Preliminary
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Direct reimbursement schemes in compulsory motor liability insurance[1]

by

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Summary

A law that has recently been proposed in Italy would introduce compulsory direct reimbursement for almost all types of claims related to liability motor insurance. The paper discusses pros and cons of such proposal, which remains within the domain of tort law, and compares the two direct reimbursement schemes that are now in place, on a voluntary basis, in France and in Italy. It argues that, although direct reimbursement is likely to improve the relation between insurers and consumers, only under certain conditions it would reduce costs in the short run. The Italian scheme seems to be somewhat more efficient than the French one, but may more problematic from the viewpoint of antitrust authorities.

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Direct reimbursement schemes in compulsory motor liability insurance

1. Introduction

In a study inquiring into the crisis that has plagued the Italian motor liability insurance sector in the last several years, the national Antitrust Authority has suggested that the functioning of the system could be significantly improved by adopting a generalized direct reimbursement scheme.[3] The Authority has also expressed some criticism of the direct reimbursement scheme that is currently in place, on a voluntary basis and for a subset of accidents, in Italy and has expressed favor for the scheme that is currently used in France.

Direct reimbursement or direct indemnification should not be confused with no-fault insurance, which is rather widespread outside Europe.[4] A European Directive establishes that motor liability insurance in the European Union should be based on tort law, according to which only those suffering an unjust damage have the right to an indemnity from the person who is deemed responsible, or partially responsible, for the accident.[5] Normally in such a system, indemnification is based on a third party scheme, whereby the claimant is indemnified by the insurance company covering the person who has is deemed responsible.

However in some countries, among which France, Italy, Spain and Portugal, insurers have agreed to participate in direct indemnifications schemes for certain types of collisions. In such schemes, once responsibility is ascertained, the claimant is indemnified by her own company, which legally acts as an agent for the company insuring the responsible party.

All of these systems preserve the tort principle requiring that the agent company be subsequently "reimbursed" by the principal company. The reimbursement procedure typically does not foresee a full compensation for the loss incurred in each claim, so as to avoid opportunistic behavior on the part of the agent, who must have appropriate incentives to control costs.

The initial proposal of the Antitrust Authority has met with generalized consensus among consumers' associations and the public opinion to the point that the Italian parliament has recently passed a law that establishes direct reimbursement as a general principle applicable to motor liability insurance.[6] At the time of writing this article, such law is little more than a statement of principles and is not yet applicable, because the required secondary legislation has not been issued. It is however clear that a procedure will be established according to which the claimant normally informs her own company about the loss and that, in case of disagreement, she will have recourse in court

[3] "Indagine Conoscitiva sul Settore Assicurativo Autoveicoli", Autorità Garante per la Concorrenza e il Mercato, decision n° 11891 of 17 April 2003. See www.agcm.it.
[4] See Carrol et al. (1991), Cummins et al. (1992), Harrington et al. (1999).
[5] Council Directive 72/166/EEC of 24 April 1972 on the approximation of the laws of Member States relating to insurance against civil liability in respect of the use of motor vehicles, and to the enforcement of the obligation to insure against such liability.
[6] Code of Private Insurance. *Law of 7 September 2005*, n° 209.

against such company, rather than the company of the person whom she deems responsible of the accident.

The basic reason why direct reimbursement, especially in the French version, has attracted so much interest in Italy is that in the decade following the liberalization of the sector, in 1994, motor liability costs and prices have skyrocketed.[7] In spite of the improvements occurred in the last three years, in which insurance prices have risen more or less at the same pace as the CPI, their level is viewed as outrageously high by the public opinion and has become a major source of tension between consumers and insurers. In France, on the other hand, the system seems to have worked reasonably well, in that it has been associated with moderate price increases for a long period of time and a rather smooth relation between insurers and consumers.

In the view put forward by the Antitrust Authority, direct reimbursement would increase competition among companies and contribute to reducing prices or, at least, their rate of increase.

Against this background, this paper brings together the main reflections that have been made on the subject within the Italian insurance market and proposes an analytical framework to examine the implications of the various schemes (standard third party and direct reimbursement, in both the French and Italian versions) in terms of total costs and their distribution among companies and categories of consumers.

The main conclusion is that, although direct reimbursement is likely to improve the relation between insurers and consumers, only under certain conditions it would reduce costs in the short run. The Italian scheme seems to be somewhat more efficient than the French one, but may more problematic from the viewpoint of antitrust authorities.

The paper is organized as follows. Section 2 examines the basic rationale behind the proposal to switch to generalized direct reimbursement. Section 3 explains the mechanics of the different schemes and proposes the basic analytical framework, which is then used in sections 4 and 5 to simulate the functioning of the three systems under different realistic assumption about costs, frequencies and distribution of categories of policyholders across companies and regions of a country. Section 6 discusses the moral hazard problems that can arise in direct reimbursement schemes between the principle company and the agent company. Section 7 discusses the implications of the different schemes for competition policy and section 8 draws the conclusions of the analysis.

2. The rationale behind the proposal

Proponents of direct reimbursement (henceforth DR) point at three possible benefits of this system relative to standard third party (henceforth TP), whether in the French or some other version.

1. In DR schemes, insurance companies handle the claims of their own clients. This creates healthy competition among insurers on the quality of the service: if the service is not judged satisfactory, the client may decide to change for another company. Instead in a TP scheme, a person needs not care at all about quality. She buys a policy from a given company and, in case of accident, is indemnified by some other company for which she is normally an unknown subject.

[7] The measurement of the rate of increase of motor liability prices is a rather complex issue. From 1994 to 2004 prices have increased by 155% according to the fixed weight (Laspeyres) index computed by the National Institute of Statistics and by 65% according to a variable weight index (Paasche) computed dividing total premiums collected by the number of circulating vehicles.

2. A related argument is that in a direct relationship the client is less likely to try to commit fraud against her company.

3. In a direct relationship, it should be easier to induce claimants to resort to repair shops and, perhaps, even physicians chosen or suggested by the company. This may be obtained through appropriate contractual arrangements, whereby, for instance, the company proposes a discount on a policy if the client is willing to oblige herself to resort to such shops or physicians, in case of accident. The company may also propose to handle the reparation of the car directly and lend a substitute car to the client, who would save time and headaches. All such arrangements may have the effect of reducing costs because the productive process of the insurance service would be better controlled by the company: opportunistic behavior by clients, repairers, lawyers and other subjects involved in the loss arrangement process may thus be minimized.

The first argument is quite clear and may be very important in terms of improving the perception of insurers by consumers in the long run.

It is not clear however that it can have positive effects on costs and prices. *Per se*, tougher competition on the quality of a service implies higher, not lower costs. Precisely because the company knows that it is serving its client, rather than an unknown third party, it will tend to be more lenient towards her request than in TP. A better service, however desirable in its own right, is more likely to have the effect of increasing costs and prices.

If the perception of insurers improves, it is possible that in the long run there will be fewer attempts to commit small frauds, much in some way as it is usually thought that tax evasion is larger in countries in which the government is perceived to provide insufficient services in exchange for what it gets from taxpayers. Indeed in several countries there is no moral stigma on people who cheat the government or an insurance company.

This positive effect may work, if at all, after a fairly long period of time and certainly requires much more than just changing the reimbursement scheme in motor liability insurance.

The third argument is the most important one. It requires no particular comment, except that for costs to be reduced it is necessary that companies put in place appropriate contractual provisions as well as an appropriate system of relations with all the subjects involved in the loss adjustment process, including the claimants. Essentially, a major change is needed in terms of industrial organization.

Summing up, it is clear that DR schemes may improve the quality of the insurer-consumer relationship and that this may have positive implications for costs and prices in the long run. In the short run, however, the effect on costs is ambiguous and depends rather critically on how rapidly and effectively companies succeed in putting in place the type of contractual provisions and industrial organization that are necessary to gain a better control over the loss adjustment process.

When a DR scheme is introduced by law, as is being proposed in Italy, certain specific legal clauses may turn out to be of the utmost importance. For instance, in Italy for the claims that are now handled through the existing voluntary DR scheme, legal expenses paid by insurers are negligible. The point is that the law must fix the rights of the claimants. Should it state that the damaged person has the right to be compensated for legal expenses, even when the company makes a satisfactory payment within statutory time limits (say, 30 or 60 days), the result could be an increase in the legal component of costs. On the contrary, if the law is explicit in rejecting such right, costs will fall,

because the right is suspended, temporarily, on that large majority of claims that would now be handled through direct reimbursement.

It is quite difficult, nor shall we try, to provide an empirical assessment of the extent to which the success of motor liability insurance in France is due to direct reimbursement or to other factors. In the rest of the paper, we instead try to compare the various systems, which requires first of all a more analytical description of their functioning.

