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FROM REGULATION TO FREE MARKET. THE EXPERIENCE OF THE EUROPEAN MOTOR INSURANCE MARKET

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1. Introduction

It has now gone more than a decade by since the second and third UE directives on non-life insurance were issued to promote the integration of the national insurance markets into a single European market. By imposing the removal of regulation on prices and contractual design, as well as the abolishment of barriers to entry foreign markets, the Council aimed at favouring competition in an industry which had been long protected. However, in several countries, liberalization has yielded such unexpected and disappointing results, to induce many observers to assess it as a failure, at least for what concerns motor liability insurance[1]. The most salient features of this failure can be well represented in the controversy risen between consumers (insured drivers) and companies (insurers), both being unhappy with liberalization and disputing on the responsibilities for its poor outcome.

The consumers' *cahier de doléance* consists of two main complaints: first, in several countries, policies average prices have undergone a substantial (sometimes sharp) increase; second, almost everywhere, the riskiest (or perceived as such) categories of drivers have been charged with very high premiums which, in the presence of compulsory insurance, have in fact compromised their right to mobility. According to a popular view, insurers would be the main (or only) responsible of fare inflation: they would have taken the chance supplied by the new regime of free pricing to collude[2], reduce monitoring costs and raise their profits. On the other hand, companies lively protest their innocence, hinging on a number of considerations. First, their balance sheets show decreasing and sometimes negative profits throughout the decade; second, they reject the hypothesis that fare inflation be due to collusion, by stressing the lack of any kind of agreement[3]; third, they blame the harsh competition to force them to an increasing price discrimination; fourth, they argue that escalating compensation costs are the real cause of fare inflation and maintain that the main responsible for the deregulation failure are the increasing car healing and personal bodily injuries costs and above all the pervasive phenomenon of frauds[4].

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[1] For example, this seems to be the opinion of the Italian antitrust authority (AGCM). See on this point the latest investigation AGCM (2003).

[2] Recently, the Italian antitrust authority has concluded a detailed investigation on motor insurance industry – see AGCM (2003) – by stating that "premiums have increased because companies have inadequately reacted to increasing costs, by adopting *common* solutions which have accelerated fare inflation". In July 2000, the same Authority had challenged an information sharing scheme operated by Italian companies as a collusion facilitating practice. See Grillo (2002).

[3] On this point, it is worthwhile to recall that the recent literature as well as antitrust practices have pointed out the need for a more comprehensive and satisfactory definition of the set of actions and behaviours which outline the existence of collusion so that, in addition to direct conspiracy, even "facilitating practices", (i.e. explicit or tacit agreements to engage in practices that make collusion easier) are to be disputed on the basis of their anticompetitive purpose. See Kühn and Vives (1995), Kühn (2001) and Grillo (2002).

[4] These arguments are brought forward by several insurers associations. See for example APS (2002) and ANIA (2002).

In this paper, we propose an explanation of the average fare increase occurred in the European motor insurance market which to some extent accepts both consumers and insurers viewpoints. We argue that fare inflation – as insurers maintain – may be properly considered not as a consequence of collusion or other pathological misapplications of deregulation but rather as a by-product of the impact of liberalization on the companies' optimal choices in markets characterised by a rigid demand – as consumers point out. Conventional wisdom tends to consider free market (i.e., the absence of barriers to entry and price regulations) as a synonym with perfect competition (or at least perfect contestability) so that deregulation is immediately associated to the idea of falling prices, increasing efficiency and welfare gains. However this equivalence may fail to hold, because of non competitive or imperfectly competitive market features as well as strategic interaction among producers. In this case, one can not exclude that moving from a regulated context to free market may yield disliked surprises. This should be borne in mind whenever extreme deregulating reforms (especially with reference to necessary goods' markets, such as motor liability insurance) are unduly evocated as a safe panacea against the evils of public interference[5].

To make our point, we start from the simple and commonly shared idea that a part of compensation costs borne by insurers be not exogenous but negatively related to their effort in claims processing and investments in monitoring structures, like legal departments, informational systems, contract designs, garages and so on. If deregulation affects marginal costs and benefits from monitoring investment, the optimal size of monitoring structures may scale down, altering costs, prices and profits. We implement this idea in a differentiated oligopoly model developed in Scalera and Zazzaro (2003). More specifically, we consider a simple extension of the Salop-Economides circular city model assuming that companies endogenously determine the optimal size of monitoring structures in a stage preliminary to the price game and so affecting fraudulent claims and compensation costs. By using this framework, we show that price deregulation involves decreasing expenses for the monitoring apparatus and increasing compensation costs. In this context, the transition from regulation to competition can yield in the short run (i.e., as long as the number of firms remain unaltered) prices and profits moving either direction and possibly to opposite directions, as actually occurred in some European countries. In addition, as variable costs depend on the number of companies and prices are not monotonically decreasing in it, in the long run, it may happen that firms' entry (exit) be accompanied by an increase (decrease) of premiums.

