



## SCOR CHAIR

### « Market Risk and Value Creation »

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## 1. OBJECTIVE

The creation of the SCOR Chair "Risk Markets and Value Creation" in 2008 has been the result of a process of reflection of the SCOR management that has led IDEI researchers to focus their research on different themes, all having in common: the study of risk sharing mechanisms.

The aim of the chair is to support the theoretical and applied research on risk sharing with the willingness to combine methodologies from financial economics, industrial organization and econometrics.

SCOR Chair "Risk Markets and Value Creation" is built around 5 projects involving a team of dedicated researchers. This report will provide below a detailed presentation of the work of each project.

## 2. DESCRIPTION OF THE PROJECTS

### a) *Ambiguity and Long-term Investments*

The objective of this research program is to better understand investment decisions under uncertainty. It specifically studies the impact of the "type" of uncertainty (small risk, catastrophic risk, ambiguity etc.), and of the temporality (horizon, sequentiality etc.) of the decision-making process. The typical applications are long term financial, insurance and environmental decisions. Hereafter, we discuss shortly the prolific contribution of IDEI researchers to this topic.

Several countries, including France and Great Britain, have adopted a method of valuing public investments in which discount rates may differ substantially from the rates of return on capital observed in financial markets. Economists agree that the prices of financial assets do not offer good signals to economic agents to guide their long-term investment choices. In order to avoid the short-term nature of these market prices, governments use reduced discount rates to evaluate their investments, which are closer to those used by the stakeholders who finance them (taxpayers, users, etc.). In many sectors of the economy, public goods and services are produced by parapublic or private operators that the State compensates to enable them to cover their costs and remunerate their risks. Therefore, this leads to the question of the remuneration of the capital for these operators. As economic theory teaches that in a perfect world, the cost of capital is equal to the discount rate, several regulators of these public contracts have recently proposed to use these reduced discount rates as a benchmark for Capital offered by the State to these operators. The aim of Gollier (2016-a) is to show that this proposal would lead to consequences diametrically opposed to those sought by the authors of the Lebègue, Gollier and Quinet reports, who argued in favor of these reduced discount rates.

Using the gamma discounting argument of Weitzman (1998, 2001) when future interest rates are uncertain, several countries have decided to base their investment and sustainability policy evaluation on a decreasing term structure of discount rates. In Gollier (2016-b), we show that this interpretation of the gamma discounting argument is in fact equivalent to the Local Expectations Hypothesis, a hypothesis globally rejected in empirical finance. We also show that gamma discounters are time-inconsistent and short-termist when shocks to economic growth are persistent. This is because they fail to account for the correlation between future consumption levels and spot interest rates.

Under expected utility, the uncertainty that affects the parameters of the random walk of consumption growth has no effect on the value of short-term claims and makes the term structure of risk-free rates decreasing. The term structure of aggregate risk premia is increasing when the uncertain cumulants of log consumption are independent. In Gollier (2016-c), we apply these generic results to the case of an uncertain probability of catastrophes, and to the case of an uncertain trend or volatility of growth. Adding some persistence to

unobservable shocks into our benchmark model, we show that the term structure of risk premia is hump-shaped.

In Gollier (2016-d) We assume that the ex-post utility of an agent facing a menu of lotteries depends upon the actual payoff together with its forgone best alternative, thereby allowing for the ex-post emotion of regret. An increase in the risk of regret is obtained when the actual payoff and its forgone best alternative are statistically less concordant in the sense of Tchen (1980). The aversion to any such risk of regret is thus equivalent to the supermodularity of the bivariate utility function. We show that more regret-risk-averse agents are more willing to choose the risky act in a one-risky-one-safe menu, in particular when the payoff of the risky choice is highly skewed. This is compatible with the "possibility effect" that is well documented in prospect theory. Symmetrically, we define the aversion to relation-risk that can prevail when the ex-post utility is alternatively sensitive to the forgone worst payoff. We show that relation-risk-seeking is compatible with the "certainty effect". We finally show that regret-risk-averse and relation-risk-seeking people behave as if they had rank-dependent utility preferences with an inverse-S shaped probability weighting function that reproduces estimates existing in the literature.

Natural capital is complex to price notably because of the high uncertainties surrounding the substitutability of its future ecosystem services. In Gollier (2016-e), we examine a two-tree Lucas economy where both the economic growth and the degree of substitutability are uncertain. We show that the uncertain substitutability raises the expected value of the service and the rate at which it should be discounted. The value effect dominates the discounting effect, so the economic value of natural capital is increased. When the prior beliefs about substitutability are Gaussian, the economic value of future ecosystem services goes to infinity for finite maturities.

In Armantier and Treich (2016), we explore the reasons for why individuals may be ambiguity averse in some situations. We show experimentally that subjects behave differently when they face simple objective risk compared to ambiguous risk. This is reminiscent to the initial Ellsberg's thought experiment and of many subsequent experimental results. More interestingly, in Armantier and Treich, we show that subjects in the experiment behave similarly when they face "complex" or compound objective risk and ambiguous risk. These results raise questions about the characterization of ambiguity aversion and the modeling of decisions under uncertainty. In particular, these results suggest that ambiguity aversion should generally be thought as a particular case of an aversion to complexity.

