From regulation to free market: the experience of the European motor insurance market[•]

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Abstract

Increasing premiums, increasing claims and decreasing profits are three striking facts associated in some European countries to motor insurance liberalization of 1990's. In this paper, we argue that these phenomena may be considered not a consequence of collusion or other misapplications of deregulation but rather an effect of the impact of liberalization on the companies' optimal choices. In particular, by extending the Salop-Economides model, we show that price deregulation involves decreasing investments in monitoring and increasing compensation costs. Therefore, the transition from regulation to competition can yield prices and profits moving in either direction and possibly opposite directions.

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1. Introduction

More than a decade has now gone by since the second and third EU directives on non-life insurance were adopted 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 to favour competition in an industry which had been long protected. However, in several countries, liberalization has yielded such unexpected and disappointing results as to induce many observers to assess it as a failure, at least as regards motor liability insurance[1]. The most salient features of this failure are well summarised in the controversy arising between consumers (insured drivers) and companies (insurers), both being unhappy with liberalization and disputing responsibilities for its poor outcome.

The consumers' *cahier de doléance* consists of two main complaints: first, in several countries, average prices of policies 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 chiefly, if not solely, responsible for fare inflation: they are said to have taken the chance offered by the new regime of free pricing to collude[2], reduce their effort to

[1] For example, this seems to be the opinion of the Italian antitrust authority – AGCM (2003) – as well as of the authors of the BdV report on European car insurance tariffs – BdV (2000). In the same vein, Jaffee and Russell (2001) show the many beneficial effects for consumers and companies from the introduction of Proposition 103 that strongly regulated California's car insurance market in November 1988.

[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) and Porrini (2004).

control costs and raise their profits. By contrast, companies protest their innocence vigorously, which hinges on a number of considerations. First, their balance sheets have shown decreasing and sometimes negative profits throughout the decade; second, they reject the suggestion that fare inflation be due to collusion, by stressing the lack of any kind of agreement[3]; third, they blame the harsh competition for forcing them towards increasing price discrimination; fourth, they argue that escalating compensation costs are the real cause of fare inflation and maintain that the main parties responsible for deregulation failure are the increasing car healing and personal bodily injuries costs and above all the pervasive phenomenon of fraud[4].

In this paper, we propose an explanation of the average fare increase occurring in the European motor insurance market which to some extent accepts both consumer and insurer viewpoints. Like insurance companies, we argue that fare inflation may be properly considered not a consequence of collusion or other pathological misapplications of deregulation but rather, as consumers point out, an effect of the impact of liberalization on the companies' optimal choices, in markets characterised by a rigid demand.

Conventional wisdom tends to consider free market (i.e., the absence of barriers to entry and price regulations) as synonymous with perfect competition or 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-

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[3] On this point, it is worth recalling 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).

competitive or imperfectly competitive market features as well as strategic interaction among producers. In this case, one cannot exclude that moving from a regulated context to free market may yield unwelcome surprises.

But how has deregulation involved higher fares? Among many apparently sound explanations, two have been assigned a major role by recent economic literature[5]. The first, as mentioned above, is collusion. A deregulation process taking place in a market characterized by rigid demand, such as compulsory motor insurance, may favour tacit or explicit collusive agreements (or facilitating practices) among companies. Whatever form it takes, collusion should involve an increase in company profits for which, as we will see, there is no clear indication in the data.

The second explanation is connected to the hypothesis that liberalization may have affected the effort of insurers in controlling costs. The latter idea has been explored by the literature which has identified at least two channels through which a deregulated market may give fewer incentives to tackle fraudulent claims: one concerns the optimal indemnification strategies and the other optimal monitoring investment. The optimal indemnification approach has its theoretical underpinnings in the contributions of Lacker and Weinberg (1989), Picard (1996), Bond and Crocker (1997), and Crocker and Tennyson (2002). The optimal monitoring investment approach has probably drawn less attention. To our knowledge, the only formal model following this approach is due to Buzzacchi and Siri (2002) who, in the context of a duopoly model with switching costs, show that price deregulation may reduce the incentive to invest in monitoring and therefore increase costs and prices. In this paper we embody a similar idea in a spatial imperfect competition model which extends the analysis to cover long run issues, allowing for an endogenously determined number of firms.

[5] See Cummins and Tennyson (1992) for a survey of alternative explanations.

We start from the simple and commonly shared idea that part of the compensation costs borne by insurers is not exogenous but is negatively related to their effort in claims processing and investments in monitoring structures, like legal departments, informational systems, contract designs, garages and so on. Therefore, if deregulation of motor insurance market affects marginal costs and benefits from monitoring investment, the optimal size of monitoring structures may scale down, altering costs, prices and profits.

To implement this idea we propose 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, thus 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. Hence, as long as the number of firms remains unaltered, the transition from regulation to competition can yield prices and profits moving in either direction and possibly opposite directions, as has actually occurred in some European countries. In particular, it is easy to show that to obtain profits equal to those admitted by the regulator, insurers must increase premiums. Even in the long run, when the number of firms endogenously change, premiums may again go down or up, according to the dominance of a "competition effect" connected to entries or to a "cost effect" due to lower monitoring investments resulting from the reduction in market share.

If price collusion takes place, the outcome is different. The optimal effort, and therefore claims, remain at the same level as in regulation (which, for a given number of firms, is also the welfare maximizing level) and costs stay unaltered too. In this case, price increases may obviously occur, but they must be associated with increasing profits. Remarkably, in both imperfect competition and collusion, 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. Indeed, if companies were price-takers, the liberalization of the car insurance market would not cause a reduction in monitoring investments since they would be unresponsive to the circumstance that a regulator rather than market-mechanism makes the price.