3. Key features of the French and Italian DR schemes

The French scheme

In France the direct reimbursement scheme, in operation since 1965, is the outcome of a private agreement amongst motor insurers. It is a non compulsory system, but over time it has become very widespread. Since 2002, the scheme includes the management of claims relative to bodily injuries (drivers, passengers, bicyclists, pedestrians) including death. Presently, 80% of the claims are handled by French insurers through the direct reimbursement scheme.[8]

The basic scheme, which is the object of the present study, is applicable to collisions between two vehicles implying damages for less than a given threshold (6,500 euros in 2005). Other schemes (including, in some cases, 100% reimbursement among companies) are used for other types of accidents, such as collisions between two vehicles with damages over the threshold, chain accidents and more complex accidents ("carambolage"). Bodily injuries up to 5% permanent disability are refunded according to a pre-specified list of economic values assigned to the types of injury, with a deductible of 500 euros.

In the basic scheme, the principal insurer pays the agent a pre-determined amount (in French, "forfait") per claim managed. The amount of the forfait is decided every year by IRSA (a consortium of insurance companies), based on statistical and qualitative considerations and is fixed across firms and types of claims The agent company hence incurs a loss for every claim for which it has indemnified its client more than the forfait; in the opposite case it has a gain. In 2005 the value of the forfait was 1,204 euros per claim. Payments are carried out through a central clearing room.

It is useful to describe the process leading to the final cost of a given company as involving two steps.

Step 1. Indemnification. The company indemnifies its own clients. At this stage total costs of the company are given by the product of collisions suffered by its clients times the average cost of such collisions. Note that this notion of average cost is generally different from the notion of average cost that is relevant in a standard third party scheme and depends on a different set of factors.

Step 2. Settlement amongst companies. The agent company receives the forfait from each of the principal companies with which its clients have had a collision. At the same time, it pays the forfait to each of the companies for all the collisions caused by its client to their clients.

[8] For additional information, see www.ffsa.fr.

After step 2, total claim costs of the company are the sum of the costs borne in step one plus the value of the forfait multiplied by the difference between the number of collisions caused and those suffered by its clients.

The Italian scheme

As in the case of France, in Italy, the system, which was set up in 1978, is based on a voluntary agreement amongst companies. Its application is limited by the concurrence of the following conditions:

- no more than two vehicles are involved in the collision;
- both drivers sign a joint statement describing the circumstances of the accident, thus making it relatively easy for the two companies involved to determine the shares of responsibility;
- there should be no legal intermediaries (lawyers) between the claimant and the company.

The scheme applies to all material damages to the vehicle (without limits), as well as to bodily injuries (of the driver and passengers) and transported goods up to a value of 15,000 euros. It now covers a bit less than 30% of all accidents (about 1 million accidents out of a total of 3.6 millions).[9]

The basic procedure is as follows. The agent company directly indemnifies its policyholders for the damages caused by other drivers. At the end of each month, principal insurers refund agent insurers the entire monetary value of the damages, with the exclusion of claim management and verification expenses.

Once a year, a final settlement among companies takes place in a central clearing room. The settlement is based on a bilateral comparisons of costs. Company *A* pays company *B* the net amount (positive or negative) resulting from the difference between its average cost in handling accidents as an agent of *B* and the *B*'s average cost in handling accidents as an agent of *A*, multiplied by the number of collisions caused by the clients of the company with the lower cost. This latter step penalizes companies who are either inefficient or too benevolent to their own clients.

There are hence three steps in this procedure, that can best be explained with a simple example.

Step 1. Indemnification of own clients. Same as in the French scheme.
Step 2. "Pay back" amongst companies, which takes place monthly.
Step 3. Final settlement, which takes place at year-end, according to the rule described above.

[9] For additional information, see www.cid-ania.it.

Company	*A*	*B*
Claims handled by agent company	*k(B,A) = 100*	*k(A,B) = 90*
Average cost of above claims	*c(A) = 20*	*c(B) = 25*
Indemnification of clients (*step 1*)	$k(B,A)\times c(A)$ = *2,000*	$k(A,B)\times c(B)$ = *2,250*
Pay back *(step 2)*	*2,250*	*2,000*
Settlement *(step 3)*	*-450*	*450*
Final cost *(2+3)*	*1,800*	*2,450*

Company *A* has handled 100 claims as an agent for *B*, i.e. for collisions caused by clients of *B* to clients of *A*, which we indicate as *k(B,A)*. The average cost of such claims, *c(A)*, is 20 euros. Company *B* has handled 90 claims, *k(A,B)*, as an agent for *A* at an average cost, *c(B)*, of 25 euros. Therefore, in step 1 company *A* pays out to its clients 2,000 euros and company *B* pays out 2,250. In step 2, companies exchange costs (claim by claim reimbursement): *A* gives *B* 2,250 euros (what *B* has spent to handle collisions caused by clients of *A*) and *B* gives A 2,000 euros. Step 3 is calculated as follows:

$$k(A,B)\times\left[c(B)-c(A)\right]=90\times(25-20)=450$$

Since the average cost of *A* is lower than the average cost of *B* by 25-20=5 euros, *B* owes *A* 5 euros times the number of collisions caused by *A, k(A,B)*. Note that, rearranging terms, final costs[10] for *A* can be calculated as:

$$k(A,B)\times c(A)=90\times 20=1{,}800$$

This is (almost[11]) the same expression that yields total costs under a standard third party scheme.

In turn, final costs of *B* can be computed as:

$$k(B,A)\times c(B)+\left[c(A)-c(B)\right]\times\left[k(B,A)-k(A,B)\right]=100\times 25+(20-25)\times(100-90)=2{,}450$$

The first part of this expression (10×25) is (almost) the same as in a third party scheme. The second part can be seen as a necessary correction to satisfy the constraint that settlements amongst companies must sum up to zero (2,000+2,250 = 1,800+2,450 = 4,250). Note that in this example aggregate costs (4,250 euros) are lower than under a third party scheme, in which they would be 4,300 = (90×20)+(100×25).

[10] These are the costs relative to collisions with *B*. To obtain total costs, it is necessary to sum up the costs resulting from bilateral operations with all other companies.

[11] "Almost" because the clients of *A* may have different characteristics from those of *B*, for instance because *A* insures cars which are heavier and tend to cause larger damages than the cars insured by *B*. Thus *c(A)* is the average cost of *A*, when *A* handles cars that have suffered an accident from *B's* clients.

The fact that only for company that has the lower cost (*A*) final costs are equal to those that would prevail under a third party scheme is a consequence of the choice to use *k(A,B)*=90 in step 3 as a weighting factor of cost differentials. A different choice, such as using *k(B,A)* or a weighted average of the two measures [(100+90)/2=95], would be possible and would not alter the basic properties of the system.

In the Appendix these concepts are given a more precise mathematical formulation.

4. Numerical simulations

Using these formulas, we run some numerical simulations which help understanding the basic properties of the different schemes.

We consider three firms of different size: S (for small), M (for medium) and R.o.M. (rest of market). To each one we associate a frequency and an average cost per claim. The results, in terms of expected claims costs (ECCs), are then computed for the standard third party (TP) scheme and for the two direct reimbursement (DR) schemes: modified French and Italian. The French one is "modified" in the sense that, except when is otherwise indicated, we consider a value of the forfait that is computed ex-post and is exactly equal to the average of ECCs of the system.

In the tables, ECCs are divided by the relevant number of policyholders. So they have the dimensionality of a pure premium. We however need to qualify the term "pure premium" in our context, since this concept is closely associated with objective factors related to the characteristics of the policyholder (it measures the, private and social, cost of her risk), while in this analysis with have different premiums, depending on such conventional factors as which company indemnifies the claimant and how settlements schemes among companies are designed.

Since we are only concerned with ECCs per policy, the total number of policyholders is not relevant; it is hence not shown in the tables.

In order to focus on the key issues, we start by making some restrictive assumptions on the general model. The effects of relaxing such assumptions will be seen one at a time.

4.1 Basic model

The first exercise is performed under the following assumptions:

A1. Average costs per claim differ across companies only because of differences in the efficiency with which companies handle the claims.

A2. Geography does not matter, in the sense that either the country is homogeneous (in terms of frequency and claim costs) or, if not, market shares of the different companies are the same across the different (non homogeneous) areas.

Assumption A1 implies that companies do not differ too much in their portfolio mix. Otherwise, for instance, average costs per claim would be higher for companies who insure more powerful or heavier cars, which, in a collision, tend to cause larger damages to third parties than smaller cars.

We hence isolate a single dimension of costs, the one that depends on companies' efficiency. This dimension is of crucial importance because we want to make sure that competitive pressure among companies is not reduced or eliminated by moving away from TP. In principle the less efficient company should either restructure or lose market share in favor of the more efficient companies.

Assumption A2 is crucial, and will be relaxed in a specific paragraph that deals with geographical clusters.[12]

Conditional on these assumptions, we consider two polar cases:

Case 1. For each company, the average frequency of collisions without responsibility, or "collisions suffered" by clients of the company (those that in a DR scheme are handled by the agent company), is equal to the frequency of collisions with responsibility, or "collisions caused" by clients of the company (those that are normally considered in a standard third party scheme).