In a standard economic model, the decision to invest in risky assets and the decision to insure against the risk of loss reflect the same, albeit opposite, risk retention tradeoff. In both cases, the agent chooses which portion of the risk to retain. Insurance and portfolio decisions should therefore produce similar, but opposite, behavior and comparative statics. In particular, changes in the agent's initial wealth should have an opposite effect on insurance coverage and on portfolio risk composition.

It has now been well established empirically that the wealth elasticity of demand for risky assets is positive (e.g., Guiso, Tullio and Terlizzese 1996, Brunnermeier and Nagel 2008). Thus, we should expect insurance to be an inferior good, i.e. the demand for insurance should decrease with wealth. This hypothesis is consistent with the canonical model of insurance under Decreasing Absolute Risk Aversion (DARA) (Pratt 1964, Mossin 1968, Arrow 1971). Nevertheless, there is circumstantial evidence against this hypothesis as some cross-country comparisons suggest a positive relationship between per capita income and insurance demand (Beenstock, Dickinson and Khajuria 1988, Enz 2000, OECD 2011). These studies, however, have several limitations. In particular, they rely on aggregate data, they do no control for key determinants (e.g. the value of the goods insured, the risks faced by the insured), and they do not model jointly portfolio and insurance decisions.

In Armantier, Foncel and Treich (2016), we test whether, consistent with standard theory, the wealth elasticity of demand for insurance and risky assets have opposite signs. We do so using survey data for a

representative sample of U.S. households which combine individual level information on wealth and car insurance coverage. The empirical analysis consists of two steps. In step one, we estimate a baseline, easily interpretable, model. In step two, we conduct an extensive series of robustness checks by considering i) different specifications, ii) other forms of insurance (e.g. homeowner insurance) for the same sample of households, and, more importantly, iii) a different sample of industry (i.e. not self-reported) data on individuals' wealth and car insurance coverage from a different country (France).

The empirical analysis produces two main results. First, we find strong evidence that insurance is a normal good. This is in itself an important result because i) it is not consistent with the canonical expected utility DARA model used to derive most of the results in risk and insurance theory (Gollier 2001, Schlesinger 2013), and ii) it may have important consequences for the insurance industry, one of the largest sectors in the world economy. Second, we identify a puzzle in the sense that, contrary to standard theory, the wealth elasticity of demand for risky assets and insurance have the same positive sign.

To try to explain this puzzle, we first turn to conventional theory. We enrich the standard model by adding in particular (endogenous) background risks, savings, and wealth-dependent losses. However, we conclude that none of these explanations from conventional theory seems plausible. Next, we discuss how various behavioral factors may contribute to the puzzle, including loss aversion, context-dependent preferences, "peace of mind," or wealth-dependent risk perceptions. We also conclude that these behavioral hypotheses are not convincing at explaining the puzzle, or remain to be rigorously tested.

Finally, catastrophe aversion and risk equity are important concepts in both risk management theory and practice. Keeney (1980) was the first to formally define these concepts. He demonstrated that the two concepts are always in conflict. Yet this result is based on the assumption that individual risks are independent and has thus limited relevance for real world catastrophic events. In Bernard, Rheinlander and Treich (2016), we extend Keeney's result to dependent risks and derive the conditions under which more correlation between two risks induces a more catastrophic risk. We then generalize some of the results for multiple correlated risks.

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## b) *Dynamic Corporate Finance*

One of the main objective of dynamic corporate finance is to apply the rigor of the mathematical techniques of continuous-time finance models to very concrete financial problems faced by firms, such as how to finance their investments, when to distribute dividends and when to default on their debt.

In a world of perfect capital market, profitable firms could finance their operating costs and investments by issuing shares at no cost. As long as the net present value of a project is positive, it will find investors ready to supply funds. This is the central assumption of the Modigliani and Miller theorem. On the other hand, when firms face external financing costs, these costs generate a precautionary demand for holding liquid assets and retaining earnings, the liquidity management problem. This departure from the Modigliani-Miller framework has received a lot of attention in recent years and has given birth to a series of papers explaining why firms hold liquid assets. Pioneering papers are Jeanblanc and Shiryaev [7], Radner and Shepp [27] while more recent studies include Bolton, Chen and Wang [2], Décamps, Mariotti, Rochet and Villeneuve [4] and Décamps, J.P., Gryglewicz, S., Morellec, E. and S. Villeneuve [3]. In all of these papers, it is assumed that firms are all equity financed. Should it run out of liquidity, the firm either liquidates or, if the issuance costs are not severe, raises new funds in order to continue operations by issuing equity.

Our ongoing research program aims to answer the following question, what is the optimal liquidity management policy when the firm profitability is uncertain? In [6], we develop a dynamic model of corporate cash management in which cash constrained shareholders learn about the firm's long-term profitability by observing earnings. Shareholders weight the costs and benefit of holding cash and cope both a profitability concern (the risk to run a non-profitable project) and a liquidity concern (the risk to be forced to liquidate a profitable project). At each date, they decide whether or not to continue the project, and their insurance and dividend policies. These questions are of primary importance for young businesses or newly restructured firms by major investments. Typically, these corporations do not precisely know their long-term prospects and learn their project's average profitability as time passes.

In [3], we analyze risk management in the presence of transitory and permanent shocks to determine whether the management of these two sources of risk is substantially different.

