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Theoretical Framework and Applications of Insurance Microeconomics Focused on Asymmetric Information under an Actuarial Perspective*

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Abstract: *Microeconomics applied to insurance sector has always been a challenging part of information theory in economics because of uniqueness of insurance business. In particular, reverse production cycle and consequent significance of insurance premium estimate does not allow treating this topic in traditional ways. On the other hand, the most recent articles recognize insurance as one of the most interesting research field on asymmetrical information, and particularly on correlations between risk and coverage. In this framework, actuaries would be more involved than in the past in both microeconomic theory and business practice as their active role in both academic literature and insurance management is continuously stimulated. In this paper, the aim is to review the related literature in order to better show connections between actuarial sciences and economics, giving also some applications and insights on further improvements of this topic.*

Keywords: *Adverse selection; Moral hazard; Separating equilibrium; Insurance market.*

JEL Classification Numbers: *D4, D5, D8.*

1. INTRODUCTION

The reverse production cycle, the length of liquidation process and the investment of financial resources characterize insurance companies. These activities are related with the core business of insurance sector: to be insured against a specific event means to protect your wealth from adverse economic effects caused by the event. Its function and purpose can be then found in the offer of guarantees for the insured, through future and eventual services. It is fundamental to pay attention to how the inversion of the production cycle, whereby revenues (premiums) precede costs (compensation), entails greater elements of risk than industrial enterprises. The transfer (total or partial) of the economic impact deriving from these uncertain events takes place against the payment of a certain premium.

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* Remark that this article reflects the personal view of the authors and not necessarily that of their Institutions.

The probabilistic nature of the risks and their quantification have led to the construction of actuarial science, which is based on probability theory and statistics. Actuaries evaluate risks developing and using several models discovering connection between when and how risks occur (classical frequency-severity approach). Econometric modelling has been useful for actuaries to describe this link, in particular with regard to estimate probability of insured event and its economic impact on the insurance company in order to determine insurance premiums reflecting severity of risks considered.

The need to apply different rates depending on the degree of risk is justified, in addition to objectively detectable characteristics, by the presence of heterogeneity within the insurance portfolio, which also implies the appearance of asymmetric information. In fact, applying the same premium for the entire portfolio leads to the double effect of discourage the coverage of low risk individuals and encouraging the acquisition of risky business, where contracts are priced at a lower premium than their fair price. This scenario can produce a spiral, which means that the insurer may maintain a disproportionate number of "bad" risks in the portfolio and, consequently, needs to increase continuously the insurance premium. Rotschild and Stiglitz (who received Nobel Prize for Economics in 2001 mainly due to this seminal work [21] have introduced this result, known as nonexistence problem.

This concept can be summarized with the following definition: "*There exist only two risk classes (high and low) and if premium paid by these classes is the same it will not exist a pooling equilibrium. Insurance companies can solve this adverse selection problem by differentiating premium rates and consequently the policyholders through auto-selection mechanisms (i.e. insurers offer lower premiums to individuals accepting a higher contract limitation). In this case, a separating equilibrium exists if and only if the proportion of high risky individuals is not too low.*"

From an actuarial perspective differentiated premiums are designed with the pricing process consisting of various steps. Before underwriting insurance contracts, the entities need to analyze portfolio classification in terms of risk factors. At this stage, actuaries estimate the economic impact on insured contract of these observable variables as well as the existence of any dependency between them and claims occurrence. Nevertheless, actuarial underwriting management consists also of a second phase pricing process related with credibility theory. At this second step, policyholders are evaluated based on individuals' information observable after stipulating the contract, adding a retrospective component in the calculation of the insurance premium. In other words, a posteriori premiums analysis lead to the correction and adjustment of a priori premium in order to obtain a reasonable forecast.

This highlights the importance information and data has for actuaries when they are involved in insurance products pricing process. Furthermore, new technological innovations allow to manage so-called Big Data using advanced and continuously updated software. On this topic, a recent paper published on *The Actuary* titled *"Are actuaries competitive in data science?"* defines Data Scientist as experts with heterogeneous knowledge:

1. Coding and programming in order to manipulate data and create algorithms;
2. Maths and statistic in order to use these data for forecasting;
3. Business knowledge in order to understand and solve problems.