The rest of the paper is organized as follows. In section 2, we present a short outline of some 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 the simple formal framework which allows us to analyse the possible short-run (section 4) and long-run effects (section 5) of deregulation on prices, compensation costs and profits in the cases of imperfect competition and collusion. Section 6 concludes.

2. The deregulation of the European motor insurance market: some stylised facts

While the controversy between consumers and insurers sketched in the introduction is a useful shortcut to approach the topic, the discussion about the recent disappointing evolution of the European motor liability insurance market has obviously been much richer. In what follows, with the help of some descriptive data, we will review the basic issues of the debate, selectively emphasizing the points most relevant to our argument.

The most striking facts connected to motor insurance liberalization are the increasing price differentiation and average fare inflation. Although price dispersion is not the objective of this paper, it deserves at least a mention. In fact, during the deregulation process, market segmentation into consumers' risk classes has substantially grown. It is well known that when facing adverse selection problems or when strategically competing in imperfectly competitive markets, insurers can find it profitable to group drivers into categories according to some discriminating variables (sex, race, married status or place of abode) statistically correlated to risk, and charge risk-adjusted premiums[6]. However, while being effective in reducing adverse selection, this behaviour may entail major undesired consequences in terms of average premiums[7], consumer discrimination and social exclusion[8]. As a consequence, the sensitiveness of consumers and policy makers toward the problem of discrimination in motor insurance markets has recently significantly risen so that some governments look currently oriented to recover some room for regulatory intervention[9].

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[6] 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).

[7] 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 may well be driven toward too high, to socially inefficient levels which can make it an autonomous source of premium inflation – Buzzacchi (1998) and Buzzacchi and Valletti (2002).

[8] Increasing customers classification, by reducing the cross-subsidization among low risk and high risk drivers, may easily turn into social exclusion, calling in question the right to mobility of some citizens. Many 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 the European Parliament (2001) for Finland, Meyer (2000) for Germany, Buzzacchi and Siri (2002) for Italy and Smith and Wright (1992) for the United States.

[9] 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 has more or less effectively 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, the

Concerning fare inflation, Figure 1 shows its quantitative importance during the 1990s. Each panel shows the dynamics of premiums, claims and loss ratio (i.e. claims over premiums ratio) together with a Consumer Price Index for one of the ten countries considered[10]. 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.

Inspection of Figure 1 shows that real premiums and claims have increased in all the countries considered, although at very different rates, while the evolution of the loss ratio seems to support the hypothesis that companies have generally obtained equal or lower profits.

[Insert Figure 1]

In the face of this unexpected evidence, a preliminary point is to understand whether the boom in fares should be imputed to deregulation or rather to factors exogenous to insurance markets. A closer look at the data reported in Figure 1 may help to decide between these two possibilities. First of all, data clearly show that fare inflation has not been homogeneous throughout Europe but stronger where deregulation has been more effective with respect to initial market conditions. In fact, we can distinguish, by and large,

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.

[10] 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.

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[11] (which by the way is in a dispute over admissibility) plus Germany. Another group, to which Denmark, Netherlands and Norway belong (i.e. countries which already had a relatively free motor insurance market before 1994), appears to have faced a moderate fare inflation[12]. Finally, there is a third group, including Finland, Italy and Portugal, which is the one most affected by liberalization, as these countries experienced marked regulation until the early 1990s and then rapid deregulation[13]. These countries are clearly those which show, together with Ireland[14], the fastest growth in premiums, far exceeding consumer price inflation.

Second, the impressive escalation of claims indicates that increase in costs and fraud have played a crucial role in the evolution of premiums. Such a remarkable increase in claims can hardly be seen as entirely exogenous. It is certain true that numerous exogenous components of compensation costs have undergone significant changes over the decade, giving rise to some effects on premiums. The progress in diagnostic instruments and therapies, as well as the availability of more technologically advanced automobiles, has certainly entailed a growth in expenses for medical treatment and car healing. Also, a role

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

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

[13] Actually, Portugal had strict regulation until 1986. Then public intervention was progressively reduced up to full deregulation in 1989 – see Barros (1996).

[14] As highlighted by the data of the Irish Insurance Federation, the case of Ireland is characterised by a strong increase in the number and severity of accidents.

may have been played by increasing legal expenses (which often induce insurers to settle claims out of court), as well as wider protection granted to the victims of road accidents (including pedestrians and cyclists)[15]. Finally, even declining interest rates (which increase the present discounted value of future claims) and increasing tax rates may have helped to raise costs. Nevertheless, the unfavourable evolution of exogenous costs cannot explain why fare inflation has been so heterogeneous across European countries. Moreover, other cost issues, like operational costs or underwriting expenses, showed a declining trend throughout the 1990s, partly offsetting the rise in compensation costs. Finally, the fact that fare inflation has always been much higher than consumer price inflation makes it hard to attribute sole responsibility for rising premiums to rising compensation costs.

Besides compensation costs, the number of cases involving fraud also seems to have risen sharply in the 1990s. This is directly confirmed in some empirical investigations[16] and is also suggested by several indications. In many countries, detected fraud has steadily increased. In 2002, the number of claims rejected by Norwegian insurers as fraudulent was the highest ever recorded. In Ireland, the Irish Insurance Federation has recently denounced a continuous increase in the amount of fraud over the last three years. The Italian insurers association ANIA has carried out several investigations on the topic showing that in that country the problem of fraud is particularly serious. Moreover, data show situations so differentiated among countries that they can be hardly ascribed to other than fraud. For instance, the share of people involved in road accidents suffering from whiplash associated disorders with respect to the overall number of injured is currently around 66% in Italy (more than doubling in one decade) and 40% in Germany while in France, Norway and Denmark does not exceed 6%. Similarly, between 1992 and 2001, the average cost of

[15] Incidentally, the recent proposal for the fifth Motor Insurance Directive takes further steps in this direction.

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

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 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.