One result is that hedging policies using derivatives with respect to transitory and permanent shocks are markedly different. The hedge ratio with respect to transitory shocks is constant while the hedge ratio with respect to permanent shocks is linear in scaled cash holdings. Furthermore, the signs of the optimal hedge ratios can be opposite.

An alternative to risk management using derivatives is to change the firm's assets to achieve a different exposure to transitory or permanent shocks. This is a version of asset substitution. An important difference between asset substitution and hedging with derivatives is that the former does not generate cash flows. Whether risk management generates cash flows or not is not important in models with unconstrained financing, but this is relevant in a model with financing frictions like ours. Managing permanent risk with either derivatives or asset substitution boils down to balancing the effect of risk management on the volatility and persistence of cash flows. Typically, risk management of either type would increase beneficial persistence at the cost of an increased volatility. The difference between derivatives and asset risk management is that the former manipulates short-term cash flow volatility and the latter affects long-term asset-profitability volatility. This implies that the two strategies have different incentives with varying  $c$  for a financially constrained firm. For example, derivative hedging looses some of its potential when a firm is financially weaker, i.e. when the level of cash reserve is low. A firm with little cash, cannot afford to generate cash flow shocks to benefit from persistence, as this would put it at risk of running out of cash quickly. By contrast, a distressed firm would have strong incentives to engage in asset substitution to increase volatility.

In [9], we model a liquidity management problem in a setup where a cash-constrained firm can draw on a credit line as a full commitment lending relationship between a firm and a bank. The lending contract specifies that the firm can draw on a line of credit as long as its outstanding debt, measured as the size of the firm's line

of credit, is below the value of total assets (credit limit). The liability side of the balance sheet of the firm consists in two different types of owners: shareholders and bankers. Should the firm be liquidated, bankers have seniority over shareholders on the total assets. We assume that the secured line of credit continuously charges a variable spread over the risk-free rate  $r$  indexed on the firm's outstanding debt, the higher the size of firm's line of credit, the higher the spread is. With this assumption, the secured line of credit is somehow similar to the performance-sensitive debt, except that the shareholders are here forced to go bankrupt when they are no more able to secure the credit line with their assets. It is interesting to compare our results with those obtained in the case of all equity financing. First, because the use of credit line is costly, it is optimal to wait that the cash reserves are depleted to draw on it. Moreover, there exists a target cash level above which it is optimal to pay out dividends. These two first findings are similar to the case of all equity financing. On the other hand, the marginal value of cash may not be monotonic in our case. Indeed, when the cost of the credit line is high, it becomes optimal for shareholders to terminate the lending relationship. This embedded option value makes the shareholder value locally convex in the neighborhood of the liquidation threshold. The higher is the cost, the sooner is the strategic default because the embedded exit option increases, with the cost of the credit line. The strategic default comes from the fact that the instantaneous firm's profitability becomes negative for low value of equity capital. This is a key feature of our model that does not appear when the firm is all-equity, where the firm profitability is constant and the marginal value of cash at zero is the only statistic either to trigger the equity issuance or to liquidate.

The liquidity management models we have discussed above rely on exogenous financial frictions (costly refinancing and bankruptcy costs). A crucial extension is to focus on endogenous frictions arising from agency problems between management and shareholders. As a consequence, we have studied the long-term optimal contract between shareholders and the manager in Biais, Mariotti, Rochet and Villeneuve [1]. One of the major result is that the optimal contract uses cash-reserve as one of its instruments establishing a nice connection with the liquidity management models. In Decamps and Villeneuve [5], we have analyzed the optimal investment timing for a firm facing a moral hazard problem. We have fully characterized the optimal contract and measured the cost of moral hazard. Indeed, profitable investments must be abandoned after a bad output because the agent is too poor to be punished effectively.

Finally, in [10], we discuss the systemic relevance of the insurance sector. Systemic risk is defined as the propensity of a financial institution to be undercapitalized when the financial system as a whole is undercapitalized. By the law of large numbers, traditional lines of insurance with idiosyncratic non-catastrophic risks cannot be systemic. On the contrary, undiversified insurers specialized in activities whose insured risks are highly correlated with GDP are systemic. In the life insurance sector, some contractual clauses such as unhedged minimum guarantees and free options to surrender raise the chance of systemic relevance. On the contrary, life insurers satisfying the classic solvency capital requirements contribute to the liquidity of financial markets thanks to the long-termist approach of their portfolio management. Finally, using historical data in the U.S. on the contribution of different sectors to the aggregate volatility of the economy, we show that investment banking is almost twice as volatile as aggregate GDP, while insurance is one fifth as volatile as aggregate GDP. The insurance sector thus appears to be a stabilizing force of the economy.

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### c) Longevity risk, long term care and (social) insurance

Social insurance has long been at the core of public concerns, in France and elsewhere. This has been reinforced lately by the increasing importance of the longevity risk, including its long-term care (LTC) dimension. We study the various aspects of this topic by using tools from the risk theory, microeconomics analysis, macroeconomic dynamics, optimal taxation, political economy, public economics and/or insurance theory. In this research, we have considered four main questions: the optimal design of a LTC social insurance given the market and the family, the reimbursement rule: coinsurance or at benefit, the political support of LTC social programs, and finally the role of social norm and family altruism to explain informal care.