However, the author Colin Priest states that, while the actuaries know a lot about insurance laws and regulations, underwriting, claims management and product design, they have a very specific and not mathematical and statistical education neither programming know-how. In the United States, data scientists without any particular insurance knowledge replace traditional actuaries. Therefore, actuaries, must prepare themselves acquiring new skills and particularly on:

- Data manipulation and tables construction;
- Machine learning techniques and algorithm;
- Imputation of missing values, optimization and numerical estimates in mathematical and statistical fields.

The good news is that modern technology makes this easier than in the past.

On the other hand, actuarial activities should also have a microeconomic view in order to breach the cultural barrier that often separates actuaries from economists. Actuaries can better test econometric models as well as the correlation between risk and coverage if they have a deep understanding of insurance business. Nevertheless, they are involved in pricing processes so that they may benefit from enhancing risk-coverage dependencies in order to improve their estimates.

This paper is aimed to give a literature review of the conceptual and empirical models applied on microeconomics of insurance markets with potential connections with actuarial activity and is organized as follows. In Section 2, a definition of asymmetrical information is given, in particular adverse selection, moral hazard phenomena are described, and some comments of basic literature are reported. In Section 3 we give a deeper analysis of the most important articles related to microeconomics in insurance. Section 4 focuses on the model introduced by Wambach in 2000 with some comments and comparisons with previous articles on the same topics. Section 5 shows estimations, method and results of our analysis. Finally, in Section 6, we give a high-level analysis of competition in insurance markets under an actuarial perspective. Concluding remarks are showed in Section 7.

2. ASYMMETRIC INFORMATION

In the insurance industry, the need of setting different premium rates for different policyholders is due to the insurance portfolio heterogeneity, which in turn leads directly to the so-called concept of information asymmetry as well as to the objective characteristics of the risks. Information problems between insurers and insured individuals arise when the former has difficulty assessing the risk level of the policyholder. Economic literature is concerned on two asymmetric information aspects, adverse selection and moral hazard.

Denuit, Marchal, Pitrebois and Walhin (see [8]) believe that adverse selection occurs when individuals have a better understanding of their claims behavior than insurer and take advantage of this information before contracts are signed.

In other words, there is adverse selection (pre-contractual opportunism) when, before policy stipulation, agent has better information on his own characteristics (or on characteristics of goods traded) than the principal (agents' actions are easily verifiable). If an insurance company (principal) ask for a premium that is the average between high risk individuals rates and low risk individuals ones, the latter, that have a low probability that claims occur (better agents), tend not to insure themselves, causing a deterioration in the agents quality traded on the market.

For example, an insurer faces an adverse selection problem when ensures the life of a client without knowing that he is sick. Nevertheless, in Non-Life insurance the risk of theft of a car depends on certain characteristics of the car owner often unknown to the insurance company: neighborhood of residence, possession or not of a garage, and so on.

In case of adverse selection, main economic problem is how to incentivize who has private information to reveal it or to find instruments that let them have as more information as possible.

Private remedies can be introduced: strategies to mitigate the perverse effects of price on quality, principal offers a list of different contract to make agents revealing through the choices made their private information (as their risks characteristics), in order to separate and to differentially treat them. For example, insurance companies offer a list of contracts with lower premium rates to people accepting limitations on coverage thus highlighting a lower probability that a claim occurs. Public remedies also exist and State intervention can take different forms. For example, a public program of compulsory retirement contributions that forces citizens to save money when they are young. Or a system of regulations that constraints companies to provide pension insurance for everyone avoiding private insurances that follow the same logic of adverse selection (discriminating citizens according to their expected life). The recent book by the actuary Guy Thomas (see [25]) argues with numerous examples that a contained dose of adverse selection, especially for life insurance, is a necessary stimulant to increase the level and extension of insurance coverage in the market.

The moral hazard, or hidden action or post-contractual opportunism, requires that parties interested in the agreement (principal and agent) have the same ex ante information with regard to aspects relevant for contract designing, but asymmetric information arises after policy stipulation. Who acts executing the contract is so able to carry out actions unobservable by the other party (hidden action) or has information that the other party cannot access (hidden information).

