



Sustainable
Finance
Center

Toulouse
School of
Economics

Insurance Economics

SCOR chair -- Activity report 2019

SCOR
The Art & Science of Risk

Fondation
pour la science



Economics for the common good

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SCIENTIFIC TEAM

Head of the Chair: Jean Charles Rochet

Co-Head of the Chair: Andrea Attar and Thomas Mariotti

1. OBJECTIVE

The objectives of the SCOR-TSE Chair are to develop academic research in Insurance Economics that can be relevant for SCOR and more generally for the insurance and reinsurance industries.

The following pages provide an overview of the research projects finalized by TSE researchers in the context of the SCOR-TSE chair during 2019. As discussed in greater detail below, most of the projects investigate the aggregate implications of competition in financial and insurance markets. We look forward to develop closer relationships with SCOR researchers and to enlarge the scope of our complementarities. In this perspective, we planned to organize a conference on Insurance Economics, involving world class academics and practitioners, in the style of the conferences periodically organized by Swiss Re in Zurich.

2. RESEARCH PROJECTS CARRIED OUT IN 2019

a. The Dynamics of Insurance Capacity

Insurance capacity is an important concept for insurance practitioners but it has surprisingly received little attention by academic researchers. It is usually defined as the largest amount of insurance or reinsurance available from a company or the market in general. The objective of the first project is to clarify what are the main determinants of insurance capacity and its implications for the comprehension of underwriting cycles.

TSE Researcher: Jean Charles Rochet.

A first step of this research project is contained in a manuscript published in 2019:

1. Reppen, M. Rochet, J.C. and H. Mete Soner (2019): “Optimal dividend policies with random profitability”, *Mathematical Finance* 29(5), 1110–1130.

This paper studies the optimal dividend problem under a solvency constraint. Firms face a trade-off between potential bankruptcy and extraction of profits. In contrast to previous works, general cash flow drifts, including Ornstein–Uhlenbeck and CIR processes, are considered. We provide rigorous proofs of continuity of the value function, whence dynamic programming, as well as comparison between the sub- and super-solutions of the Hamilton–Jacobi–Bellman equation, and we provide an efficient and convergent numerical scheme for finding the solution. The value function is given by a nonlinear PDE with a gradient constraint from below in one dimension. We find that the optimal strategy is both a barrier and a band strategy and that it includes voluntary liquidation in parts of the state space. Finally, we present and numerically study extensions of the model, including equity issuance and gambling for resurrection.

Further research on this topic:

In collaboration with Elisa Luciano, from the University of Torino, Jean Charles has started, at the beginning of 2019, to investigate the determinants of the capacity of an insurance or reinsurance company and its variations over time. They build a simple Markovian model of an insurance market with financial frictions in which capacity is endogenously determined as a function of the total capitalisation of the insurance industry and of the concentration of the insurance market. They study the dynamics of this capacity, the corresponding market price of risk and their stationary distribution. The model is able to explain empirical behaviour of insurance supply and risk aversion of insurance companies.

b. Adverse Selection in Nonexclusive Markets

This research line deals with financial markets subject to hidden information. A seller may have superior information about the value of the assets she offers, or a policy-holder may be better informed than outsiders about personal characteristics that determine her level of risk. Early contributions have shown the dramatic effects that such informational asymmetries may have on the functioning of financial markets. Standard models of strategic competition under asymmetric information (à la Rothschild and Stiglitz, 1976) rely on the assumption that exclusive contracts can be enforced at no cost: each informed party can only contract with at most one agent. The assumption of exclusive trades is natural and realistic for some insurance markets. Exclusivity of contractual agreements is however a strong assumption, and while it is useful as a benchmark, there are relevant economic contexts in which the costs of enforcing exclusive contracts are extremely high. Our research analyses non-exclusive competition in financial markets subject to asymmetric information.

TSE Team: Andrea Attar (CNRS), Thomas Mariotti (CNRS), Francois Salanie (INRA)

This project has been developed in four manuscripts in 2019. Two of them have been published (or accepted for publication) in international journals, one of them has been invited to be resubmitted, and the last one has been submitted (more details below).