However, even recognizing the increase in the amount of fraud, it is difficult to justify a significant change in the propensity to fraud as an exogenous phenomenon, without considering a change in the profitability and/or success probability of frauds. It may therefore be hypothesized that deregulation has reduced the incentives to monitor claims or led companies to take a more conciliatory approach toward claimants as, in the presence of an imperfectly competitive market, companies have been able to translate higher compensation costs into higher fares.

All in all, it seems clear that the conjecture that premium escalation experienced in European countries[17] has been a direct consequence of liberalization looks definitely more realistic than the alternative of an entirely exogenous increase in costs. Moreover, the evolution of loss ratios, depicted in Figure 1, shows that the third party motor insurance industry did not enjoy a particularly brilliant season in the 1990s in any European country, and especially in those countries in which the premium increase was more pronounced. For the latter cases, the data indicate that prices and profits often moved in opposite directions. Such evolution is barely consistent with the hypothesis of collusion among producers and calls rather for alternative explanations.

[17] During the 1980s, the U.S. insurance market lived an analogous experience of increasing premiums. In this case, the absence of any major structural or institutional change led 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).

3. The model

We describe the motor insurance market as a horizontally differentiated oligopoly *à la* Salop (1979) with endogenous fixed costs. Spatial competition models fit the main features of the automobile liability insurance market fairly well[18]. Motor insurance products can be considered strategic complements in prices, and typically differ in 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, provided that the surplus he/she derives from using a car is non-negative. Consequently, as long as the surplus of the marginal consumer is non-negative at the highest premium, the overall demand for motor insurance is inelastic too.

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

[18] Empirical surveys concerning different countries and times show that consumers tend to perceive the quality of car insurance products heterogeneous among companies – Cummins et al. (1974); Schlesinger and von der Schulenburg (1990). Moreover, during the last decade, even in countries where third party insurance represents a very large share of the motor insurance market (such as Portugal and Italy), companies have intensively sought to differentiate motor insurance policies in terms of accessory characteristics, coverage, guarantees and financial reliability, as a means to gain market shares on competitors in the deregulated context and design more flexible, comprehensive and profitable products able to compensate losses deriving from the third party liability insurance branch. Finally, from a theoretical viewpoint, models of spatial competition have already been used in the literature on motor insurance for example by Schlesinger and von der Schulenburg (1991), and Buzzacchi and Valletti (2002).

symmetric policy varieties[19] $v_i = i/N$ 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 a 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 k obtains from subscribing to the insurance policy with company i is:

$$S_k = U - p_i - a(v_i - v_k)^2 \qquad \textbf{(1)}$$

where $a(v_i - v_k)^2$ 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 $S_k \geq 0$. Given the assumption of symmetric varieties, the marginal consumers (i.e., those who are indifferent between two neighbouring varieties v_i and v_{i+1}), from the right k^- and from the left k^+ are respectively characterised by the ideal varieties $v_k^- = \frac{2i-1}{2N} + \frac{N(p_i - p_{i-1})}{2a}$ and $v_k^+ = \frac{2i+1}{2N} + \frac{N(p_{i+1} - p_i)}{2a}$. If U is sufficiently high to allow all consumers to buy a policy, i.e., if $U - \frac{a}{4N^2} \geq p_{\max}$, the individual firm's demand is:

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

[19] Confining the attention to the case of symmetric varieties is not strongly restrictive as it can be proved that symmetric location is an equilibrium in this type of spatial competition models; see, Novshek (1980) and Economides (1989).

To carry out their business, insurance companies face variable and fixed costs. Variable costs (VC_i) 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 of the number of accidents: $C_i^P = c_P D_i$. The latter encompass all the costs related to any accident involving their insured driver(s); these costs may be represented as a share q of subscribed policies.

When the severity of damage is the driver's 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 behaviour through auditing and monitoring which enable them to collect information to counter 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, information systems, contract designs, garages, and so on, i.e. $C_i^I = [c_I - \theta e(m_i)]qD_i$, with $\theta > 0$.

In our framework investments in monitoring structures represent the only fixed costs of insurance companies (FC_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 monitoring structure of insurance company *i*. Assuming that monitoring investment costs are an increasing quadratic function of m_i i.e. $FC_i = \left(\mu m_i^2 / 2\right)$,

[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, Bond and Crocker (1997), Crocker and Morgan (1998) and Crocker and Tennyson (2002).

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:

$$TC_i = VC_i + FC_i = [c - \boldsymbol{b} m_i] D_i + \frac{m m_i^2}{2} \qquad \textbf{(3)}$$

where $c = (c_P + q c_I)$, and $\boldsymbol{b} = \boldsymbol{q} q$. From (2) and (3), it follows that profits amount to:

$$\boldsymbol{p}_i = [\, p_i - c + \boldsymbol{b} m_i] \left[\frac{1}{N} + \frac{N}{2\boldsymbol{a}} \left(p_{i-1} + p_{i+1} - 2 p_i \right) \right] - m \frac{m_i^2}{2} \qquad \textbf{(4)}$$

Each insurance company takes part in a sequential two-stage game. 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 $\boldsymbol{p}_i \left(p_i^*, \mathbf{p}_{-\mathbf{i}}^*, m_i^*, \mathbf{m}_{-\mathbf{i}}^* \right) \geq \boldsymbol{p}_i \left(p_i, \mathbf{p}_{-\mathbf{i}}^*, m_i, \mathbf{m}_{-\mathbf{i}}^* \right)$, for all m_i, p_i and any company *i*.

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

In this section, we derive the pure-strategy symmetric equilibrium for monitoring investments and insurance premiums under regulatory, imperfectly competitive and collusive regimes always assuming a fixed number of companies. In the next section, we extend the analysis to the long run by allowing for endogenous changes in the number of incumbent firms.