In [10], we analyze which features an optimal LTC insurance policy should incorporate. Following Arrow (1963) we suggest that such policy should consist of complete insurance above a deductible amount. In [6], we consider an economy where individuals differ in productivity and in risk. We examine the role of uniform and non-uniform social insurance to supplement a general income tax when neither public nor private insurers can observe individual risk and when it is positively correlated with wages. Consequently, an equilibrium à la Rothschild and Stiglitz (1971) emerges in the private insurance market and low-wage/low-risk individuals are not fully insured. It shows that even when social insurance provided to the poor has a negative incentive effect, it also increases their otherwise insufficient insurance coverage. Social insurance to the rich produces exactly the opposite effects. Whichever of these effects dominates, some social insurance is always desirable. Finally, we introduce risk misperception which exacerbates the failure of private markets. The insurance term now reflects the combined failure brought about by adverse selection and misperception. Now the low-risk individuals are not only underinsured, but also pay a higher than fair rate. However, and rather surprisingly, it turns out that this does not necessarily strengthen the case for public insurance. In [4], we study the design of a social LTC insurance when altruism is two-sided. The laissez-faire solution is not efficient, unless there is perfect altruism. Under full information, the first-best can be decentralized by a linear subsidy on informal aid, a linear tax on bequests when the parent is dependent and state specific lump-sum transfers which provide insurance. We also study a second-best scheme comprising a LTC benefit, a payroll tax on children's earnings and an inheritance tax. This scheme redistributes resources across individuals and between the states of nature. The tax on children's labor enhances informal care to compensate for the children's possible less than full altruism. In [2], we study the design of LTC insurance contracts in the

presence of ex post moral hazard. While this problem bears some similarity with the study of health insurance, the significance of informal LTC affects the problem in several crucial ways. First, there is the potential crowding out of informal care by market care financed through insurance coverage. Second, this adds a third player to the process, namely the informal caregiver. Third, the information structure becomes more intricate. Informal care is not likely to be publicly observable and one can expect the caregivers to have better information on the true needs of their relatives than the insurer. We determine the optimal second-best contract and show that the optimal reimbursement rate can be written as an A-B-C expression à la Diamond (1998). Interestingly, informal care directly affects only the first term. More precisely the first term decreases with the presence and significance of informal care. Roughly speaking this means that the efficient LTC insurance contract should offer lower (marginal) reimbursement rates than its counterpart in a health insurance context. Finally, one of the pervasive problems with means-tested public long term care (LTC) programs is their inability to prevent individuals who could afford private long term services from taking advantage of public care. They often manage to elude the means-test net through strategic impoverishment. In [3], we show how this problem comes about, how it affects welfare and how it can be mitigated.

The main puzzle in the political economy of long term care (LTC) is the lack of political support for a generous LTC social insurance program, especially compared to other programs benefiting older people, such as pensions. We address this issue in two contributions. In [8] and [9], we concentrate on the fact that the family is a major source of help for dependent individuals. In [9], we study the political determination of the level of social LTC insurance when voters can top up with private insurance, saving and family help. Agents differ in income, probability of becoming dependent and of receiving family help, and amount of family help received. Social insurance redistributes across income and risk levels, while private insurance is actuarially fair. We obtain that family support crowds out the demand for both social and, especially, private insurance, while the availability of private insurance decreases the demand for social insurance but need not decrease its majority chosen level. In [8], we model the more general case where the family can provide help in time and/or in money, and where dependent parents have an intrinsic preference for help in time by family members. We first show that low (resp., high) income children provide help in time (resp. in money), whose amount is decreasing (resp. increasing) with the child's income. The middle-income class may give no family help at all, and its elderly members would be the main beneficiaries of the introduction of social LTC transfers. We then provide several reasons for the stylized fact that there are little social LTC transfers in most countries. First, social transfers are dominated by help in time by the family when the intrinsic preference of dependent parents for the latter is large enough. Second, when the probability of becoming dependent is lower than one third, the children of autonomous parents are numerous enough to oppose democratically the introduction of social LTC transfers. Third, even when none of the first two conditions is satisfied, the majority voting equilibrium may entail no social transfers, especially if the probability of becoming dependent when old is not far above one third. This equilibrium may be local (meaning that it would be defeated by the introduction of a sufficiently large social program). This local majority equilibrium may be empirically relevant whenever new programs have to be introduced at a low scale before being eventually ramped up.

The rising level of LTC expenditures and their financing sources are likely to impact savings and capital accumulation and henceforth the pattern of growth. In [1], we study how the joint interaction of the family, the market and the State influences capital accumulation in a society in which the assistance the children give to dependent parents is triggered by a family norm. Our analysis focus not only on the steady state but also on the dynamics of the equilibrium. Our approach is both positive and normative. Through a scheme of social insurance and subsidies the government can induce the economy to get closer to an optimal path. For instance, if family help is size-ably more productive than other LTC financing sources, pay-as-you-go social insurance might be a complement to private insurance and foster capital accumulation. Based on the demonstration-effect approach used in [1], we also study the strength of family norms in [11].