1. **Attar, A., T. Mariotti and F. Salanie' (2019): "On Competitive Nonlinear Pricing", *Theoretical Economics*, 14(1): 297-343.**

The paper analyzes the formation of prices on markets which rely on a discriminatory limit-order book to balance supply and demand. We address this question by setting up a general model of trade under adverse selection, in which a privately informed insider trades with several market makers. We derive striking results. First, any pure-strategy equilibrium with weakly convex tariffs requires linear tariffs. Second, such linear equilibria essentially exist only in the special Bertrand case, that is, when there is no adverse selection and market makers have a constant unit cost of serving demand. In all other cases, pure-strategy linear equilibria do not exist, apart from exceptional cases where only one type of insider trades in equilibrium. The analysis can be interpreted in the light of Glosten (1994), who proposed a candidate nonlinear tariff, meant to describe the limit-order book as a whole, and that can be interpreted as a marginal version of Akerlof (1970) pricing. Namely, this tariff specifies that an additional share beyond any quantity Q can be bought at a price equal to the expected value of the asset, conditional on the event that the insider buys at least Q shares. By construction, this tariff is convex, and yields zero expected profit to the market makers. Glosten (1994) additionally shows that this tariff is the only one which survives entry by an uninformed market maker. A natural question is whether this tariff can be sustained in an equilibrium of a competitive game with strategic market makers. Our results provide a negative answer to this question, as long as attention is restricted to competitive screening models.

2. **Attar, A., T. Mariotti and F. Salanie' (2019): "The Social Costs of Side Trading", TSE Working Paper 2019, *forthcoming in The Economic Journal*.**

In this paper we lay down the foundations for a normative analysis of nonexclusive competition under adverse selection. We study a general environment in which firms can provide a divisible good to privately informed consumers who may be of two types. Consumers' preferences satisfy a single-crossing condition, and there is adverse selection in that consumers who are more willing to trade are also more costly to serve.

In this setting, we fully characterize the allocations that can be achieved by a planner who observes neither consumers' types nor the trades they may conduct with firms. To do so, we strengthen the notion of incentive-feasibility by focusing on allocations that are robust to side trading. This reflects two additional constraints on the allocation problem. First, the planner cannot force consumers to trade with him; this is the case, for instance, when consumers can opt out of a publicly provided health-insurance plan, as in the current German system. Second, he cannot prevent them from engaging in mutually advantageous additional trades with a firm. We formalize these constraints by requiring the planner to offer a tariff such that no firm, acting as an entrant, can guarantee itself a positive profit by offering complementary side trades. This approach provides a modified criterion of incentive feasibility which is useful for evaluating the social costs of side trading.

We show that the social costs of side trading are twofold. On the one hand, second-best allocations are typically not robust to side trading, so that the planner's inability to monitor consumers' trades has significant welfare implications. On the other hand, only one budget-feasible allocation is robust to side trading, so that the third-best efficiency frontier reduces to a point: the threat of side trading effectively deprives the planner from any capacity to redistribute resources between different types of consumers. The allocation we characterize is thus the natural candidate for a competitive equilibrium, but, being the only feasible one under side trading, little, if anything, can be argued about its desirability.

3. Attar, A., T. Mariotti and F. Salanie' (2019): "Entry-Proofness and Market Breakdown under Adverse Selection", TSE Working Paper 2019, revisions requested by *the American Economic Review*.