Case 2. All drivers have the same probability of being hit by a third party, although the probability of causing an accident differs across clients of different companies. In this case, for each company, the average frequency of collisions without responsibility is independent from the frequency of collisions with responsibility.

The distinction between the two cases is relevant because in a DR scheme what matters is not only how many accidents are caused by clients of a given company, but also how many accidents they suffer because of third parties' responsibility. Such accidents are handled directly by the company and later reimbursed according to the different settlement schemes.

Reality is likely to be a mixture of cases 1 and 2, and it would be easy to run simulations with elements of both. This would not however be very informative, relative to considering the two polar cases of perfect correlation and zero correlation between the two notions of frequency.[13] Negative correlation does not seem to be a relevant possibility.[14]

Case 1 is probably the more relevant case in reality because drivers who use the car less often (e.g., in some countries, females relative to males) are both less likely to hit and to be hit than frequent drivers. Reckless drivers (e.g., very young people) are more likely not only to cause an accident, but also to put themselves in troublesome situations and therefore be hit by third parties.

Case 2 is however useful to isolate the effects of the most common notion of "frequency" in standard third party schemes. It can make sense in a general context, if companies do not differ too much in their mix of clients.

Under assumptions A1 and A2, in Case 1 we get the following:

Proposition 1 . The three systems yield identical ECCs in the aggregate and for each company, regardless of cost differentials across companies (tab. 1).

[12] Assumption A2 allows to recover the full joint distribution of collisions from the marginal distributions, as is shown in the Appendix.

[13] Given the constraint that the number of collisions "caused" must equal the number of collisions "suffered", unit correlation implies that for each company the frequency of collisions with responsibility be equal to the frequency of collisions without responsibility, as assumed under Case 1.

[14] A possible exception might be a person who usually drives at an annoyingly low speed on a highway.

The intuition behind proposition 1 is quite simple. Under TP, ECCs for each company are readily obtained with the familiar formula: frequency (of collisions with responsibility) times average costs (of such collisions). For instance in the case of company Small: $\mathbf{7\% \times 4 = 0.280}$.

Under the French scheme, no transactions will be expected to take place in the settlement system amongst companies because, by assumption, the number of accidents caused by clients of one company is equal to the number of accidents suffered.[15] This implies that the value at which the forfait is set is irrelevant: it could as well be zero. The formula of the French scheme then simplifies to: frequency of collision without responsibility multiplied by the average cost of such collisions. Both the first and the second term of this equation are equal to the corresponding terms of the familiar TP equation (frequency times average cost). The first one because of the assumption made under Case 1; the second one because of assumption A1; since costs differ only because of efficiency considerations, average costs for a given company are the same, regardless of whether it acts as a principal under TP (handling collisions with responsibility) or as an agent under DR, handling collisions suffered by its clients. A similar explanation applies to the Italian system, although, in this case, there will be intra company transactions in step 2 (reimbursement) and step 3 (settlement).

Because of the same logic, different simulations, not shown here, demonstrate that the three systems are identical regardless of the size of the companies, their frequency and their costs.

Proposition 1 establishes a rather general presumption that the three systems tend to yield similar result for the companies as well as and for their clients.

We now turn to Case 2 (all drivers have the same probability of suffering an accident). Here things are a bit more complex, but a number of equivalence propositions nonetheless do emerge.

Proposition 2. The three systems (TP, French and Italian) yield exactly the same ECCs both in the aggregate and for each company if companies either: a) have the same frequencies, or b) have the same costs per claim.

These results, which are motivated analytically in the Appendix[16], are illustrated in tables 2 and 3. The values of ECCs under TP are easily calculated with the usual formula: frequency times average cost per claim. In the case of the two DR schemes the results are deceptively simple. It should be noticed, in particular, that the claims settled to clients are generally different from the values shown in the table. The latter in fact show up only after the various settlements have taken place.[17]

Proposition 2 reinforces the presumption that the three systems tend to yield rather similar results. Note however that, contrary to Proposition 1, this proposition holds with respect to the French scheme only if the value of the forfait (5.8 euros in table 2 and 5.0 in table 3) is equal to the actual average cost incurred by the system in a given period.

If both frequencies and costs differ across companies (tab. 4), we get the following:

[15] Of course, all these propositions hold in expected value sense. Ex-post, the number of accidents caused and suffered may be somewhat different.
[16] Note that part a) of Proposition 2 can be viewed as a particular case of Proposition 1.
[17] Except for the French system in table 2 (equal frequencies). In the Italian scheme, in table 3 (equal costs), step 2 of the procedure (monthly reimbursement) is non trivial, but no transactions occur in step 3 (year-end settlement).

Proposition 3. Aggregate ECCs are identical in the two DR schemes. They are lower than in TP (by 0.4% in the example of tab. 4) if costs and frequencies are positively related and vice versa, if they are negatively related.

Proposition 4. Spreads between ECCs of the three companies, as measured by the standard deviation around the mean, are higher than in TP in the French scheme and slightly lower in the Italian system.

Proposition 5. On average, in the Italian system, individual companies' ECCs are closer to TP than in the French system (standard deviation of percent differences of 0.2% against 6.3% of the French system).

Proposition 6. In the Italian scheme the most efficient company (Small) has exactly the same ECCs as in TP. In the French system, the largest company (R.o.M.) has almost the same ECCs as under TP.

Some of these results are very general. Some are not.

A very general result is that aggregate ECCs are the same in the two DR schemes. This is due to the fact that net settlements among companies must sum up to zero. Hence aggregate costs only depend on what is handed out to clients in the first stage of the scheme. Different settlement schemes may only affect the distribution of costs across companies (and their clients)

The second result of Proposition 2 (aggregate ECCs lower under DR than under TP costs and frequencies are positively related and vice versa) depends on the fact that, with a positive relation, under a DR scheme, relatively more efficient companies (say, S rather than R.o.M.) handle a larger number of claims than under TP because their frequency (7% in the case of S) is lower than aggregate frequency (8.8%). Hence clients of S suffer a greater number of collisions than those for which they are responsible. The opposite is true with a negative relation.

The important consideration that emerges from the above reasoning is that, even under Case 2, it is extremely unlikely that DR schemes yield aggregate ECCs that are significantly different from TP. The differences that may emerge depend crucially on the combination of three factors: differences in efficiency among companies, redistribution in the number of claims handled by more or less efficient companies and the relation between costs and frequency. Aggregate ECCs are hence likely to be the same if companies do not differ too much in terms of cost efficiency or frequencies. Even if they differ on both these dimensions, aggregate ECCs do not change relative to TP, if there is no clear pattern of correlation (either positive or negative) between costs and frequencies (see tab. 5).[18] Note that, in this latter case, ECCs for the least efficient company are the same in the two DR schemes.

Proposition 4 has some interest because it is sometimes thought that a French scheme should reduce spreads (or tariff personalization) since the settlement system is based on a single aggregate parameter. As we shall see, this may be true in some very specific cases (for the Italian scheme as well as for the French one), but, on technical ground, it is by no means a general proposition.

[18] The relevant notion is the weighted correlation between costs and frequencies (see Appendix). This corresponds to a simple correlation if all companies have the same market shares.

Proposition 5 is rather robust. The Italian settlement scheme, being based on finer bilateral comparisons of costs, is much less likely to produce arbitrary results, relative to TP, than the French scheme.

Finally proposition 6 states that in the Italian scheme there is company, always the most efficient, that is indifferent between DR and TP[19]. This result is rather general, but we shall see cases in which it is no longer valid. As to the French system, proposition 6 states essentially that the size of a company does matter. This is because a large company has a greater weight in shaping the value of the forfait than a smaller company. Note however that this need not be an advantage for the large company. Indeed, in the case of tab. 4 the reduction in aggregate ECCs relative to TP brings proportionally larger benefits to companies S and M than to the largest company.

In any case, this feature of the French system could be corrected by fixing the forfait at a different level: for example the median rather than the mean of the system. In practice, this might involve rather difficult negotiations among members of the system.

The next exercise (tab. 6) is useful to inquire into the consequences of fixing the forfait, in the French scheme, at a different value from average costs. To make a clear point, in the exercise the forfait is set at zero (as is the case for certain types of claims in the Canadian province of Quebec) and costs per claim are set at the same value for all companies. We then have:

Proposition 7. In the French scheme, aggregate ECCs (hence average premium) is invariant with respect to the forfait.

Proposition 8. In the forfait is set at zero ("Quebec model", not to be confused with "no-fault"), frequency becomes an irrelevant factor in shaping individual companies' ECCs. Companies no longer have an incentive to select cautious drivers. More generally the lower the value of the forfait, the smaller the incentive to classify drivers according to frequency.