4.1. *Regulation*

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 it might be supposed that only domestic firms are admitted to the market), while the second constraint aims at keeping prices 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[21].

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

$$\hat{m}_i^R = \hat{m}^R = \frac{b}{m\overline{N}} \quad \textbf{(5)}$$

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

$$\hat{p}^R = \frac{1}{\overline{N}}\left[\overline{p} - c + \frac{b^2}{2m\overline{N}}\right] \quad \textbf{(6)}$$

After describing imperfect competition and collusion, we will be able to compare the regulation vector of values $\left(\overline{p}, \hat{m}^R, \hat{p}^R\right)$ with the market outcome.

[21] The issues concerning how the regulator chooses the price cap $\overline{p}$ and how he/she tackles the productive and allocative efficiency problems generated by asymmetric information are beyond the scope of this paper. So, for the sake of simplicity, we assume that the regulator sets the price equal to a constant.

4.2. *Imperfect competition*

Let us 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., $N^S = \overline{N}$) while in the long run it may endogenously change, assuming free entry, in response to profits dynamics. Postponing the latter case to the next section, now we deal with the short run equilibrium.

Consider the price subgame first. At 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*:

$$p_i = \frac{p_{i-1}}{4} + \frac{p_{i+1}}{4} + \frac{a}{2\overline{N}^2} + \frac{c}{2} - \frac{b}{2} m_i \qquad \textbf{(7)}$$

The equilibrium premium vector is therefore obtained by solving the system

$$\mathbf{p} = \mathbf{A}^{-1}\mathbf{y} \qquad \textbf{(8)}$$

where

$$\mathbf{A} = \begin{bmatrix} 1 & -\frac{1}{4} & 0 & 0 & 0 & 0 & .... & -\frac{1}{4} \\ -\frac{1}{4} & 1 & -\frac{1}{4} & 0 & 0 & 0 & .... & 0 \\ 0 & -\frac{1}{4} & 1 & -\frac{1}{4} & 0 & 0 & .... & 0 \\ 0 & 0 & -\frac{1}{4} & 1 & -\frac{1}{4} & 0 & .... & 0 \\ .... & ..... & ..... & ..... & ..... & ..... & .... & ..... \\ .... & .... & .... & .... & .... & .... & .... & .... \\ -\frac{1}{4} & 0 & 0 & 0 & .... & 0 & -\frac{1}{4} & 1 \end{bmatrix}; \text{ and } \mathbf{y} = \begin{bmatrix} \frac{1}{2}\left(\frac{a}{\overline{N}^2} + c - bm_1\right) \\ .... \\ .... \\ \frac{1}{2}\left(\frac{a}{\overline{N}^2} + c - bm_i\right) \\ .... \\ .... \\ \frac{1}{2}\left(\frac{a}{\overline{N}^2} + c - bm_{\overline{N}}\right) \end{bmatrix}$$

Matrix **A** is a symmetric circulant matrix. It is positive definite and invertible, as it can be considered a Leontief matrix, so that system (8) admits solution. The inverse $\mathbf{A}^{-1}$ is in turn symmetric and circulant and all its elements are non-negative. Also, we can state

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

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 investments in monitoring structures made by all companies.

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

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

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, by recalling properties (2) and (4) of lemma 1, it emerges that:

$$\hat{m}^S = g\frac{b}{m\bar{N}} = g\hat{m}^R \quad \textbf{(11)}$$

where $g \equiv 1 - a^{i-1,i}/2$ indicates the degree of market competitiveness or, what is the same, the weight of neighbour rivals. Substituting (11) back in (9) and then in (4), we get the equilibrium price made by every company as well as their expected profits:

$$\hat{p}^S = \frac{a}{\bar{N}^2} + c - \frac{gb^2}{m\bar{N}} \quad \textbf{(12)}$$

$$\hat{\boldsymbol{p}}^S = \frac{1}{\bar{N}}\left[\hat{p}^S - c + b\hat{m}^S\right] - m\frac{\hat{m}^{S2}}{2} = \frac{a}{\bar{N}^3} - \frac{g^2 b^2}{2m\bar{N}^2} \quad \textbf{(13)}$$

Remarkably, due to property (3) of Lemma 1, g is such that $1/2 < g \leq 1$ and increasing with N since the size of the reaction of firm i's closest rivals, $a^{i-1,i}$, tends to become smaller and smaller. In Table 1 we selectively reported numerical computations on g and g/N, for N ranging from 3 to 300. As one can see, g rapidly converges to the value 0.8453 for $N \geq 6$ while g/N steadily decreases to zero.

Table 1 – Numerical computations on g and g/N .

N	g	g/N
3	.800000	.266666
6	.844445	.140740
7	.845071	.120724
9	.845283	.092930
15	.845300	.056353
300	.845300	.002818

From (5), (6), (11), (12) and (13), and taking into account the numerical values of g and $g/\overline{N}$, we can easily derive the following two results:

Result 1. *Moving from a regulated to a free pricing context, investments in monitoring structures decrease as* $\hat{m}^S < \hat{m}^R$ *. While the absolute value of monitoring investments under competition decreases along with* $\overline{N}$ *- i.e.,* $\hat{m}^S(\overline{N}+1) < \hat{m}^S(\overline{N})$ *-, the relative difference with respect to monitoring investments under regulatory regime i.e.* $\left|\frac{\hat{m}^S - \hat{m}^R}{\hat{m}^R}\right| = |g-1|$ *is lower as* $\overline{N}$ *increases and becomes almost constant for* $\overline{N} \geq 6$.