In this paper we propose a unified theoretical perspective to analyze competitive markets under adverse selection, taking as a starting point the minimal requirement that any perfectly competitive market should be immune to entry. We consider a general adverse-selection environment in which little structure is put on the buyers' preferences, except a single-crossing condition on the informed agents (buyers) preferences. In this context, we argue that entry-proofness provides a tractable and detail-free alternative to both the Walrasian and the strategic approaches adopted in the literature. Our results are derived in two theorems, which apply to the cases of inactive and active markets, respectively. These results are fundamentally linked: the very conceptual tools that are relevant for the case of inactive markets can be used to characterize entry-proofness for the case of active markets. Theorem 1, which states a necessary and sufficient condition for entry to be unprofitable in inactive markets, provides a generalized version of the market unravelling condition first formulated by Akerlof (1970) and recently extended by Hendren (2013) to the case of a Rothschild and Stiglitz (1976) insurance economy. That is, the willingness to pay of each buyer type at the no-trade point should not exceed the corresponding upper-tail expectation of costs. We next consider active markets, and characterize the set of offered contracts that prevent subsequent profitable entry by a seller. We focus on nonexclusive environments: buyers cannot be prevented from complementing the offered contracts with those proposed by the entrant. Thus, a set of contracts, or a market tariff, is entry-proof if it prevents any profitable entry by a seller whose menu offer complements the market tariff. We restrict attention to convex tariffs, a restriction in line with the rules of competition in many financial markets in which sellers post limit orders. The focus on convex tariffs allows us to build on the results derived for inactive markets to characterize entry-proof tariffs. From an entrant's view-point, everything happens as if he were facing buyers whose preferences, for any given trade with the entrant, were represented by indirect utility functions incorporating their optimal trades along the tariff. Convexity guarantees that these indirect utility functions inherit the original properties of the buyers' utility functions required for the application of Theorem 1. From the entrant's viewpoint, we are hence back to the case of an inactive market; it hence follows that a (convex) tariff is entry-proof if and only if each buyer type's indirect willingness to pay is at most equal to the corresponding upper-tail expectation of unit costs. Theorem 2 relates this abstract property to a more transparent characterization of the tariff. Specifically, we show that there is a unique budget-feasible allocation implemented by an entry-proof market tariff, and essentially a unique such tariff. Importantly, and in contrast to the exclusive-competition case studied by Rothschild and Stiglitz (1976), existence of this tariff obtains under very general conditions. The resulting tariff is nonlinear and it is competitive in the sense that each marginal quantity is priced at the upper-tail expected cost of serving the buyer types who purchase it. Thus, it involves a marginal version of Akerlof (1970) pricing.

4. Attar, A., T. Mariotti and F. Salanie' (2019): "Regulating Insurance Markets: Multiple Contracting and Adverse Selection", TSE Working Paper 2019, submitted for publication.

In this paper we investigate the regulation of non-exclusive insurance markets under adverse selection. The motivation for our analysis is offered by the relevance of multiple contracting, whereby consumers purchase several policies from different public or private insurers to cover the same risk, in many modern insurance settings. Starting with the pioneering works of Akerlof (1970) and Rothschild and Stiglitz (1976), there has been a presumption that these insurance markets are exposed to adverse selection. As a result, many market interventions aimed at implementing an efficient provision of insurance provision under adverse selection have been proposed in recent decades. However, few, if any, of them explicitly take into account the implications of multiple contracting. The paper contributes to analyzing this issue. From the perspective of a single firm, the fact that its customers can also contract with its competitors makes it harder to screen them according to how much coverage they purchase. This calls for a determination of the combined welfare impact of adverse selection and multiple contracting. The benchmark is provided by the set of allocations that can be achieved by a social planner who observes neither consumers' riskiness nor their trades with private firms. In this paper, we suggest a simple intervention which uniquely implements this Jaynes-Hellwig-Glosten (JHG) allocation in an equilibrium of a large class of insurance economies. The regulation we propose essentially prevents firms from destabilizing the market through dumping practices. We provide two main results. The first one, encapsulated in Theorem 1, shows that the JHG allocation is the only candidate equilibrium allocation of this regulated game. The second result, established in Theorem 2, yields an implementation of the JHG allocation in an equilibrium of the regulated game. To clarify the logic underlying our analysis, we remark the JHG allocation features cross-subsidization across consumers' types, with low- and high-risk consumers being pooled on the same basic-coverage amount. This makes it potentially fragile against cream-skimming deviations. In insurance economies, such deviations allow a firm to gain by exclusively serving low-risk consumers, which suggests that, to sustain an equilibrium, firms should introduce some appropriate threats. Under multiple contracting, such threats take the form of ad-hoc, latent contracts, which are not meant to be traded in equilibrium but only to block cream-skimming deviations. An attractive feature of our regulation is its parsimony in informational terms, as the regulator only needs to observe the aggregate profit that firms earn on each of their traded contracts. This is in line with the recent evolution of financial reporting standards.

