est surtout d'Italie en Espagne que passent les assurances : elles apparaissent d'abord à Barcelone, qui entretient un trafic commercial intense avec Gênes, puis à Séville. Au XVI^e^ siècle, c'est Burgos qui est particulièrement réputée pour le sérieux de ses assurances, auxquelles font appel les marchands de Bilbao ou de Lisbonne. Les assureurs étaient les marchands eux-mêmes, qui se réunissaient dans des bourses pour y négocier une répartition des risques entre eux. Et c'est la législation espagnole qui a fortement contribué à faire évoluer le droit européen des assurances maritimes au XV^e^ siècle.

Toujours venant d'Italie, les assurances apparaissent à Bruges, depuis longtemps fréquentée par les navires génois; des assureurs génois y sont établis dès 1370, et dans une Chronique de Bruges qui date du XIV^e^ siècle on trouve déjà la mention de l'existence sur cette place de nombreux assureurs italiens, qui y ont constitué une Chambre des Assurances. Après le déclin de Bruges, c'est Anvers qui hérite de ce rôle d'étape vers la Mer du Nord de la navigation conquérante de la Méditerranée : à Anvers, au XVI^e^ siècle, au temps de sa grandeur, des assureurs (souvent eux aussi d'origine italienne)

offrent largement leurs services aux marchands qui y sont établis et aussi à ceux qui résident dans des contrées voisines. Et la ville devient alors, grâce en particulier à sa bourse, la métropole européenne des assurances.

Toutes ces places constituent désormais en Europe autant de marchés des assurances maritimes, où on trouve toujours des possibilités de s'assurer, grâce à l'activité des courtiers, et aussi à la présence d'assureurs, qui sont généralement des individus isolés, s'associant temporairement pour une opération donnée. On peut y suivre les fluctuations des primes, qui varient en fonction de la valeur des marchandises transportées, des risques de piraterie, de l'état de guerre ou de paix, etc... Les taux de ces primes peuvent être relativement bas, de l'ordre de 1,5 %, en particulier pour le transport des métaux précieux d'Amérique, qui est relativement sûr, mais ils atteignent 9 % et plus, pour un transport de blé dans le Levant exposé à la piraterie. À Raguse, d'après Tenenti, les taux se situaient généralement de 3,25 à 4 %.

Mais ces assurances deviennent souvent de pures spéculations et des jeux hasardeux. Aussi très vite apparaissent des lois destinées à les réglementer, parfois à les prohiber ou à les soumettre à diverses taxes. Ces lois confirment l'extension du champ géographique de ces activités liées au commerce maritime. Les premières voient le jour au XIV^e^ siècle à Gênes et en Catalogne sous le règne de Jacques I^er^ d'Aragon, mais on en trouve ensuite en Italie, à Florence ou à Naples. Dans ses placards de 1537 et de 1649, Charles-Quint s'efforce de condamner l'abus du contrat d'assurance, et en 1570 Philippe II intervient dans le même sens par son ordonnance d'Anvers.

☐ La diffusion des assurances maritimes dans le Nord de l'Europe

Du XVI^e^ au XVIII^e^ siècle, le commerce maritime se développe considérablement, en même temps que la navigation devient moins hasardeuse et les navires plus fiables. Au point de vue économique, « l'Europe bascule alors sur elle-même, au bénéfice du Nord » du continent, selon l'expression de F. Braudel. Le fait que les navires hollandais ou anglais aient été mieux défendus et plus sûrs que ceux des Vénitiens dans le Levant, leur vaut de payer des primes d'assurances moins élevées, ce qui a pu contribuer au changement de « l'économie-monde » (F. Braudel).

Les assurances, qui déclinent à Bruges ou à Burgos, continuent à prospérer en Italie, notamment à Livourne, mais désormais elles

se développent surtout dans le Nord-Ouest de l'Europe qui est maintenant la zone dominante du grand commerce. Après Bruges et Anvers, les marchands italiens avaient, dès le XIVe ou le XVe siècle, acclimaté les assurances dans les futures Provinces-Unies, à Hambourg, et en Angleterre, où elles connaissent à partir du XVIe siècle un essor spectaculaire. Elles trouvent un terrain propice dans ces pays protestants, où le commerce est particulièrement actif. D'abord aux Provinces-Unies, qui constituent « une économie urbaine survoltée », et tout particulièrement à Amsterdam, où elles sont favorisées par la liberté des transactions, l'existence d'une Bourse et de grandes compagnies de commerce, la passion du jeu. Pour l'année 1596, on a pu trouver la mention d'une coopération entre Venise et Amsterdam destinée à assurer des navires dans toutes les régions du monde, y compris aux Indes. Hambourg est la première ville d'Allemagne où on connaisse un contrat d'assurance maritime, daté de 1588.

Mais c'est en Angleterre que le succès des assurances maritimes est le plus spectaculaire et le plus durable. Dans ce pays, l'introduction par les Italiens de l'assurance maritime remonterait au XVe siècle. En tout cas, une des plus anciennes polices maritimes, datée du 20 septembre 1547, souscrite à Londres par des commerçants anglais et d'autres personnes en qualité d'assureurs, était écrite en italien. Mais très vite ces contrats ont été souscrits par des marchands de Londres, qui centralise toute la modernité de la vie anglaise, et négociés par des courtiers, qui étaient citoyens de la *City*, assistés eux-mêmes par des notaires chargés de préparer et de remettre les polices aux contractants. On ne peut avoir accès aux assureurs que par l'intermédiaire des courtiers, et les litiges étaient soumis au Lord Maire de la *City*. Au XVIIe siècle, le Royal Exchange, la première Bourse de Londres, est devenu la bourse des assurances maritimes, concentrant toutes les transactions en ce domaine. Mais l'assurance maritime londonienne ne concerne encore que le commerce britannique, et ce n'est qu'au XVIIIe siècle qu'elle acquiert une envergure internationale[21].

Dans l'Angleterre de cette époque, l'assurance maritime ne connaît pas seulement une expansion nouvelle, la façon dont elle se pratique se transforme alors profondément. Tout d'abord elle n'est plus seulement le fait de capitalistes isolés, ou d'assureurs « privés », mais de compagnies par actions : les deux premières compagnies de ce type qui aient réussi durablement, la London Assurance Company et la Royal Exchange Assurance Corporation, datent de 1720, ce sont les seules compagnies à être autorisées. Cet exemple fut suivi, puisqu'on vit par la suite se constituer de semblables sociétés

d'assurances maritimes dans d'autres villes du Nord de l'Europe : à Copenhague en 1726, à Stockholm en 1739. Jusqu'à cette date, le royaume de Suède dépendait des Hollandais pour les assurances maritimes.

Par ailleurs ces compagnies, tout comme les assureurs particuliers, qui répondent à une demande croissante, conçoivent de plus en plus leurs affaires comme des entreprises sérieuses et stables, ayant pour but le profit, et non plus comme des aventures éphémères à haut risque, relevant du pur jeu spéculatif. Elles sont donc en quête d'informations leur permettant d'établir de manière plus rationnelle le taux des primes.

L'histoire du Lloyd's est révélatrice de cette évolution vers un métier solidement organisé de l'assurance. Le Lloyd's, créé en 1688 (six ans avant la fondation de la Banque d'Angleterre) est à ses débuts une taverne, tenue par Edward Lloyd et fréquentée par des marchands et aussi des aventuriers, prêts à se lancer dans les assurances les plus risquées, qui n'étaient que des paris sur l'avenir (les « gambling insurances »). Il publiait une petite feuille imprimée, les *Lloyd's News*, contenant des informations maritimes destinées aux propriétaires de bateaux et aux assureurs, mais on continuait à y pratiquer les opérations les plus spéculatives. En 1769, une scission se produisit, et le nouveau Lloyd's (The New Lloyd's Coffee House), publie une New Lloyd's List, qui fournit tous les renseignements utiles sur les mouvements des navires; c'est une source de renseignements inépuisable pour ses adhérents, qui sont des marchands, surtout des assureurs particuliers et des courtiers. Ils ont formé entre eux une société fermée, à laquelle ne peuvent adhérer que des spécialistes réputés sérieux. Il louent des locaux à la Bourse de Londres, et, dès 1779, ils mettent au point un formulaire de police maritime qui va être utilisé pratiquement sans changement pendant 200 ans. Le Lloyd's moderne, réputé pour son exceptionnelle fiabilité et son intégrité, est né[22].

L'assurance est devenue en Angleterre une affaire bien organisée, avec ses techniques éprouvées. Aussi Adam Smith, en 1776, classe-t-il cette activité parmi « les affaires dont toutes les opérations peuvent être réduites à ce qu'on appelle une routine, ou à une telle uniformité de méthode qu'elles n'admettent que peu ou point de variation ». Ce sont donc selon lui « les seuls genres d'affaires qu'il paraît possible, pour une compagnie par actions, de suivre avec succès sans privilège exclusif... Quoique la valeur des risques, soit du feu, soit des pertes par mer ou par capture, ne puisse guère se calculer peut-être bien exactement, néanmoins elle est susceptible d'une évaluation en gros qui fait qu'on peut, à certain point,

l'assujettir à une méthode et à des règles précises. Par conséquent le commerce d'assurance peut être fait avec succès par une compagnie par actions, sans aucun privilège exclusif. La compagnie d'assurances de la ville de Londres, ni celle du champ royal, n'ont aucun privilège de ce genre »[23].

☐ L'émergence de nouvelles branches d'assurance

Si les assurances maritimes constituent toujours la branche pionnière et aussi la branche motrice de l'ensemble du secteur assurantiel, d'autres branches apparaissent progressivement. Parmi les assurances terrestres, certaines ne sont que des prolongements des assurances maritimes, comme l'assurance des transports par terre, les assureurs continuant à prendre en compte les cargaisons après leur débarquement, jusqu'à ce qu'elles parviennent à leur destination finale. D'autres n'ont qu'une importance relativement secondaire (comme les premiers exemples d'assurance contre la grêle vers 1765, ou encore la plus ancienne entreprise privée d'assurance contre ce fléau créée en 1797 dans le Mecklenbourg), voire marginale ou anecdotique. Mais deux branches promises à un large développement ultérieur émergent au XVIII[e] siècle : l'assurance-incendie et l'assurance-vie.

Le feu constituait un des grands fléaux urbains depuis le Moyen Âge. Les autorités faisaient des efforts impuissants pour le combattre, et les moyens mis en oeuvre restaient peu efficaces. L'extension même des villes, où beaucoup de maisons étaient en bois et entassées les unes contre les autres, rendait les incendies plus redoutables. Quand le feu avait démarré, souvent chez un boulanger, les citadins comptaient sur l'aide de leurs voisins pour limiter les dégâts; les victimes faisaient appel aux secours des autres habitants, sollicités dans les églises ou chez eux par des sociétés de charité, ou à la solidarité des guildes pour les aider à reconstruire leurs maisons. Les rares projets d'assurances contre les dégâts par le feu n'avaient guère abouti à des entreprises durables.

Dans les territoires germaniques, des guildes contre l'incendie s'étaient formées dès le XVI[e] siècle, notamment au Schleswig-Holstein : leurs plus anciens statuts remontent au XVI[e] siècle. À Hambourg, à partir de 1591, on voit des propriétaires d'immeubles (au début il s'agit seulement de propriétaires de brasseries) s'engager mutuellement à se porter secours financièrement en cas de dommages causés par le feu. Les contrats d'incendie de Hambourg sont réunis en 1577 pour fonder la Hamburger Feuerkasse, qui sert de modèle à de nombreuses autres institutions d'assurance incendie de droit public, fondées à Magdebourg (1685), Berlin (1718), etc...

Mais pour cette branche, l'événement fondateur a été le grand incendie de Londres de 1666 : le feu, qui avait pris après une longue période de sécheresse chez le boulanger du roi le 2 septembre, dura cinq jours et détruisit 13 000 maisons, les quatre cinquièmes de la Cité. La réaction des Anglais à ce sinistre sans précédent témoigne des progrès de l'idée d'assurance dans leur pays. Il suscita en effet l'apparition d'une série de grandes compagnies d'assurances contre l'incendie : en 1680, le Fire Office, fondé par Barbon, dont les activités cessèrent un peu avant 1720, en 1683 la Friendly Society, une mutuelle, et en 1696, une autre mutuelle, l'Amicable, plus connue en raison de son logo sous le nom de Hand-in-Hand (Main-dans-la-Main), qui fonctionna pendant 200 ans. Ces compagnies assuraient essentiellement des immeubles sis à Londres, mais le Sun Fire Office, créé en 1710, assura aussi contre les dommages du feu les meubles, les objets domestiques et les stocks, et ce dans l'ensemble du pays, qui était couvert par ses nombreux agents : dès 1720, il avait émis plus de 17 000 polices d'assurance-incendie. C'est aussi de 1720 que date la création à Edimbourg de la Friendly Society, première compagnie d'assurance écossaise contre l'incendie.

Les progrès de l'assurance-incendie ont peut-être été lents (selon Adam Smith, en 1776, 19 maisons sur 20 n'étaient pas assurées[24], mais cette affirmation a été jugée trop pessimiste par l'historien J. H. Clapham ...), mais ils paraissent s'être accélérés à la fin du siècle, et c'est aussi à ces compagnies anglaises d'assurance-incendie que l'on doit une organisation plus efficace de la lutte contre le feu. Leur exemple a d'ailleurs été imité par des compagnies similaires, créées peu après, à Copenhague (en 1731, après l'incendie de cette ville en 1728) et à Bruxelles. En Suède aussi, le développement des constructions urbaines au XVII[e] siècle conduisit à la fondation de caisses-Incendie municipales, qui sombrèrent rapidement par suite de la faible dispersion de leurs risques. Elles furent remplacées à partir de 1782 par un Fonds général d'assurances contre l'incendie, qui se scinda en 1808 en deux sociétés couvrant l'une les risques urbains, et l'autre (qui prit la forme d'une mutuelle) les risques ruraux.

Alors qu'en Angleterre l'assurance-incendie est née d'initiatives privées constituant librement des sociétés à cette fin, en Allemagne et dans les pays scandinaves, l'impulsion vint souvent d'en haut : sous l'influence du despotisme éclairé, ce sont les souverains qui organisèrent, chacun dans leur territoire, des établissements dont ils se réservèrent la direction et auxquels les propriétaires d'immeubles étaient tenus d'adhérer : l'assurance était ainsi tout à la fois

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L'assurance-vie proprement dite est née plus tardivement, mais elle a eu un certain nombre de précédents. Ainsi la tontine, qui est une association de survie, regroupant des adhérents d'une même tranche d'âge, qui, à une date fixée d'avance, devaient se répartir, en proportion de leurs apports, l'ensemble de leurs cotisations majorées des intérêts perçus. La formule, qui était déjà usitée en Italie, a été introduite en France en 1753 par le banquier napolitain Lorenzo Tonti, et elle aboutit en 1689 à l'institution de tontines de l'État : ce sont dès lors un simple moyen pour l'État de recourir à un emprunt déguisé. Les Pays-Bas créent aussi des tontines de l'État, dès 1672. En Allemagne, depuis le Moyen Âge, les compagnonnages et les confréries d'artisans, les corporations de mineurs et les associations religieuses dispensent des secours en cas de décès. Depuis la fin du XVIIe siècle, l'Allemagne voit naître de véritables caisses de secours en cas de décès pour les orphelins, et en particulier à partir de 1750, des caisses de veuvage, qui garantissent les veuves de certains groupes professionnels contre l'appauvrissement causé par la mort de leur mari[26]. Mais leur méconnaissance des principes de l'assurance leur permit rarement de subsister durablement.

Par ailleurs, certaines conventions d'assurances maritimes ont assuré l'équipage, puis les passagers, contre les risques d'être capturés par des pirates exigeant une rançon ou menaçant de les vendre comme esclaves.

Plus généralement, on vit un peu partout, surtout à Anvers d'abord, puis à Londres, se multiplier des assurances-vie à court terme ou des assurances-décès, sur une durée ne dépassant généralement pas un an. La plus ancienne police d'assurance-vie connue actuellement est datée du 18 juin 1583. Elle couvrait une période de douze mois de la vie de William Gibbons, la somme assurée, qui était de 382 livres 6 shillings et 8 p., était partagée entre 16 assureurs et la prime était de 8 %. Cette police a été enregistrée auprès de la Chambre des Assurances du Royal Exchange de Londres, et elle indique qu'une police antérieure avait été souscrite par la même personne[27].