Result 2. *Moving from a regulated to a free pricing context, optimal prices and profits may be higher or lower than in regulation. However, to get the same profit as in regulation, premiums must increase i.e., more specifically,* $\hat{\pi}^S = \hat{\pi}^R \Leftrightarrow \hat{p}^S = \overline{p} + \frac{b^2(1-g^S)^2}{2m\overline{N}}$ *while if premiums stay unaltered, profits decrease* $\hat{p}^S = \overline{p} \Leftrightarrow \hat{\pi}^S < \hat{\pi}^R$.

Results 1 and 2 are consistent with the evidence on claims and premiums dynamics reported in section 2 as well as with the "populist view" that in a free pricing market regime companies reduce monitoring investment since they may pass the higher expected fraud costs over to consumers by increasing premiums[22]. As a consequence, if the regulation

[22] 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". In our model, instead, the reduction in monitoring investment

price was not very low, the profit of insurers may decrease, and turn out to be even negative, despite increasing prices.

In particular, the reduction of monitoring investments can be explained by considering the different effects of unit changes in m on profits in the two different regimes. In the case of regulation, an increase in fixed costs m gives place to the positive effect of reducing marginal costs, whereas it does not affect price (which is fixed) or individual demand. Conversely, in the case of imperfect competition, increasing m also leads to a reduction in optimal prices. When individual demand is rigid, as in symmetric equilibrium, this pushes revenues and profits downward, reducing the incentive to carry out monitoring investment.

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

4.3. *Collusion*

Let us finally consider a collusion regime. Suppose that immediately after market liberalization, the $\overline{N}$ incumbent firms create a cartel by engaging in explicit or tacit collusive agreements. 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:

$$\hat{m}_i^C = \hat{m}^C = \frac{b}{m\overline{N}} \qquad \textbf{(14)}$$

---

allows companies to save sunk costs today at the expense of an increase in expected fraud tomorrow which can be neutralised by an increase in insurance rates.

and

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

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

Result 3. *Under collusion, optimal monitoring investment is the same as in regulation and greater than under imperfect competition. If premiums charged by companies engaged in collusion are higher than rates fixed by the regulating authority, then profits must be higher too.*

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 price. Profits clearly follow the dynamics of prices. Therefore, unlike the imperfect competition case, we cannot observe at the same time increasing prices and decreasing or stable profits, which is what has actually occurred in some European countries during the last decade.

5. Long run and welfare analysis

Following the removal of constraints on entry, in the long run the number of firms may endogenously vary in response to profit dynamics. We assume that whenever a new firm enters the market, the location of producers around the circle (i.e. the produced varieties) changes instantaneously and without cost so that the symmetry assumption always holds[23].

[23] In other words, using the terminology of Norman and Thisse (1996), we analyse the case of *perfect spatial contestability*, while neglecting the other extreme case of prohibitively high relocation costs (*non-spatial contestability*).

As we stated, changes in N involve changes in the parameter g, in the optimal values of monitoring investments and premiums, as well as in profits. Taking into account the numerical computations on g reported in Table 1, in what follows we assume that $\hat{p}_{|N=6} \geq 0$, an assumption that can be considered sufficiently realistic, as it is consistent with the number of companies actually operating in the European insurance market. Formally, this implies that the heterogeneity of insurance products must be sufficiently large and precisely that the following assumption holds:

Assumption 1. $a \geq 2.142 \frac{b^2}{m}$.

Due to Assumption 1, g = 0.845 and hence monitoring investments, prices and profits are respectively:

$$\hat{m}^L = \frac{0.845}{N^L} \frac{b}{m} \qquad \textbf{(11')}$$

$$\hat{p}^L = \frac{a}{N^{L^2}} + c - \frac{0.845}{N^L} \frac{b^2}{m} \qquad \textbf{(12')}$$

and

$$\hat{p}^L = \frac{a}{N^{L^3}} - \frac{0.357 b^2}{m N^{L^2}} \qquad \textbf{(13')}$$

Whence, it is straightforward to derive:

Result 4. *Without barriers to entry, in the long run profits are driven to zero as the number of incumbent companies approaches* $\hat{N}^L = I\left[2.801\frac{\boldsymbol{am}}{\boldsymbol{b}^2}\right]$, *where* $I[\bullet]$ *indicates the integer part of the number in parentheses. Investments in monitoring apparatus and premiums are, therefore, approximately equal to* $\hat{m}^L \approx 0.302\frac{\boldsymbol{b}^3}{\boldsymbol{am}^2}$ and $\hat{p}^L \approx c - 0.174\frac{\boldsymbol{b}^4}{\boldsymbol{am}^2}$.

Like in the standard Salop model, imperfect spatial competition with free entry leads to a finite number of firms. However, unlike the Salop model, here premiums are not monotonically decreasing with the number of companies but follow the evolution described by (12’). More generally, we can state

Result 5. *If* $\boldsymbol{a} \geq 2.142\boldsymbol{b}^2/m$: (i) *Symmetric equilibrium premium reaches a minimum for* $N^{MP} < \hat{N}^L$ *;* (ii) *If the number of companies operating under regulatory regime is such that* $I\left[2.049\frac{\boldsymbol{am}}{\boldsymbol{b}^2}\right] = N^* < \overline{N} < \hat{N}^L = I\left[2.801\frac{\boldsymbol{am}}{\boldsymbol{b}^2}\right]$, *when moving from regulation to competition, long-run premiums are higher than short-run premiums, i.e.,* $\hat{p}^L > \hat{p}^S$ *.*

Proof: See Appendix.

On the basis of results 4 and 5, we can draw Figure 2, where profits and prices are depicted as functions of N. Notably, the fact that $N^{MP} < \hat{N}^L$ implies that, in contrast with one popular argument often mentioned to sustain deregulation of insurance markets, an increase (decrease) in the number of companies may be accompanied by an increase (decrease) in 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. In particular, this happens because the reduction of market share makes it less and less profitable to invest in monitoring, and this pushes variable indemnification costs upward. As shown by (12’), when *N* increases, prices tend to go downward on one side because of the “competition effect” due to the larger number of firms and upward on the other side because of the “cost effect”. As a consequence, it is therefore quite possible that, in a given interval of *N*, profits are decreasing and prices increasing even in the long run.