In insurance context, Chiappori, Jullien, Salani e Salani in 2006 (See [4]) have highlighted how moral hazard arises when the occurrence probability of a claim depends on policyholders' behavior and decisions. A policyholder performing rash actions after stipulating the insurance contract without the insurer being able to control it is an example of hidden action. In car theft insurance, the claims probability is influenced by the policyholders behavior (not observable by the insurer) that in turn is modified by claim coverage in such a way that the agent, once insured, reduces precautions to prevent the insured event (i.e. he avoids a Theft Protection), then increasing the probability of claim. Furthermore, in motor vehicle liabilities insurance coverage can lead the insured people to be less careful. Policyholders imprudent behavior increases social probability of claims.

Several authors have investigated differences between these two phenomena in the insurance sector. Among others, Dionne, Michaud e Pinquet in 2013 (see [9]) shortly argue that adverse selection represents the effect of unobserved differences between individuals which in turn influence the optimality of insurance contract trading whereas moral hazard is the unobserved policyholders behavior effect arisen after stipulating the contract. In a nutshell, in the insurance market information issue can be defined as the effect of applying the same premium rate to the whole portfolio. This approach implicitly assumes the insurance of unfavorable risks (at a lower price than the real cost of coverage) and discourage insurance of medium risk individuals. Therefore, the insurance portfolio is divided into sub-portfolios where risks can be considered homogeneous in order to establish an insurance premium that faces the asymmetric information. This leads to the definition of several risk classes with different premium rates depending on the severity of risks considered.

Most of the empirical literature on asymmetric information in insurance markets analyzes insurance data alone and tests the sign of the correlation between the level of insurance coverage and ex post realizations of risk controlling for the risk classification of the insurance company (See [10]). Whereas recent literature tests the effects of multidimensional private information in insurance markets (See [11] and [20]). Alternatively, they test the effects of private information in insurance markets based on a data set of a single insurance company (See [22]).

Last, our setting further benefits from the fact that liability insurance is mandatory and policyholders who are rejected by an insurer are distributed evenly among all insurance companies in the market (See [12]).

3. THE EMPIRICAL MODEL

The study of competition and equilibria of the insurance market in terms of microeconomic theoretical models, rather unknown to actuaries - except an article by English actuaries from 2012, Games Theory in General Insurance (see [10]) - generally follows the trend started by the article of Rothschild and Stiglitz, which has also stimulated the debate on the non-existence of equilibrium in pure strategies in relation to the limits of the model. In their seminal work, authors have therefore shown that, in competitive insurance markets with asymmetric information and particularly with adverse selection phenomena, pooling contracts cannot exist in balance but only with the separation of risks. Companies make extra zero profits and under some hypotheses, when the worst risks are in a low proportion, equilibrium does not exist. All these features are not known by conventional competitive analysis.

The basic conditions of the model were not measured nor the results were verified. The authors only reiterate that the significant demonstrations on equilibrium were supported by the presence of partial insurance coverage in reality. They indeed strongly advocated studies verifying their conjectures over time. But many years after, a series of theoretical microeconomic articles have been published - often in conflict with each other. As it can be seen from the next schema from the paper Empirical applications of the information asymmetry theory and the documented results regarding the correlation between risk and coverage by Matis and

Matis (See Table 1 in [15]) without further development on results validation nor mutual refutations. Since 2000, when various econometric studies have been inaugurated (first of all Chiappori e Salani [3]) with the aim of confirming these models through historical observations. A first result of this analysis confirms that, in an asymmetrical information context, a positive correlation between risk and coverage seems to be a direct and robust consequence of the competitive assumption. Although the problem of non-existence of equilibrium was the main objective of the research, the other main result of Rothschild and Stiglitz is that, in a competitive environment, the distribution contracts cannot exist in equilibrium; at the same time, the profit zero rule always applies. The existence of pay-as-you-go contracts is possible in environments where alternative equilibrium concepts are considered. Furthermore, Spence argued "not only can individuals differ in the expected cost they impose on the insurer, they may also differ in their preferences regarding insurance coverage."

In 2001 Inderst and Wambach model (See [14]) adds to the discussion about the problem of non-existence the following problem which to date has received little attention: if an insurer deviates from the equilibrium by offering a new series of contracts, who chooses these contracts? So far, it was always assumed that every new contract offered is potentially able to serve the entire market. In their model, the authors believe that companies face capacity constraints, for example due to limited capital, and it is no longer guaranteed that a new offer can attract a representative selection of the market. In fact, the distribution of the types of risk corresponding to a contract (deviation) of a given company is now determined endogenously.