Lastly, we revisit the Becker's rotten kid theorem which has by now become one of the cornerstones of family economics. In [7], we study the determination of informal LTC (family aid) to dependent elderly in a worst-case scenario concerning the harmony of family relations. Children are purely selfish, and neither side can

make credible commitments (which rules out efficient bargaining). We show that when family aid (and long-term care services in general) are introduced the outcome is likely to be inefficient. Still, the rotten kid mechanism is at work and ensures that a positive level of aid is provided as long as the bequest motive is operative. We identify the inefficiencies by comparing the laissez-faire (sub-game perfect) equilibrium to the first-best allocation. We initially assume that families are identical ex ante. However, the case where dynasties differ in wealth is also considered. We study how the provision of LTC can be improved by public policies under various informational assumptions. Interestingly, crowding out of private aid by public LTC is not a problem in this setting. With an operative bequest motive, public LTC will have no impact on private aid. More amazingly still, when the bequest motive is (initially) not operative, public insurance may even enhance the provision of informal aid. In [5], we show that the rotten kids mechanism combined with a contribution game to a household public good may lead to an astonishing equalization of consumptions between the spouses and their parents, even when their parents' wealth levels differ. We consider two families, each consisting of a parent and an adult child, who are linked by the young spouses. Children contribute part of their time to a household (couple) public good and provide attention to their respective parents in exchange for a bequest. Spouses behave towards their respective parents like Becker's rotten kids; they are purely selfish and anticipate that their altruistic parents will leave them a bequest. The most striking results obtain when wages are equal and when parents' initial wealth levels are not too different. For very large wealth differences the mechanism must be supplemented by a (mandatory) transfer that brings them back into the relevant range. When wages differ, but are similar the outcome will be near efficient (and near egalitarian).

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#### d) *Nonexclusivity in Insurance and Financial Markets*

Standard theoretical models of insurance provision under adverse selection are derived from the Rothschild and Stiglitz (1976) model, with a focus on exclusive insurance markets: each informed consumer can get insurance from at most one insurer. Yet multiple contracting, whereby individual consumers purchase several policies from different insurers to cover the same risk, is a widespread phenomenon in insurance markets. A case in point is the US life-insurance market, in which around 25 percent of consumers hold more than one term policy. A similar phenomenon arises in annuity markets: as an example, the six million annuities in payment in the UK in 2013 were owned by about five million individuals. Most health-insurance markets also exhibit multiple contracting, in forms that depend on the relative importance of the public and private insurance sectors. Finally, financial markets in general typically feature simultaneous trading with several counterparties. The objective of this research program is to study the impact of multiple contracting on markets where trade is impeded by adverse selection. Our approach to this problem has been so far mostly of a theoretical nature, though we are actively searching for data to test some of our results. In 2016 we completed two papers that complement and significantly extend our published work on the subject (Attar, Mariotti, and Salanié (2011, 2014)).

In Attar, Mariotti, and Salanié (2016a) we focus on a specific form of financial markets, namely, a discriminatory limit-order book in which uninformed market makers compete in nonexclusive nonlinear tariffs to serve an informed insider. Our model differs from the literature by allowing for general nonparametric specifications of preferences and for arbitrary discrete distributions for the insider's private information. We show that adverse selection severely restricts possible equilibrium outcomes: in any pure-strategy equilibrium, tariffs must be linear and at most one type may trade, leading to an extreme form of market breakdown. As a result, such equilibria only exist under exceptional circumstances. The Bertrand-like logic underlying these results markedly differs from Cournot-like analyses of the limit-order book that postulate a continuum of types (Biais, Martimort, and Rochet (2000, 2013), Back and Baruch (2013)). We argue that these contrasting outcomes can be reconciled when one considers approximate equilibria of either the game with a large number of market makers or the game with a large number of insider types. Mixed-strategy equilibria, of which we offer a simple example, lead by contrast to a new class of equilibrium predictions that calls for further analysis.

In Attar, Mariotti, and Salanié (2016b) we study insurance markets in which privately informed consumers can purchase coverage from several insurers. We show that, under adverse selection, multiple contracting severely restricts the set of feasible trades. Indeed, it turns out that only one budget-balanced allocation is implementable by an entry-proof tariff. That is, a social planner is unable to redistribute between different types of consumer if he faces the threat of subsequent entry by private insurers, unlike in the second-best case studies by Prescott and Townsend (1984) and Crocker and Snow (1985). This allocation has a simple and natural structure: each layer of coverage must be fairly priced given the consumer types who purchase it. For instance, if there are two classes of consumers, with respectively low and high risks of incurring a loss, both types purchase basic insurance at an average rate, while high-risk consumer purchase in addition a complementary insurance policy at a high rate. While this allocation cannot be implemented in a fully nonexclusive scenario where there are no restrictions on the type of contractual instruments available to firms, we show that it is the unique equilibrium outcome of a game in which cross-subsidies between contracts are prohibited. Strikingly, and in sharp contrast with the literature, equilibrium contracts exhibit quantity discounts and negative correlation between risk and coverage. We argue that public intervention

should target insurers' strategic behavior, while consumers can be left free to choose their preferred amount of coverage.