[Insert Figure 2]

Figure 2 shows the social planner optimal number of firms N^W too. Given the specific features of the demand function, an omniscient planner would maximize welfare by simply minimizing, with respect to *N* and *m*, the sum[24] (*TSC*) of overall firms’ costs – i.e. *N* times total costs as described in formula (3) – and the consumers’ transportation costs, given by the squared distances from the ideal variety, that is:

$$\min_{N,m} TSC = [c - \beta m] + N\frac{\mu m^2}{2} + 2\alpha N \int_0^{\frac{1}{2N}} v^2 dv = [c - \beta m] + N\frac{\mu m^2}{2} + \frac{\alpha}{12N^2} \qquad \textbf{(16)}$$

whence:

Result 6. *The socially optimal equilibrium monitoring investments and number of firms are respectively* $\hat{m}^W = \frac{3\beta^3}{\alpha\mu^2}$ *and* $\hat{N}^W = I\left[0.333\frac{\alpha\mu}{\beta^2}\right]$ *hence* $N^W < N^L$. *Substituting* N^W and N^L in (11’) and (12’), we get $\hat{m}^L < \hat{m}^W$ and $\hat{p}^L < \hat{p}^W$.

[24] Obviously, in social welfare we do not include the illegal gains obtained by fraudsters.

Like in the Salop model, free market yields too many firms and products. In addition, firms choose to bear too low fixed costs (that in Salop are exogenous), thus leading to an increase in claims and compensation costs. Due to the interaction of the competition effect and the cost effect, premiums are lower than at the social optimum but greater than at the minimum price level. Profits, driven to zero by free entry would be higher at the minimum price level and even higher at the social optimum.

6. Conclusions

Ten years after the completion of the liberalization in the European motor insurance market, expectations and hopes have clearly not been fulfilled. In many countries premiums have undergone increases largely greater than average inflation while claims and companies' loss ratios have rapidly grown. These poor results are hard to explain only through exogenous cost increases or collusive practices by producers. In particular, the striking escalation of claims suggests that significant changes may have occurred in the companies' attitude to dealing with fraudulent behaviour.

In this paper we analysed the latter possibility in more detail. We developed a circular city competition model in which we assumed that insurance companies endogenously set the size of their monitoring structures in a stage preliminary to the price game. The higher the investment in monitoring, the fewer the fraudulent claims and compensation costs borne by companies and, therefore, their variable marginal costs. By using this framework, we show that price deregulation makes investments in monitoring structures less profitable by allowing firms to recover the implied larger compensation costs by rising premiums. In particular, we demonstrate that unlike the case of collusion, the reduction in monitoring investments may be accompanied by increasing premiums and decreasing profits, exactly as has recently happened in some European countries. Finally, it cannot be ruled out that premium growth will not be confined to the short run, as it may continue despite new entries on the market and increasing competition among firms.

Appendix

Proof of Lemma 1.

Property (1) derives from the fact that positive definite matrices have $a^{ii} \geq 1/a_{ii}$, with equality if and only if $a_{ij} = 0 \quad \forall j \neq i$ (see Rao (1973), page 74, property 20.2). In our case clearly $a_{ii} = 1$ and $a_{ij} \neq 0 \quad for\ \ j = i \pm 1$, so that $a^{ii} > 1$.

To prove property (2), 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

$$\begin{aligned}
&a_1 a^1 + a_2 a^N + ... + a_{N-1} a^3 + a_N a^2 = 1 \\
&a_1 a^2 + a_2 a^1 + ... + a_{N-1} a^4 + a_N a^3 = 0 \\
&\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots \\
&a_1 a^N + a_2 a^{N-1} + ... + a_{N-1} a^2 + a_N a^1 = 0
\end{aligned}$$

where a_j and a^j are respectively the *j-th* element of the first row of $\mathbf{A}$ and $\mathbf{A^{-1}}$.

Summing up, one obtains:

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

hence:

$$\sum a^j = 1/\sum a_j \ .$$

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

Recalling that $\mathbf{A^{-1}}$ has only non-negative elements, property (3) follows from (1) and (2), whereas property (4) follows from the fact that $\mathbf{A^{-1}}$ is symmetric and circulant.

Proof of Result 5

To prove proposition (*i*) we first show that $\hat{p}^L(N^L)$ has a minimum, i.e., that N^{MP} does exist, and then that for $N^L = \hat{N}^L$, the inequality $\hat{p}^L(N^L+1) - \hat{p}^L(N^L) > 0$ holds. Given assumption 1, from (12') we have:

$$\hat{p}(N^L+1) - \hat{p}(N^L) = \frac{\boldsymbol{a}}{(N^L+1)^2} + c - \frac{0.845\boldsymbol{b}^2}{m(N^L+1)} - \frac{\boldsymbol{a}}{N^{L2}} - c + \frac{0.845\boldsymbol{b}^2}{mN^L}$$

Therefore:

$$\hat{p}(N^L+1) - \hat{p}(N^L) < (>) 0 \iff -\boldsymbol{a}\left[\frac{2N^L+1}{N^L(N^L+1)}\right] + \frac{0.845\boldsymbol{b}^2}{m} < (>) 0$$

Since the term in the square bracket decreases with N^L, a value N^{MP} such that $\hat{p}(N^{MP}) - \hat{p}(N^{MP}-1) < 0$ and $\hat{p}(N^{MP}+1) - \hat{p}(N^{MP}) \geq 0$ will exist. Substituting for $\hat{N}^L$ in the last expression, after some simple algebraic manipulation, we have:

$$\hat{p}(\hat{N}^L+1) - \hat{p}(\hat{N}^L) = 2.801\boldsymbol{a}m(0.845 * 2.801 - 2) + \boldsymbol{b}^2(0.845 * 2.801 - 1) > 0$$

which shows that $N^{MP} < \hat{N}^L$.