As mentioned, one of the reasons of capacity constraints is solvency regulation. For a given amount of capital, only a finite number of risks can be added to the insurer's portfolio, otherwise, depending on how the solvency requirement is calculated, the ratio of premiums to capital or the risk exposure ratio and the capital will exceed a given thresholds. Other reasons for a company not serving the entire market are related to the sheer size of the company, the number of employees, the size of the IT system, etc. This makes it difficult to manage more than a given number of policies.

In the presence of capacity constraints, under certain hypotheses, the main result is that the Rothschild-Stiglitz (RS) contracts are equilibrium contracts, even when they do not represent a balance in the original game. eE.g., consider the pooling contracts that, in the original document, destabilized the RS contracts, if the new contract is also supposed to attract the low risk typology and if the proposer intends to make a strictly positive profit, the coverage of the type of low risk must increase compared to the

RS contract. It should be noted that the incentive of the compatibility constraint to the high-risk type is stringent in the context of RS allocation and it benefits more strictly from an increase in coverage. Consequently, the usefulness of the high-risk typology will increase more under the contract that deviates and in this way; the high risks are prepared to bear a more severe rationing in the event that the capacity constraint of a company becomes stringent. This intuitive property can therefore be applied to any offer deviation, even with a menu of contracts, which will be unprofitable if it does not guarantee to the company the desired mix of types.

The authors have shown how a result of an existence of equilibrium in pure strategies for companies can be obtained in an insurance market, in the case of limited ability to sign contracts sufficiently dispersed among competing companies. A family of Rothschild- Stiglitz contracts cannot be destabilized: any deviation with a contract that was designed to make profits with low-risk customers will be (relatively) more attractive for high risks. When customers take into account capacity constraints and the expected degree of congestion in force at the diverting company, the same offer will fail to attract a sufficient number of low risks to become profitable. The derived equilibrium is, however, not unique based on capacity constraints. In particular, the possibility of failure of coordination among customers makes it possible to support equilibria where companies make positive profits, even if each single company not necessarily registers a profit.

Inderst in 1999 (See [13]) discusses (with complete information), two ways to make prices converging to the unique and competitive result. First, if the number of buyers increases while the capacity ratio between buyers and the number of companies remains constant, coordination is facilitated as buyers more accurately predict the prevalent congestion in a single seller. Secondly, the lack of coordination becomes less serious if the costs of visiting another seller decrease.

4. WAMBACH'S MODEL

Following Spence observations, Wambach introduced the assumption that individuals deviates, other than for their risks, also for risk aversion (often measured by the inverse of their wealth). Then, there exist a two-dimensions asymmetrical information since the insurer do not observe neither the risk nor the degree of risk aversion of the individual: he models different degrees of risk aversion by assuming that individuals show a decreasing absolute risk aversion and several income levels. In Wambach's model four different type of individuals are derived from the intersection of high or low risks and between high or low income (*hh, lh, hl, ll*).

From its results it arises that in competitive insurance market with multidimensional adverse selection an equilibrium can be represented or by a pooling of types that are grouped by income and at the same time with complete separation of risks, or with a partial pooling of risk, where some types of the same risk are separated.

Particularly, when the wealth difference is small then various types of income are grouped whereas the different risks remain separate, while if the wealth difference is significant, equilibria in which companies make positive profits with separation of contracts can exist. In equilibrium, the different types of income can be separated with the same risk, furthermore there may be contracts with partial risk pooling, while the complete pooling contracts of the two types of risk exist only in very particular circumstances. To introduce an additional unobservable parameter has not allowed Wambach to solve completely the problem of non-existence of equilibrium: nevertheless, the analysis demonstrated that in some circumstances the problem could be strengthened while in some other cases could be weakened.

As an example, in an indemnity-premium scheme, for relevant wealth differences the partial-sharing risk contracts are plausible, where a type of individual chooses between two equilibrium contracts whereas another type chooses one of them (the profitable contract). This situation is well known as *no single crossing* property.