We finally have started to investigate the empirical relevance of our theoretical results. The theory of insurance with asymmetric information and exclusive contracts predicts that riskier individuals purchase a larger quantity of insurance than less risky individuals (Chiappori and Salanié (2000, 2003)). Indeed, our findings in Attar, Mariotti, and Salanié (2016b) highlight that, in markets with nonexclusive contracts, riskier individuals purchase a larger aggregate quantity of insurance than less risky individuals. However, to do so, they have to split their trades between different insurers; in particular, complementary policies must offer less coverage than basic policies in equilibrium, leading to a negative correlation between risk and coverage at the firm level. This is the first fundamental difference between exclusive and nonexclusive markets that we want to test using data from individual insurance companies. In the case of life insurance, we would need to have data on the ex-post performance of the policy (that is, the mortality of the policyholder), as well as the policy characteristics, such as the policy amount and the determinants of its pricing at origination (that is, demographic characteristics). The second and related prediction we would like to test is that the unit price of the policies offered by each single insurer is larger for smaller policies. This is a necessary consequence of the aforementioned fact that, within a single insurer's pool of clients, riskier individuals purchase a smaller quantity of insurance than less risky individuals. In the case of life insurance, this amounts to studying the price-quantity schedule that policyholders face for any given insurer, thus conditional on demographic characteristics. Finally, the third theoretical prediction that we would like to test is that individuals purchasing multiple policies are riskier than individuals purchasing fewer policies. Overall, the key feature of our empirical strategy is that data provided by a single company (who can only monitor the consumers' trades with it), and data provided by a consumer survey or an insurance/credit registry (which should provide a more-complete picture of each consumer's trades) contain differential information, a distinction that is of course irrelevant when insurance contracts are exclusive.

Motivated by this empirical strategy, we have performed a preliminary empirical analysis of the life-insurance market using the US Health and Retirement Survey (HRS), since this survey has been widely used to study the role of asymmetric information in insurance markets (see, for example, Cawley and Philipson (1999)). These data reveal that multiple-insurance holdings are a pervasive feature of the US life insurance market: more than 25% of insurees have multiple policies. Interestingly, they also indicate that individuals with multiple policies have a greater aggregate amount of coverage, which is consistent with the theoretical framework outlined above. However, we believe that the HRS data are not well-suited for a thorough empirical analysis, as they do not report the terms of individual policies, such as the amount of coverage and the premia paid. Data of higher quality are therefore required to conduct the empirical program outlined above

## IDEI Team

Andrea Attar, chargé de recherché CNRS  
Thomas Mariotti, directeur de recherche CNRS  
François Salanié, directeur de recherche INRA

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#### e) **Econometrics of risk, volatility and predictability of asset returns**

The paper [1] is a substantial revision of the former paper "Moment-based tests for discrete distributions". In this paper, we deal with the parameter uncertainty. When one tests moment assumptions (no correlation, kurtosis, number of Hit violations in a VaR model), one has to take into account that it is implemented on estimated quantities rather than observed ones. Ignoring it would lead to invalid procedures that might conclude wrongly. Assume for example that we are interested in a linear forecasting model for  $Y(t)$  at the next period, based on explanatory variables  $X(t)$ . The model does a good job if there is no longer any autocorrelation within the error terms of the regression of  $Y(t)$  on  $X(t)$ . This can be tested by testing that the first auto-covariance is equal to zero. Unfortunately, we do not observe the true error terms and our testing procedure is based on the residuals, i.e. quantities derived from an estimation step.

Here we propose a simple linear correction that takes into account this parameter uncertainty problem. Interestingly, our resulting testing procedure is valid whether we observe the real data or we estimate it. We also apply this methodology to the back-testing of Value-at-Risk models. Monte Carlo simulations provided in the paper suggest that our tests, which have good small sample properties, also perform better than the existing procedures. The paper has been revised and resubmitted in November 2016 to the *Review of Economics and Statistics*.

We are still working on the paper [2], where we are interested in deriving optimal moments under parameter uncertainty when one tests distributional assumptions for risk management purposes. The analysis is almost done in the i.i.d. case. However, the time series context is more difficult handle because the characterization of the optimal moment test is difficult in general. We are now focusing on diffusions and Markov processes.

We also started a work on testing copula models. A student from the second year of the Master wrote his thesis on the topic under our supervision [3]. The student is accepted in TSE's Ph.D. program but had to back to his country for a year. We are working together on writing a research paper.

The main contribution of the paper [4] is to propose a bootstrap method for inference on integrated volatility based on the pre-averaging approach, where the pre-averaging is done over all possible overlapping blocks of consecutive observations. The overlapping nature of the pre-averaged returns implies that the leading martingale part in the pre-averaged returns are  $k(n)$ -dependent with  $k(n)$  growing slowly with the sample size  $n$ . This motivates the application of a blockwise bootstrap method. We show that the "blocks of blocks" bootstrap method is not valid when volatility is time-varying. The failure of the blocks of blocks bootstrap is due to the heterogeneity of the squared pre-averaged returns when volatility is stochastic. To preserve both the dependence and the heterogeneity of squared pre-averaged returns, we propose a novel procedure that combines the wild bootstrap with the blocks of blocks bootstrap. We provide a proof of the first order asymptotic validity of this method for percentile and percentile-t intervals. Our Monte Carlo simulations show that the wild blocks of blocks bootstrap improve the finite sample properties of the existing first order asymptotic theory. We use empirical work to illustrate its use in practice. The paper has been accepted for publication by *Econometric Theory*.