[5] Another interesting example is given by the British privatisation programme on transport, by which British Railways, national air traffic services and finally London Underground have been sold off. Concerning this latter, it has been calculated that "the Tube" currently requires subsidies of about £1 billion per year, much more than ever received before.

Conversely, when price collusion takes place, the optimal effort (and therefore claims) remain at the same level as in regulation. In this case, price increases must be associated with increasing profits. Remarkably, in both cases, if free market prices are higher than regulated prices, consumers as a whole undergo a loss, respectively in favour of companies (in case of collusion) or dishonest drivers (in case of competition). These results crucially depend on the assumption of imperfectly competitive markets; in perfect competition firms are price-takers and their optimal effort is unresponsive to the circumstance that a regulator rather than market makes its price.

The paper is organised as follows. In section 2, we present a short outline of the basic issues concerning the evolution of the European motor insurance market in the last decade and supply some evidence on the dynamics of premiums and claims in a set of European countries. In particular, we highlight the case of those countries which show the puzzling evidence of escalating premiums in the presence of static or decreasing profits. In section 3, we set up a simple model which allows us to analyse, in section 4, the implications of different market regimes (regulation, competition and collusion) in terms of prices, compensation costs and profits. Finally, section 5 is devoted to draw the main conclusions of the paper.

2. The deregulation effects: aspects of the current debate and some data

While the controversy between consumers and insurers is a useful shortcut to approach the topic, the debate on the recent disappointing evolution of the European motor liability insurance market has obviously been much wider. In what follows, we will supply a short review of some basic issues of this debate, selectively emphasizing the points more relevant to our argument.

First of all, economists have sought to understand whether the burst of premiums should be entirely imputed to deregulation or it is at least partially due to factors exogenous to insurance markets. In fact, numerous exogenous components of insurance costs have undergone significant changes over the decade, giving probably place to a negative overall impact on premiums. Actually, on one hand the number of accidents (but not their severity), operational costs and underwriting expenses have shown a declining trend throughout the Nineties. On the other hand, other factors have determined an upward pressure on costs. The progress in diagnostic instruments and therapies, as well as the availability of more technologically advanced automobiles have certainly implied a growth of expenses for medical treatments and car healing. Also, a role may have been played by increasing legal expenses (which often induce insurers to settle claims out of the court), as well as a wider protection granted to the victims of road accidents (including pedestrians and cyclists)[6].

[6] By the way, the recent proposal for the fifth Motor Insurance Directive takes further steps in this direction.

Finally, even declining interest rates (which increase the present discounted value of future claims) and increasing tax rates may have helped to raise costs.

In general however the unfavourable evolution of exogenous costs, while by no means negligible, does not seem in itself decisive in determining an increase in insurance fares as continuous and pronounced as the one occurred in some European countries during the Nineties. Therefore, the hypothesis that premium escalation be independent from deregulation has had for the European case very few advocates[7]. On the contrary, the idea that the increase of compensation costs has been mainly due to endogenous factors is shared by several authors who have emphasized how moving to competition, insurance companies may have had fewer incentives to contrast fraudulent claims. In particular, Buzzacchi and Siri (2002) have implemented this idea in a formal framework, setting up a duopoly model with switching costs a là Klemperer (1987), which indicates how price deregulation may reduce the incentive to invest in monitoring and simultaneously increase prices and profits.

As said before, the most remarkable evidence concerns the increasing price discrimination and the average fare inflation. The former looks to be a direct effect of liberalization: during the deregulation process, market segmentation has substantially grown, due to the insurers' attempt to efficiently cope with the problem of adverse selection. It is well known that when facing adverse selection, insurers can find profitable to categorize risks (i.e. to group drivers into risk categories according to some discriminating variables) and charge risk-adjusted premiums[8]. However, while being effective in reducing adverse selection, this behaviour may imply relevant undesired consequences. First, since classification is a dominant strategy for insurers (i.e. when a new variable is used by one company, the others are forced to do the same), investment in information gathering can be likely driven toward too high, socially inefficient levels which can make it an autonomous source of premium inflation[9]. Second, classification may easily turn into discrimination and, by reducing the cross-subsidization among low risk and high risk drivers, exacerbate social exclusion[10]. The sensitiveness of consumers and policy makers toward the problem of

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[7] During the Eighties, the U.S. insurance market lived an analogous experience of increasing premiums. In that case, the absence of any major structural or institutional change induce some authors – for example, Cummins and Tennyson (1992) – to maintain that the source of fare inflation was essentially in exogenous costs. An alternative explanation, in terms of market failure was provided by Smith and Wright (1992).

[8] In their seminal work, Rothschild and Stiglitz (1976) showed that in a competitive insurance market only a separating equilibrium may exist, where individuals with different risks purchase different contracts, with greater or less coverage. When a minimal coverage is legally imposed, firms usually prefer to (try to) assess the ex-ante riskiness through classification and to charge premiums commensurate to risks; see for example Hoy (1982), Rea (1992), Crocker and Snow (2000) and Buzzacchi and Valletti (2002).

[9] This interesting point is made for example by Buzzacchi (1998).