5. A STATISTICAL APPROACH FOR TESTING WAMBACH MODEL

5.1 Introduction

In this chapter, we want to introduce the use of some generalized linear models of statistical inference to measure both the adverse selection conditions and the compatibility with some remarkable results of the

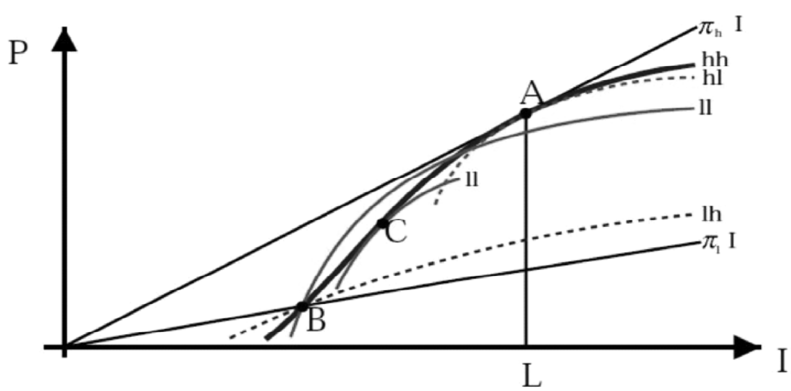

Figure 1: Indemnity-Premium scheme - from [26]

theoretical models presented previously. The formulas of the Chiappori statistical model and others will also be verified, with the reservations about the results of this work. In fact, in addition to the fact that the conclusion of the positive correlation was demonstrated by referring more to intuitive aspects than to a rigorous mathematical exposition, concrete aspects such as tariff flexibility or the estimate of claims reserves could lead to the conclusion as will be shown later. In the case of test failure, it can mean that the information asymmetry is not verified only because the constraints are too strict. In general, we want to test the variables used to define risk profiles ab origine - in terms of personalization, guarantee offered and risk aversion - representing them as polytomic qualitative variables. For this purpose, the LOGIT and PROBIT models can be well adapted, in which the response variable can assume only the values 0 and 1 which in this context means that the policy can be damaged or not.

The probabilities are given by a non-linear function of the observed explanatory variables and to determine the parameters of this function the maximum likelihood method is used which provides non-analytical solutions with a closed formula but obtained with numerical methods. These probabilities are given by:

LOGIT $$p(x)=\frac{e^{x'\beta}}{1+e^{x'\beta}}$$

PROBIT $$p(x)=\int_{-\infty}^{x'\beta}\frac{1}{\sqrt{2\pi}}e^{-\frac{s^2}{2}}ds$$

In addition, for these models, the asymptotic properties of the linear regression model are valid and an estimate of the variance of the maximum likelihood estimator is defined in order to make statistical inference.

5.2 Asymmetrical information analysis

The following are the LOGIT and PROBIT applications to measure the significance of the effects of the parameters on the probability of loss. First with reference to two contracts with different coverage in different geographical regions, in order to take into account the environmental heterogeneity, for the risk hail of farms (one product for 19,176 policies the other at 14,826). Then following the same scheme for the risk of electrical faults in the home (a product relating to 137,469 policies the other to 87.825). The different coverages, referring to the same risk, but with guarantees of different amplitude, should be the reference respectively for the risks with low and high probability of causing damage or possibly suffering. The following results for the LOGIT model (the PROBIT model is omitted, which gives similar results) provide evidence of significant difference between the probability of loss of the two coverages (products A and B) in the presence of geographical segmentation. The group of regions differentiated for agriculture policies are represented by a core of the regions of Lombardy, Piedmont, Friuli, Tuscany and Sicily (probably because they are wine regions) compared to the rest of Italy and, from the North and the rest of the country with reference to the home insurance policies. In fact, for both applications, the parameters pass the significance tests for the intercept, the product and the geographical region; the coefficient for a class of the variable is conventionally set to zero.

risk hail of farms

Deviance Residuals:

Min	1Q	Median	3Q	Max
-4.2009	-1.1107	-0.5334	1.2560	4.6232

Coefficients:

	Estimate	*Std. Error*	*t value*	*Pr(>|t|)*
(Intercept)	-2.66698	0.04069	-65.545	< 2e-16 ***
regionb2	-1.45256	0.08556	-16.976	< 2e-16 ***
productbA	-0.38994	0.05620	-6.939	3.96e-12 ***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