Abstracting from the problem of integer, proposition (*ii*) is proved by substituting $\hat{p}^L(\hat{N}^L) = c - 0.174\frac{\boldsymbol{b}^4}{\boldsymbol{a}m^2}$ in (12') and solving for *N*.

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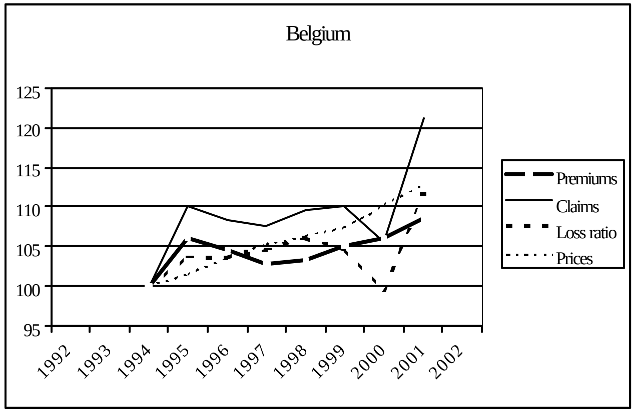
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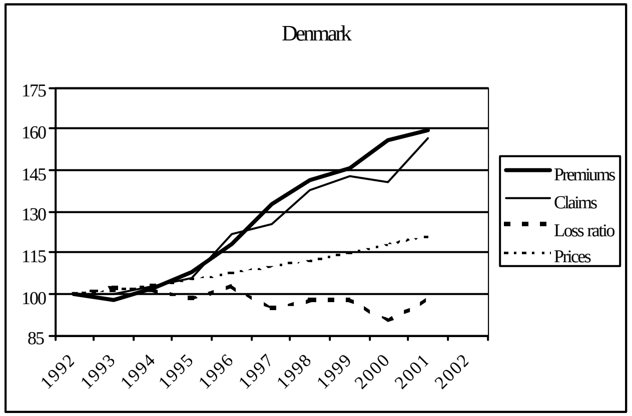
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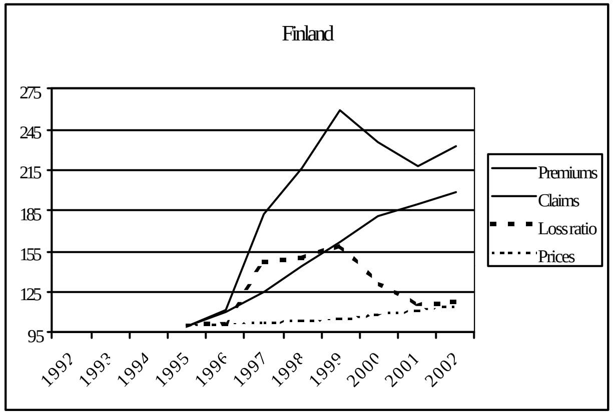
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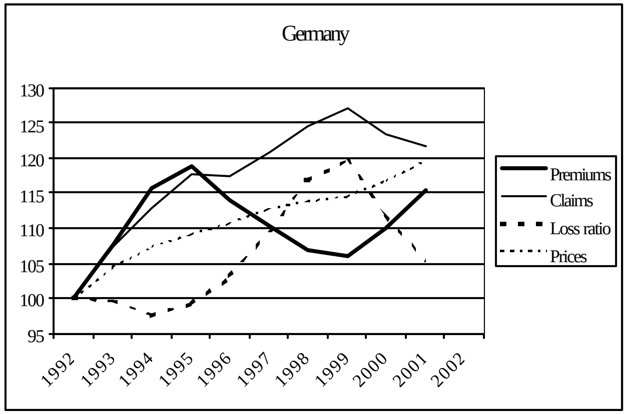
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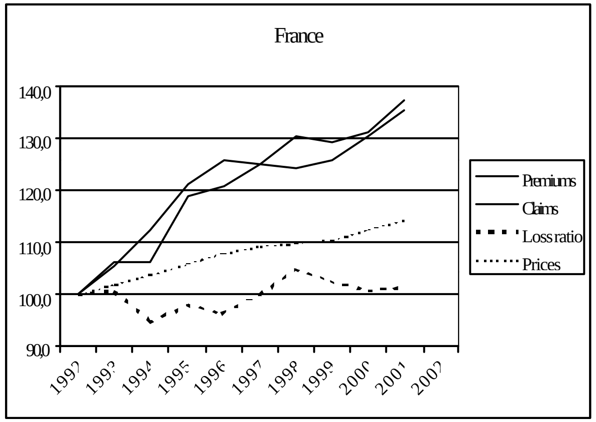
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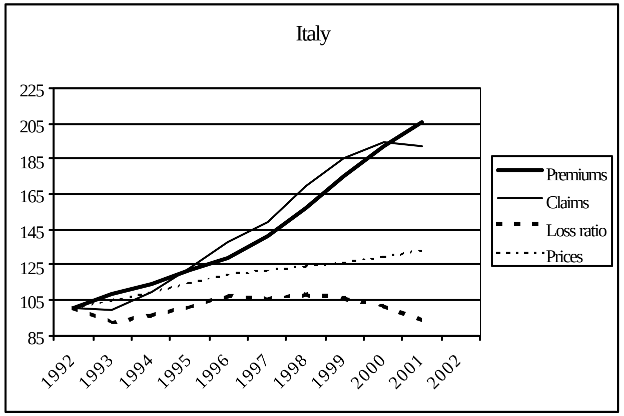