Ces anciennes polices d'assurance-vie étaient le plus souvent souscrites en garanties d'emprunts, ou bien étaient des paris spéculatifs, purement aléatoires, sur la vie de divers individus, des rois et des hommes d'État, des soldats lors d'une guerre, etc.... De telles polices ont été interdites dans les Flandres par Philippe II, et dans de nombreux pays, les autorités religieuses condamnèrent de telles pratiques contraires à la volonté du Ciel, en rappelant que la vie humaine ne pouvait être considérée comme représentant un capital et faire l'objet d'un contrat. À Londres, elles continuèrent pourtant à se développer librement; on vit même se créer les premières sociétés d'assurance-vie, comme l'Amicable Society for a Perpetual Assurance en 1705, mais ces sociétés ne sont pas gérées sur des bases scientifiques, et, vers 1720, une fièvre intense de paris purement spéculatifs sur la vie se déchaîne et entraîne la disparition de toutes ces associations.

Pour qu'apparaisse une assurance-vie à long terme, au sens moderne du terme, basée sur le calcul des primes en fonction de l'espérance probable de vie et des intérêts composés, il fallait que se développent des connaissances scientifiques adéquates, portant sur le calcul des probabilités. La découverte du calcul des probabilités par Pascal (1662), l'établissement de la première table de mortalité par Halley (1693), les travaux de mathématiciens comme les Suisses Euler et Bernoulli et le Français Deparcieux, les premiers travaux de statistiques contribuent à fonder en Europe des techniques permettant de prévoir la durée de vie des hommes, sur la base de calculs effectués par des actuaires. A partir du milieu du XVIII[e] siècle, on dispose dans divers pays de tables de mortalités, les plus appréciés de ces « états de mortalité » tirant leurs données des villes de Londres, Dublin et Breslau.

Mais ces bases scientifiques, si elles sont la condition indispensable à l'éclosion de l'assurance-vie moderne, ne suffisent pas à elles seules à susciter son apparition, qui ne se produit d'abord qu'en Angleterre en 1762 avec la création de l'Equitable Life Assurance Society. Basée sur des principes sérieux et prudents (une solide estimation des taux de mortalité, la sélection des clients, la constitution de réserves importantes et des placements en fonds publics sûrs), cette société devait prospérer sans concurrente sérieuse pendant trente ans. La plus ancienne entreprise d'assurance-vie allemande est une mutuelle d'assurances à bases mathématiques qui apparaît à Hambourg en 1778[28].

Si on compare le paysage des assurances à la fin du XVIII[e] siècle ou au début du siècle suivant à ce qu'il était lors de son apparition au XIV[e] siècle, on constate qu'il s'est profondément transformé : les

publique et obligatoire pour les propriétaires d'immeubles. Comme ce sont les percepteurs qui étaient chargés de recevoir leurs cotisations (il n'y avait donc pas d'agents d'assurances), on peut voir là aussi une forme déguisée de l'impôt, à laquelle les premiers à avoir eu recours furent, après l'incendie d'Altona par les Suédois en 1713, Frédéric III de Prusse, puis, avec plus de succès, son successeur Frédéric-Guillaume 1er[25]. Ici, tout comme en Angleterre, l'assurance incite à mieux se protéger contre le danger du feu.

L'assurance-vie proprement dite est née plus tardivement, mais elle a eu un certain nombre de précédents. Ainsi la tontine, qui est une association de survie, regroupant des adhérents d'une même tranche d'âge, qui, à une date fixée d'avance, devaient se répartir, en proportion de leurs apports, l'ensemble de leurs cotisations majorées des intérêts perçus. La formule, qui était déjà usitée en Italie, a été introduite en France en 1753 par le banquier napolitain Lorenzo Tonti, et elle aboutit en 1689 à l'institution de tontines de l'État : ce sont dès lors un simple moyen pour l'État de recourir à un emprunt déguisé. Les Pays-Bas créent aussi des tontines de l'État, dès 1672. En Allemagne, depuis le Moyen Âge, les compagnonnages et les confréries d'artisans, les corporations de mineurs et les associations religieuses dispensent des secours en cas de décès. Depuis la fin du XVIIe siècle, l'Allemagne voit naître de véritables caisses de secours en cas de décès pour les orphelins, et en particulier à partir de 1750, des caisses de veuvage, qui garantissent les veuves de certains groupes professionnels contre l'appauvrissement causé par la mort de leur mari[26]. Mais leur méconnaissance des principes de l'assurance leur permit rarement de subsister durablement.

Par ailleurs, certaines conventions d'assurances maritimes ont assuré l'équipage, puis les passagers, contre les risques d'être capturés par des pirates exigeant une rançon ou menaçant de les vendre comme esclaves.

Plus généralement, on vit un peu partout, surtout à Anvers d'abord, puis à Londres, se multiplier des assurances-vie à court terme ou des assurances-décès, sur une durée ne dépassant généralement pas un an. La plus ancienne police d'assurance-vie connue actuellement est datée du 18 juin 1583. Elle couvrait une période de douze mois de la vie de William Gibbons, la somme assurée, qui était de 382 livres 6 shillings et 8 p., était partagée entre 16 assureurs et la prime était de 8 %. Cette police a été enregistrée auprès de la Chambre des Assurances du Royal Exchange de Londres, et elle indique qu'une police antérieure avait été souscrite par la même personne[27].

Ces anciennes polices d'assurance-vie étaient le plus souvent souscrites en garanties d'emprunts, ou bien étaient des paris spéculatifs, purement aléatoires, sur la vie de divers individus, des rois et des hommes d'État, des soldats lors d'une guerre, etc.... De telles polices ont été interdites dans les Flandres par Philippe II, et dans de nombreux pays, les autorités religieuses condamnèrent de telles pratiques contraires à la volonté du Ciel, en rappelant que la vie humaine ne pouvait être considérée comme représentant un capital et faire l'objet d'un contrat. À Londres, elles continuèrent pourtant à se développer librement; on vit même se créer les premières sociétés d'assurance-vie, comme l'Amicable Society for a Perpetual Assurance en 1705, mais ces sociétés ne sont pas gérées sur des bases scientifiques, et, vers 1720, une fièvre intense de paris purement spéculatifs sur la vie se déchaîne et entraîne la disparition de toutes ces associations.

Pour qu'apparaisse une assurance-vie à long terme, au sens moderne du terme, basée sur le calcul des primes en fonction de l'espérance probable de vie et des intérêts composés, il fallait que se développent des connaissances scientifiques adéquates, portant sur le calcul des probabilités. La découverte du calcul des probabilités par Pascal (1662), l'établissement de la première table de mortalité par Halley (1693), les travaux de mathématiciens comme les Suisses Euler et Bernoulli et le Français Deparcieux, les premiers travaux de statistiques contribuent à fonder en Europe des techniques permettant de prévoir la durée de vie des hommes, sur la base de calculs effectués par des actuaires. A partir du milieu du XVIII[e] siècle, on dispose dans divers pays de tables de mortalités, les plus appréciés de ces « états de mortalité » tirant leurs données des villes de Londres, Dublin et Breslau.

Mais ces bases scientifiques, si elles sont la condition indispensable à l'éclosion de l'assurance-vie moderne, ne suffisent pas à elles seules à susciter son apparition, qui ne se produit d'abord qu'en Angleterre en 1762 avec la création de l'Equitable Life Assurance Society. Basée sur des principes sérieux et prudents (une solide estimation des taux de mortalité, la sélection des clients, la constitution de réserves importantes et des placements en fonds publics sûrs), cette société devait prospérer sans concurrente sérieuse pendant trente ans. La plus ancienne entreprise d'assurance-vie allemande est une mutuelle d'assurances à bases mathématiques qui apparaît à Hambourg en 1778[28].

Si on compare le paysage des assurances à la fin du XVIII[e] siècle ou au début du siècle suivant à ce qu'il était lors de son apparition au XIV[e] siècle, on constate qu'il s'est profondément transformé : les

pratiques assurantielles se sont étendues dans toute l'Europe, elles se sont diversifiées, et elles se sont modernisées. Mais les progrès ont été très inégaux selon les pays. L'Angleterre est la seule nation qui possède de grandes compagnies d'assurances couvrant tout le spectre des assurances existant à l'époque. Ce pays, le plus moderne, celui où le capitalisme commercial et financier a le mieux réussi, celui aussi où l'individualisme et l'utilitarisme se sont le mieux affirmés, s'est avéré une terre propice au développement de toutes les affaires d'assurances : c'est le pays pionnier pour les assurance-vie et incendie, et Londres a affirmé sa prééminence dans le domaine des assurances maritimes : la plupart des marchands assureurs des ports qui cherchent à se couvrir par des réassurances font en effet appel au marché de Londres.

Sur le continent, seule Amsterdam peut encore prétendre rivaliser avec lui pour les assurances maritimes. Certaines villes italiennes restent actives en ce domaine, mais Livourne est en déclin en raison du « retard accumulé dans les processus de transformation de l'entreprise assurance », alors que la place de Trieste s'appuie sur un oligopole de puissantes compagnies[29]. L'Espagne a pris beaucoup de retard dans tous les domaines. L'Italie est considérablement en retard sur les pays de l'Europe du Nord pour la branche incendie. « En 1786, le Banco di Assicurazioni de Trieste cherche à introduire une branche incendie à côté de celle de l'assurance maritime, sans pour autant rencontrer la faveur du public »[30].

Les États allemands ont vu se développer des institutions spécifiques, comme les caisses de veuvage ou l'assurance publique des dommages-incendie, mais l'assurance maritime y est, sauf exception (à Hambourg notamment), peu développée. Et la Suisse elle-même n'a que des caisses locales d'assurance-incendie peu actives, handicapées par la division en cantons du pays.

En France, qui est le pays le plus peuplé d'Europe, les assurances maritimes se sont établies difficilement, principalement d'abord à Lyon, puis à Paris. Les usages en la matière, d'abord inscrits dans le Guidon de la Mer au XV^e siècle, ont été codifiés en 1681 par la Grande Ordonnance de la Marine de Colbert. Malgré les efforts de ce ministre, ces assurances se développent inégalement, et il faut attendre 1650 pour que se constitue une Compagnie d'Assurances maritimes. Quand à l'assurance-incendie et à l'assurance-vie, – cette dernière avait été prohibée par l'ordonnance de 1681 – , elles ont été longtemps inexistantes. Les choses changent seulement à l'extrême fin de l'Ancien Régime : en 1786, le sieur Labarthe peut fonder la Compagnie Royale d'Assurances Incendie, et l'année suivante il est autorisé à créer une compagnie d'assurance-vie par

un arrêt du conseil qui justifie ainsi l'introduction de cette activité en France : « Le roi, s'étant fait rendre compte de la nature et des principes de divers établissements fondés en Europe sous le nom d'assurances sur la vie, ... a reconnu qu'ils renfermaient des avantages précieux ». Mais le 24 août 1793 la Convention, supprimant les sociétés par actions, casse net cet essor tardif de l'assurance moderne en France. Cette législation ne fut pas abolie par Napoléon.

■ CONCLUSION

En définitive, le développement de l'assurance dans l'Europe médiévale puis à l'époque qualifiée de moderne par l'historiographie française (XVI[e]-XVIII[e] siècle) correspond étroitement, dans l'espace et dans le temps, au développement inégal du capitalisme commercial. C'est parce que l'Europe est la première région du monde à avoir vu l'essor du grand commerce, qui est alors le secteur moderne, innovant, qu'elle a inventé l'assurance, et qu'elle a transplanté ce type d'activité dans les contrées d'autres continents alors sous sa domination ou sous son influence économique, comme l'Argentine (où la Compagnie Royale d'Assurances Terrestres et Maritimes de Madrid établit une agence en 1784), ou même la Chine : le commerce avec ce pays suscita la création par des Anglais de la Canton Insurance, dès le début du siècle, à laquelle succéda en 1835 la China Insurance Company, dont le siège fut transféré à Hong Kong en 1841, lors de la cession de cette île à la Grande-Bretagne. Dans les colonies anglaises d'Amérique, avant que celles-ci ne conquièrent leur indépendance, plusieurs compagnies d'assurances contre l'incendie avaient été formées à partir de 1735 sur le modèle des compagnies anglaises qui fonctionnaient alors, mais la plupart d'entre elles ont échoué rapidement. La seule qui ait duré jusqu'au XX[e] siècle est la *Philadelphia Contributionship for the Insurance of Houses from Loss by Fires*, une mutuelle fondée en 1752 par Benjamin Franklin.

À l'intérieur de l'Europe, ce sont les villes et les pays qui ont successivement joué un rôle moteur dans l'essor des activités marchandes qui ont aussi tenu, au même moment, une place essentielle dans l'expansion des assurances et les progrès de leurs techniques. D'abord les grandes cités marchandes du nord de l'Italie, qui ont réellement inventé l'assurance, puis la péninsule ibérique au XV[e]-XVI[e] siècle, et ensuite les Provinces-Unies et, surtout, l'Angleterre.

La domination de l'Angleterre, et plus particulièrement de Londres, sur le marché de l'assurance est incontestée au cours du XVIII[e] siècle. Cette domination a accompagné, voire précédé l'avènement de la révolution industrielle, née elle aussi en Angleterre.

Du XIV[e] au XVIII[e] siècle en effet, les Européens, ceux d'entre eux du moins qui sont intégrés dans les circuits monétaires et les activités commerciales, ont innové et tenté des expériences diverses dans le domaine de l'assurance : ils ont constitué, pour répondre à ce besoin de sécurité qui croît avec la modernisation de l'économie, des firmes de divers types (compagnies privées, mutuelles, établissements dépendant de l'État ou des pouvoirs publics locaux ...), ils ont couvert des risques de plus en plus nombreux (les risques liés au commerce maritime, dont l'importance reste prépondérante, la maladie et la mort, l'incendie et les autres causes de destruction des biens ou des récoltes), ils ont mis au point des techniques particulières... Ces tentatives se sont souvent soldées par des échecs, parce que les entreprises n'ont pas su diversifier suffisamment leurs risques, parce que leurs dirigeants se sont comportés comme des spéculateurs imprudents, ou parce que les techniques à leur disposition restaient incertaines.

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DEALING WITH THE INSURANCE BUSINESS IN THE ECONOMIC ACCOUNTS

by Tarek M. Harchaoui

ABSTRACT

This article synthetizes and extends the treatment of the insurance business in the system of national accounts, with a focus on the measurement of the production activity. The framework begins with an overall discussion, at the macroeconomic level, on the past and current approaches on the measure of the insurance business production activity in the system of national accounts. But this macroeconomic approach of the insurance business turns out to be limited in many important respects. In extending the framework, I adopt a more disaggregated approach, making a strong case on the need to understand the behaviour and to measure the activity of the insurance business at the level of the line of business. This approach, overlooked by the existing economic literature, provides many insights in terms of the delineation of insurers' lines of business, the measurement of their activity and their interaction within an integrated input-output framework. As a by product, the article also discusses issues related to the regional breakdown of insurers' activities and the unduplicated measure of the insurance firm's output.

Keywords: Output, producing units, technology.

JEL numbers: C8, L8, M4.

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RÉSUMÉ

Cet article résume et élargit le traitement des assureurs dans le système de comptabilité nationale, en mettant cependant l'accent sur la mesure de l'activité de production. Le cadre d'analyse débute avec une discussion générale, au niveau macroéconomique, sur les approches passées et présentes de la mesure de l'activité de production des assureurs dans le système de comptabilité nationale. Cependant, cette perspective macroéconomique s'avère limitée sur plusieurs aspects. En élargissant le cadre d'analyse, nous avons adopté une approche désagrégée, en insistant sur la nécessité de comprendre le comportement et de mesurer l'activité des assureurs au niveau du segment d'activité. L'approche, négligée par la littérature économique existante, fournit un éclairage supplémentaire sur la délimitation des activités dans lesquelles sont engagés les assureurs, la mesure de leurs activités et leur interaction dans un cadre intégré de tableaux entrées-sorties. À titre d'extension de ce cadre, cet article discute également de la mesure des activités régionales des assureurs et leur mesure de production au niveau de l'ensemble de la firme.

Mots clés *: Sortie, unités de production, technologie.*

Classification JEL *: C8, L8, M4.*

1. INTRODUCTION

Insurance companies have historically been an important player of the 'four pillars' of developed countries' financial services sector, offering financial protection, investment products and reinsurance services. Banks (concentrating on lending to businesses, collecting households and business deposits, and offering payment services through these deposits), trust and mortgage loan companies (concentrating on fiduciary services and mortgage lending to households), and securities dealers (focussing on the underwriting and marketing of investment products) were considered the other pillars in the financial services sector.[1]

The recent years have witnessed a gradual merging of the four pillars, with much greater overlap of business lines. These developments stemmed from many factors, including globalization of financial markets, technological innovation, changing demographics, rising household wealth, and adjustments within the financial sector to shifting business prospects. Changes in the environment have been a major factor in the legislative and regulatory revisions that have widened the powers of financial institutions and placed financial groups in direct competition with each other.