The main contribution of the paper [5] is to propose a bootstrap test for jumps based on functions of realized volatility and bipower variations. Bootstrap intraday returns are randomly generated from a mean zero Gaussian distribution with a variance given by a local measure of integrated volatility. We first discuss a set of high level conditions on the estimators of the local volatilities such that any bootstrap test of this form has the correct asymptotic size and is alternative-consistent. Our results show that the choice of these local estimators is crucial for the power of the test. In particular, we should choose these estimators in a way that is robust to jumps. We then focus on a thresholding-based estimator for these local volatilities and provide a set of primitive conditions under which our bootstrap test is asymptotically valid. We also discuss the ability of the bootstrap to provide second-order asymptotic refinements under the null of no jumps. The cumulants expansions that we develop show that our proposed bootstrap test is unable to mimic the first-order cumulant of the test statistic. The main reason is that it does not replicate the bias of the bipower variation as a measure of integrated volatility. We propose a modification of the original bootstrap test which contains an appropriate bias correction term and for which second-order asymptotic refinements obtain. The paper has been revised and resubmitted to the *Journal of the American Statistical Association*.

## IDEI TEAM

Christian Bontemps, Professor at ENAC and Toulouse School of Economics.

Nour Meddahi, Professor of Economics, Toulouse School of Economics.

## Bibliography

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### 3. SUMMARY OF THE ACTIVITIES OF 2016 FUNDED BY THE CHAIR

#### a) Steering committee

At regular intervals and at least once a year, IDEI projects leaders meet with representatives of SCOR during a steering committee. The latest steering committee was held on March 9th 2016 in the presence of Philippe Trainar, Michal Zajac chief risk officer and economist at SCOR and Hervé Ossard, Sébastien Pouget and Stéphane Villeneuve as representatives of IDEI.

The committee is an opportunity for IDEI researchers to present their research results and enables the SCOR representatives to express their needs in terms of research. It also determines the orientation of applied research to meet the needs expressed by the SCOR management. Monitoring is done in two ways: the delivery of research papers and the development of internal seminars. Hence, SCOR teams are in constant contact with the IDEI researcher.

The SCOR representatives have recommended through the steering committee that the research chair focuses on the 5 main topics that have been presented above with a emphasis to extreme risks sharing, quantification of extreme risks and dependency problems.

#### b) Meetings and Conferences organized by the chair:

- Optimization of the flow of dividends: 20 years after, Palais Brongniart, Paris, May 26-27 2016.

The workshop has celebrated the 20<sup>th</sup> anniversary of the publication of the Monique Jeanblanc and Albert Shiryaev influential paper "Optimization of the flow of dividends" and brought together researchers who use stochastic control modeling in banking, corporate finance, contract theory, insurance.

- The Economics of long-term care, Paris, SCOR, June 10th, 2016.

#### c) Conferences scheduled by the chair 2017:

- Financial Econometrics Conference, May 12 & 13, 2017, Toulouse.

#### d) Presentation in connection with the Chair:

We list below some talks that have been made last year in connection with the research initiative:

- Gollier: Conférence AXA/ACPR "The Future of Savings' Conference Business models and regulatory changes in the new environment". Présentation de "A view from Europe".
- Gollier: Conference of the European Group of Risk and Insurance Economists, Limassol. Présentation de "Aversion to risk of regret and preference for positively skewed risks".
- Gollier: Keynote lecture at the annual conference of the Canadian Economic Association. Présentation of « Evaluation des actions de développement durable dans un monde profondément incertain ».
- Gollier: Annual conference of the Risk Theory Society, New York. Présentation de "Aversion to risk of regret and preference for positively skewed risks".

- Gollier: PER distinguished lecture, Columbia University. “Do we do enough for the future?”.
- Gollier: Conference at the University of Pennsylvania. presentation of “Political, Economic and Social Considerations for Universal Carbon Pricing”.
- Treich: Keynote speaker at TRIA, Taiwan of “Catastrophe Aversion”.
- Décamps: Integrating profitability prospect and cash management, European Finance Association Meeting, Oslo, 18-20 Août 2016
- Decamps: Integrating profitability prospect and cash management, Cambridge Corporate Finance Theory Symposium, 16-17 Septembre 2016
- Villeneuve: Keynote Speaker at Robust Finance and beyond: Closing Conference, Bielefeld.
- Meddahi, “Optimal Moment-based Tests for Distributional Assumptions,” Montreal conference in econometrics, May 2016.

#### **e) Prize and award:**

- Scor Won the « Risk Innovation of the year » category at the Insurance ERM award on december, 20th 2016. This prize recognizes the SCOR’s organization in june 2015, of the SCOR Foundation Seminar on Climate Risks in collaboration with the Toulouse School of Economics (TSE) and with the Geneva Association (GA).
- Nicolas Treich is co-editor with Mike Hoy of the Geneva Risk and Insurance Review.

#### **f) 2016 Scor Prize:**

- SCOR/EGRIE Young Economist Best Paper Award attributed to Maria Efthymiou and Andreas Milidonis for Does limited attention affect institutional trading?
- SCOR/GRIR Best Paper Award attributed to Vickie Bajtelsmit and Paul Thistle for “Liability, Insurance and the incentive to obtain information about risk” GRIR, 40, 171-193.

#### **g) PhD Student and Internship**

In September 2016, Vincent Téna from the University Toulouse 1 Capitole started a Ph-D thesis under the supervision of Stéphane Villeneuve on Incentives, Dynamic contracting and Limited liability.