[10] A number of authors have recently dealt with this problem, especially with reference to countries where the differences between low risk and high risk rates are particularly pronounced. See for example Meyer (2000) for Germany, Buzzacchi and Siri (2002) for Italy and Smith and Wright (1992) for the United States. The severity of the situation in Finland is witnessed by European Parliament (2001).

discrimination in motor insurance markets seems to be significantly risen in the last years so that some governments look currently oriented to reconsider the past choices and possibly to recover some room for a regulatory intervention[11].

Concerning fare inflation, which is the main objective of this paper, a look at Figure 1 can give an idea of its quantitative relevance during the Nineties. Each panel shows the dynamics of premiums, claims and loss ratio (claims over premiums) together with the Consumer Price Indexes for one of the ten countries considered[12]. The data refer to third party insurance and are expressed by setting the initial year value equal to 100, in order to easily appreciate relative differences. As one can see, after the liberalization, real premiums and claims have increased in all the countries considered, although at very different rates, while generally the evolution of the loss ratio does not seem to support the hypothesis that companies have obtained larger profits. Starting from Figure 1, three points are worth to be remarked: the relationship between deregulation, price inflation and premium increase, the dynamics of claims, the evolution of profits.

[Insert Figure 1]

A simple observation of data is useful to heuristically verify the connection between deregulation and fare inflation. As a matter of fact, the actual degree of incidence of the third EU directive in terms of deregulation seems to be a major factor in explaining the different rates of increase shown by Figure 1. In other words, we can distinguish, by and large, three different groups of countries. The first one, displaying the lowest rates of increase, include Belgium and France, i.e. the countries which currently still keep a relatively more regulated environment[13] (which by the way is in dispute of admissibility) plus Germany. Another group, to which Denmark, Netherlands and Norway (i.e. countries which had already a relatively free motor insurance market before 1994)

[11] To tell the truth, several European countries (i.e. Austria, Finland, Italy, Netherlands, Spain) have always kept a (more or less abstract) principle of non discrimination which more or less effectively has prevented companies from applying unreasonable rates for handicapped, young drivers and other disadvantaged categories. Other countries consider rating by sex, nationality or race illegal (Germany, Luxembourg, Sweden, United Kingdom). In August 2002, in response to the difficulties faced by a growing number of drivers, Belgian Parliament approved the Monfils Law according to which drivers charged with fares five times higher than the average can resort to a Tariff Bureau to obtain more reasonable conditions.

[12] There are nine EU countries plus Norway. The choice of the sample is only due to data availability. Data sources are: for Belgium, Union Professionelle des Enterprises d'Assurances; for Denmark, Danish Insurance Information Service; for Finland, Suomen Vakuutusyhtioden Keskusliitto; for France, Fédération francaise des sociétés d'assurances; for Germany, Gesamtverband der Deutschen Versicherungswirtschaft; for Ireland, The Irish Insurance Federation; for Italy, Istituto di Vigilanza Assicurazioni; for the Netherlands, Verbond van Verzekeraars; for Norway, Norwegian Financial Services Association; for Portugal, Associação Portuguesa de Seguradores.

[13] In Belgium there is a statutory minimum rate for the net premium and a statutory bonus-malus system is prescribed. In France prices have to be consistent with reference rates and a there is a binding statutory bonus-malus system. On the fundamental legal principles and the system of rating of EU countries, see Schwintowski (2000)

belong, appears to have faced a moderate fare inflation[14]. Finally, there is a third group, including Finland, Italy and Portugal, which is the one most affected by liberalization, as these countries have had a pronounced regulation until early Nineties and then a rapid deregulation[15]. These countries are clearly the ones which show, together with Ireland[16], the fastest growth of premiums, much larger than consumer price inflation.

The impressive escalation of claims indicates that they have probably played a crucial role in the evolution of premiums. Again, such a remarkable increase can hardly be seen as entirely exogenous: a significant change in the propensity to fraud is difficult to justify without considering a change in the profitability and/or success probability of frauds. As said in the introduction, our view (shared by many observers) is that deregulation has reduced the incentives to monitor claims or induced companies to a more conciliating approach toward claimers as, in the presence of an imperfectly competitive market, companies can translate higher compensation costs into higher fares.

The problem of frauds in the representation of loss magnitudes has recently drawn considerable attention[17]. According to a number of investigations, frauds have been increasing throughout Nineties both in Europe and elsewhere[18]. As a matter of fact, beside the strong increase in the average value of claims, several hints support this view. In many countries, the spotted frauds have steadily increased. In 2002, the number of claims rejected by Norwegian insurers as fraudulent has been the highest ever recorded. In Ireland, the Irish Insurance Federation has recently denounced a continuous increase in the amount of frauds over the last three years. Concerning Italy, the insurers association ANIA has argued that in that country the problem of frauds is particularly serious by producing several investigations and showing extremely suggestive data. For example, the share of people suffering from whiplash associated disorders with respect to the overall number of injured people is very (probably too) different across European countries. In Italy, where it has more than doubled in a decade, it is currently about 66%; in Germany it is 40% while in France, Norway and Denmark does not exceed 6%. In the same vein, between 1992 and 2001, the average cost of automobile healing services (as recorded from claim documents) has increased around 20% in the Netherlands, 26% in France and Germany, 48% in Spain and 73% in Italy. Finally, according to CEA (Comité Européen des Assurances) data, even the number of claims for every 100 vehicles is

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[14] According to Eurostat data, Spain would belong to this group too. Spain shows an overall premium increase around 36% between 1996 and 2002.