Structural change in some major countries' financial system in the 1980s and early 1990s was similar to developments in many other industrialized countries. As one would expect, such forces have significantly affected the financial sector in general and the insurance business in particular. Their product lines have broadened considerably beyond the core business of financial protection. Therefore, one of roles of economists concerned with organizing economic data into meaningful formats is to ask periodically whether existing data sets of accounts adequately describe important economic trends and are useful to public and private policymakers as possible. This is one of the objectives of this article.

The other goal of this article is to provide an overall picture of the treatment of insurance in the SNA at the micro and macro levels. The article discusses the previous and actual treatments of insurance in the system of national accounts (SNA) framework and discusses some of the ways in which the framework is applied, depending on specific country requirements. It then introduces the main categories for national accounting which draw upon the records of businesses, and the accounting rules to be followed when recording the various entries. The article then describes the activities of the producing units and their classification required for a program of economic statistics. The article also investigates the behaviour and activities of business and the transactions that take place between them within an integrated input-output framework. In particular, this article looks at shows the link between the line of business and the enterprise from the standpoint of a complete production account statement.

■ II. INSURANCE IN THE SYSTEM OF NATIONAL ACCOUNTS: A MACROECONOMIC APPROACH

☐ A. Background

The SNA is implemented at different levels of aggregations: at the level of the institutional sectors and at the level of the economy. Although traditionally described as a SNA, for analytical purposes the SNA is also to be implemented at lower levels of aggregation. In order to understand the workings of the economy of some specific industries, it is essential to be able to observe and analyse the economic interactions taking place between different producing units.

Certain key aggregate statistics, such as GDP, that are widely used as indicators of the economic activity at the level of the economy, are also defined at the level of these units.

As emphasized by Bloem (1990, section 3), national economic accounts retain in general two distinct types or statistical reporting units: a) the establishment, yielding industrially homogeneous production and related data, and b) the enterprise, yielding financial and related data on a consolidated basis for the unit's total constituent establishments. (The enterprise can also yield industrially heterogeneous production data on a consolidated basis). Also, national accounts construct input-output tables reflecting aggregation and allocation of establishment-based data and flow-of-funds tables and sectoral balance sheets, reflecting aggregation of enterprise-based data.

At the higher level of aggregation, there are institutional units which a) are centres of decision-making for all aspects of economic activity and b) owns assets and incur liabilities on their own behalf. The institutional units are grouped together to form institutional sector.

The institutional units involved in insurance are pre-eminently insurance corporations. In principle it is possible for another type of enterprise to carry out insurance as non-principal activity, but usually the legal regulations surrounding the conduct of insurance mean a separate set of accounts covering all aspects of the insurance activity must be kept and thus in the SNA a separate institutional unit, classified to the insurance corporations and pension funds sub-sector, is identifiable. According to Skipper (1993, 116), in many countries, including US, regulation prevents insurers from undertaking activities not reasonably related to insurance. However, insurers that wish to engage in other activities, except banking, are allowed to do so through holding companies.

The activity of insurance is intended to provide individual institutional units exposed to certain risks with financial protection against the consequences of occurrence of specified events. It is also a form of financial intermediation in which funds are collected from policyholders and invested mainly in financial assets which are held as technical reserves to meet future claims arising from occurrence of the events specified in the insurance policies.

Is there any rational classification of the insurance business? The buyers of insurance are either private persons or business firms and their motivation for buying insurance may differ from one case to another. Borch (1981) provided an interesting classification of the insurance business into three parts:

i) *Life insurance,* i.e., annuities and ordinary life insurance with payment at death;

ii) Business insurance, the insurance bought by businessmen, covering commercial risks of all kinds;

iii) Household insurance, bought by the ordinary consumer as protection against the risks in everyday life.

Three reasons at least underline the delineation of these three classes of insurance:

i) Each class seems to require its own special types of theoretical analysis;

ii) In the market each class of insurance faces different types of competition;

iii) The government, through its regulatory authority, often takes different attitudes to these three classes of insurance.

Because of what are perceived as substantial operational and product differences, insurance regulation generally requires legally separate companies for the transaction of the life and non-life business and, hence, the maintenance of a separate set of consolidated accounts for each type of business. Unlike the approach proposed by Borch (1981), the latter corresponds exactly to the needs of the SNA's sectoring.

Accordingly, the SNA defines two classes of insurance businesses in terms of the services they provide. Life insurers sell life insurance and annuities, manage pension funds and sell accident and sickness insurance. Non-life insurers offer a wide range of financial protection on all kinds of assets (automobile, property, liability insurance etc.). The way in which insurance businesses provide financial protection is to spead the risk among the other insureds and, if necessary, with other insurers by means of reinsurance. If, for example, an insurer found that there was only one particular policy of a kind being insured by him, then there might wish to share the risk with other insurers by paying a premium to them.[2] Despite the similarity of the activity of life and non-life insurance (see section III below), there are significant differences in terms of the characteristics of the product which lead to different types of treatement in the SNA.

☐ B. Measurement of the Output

There are two *non exclusive* approaches to the measurement of output: gross output and value added. Gross output can be measured either by the value of services produced, or by the sum of

income payments and other costs. Business purchases on current account from other businesses are subtracted from gross output to arrive at value-added, or gross product originating, an unduplicated measure of economic activity.

■ 1. Nominal Output

As emphasized by Ruggles (1983b, 67) and many others, in the insurance business, much like banking, the problem of specifying the output of the business is complicated by the two factors which are not shared by goods producing industries. These are: i) the consumer's expenditures on insurance premiums are for a bundle of services plus transfers; ii) the prices and the values of the service portion are not separated from the transfer portion. For example, premiums paid for life insurance are paid partly to cover the value of services produced by the insurance company and partly to accumulate a financial asset (cash value) in the policyholder's name, and partly to pay for claims. The non-life insurance business provides a similar example—premiums cover both the value of services produced and, on an actuarial basis, claims paid out (which are not a measure of production but of transfers). In both cases, the policyholder does not know the split between payment for service and the transfer component—these are not priced separately. As a result, the output of the insurance business must be specified and their prices imputed.

a) What Do Insurers Do?

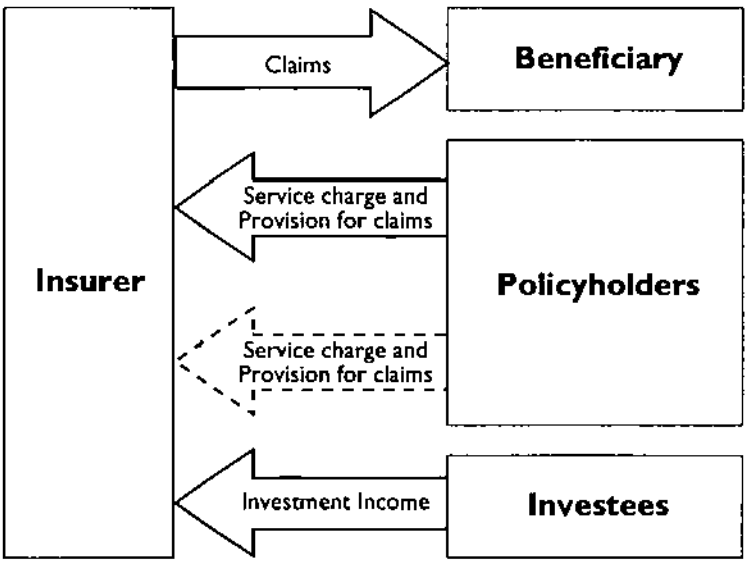
The interest of economists in insurance is probably as old as economics itself. In his *Wealth of Nations*, (Book I, Chapter 10) Adam Smith (1776) writes that «*premiums must be sufficient to compensate the common losses, to pay the expense of management, and to afford such a profit as might have been drawn from an equal capital employed in any common trade*». This is a remarkable insight as to how insurance premiums should be determined. As for the peculiarity of the insurance business itself, Adam Smith writes (Book V, Chapter 1): «*The trade of insurance gives great security to the fortunes of private people, and by dividing among a great many that loss which would ruin an individual, makes it fall light and easy upon the whole society. In order to give this security, however, it is necessary that the insurers should have a very large capital.*» More than 100 years later, Alfred Marshall defines in his *Principles* (1890) the premiums as the price one has to pay to get rid of the 'evils of uncertainty.' He also noted that businessmen paid insurance premiums «*which they know are calculated on a*

scale sufficiently above the true actuarial value of the risk to pay the companies' great expenses of advertising and working, and yet to yield a surplus of net profits».

The passages quoted above show that, although more than 200 years ago classical and neo classical economists had a good insight into the essentials of insurance, they have not addressed the issue of the value of insurance services. As it will be shown later, measuring the output of this business represents one of the building blocks of the SNA.

Insurers are engaged in the pooling of risk. Insured persons or businesses pay a premium to insurance carriers to perform this function. In addition, there is an associated function of providing annuities and managing pension funds. All of these activities involve investment of the policyholders funds. These two activities—underwriting insurance and investing funds—are reflected in two accounts — an underwriting account and investment account. From the point of view of the insurer much of the income is derived from capital gains and investment income which are not traditionally considered income from the production of goods and services in the SNA. Rather they are considered as transfers.

FIGURE I
SERVICE AND PAYMENT FLOWS INVOLVED BY THE INSURANCE BUSINESS



The various payment flows that take place between the insurer, the policyholders and any other third party are illustrated in figure 1. There is a flow of premiums between the insured and the insurer. The premium received should be considered as consisting of two parts— an amount placed in reserve to pay future claims and the remainder used to cover expenses including a return to shareholders of the insurer (service charge). The payment for future claims is a transfer to the insurer. The reserves are used to generate investment income which is used to cover expenses and claims. Between the insurer and the insured there is a barter arrangement in which the insured barters the investment income on the reserves to pay future claims to lower the overall payment for service charges and claims. There is a flow of investment income between the investee and the insurer. This investment income is a transfer between the investee and the insurer. The right to retain the investment funds represents the barter arrangement with the insured. There is a payment in respect of claims incurred in the current period between the insured and the insurer.

b) Gross Output under the 1968 SNA

Under the 1968 SNA, the gross output of insurance firms is not equal to premiums received. A large part of premium income is paid out as claims, hence the bulk of funds flowing through the insurance business are treated as transfers. By the conventions of the SNA, the gross output of the insurance business is equal to premiums less claims paid. Gross domestic product (GDP) is therefore premiums less claims less intermediate expense, or equivalently, labour compensation plus underwriting gain (surplus).

$$\text{Gros Output} = \text{Premiums} - \text{Claims}$$

$$\text{GDP} = \text{Gros Output} - \text{Intermediate Expense}$$

But not everyone agrees with the SNA approach to the measurement of insurance output. Ruggles (1983), who claims that there are several inconsistencies in the way the treatment of the insurance in the SNA, proposed the use of premiums as a measure of output. Diewert (1995) seems also to agree with this way of measuring the output. Claims are considered to be part of transactions that affect the capital account and not the current account. Ruggles' understanding of the current treatment of the insurance in the SNA is clearly summarized in the following paragraph (p. 68):

"It is apparent that the present national income accounting treatment of insurance transactions would be quite inappropriate for the accounts of the individual transactor. If this treatment were used, business suffering no loss would record the cost of insurance as the premiums actually paid, but for those having a loss the cost in insurance would equal 'net premiums,' that is, premiums paid less claims received, and could be sizable negative flow; at the same time the fire or casualty loss would appear as a large increase in capital consumption allowance. These distortions are due in part to the failure of the national income accounts to achieve a proper separation of current transactions from capital transactions, and in part to a willingness to deal with consolidated accounts for all businesses as a group."

This claim is partly true. The production account of the insurance business, based on the majority of items included in the income statement, certainly considers claims as part of the production account. They constitute the largest component of the operating expenses of the business, but unlike the other expenses, they belong neither to the category of intermediate expenses not to the primary expenses. They merely represent payout, much like dividends and experience rating refunds, that are transferred back to the consumer.

c) Gross Output under the 1993 SNA

It is not uncommon for underwriting gain and the corresponding value-added to be negative as intermediate expense (which includes commissions paid to brokers and agents of all kinds) represents one of the most important element of total expenses.

The profitability of the insurance business is preserved by net receipts of investment income which, until recently, were not included in the SNA measure of the gross output of the business. The new SNA recommends that investment income be added to the current measurement of gross output to arrive at measure of value added that is non negative.[3] The proposed approach is not necessarily new as it has been proposed almost ten years ago by Weiss (1987) and Schiltz (1987) and it has been used by US Bureau of Economic Analysis for life insurance services for many years (see Ruggles 1983a).

The rational behind this proposed treatment is the following: insurance companies usually perform two activities. First, they are engaged in a 'pure insurance' activity, i.e., they sell insurance policies for a premium on which they pay a claim with expected value. If the premium and claim payments are coincident in time, the companies' gross output in an expected value sense is. The second

activity performed by insurance companies is financial intermediation, which arises from the fact that premiums P_t are paid at time in advance of claims C_s, which are paid at time $s(t < s)$. Essentially, the problem of negative underwriting gain is caused by the error of comparing dollars of one period (P_t is valued at time t) with dollars of another period (C_s is valued at time s).

The expression $P_t(1 + r)$, where r is the (certainty equivalent) interest rate, represents premium revenue properly expressed in dollars of the same time period in which claims are paid. Clearly, the 1993 UN SNA recommends that the financial intermediation activity of P&C insurance companies be made explicit via an imputation equal to $P_t \cdot r$, the investment income, to be added to interest receipts, premium income and interest payments.

d) The SNA Approach in Practice

In an elegant multisectoral framework, Hartwick (1997) proposed a measure of value added of the insurance business that departs significantly from the new SNA. His concept of value added (payment to the primary inputs adjusted for the risk premium demanded by shareholders) corresponds roughly to the new SNA concept of gross output (premiums *minus* claims *plus* investment income) (see his equation (16), p. 15). However, this result looks peculiar, as it is not clear how his model treats intermediate expenses to arrive at the value added. The same ambiguity in the treatment of intermediate expenses can also be found in Cummins and Weiss (1998) where all expenses are supposed to be part of value added (see their equation (14)).[4] However, intermediate expenses composed of commissions of all kinds paid to non employees and purchased goods and services can be as high as 30 percent of gross output. Thus, ignoring them may be grossly in error.

Although the SNA approach to the measurement of output is still in its infancy, it has been successfully applied in areas such the analysis of costs structures of the insurance business (Bernstein 1992) and productivity measurement (Bernstein and Geehan 1988; Bernstein 1997 and Harchaoui 1997). Analyses of productivity are, however, only as good as the real output measure on which they are based. Unfortunately, the estimates of real output and, accordingly, productivity based on national accounts estimates are extremely poor. In some instances, the real output of insurance in national accounts is no more than an index of factor inputs, with the result that productivity change is, by definition, zero. In other instances like in Canada, the deflation leads to volatile estimates of labour productivity (see Lal 1990).

Griliches (1992) has suggested that an important source of the differential in productivity growth between goods and services is measurement error. He argued that problems in defining service-sector outputs and identifying price versus quality changes, as well as paucity of data on services, have resulted in underestimation of service-sector output. One of the most serious problem that face statistical agencies is the measurement of meaningful price series for financial services industries. For example, of the finance, insurance and real estate subsector, commercial banking is the only industry for which the US Bureau of Labor Statistics publishes a productivity measure (see Dean and Kunze 1992, 85).

Real output is generally measured in either of two way: by deflating current dollar values with an aggregate price index or by projecting base year values using an index of quantities (in which case real output is the ratio of current period quantities multiplied by base year prices divided by base year values). Either approach requires the specification of output in terms which clearly separates quantities from prices. The second approach has been applied by Weiss (1986). The first approach requires the construction of a consistent time series on prices indices.

With the exception of Jensen and Morrisey (1990), there has been no attempt to measure the problem of quality change in the insurance business using the hedonic approach which turned out to be particularly useful in many areas where prices were suspected not to measure the pure price change. Reece (1993) has developed an ad hoc measure of life insurance price indices that builds on the availability of series on number of policies by product line. The idea, which has been applied by Bernstein (1997) and Harchaoui (1997) to the measurement of the real output of the Canadian life insurance business, consists of the following steps:

a) for every product line i calculate the (average) nominal price:

$$p_i = \frac{V_i}{N_i}$$

where

V_i = nominal gross output of the product line i;

N_i = number of policy of the product line i;

b) construct an aggregative index where the weights are based on the face value of the policy i, that is

$$\ell np_t - \ell np_{t-1} = \sum_{i=1}^{n} \overline{\omega}_{i,t} \left(\ell np_{i,t} - \ell np_{i,t-1}\right)$$

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where $\overline{\omega}_{i,t} = \frac{1}{2}\ (\omega_{i,t} + \omega_{i,t-1})$ and $\omega_{i,t} = \frac{V_{i,t}}{V_t}$.