Contrary to what is sometimes thought, the value of the forfait does not affect average tariffs, but it does affect their dispersion around the mean, at least under the assumption of Case 2 (it is instead irrelevant under Case 1, as we have already shown). If the forfait is set too low, good and bad drivers will no longer pay the efficient price for the social cost of their conduct. Indeed, as can be seen, for each company ECCs can be obtained by multiplying average costs per claim (in this case, 5 euros for all companies) by the average frequency of the system (8.8 %), rather than by the frequency of each single company. If costs per claim differ across companies, ECCs will also differ, but only to reflect differences in costs. Frequency of accidents with responsibility would remain an irrelevant factor. However, frequency of accidents suffered by clients of a given company could to same extent be used to set tariffs.

Proposition 7 is technically undisputable. However, the value of the forfait may have a psychological effect rather than a technical one. If the body (typically composed of experts representing the companies) decides to increase its value by x% relative to the previous year, this may be taken by companies, as well by the public opinion, as a signal that costs and prices are forecast to rise by x%. Hence the forfait may play the role of a coordination mechanism in the process of price determination by companies. This raises two sets of issues, compatibility with antitrust regulation and risks inappropriate of political pressures, that will be analyzed later.

[19] This is due to the fact that, as has been explained in sect. 3, in the settlement procedure (step 3 above) the relevant differences in average costs are weighted by the number of accidents of the more efficient company.

The next step is to relax assumptions A1 and A2, along different possible gradients. We start with the one that is perhaps the most relevant in practice: clusters of companies in different geographical areas, where drivers have different characteristics.

4.2 Geography

The key results are shown in tables 7 and 8, where it assumed that there are two geographical areas: N an S (which can stand for north and south or non - suburban and suburban). 70% of the insured population is assumed to reside in N and 30% in S. The three companies have different market shares in the two areas: for instance, company Small has a 2% market share in N and a 15% share in S; vice versa for company M. The two areas differ as far as frequency of accidents (6% in N and 8% in S). They also differ with respect to average costs per claim (on average, 7.8 euros in N and 4.7 in S), for instance because cars that circulate in N are more expensive to repair than cars that circulate in S or because, in the courts, human life and bodily injuries have a higher value in N.

Within each cluster we maintain assumptions A1 and A2. The novelty is that, due to clustering, these assumptions no longer apply on average, i.e. at the national level. Thus even if the three companies were identical in terms of efficiency, they would differ, in terms of average costs, because their clients are clustered in one of the two areas.

We are still assuming, for the sake of generality, that companies have different levels of efficiency (Small being the most efficient company both in N and in S), but the key difference now is between the average cost of compensating for the loss occurred to a (cheaper) car, or person, in S and to a (more expensive) car, or person, in N. Average costs per claim, in other words, depend not only on companies' efficiency, but also on the specific characteristics of the policyholders in the two clusters.

As concerns frequencies, there is no longer any need to analyze separately Case 1 and Case 2, because we already know that in Case 1 (equal probability of hitting and being hit), the results would be identical for all three schemes. We hence concentrate attention on the, more complex, Case 2 (all drivers have the same probability of being hit), like in propositions 2 to 8 above.

With this setting, we have the following:

Proposition 9. If frequencies are the same for all companies in each area, the three systems yield identical ECCs in the aggregate, for each company and in each area.

This proposition, illustrated in tab. 7, should not be too surprising, since it is essentially an extension of Proposition 2 above.

Note that in the table we have added a forth scheme, that is a French scheme with two different forfaits: one for settling claims occurred in area N (7.8 euros per claim) and one for area S (4.7 euros). Once we allow for different forfaits in the two areas, we are in fact replicating the results of the previous section for two different nations. In principle, this is simple and clear. In practice, however, there is a caveat, due to the fact that there is no obvious and natural definition of a cluster (region, province, urban, suburban etc.). We will return to this point later.

A somewhat less intuitive and more interesting result is shown in tab.8:

Proposition 10. With equal costs across companies in each cluster and different frequencies both across companies and clusters, ECCs are the same in all systems both in the aggregate and for residents in each area. ECCs do instead differ across companies.

The most relevant part of this proposition is that, under DR schemes, residents in the two areas have the same ECCs per policy as in TP. Residents in the different areas should hence be indifferent to a change from TP to any of the various DR schemes.

ECCs of the different companies do instead differ across different schemes. The main thing that can be said in this regard is that, once again, the Italian system yields smaller differences relative to TP than the French scheme (with a single forfait) : the standard deviation of percent differences is in fact 0.416 in the Italian scheme against 3.990 in the French scheme. This is due to the finer system of bilateral exchanges that characterizes this system relative to the French one. Different simulations with very different costs and frequencies across clusters and companies (not shown here) confirm that this is a robust result.

In the final step of our analysis, we relax assumption A1 (while maintaining A2) by considering differences in costs that do not depend on companies' efficiency nor on clusters, but, more generally, on the characteristics of the portfolio mix of the different companies. One company insures light cars and another heavy cars. One insures cars that perform well in crash tests; another does not.

4.3 Costs linked to the portfolio mix

Typically, average costs per claim differ across companies because of differences in their portfolio mix. Indeed, in competitive markets differences due to efficiency should in principle vanish over time as policyholders realize that they can find coverage at lower prices.

In the usual context of TP, the cost variable that matters is the value of the damage that a car is likely to inflict on third parties in a collision with responsibility. This is the reason why heavy (or powerful) cars pay higher premiums. In DR schemes instead what matters is the value of the damage suffered by the policyholder, much like in standard first party (or Kasko) insurance.

This distinction is crucial when we compare the different systems, as we do in tables 9 and 10.

In table 9, costs differ across companies because of the different values of the damages suffered by their own clients following collisions caused by third parties. For example, company Small has lower costs than Medium because its clients drive cheaper cars. Replacement costs for parts of its clients' cars are hence cheaper. Company R.o.M. has the highest cost. This may be due to the fact that it insures such means as Rolls Royce or, on the contrary, that it insures cars that are very cheap, but not safe. In this case, it is exposed to higher costs for bodily injuries.

In order to focus on costs differentials and to avoid considering separately Case 1 and Case 2, we let frequencies be the same across companies. We then have the following:

Proposition 11. Aggregate ECCs are the same under the three schemes, but, under TP, ECCs of individual companies are invariant with respect to the cost differentials of the collisions suffered by their clients.

Proposition 12. The two DR schemes yield the same results in terms of individual companies' ECCs. Differences across companies reflect differences in average costs per claim.

Since companies are assumed to be equally efficient, the distribution of claims among companies is irrelevant in the determination of aggregate costs. For this reason ECCs are the same under the three schemes.

The fact that, under TP, ECCs are invariant with respect to costs suffered is sometimes considered as an unfair social aspect of the system. An implication is that a (poor) person who drives a cheap car in a rich city will pay a lot for her policy (more than the same person driving in a poor city), because she is likely to inflict damages on such means as limousines and Cadillac, with their precious cargos of rich drivers and passengers.

DR schemes are immune to this problem.

The opposite situation is depicted in Table 10, where costs differ across companies for the usual reason in TP: different types of cars cause different liabilities to third parties. The results here are symmetric to the ones just described:

Proposition 13. Aggregate ECCs are the same under the three schemes, but, under DR schemes, individual companies' ECCs are invariant with respect to the costs of collisions inflicted to third parties.

In this case, DR schemes have the effect of "flattening" ECCs, and presumably prices, relative to TP. Note however that expensive cars will continue to pay higher premiums than cheaper cars, since they are exposed to higher losses. Note also that the "flattening" effect is the same in the French and in the Italian scheme.

We now sum up the results that appear to be reasonably robust.

5. Summing up

Comparing the mechanics of TP and of the different DR schemes that are now in place, on a voluntary basis, in France and in Italy, we got a number of results that can be summarized as follows.

A first set of results concerns the comparison between TP and DR schemes (either French or Italian).

- The "mechanical effects" of switching from TP to DR are likely to be small in terms of aggregate costs for the industry. "Mechanical effects" are those that emerge when frequencies and costs per claim are held constant in the comparison of the different systems.
- Distributive effects among companies and classes of policyholders do exist, but are also unlikely to be a serious concern. In particular, redistribution among different regions of a country does not seem to be a relevant factor.
- Both DR systems force actuaries and managers of companies to think in terms of a different and richer menu of variables than under a TP scheme. The technical and statistical basis necessary to set tariffs is different and it borrows some elements of a typical first party (or Kasko) motor insurance.
- In TP, tariffs are based on two sets of variables:
    a) frequency of collisions with responsibility, and
    b) the costs associated with such collisions (with responsibility).

- In DR schemes, instead, there are three relevant set of factors:
  a) frequency of collisions with responsibility,
  b) frequency of collisions without responsibility, and
  c) the costs associated with such collisions (without responsibility).
- Since in TP these latter costs (associated with collisions without responsibility) do not matter, TP produces "flat" ECCs, and prices, with respect to this particular factor. Likewise, since in DR schemes costs associated with collisions with responsibility do not matter, DR schemes produce "flat" ECCs with respect to this factor. In practice, in a standard TP scheme liability insurance for big cars tends to be expensive because big cars cause more serious damages than small cars to third parties. In DR schemes, insurance for big cars will still tend to be more expensive, but for a different reason: they suffer more expensive damages when they are hit. An implication is that, under TP, a poor person driving a cheap car in a rich city pays for the fact that she has a high probability of hitting limousines and Mercedes. Under DR schemes the policy is cheap, because cheap cars are cheap to repair.