[15] Actually, Portugal had strict regulation until 1986. Then public intervention was progressively reduced up to the full deregulation occurred in 1989.

[16] The case of Ireland is characterised by a strong increase in the number and severity of accidents.

[17] Theoretical contributions on the topic are due to Lacker and Weinberg (1989), Crocker and Morgan (1998) and Crocker and Tennyson (2002).

extremely differentiated: it amounts to 3.4 in Finland, 4.5 in Norway, 5.6 in the Netherlands, 6.7 in France, 8 in Germany, 8.5 in Austria, 11 in Portugal, 11.6 in Spain and 12.1 in Italy. The severe increase of compensation costs has urged companies and public authorities to find remedies to contrast frauds. So across the last decade, in many European countries, and especially in the ones plagued by fare inflation, penalties for fraudsters have become heavier, claim databanks have been set up and made accessible to insurance companies, lists of authorised car repairers have been introduced.

Finally, a closer look at the evolution of profits seems to be necessary. From the data shown in Figure 1, the third party motor insurance industry has not lived a particularly brilliant season in the Nineties in any European country and especially in those countries in which the premium increase has been more pronounced. In these latter cases, the data indicate that often prices and profits have been moving to opposite directions; as we will see in the next sections, such evolution looks little consistent with the hypothesis of collusion among producers and calls rather for alternative explanations.

3. The model

We describe the motor insurance market as a horizontally differentiated oligopoly *a là* Salop (1979), with endogenous fixed costs, as developed in Scalera and Zazzaro (2003). The spatial competition models fit the main features of the automobile liability insurance market fairly well[19]. Motor insurance products can be considered strategic complements in prices, and typically differentiate for some characteristics endogenously chosen by the insurance companies over which consumers have idiosyncratic preferences (such as their location or their risk classification policy). Individual demand for compulsory automobile insurance is perfectly inelastic. Each person subscribes one policy at most, whatever its price is, provided that the surplus she derive from using a car is nonnegative. Consequently, as far as the surplus of the marginal consumer is non-negative at the highest premium, the overall demand for motor insurance is inelastic too.

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[18] On this point, see for example Porrini (2002) for Europe, and Dionne and Belhadji (1996) and Caron and Dionne (1997) for Canada.

[19] To some observers third party motor insurance may look like a homogeneous product with little propensity to differentiation. However, as a matter of fact, during the last decade, even in countries where third party insurance represents a very large share of motor insurance (such as Portugal and Italy), companies have intensively (and successfully) sought to differentiate motor insurance policies in terms of accessory characteristics, coverage and guarantees on one side and financial reliability on the other. This behaviour has been probably due at least to two reasons: first, differentiation has been seen as a means to gain market shares on competitors in the deregulated context; second, third party liability insurance has turned out to be the worst branch of the business in terms of profitability so that companies have tried to assembly a more flexible, comprehensive and profitable (for them) product. Also, from a theoretical viewpoint, models of spatial competition have already been used in the literature on motor insurance for example by Buzzacchi and Valletti (2002), who employ the Hotelling framework to describe the categorisation and price discrimination strategies of insurance companies.

Let us assume a continuum of consumers of measure one uniformly distributed on the product space represented by the unit circle and N insurance companies supplying symmetric policy varieties $v_i = i / N$ at premiums p_i, with i = 1, … , N. Let U be the utility arising from being able to use the insured car (net of alternatives such as car renting, sharing, etc.), and α the consumers' preference for variety. If insurance is compulsory for driving and the compensation system for damages is third-party, the surplus that an insured consumer j obtains from subscribing the insurance policy with the company i is:

$$S_j = U - p_i - \alpha (v_i - v_j)^2 , \quad \textbf{(1)}$$

where $\alpha (v_i - v_j)^2$ measures the disutility of the distance between the subscribed policy variety and the preferred one, assumed to be quadratic as in Economides (1989).