2. Nominal Value-added

National economic accountants take the value-added approach of output and construct from them a set of accounts showing production and distribution. The inception of the concept of value-added in national accounts goes back to Fabricant (1940) in his early work on US national accounts:

> *"The ideal index of the net physical output of an industry would measure the changes in the aggregate value of net output attributable exclusively to changes in the physical quantities of the final products and to changes in the quantities of the materials and other commodities consumed in the fabrication of the final products..."*

The nominal value-added of industries represents the value which industries add to commodities that they processed. That value is equal to the primary input costs of the industries, taken generally to be the cost of their labour and capital services. The primary input costs are to be contrasted with the intermediate input costs, that is the costs of goods and services purchased by industries from *upstream* supplying industries.

The nominal notion of value-added in terms of costs and sales may be closely associated with the idea of a real production process. Industries may be seen as jointly contributing, by using their capital and labour resources, to the production of the commodities delivered to final demand. In that production framework, each industry is viewed as contributing only partly to the production of some final demand commodity (ies). The contributions of each industry to all final demand commodities may consequently be seen as its contribution to the final output of the economy or as its real value-added.

3. Double Deflation

Measured growth rates for insurance industries are generally lower than the rates obtained for manufacturing industries. However, as emphasized by Bernstein and Geehan (1988) in the Canadian context, this finding is suspect, because of the difficulties in using official statistics to measure real output of insurance industries. In the SNA the process of eliminating price change from a time series to lay bare the underlying real movements in production is known

as deflation. The removal of price change from current price value series series is an attempt to provide a proxy for the sum of the real quantities embodied in the series. Aggregating physical commodities of differing nature (eggs and automobiles) is clearly an impractical proposition. Employing an underlying principle that involves holding prices of commodities fixed at some selected base year, and from that period forward valuing production in the prices of that base year, yields values for diverse products that are both proportional to real production and additive.

A large variety of different methods have been devised by countries to estimate real value added of insurance industries. Double deflation, one of the method which has been proposed to measure the real industry value-added, involves the deflation of the gross output of commodities and the deflation of intermediate inputs (see David 1962; David and Sato 1966). That subtraction is closely linked to the Laspeyres index number formula. Consequently, in the application, double deflation is generally based on a fixed base year Laspeyres index number formula. The base year applies to a delimited number of years before being moved forward. Then either the whole historical series are entirely based on that new base year (historical series are re-based on the new set of relative prices) or historical series are statistically linked to the new estimates while still based on the set of the past relative prices of their previous base year.[5]

Other methods of estimating real value-added have also been proposed in the past such as the single deflation method (see Hill 1971 for an overview), yet double deflation remains by far the most commonly used amongst OECD countries for the financial sector (see OECD 1998).

Despite its popularity, the double deflation approach has been at the centre of several criticism by the economic literature, including Sims (1969), Sato (1976) and Bruno (1978), as it does provide a meaningful measure of real output only under stringent assumptions. Other contributions, such as Denny and May (1977, 1978), have shown that for the Canadian manufacturing industries the double deflation' underlying assumptions are unlikely to be satisfied in the real world. Diewert (1978) finds that these conditions are unlikely to be satisfied empirically, in particular, because of the rapid relative price increase of energy following the 1973 oil shock. The second oil shock followed by the changes in the prices of computers prevented the conditions to be satisfied in recent years either. Durand (1994) proposed an alternative approach to double deflation which displays better theoretical properties. The new approach does

not rest on the stringent assumptions of double deflation. In particular, it does not rest on the separability condition between intermediate and primary inputs. Empirically, the proposed approach does not have the major defects of double deflation, including negative real value-added when nominal value-added is positive or real value-added higher than gross output. The real GDP estimates obtained under this approach displays less volatility than the standard estimates obtained under the double deflation approach, particularly for the industries where output is hard to measure.

■ III. A MICROECONOMIC APPROACH OF THE INSURANCE BUSINESS IN THE SYSTEM OF NATIONAL ACCOUNTS

□ A. Background

In many developed countries, insurance firms correspond largely to institutions which are governed by regulations. Institutions are legally constituted but usually belong to enterprises that are involved in activities in addition to those usually reserved to those institutions. The boundaries created by regulation may not correspond to the way a business organizes its operations. Furthermore, in recent years the institutions have been expanding their activities into areas previously reserved to other institutions. This creates two related problems. An industry based on institutions may contain a number of unrelated activities. Secondly, like activities are not grouped within the same industry if industry classes are based on institutions.

This section has two related goals:

a) To propose a delineation of the insurance business along the various producing units. In this business data are usually collected at the level of institution, accordingly, there is very little experience with the organization of operating units. It is necessary to decide which of these units are technical units (or profit centres) and which are auxiliary units (cost centres). Technical units must have an industrial class into which to place them. Support units, depending on the conceptual approach, do not necessarily have to be classified to their own industry; they may be classified to the major industrial activity of the business. An additional problem is that the organization of activities and products

into organizational units may vary from one business to another. Therefore, it is necessary to propose a general framework that encompasses the major characteristics of the business.

Collecting the data at the level of the various producing units offer two kinds of advantages. From an operational perspective, there will be a consistency in the unit of observation across the business sector, as the data will be collected at the level of the producing unit from all kinds of industries, including those traditionally regulated. From the analytical perspective, the move away from the institutional framework is merely driven by the fact that a broad range of issues simply cannot be addressed without microdata on producing units and the firms that own them. As emphasized by McGuckin (1995), for many problems, the producing unit is a sensible unit of analysis. For example, from the standpoint of the production decision, the choice of inputs for use in output creation is often made at the plant level. Although the firm is the ultimate decision maker and thus the preferred unit of analysis for many problems, producing units have very different behavioural patterns, even when owned by the same firms. Thus producing units data are also necessary to understand the behaviour of the firm. The behaviour of one producing unit is not completely differentiated from other simply by the identity of its owner. Producing units data are also necessary to estimate the marginal impact of some event—for example, a purchase or divestiture of assets—on the firm. Focusing on the production relationship, one can see that their establishments are the primary purchasers of inputs. Even though primary resource-allocation decisions are often made at the firm level, producing unit data are useful in analysis of technical change because technical change is characterized by changes in the production relationship.

b) To analyse how the company-establishment problem, which has a long history in the national economic accounting literature, can be overcome in the particular context of the insurance business. The problem is of key importance in a paper by Sigel (1955) together with comments of Jaszi (1955). Their discussion is concerned with the technical issues of relating establishment-based input-output tables to a company-based flow-of-funds accounting system. This theme and others also turn up in the Report of a Conference

on the Proposals for Revision of the United Nations of National Accounts (see Tice 1967). Copeland's (1957) classic challenge to Leontief to show how the input-output system could be synthetized with money-flows certainly implies respect for the company-establishment problem. A particularly clear statement of the problem, in a more general setting, appears later in Jaszi (1971): production and related statistics are best reported on the basis of industrially homogeneous units, the individual establishment; financial and related statistics come naturally from the (heterogeneous) legal entity responsible for and controlling their constituent establishments. More recently the company-establishment problem is the centre of attention in the debate between Ruggles and Ruggles (1982a, b) and a number of commentators concerning a proposed Integrated Economic Accounts for the United States.

B. Dealing with the Insurance Business at the Producing Unit Level

1. The Literature on Multiunit Firms

The modern multiunit business firm is one of the most prominent and significant innovations in the organization of production of recent years. For most of the two previous centuries, firms were organized as traditional single-unit firms. These firms operated in a local or regional market, produced a single product line, and were owned and managed by a single individual or a partnership. During the last two decades of the nineteenth century, the multiunit business firm emerged and began to displace the single-unit firm in a number of industries. The multiunit firm operated plants in many regions, produced various product lines, and were controlled by a hierarchy of managers. During the twentieth century, the predominance of multiunit firms grew domestically and internationally in the form of multinational firms.

For economists, the analysis of the rise of the modern multiunit firm, and of firm size in general, is based on transaction cost theory of the firm. This theory, originating from Coase (1937), revived and popularized by the works of Williamson (1975, 1985), Alchian and Demsetz (1972), and Klein, Crawford and Alchian (1972), argues that firms internalize production because they incur greater transaction costs when they use markets. The analysis of the rise of multiunit firm has been influenced by the works of Chandler (1977, 1990), who combined the elements of the traditional industrial

organization literature and the transaction cost literature to explain the rise of the modern business firm. Chandler (1990, 17-18) argued that firm size is determined by transaction costs, but that these costs are, in turn, linked to technology:

> *"Transaction cost economies are, of course, closely related to those of scale and scope. The economies of scale and those of scope within a single unit of production or distribution permit that unit to expand the output of goods and services, which in turn, increases proportionately the number of recurring commercial transactions and contractual relations the enterprise may carry on with other operating units."*

Although the modern multiunit enterprises have been heralded by Chandler (1977, 1990) and others as a major and important phase of organizational change, and a significant source of growth, the prevalence of the multiunit firm engaged in financial services has been neglected by the economic literature. Bohman (1979), one of the few attempts that looked inside the insurance firm's black box, developed a framework that captures the transactions that take place between the two funds that compose the insurance firm—the insurance fund and surplus fund. But these two funds are not considered as producing units with the result that measurement of production was overlooked in his contribution. In the next section, we extend Bohman's framework along the following lines: a) the insurance firm is separated into various lines of business on the basis of the concept of production; the production of the various lines of business is measured and the transactions flows that take place between them is outlined; b) we show how the production account of each of these producing units can be used to arrived at the production at the enterprise level; c) finally, the delineation of the different lines of business is assessed.

■ 2. Implementing the Multiunit Concept in the Insurance Business

a) Framework

The insurance industry is in general dominated by large multi-product and multi-activity institutions. The large institutions, which operate a network in many regions, are generally engaged in direct insurance, reinsurance and investment activities. However, these activities often take place in separate organisations of the institution. What makes them insurers is that they are primarily involved in financial protection and diversification of risks although increasingly they are also engaged in all kinds of financial activities. They

may have both domestic and foreign clients for any of these services provided by these activities. As multi-regions implies, most of the dealings with clients are through a network of agents, brokers and claims adjusters. For other customers seeking for reinsurance and investment services, the dealings may be through the head office where the bulk of the decisions take place.

As previously indicated, there is nowhere a tradition of dealing with the insurance business at the level of producing units and this holds true for the whole financial sector. Therefore, this section, based on the work of Harchaoui (1998) for the Canadian banking industry, provides not only background material but also a framework for a proposed delineation of the insurance business at the level of the line of business. But what precisely constitute a line of business (or producing unit) reporting and its motivation? Large diversified insurance corporations are motivated to break down their operations into units of manageable size. The existence of such units creates a need on the part of the corporate management to know and appraise the performance of the units. The organization of corporation along producing units (or lines of business) has become increasingly popular and dominant in recent years (Reece and Cool 1978).

The particular context assumed here is the large multi-establishment multi-industry corporation whose industrial origins, strategy and structure are so well described in Williamson (1981). What are the natural organizational units of the large multiproduct and multiactivity enterprise featuring decentralized decision-making? There are essentially three (see Kaplan 1982, chapter 13): Cost centers are units that are responsible for satisfying externally given demands subject to a cost-minimizing efficiency standard. The cost of materials used and labour employed are controlled, but production sales revenue may not even be known. Revenue centers are units organized with the goal of attaining certain sales targets or market shares. These units may set the prices and choose product-mix, but are not directly concerned with cost of materials or labour employed in production. When output is difficult to measure and not necessarily related to inputs, then the organizational unit becomes a cost centre (e.g. general and administrative service departments). The cost centre is reminiscent of the national economic accountants' ancillary unit. The unit typically serves other (internal) units of the enterprise. If the management of an operating unit is given responsibility both for obtaining required inputs and for choosing and selling well-measured outputs, then this particular unit is know as a profit centre. Thus a profit centre combines the tasks of the standard cost centre and revenue centre.

For our purpose, a producing unit will refer to a business unit which combines the scope of the profit centre with at least for the units' working capital and physical asset base. A producing unit is conceptually capable of reporting all the production-related information of an establishment. Producing units reports *per se* usually contain industrially-specified production (or operating revenue) data and the various costs of materials used and labour employed are detailed. On the other hand, the production statement tends to be complete in the sense that intermediate service input expenses charged are accounted for (these are mostly corporate overhead and indirect expenses charged to individual units). There certainly are common cost allocation problems to be resolved in producing unit reporting, but these problems are handled internally by corporate management accountants in a position of full information. In addition, the producing unit's gross operating surplus may be further refined by explicitly deducting depreciation.

b) Delineation of the Units

Recent decades have seen trends towards greater complexity and multiform legal structures of the institutions participating in the economic process. A number of factors have played role in this respect. First of all, in many countries there is trend towards formation of larger and larger units. Mergers led to large conglomerations of enterprises which often had a variety of activities. The roots of this development were, among other things, the need to spread risks, a wish for additional financial possibilities and the desire for product differentiation. Secondly, this desire for product differentiation led to enterprises turning their attention to various production processes and entering new markets.

While there are variations in structure among the major insurers, the internal organization of insurers is usually composed of two major divisions each performing various activities—head office operations and branch or field operations. The head office may be structured along vice-presidential lines on a activity basis. The direct insurance vice-president usually has actuarial, agency, advertising, sales promotion and field force supervision under his direction. The financial vice-president is usually responsible for investment operations, the management of the portfolio of the company's or various clients' assets. The reinsurance vice-president performs essentially functions that allow the insurance company to increase its underwriting capacity through reinsurance assumed and/or reduce it through reinsurance ceded and retrocession. The administrative vice-president is usually responsible for internal audit,

controllership, banking and accountancy functions and general service departments of the corporation. Among the other units that potentially could be auxiliary units because they provide support services to the principal activities of insurance are investment, general and administrative services where one can finds human resources, advertising, promotion and public relations etc.

TABLE I
DELINEATING THE UNITS OF THE INSURANCE BUSINESS

Type of Unit or Account	Highest Level Unit	Activity
Core Business Lines	Direct Insurance	Underwriting insurance policies; Retail Network: Agents, Brokers and Claims Adjusters
	Reinsurance	Reinsurance ceded; reinsurance assumed; retrocession
	Investment	Portfolio management
Support Business Lines	General Administrative and Corporate Services	Finance
		Human Resources
		Computer Services
		General Administration: Legal Services, Public Affairs and Treasury
		Other Corporate Services

Branch or field operations may be carried out by a branch office system or a general agency and broker system. The branch office system consists of branch managers, known as agents, who are sales experts directing agents who market their product line of one insurance company only. In contrast, a broker runs his own office, pays his own expenses and may represent one or more insurance companies and carry life and non life product lines. Berger, Cummins and Weiss (1997) and Cummins and Weiss (1998) treat direct insurance, investment and branch operations as services and not as lines of business. This is incorrect for two reasons: a) there are clearly identifiable inputs that operate within each of these lines of business and b) each of these lines of business sells for profit different kinds of services.[6]

The internal organization of a typical insurance form is mainly important in delineating and valuing flows and perhaps in determining industrial classification (more on that below). If, for example, a

unit supports direct insurance exclusively, then the only flows of services should be to direct insurance. In addition, its industrial classification should be the same as the direct insurance units. In general, the delineating of flows has two aspects: the delineation of flows to ultimate customers and the delineation of internal flows between units in the same enterprises.

3. The Production Account at the Level of the Line of Business

Consider an economy with two regions A and B and an insurance firm which operates with three producing units: direct insurance, investment and reinsurance. Assume that the head office of the firm is located in the region A, where all the decisions related to direct insurance and reinsurance take place; the network of the firm which provides retails services to consumers is located in both regions.

a) Direct Insurance Activity with a Regional Network of Agents

Measurement of output can be derived from the income statement. The basic identity underlying the income statement is profit before income tax which is equal to its revenue less its costs. In the income statement shown in table 2, operating revenue comes from premiums and from investment income earned on interest and dividends-paying securities (including gains (net of losses) on sales on fixed assets and securities). Operating expenses includes insurance claims paid, wages and salaries, purchased goods and services and investment service fees (for the sake of simplicity, policyholder dividends, depreciation and amortization, indirect business taxes and home office overhead are assumed equal to zero).