A second set of results concerns the comparison of the French and Italian DR schemes:

- Although these two schemes may appear quite different in their operating mechanisms, they yield very similar results in terms of total costs and their distribution among companies and policyholders.
- Both schemes seem to have desirable properties, as they provide incentives which are very similar to those prevailing in TP to minimize costs, through portfolio selection and operational efficiency.
- It is generally not true that the French scheme, being based on a single parameter for settlements among companies, tends to produce "flatter" tariffs than TP or the Italian system.
- Flat tariffs, with respect to the frequency factor, may however emerge in the French scheme if the value of the forfait is set an inappropriately low level (at least if there is a low correlation between the probability of being hit and the probability of hitting). If the forfait is set too low, there is a weakening of the incentive for companies to select careful drivers, through classification and experience rating. Symmetrically, an inappropriately high forfait will tend to increase costs differentials due to different frequencies.
- The Italian RD scheme seems to be more robust than the French one, in the sense that it is less likely to produce arbitrary results, relative to TP. The reason is that settlements among companies are based on a finer system of bilateral comparison of costs.
- The French scheme can be made more robust, through wise cooperation among actors of the system, by fixing different values of the forfait for different geographical areas as well as for different types of vehicles (e.g. trucks, cars, motorbikes etc.) or different types of collisions (e.g. depending on such factors as the value of the claim or whether bodily injuries are involved). However, the point remains that the Italian system is essentially immune from these problems and can be run in a more mechanical way. It does not need cooperation or negotiations among companies.

6. Moral hazard

As in any relation between a principal and an agent, there may be moral hazard problems between the company that has the final responsibility for a claim and the company that handles the claim.

A first set of problems concern very small claims. In DR schemes an agent company may be tempted to be quite generous in indemnifying its clients for a large number of very small claims. In thus doing, it will give satisfaction to its clients, and, more importantly, it will gain in the settlement

system at the expense of other companies. To see how this occurs in the French system, suppose that the forfait is equal to 5 euros. This means that the agent company receives 5 euros from the principal for each claim it handles, no matter what is the actual value of the settlement. It is obvious that there is an incentive to handle a large number of claims with a lowest possible value. Through a similar reasoning, the same consideration applies to the Italian scheme, whereby company A receives a payment from company B (or makes a payment to it) if its average cost in handling claims on behalf of B is lower (higher) than the average cost incurred by company B when handling claims on behalf of A.

This situation is depicted in tab. 11, where, to make things as clear and simple as possible, we have assumed that the three companies are identical in terms of all usual variables (size, frequencies, efficiency, portfolio mix). The only difference is that one company, the one which we still call Medium, handles additional small, or "fake", claims amounting to 20% of the normal claims. Normal claims have an average cost of 5 euros. Fake claims only cost 1 euro. The results are the following:

Proposition 14. Aggregate ECCs rise (by 1.3%) in both schemes relative to TP (taken as a benchmark, as it is immune from this moral hazard problem) because the system is handling a larger number of claims. Company Medium reduces its ECCs at the expense of the other companies. The problem is slightly less serious in the Italian system in the sense that Medium gains a bit less than in the French scheme and the others lose a bit less.

Note that, since normal and fake claims cannot be distinguished, in the French system the value of the forfait is not set at 5 euros, but at 4,8, which turns out to be the actual average cost faced by the system, inclusive of fake claims. The Italian scheme is only slightly less exposed to moral hazard than the French one.

A possible solution to this problem seems to be the most classic one for moral hazard problems in general: monitoring. This requires detailed, claim by claim, exchanges of information from the agent to the principal companies. So that, at some point, insurers either put pressure on the deviating company or find other ways to avoid letting one company gain at the expense of the others.

Indeed, this is what happens in France within the IRSA convention. The principal company is informed in real time about the cost of each settlement incurred by the agent company. In Italy information flows occur monthly in step two of the procedure when a company is reimbursed by other companies for the claims it has handled on their behalf.

A second set of problems concern very large claims that have to be handled by the agent company: a school bus gets hit by a third party and falls from a bridge; a toxic gas emanates from a truck and causes a disaster. For such accidents, or even for much smaller ones, the temptation of the agent company is to offer inadequate compensation, thus inducing the claimants to sue the principal company.

There are various ways to face these problems. In voluntary schemes, such as the ones that have been in place so far both in France and in Italy, one partial remedy is to set limits above which claims fall outside the standard DR scheme or are managed according to the usual third party scheme. As we have seen in section 3, this is what happens, in different ways, both in Italy and in France.

Remedies of this kind are probably necessary, but are partial and not entirely satisfactory. For one thing, the perception of the consumer is that the company with which she is insured abandons her precisely when she would most need it, because of the large damage she has suffered. As regards moral hazard, especially when thresholds are defined in terms of euros per claim, there remains the temptation for the agent company to convince the claimant that she could get a payment surpassing the threshold if she calls up a good attorney and asks to be indemnified by the principal company.

Again there does not seem to be any way out except monitoring, through detailed exchange of information, and peer review and pressure.

Exchanges of information are not appreciated by antitrust authorities, but it seems rather difficult to get rid of them.

In a DR system which is introduced by law, a legal provision could attenuate this type of moral hazard problem. Such provision would foresee that the claimant has the right to sue her own company, rather than the company of the person whom she deems responsible for the accident. As we have seen, this provision is present in the law that is being proposed in Italy. It is not clear that it can override a general principle of tort law according to which a person who suffers an unjust loss from a third party has the right to bring her to court, whatever the role of the insurance company.

The final set of problems are specific to the French system. As we have seen, the adoption of a single forfait may be a cause of inefficiency if, for instance, frequencies and costs are significantly different in different areas of a country or for different classes of policyholders. In addition, it may be perceived as unfair by companies who operate in different regions or insure different classes of drivers. For whatever reason (inefficiency, real or perceived unfairness for some companies), a French scheme may end up being managed with a multiplicity of forfaits. This is currently not the case in France, but used to be the case in Italy until 2003, when a scheme, rather similar to the French one, was run with a rather cumbersome multiplicity of forfaits.

The decision on how to define the classes of accidents that fall under one or another forfait is not an easy one. It may involve tensions among companies and possibly consumers and is unlikely to entirely solve the problems at hand, given that it would make no sense to adopt a very large number of different forfaits.

From the viewpoint of minimizing moral hazard among companies, there should be no problem if the classes are defined according to some non monetary criterion: for example, areas of the country or types of vehicle (such as trucks, cars, motorcycles etc.). Instead, it would pose a problem if the classes were defined according to a criterion based on the monetary value of the loss. In all borderline cases, a company will have an interest in paying a little more than fair to its client in order for the claim to be classified in the next higher class, where the intra company settlement is based on a higher value of the forfait. More generally a smart company will manage its claims so that the value of most of them will stand just above the threshold of some of the predefined value classes.

The solution to this particular problem seems to be relatively easy, since it only involves giving up the idea of defining classes of accidents on the basis of their monetary value.

7. Implications for competition policy.

Both DR schemes are exposed to possible criticism from the viewpoint of antitrust policies, for very different reasons.

As we have seen above, the French system is exposed to the critique that the fixing of the value of the forfait may be considered as a signaling device for coordinating price decisions of companies.

On the other hand, the Italian system requires a detailed exchange of information about the cost of each single claim handled by the agent company on behalf of the principal. Each company acquires information on an almost continuous basis (every month when step two of the procedure, reimbursement among companies, takes place) about the evolution of costs of its competitors. It has been argued, for instance by the Italian Antitrust Authority, that, under some circumstances, the availability of such information may facilitate the coordination of pricing decisions in the market.[20]

A possible solution for problems arising in the French scheme involves the adoption of some automatic rule for fixing the forfait. For instance, the system could use an average of the previous year's costs as the forfait for infra annual settlements among companies. At the end of the year or at the beginning of the succeeding year, a final settlement would take place in order to make up for the differences resulting from a calculation of the actual system's average cost incurred during the year.

A similar scheme could be adopted for a modified Italian system. Infra annual settlements could be determined as above in the "modified" French system. Year-end settlements should then make up for the difference resulting from the calculation of actual costs incurred during the year, as in the French scheme, as well as for the discrepancy between ECCs implied by the Italian and the French system. The feasibility of such proposal depend on two factors: whether "French type" infra annual settlements do or do not give companies a sufficiently reliable information on how their costs are evolving during the year and the benevolence of the antitrust authority, given that in the Italian scheme a detailed, claim by claim, exchange of information is inevitable.

The proposed solution would reduce the sensitivity of the exchange of information from the viewpoint of competition policy, because the information about the costs of individual claims would take place only at the end of the year or at the beginning of the next, rather than, say, on a monthly basis.