Consumers choose their favoured policy to maximise surplus, subject to the rationality constraint $S_j \geq 0$. Given the assumption of symmetric varieties, the marginal consumers (i.e., the one who are indifferent between two neighbouring varieties v_i and v_{i+1}), from the right j^- and from the left j^+ are respectively characterised by the ideal varieties $v_j^- = \frac{2i-1}{2N} + \frac{N(p_i - p_{i-1})}{2\alpha}$ and $v_j^+ = \frac{2i+1}{2N} + \frac{N(p_{i+1} - p_i)}{2\alpha}$. If U is sufficiently high to allow all consumers to buy a policy, i.e., if $U - \frac{\alpha}{2N^2} \geq \max p_i$, the individual firm's demand is:

$$D_i = \frac{1}{N} + \frac{N(p_{i+1} + p_{i-1} - 2p_i)}{2\alpha} \quad \textbf{(2)}$$

To carry out their business, insurance companies face variable and fixed costs. Variable costs can be ideally divided into two categories: policy costs (C_i^P) and indemnification costs (C_i^I). The former include all the operating costs related to the policy subscription and management and are independent on the amount of accidents: $C_i^P = c_P D_i$. The latter encompass all the costs related to any event of accident involving their insured driver(s); these costs can be likely represented as a share q of subscribed policies.

When the severity of damages is drivers' private information, a problem of moral hazard can occur, as the insured has an obvious incentive to overestimate the damage. Insurers may try to discourage fraudulent behaviours through auditing and monitoring activities which enable them to collect information to contrast exaggerated claims before a court. In particular, we assume that indemnification costs are inversely proportional to the effectiveness of auditing[20] in deterring frauds (and therefore reducing costs), which in turn depends on investments that companies make in monitoring structures, like legal departments, informational systems, contract designs, garages, and so on, i.e. $C_i^I = [c_I - \theta\, e(m_i)]qD_i$.

In our framework investments in monitoring structures represent the only fixed costs of insurance companies (MC_i). These costs are not dependent on the amount of policies since monitoring investments are determined before marketing and selling insurance policies. Let m_i denote the size of the insurance company i monitoring structure. Assuming that monitoring investment costs are a quadratic and increasing function of m_i: $MC_i = \left(\mu m_i^2/2\right)$, and that the effectiveness of auditing is linearly related to the size of the monitoring structure, i.e. without loss of generality $e_i = m_i$, we easily get total costs:

$$TC_i = [c - \beta m_i]D_i + \frac{\mu m_i^2}{2} \tag{3}$$

where $c = (c_P + qc_I)$, and $\beta = \theta q$. From (2) and (3), it follows that expected profits amount to:

$$\pi_i = [\, p_i - c + \beta m_i] \left[\frac{1}{N} + \frac{N}{2\alpha}(p_{i-1} + p_{i+1} - 2p_i)\right] - \mu \frac{m_i^2}{2} \tag{4}$$

Each insurance company takes part in a sequential two stage games. In the first stage, it chooses the size of its monitoring apparatus, while in the second stage the optimal premium has to be determined. The solution notion is the subgame-perfect Nash equilibrium. A pair of arrays **($\mathbf{p}^*$, $\mathbf{m}^*$)** is an equilibrium if $\pi_i\left(p_i^*, \mathbf{p}_{-\mathbf{i}}^*, m_i^*, \mathbf{m}_{-\mathbf{i}}^*\right) \geq \pi_i\left(p_i, \mathbf{p}_{-\mathbf{i}}^*, m_i, \mathbf{m}_{-\mathbf{i}}^*\right)$, for all m_i and p_i.

4. Premiums, monitoring costs and profits under competition, regulation and collusion.

In this section we derive the pure-strategy symmetric equilibrium for monitoring investments and insurance premiums under three different market regimes. We start from the case of regulation and then shift to consider oligopolistic competition respectively with free pricing or collusion among producers.

[20] Here we assume an exogenously given negative relationship between auditing activities and indemnification costs. A recent strand of models on costly state falsification endogenously derive similar kinds of relations; see for example Crocker and Morgan (1998) and Crocker and Tennyson (2002).

4.1. *Regulation*

Here we define regulation as a regime characterised by two constraints imposed by a public regulator. The first constraint concerns the number of firms (for instance one could think that only domestic firms are admitted to enter the market) while the second constraint aims at keeping price under a given threshold.

Let $\overline{N}$ and $\overline{p}$ be respectively the number of firms and the highest insurance premium allowed by the authority. Let us assume that $\overline{p}$ be lower than the lowest optimal price that firms would choose in the absence of price constraints, so that all companies make premiums equal to $\hat{p}_i^R = \overline{p}$, facing each an individual demand $D_i = 1/\overline{N}$. Substituting into (4) and maximizing with respect to m_i, one immediately finds that optimal monitoring investment is:

$$\hat{m}_i^R = \hat{m}^R = \frac{\beta}{\mu\overline{N}} \qquad \textbf{(5)}$$

Substituting back this value into the profit function, it is straightforward to verify that:

$$\hat{\pi}_i^R = \hat{\pi}^R = \frac{1}{\overline{N}}\left[\hat{p}^R - c + \frac{\beta^2}{2\mu\overline{N}}\right] \qquad \textbf{(6)}$$

4.2. *Competition with free pricing and entry*

Now, suppose that Government makes the decision to liberalize the motor insurance market by removing price regulation and constraints on entry. For the sake of realism, we distinguish between short run and long run. In the short run, the number of firms remains the same as in regulation (i.e., $N^S = \overline{N}$). In the long run it may endogenously change, assuming free entry, in response to profits dynamics.