TABLE 2
INCOME STATEMENT OF AN INSURANCE FIRM

	Direct premiums earned	1,000	
Plus:	Investment income	100	
Equals:	Operating revenue	1,100	
Less:	Operating expenses	750	
	Insurance claims paid	500	
	Wages and salaries (total)	75	
	• Head office (province A)		25
	• Network (province A)		25
	• Network (province B)		25
	Purchased goods and services (total)	125	
	• Head office (province A)		105
	• Network (province A)		10
	• Network (province B)		10
	Investment service fees	50	
Equals:	Profit before income tax	350	

Rearranged and modified, the income statement provides the production account, which records the production attributable to the firm in terms of services produced and the income payments and other costs arising in the production. The derivation of the production accounts is described in two steps: 1) The rearrangement of the business accounting statements into the T-account form and 2) the modification of the T-accounts to obtain economic accounts that measure production. The production account shows, on the right side, the value of the firm's production in terms of services produced and, on the left, the value added by the firm in terms of income payments to primary inputs.

To the extent that all the decisions related to the insurance business take place at the head office, located in region A, it then makes sense to attribute all the value of output to that region. Indeed, the network located in the two provinces are essentially cost centres whose *raison d'être* is to support direct insurance activity. Under this assumption, the production account of direct insurance is shown in table 3.

TABLE 3
THE PRODUCTION ACCOUNT OF THE DIRECT INSURANCE ACTIVITY IS ASSUMED TO TAKE PLACE ONLY IN REGION A

Uses		Sources	
Wages and salaries	75	Gross Output	600
Profit before income tax	350	*Equals:*	
		Direct premiums	1,000
		Plus:	
		Investment income	100
		Less:	
		Insurance claims incurred	500
		Less:	
		Purchased goods and services	125
		Less:	
		Investment Service Fees	50
Charges against output	**425**	**Value Added**	**425**

The problem with the above assumption is that all the insurance production will be assigned to one region. In some countries where regions constitute an important level of decisions and where the provincial breakdown of output represents an important tool for policy makers, this assumption is clearly unrealistic. Therefore, one needs to assume that production is attributed to the region where the inputs are expensed. In other words, the network itself generates retail services for which it receives an explicit service charge. Assume that the head office pays $45 in terms of commissions to each network for services rendered (we assume that the commissions, which represent 9% of premiums, are equally distributed between the network A and B).[7] Under this new scenario, as shown in tables 4, we will have three production accounts: two for the region A (one for the direct insurance activity and another for the network located in that region) and one for the network located in region B.

TABLE 4A
THE PRODUCTION ACCOUNT OF DIRECT INSURANCE LOCATED AT THE HEAD OFFICE IN REGION A

Uses		Sources	
Wages and salaries	25	Gross Output	600
Profit before income tax	330	*Equals:*	
		Direct premiums	1,000
		Plus:	
		Investment income	100
		Less:	
		Insurance claims incurred	500
		Less:	
		Purchased goods and services	105
		Less:	
		Investment service fees	50
		Less:	
		Commissions to agents	90
Charges against output	**355**	**Value Added**	**355**

TABLE 4B
THE PRODUCTION ACCOUNT OF THE NETWORK LOCATED IN REGION A

Uses		Sources	
Wages and salaries	25	Gross Output (commissions)	45
Profit before income tax	10	*Less:*	
		Purchased goods and services	10
Charges against output	**35**	**Value Added**	**35**

TABLE 4C
THE PRODUCTION ACCOUNT OF THE NETWORK LOCATED IN REGION B

Uses		Sources	
Wages and salaries	25	Gross Output (commissions)	45
Profit before income tax	10	*Less:*	
		Purchased goods and services	10
Charges against output	**35**	**Value Added**	**35**

b) Introducing Reinsurance and Investment Activities

Let us now introduce the reinsurance and investment activities, the other two major activities of insurers very often neglected by the economic litterature. Essentially, reinsurance activity under-

takes the following operations: It assumes reinsurance of a third party located in a foreign country (in which case this we are dealing with exports of reinsurance services) and cedes reinsurance on behalf of direct insurance activity. The following flows involve reinsurance activity:

- Premiums, claims and investment income associated with reinsurance assumed, respectively, \$300, \$150 and \$30;
- Reinsurance activity cedes a portion of the direct insurance activity to a third party: \$100 of premiums ceded; \$50 of claims ceded and \$10 of investment income. The reinsurance activity incurs the following expenses: wages and salaries for \$70, purchased goods and services for \$50, investment service fees for \$10.

Using this information, the production account of reinsurance activity is displayed in table 5 which shows the supply of reinsurance services by this activity. The demand side of this market is represented by direct insurance activity and the foreign sector. Owing to a lack of the required price of reinsurance services, the measurement of the elasticity of supply and demand of reinsurance services constitutes a major gap in our understanding of the reinsurance market. An important attempt has been made recently by Froot and O'Connell (1997) who concluded that in the market of catastrophic reinsurance services, the supply is by far more elastic than the demand side.

TABLE 5
THE PRODUCTION ACCOUNT OF REINSURANCE ACTIVITY LOCATED IN REGION

Uses		Sources	
Wages and salaries	70	Gross Output (reinsurance assumed)	180
Profit before income tax	110	*Equals:*	
		Premiums assumed	300
		Plus:	
		Investment income	30
		Less:	
		Insurance claims incurred	150
		Gross Output (reinsurance ceded)	60
		Less:	
		Purchased goods and services	50
		Less:	
		Investment Service Fees	10
Charges against output	**180**	**Value Added**	**180**

An important aspect of the reinsurance market is its international scope. As stressed by Wasow (1986), international trade in insurance occurs in good part through reinsurance, as residents do not directly by insurance abroad nor do non-residents travel to a foreign country to buy insurance. Carter and Dickinson (1992) and United Nations (1993b) indicate that the reinsurance activity has been historically less subjected to the constraints affecting delivery of insurance and the regulatory barriers to international transactions observed in life and non-life industries. Consequently, the most important developments in international insurance transactions have taken place in the reinsurance industry.

As for the investment activity, the following transactions are recorded in its production account shown in table 6:

- In terms of revenue, the investment activity charges a service fee to direct insurance and reinsurance activities for a total of $60 ($50 for direct insurance and $10 for reinsurance); it also charges $40 to a client for the management of his pension fund.
- It pays $20 of wages and salaries, $20 for purchased goods and services.

TABLE 6
THE PRODUCTION ACCOUNT OF INVESTMENT LOCATED IN REGION A

Uses		Sources	
Wages and salaries	20	Gross Output (Service fees)	100
Profit before income tax	60	• Direct Insurance	50
		• Reinsurance	10
		• External Client	40
		Less:	
		Purchased goods and services	20
Charges against output	**80**	**Value Added**	**80**

In reality, the measurement of investment activity's output is not always that easy. In facts, the output of this activity is one the hardest to measure as it transforms liabilities (policyholders' deposits) into earning assets (loans through different financial instruments). The measurement of the investment unit output is hindered by the inapplicability of standard national income accounting procedures.[8] Here the experience gained in the area of measurement of banking output may be useful.

The role of the investment unit as a financial intermediary suggests that deposits accounts should be considered as inputs since the unit acquire these funds in order to acquire earning assets. But as Sealey and Lindley (1977) recognized, deposits are not inputs in the same sense as labour and capital; they are in effect a technical output of the unit. Nevertheless, because deposits are used to produce earning assets, Sealey and Lindley argued that earning assets should be viewed as the final output of financial intermediaries. The problem with this view is that it misses the importance of the financial services attached to deposit accounts.

Until recently, the striking feature of the input-output issue was the absence of a mechanism that determines inputs and outputs. Hancock (1985) established such a mechanism through the application of the user cost of money concept developed in Barnett (1980). The user cost of money is analogous to the user cost of capital and measures the net benefit of a particular way of holding money. In general, the user cost measures the economic cost of providing the financial services attached to investment unit output. Accordingly, the user costs are the signals by which the investment unit allocates resources to provide the financial services and therefore qualify as service process. Because the user costs can be either positive or negative, the prices are defined in terms of the absolute value of the user costs. The variability in the sign of the user cost creates a way to determine input-output status endogeneously. A positive user cost indicates that the financial service is an input while a negative user cost indicates that the financial service is an output. With the nominal measure of investment unit output the user cost of the assets is given by $u = \frac{(\rho - h)}{(1+\rho)}$ while the user cost for the liability is given by $u = \frac{(h-\rho)}{(1+\rho)}$, where u denotes the user cost of the asset (liability), ρ is the bank's opportunity cost and h the holding cost or revenue for the financial good.

To provide some of the intuition underlying the expression for the user cost, consider the case where the only concerns of the investment unit are the interest rate and the opportunity cost of capital. Suppose that the unit has only bonds with a face value of V^0 in period 0. If the investment unit's holding of bonds remains fixed the value of its holdings in period 1 is $V^0(1 + \pi)$ where π is the interest rate on bonds. The investment unit decides between selling bonds in period 0 and holding them until period 1. The user cost in effect is the difference between the two alternatives, that is

$$\text{Net Return} = V^0 - \left[V^0 \frac{(1+\pi)}{(1+\rho)}\right] = V^0 \frac{(\rho-\pi)}{(1+\rho)}$$

and thus the user cost per bond dollar is simply $\frac{(\rho-\pi)}{(1+\rho)}$. Similar reasoning would apply to the derivation of the user cost for a liability. Observe that in this example the sign of the user cost is determined by the difference between the two rates of return. Since the investment unit would maintain its bonds holdings only if π was greater then ρ it follows that the user cost for bonds should be negative and they are therefore classified as a financial output; that is, the purchase of bonds by the investment unit (making a loan) is a financial output.

The production account of direct insurance activity, which now should record the flows of services purchased from reinsurance and investment activities, is shown in table 7.

TABLE 7
MODIFIED PRODUCTION ACCOUNT OF DIRECT INSURANCE LOCATED AT THE HEAD OFFICE IN REGION A

Uses		Sources	
Wages and salaries	25	Gross Output	600
Profit before income tax	270	*Equals:* Direct premiums	1,000
		Plus: Investment income	100
		Less: Insurance claims incurred	500
		Less: Purchased goods and services	105
		Less: Commissions to agents	90
		Less: Purchased reinsurance services (Premiums *minus* Claims *plus* Investment Income of reinsurance ceded)	60
		Less: Investment Service Fees	50
Charges against output	**295**	**Value Added**	**295**

■ 4. Integrating All the Lines of Business

a) The Consolidated Production Account

In constructing national economic accounts, it is necessary to add together corresponding accounts belonging to two or more transactors and, occasionally, to add together two or more accounts belonging to the same transactor. In the aggregate account, an entry may occur twice, either once on each side of the account, or twice—with opposite signs—on the same side. If such entries are netted out, the aggregate account is a consolidation; if these cancellations are not made, the aggregate account is a combined account.

Production account of the insurance firm (table 8) is obtained by adding together the production account shown for all producing units in tables 4-7. The account is prepared on a consolidated basis. The entries for a transaction between two producing units cancel, leaving only transactions between the producing unit and units outside the firm. These entries are: direct insurance (– $90 for commissions) and agency (+ $90); direct insurance (– $60 for reinsurance

TABLE 8
PRODUCTION ACCOUNT OF THE INSURANCE FIRM

Uses		Sources	
Wages and salaries	165	Gross Output (direct insurance)	600
Profit before income tax	460	*Equals:* Direct premiums	1,000
		Plus: Investment income	100
		Less: Insurance claims incurred	500
		Gross Output (reinsurance assumed)	180
		Equals: Premiums	300
		Plus: Investment income	30
		Less: Insurance claims incurred	150
		Gross Output (investment)	40
		Less: Purchased goods and services	195
		• Direct Insurance	105
		• Reinsurance	50
		• Investment	20
		• Agency	20
Charges against output	**625**	**Value Added**	**625**

ceded) and reinsurance (+ $60); direct insurance (– $50 for purchase of investment services) and investment (+ $50) and reinsurance (– $10 for purchase of investment services) and investment (+ $10).

It is important to note that the sum of value added generated by the different lines of business (see tables 4b-7) is equal to the value added calculated at the consolidated level of the insurance firm (table 8). Therefore, given this property of additivity, the sum of value added generated by the different lines of business constitutes a sufficient statistics to estimate an unduplicated measure of production activity at the level of consolidation (i.e., the insurance firm).

b) Input-Output Accounting

Information on the flows of goods and services that make up the production relationships between insurance industries and the rest of the economy is missing from the income and expenditures accounts (IEA), but is provided by the input-output (I-O) accounting. I-O accounting can be viewed as a deconsolidation, along detailed industry lines, of the subsectoral production account of table 7, with a separate production account presented for each industry. Both IEA and I-O accounts present GDP in terms of final product flows (final demand, using I-O terminology) and in terms of charges against GDP (value added, using I-O terminology). The distinctive feature of the I-O accounts is the presentation of detailed information for each industry on the consumption of purchased materials and services that cancelled in arriving at an unduplicated measure of production for the business sector. This detailed information is presented in a matrix—an I-O table.

In the I-O table, each column records the gross output of an industry and the inputs used by that industry in production; that is,

Gros Industry Output = Consumption of Purchased Goods and Services
+ Value Added

Each row records the gross output of a good or services (commodity in I-O terminology), the consumption of the commodity by producing industries, and the final demand for the commodity, where final demand consists of sales of the commodity to final users, the change in inventories of the commodity held by both the producing and consuming industries, less imports of the commodity; that is,

Gros Commodity Output = Consumption by Producing Industries
+ Sales to Final Users
+ Change in Inventories
– Imports.

To illustrate the derivation of the I-O Account, tables 9-13 present production accounts for the four hypothetical insurance industries—agency and brokerage, direct insurance, reinsurance and investment—and the rest of the business sector that make up the whole business sector. Unlike the production accounts derived above, these accounts record production on a gross basis; that is consumption has not been subtracted from both sides. Also, these accounts provide a breakdown of purchased goods and services shown in tables 4b-7 in terms of services transacted between the insurance lines of business and goods and services purchased outside the insurance firm. For the rest of the economy, table 13 presents a single consolidated production account.

TABLE 9
AGENCY INDUSTRY

Uses		**Sources**	
Consumption		Sales of agency services	
Intermediate expenses		To producers	
Agency services		Agency industry	0
Direct insurance services	10	Direct insurance industry	90
Reinsurance services		Reinsurance industry	0
Investment services		Investment industry	0
Other goods and services	10	Rest of the economy	0
Less:		To final users	0
Change in raw materials inventories		Change in work-in-process and finished goods	
Agency services		Inventories	0
Direct insurance services		*Less:* Imports of agency services	0
Reinsurance services			
Investment services			
Goods and services			
Value added	70		
Charges against gross output	**90**	**Gross output**	**90**

TABLE 10
DIRECT INSURANCE INDUSTRY

Uses		Sources	
Consumption		Sales of direct insurance services	
Intermediate expenses		To producers	
Agency services	90	Agency industry	10
Direct insurance services	10	Direct insurance industry	10
Reinsurance services	60	Reinsurance industry	10
Investment services	50	Investment industry	10
Other goods and services	95	Rest of the economy	160
Less:		To final users	400
Change in raw materials inventories		Change in work-in-process and finished goods	
Agency services	0	Inventories	0
Direct insurance services	0	*Less:*	
Reinsurance services	0	Imports of direct insurance services	0
Investment services	0		
Goods and services	0		
Value added	295		
Charges against gross output	**600**	**Gross output**	**600**

TABLE 11
REINSURANCE INDUSTRY

Uses		Sources	
Consumption		Sales of reinsurance services	
Intermediate expenses		To producers	
Agency services	0	Agency industry	0
Direct insurance services	10	Direct insurance industry	60
Reinsurance services	0	Reinsurance industry	
Investment services	10	Investment industry	
Goods and services	40	Rest of the economy	
Less:		To final users	180
Change in raw materials inventories		Change in work-in-process and finished goods	
Agency services	0	Inventories	0
Direct insurance services	0	*Less:*	
Reinsurance services	0	Imports of reinsurance services	0
Investment services	0		
Other goods and services	0		
Value added	180		
Charges against gross output	**240**	**Gross output**	**240**

TABLE 12
INVESTMENT INDUSTRY

Uses		Sources	
Consumption		Sales of investment services	
Intermediate expenses		To producers	
Agency services	0	Agency industry	0
Direct insurance services	10	Direct insurance industry	50
Reinsurance services	0	Reinsurance industry	10
Investment services	0	Investment industry	0
Goods and services	10	Rest of the economy	40
Less:		To final users	0
Change in raw materials inventories		Change in work-in-process and finished goods	
Agency services	0	Inventories	0
Direct insurance services	0	*Less:*	
Reinsurance services	0	Imports of investment services	0
Investment services	0		
Other goods and services	0		
Value added	80		
Charges against gross output	**100**	**Gross output**	**100**

TABLE 13
REST OF THE ECONOMY

Uses		Sources	
Consumption		Sales of goods and services	
Intermediate expenses		To producers	
Agency services	0	Agency industry	10
Direct insurance services	160	Direct insurance industry	95
Reinsurance services	0	Reinsurance industry	40
Investment services	40	Investment industry	10
Goods and services	10	Rest of the economy	10
Less:		To final users	100
Change in raw materials inventories		Change in work-in-process and finished goods	
Agency services	0	Inventories	20
Direct insurance services	0	*Less:*	
Reinsurance services	0	Imports of goods and services	10
Investment services	0		
Other goods and services	0		
Value added	65		
Charges against gross output	**275**	**Gross output**	**275**

Several features of the illustration in tables 9-13 should be noted: a) each industry produces a single commodity and that commodity is not produced by any other industry; b) the commodities produced by agency, direct insurance, reinsurance and investment industries are services, therefore, they are not inventoried; the commodity produced by the rest of the business sector is inventoriable; c) producing units in each industry purchase inputs from other units in the same industry.