## APPENDICES

- Program of Optimization of the flow of dividends 'conference: 20 years after, Palais Brongniart, Paris, May 26-27 2016.
- Program of the Economics of long-term care conference, Paris, SCOR, June 10th, 2016.

# Program

## Optimization of the flow of dividends : 20 years later

**Paris, May 26-27, 2016**

Conference sponsored by SCOR, IDEI, ILB & TSE

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### Conference venue

Petit auditorium, Palais Brongniart  
28 place de la Bourse  
75002 Paris, France

<https://www.tse-fr.eu/fr/conferences/2016-optimization-flow-dividends-20-years-later>

### Conference Secretariat

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# Optimization of the flow of dividends : 20 years later

26th and 27th May, 2016

Palais Brongniart, Paris

**Thursday, May 26**

**8:30 - 9:00**     *Registration – Welcome coffee*

**9:00 - 12:30**     SESSION 1

- **9:00 - 09:45 “Monique and Albert make Mathematicians and Economists happy !”**  
Jean-Paul DECAMPS (*Toulouse School of Economics*)
- **09:45 - 10:30 “Bank capital, liquid reserves, and insolvency risk”**  
Julien HUGONNIER (*Ecole Polytechnique Fédérale de Lausanne*)

**10:30 - 11:00**     *Coffee Break*

- **11:00 - 11:45 “Delegated investment in a dynamic agency model”**  
Sebastian PFEIL (*University of Bonn*)
- **11:45 - 12:30 “Growth options, incentives, and pay-for-performance: theory and evidence”**  
Sebastian GRYGLEWICZ (*Erasmus School of Economics, Rotterdam*)

**12:30 - 14:00**     *Lunch*

**14:00 – 15:30**     SESSION 2

- **14:00 – 14:45 “Mean field games with singular controls, and applications”**  
Xin GUO (*UC Berkeley*)
- **14:45 - 15:30 “Control of stochastic McKean-Vlasov equation and financial applications”**  
Huyên PHAM (*Université Paris 7 Diderot*)

**15:30 - 16:00**     *Coffee Break*

- **16:00 – 16:45 “Jeanblanc and Shiryaev in general equilibrium : Insurance”**  
Jean-Charles ROCHET (*TSE & Université de Zürich*)

**20:00**     *Conference dinner*



Conference: Petit Auditorium

# Optimization of the flow of dividends : 20 years later

26<sup>th</sup> and 27<sup>th</sup> May, 2016

Palais Brongniart, Paris

**Friday, May 27**

**9:00 - 12:30**      SESSION 3

- **9:00 - 09:45 “Renegotiation-proof financial contracting”**  
Mihail ZERVOS (*London School of Economics*)
- **09:45 - 10:30 “Optimal dividend policies for jump-diffusion processes under transaction costs”**  
Jostein PAULSEN (*University of Copenhagen*)

**10:30 - 11:00**      *Coffee Break*

- **11:00 – 11:45 “Aggregate bank capital and credit dynamics”**  
Nataliya KLIMENKO (*University of Zürich*)
- **11:45 – 12:30 “Expected supremum and singular stochastic control”**  
Luis H.R. ALVAREZ (*University of Turku, Finland*)

**12:30 - 14:00**      *Lunch*

**14:00 – 15:30**      SESSION 4

- **14:00 - 14:45 “A Jeanblanc-Shiryaev model under partial information”**  
Stéphane VILLENEUVE (*Toulouse School of Economics*)





## Workshop on Long Term Care

Paris, SCOR, June 10, 2016

SCOR

5 Avenue Kléber

75016 Paris

Room La Pérouse GOP1

- 9h30 – 10h. *Coffee & Tea Break.*
- 10h – 10h45. **Christophe Courbage**, Haute Ecole de Gestion de Genève, “Means-Tested Public Support and the Interaction between Long-Term Care Insurance and Informal Care” (with Jean-Marc Bascans and Cornel Oros).
- 10h45 – 11h30. **Matthias Kredler**, University of Carlos III Madrid, “Evaluating Long-Term Care Policy Options, Taking the Family Seriously” (with Daniel Barczyk).
- 11h30 – 12h. *Coffee & Tea Break.*
- 12h – 12h45. **Helmuth Cremer**, Toulouse School of Economics, “Social Insurance with Competitive Insurance Markets and Risk Misperception” (with Kerstin Roeder).
- 12h45 – 14h30. *Lunch at the “Brasserie SCOR”.*
- 14h30 – 15h15. **Jean-Marie Lozachmeur**, Toulouse School of Economics, “The Design of Long Term Care Insurance Contracts” (with Helmuth Cremer and Pierre Pestieau).
- 15h15 – 16h00. **Pierre Pestieau**, CORE, TSE and University of Liege, “Long-Term Care Social Insurance. How to Avoid Big Losses?” (with Justina Klimaviciute).
- 16h00 – 16h30. *Coffee & Tea Break.*
- 16h30 – 17h15. **Marianne Tenand**, Paris School of Economics, “TAXIPP-LIFE : A New Dynamic Microsimulation Model to Evaluate Elderly Care Policies” (with Mahdi Ben Jelloul and Antoine Bozio).
- 17h15 – 17h30. **Concluding Remarks.**

*Organizers : Pierre Pestieau and Emmanuel Thibault.*