4.2.1. *Short run equilibrium*

Consider the price-game first. In this stage firms, which have previously invested in monitoring structures m_1, ..., $m_{\overline{N}}$, have to choose premiums simultaneously. Maximising (4) with respect to p_i yields the reaction function of company *i*:

$$p_i = \frac{p_{i-1}}{4} + \frac{p_{i+1}}{4} + \frac{\alpha}{2\overline{N}^2} + \frac{c}{2} - \frac{\beta}{2} m_i \quad . \tag{7}$$

The equilibrium premium vector is therefore obtained by solving the system

$$\mathbf{p} = \mathbf{A}^{-1}\mathbf{y} \tag{8}$$

where

$$\mathbf{A} = \begin{bmatrix} 1 & -\frac{1}{4} & 0 & 0 & 0 & 0 & .... & -\frac{1}{4} \\ -\frac{1}{4} & 1 & -\frac{1}{4} & 0 & 0 & 0 & .... & 0 \\ 0 & -\frac{1}{4} & 1 & -\frac{1}{4} & 0 & 0 & .... & 0 \\ 0 & 0 & -\frac{1}{4} & 1 & -\frac{1}{4} & 0 & .... & 0 \\ .... & ..... & ..... & ..... & ..... & ..... & .... & ..... \\ .... & .... & .... & .... & .... & .... & .... & .... \\ -\frac{1}{4} & 0 & 0 & 0 & .... & 0 & -\frac{1}{4} & 1 \end{bmatrix}; \text{ and } \mathbf{y} = \begin{bmatrix} \frac{1}{2}\left(\frac{\alpha}{\overline{N}^2} + c - \beta m_1\right) \\ .... \\ .... \\ \frac{1}{2}\left(\frac{\alpha}{\overline{N}^2} + c - \beta m_i\right) \\ .... \\ .... \\ \frac{1}{2}\left(\frac{\alpha}{\overline{N}^2} + c - \beta m_{\overline{N}}\right) \end{bmatrix}$$

Matrix **A** is a positive definite circulant Toeplitz matrix. This means that the inverse $\mathbf{A}^{-1}$ does exist – so that system (7) admits solution – and that it is in turn a circulant matrix. Also, we can state

Lemma 1. Let $a^{i\pm j}$ for *j=0, 1…N-1*, be a generic element of matrix $\mathbf{A}^{-1}$. For any value of *N*, the following properties hold: (1) $a^{i-j} = a^{i+j}$ for any *i* and *j*; (2) $a^i > 1$ for any *i*; (3) $\sum_j a^{i\pm j} = 2$ for any *i* and for *j=1…N-1*; (4) $0 \le a^{i\pm j} < 1$ for any *i* and *j*.

Proof: See Appendix.

On the basis of Lemma 1, the equilibrium premium charged by firm *i* is:

$$p_i = \frac{\alpha}{\overline{N}^2} + c - \frac{\beta}{2}(\mathbf{a}^i)\mathbf{m} \tag{9}$$

where $\mathbf{a}^i$ denotes the i-th row of matrix $\mathbf{A}^{-1}$ and $\mathbf{m}$ is the vector of monitoring structures.

Moving to the second stage, we can substitute (9) in (4) to obtain:

$$\pi_i = \left[\frac{\alpha}{\overline{N}^2} - \frac{\beta}{2}(\mathbf{a}^i)\mathbf{m} + \beta m_i\right]\left[\frac{1}{\overline{N}} + \frac{\overline{N}}{2\alpha}\left(\beta(\mathbf{a}^i)\mathbf{m} - \frac{\beta}{2}(\mathbf{a}^{i-1})\mathbf{m} - \frac{\beta}{2}(\mathbf{a}^{i+1})\mathbf{m}\right)\right] - \mu\frac{m_i^2}{2} \qquad \textbf{(10)}$$

Deriving (10) with respect to m_i and setting $m_i = \hat{m}^S$ for any *i*, one easily gets the symmetric equilibrium size of the monitoring structure. In particular, recalling lemma 1, it comes out:

$$\hat{m}_i^S = \hat{m}^S = \gamma^S \hat{m}^R = \gamma^S \frac{\beta}{\mu\overline{N}} \qquad \textbf{(11)}$$

where $\gamma \equiv 1 - \frac{a^{i\pm1}}{2}$ and γ^S is the specific value of γ for $N^S = \overline{N}$. Remarkably, due to property (4) of Lemma 1, $\frac{1}{2} < \gamma \leq 1$, for any value of *N*.

Finally, substituting back (11) in (9) and then in (4), we get the equilibrium price made by every company as well as their expected profits:

$$p_i^S = p^S = \frac{\alpha}{\overline{N}^2} + c - \frac{\gamma^S \beta^2}{\mu\overline{N}} \qquad \textbf{(12)}$$

$$\hat{\pi}_i^{SF} = \hat{\pi}^{SF} = \frac{1}{\overline{N}}\left[p^S - c + \beta\hat{m}^S\right] - \mu\frac{\hat{m}^{S2}}{2} = \frac{\alpha}{\overline{N}^3} - \frac{\gamma^{S2}\beta^2}{2\mu\overline{N}^2} \qquad \textbf{(13)}$$

From (5), (6), (11), (12) and (13), we can easily derive the following results.