For a balanced assessment of whether it is preferable to fix the forfait ex-ante or according to an automatic rule two other considerations ought to be mentioned. On one hand, if the forfait is set ex-ante, there may be pressures from consumers' associations and the public opinion to fix at an appropriately low level. On the other hand, it has been argued by the French supervisory authority that the ex-ante forfait plays a positive role in that it provides a benchmark for loss settlements and helps companies to keep costs under control.[21]

[20] Autorità per la Concorrenza e il Mercato. Recommendation (2006).
[21] See ISVAP (2000).

8. Conclusions

Let us once again recall that all the schemes that have been analyzed in this paper remain within the context, which is compulsory for Member States of the European Union, of a legal regime based on tort law. No-fault systems, of which there exists several variants across the Atlantic, are outside the scope of this analysis.

Our focus is on schemes of direct reimbursement, which do not change the basic legal framework, but may have important implications in terms of industrial organization, costs and quality of service.[22] In such systems, the claimant is normally indemnified by the company with which she is insured rather than by the company of the person who bears the responsibility for the accident. In turn the company of the claimant (agent) is reimbursed by the other company (principal), according to a scheme that must have desirable properties in terms of incentives to minimize costs.

Direct reimbursement schemes are very likely to improve the quality of the loss settlement service and the relationship between insurers and policyholders. In the long run, this fact may have the effect of reducing those extra costs that can be imputed to ex-post moral hazard in the insurer-insured relationship. Whether such schemes can reduce costs also in the short run appears to be a more controversial matter. On one hand, if accompanied by appropriate legislation, contractual provisions and industrial organization, direct reimbursement schemes allow companies to achieve a better control on the complex productive process that is necessary to settle claims. On the other hand, they may induce them to be more lenient to the claimants, because the latter would become "clients", rather than a "third party", as in a standard tort liability system. Such aspects as the legal treatment of accessory expenses may well turn out to be critical for the success of the system in the short run.

These matters aside, the analytical contribution of this paper has been to show that direct reimbursement schemes, both in the French and the Italian version, are unlikely to produce significant differences relative to the standard third party scheme, in terms of the distribution of costs across companies and categories of consumers. Under a wide set of realistic circumstances, they yield essentially the same distribution of costs for companies and consumers as a standard third party scheme.

The two schemes are more similar to each other than it might appear at a superficial analysis. In most circumstances, they yield very similar results for companies and categories of consumers.

The introduction of any of these two schemes requires actuaries and managers of companies to adapt their way of thinking, as they have to change the approach for the setting of prices and reserves. The adaptation may be difficult initially especially if, as is being proposed in Italy, the system is introduced by law and is supposed to be applied to almost all kinds of claims.

Both schemes are exposed to some moral hazard problems in the principal-agent relationship that they imply between the company that handles the claim and the company of the person who bears the responsibility for an accident. Such problems may be fairly serious, but one should not lose the sense of proportion. For instance, they certainly have a smaller impact than the moral hazard problems that often arise in the relation between insures and claimants when companies do not have a very solid control over the loss settlement process at a very decentralized and detailed level.

[22] A change would be introduced by the Italian proposal to let the claimant have legal action against her company, rather than against the principal company. As we have seen, however, based on general principles of the legal system, the claimant could still sue the person whom she deems responsible of the accident.

In any case, we have indicated some remedies that can be put in place to try to minimize these problems: in some cases they imply appropriate legislation. Generally, however, it is difficult to give up the most classic of all remedies to moral hazard problems, that is monitoring, through detailed exchange of information, and peer pressure among companies.

There does not seem to be any valid technical reason for the view that the French scheme, being based on a single parameter for intra-company settlements, tends to cause "flatter" costs, and prices, than the Italian scheme. It is true however that, in such scheme, tariffs differentials between different categories of consumers may depend on the value of the forfait. Under some circumstances, an inappropriately high (low) value of the forfait tends to cause excessively large (small) differentials with respect to the frequency gradient than it would be socially efficient. It is also true that, under some circumstances (e.g. regional differences), the adoption of a single forfait may determine a redistribution of costs among companies that may be, or may be perceived, as unfair by some companies. These problems can be solved by using different forfaits for different categories of accidents, with respect to such factors as geographical location or type of vehicle. This may be seen as a disadvantage because, in any case, one cannot adopt as many forfaits as would be fair or efficient and because it requires cooperation and perhaps difficult periodic negotiations among companies; under some circumstances, it may also increase the problem of moral hazard among companies.

The Italian system seems to be the natural solution to these problems and can be run almost on an automatic basis.[23]

Both systems are exposed to some criticism from the viewpoint of competition policy. The French scheme because the value at which the forfait is fixed by the body that runs the system may act as a signaling device for coordinating price decisions of insurers. The Italian system because it requires detailed, claim by claim, exchanges of information from the agent company to the principle. As we have argued, the problem with the French system can be solved by resorting to a less discretionary set of rules for setting the forfait or the forfaits. The problem with the Italian system can be attenuated by retarding the exchange of information, but cannot be eradicated completely.

Summing up, there are trade offs between antitrust and other efficiency considerations. The Italian schemes appears to be somewhat more efficient and fair than the French one, but cannot be run without detailed exchanges of information. Such exchanges however are very useful, and perhaps necessary, in both schemes to allow for intra company monitoring against various possible sources of moral hazard, but may not encounter much favor from antitrust authorities.

[23] Historically, the Italian system has been introduced precisely in order to overcome the problems arising from the previously existing system that did use a multiplicity of forfaits.

A) Same probabilty of hitting and being hit

Tab. 1

Assumptions			
Company:	Market shares (in %)	Frequency of claims (*) (in %)	Average cost per claim (euros)
Small	2.0	7.0	4.0
Medium	15.0	8.0	5.0
Rest of Market	83.0	9.0	6.0
Total/average	100.0	8.8	5.8

Expected claim costs ("pure premium"): euros					
	Standard third party	Direct reimbursement		% difference relative to standard third party	
Company:		French	Italian	French	Italian
Small	0.280	0.280	0.280	0.0	0.0
Medium	0.400	0.400	0.400	0.0	0.0
Rest of Market	0.540	0.540	0.540	0.0	0.0
Average	0.514	0.514	0.514	0.0	0.0
Standard deviation	0.130	0.130	0.130	0.0	0.0
Forfait (**)		5.8			

(*) Frequency of accidents “caused” = frequency of accidents “suffered” by clients of the company

(**) The forfait is set equal to average costs in the French scheme.

B) Probability of being hit independent of probability of hitting

Same frequencies and different costs — Tab. 2

Assumptions			
Company:	Market shares (in %)	Frequency of claims (*) (in %)	Average cost per claim (euros)
Small	2.0	8.0	4.0
Medium	15.0	8.0	5.0
Rest of Market	83.0	8.0	6.0
Total/average	100.0	8.0	5.8

Expected claim costs ("pure premium"): euros					
	Standard third party	Direct reimbursement		% difference relative to standard third party	
Company:		French	Italian	French	Italian
Small	0.320	0.320	0.320	0.0	0.0
Medium	0.400	0.400	0.400	0.0	0.0
Rest of Market	0.480	0.480	0.480	0.0	0.0
Average	0.465	0.465	0.465	0.0	0.0
Standard deviation	0.080	0.080	0.080	0.0	0.0
Forfait (**)		5.8			

Same costs and different frequencies — Tab. 3

Assumptions			
Company:	Market shares (in %)	Frequency of claims (*) (in %)	Average cost per claim
Small	2.0	7.0	5.0
Medium	15.0	8.0	5.0
Rest of Market	83.0	9.0	5.0
Total/average	100.0	8.8	5.0

Expected claim costs ("pure premium"): euros					
	Standard third party	Direct reimbursement		% difference relative to standard third party	
Company:		French	Italian	French	Italian
Small	0.350	0.350	0.350	0.0	0.0
Medium	0.400	0.400	0.400	0.0	0.0
Rest of Market	0.450	0.450	0.450	0.0	0.0
Average	0.441	0.441	0.441	0.0	0.0
Standard deviation	0.050	0.050	0.050	0.0	0.0
Forfait (**)		5.0			

(*) All drivers have the same probability of being hit
(**) The forfait is set equal to average costs in the French scheme.

B) Probability of being hit independent of probability of hitting

Positive correlation between costs and frequencies — Tab. 4

Assumptions			
Company:	Market shares (in %)	Frequency of claims (*) (in %)	Average cost per claim (euros)
Small	2.0	7.0	4.0
Medium	15.0	8.0	5.0
Rest of Market	83.0	9.0	6.0
Total/average	100.0	8.8	5.83

Expected claim costs ("pure premium"): euros					
	Standard third party	Direct reimbursement		% difference relative to standard third party	
Company:		French	Italian	French	Italian
Small	0.280	0.247	0.280	-11.7	0.0
Medium	0.400	0.393	0.400	-1.6	-0.1
Rest of Market	0.540	0.540	0.538	-0.1	-0.4
Average	0.514	0.512	0.512	-0.4	-0.4
Standard deviation	0.130	0.146	0.129	6.3	0.2
Forfait (**)		5.81			

(*) All drivers have the same probability of being hit
(**) The forfait is set equal to average costs in the French scheme.