Table 14 illustrates the construction of the I-O table from the information contained in tables 9-13. The first five columns on the left side of the matrix record the consumption of intermediate inputs, as well as value-added, by the producing industries. For each industry, consumption is derived from the left side of the industry's production account in tables 9-13 as the purchase of the commodity less the change in raw material inventory. Value added is also taken from the left side of the industry production account. Three columns, further to the right, record the components of final demand. Sales to final users are obtained from the right side of the production accounts in tables 9-13.

TABLE 14
INPUT-OUTPUT TABLE

Distribution of output / Composition of inputs	Producers					Final demand					
	Agency	Direct Insurance	Reinsur-ance	Invest-ment	Rest of the economy	Total Interme-diate use	Sales to final users	Change in inven-tories	Imports	Total of final demand	Gross commodity output
Agency services	0	90	0	0	0	90	0	0	0	0	90
Direct insurance services	10	10	10	10	160	200	400	0	0	400	600
Reinsurance services	0	60	0	0	0	60	180	0	0	180	240
Investment services	0	50	10	0	40	100	0	0	0	0	100
Goods and other services	10	95	40	10	10	165	100	20	-10	110	275
Total intermediate inputs	20	305	60	20	210	635	–	–	–	–	–
Value added	70	295	180	80	65						690
Gross industry output	90	600	240	100	275	–	680	20	-10	690	–

C. Assessing the Delineation of Insurance Producing Units

a) Set Up

So far I have delineated the insurance firm is viewed as a set of integrated producing units performing different activities. The question is now how meaningful are these activities. Following Clarke (1989), I investigate how well the proposed delineation of the insurance business separates groups of insurance firms into economically distinct activities. The maintained hypothesis is that there are input shares that are more similar among producing units that occupy the same industry than among units that are in more remotely connected industries.

The delineation of insurance industries is said to be significant if, and only if, the production units of an industry react the same way to any exogenous shock (industry-wide or economy-wide). For this to be true, the production units of this industry must have similar technologies. However, the similarities diminish within coarser industrial groups. To test this proposition, I use a variation of the diversification concept developed by Gollop and Monahan (1991), which allows me to quantify the extent to which an industry's production units have similar technologies.

The properties of a technology are captured in parameters defining the relationships among inputs, outputs and costs. Identical cost function parameters across producing units suggest homogeneous technologies while different parameters specify heterogeneous technologies. Identifying and measuring these parameters is the key to designing a statistical measure that can be used to assess the delineation of the insurance business. It turns out that, under reasonable assumptions, the information required for identifying these technology parameters can be extracted from data commonly available in industrial accounts. To show this, consider the following cost function of a production unit i defined in (1)

$$G_j(w, Q, R, t) \tag{1}$$

where w, Q, and R represent, respectively, vectors of input prices, output, and any other input peculiar to the activity of the production unit[9]; G_j represents the minimal cost incurred by the production unit j in order to produce a vector of output Q under given market conditions, and any idiosyncratic aspect represented by w and R, respectively. The simplest parameterization of this cost function is to assume that it has the Cobb-Douglas form

$$\ell nC_j = \sum_f^J \beta_{j,f} \ell nw_{j,f} + \sum_\kappa^I \lambda_{j,\kappa} \ell nQ_{j,\kappa} + \sum_\tau^M \alpha_{j,\tau} \ell nR_{j,\tau}, \qquad (2)$$

Assuming competitive (input and output) markets, the Cobb-Douglas parameters $\beta_{j,f}$ and associated $\alpha_{j,i}$ with the inputs are equal to the corresponding revenue shares (using Shephard lemma)

$$\beta_{j,f} \equiv \frac{\partial \ell nC_j}{\partial \ell nw_{j,f}} = \frac{w_{j,f} \cdot X_{j,f}}{V_j} = s_{j,f}$$

$$\alpha_{j,\tau} \equiv \frac{\partial \ell nC_j}{\partial \ell nR_{j,\tau}} = \frac{z_{j,\tau} \cdot R_{j,\tau}}{V_j} = \omega_{j,\tau} \qquad (3)$$

$$\lambda_{j,\kappa} \equiv \frac{\partial \ell nC_j}{\partial \ell nQ_{j,\kappa}} = \frac{p_{j,\kappa} \cdot Q_{j,\tau}}{V_j} = \vartheta_{j,\kappa}$$

so that $\sum_f^J s_{j,f} + \sum_\tau^M \omega_{j,\tau} = 1$ where

$w_{j,f}$ = the price of the input f,

$z_{j,\tau}$ = the (shadow) price of the input τ,

$X_{j,f}$ = the quantity of the input f used by the $j-th$ production unit,

$R_{j,\tau}$ = any other input τ used by the $j-th$ production unit,

V_j = the nominal output produced by the $j-th$ production unit,

Q_j = the quantity of output produced by the $j-th$ production unit,

$\alpha_{j,\tau}$ = the (shadow) revenue service share of any of the $\tau-th$ inputs in the total nominal output of the $j-th$ production unit,

$\lambda_{j,\kappa}$ = the revenue share of the $\kappa-th$ output in the total nominal output of the $j-th$ production unit.

If one considers another producing unit, say h, which performs the same activity and uses a Cobb-Douglas technology, this technology will correspond to parameters $\beta_{h,f}$, $\alpha_{h,\tau}$ and, accordingly, to input shares $s_{h,f}$, $\omega_{h,\tau}$. If both production units have the same technology, then one may expect to obtain $s_{j,f} = s_{h,f}$ and $\omega_{i,\tau} = \omega_{h,\tau}$. Otherwise, none of these equalities would hold. Differences in input cost

shares and output shares among producing units, which, therefore, quantify differences among parameter technologies, can be used to calibrate the extent of heterogeneity among producing units within an industry. The heterogeneity index has the following form

$$\Delta = \sum_{j}^{J} \mu_j \Delta_j \tag{4}$$

with

$$\mu_i = \frac{V_j}{\sum_j V_j}, \tag{5}$$

and

$$\Delta_j = \sum_{h} \mu_h = \left(\frac{\sum_j \left| s_{j,f} - s_{h,j} \right|}{2} + \frac{\sum_\tau \left| \omega_{j,\tau} - \omega_{h,\tau} \right|}{2} \right) \tag{6}$$

The symbol $|\cdot|$ refers to the absolute value. Dividing by two prevents double counting and ensures that the index Δ is bounded in the zero-one interval, $0 \leq \Delta \leq 1$. As differences among the parameters increase, Δ increases. As the differences decrease, the index Δ approaches zero. It turns out that the heterogeneity index is simply a weighted sum over differences in cost function parameters describing the technology structures employed by producing units within an industry, where the weights μ_j and μ_h are defined as the shares of the $j-th$ and $h-th$ producing units in the industry's nominal output. For any given difference in the input shares of the $j-th$ and $h-th$ producing units, the overall effect on industry Δ is determined by the relative importance of the $j-th$ and $h-th$ producing units. Therefore, input differences between large producing units have more impact on Δ than do input differences between small establishments. The share variables μ_j and μ_h insure this result.

■ b) Empirical Results

Once the delineation has been completed, the issue is whether production units in each industry operate under the same technology or not. This question is crucial since firms specialized in the same product line can use a different technology or different input mix. This, in turn, means that they will not react identically to a common

shock. For this purpose, the heterogeneity index appears to be helpful. It enables us to examine whether or not there is a large dispersion in the technology of production units that are members of the same industry by using information on the input shares of each of them. This index also indicates whether or not the industrial classification is becoming more accurate by progressive refinements to the structure of the classification. For example, does it suggest that the heterogeneity in the technology of producing units substantially decreases as we move from a classification based on institutions to another based on producing units? If so, this implies that it is likely that the production units that are members of the institutions display different technologies.

TABLE 15
HETEROGENEITY INDEX APPLIED TO INSURANCE INDUSTRIES

Insurance		88
Life Insurance		85
Agency	33	
Direct insurance	64	
Reinsurance	79	
Investment	45	
Non-Life Insurance		93
Agency	42	
Direct insurance	66	
Reinsurance	48	
Investment	74	

Table 15 summarizes the application of the heterogeneity index Δ at the different level of refinement for both life and non-life insurance using data from the Office of Superintendent of Financial Institution, the regulator of the insurance business in Canada. Although the results are based on 1994 data, they do seem to be fairly stable over time. The level of the heterogeneity index for the whole insurance subsector is fairly high at .88. Making the distinction between life and nonlife insurance industries at the institutional level (i.e. the insurance firm) somehow reduces, albeit not dramatically, the level of heterogeneity. Although the level of heterogeneity still remains high for both types of insurance, life insurance industry displays a slightly lower level of heterogeneity that non-life insurance industry (.85 versus .93). Separating the insurance firm

into distinct lines of business significantly decreases the level of heterogeneity for both life and non-life insurance businesses. In both instances, agency industry display the lowest level of heterogeneity in comparison with other industries. Owing to the small number of producing units accounted for in the sample in comparison with other insurance industries, reinsurance and investment industries display a relatively high level of heterogeneity, respectively, for life insurance and non life insurance. Despite the refinement made to the insurance business through these four industries, direct insurance industry still shows a high level of heterogeneity for both life and non-life insurance businesses. This tends to suggest that a further refinement can be implemented in this particular industry through the distinction between multiproduct and monoproduct producing units.[10] Finally, it is important to note that the level of the heterogeneity index is not significantly different between pairs of the same industry that belong to life and non-life insurance. This clearly suggest that, on the basis of the technology, the distinction between life and non-life insurance businesses is irrelevant. What is more relevant, however, is the delineation of the various lines of business which happen to display the same technology across the type of insurance.

In most cases, the results indicate that heterogeneity in technology tends to increase when n-digit level of refinement is coarsened into $(n - 1)$-digit level refinement. These results suggest that the delineation of the insurance business proposed in this paper is quite robust as a method to separate insurers' production units into very refined groups based on similar technologies. Since the latter level is the one that most economists view as being close to economic industries, the proposed approach turns out to be successful at delineating economic industries.

IV. CONCLUDING REMARKS

This article reviews and extends the measurement framework of the insurance business at both macro and micro levels. The main results of this framework are easily summarized. First, the SNA consists of a coherent, consistent set of macroeconomic accounts and tables designed for a variety of analytical and policy purpose. Nevertheless, certain key aggregates of the system, such as industry GDP, have acquired an identity of their own and are widely used by users of all kinds as summary, global indicators of economic and welfare. Movements of such aggregates, and their associated price

and volume measures, are used to evaluate the performance of the economy and industries. The first part of the article applies illustrates this framework using the insurance sub-sector as an example.

Second, although the SNA was born in the world of macroeconomics, its roots have been in the data relating to individual decision-making units in the economy. Since its inception, both the complexity of the economic system and the concern with new analytical problems have increased. Currently, governments are faced with the need to evaluate both the macro and micro aspects of their policies in many areas. The national accounts alone are not sufficient for this task. Both the need and technical feasibility of linking the macro framework with micro data have increased.[11]

The second contribution of this paper is to unravel the behaviour of the various activities performed by insurance firms, with a special focus on the interactions between the various production units, their output and the characterization of their behavioural functions. The need to go beyond the concept of insurance firm builds on the tradition initiated by Coase. Just recently, in his Alfred Nobel Memorial Prize in Economic Sciences' lecture, Coase (1992, 714) emphasized once again the need to go beyond the traditional "black box" concept of firms:

> *"What is studied (in the mainstream theory of firm) is a system which lives in the minds of economists but not on earth. The firm in mainstream economic theory has often been described as a 'black box.' And so it is. This is very extraordinary given that most resources in a modern economic system are employed within firms, with how these resources are used depended on administrative decisions and not directly on the operation of a market. Consequently, the efficiency of the economic system depends to a very considerable extent on how these organizations conduct their affairs, particularly, of course, the modern corporation."*

On the other hand, the practical reasons that motivate this option are numerous. In North America, like in many other developed continents, the financial services business corresponds exclusively to regulated institutions, legally constituted, and often members of enterprises with a wide variety of activities. The concept of institutional entity is far from unambiguous and that the motives for legal structures are often other than purely organizational. They are often associated with tax-legislation and regulation, rather than reflecting economic reality. It is questionable whether the chosen legal structure corresponds with the way in which economic agents perceive reality themselves. It is even very likely that their view of economic reality is a very different one.

At least three areas of the analysis of the insurance business remain fertile ground for further research. First, I suggest that the analysis of the insurance production structures at the level of the line of business should be listed to the top of the agenda in applied econometrics and determine which production units drive the economic performance of the insurance firm. While many studies documented the fact that the life insurance industry shifted from financial protection services to investment products (see Poterba, 1997), no contribution has ever tried to determine the difference in the economic performance between financial protection (direct insurance) and financial intermediation (investment activity).

The other remaining areas for further research concern the economic performance of the investment activity and reinsurance. This last item includes issues such as the turbulence in the insurance business in terms of entry-exit, concentration by product line, pricing and a cross country comparison in the structures, conduct and economic performance of insurers lines of business.

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☐ Notes

1. The co-operative credit movement is sometimes cited as a "fifth pillar", offering banking and other financial services to households. Other financial institutions include pension funds, mutual funds, finance companies and leasing companies.

2. Reinsurance is a process by which the reinsurer (the first party) in consideration of a premium agrees to indemnify the reinsured (the second party) against a risk insured by the reinsured under a policy in favour of the insured (a third party).

3. Changes in actuarial reserves are not considered in this chapter for the sake of simplicity.

4. "*The total value-added, (...), thus equals the insurers expenses plus the owners's profit charge for bearing insurance risk*". (p. 26)

5. The historical growth rates of industries' value added are preserved and the series are projected backward from the new base year on that basis while the following years are established on the basis of the relative prices of the new base year.

6. Direct insurance sells financial protection for various kinds of assets; reinsurance provides diversification of risks on various kinds of financial protection; investment provides various kinds of investment advises to different clients.

7. In practice, if this information is not available, one may use the commissions rate that insurers apply to independent brokers.

8. Specifically, the use of standard national accounting procedure to measure the output (gross output or value added) originating in financial intermediation would yield a figure that would be too low without the addition of an imputed value of financial services rendered (see Berger and Humphrey 1992; Fixler and Zieschang 1991). To illustrate, suppose that the GDP for the investment unit was calculated simply by summing wages, profits and net interests (where net interests are interest earned on loans and interest paid to the direct insurance for funds loaned). A characteristic of the investment unit is that interest received typically exceeds interest paid; it typically pays below market interest rates on liabilities. The interest rate differential serves as an implicit payment for services rendered. Without the explicit addition of the value of these implicit payments the GDP for investment would be understated.

9. The variable could represent reinsurance ceded for direct insurance production unit.

10. The new North Americain Industrial Classification System for the Canadian insurance business actually does introduce this distinction between multiproduct and monoproduct producing units. See Statistics Canada (1998).

11. The UN SNA (1993) states explicitly its position concerning the relation of the macro accounts to micro data: "*Nevertheless, as a general objective, the concepts, definitions and classifications used in economic accounting should, so far as possible, be the same at both a micro and macro level of facilitate the interface between the two kinds of data*". (p. 12).