Result 1. *Moving from a regulated to a free pricing context, in the short run investments in monitoring structures reduce as shown by (11). Also, if under regulation premiums are not too low, profits can reduce even when insurance premiums increase i.e., more specifically,* $\hat{\pi}^S < \hat{\pi}^R \Leftrightarrow \hat{p}^S < \hat{p}^R + \frac{\beta^2(1-\gamma^S)^2}{2\mu\overline{N}}$ or, substituting for $\hat{p}^S$, $c + \alpha/\overline{N}^2 < \hat{p}^R + \frac{\beta^2(1+\gamma^{S2})}{2\mu\overline{N}}$.

Result 1 is consistent with the evidence on claims and premiums dynamics reported in Section 2 as well as with the "populist view" that in a free market pricing regime companies reduce monitoring investment since they may pass the higher expected fraud costs along to consumers by increasing policy rates[21]. As a consequence, if the policy rate under regulation was not very low, the profit of insurers may decrease, and turn out to be even negative, although policy rates are increasing.

The intuition of Result 1 can be given by considering the different effects of unit changes in *m* on profits in the two different regimes. In case of regulation, an increase in *m* gives merely place to the positive effect of reducing marginal costs, whereas it do not affect either price (which is fixed) or individual demand. Conversely, if competition holds, out of equilibrium increasing *m* leads to a reduction in optimal prices. When demand is sufficiently rigid and variable costs are high, this can push revenues and profits downward, reducing the incentive to monitoring investment.

In equilibrium, the decrease in monitoring investments brings about an increase in frauds and therefore in total costs which leads prices upward. If saving in fixed costs is small (i.e. if μ is small), while the rise of frauds is large (i.e. if β is large), it is possible that following deregulation profits may shrink in the short run.

4.2.2. *Long run equilibrium*

Turning to the long run, let us now consider the possibility that, given the removal of constraints on entry, the number of firms may endogenously vary in response to profit dynamics. Compared to Salop (1979), in our case the long run analysis is made more difficult by the fact that the parameter γ varies along with *N*. However, since the magnitude of γ is limited, the result of a finite number of firms still holds. In particular, hinging on (12) and (13), it is straightforward to verify that:

Result 2. *Without barriers to entry, in the long run profits are driven to zero as the number of operating companies approaches* $N^L = I\left\lfloor 2\alpha\mu / \beta^2 {\gamma^L}^2 \right\rfloor$, *where* $I[\bullet]$ *indicates the integer part of the number in parentheses, and premiums are* $\hat{p}^L = c - \dfrac{{\gamma^L}^3 \beta^4}{2\alpha\mu^2}\left(\dfrac{2-\gamma^L}{2}\right)$.

More than the long run final equilibrium, the transition between short run and long run equilibrium seems worthwhile being explored. In particular it is interesting to notice that in contrast with the conclusions of the Salop model and with the popular arguments sustaining the deregulation

[21] Concerning the relations between fraud costs and prices, it is interesting to point out that the reason why Cummins and Tennyson (1992, p. 161) dismiss the "populist view" as a blunder is that they only consider the effect of past losses on prices. In this case, of course, "past losses represent sunk costs [and] companies attempting to load prior losses into rates for future periods would lose market share to competitors and new entrants that did not use retroactive loadings".

of insurance markets, an increase (decrease) in the number of companies may be accompanied by an increase (decrease) of insurance rates. This result is due to the circumstance that when fixed costs and marginal costs are endogenous, equilibrium prices and profits are no longer monotonically decreasing in *N*. It is therefore possible that, for a given number of firms in the market, profits be positive and equilibrium price be on the increasing section of price function given by equation (12).

To see more closely the evolution of *N* and *p* from the short to the long run equilibrium, we need first define $\eta_{\gamma,N} \equiv \frac{N\Delta\gamma}{\gamma}$ where $\Delta\gamma$ is the finite change associated to a unit change in *N*. Simulations run over *N* ranging from 2 to 100 indicate that $0 < \eta_{\gamma,N} < 1$ and that $\eta_{\gamma,N}$ decreases as *N* increases. Therefore we can state

Lemma 2. The symmetric equilibrium premium reaches its minimum when $N = \tilde{N} = I\left[2\alpha\mu / \beta^2 z\tilde{\gamma}\right]$, where $z \equiv 1 - \eta_{\gamma,N}$. A sufficient condition for $N^L > \tilde{N}$ is $\gamma_L < \sqrt{z/2}$ [22].