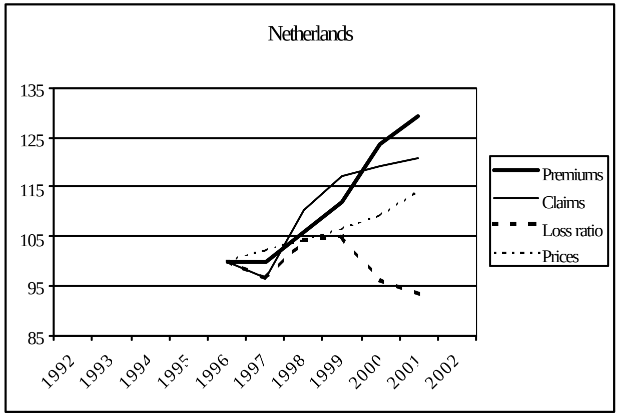

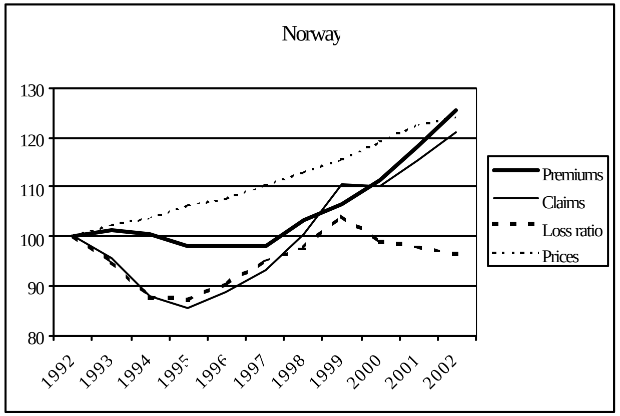

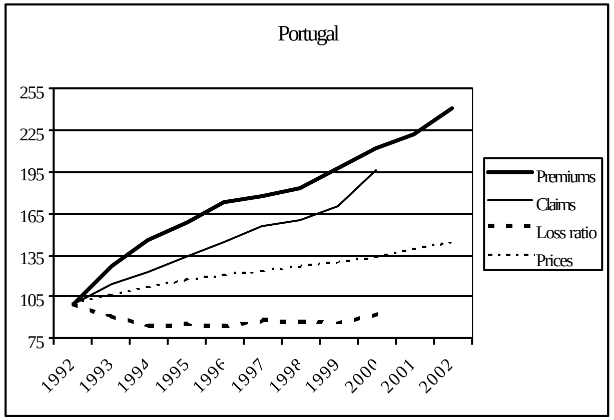

Figure 1 – Premiums, claims and loss ratio in ten European countries

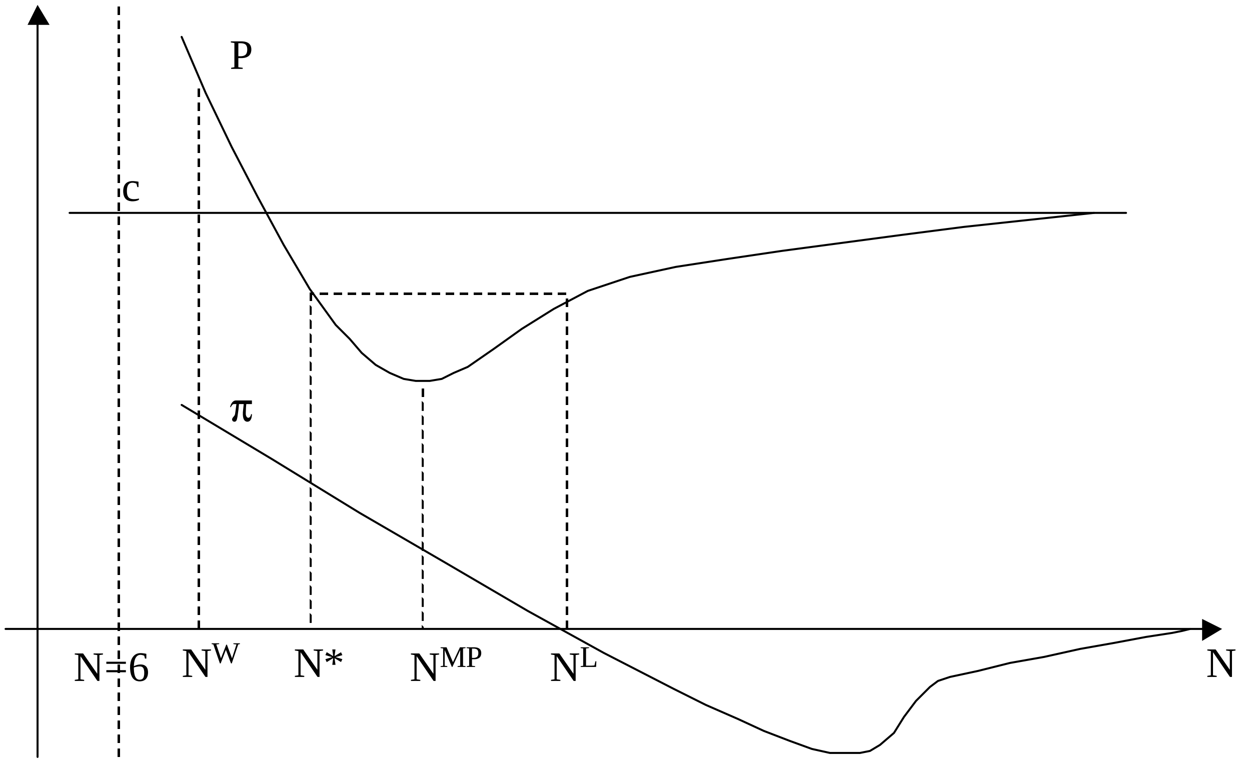

Figure 2 – Prices and profits in the long run