c. Longevity risk, long term care and (social) insurance Multiple Investors, Financial Covenants and Market Outcomes

Investors who compete in modern financial markets can trade an increasing number of divisible assets and, at the same time, they hardly control the quantities of those assets that their counterparties trade with others. To the extent that the composition of their portfolio affects their market behaviors, this gives rise to a fundamental externality: an investor's profit is affected by the customers' side trades with his opponents via its impact on their performances. This externality is prominent in several financial markets. Our project aims at analyzing to what extent the above externality can be internalized by letting agents design appropriate financial contracts, that possibly incorporate exclusivity clauses. The issue is particularly relevant in capital markets, in which, although no legal system imposes entrepreneurs to raise funds from a single financier, financial transactions are typically not secret and investors can use the available information to design financial covenants

in an attempt to control firms' financing policy. As a matter of fact, financial covenants are a prominent feature of most corporate debt relationships. The relevant research question can therefore be formulated as follows: does the competitive outcome associated with de-jure exclusivity emerges de-facto in a decentralized market in which competing investors strategically design contracts potentially including exclusivity clauses?

TSE Team: Andrea Attar (CNRS), Catherine Casamatta (UT1), Jean Paul Decamps (UT1)

A first step of our research project consists in providing a deeper interpretation of the strategic supply of funds. We started to analyze this issue in the two manuscripts published in 2019:

1. **Attar, A., C. Casamatta, A. Chassagnon and J.P. Décamps (2019): "Multiple Investors, Strategic Default and Covenants", *American Economic Journal (Micro)* 11(2): 98-130.**

We study capital markets in which investors compete by designing financial contracts to control an entrepreneur's ability to side trade and default on multiple loans. We show that covenants may have anticompetitive effects: in particular, they prevent investors from providing additional funds and reduce the entrepreneur's investment capacity. As a result, a large number of inefficient allocations is supported at equilibrium. We propose a subsidy mechanism similar to guarantee funds in financial markets that efficiently controls the entrepreneur's side trading and sustains the competitive allocation as the unique equilibrium one.

2. **Attar, A., C. Casamatta, A. Chassagnon and J.P. Décamps (2019): "Contracting Sequentially with Multiple Lenders: the Role of Menus", *Journal of Money, Credit, and Banking* 51(4): 977-990.**

We study a credit market in which multiple lenders sequentially attempt at financing a single borrower under moral hazard. We show that restricting lenders to post single offers involves a severe loss of generality: none of the equilibrium outcomes arising in this scenario survives if lenders offer menus of contracts. This result challenges the approach followed in standard models of multiple lending.

d. Competing Mechanisms: Equilibrium Mechanisms and Folk Theorems

In most of the above projects we investigate market settings in which an agent cannot monitor, and a fortiori contract on, the aggregate level of trades chosen by her counterpart. The researchers involved in the SCOR-TSE share the idea that this issue is central in several modern financial markets, ranging from health and life-insurance to OTC ones. With this idea in mind, we also developed a methodological research project, which aims at building the game-theoretic tools allowing to properly address competition in the above settings. The project is devoted to the study of contexts in which a group of players, usually referred to as principals, compete through mechanisms in the presence of several agents who are privately informed about their characteristics. Competition is therefore represented as a game played between several mechanism designers, with none of them retaining full control of the communication structure between principals and agents. In such a context, contracts are de facto incomplete: they cannot prevent an agent from contracting with other principals.

TSE Team: Andrea Attar (CNRS), Thomas Mariotti (CNRS)

A first step of our research project consists in providing a deeper interpretation of the strategic supply of funds. We started to analyze this issue in two manuscripts in 2019. One of them has been published in an international journal, the other one has been invited to be resubmitted (more details below).