As shown in figure 2, lemma 2 implies that the profit function (13) intersects the horizontal axis at the right of the point corresponding at minimal optimal price. This leaves room to different possible dynamics in the transition from the regulatory regime to the long run free pricing equilibrium, according to the initial number of firms admitted by regulation. In particular, at least three different cases may occur, as illustrated by figure 2 and stated by

Result 3. *If $\overline{N} < \tilde{N}$ then, following deregulation, profits are positive, the number of firms increases and prices go initially down and then turn upward. If $\tilde{N} < \overline{N} < N^L$, profits will be still positive, the number of firms increase while prices tend to grow. Finally, if $\overline{N} > N^L$, shifting to free market leads profits below zero, some firms exit the market and premiums go down.*

The explanation of the unusual non monotonic relationship between prices and the number of firms highlighted in Result 3 lies in the behaviour of monitoring investments. When the number of firms increases, monitoring investments decrease because the reduction of individual demand

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In our model, instead, the reduction of monitoring investment allows companies to save sunk costs today at the expense of an increase of expected frauds tomorrow which can be neutralised by an increase in insurance rates.

[22] We verified numerically (for suitable values of parameters) that this condition actually holds by starting from *N=2* and then increasing *N* and so pushing profits downward to zero.

reduces the relevance of price over marginal cost with respect to fixed cost[23]. Prices, which on one hand go down, as market share is lower, tend on the other hand go up as a consequence of larger claims connected to lower monitoring investments. So the overall response of prices to an increase in the number of companies is ambiguous. In any case, for *N* adequately high, premiums approach the cost *c* as both the differentiation factor and the monitoring benefit tend to vanish. Prices approach *c* from below; therefore a larger number of firms involve higher costs (due to larger claims) and prices.

[Insert Figure 2]

4.3. *Collusion*

Let us finally consider a collusion regime. Suppose that immediately after market liberalisation, firms create a cartel by engaging in explicit or tacit collusive agreements, so that $N^C \equiv \overline{N}$. Let $\hat{p}^C$ denote the highest price that makes the collusive agreement feasible, given the intertemporal preferences of companies, the importance that consumers attach to their idiosyncratic preferences and the punishment strategies of non-deviating companies. In this case, optimal monitoring investments and profits are respectively

$$\hat{m}_i^C = \hat{m}^C = \hat{m}^R = \frac{\beta}{\mu\overline{N}} \quad \textbf{(14)}$$

and

$$\hat{\pi}_i^C = \frac{1}{\overline{N}}\left[\hat{p}^C - c + \frac{\beta^2}{2\mu^R N}\right] \quad \textbf{(15)}$$

Comparing (14) with (5) and (15) with (6), we can establish the following

Result 4. *Optimal monitoring investment under collusion and regulation are equal and bigger than optimal monitoring investment under free pricing competition. If rates charged by companies engaged in collusion are higher than rates fixed by the regulating authority, then profits must be higher too.*

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[23] Analytically, it can be easily shown that $\Delta m = -\frac{\beta z \gamma}{\mu N^2}$.

Again, if price is fixed, due to regulation or collusion, monitoring investments are more valuable because the savings they bring about in terms of fewer claims translate into the price over cost margin without affecting the price. Profits clearly follow the dynamics of prices. Therefore, unlike the competition case, we cannot observe at the same time increasing prices and decreasing or stable profits, as often occurred in some European countries during the last decade.

5. Concluding remarks

The poor results of liberalization of the European motor insurance market can be hardly explained only by exogenous cost increases or collusive practices by producers. The impressive escalation of claims highlights a possible change in the companies' attitude, which has become less effective in contrasting fraudulent behaviours. In this paper we have argued that such a change may have occurred because the competitive context has made less profitable for firms to invest in monitoring structures as the implied larger compensation costs could be recovered by rising premiums.

Appendix

Proof of Lemma 1:

Property (1) is due to the symmetry properties of circulating matrices. Property (2) derives from the fact that positive definite matrices have $a^{i,i} \geq 1/a_{i,i}$, with equality if and only if $a_{i,j} = 0 \quad \forall j \neq i$, see Rao (1973), page 74, property 20.2. In our case clearly $a_{i,i} = 1$ and $a^{i,i} \equiv a^i > 1$.

To prove property (3), consider a generic row of matrix $\mathbf{A}$, say, without loss of generality, the first row. Multiplying by $\mathbf{A}^{-1}$, one gets the system

$$a_1 a^1 + a_2 a^N + \ldots + a_{N-1} a^3 + a_N a^2 = 1$$
$$a_1 a^2 + a_2 a^1 + \ldots + a_{N-1} a^4 + a_N a^3 = 0$$
$$\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots$$
$$a_1 a^N + a_2 a^{N-1} + \ldots + a_{N-1} a^2 + a_N a^1 = 0$$

Summing up, one obtains

$$a_1 \sum a^i + a_2 \sum a^i + \ldots + a_{N-1} \sum a^i + a_N \sum a^i = 1$$

hence

$$\sum a^i = 1/\sum a_i \, .$$

In the specific case of matrix $\mathbf{A}$, regardless the value of *N*, we have $\sum a_i = 1/2$ whence property (3) of Lemma 1 immediately follows.

Finally property (4) stems from the coefficients of matrix $\mathbf{A}$ and the previous properties (2) and (3).

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