(Dispersion parameter for binomial family taken to be 1)

Null deviance: 569.91 on 35 degrees of freedom

Residual deviance: 129.49 on 33 degrees of freedom

AIC: 242.61

Number of Fisher Scoring iterations: 5

risk of electrical faults

Deviance Residuals:

Min	1Q	Median	3Q	Max
-10.224	-3.094	-1.054	1.470	11.644

Coefficients:

	Estimate	*Std. Error*	*t value*	*Pr(>|t|)*
(Intercept)	-3.23429	0.01997	-161.962	<2e-16 **
regioneb2	-0.97349	0.03465	-28.094	<2e-16 **
productbA	0.21550	0.02385	9.036	<2e-16 ***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Null deviance: 1903.23 on 35 degrees of freedom

Residual deviance: 800.22 on 33 degrees of freedom

AIC: 1005.9

Number of Fisher Scoring iterations: 5

5.3. Theoretical model verification

A more interesting analysis that can be carried out with these models is the following: having a database of a civil responsibility contract of a company designed for small and medium craft enterprises. Database contains about 10,000 policies with information as well as of premiums and claims, of guarantees given (third party liability or the same including operator's liability insurance) to identify the various coverages (product) with a view to adverse selection and the product sector, in order to introduce risk heterogeneity. Moreover, to introduce the presence of the heterogeneity of income / risk aversion in the sense of Wambach's adverse multidimensional selection, reference was also made with approximation of the information on the insured limit (high for the most risk-averse and therefore with low income and the other way around). The product in question is characterized by a ratio of claims to premiums of 65% which, considering an expenses ratio of 35% for the branch, does not globally produce profits (even if you remember it is a multi-line policy).

Therefore, a LOGIT model was built with three explanatory variables (product sector, product and limit class):

Min	1Q	Median	3Q	Max
-2.09723	-1.02088	-0.04655	0.58724	2.71861

Coefficients:

	Estimate	*Std. Error*	*t value*	*Pr(>|t|)*
(Intercept)	-4.00366	0.42021	-9.528	< 2e-16 **
ProductSectorb	0.86133	0.42551	2.024	0.042947 *
ProductSectorc	1.19629	0.45030	2.657	0.007892 **
ProductSectord	-0.12548	0.53356	-0.235	0.814072
ProductSectore	1.52172	0.48651	3.128	0.001761 **
ProductSectorf	-0.91608	0.71250	-1.286	0.198539
ProductSectorg	0.57918	0.65880	0.879	0.379324
ProductSectorh	1.86669	0.41867	4.459	8.25e-06 ***
ProductSectori	1.49718	0.42178	3.550	0.000386 ***
ProductSectorj	1.76758	0.43840	4.032	5.53e-05 ***
ProductSectork	2.19657	0.42785	5.134	2.84e-07 ***
productB	0.66035	0.08414	7.848	4.23e-15 ***
limitB	-0.36695	0.08028	-4.571	4.85e-06 **

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Null deviance: 320.618 on 43 degrees of freedom

Residual deviance: 48.006 on 31 degrees of freedom

AIC: 219.89

Number of Fisher Scoring iterations: 5

The parameters are all significant, except for some product sectors and this would imply further groupings. However, this does not change the evidence that the results of this application, limited to the LOGIT model, besides verifying the conditions of the Wambach model on the probability of left in the presence of adverse two-dimensional selection, configures a situation compatible with that of the proposition of the same model. The proposition refers to the violation of the ownership of the single intersection. If one assumes the portfolio of the company a sample exemplification of the market, also with reference to the ordering of the premium and the average performance by type (following table) as well as on the possible realization of a partial risk pooling between type *ll* and type *hh*. It should be noted that the products that refer to previous graph (4) to points C and to pooling between A and C represent the ex-post results between the guarantee-limit combinations rather than several real guarantees.