Zero correlation between frequencies and costs(*) — Tab. 5

Assumptions			
Company:	Market shares (in %)	Frequency of claims (**) (in %)	Average cost per claim (euros)
Small	2.0	7.00	5.0
Medium	15.0	8.00	6.0
Rest of Market	83.0	7.77	7.0
Total/average	100.0	7.79	6.81

Expected claim costs ("pure premium"): euros					
	Standard third party	Direct reimbursement		% difference relative to standard third party	
Company:		French	Italian	French	Italian
Small	0.350	0.336	0.350	-4.083	0.000
Medium	0.480	0.482	0.480	0.355	-0.042
Rest of Market	0.544	0.544	0.544	0.007	0.007
Average	0.530	0.530	0.530	0.000	0.000
Standard deviation	0.099	0.107	0.099	2.468	0.026
Forfait (***)		6.81			

(*) See appendix for the exact definition of correlation.
(**) All drivers have the same probability of being hit.
(***) The forfait is set equal to actual average costs in the French scheme.

B) Probability of being hit independent of probability of hitting

"Quebec scheme" (French with forfait = 0) Tab. 6

Assumptions			
Company:	Market shares (in %)	Frequency of claims (*) (in %)	Average cost per claim (euros)
Small	2.0	7.0	5.0
Medium	15.0	8.0	5.0
Rest of Market	83.0	9.0	5.0
Total/average	100.0	8.8	5.0

Expected claim costs ("pure premium"): euros					
	Standard third party	Direct reimbursement		% difference relative to standard third party	
Company:		French	Italian	French	Italian
Small	0.350	0.441	0.350	25.9	0.0
Medium	0.400	0.441	0.400	10.1	0.0
Rest of Market	0.450	0.441	0.450	-2.1	0.0
Average	0.441	0.441	0.441	0.0	0.0
Standard deviation	0.050	0.000	0.050	14.0	0.0
Forfait		**0.0**			

(*) All drivers have the same probability of being hit

C) Geography

Same frequencies and different costs in each area — Tab. 7

Assumptions						
	Market Shares (in %)		Frequency of claims (*) (in %)		Average cost per claim (euros)	
Company:	N	S	N	S	N	S
Small	2.0	15.0	6.0	8.0	6.0	3.0
Medium	15.0	2.0	6.0	8.0	7.0	4.0
Rest of Market	83.0	83.0	6.0	8.0	8.0	5.0
Total/average	100.0	100.0	6.0	8.0	7.8	4.7
Insured population	70	30				

Expected claim costs ("pure premium"): euros							
	Standard third party (STP)	Direct reimbursement			% difference relative to STP.		
		French		Italian	French		Italian
		1 forfait	2 forfait		1 forfait	2 forfait	
Company:							
Small	0.268	0.268	0.268	0.268	0.0	0.0	0.0
Medium	0.415	0.415	0.415	0.415	0.0	0.0	0.0
Rest of Market	0.456	0.456	0.456	0.456	0.0	0.0	0.0
Average	0.440	0.440	0.440	0.440	0.0	0.0	0.0
Standard deviation	0.099	0.099	0.099	0.099	0.000	0.000	0.000
Area:							
N	0.469	0.469	0.469	0.469	0.00	0.00	0.00
S	0.374	0.374	0.374	0.374	0.00	0.00	0.00
% difference N/S	25.2%	25.2%	25.2%	25.2%			
Forfait N (**)		6.7	7.8				
Forfait S (**)		6.7	4.7				

Same costs and different frequencies in each area — Tab. 8

Assumptions						
	Market Shares (in %)		Frequency of claims (*) (in %)		Average cost per claim (euros)	
Company:	N	S	N	S	N	S
Small	2.0	15.0	6.0	8.0	7.0	4.0
Medium	15.0	2.0	7.0	9.0	7.0	4.0
Rest of Market	83.0	83.0	8.0	10.0	7.0	4.0
Total/average	100.0	100.0	7.8	9.7	7.0	4.0
Insured population	70	30				

Expected claim costs ("pure premium"): euros							
	Standard third party (STP)	Direct reimbursement			% difference relative to STP.		
		French		Italian	French		Italian
		1 forfait	2 forfait		1 forfait	2 forfait	
Company:							
Small	0.344	0.323	0.344	0.346	-6.0	0.0	0.7
Medium	0.483	0.490	0.483	0.483	1.5	0.0	0.1
Rest of Market	0.512	0.512	0.512	0.512	0.1	0.0	0.0
Average	0.499	0.499	0.499	0.499	0.0	0.0	0.0
Standard deviation	0.090	0.104	0.090	0.089	3.990	0.000	0.416
Area:							
N	0.547	0.547	0.547	0.547	0.00	0.00	0.00
S	0.387	0.387	0.387	0.387	0.00	0.00	0.00
% difference N/S	41.2%	41.2%	41.2%	41.2%			
Forfait N (**)		6.0	7.0				
Forfait S (**)		6.0	4.0				

(*) All drivers in each area have the same probability of being hit
(**) The forfait is set equal to average costs in the French scheme.

D) Costs linked to portfolio mix

Same frequencies and different costs for collisions caused by third parties to clients of each company — Tab. 9

Assumptions			
Company:	Market shares (in %)	Frequency of claims (in %)	Average cost per claim (*) (euros)
Small	2.0	8.0	4.0
Medium	15.0	8.0	5.0
Rest of Market	83.0	8.0	6.0
Total/average	100.0	8.0	5.8

Expected claim costs ("pure premium") : euros					
	Standard third party	Direct reimbursement		% difference relative to standard third party	
Clients of company:		French	Italian	French	Italian
Small	0.465	0.320	0.320	-31.2	-31.2
Medium	0.465	0.400	0.400	-13.9	-13.9
Rest of Market	0.465	0.480	0.480	3.3	3.3
Average	0.465	0.465	0.465	0.0	0.0
Standard deviation	0.000	0.080	0.080	17.21	17.21
Forfait (**)		5.8			

(*) Costs incurred by clients of each of the three companies following collisions caused by third parties.
(**) The forfait is set equal to average costs in the French scheme.

Same frequencies and different costs for collisions caused to third parties by clients of each company — Tab. 10

Assumptions			
Company:	Market Shares (in %)	Frequency of claims (in %)	Average cost per claim (*) (euros)
Small	2.0	8.0	4.0
Medium	15.0	8.0	5.0
Rest of Market	83.0	8.0	6.0
Total/average	100.0	8.0	5.8

Expected claim costs ("pure premium"): euros					
	Standard third party	Direct reimbursement		% difference relative to standard third party	
Clients of company:		French	Italian	French	Italian
Small	0.320	0.465	0.465	45.3	45.3
Medium	0.400	0.465	0.465	16.2	16.2
Rest of Market	0.480	0.465	0.465	-3.2	-3.2
Average	0.465	0.465	0.465	0.0	0.0
Standard deviation	0.080	0.000	0.000	24.37	24.37
Forfait (**)		5.8			

(*) Costs of collisions caused to third parties by clients of each of the three companies
(**) The forfait is set equal to average costs in the French scheme.

E) Moral hazard

Tab. 11

Assumptions				**Moral hazard**	
Company:	Market shares (in %)	Frequency of claims (in %)	Average cost per claim (euros)	Additional 'fake' claims	Cost of additional claims (euros)
Small	33.0	10.0	5.0	0%	-
Medium	33.0	10.0	5.0	20%	1.0
Rest of Market	33.0	10.0	5.0	0%	-
Total/average	100.0	0.10000	5.0		

Expected claim costs ("pure premium"): euros					
	Standard third party	Direct reimbursement		% difference relative to standard third party	
Company:		French	Italian	French	Italian
Small	0.500	0.532	0.529	6.3	5.8
Medium	0.500	0.457	0.462	-8.7	-7.6
Rest of Market	0.500	0.532	0.529	6.3	5.8
Average	0.500	0.507	0.507	**1.3**	**1.3**
Standard deviation	0.000	0.043	0.038	8.7	7.7
Forfait (*)		4.8			

(*) The forfait is set equal to average costs in the French scheme.

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Appendix

Standard third party liability (TP)

In the standard third party reimbursement scheme insurers manage the claims originating from the collisions caused by their own policyholders. The basic formula for total expected claim costs of a given firm (*i*) is:

1. $C^{TP}(i) = \sum_j c^r(i,j) \cdot k(i,j)$

Where $c^r(i,j)$ is the average cost of the set of claims, $k(i,j)$, originated from collisions "caused" by policyholders of *i* to those of *j*. In both the *c* and the *k* functions, the first argument indicates the responsible party (in eq. 1, a person insured with company *i*) and the second one the party that has suffered the collision (a person insured with company *j*). The superscript "*r*" in the cost function stands for "responsibility" and is necessary to indicate that, under standard TP, the company who handles the claim is the company of the responsible party (*i*). When responsibility is shared, both the *c* and the *k* functions are adjusted appropriately: if a client of *i* is 30% responsible for an accident, only this fraction enters the set of *k(i, j)* collisions and its cost.