CHRONIQUE DES CHAIRES EN ASSURANCE ET EN GESTION DES RISQUES

par Gilles Bernier

LES TRAVAUX ET ACTIVITÉS DE LA CHAIRE EN ASSURANCE L'INDUSTRIELLE-ALLIANCE

Projets de recherche subventionnés en 1998-1999

- Hélène COSSETTE et Étienne MARCEAU :
  (École d'actuariat, Université Laval)
  « Étude et application de modèles de dépendance entre risques en actuariat IARD »
- Lucie COURTEAU et Robert MATHIEU :
  (Faculté des sciences de l'administration, Université Laval)
  « Le contenu informationnel des nouvelles normes comptables sur les instruments financiers »
- Étienne MARCEAU :
  (École d'actuariat, Université Laval)
  « Étude et application de modèles de taux d'intérêt dans l'évaluation de produits d'assurance-vie »

Subvention additionnelle versée en 1998-1999 sur un projet existant[1]

- Louis DORAY* et Andrew LUONG** :
  * (Département de mathématiques et de statistique, Université de Montréal)
  ** (École d'actuariat, Université Laval)
  « Méthodes de distance quadratique généralisées et valeurs extrémales en réassurance »

L'auteur :
Gilles Bernier est titulaire de la Chaire en assurance l'Industrielle-Alliance de l'Université Laval.

Bourses de recherche (2e cycle) de la Chaire en assurance L'Industrielle-Alliance

(Remise du 31 mars 1999)

- Véronique MARTEL :
  Maîtrise avec essai-concentration en droit de l'entreprise
  « Les engagements formels » (essai)
  Bourse : 1 000$ (Bourse André-Lévesque)
- Issouf SOUMARÉ :
  Maîtrise spécialisée en ingénierie financière
  « La gestion d'un portefeuille de garanties avec corrélations non nulles entre les firmes garanties » (mémoire)
  Bourse : 2 000$ (Chaire en assurance L'Industrielle-Alliance)

Bourses de l'Institut d'Assurance du Canada (1er et 2e cycles)

(Remise du 19 mai 1999)

Bourses d'études (1er cycle – Baccalauréat en administration des affaires) :

- François R. BEAUDOIN :
  Bourse : 800$
- Christine FILLION :
  Bourse : 800$
- Pascal-André RHEAULT :
  Bourse : 800$

Bourses de recherche (2e cycle – Maîtrise en administration des affaires – Option finance) :

- Vincent CASTONGUAY :
  « Développement d'un système de mesure et de gestion des risques pour une coopérative financière péruviennne » (essai)
  Bourse : 1 300$
- Karim DRIRA :
  « La réplication synthétique du risque de crédit d'un portefeuille de prêts » (essai)
  Bourse : 1 300$

Documents produits avec la participation de la Chaire en assurance L'Industrielle-Alliance

Communications

BERNIER, GILLES, ROGER ATINDÉHOU et GUY CHAREST : « Réputation des firmes et réaction boursière en période d'annonce du dividende régulier », *Association française de finance (AFFI)*, Lille (France), 28 juin au 8 juillet 1998.

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subventionnée par l'Institut de recherche en santé et en sécurité du travail du Québec (IRSST) et la Chaire en assurance L'Industrielle-Alliance de l'Université Laval).

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« Le délai de réclamation en assurance de la responsabilité civile »

Avril 1999.

Geneviève GARON :

« Théorie de la crédibilité : modèles de Bühlmann et de Bühlmann-Straub et applications »

Décembre 1998.

Caroline GENOIS :

« La gestion actif-passif des compagnies d'assurance-vie »

Janvier 1999.

Valérie GUICHARD-DOUCHE :

« La veille technologique dans les compagnies d'assurance au Canada : les domaines de la veille »

Août 1998.

Jérôme PANSÉRA :

« Le coût de disparité d'une compagnie d'assurance-vie dans des modèles aléatoires de taux d'intérêt »

Décembre 1998.

Marie-Ethel PLAZANET :

« La veille technologique dans les compagnies d'assurance au Canada : les aspects organisationnels »

Août 1998.

☐ Note

1. Ce deuxième volet généralise les travaux amorcés en 1994 sur les « Méthodes de distance quadratique minimale en assurance ». Ce dernier a d'ailleurs donné naissance à la production de trois articles publiés entre 1995 et 1997 dans des revues telles que Insurance : Mathematics and Economics; Communication in Statistics, Simulation and Computation.

FAITS D'ACTUALITÉ

par Rémi Moreau

1. Le bogue de l'an 2000, une facture mondiale d'au moins 300 milliards de dollars

Les assureurs et les courtiers n'ont cessé, depuis au moins deux ans, de mettre leurs clients en garde contre les effets du bogue de l'an 2000 et les limites de l'assurance à cet égard. En effet, faute pour eux d'auditer leurs systèmes, de corriger leurs informatiques, et de faire des tests et des plans d'urgence, les dommages assurables seraient figés par le principe du caractère aléatoire gouvernant les contrats d'assurance.

Le bogue «Y2K» serait l'un des sinistres financiers les plus retentissants de l'histoire industrielle, non pas par ses effets, car la nuit de la Saint-Sylvestre fut aussi calme que les précédentes sur la plan informatique, mais par les mesures mises en place pour réparer ou renouveler les ordinateurs et les logiciels. Il n'est devancé que par la guerre du Vietnam qui aurait coûté quelque 500 milliards de dollars aux États-Unis. Même le coût des catastrophes naturelles mondiales, en une année, n'est pas de cette ampleur. Les coûts associés aux cat nat dans le monde en 1998 furent de 93 milliards de dollars (par rapport à 10 milliards de dollars en 1960).

Cette facture ne prend pas en compte le coût des procès attendus à la suite des défaillances qui seront constatées, estimées à plusieurs centaines de milliards de dollars.

2. Deux tempêtes successives ont frappé l'Europe à la fin de l'année 1999

On se préparait, sinon au bogue tant annoncé, du moins à l'arrivée mythique de l'an 2000 savamment éclairée par les artificiers. Au lieu du sinistre technologique anticipé, ce sont deux tempêtes de vent, « Lothar » et « Martin », d'une rigueur exceptionnelle, qui ont signifié, en Europe, la fin de 1999, sans oublier la marée noire qui a souillé un large pan du littoral français.

Le bilan des tempêtes est impressionnant : 130 morts, dont 62 en France, des dégâts matériels aux immeubles, aux infrastructures, aux monuments et aux sites naturels à travers l'Europe (principalement en France où l'on compte 90 morts, mais aussi en Allemagne, en Belgique, en Autriche, en Suisse, en Espagne et en Grande-Bretagne), perturbant les transports et la distribution d'électricité. Le gouvernement français a déclaré les deux tiers du territoire en état de catastrophe naturelle et 6 000 soldats furent mobilisés. Près de 3,5 millions de foyers français ont été privés d'électricité immédiatement après les tempêtes. 600 000 foyers français ont réveillonné dans le noir ! Trente-cinq lignes à haute tension, soit un quart des autoroutes électriques représentant un million de lignes, étaient hors de fonction.

Une semaine plus tard, vers le 4 janvier 2000, près de 500 000 foyers, principalement dans le Sud-Ouest et dans l'Ouest, n'avaient pas encore de courant ni de tonalité téléphonique. On ne peut manquer de faire le parallèle entre le centre de crise d'Hydro-Québec, deux ans plus tôt, et celui de EDF (Électricité de France), qui ont eu à gérer, d'une façon similaire, un réseau lourdement endommagé, et surtout à rebrancher, fil par fil, leurs abonnés plongés dans le noir.

Dans certaines régions, plus de 10 % du massif forestier fut détruit, soit environ un demi-million d'arbres. Quelque 140 000 arbres sur les 300 000 que comptent les parcs de Vincennes et de Boulogne ont été mortellement frappés et, uniquement dans le parc du château de Versailles, quelque 10 000 arbres ont été arrachés. Le ministre français de l'Agriculture a qualifié cette catastrophe comme étant «le plus grave séisme forestier que la France ait connu au XX^{e} siècle.»

Pour les assureurs, c'est le branle-bas de combat. À titre d'exemple, pour Inter Mutuelle-Assistance, le record de 3 500 dossiers ouverts en un jour a été battu de plusieurs foulées, puisque l'assisteur a enregistré 5 700 réclamations, en assurance habitation principalement, mais aussi en assurance automobile. À titre de bilan sommaire, on a évalué les dégâts assurables à la hauteur de 7 milliards d'euros. Selon SCOR, les assureurs français pourraient assumer, seuls ou avec les réassureurs, ou conjointement avec l'État, une perte de 5 milliard d'euros (25 milliards de Francs) au titre des dommages assurables, sans prendre en compte les pertes économiques encourues par voie de conséquence. Ces chiffres pourraient être haussés vu la forte sinistralité en zones urbaines et vu certaines mesures exceptionnelles prises par les assureurs, soit le report au 31 janvier 2000 du délai de déclaration de sinistre (normalement le délai légal est de 5 jours) et la possibilité de faire une déclaration par simple lettre ou par téléphone plutôt que par envoi recommandé, tel que prévu par la loi.

Du côté de la réassurance, les deux ténors, Münchener Rück, le numéro un mondial, et Swiss Re, le numéro deux, devront payer une ardoise de plus de un milliard d'euros. Les deux tempêtes (mais un seul événement, si l'on prend en compte la définition du mot sinistre, étalé sur 72 heures), risquent de laminer leurs résultats techniques de l'année en assurance de dommages.

Ce sinistre d'une rare ampleur survient alors que l'encre des chèques d'indemnités dues aux inondations dans le Sud, en novembre, n'était pas encore sèche. En effet, les assureurs ont dû payer une facture salée de 3 millions de francs, nettement plus élevée que celle payée pour les inondations de Nîmes en octobre 1988, qui totalisait 1,9 million de francs.

En même temps, entre 100 000 et 300 000 oiseaux marins ont été tués, blessés ou englués de mazout par la pollution du pétrolier maltais Érika, au large des côtes bretonnes, qui a fait naufrage, le 12 décembre, répandant dans l'Atlantique quelque 12 000 tonnes de pétrole brut. La marée noire a souillé le littoral Nord-Ouest de l'Hexagone, sur une surface de 340 kilomètres de côtés, principalement le Finistère, la Vendée, la Loire-Atlantique et la Charente-Maritime (notamment l'Ile de Ré). Mais on oublie trop souvent qu'une telle marée noire menace non seulement les oiseaux marins, mais aussi diverses espèces, dont les dauphins, les phoques, les pingouins, les moules, les huîtres, les crevettes et même certaines réserves naturelles à l'intérieur de la zone polluée.

Dès le 22 décembre, un expert judiciaire était nommé, chargé d'évaluer la situation avec un représentant de la compagnie TotalFina, affréteur du navire, qui ne cessait de clamer sa non-responsabilité sur le plan strictement légal. En effet, selon la convention internationale de Bruxelles de 1969, c'est le propriétaire du navire (mais le mystère reste entier sur son identité, dans les dédales des prête-noms et des sociétés écrans) qui doit être tenu légalement responsable, et non l'affréteur, bien que le chargement lui appartenait. Si le propriétaire n'est pas en mesure de supporter les conséquences des dommages dus aux victimes, il appartiendrait à un fonds d'indemnisation, géré par le FIPOL, de dédommager les victimes. Le navire lui-même serait assuré auprès de P & I Clubs pour 11 millions de dollars.

3. La pire catastrophe naturelle de la décennie 90 fut au Venezuella

Le déluge et les glissements de terrains de la mi-décembre ont rayé de la carte des villes entières du Venezuella. Situé à 30 km au

nord de Caracas, Vargas, l'État martyr, a vu mourir plus de 30 000 de ses habitants, soit 10 % de sa population. Selon les bilans provisoires, la tragédie a fait entre 40 000 et 50 000 morts et forcé l'évacuation de plus de 200 000 personnes.

D'ores et déjà, ont estime que les coûts de reconstruction pourraient atteindre 15 milliards de dollars. L'Assemblée nationale a conféré au président Chavez des pouvoirs exceptionnels, notamment de déclarer l'état de guerre économique.

4. Les catastrophes naturelles ou provoquées par l'homme en 1999

Selon un rapport de la société suisse de réassurance Swiss Re, publié en décembre, (et qui ne prendrait vraisemblablement pas en compte les catastrophes naturelles de décembre en Europe et en Amérique du Sud), les catastrophes naturelles ou provoquées par l'homme, ont fait 52 000 morts dans le monde en 1999 et ont coûté 65 milliards de dollars en dommages au secteur mondial de l'assurance, sans compter les pertes économiques encourues par voie de conséquence.

En 1998, si le total des dommages assurés était à peu près du même ordre (64,6 milliards de dollars), le nombre de victimes recensées était légèrement inférieur (environ 44 000 morts). Il va sans dire que le nombre de morts s'élargit considérablement si l'on tient compte des 40 000 victimes venezuelliennes, portant ainsi le bilan à plus de 100 000 morts.

L'année 1999 serait au quatrième rang des années les plus catastrophiques, sur le plan financier dans l'histoire de l'assurance, sans prendre en compte les 5 milliards de dollars environ que coûteraient les tempêtes européennes de décembre.

5. L'assistance, un concept en croissance constante

L'assistance est perçue comme un élément de service qui permet d'enrichir une offre : contrat de vente d'un véhicule, services bancaires, forfaits de voyage.

L'assistance, focalisée à ses débuts, sur les besoins de sécurité des vacanciers en voyage, s'ouvre à divers horizons : assistance de personnes au domicile, conseil médical par téléphone, assistance aux véhicules, assistance des personnes travaillant à l'étranger. Plusieurs sociétés d'assurance en ont fait une branche distincte, au même titre que l'assurance vie, l'assurance de biens ou l'assurance responsabilité.

Nées dans les années soixante, les sociétés d'assistance représentent un chiffre d'affaires de plusieurs milliards de dollars. Ce marché s'est consolidé, en Europe, autour des assureurs, des voyagistes, des émetteurs de cartes de crédit et des fabricants d'autos, en Amérique, par les clubs automobiles (tel le CAA) et des organismes à vocation médicale.

6. Le nouveau Code de déontologie de la Chambre de la sécurité financière

Comme on le sait, c'est à la Chambre de la sécurité financière, créée en vertu de la *Loi sur la distribution de produits et services financiers* (Loi 188) qu'il incombe de réglementer les courtiers en assurance de personnes et les planificateurs financiers sous son égide. Après la mise en place de la Chambre, le 1er octobre dernier, il importait que cet ordre professionnel se dote de règles déontologiques susceptibles se sécuriser les consommateurs de ce vaste marché, règles qui s'inspirent des anciennes règles qui avaient cours sous le Règlement du Conseil des assurances de personnes d'alors. L'objectif du Code de déontologie est de favoriser la protection du public et de favoriser une pratique intègre et professionnelle.

À titre de nouveauté, il sera désormais interdit pour tout représentant d'inciter à répétition un client, ou de faire pression sur lui, pour qu'il acquière un produit ou un service financier.

De plus, le devoir de conseil a été codifié, sous l'impulsion d'une jurisprudence de plus en plus lourde à l'égard de l'intermédiaire, qui se doit d'agir avec probité et en conseiller consciencieux en accomplissant toutes les démarches raisonnables afin de bien conseiller son client. Il doit expliquer aussi, de façon complète et objective, la nature, les avantages et les inconvénients d'un produit ou d'un service offert au client.

De plus, une disposition, non encore en vigueur, obligera un représentant en assurance, avant la conclusion d'un contrat, de bien décrire le produit sur le plan des garanties, des conditions et des exclusions.

Afin d'éviter tout conflit, une disposition stipule qu'il est interdit, pour un représentant, de conseiller un client sur des placements dans une compagnie où ce représentant a un intérêt. Les intérêts du client du client éventuel priment sur ceux du représentant. De plus, tels représentants ne doivent pas conclure des ententes avec des personnes qui ne sont pas en mesure de gérer leurs affaires.

Enfin, on observe une autre disposition nouvelle : le représentant doit remettre au client, sans délai, les livres et documents lui appartenant, même si le client lui doit une somme d'argent.

Pour les personnes intéressées, les dispositions du Code de déontologie de la Chambre de la sécurité routière sont publiées dans la Gazette officielle du Québec du 15 septembre 1999 (p. 4135).

7. La Chambre de l'assurance de dommages

La Chambre de l'assurance de dommages, dont la mission est d'assurer la protection du public en matière d'assurance de dommages et d'expertise en règlement de sinistres, regroupe près de 10 000 cotisants issus de trois professions : les agents en assurance de dommages, les courtiers en assurance de dommages et les experts en sinistre.

Depuis le 1er octobre dernier, le syndic a pour mandat de recevoir les plaintes, d'enquêter et de déposer les plaintes devant le comité de discipline, s'il y a des motifs raisonnables de croire qu'une infraction déontologique a été commise.

La Loi 188 remplace l'appellation «intermédiaire de marché», alors en usage sous la Loi 134, par l'appellation «représentant», applicables tant aux agents, aux courtiers qu'aux experts.