(amounts in euro)

type	*lh*	*ll*	*hh*	*hl*
premium	217	284	540	938
Claim severity	1.701	2.771	3.846	5.118
Incurred claims/ premiums	52,5%	66,5%	60,5%	74,4%

The only exception is that the most profitable product is *lh* and not *ll*, and that the product for the *hl* type is not in balance but even in loss, but this last case could be explained in terms of convergence towards a balance not yet reached. With regard to the first evidence, the empirical assumption that, once the dichotomic separation criterion of the adverse income / selection has been decided, the average income of the same type but of different risk types is different, suggests a variation to the graph in question. That, in reason for the fact that the typology *lh* (better to say *lh'*) could be more adverse to the risk of *hh*. Therefore no longer represented by the dotted line in the figure below but by a curve that passes through B and fits between the curves *ll* and *hh* crossing this last in a point with premium-coverage higher than C. In some words, the aversion to the risk has more power than the riskiness and the risk with low claims frequency cold have a different average income or vice versa. At this point it is correct to translate the curve up to the tangency of the curve *hh* in a point D (in which the typology *lh'* creates profits) under point C with the possibility of a further partial risk pooling for the *hh* type between this new point and point A.

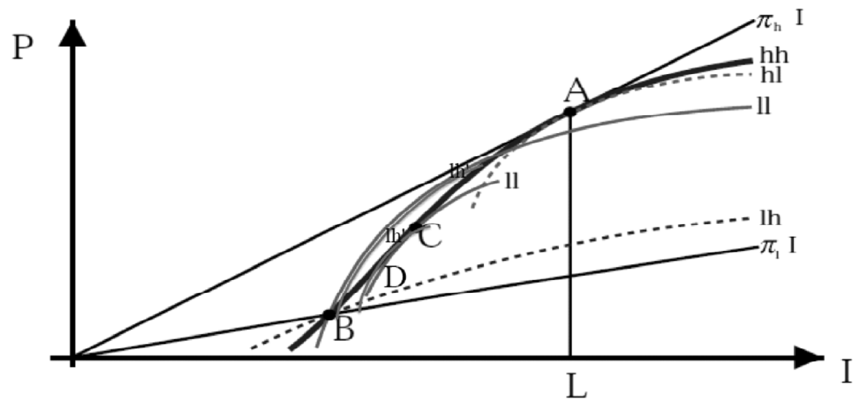

Figure 2: Variant of Indemnity-Premium scheme

A further application that proved this possible configuration of multiple partial pooling, in terms of performance of the contract, was carried out on the 2007 data relating to two products (one with wider coverage) of the craft marketed by a company, in successive moments but with the possibility of choice, with reference to the fire guarantee of the contents. The policies are equal to 9,448 (X71) and 3,777 (X72) respectively: the portfolio is segmented according to the low value of the content and fire risk category of the building. With the first variable we want to identify, in a general context, a classification of income (above and below 150 thousand euros) while with the second we consider the heterogeneity of risks. Nevertheless, it is worth noting the fact that in this context the representation in terms of average premium cannot work for the *hl* type as it is clear that the contained value range also representing a tariff variable implies a lower premium than that of the *hh* type.

The detection of adverse multidimensional selection with the LOGIT model gives the positive result:

Deviance Residuals:

Min	1Q	Median	3Q	Max
-7.5292	-1.8692	-0.4739	1.5591	8.1947

Coefficients:

	Estimate	*Std. Error*	*t value*	*Pr(>|t|)*
(Intercept)	0.05271	0.36361	0.145	0.884746
risk B	1.13397	0.37865	2.995	0.002747 **
risk C	0.65018	0.36402	1.786	0.074079 .
risk D	0.54504	0.37032	1.472	0.141075
risk E	-0.47216	0.38309	-1.232	0.217771
risk F	-0.76250	0.38909	-1.960	0.050031 .

risk G	0.63054	0.39395	1.601	0.109481
risk H	0.52465	0.39431	1.331	0.183331
risk I	-1.32836	0.43866	-3.028	0.002460 **
risk L	-0.70874	0.41833	-1.694	0.090225 .
risk Missing	-1.92273	0.70979	-2.709	0.006751 **
risk N	-2.96852	0.69386	-4.278	1.88e-05 ***
risk O	-1.55335	0.55687	-2.789	0.005280 **
risk RD	-1.98218	0.70386	-2.816	0.004860 **
riskM	-1.65836	0.44408	-3.734	0.000188 ***
conteb2	-1.47056	0.17564	-8.373	< 2e-16 ***
conteb3	-1.18619	0.13886	-8.542	< 2e-16 ***
conteb4	-2.24905	0.22964	-9.794	< 2e-16 ***
conteb5	-2.59245	0.26109	-9.929	< 2e-16 ***
prodsbX72	-0.80485	0.11400	-7.060	1.66e-12 ***