1. Attar A., E. Campioni and G. Piaser (2019): Private Communication in Competing Mechanism Games, *Journal of Economic Theory* 183: 258-283.

We study competing mechanism games in which there is complete information over agents' exogenous information. Yet principals simultaneously designing contracts to extract the relevant market information. Typically, letting agents communicate to principals additional information on top of their exogenous types supports additional allocations at equilibrium. This raises the issue of identifying a class of mechanisms inducing agents to reveal all their available information. In a fundamental contribution, Epstein and Peters (1999) introduce a communication device that incorporates the market information generated by the competing mechanisms posted by principals. In their general construction, a mechanism for a principal requires each agent to send messages from a universal type space.

We reconsider the equilibrium role of communication by allowing principals to privately communicate with agents in the spirit of the canonical construction of Myerson. The above-mentioned approaches disregard this possibility by restricting principals' communication to the public mechanisms they commit to. Any such mechanism implements decisions contingent on the private messages the principal receives from agents. Yet, to the extent that he cannot directly contract on his opponents' mechanisms, a principal could gain by sending private signals to agents so to correlate their behaviours with the decisions of all of the principals. We are the first to show that this channel of communication has relevant strategic effects.

We establish our result in the simple framework in which agents only take an (observable) action. Specifically, we construct an example with two principals and three agents and explicitly characterize the set of equilibrium allocations supportable by standard mechanisms. We then show that none of the corresponding equilibria survives when all principals can send private signals to agents. By privately communicating with agents, a principal can make them differently informed of his final decisions. This uncertainty, which cannot be reproduced by standard stochastic mechanisms without signals, crucially affects the continuation game played by agents. This allows to construct a mechanism with private communication yielding a principal a payoff greater than any of those achievable without private communication.

2. Attar A., E. Campioni, T. Mariotti and G. Piaser (2019): "Competing Mechanisms and Folk Theorems: Two Examples", TSE Working Paper 2019, revised and resubmit to *Games and Economic Behaviour*.

In this paper, we focus on equilibrium allocations, rather than on equilibrium mechanisms. Our aim is to provide novel characterization results. Since the seminal work of Epstein and Peters (1999) the literature has emphasized that allowing agents to report their endogenous market information on top of their exogenous private one may dramatically enlarge the set of equilibrium allocations. Following Yamashita (2010), several versions of a folk theorem have been provided: if equilibrium mechanisms are flexible to agents' reports about their market information any incentive-compatible allocation that yields each principal a payoff above a well-specified min-max bound can be supported at equilibrium. These results are established under fairly general conditions on the primitives, which

questions the relevance of the applied literature on competing mechanisms (competing auctions, directed search and competing hierarchies among others).

The paper further elaborates on this issue focusing on situations in which agents' participation decisions are strategic, in line with the intended economic applications. Motivated by these applications, we refer to a framework in which agents' participation decisions are closely tied to their communication ones. That is, an agent can communicate the information he possesses to a given principal only if he chooses to participate with her.

We provide two examples that fundamentally challenge the logic of folk theorems in this context. Our first example exhibits (pure strategy) equilibria of a competing-mechanism game in which some principal obtains a payoff below his min-max payoff, computed over the set of principals' decisions. In the example, the introduction of agents' participation decisions leads to discontinuities and nonconvexities that prevent from applying the standard min-max logic, despite the fact that principals are allowed to randomize over their decisions. The result suggests that, even in complete-information games, to establish a folk theorem one may need to specify bounds that explicitly depend on the available message sets, which in turn limits the predictive power of the approach. Our second example establishes that even this approach is unsatisfactory when agents' participation decisions are strategic. In this example, the min-max payoff for each principal can be straightforwardly computed over arbitrary mechanisms, and it coincides with the corresponding max-min payoff. Yet, the fact that each agent can communicate with at most one principal makes it impossible to construct sophisticated equilibrium threats. As a consequence, although there exist many incentive-feasible allocations in which principals obtain payoffs above their min-max payoffs, none of them can be supported in equilibrium.



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