À l'instar de la Chambre de la sécurité financière, la Chambre de l'assurance de dommages possède également un code déontologique. La Loi 188 prévoit des dispositions relativement à la conduite des représentants, des cabinets et des sociétés autonomes. Voici certains dispositions :

- agir avec loyauté et honnêteté envers le client ;
- ne pas aider ou amener, par un encouragement, un conseil, une autorisation ou un ordre, un représentant, un cabinet ou une société autonome à enfreindre une disposition de la Loi 188 ou de ses règlements ;
- veiller à la discipline de leurs représentants et s'assurer qu'ils agissent conformément à la Loi 188 et ses règlements (applicable au cabinet et ses dirigeants).

Le lecteur intéressé peut en apprendre davantage sur la Chambre en visitant son site Web : www.chad.qc.ca .

8. L'assurance pollution : quelques conseils

La revue *Actualités*, publiée par Elliott Risques Spéciaux Ltée, un souscripteur spécialisé en assurance contre les atteintes à l'environnement, suggère de revoir les conseils en assurance pollution. Le client doit comprendre que les risques environnementaux dépassent largement les garanties offertes, donc qu'il existe nécessairement des trous à combler sur le plan de la couverture.

Il est suggéré aussi de ne pas omettre de mentionner au client que les garanties actuelles sont devenues plus abordables que par le passé, malgré l'ampleur des lois et des règlements régissant les risques liés à l'environnement. Parallèlement, le choix des garanties est vaste. Celles-ci sont accessibles en fonction des besoins précis des clients.

Quelques aspects saillants caractérisent le contrat offert sur ce marché spécialisé :

- pollution non seulement soudaine mais graduelle (infiltration graduelle ou pollution chronique) ;
- dépollution imposée par les pouvoirs publics ;
- pollution par les déchets.

La prime minimum est de 5 000 dollars pour les divers contrats offerts en matière de pollution, sauf pour les contrats couvrant la responsabilité civile, laquelle est de 2 500 dollars.

9. Les COPrS : nouveaux titres privilégiés d'origine canadienne

Les COPrS (Canadian Originated Preferred Securities) qui ont été mis en circulation au Canada sont des titres novateurs tentant de répondre aux besoins des épargnants et des entreprises constituant une alternative face à la faiblesse des taux d'intérêt. Il s'agit de débentures (obligations non garanties) de longue échéance, similaires aux actions des entreprises, qui se transigent sur les bourses canadiennes.

Il semble que la première émission canadienne de COPrS ait été effectuée par Suncor Energy Inc., le 5 mars 1999, au prix de 25 dollars l'unité. Leurs détenteurs ont droit à des versements d'intérêts trimestriels de 0,565 $ par unité, soit 2,26 dollars par année, imposables, donnant un rendement brut de 9,05 % l'an, un rendement très attrayant qui répond aux exigences fiscales.

Les COPrS sont des véhicules de placement intéressants, mais à risques, et qui pourraient également convenir au REÉR, puisque leur revenu reste à l'abri de l'impôt à l'intérieur du régime.

(Source : Article de Pierre Brunette paru dans *Prospective*, décembre 1999, Produits financiers et placements, p. 24.)

10. L'assurance médicaments de plus en plus coûteuse

À quelques encablures d'une nouvelle tarification en l'an 2000, il est utile de se pencher sur le petit dernier des régimes étatiques d'assurance. Le régime québécois d'assurance médicaments a coûté à l'État 1,5 milliard de dollars en 1999, une spectaculaire augmentation de 30 % en deux ans. En effet, la part des usagers est passée de 287 à 329 millions de dollars de 1997 à 1999, tandis que le financement public a grimpé de 832 millions à 1,5 milliard de dollars. Ces augmentations découlent particulièrement du coût des médicaments des personnes âgées (de 491 à 633 millions de dollars) et des assistés sociaux (de 200 à 343 millions de dollars).

L'augmentation de 10 % l'an dernier du nombre de prescriptions per capita explique en partie cette explosion des coûts, alliée à d'autres facteurs, tels l'inflation, la marge des profits des compagnies pharmaceutiques et le recours aux nouveaux médicaments (très coûteux). En 1999, chacune des 2,4 millions de personnes ayant bénéficié du régime public d'assurance médicaments s'est vu prescrire 23 ordonnances dont le coût moyen était de 23,90 dollars.

La ventilation des bénéficiaires s'établissait globalement comme suit, à la fin de l'année précédente : 1,5 million d'adhérants, 850 000 personnes âgées et 70 000 assistés sociaux. Plus de 3,5 millions de Québécois souscrivent à un régime privé d'assurance médicaments.

11. L'euro, un an après

En ce premier anniversaire de l'euro, la monnaie la plus utilisée au monde après le dollar américain (quelque 290 millions de personnes dans une trentaine de pays l'utilisent), il n'est pas inutile de faire un bilan sommaire. Mais d'abord, il importe de préciser que l'arrivée officielle et obligatoire de la monnaie unique n'est prévue qu'en 2002. Après des débuts fracassants, l'euro, qui est encore dans une étape virtuelle, a cédé progressivement du terrain pour finir à parité avec le dollar américain. La monnaie unique a perdu ainsi 17 % de sa valeur face au billet vert. La raison formelle

d'une telle baisse : les taux d'intérêt sont presque deux fois plus élevés aux États-Unis qu'en Europe.

12. Nouveaux défis dans l'assurance spatiale

Face à l'évolution des systèmes satellitaires, les assureurs de risques spéciaux, notamment Münchener Rück, devront affronter de nouveaux défis, selon le dernier rapport annuel de cette société. On y apprend, notamment, que les satellites géostationnaires de télécommunications ont atteint les limites de leur capacité. Par ailleurs, d'autres systèmes satellitaires viennent d'être mis en place ou le seront bientôt (systèmes de téléphonie par satellite et systèmes chargés de l'échange mondial de l'information et de données de navigation) qui pourraient entraîner la mise en orbite de centaines de satellites spécialisés. Malgré un examen qualifié, les possibilités d'estimer la sinistralité dans la phase de lancement des fusées restent limités.

Le risque spatial est techniquement complexe, très exposé et fort volatil, ce qui entraîne des taux à la hausse et des services extrêmement sophistiqués.

13. Le crash d'Egyptair : le bilan

Le crash du Boeing 767 d'Egyptair au large des côtes de la Nouvelle-Angleterre, l'automne dernier, tuant les 217 passagers, constituerait une perte de 470 millions de dollars. La perte de l'appareil met à contribution les assureurs corps pour 53 millions de dollars. Du côté de la responsabilité civile, les indemnisations les plus prudentes seraient de l'ordre de 417 millions de dollars.

L'accident s'est produit quelques jours avant le renouvellement de la police. C'est le courtier britannique Willis qui avait le mandat de placer intégralement le risque. La tranche initiale fut acceptée par un souscripteur égyptien, la compagnie Misr. Les autres tranches furent rétrocédées sur le marché mondial, dont l'apériteur était le pool La Réunion Aérienne, regroupant des assureurs français et britannique. La police fut renouvelée le 16 novembre dernier moyennant une augmentation substantielle de prime.

Ce sinistre alourdit considérablement le bilan de l'assurance aviation en 1999, dont le marché responsabilité est déficitaire au niveau mondial.

14. Financial Supervisory Authority (FSA) : la nouvelle autorité britannique de contrôle

Sise dans une des tours du Canary Wharf, la FSA a un mandat de régulateur unique du secteur des services financiers britannique. Pour l'heure, elle opère encore en phase transitoire, attentive à la promulgation d'une loi spéciale au cours de l'an 2000, bien qu'elle possède d'ores et déjà les pouvoirs de réguler certaines matières d'assurance, dont le contrôle et la supervision des quelque 850 compagnies agréées en Grande-Bretagne, sauf les Lloyd's. En effet, la vénérable institution tricentenaire est doté d'un régime particulier lui permettant de s'autoréguler.

La FSA aurait aussi un rôle consumériste, étant chargée de publier des tableaux de comparaison des divers produits financiers disponibles sur le marché.

15. Croissance mondiale de l'assurance

Selon une récente étude de SIGMA, publiée par la Compagnie Suisse de Réassurance, l'assurance mondiale en 1998 serait en nette perte de vitesse. Les primes n'ont cru que de 2,3 % à 2 155 milliards de dollars, par comparaison à 4,4 % en 1997. L'assurance vie a continué de progresser, mais dans une mesure nettement moindre qu'en 1997. Quant au secteur non-vie, il accuse un recul de 0,8 %. Le Japon fut l'un des pays les plus touchés avec un repli des encaissements à la fois dans les secteurs vie et non-vie. Cette décroissance est largement tributaire de la crise monétaire asiatique de 1998.

16. L'accidentologie : une nouvelle science au service de l'assurance

Une nouvelle science se développe en Europe, notamment en Belgique où elle est pratiquée sur une grande échelle. Il s'agit de l'accidentologie, c'est-à-dire la reconstitution d'accidents routiers après un sinistre, soit qu'aucun conducteur ne veuille reconnaître sa responsabilité, soit que les conducteurs sont décédés.

L'accidentologie sert à départager les responsabilités par la reconstitution d'un accident en définissant de façon très précise les conditions du sinistre à partir de l'analyse des dommages, des relevés d'indices matériels existants, ou d'autres indices (traces de pneus, témoins, position des véhicules, etc.). Son développement reste très limité chez nous, quant au peu d'experts formés à cette école. C'est dommage, car de nombreux intervenants ont intérêt à déterminer toute la vérité : les victimes elles-mêmes, mais aussi les juges, les experts et les assureurs.

INDEX DES SUJETS ET DES AUTEURS

AVRIL 1999 À JANVIER 2000

par Rémi Moreau

Index des sujets

Index des auteurs

Liste des index antérieurs parus dans la revue *Assurances*

Dans chaque numéro d'avril, nous publions un index concernant les quatre numéros précédents. Le dernier index antérieur fut publié dans le numéro d'avril 1999.

List of indexes previously published in Journal Assurances

In each April issue, an index on the four previous issues is published. The last previous index was published in the April 1999 issue.

LE MONDE VIRTUEL DE L'ASSURANCE ET DE LA GESTION DES RISQUES

Nous avons visité le site web du Bureau d'assurance du Canada

http://www.ibc.ca

Le site web du BAC comprend quatre grandes sections :

■ **Naviguer sur le site**

Cette section comprend la sous-section Récentes nouvelles et Moteur de recherche. Dans la première, on peut trouver des articles récemment publiés par le BAC, des communiqués de presse ou encore des secteurs d'intérêt sur le site. Dans la seconde, on peut explorer plus facilement le site, grâce à un moteur de recherche qui opère par mots clés ou par phrases.

■ **Comment l'assurance fonctionne**

On y trouve une description de trois branches d'assurance : l'assurance automobile, l'assurance commerciale et l'assurance résidentielle.

■ **Les grands enjeux de l'assurance**

Cette sous-section est divisée en quatre parties : enjeux de l'industrie, bureaux régionaux, renseignements destinés aux consommateurs et, enfin, sécurité et prévention.

■ **Au sujet du BAC**

Le navigateur intéressé à faire des commentaires ou des suggestions, notamment quant au site, aux produits ou aux services, peut le faire en adressant un courriel au webmestre du BAC. S'il désire obtenir un numéro de téléphone ou une adresse, il peut le faire grâce à la section Contacts. Des opportunités d'emplois font également l'objet d'une rubrique.

Cette rubrique comprend aussi une sous-section intitulée Renseignements corporatifs et une sous-section Division légale.

La version française du site est actuellement en cours de construction.

Nous invitons les lecteurs, les entreprises, les associations ou les organismes d'assurance à nous faire connaître leur site. C'est avec plaisir que nous y naviguerons en vue de le faire découvrir aux lecteurs de ASSURANCES.

THE VIRTUAL WORLD OF INSURANCE AND RISK MANAGEMENT

We have visited the web site of the Insurance Bureau of Canada

http://www.ibc.ca

The IBC web site is divided into four general parts :

- **Navigating our website**

This part includes the section Whats's new and the section Search engine. The first one includes newly published articles, press releases and new areas of interest on the site. The second one allows the navigator to easily exploring the IBC website, thanks to the search engine by keywords or phrases.

- **How insurance works**

Three types of insurance are considered : automobile insurance, business insurance and homeowner insurance.

- **Insurance issues**

This part is divided into four section : industry issues, regional offices, consumer awareness and safety & loss prevention.

- **About IBC**

For comments or suggestions, please e-mail IBC at webmaster's address and tell what you think about website, products and services. If you need the phone numbers and addresses of any of the IBC consumer inquiry centres, please see the section Contacts. Employment opportunities are also available.

This part includes two other sections : Corporate information and Legal division.

The French section of the site is currently under construction.

Readers, as well as insurance companies, associations and entities are encouraged to let us know their Web page. We will be pleased to check it out and may be tell our readers about it.

MARSH
An MMC Company

Marsh & McLennan Companies a fait ses débuts en 1871. Les produits d'exploitation ont atteint 9,2 milliards de dollars en 1999 et notre société figure aujourd'hui sur la liste des *Fortune 500*.

Dans le monde entier, plus de 50 000 professionnels mettent leurs capacités d'analyse, de conseil et de négociation au service de nos clients dans plus de 100 pays.

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- **Les risques stratégiques :** concurrence, demande insuffisante, réglementation, échecs en recherche et développement
- **Les risques financiers :** volatilité des taux d'intérêt, devises étrangères ou marché des produits de base
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- **Les risques catastrophiques :** contamination alimentaire et rappel de produits, catastrophes aériennes

La pression exercée sur les marchés et les conseils d'administration ne cesse d'augmenter pour que des niveaux de performance toujours plus élevés et des résultats toujours mieux ciblés soient atteints. C'est pourquoi la haute direction des entreprises s'est mise à la recherche d'idées novatrices pour traiter l'ensemble de ces risques.

Marsh, leader mondial de services de gestion de risques, met à votre disposition une gamme complète de solutions permettant d'identifier, d'évaluer, d'atténuer et de transférer de tels risques de façon systématique et réfléchie.

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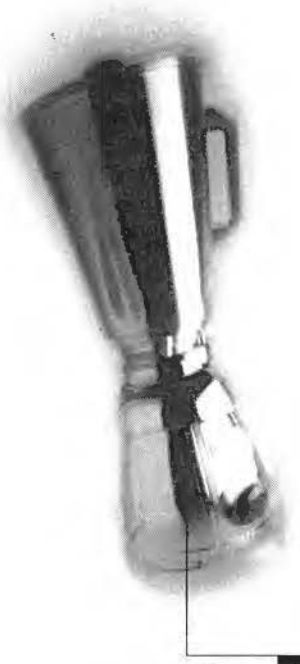

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Assurances

Revue trimestrielle consacrée à l'assurance et à la gestion des risques

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Chronique actuarielle : tirée du bulletin mensuel du Groupe-conseil Aon Inc.

Chronique de documentation : compte rendu de livres

Chronique juridique : commentaire de jugements ou de lois

Commentaires d'articles : opinions critiques de lecteurs

Document : reproduction d'un texte ou d'un article ayant une valeur historique

Études techniques : analyses particulières

Faits d'actualité : événements marquants commentés par le rédacteur en chef

Garanties particulières : études sur des garanties inédites ou une nouvelle police

Gestion des risques : étude, analyse, conférence applicable à la gestion des risques

IBC News/Nouvelles du BAC : nouvelles de l'industrie publiées par le BAC

Intermédiaires de marché : études applicables aux agents, aux courtiers ou aux experts en sinistre

Page de l'internaute : description du site Web d'une compagnie ou organisme

Projets de recherche des chaires : projets réalisés par les trois chaires canadiennes en assurance et gestion des risques

Reinsurance Dialogue : échange entre deux représentants du milieu de la réassurance

Tendances : nouvelles orientations commentées par le Centre de documentation du groupe Aon.

Columns

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Chronique actuarielle: excerpt from the Groupe-conseil Aon Inc. newsletter

Chronique de documentation: book review

Chronique juridique: commentary on laws or judgments

Commentaires d'articles: readers'critical opinions

Document: reprint of a text or article with historical value

Études techniques: technical analysis

Faits d'actualité: editor's comments on current events

Garanties particulières: special guarantees or new wording analysis

Gestion des risques: studies or conferences on risk management

IBC News/Nouvelles du BAC: news from the industry published by IBC

Intermédiaires de marché: studies on agents, brokers or loss adjusters

Internet Surfer Page: Web site description of a company or organism

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Assurances est publiée trimestriellement, soit en avril, en juillet, en octobre et en janvier. Elle contribue, par des études ou des recherches, à mieux faire connaître l'assurance et ses techniques, dans les branches IARD ou vie, ainsi que la gestion des risques.

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Assurances is published four times a year, in April, July, October and January. The paramount objective is to publish studies or research works on property & casualty insurance and life insurance, as well as risk management.

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