The division of risks could be limited but in any case does not affect the presence of adverse multidimensional selection given by the product (for the risk) and by the bands of contained value (for the income). The surveys in terms of the claims ratio to premiums seem to support, in terms of relative comparison between the indicators, the categorization of the Wambach model variant that presents the *lh* type as the one with better performance, even though they are lossless and without balance considerations. Moreover, the premium - which is a function of income for these guarantees - of the *hh* type is higher than that of the *lh* type.

Type	*lh*	*ll*	*hh*	*hl*
Claims over premiums	62,3%	118,8%	94,9%	132,9%

5.4. Remarks

These applications could be conditioned by three limitations, such as measurement errors also due to the contained adequacy of the available variables, the approximation of the reality of the model in terms of risk and performance categories and the equilibrium, even if between a single company (which has become a market paradigm) and policyholders, not yet reached. Moreover, in the main application, the product has been marketed since 2010 and the figures are for 2011. However, the good results confirm the model's ability to rationalize the possible balance of the insurance market and the flexibility it presents in being enriched with modifications. A fundamental consideration to note then, also to better understand the use of the model, is that contracts C and D are not, as is obvious, real coverages but combinations of variable guarantees that could indicate to the company or to a group the convenience of building particular policies to increase profitable portfolio segments. Finally, it is useful to remember that, given the market conditions represented, such as the sufficient dispersion of contracts between companies and the presence of opportunity costs in choosing a different insurance company, the model in question implies a balance. Equilibrium is further protected by destabilizing contracts because it benefits from the results of the Inderst and Wambach model with the corollaries obtained in 2011 to support the conclusions of the 2000 Wambach model.

6. TYPES OF COMPETITIVE MARKETS

With a view to economic and statistical empirical studies, several articles have analyzed the concentration and level of competition of companies. As well as the market context such as those of Murat , Tonkin, and Jttner of 2002 (See [16]) and of Nissan E. and Caveny R. of 2001 (See [17]), which showed that the insurance sector is characterized by an oligopolistic market structure. An oligopoly is a situation in which relatively few companies compete on a market for a given product. The key feature of an oligopoly is that companies do not passively take the market price as a given under conditions of perfect competition. Instead of their actions, they influence the overall market outcome that leads to competitive strategic behavior. In such a situation, it is possible that companies obtain (above the norm) positive profits.

Now we try to explain positive profit balances in insurance markets. Factors which favor an oligopoly, are:

- Industrial organization standardized model;
- Capacity constraints;
- Product differentiation, vertical and horizontal;
- Service quality;
- Research costs;
- Entry barriers and regulation;

In the US market, for example, Nissan and Caveny have discovered that the property and liability insurance classes are significantly more concentrated than a number of other industrial sectors. The application of the Hirschman-Herfindahl index (sum of the squares of the quotas) can also be useful for this purpose. In the Australian insurance market, Murat's empirical study generally suggests that insurers have some degree of market power: they analyzed the measure, with a model that also takes into account the company's investments, in which the insurers tend to transfer on the premiums any increase in costs, for example, due to an increase in salaries, subscription costs or other expenses. In monopolistic competition, insurers respond increasing premiums and reducing production, while under perfect competition insurers are forced to completely transfer any increase in costs; in their study - through a regression model - they discover that insurance companies do not transmit the entire increase in costs in premiums and, as a result, competition is less than perfect.

7. CONCLUSIONS

The insurance market is characterized by problems of asymmetric information. Firstly, insured individuals do not have complete information or understanding of complicated insurance contracts and lack the ability to assess the adequacy and proportionality of the premium to their risk. Secondly, informational problems can be on the assessment of the ability of the insurance company to meet its obligations (being the insurance, a typical contract deferred in time). Thirdly, insurers suffer from lack of information regarding the risk of a given insured individual. All these topics can be assessed on both economic and actuarial perspective, increasing exchange opportunities as well as interdisciplinary discussions between these two worlds in a very dynamic sector as insurance.

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