From the definition of average cost, as total costs divided by total claims, and from that of frequency, as number of collisions divided by policyholders, expression 1 can be restated in a more familiar language:

2. $C^{TP}(i) = k^r(i) \cdot c^r(i)$

3. $\pi^{TP}(i) = \frac{C^{TP}(i)}{p(i)} = f^r(i) \cdot c^r(i)$ (Pure premium = frequency times average cost)

where:

$k^r(i) \equiv \sum_j k(i,j)$	Total number of collisions " caused" by clients of *i.*
$c^r(i) \equiv \frac{1}{k^r(i)} \cdot \sum_j c^r(i,j)$	Insurer *i*'s average cost of claims (caused by its policyholders).
$\pi^{TP}(i)$	Expected claim cost per policy ("pure premium").
p(i)	Number of policyholders of company *i*.
$f^r(i) \equiv \frac{k^r(i)}{p(i)}$	Frequency (of claims with responsibility).

The French direct reimbursement scheme (FR)

Claims managed by insurance firms for collisions in which their policyholders are not considered liable are compensated under a French direct reimbursement scheme with an predetermined amount *F* ("forfait"). Hence the following basic formula for expected claim costs of a company:

4. $$C^{FR}(i) = \underbrace{\sum_j c^v(j,i)\cdot k(j,i)}_{I} + \underbrace{F\cdot\sum_j \left[k(i,j)-k(j,i)\right]}_{II}$$

where $c^v(i,j)$ is the average cost of the set of collisions, *k(j,i)*, "caused" by clients of each *j* company against clients of company *i*. The cost function now has a superscript "*v*" (for "victim") to indicate that a claim is now handled by the company of the non responsible victim of an accident.

Total expected claim costs are made up of two components. The first one represents the payments of the insurance company to its clients. The second component represents the balance of the outgoing and incoming transfers made according to the responsibilities involved in the accidents.

As above, the cost expression can be rewritten as follows:

5. $$C^{FR}(i) = k^v(i)\cdot c^v(i) + F\cdot\left[k^r(i) - k^v(i)\right]$$

or:

6. $$\pi^{FR}(i) = \frac{C^{FD}(i)}{p(i)} = f^v(i)\cdot c^v(i) + F\cdot\left[f^r(i) - f^v(i)\right]$$

where:

$k^v(i) \equiv \sum_j k(i,j)$ Total number of accidents "suffered" by *i*'s policyholders (the "victims").

$c^v(i) \equiv \frac{1}{k^v(i)}\cdot\sum_j c^v(j,i)$ Average claim cost of collisions "suffered" by *i*'s policyholders.

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$f^v(i) \equiv \frac{k^v(i)}{p(i)}$ Frequency of accidents "suffered" by *i*'s policyholders.

It is helpful to rewrite expression 6 in the following way:

7. $$\pi^{FR}(i) = f^r(i)\cdot c^v(i) + \varepsilon^{FR}(i)$$

where:

8. $$\varepsilon^{FR}(i) = \left[F - c^v(i)\right]\cdot\left[f^r(i) - f^v(i)\right]$$

Eq. 7 is very similar to eq. 6 for standard TP if the term $\varepsilon^{FR}(i)$ is small. In the simulations, we have seen many cases in which this is indeed true.

The Italian direct reimbursement scheme (IT)

Following the discussion of the main text, the basic expression for expected claim costs of a given firm under the Italian scheme is given by:

9. $$C^{IT}(i) = \sum_j c^v(i,j) \cdot k(i,j) + \gamma(i,j) \cdot \sum_j \left[c^v(j,i) - c^v(i,j) \right]$$

where

10. $$\gamma(i,j) = \begin{cases} k(i,j) & \text{if } c^v(i,j) \le c^v(j,i) \\ k(j,i) & \textit{otherwise} \end{cases}$$

The first addendum of eq. 9 represents total costs after step 2 of the procedure: (monthly) "pay backs" amongst companies. This is the sum of the costs borne by all *j* agent companies for collisions caused by clients of *i* and handled by the agent at their average cost defined as $c^v(i,j)$.

The second addendum represents step 3 of the procedure, in which company *i* receives a net payment (positive or negative) from each *j* company. Such payment is equal to the difference between its average cost in handling accidents caused by each j company's clients and the vice versa. In each bilateral transaction, this difference is multiplied by the number of collisions caused by the company with the lower average cost (eq. 10).

As we did for the French system, we rewrite eq. 9 as:

11. $$C^{IT}(i) = \sum_j c^v(j,i) \cdot k(i,j) + \sum_j \left[k(i,j) - \gamma(i,j) \right] \cdot \left[c^v(i,j) - c^v(j,i) \right]$$

Note that in the first addendum we now have the term $c^v(j,i)$, which is different from the term $c^v(i,j)$ that appears in eq. 9. Using again the definitions of average cost and of frequency, eq. 11 can be written in terms of pure premium:

12. $$\pi^{IT}(i) = \frac{C^{IT}(i)}{p(i)} = f^r(i) \cdot c^v(i) + \varepsilon^{It}(i)$$

where:

13. $$\varepsilon^{IT}(i) = \frac{1}{p(i)} \cdot \sum_j \left[k(i,j) - \gamma(i,j) \right] \cdot \left[c^v(i,j) - c^v(j,i) \right]$$

Except for the ε term this is the same expression that we have found for the French scheme and is rather similar to the familiar frequency times average cost expression used in standard TP.

Analytical proof of the main results

So far we have presented pure accounting identities, where no assumptions were involved. As in the main text, we now introduce some useful assumptions.

Assumption A1. Average costs per claim differ across companies only because of differences in efficiency. This implies the following equalities, which allow us to drop a large number of indexes and superscripts:

14. $c^r(i,j) = c^v(i,j) = c^r(i) = c^v(i) = c(i)$ for all *i* and *j*.

Assumption A2. Geography does not matter. This assumption allows us to recover the full joint distribution of accidents once we make an assumption on the marginal distributions, i.e. on the frequencies of accidents caused or suffered by clients of each firm. The basic formula resulting from A2 is:

$$15.\quad f(i,j) \equiv \frac{k(i,j)}{p(i)} = \left[\frac{f^v(j)}{f}\right] \cdot w(j) \cdot f^r(i)$$

where $f \equiv \frac{K}{P}$ is aggregate frequency (total accidents, K, divided by total policyholders, P) and $\boldsymbol{w(j) \equiv \frac{p(j)}{P}}$ is the market share of company *j*.

Eq. 15 says that the (unconditional) probability that a client of company *i* causes an accident to a client of *j* depends on the frequency of accidents caused by *i*'s clients, $f^r(i)$, times the market share of *j* (which measures the probability of anyone encountering a driver insured with *j)* times the term in square bracket, which measures the likelihood that a *j*'s driver suffers an accident relative to that of an average driver, which is measured by *f*. If all drivers have the same probability of being hit, the term in bracket is equal to 1. It can easily be checked that this expression satisfies all the necessary adding up constraint, given by the marginal distributions.

The key feature of eq. 15 is that there are no measures of distance between companies. Clearly *f(i,j)* could easily be zero if policyholders of the two companies were concentrated in two different regions that are far apart from each other.[24]

Under assumptions A1 and A2, we first consider Case 1. Equal probability of hitting and being hit implies that $f^r(i) = f^v(i) = f(i)$.

Eq. 3 for TP, then becomes:

$$16.\quad \pi^{TP}(i) = f(i) \cdot c(i)$$

In the French scheme, from eq.6 it is evident that no transactions will take place in the settlement system. Since $f^v(i) = f(i)$ and $c^v(i) = c(i)$, eq. 6 becomes the same as eq. 16 above. Expected claim costs for each company are hence the same as under TP.

The same occurs in the Italian scheme, because under A2, the matrix of collisions is symmetric[25], i.e. *k(i,j)=k(j,i)* for all *i* and *j*. Hence from eq. 13 we know that the ε term is zero for all companies and eq. 12 becomes the same as eq. 16 above.

We now turn to Case 2. All drivers having the same probability of being hit implies: $f^v(i) = f$ for all companies (recall that *f* is the aggregate frequency of the system).

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[24] The policyholders of two companies may be far apart geographically, but they may be similar in terms of the relevant variables (frequencies and costs). In this case, we can think of aggregating the two companies and geography would still not matter in terms of costs and premiums for categories of consumers.

[25] This can best be seen by noting that eq.15 implies $k(i,j) = \left[k^r(i) \cdot k^v(j)\right] / K$ and that, under the assumptions of Case 1, $k^v(i) = k^r(i)$ for all *i*.

Given A1and A2, in Case 1, we can rewrite the expressions for pure premiums in the three schemes as:

17. $\pi^{TP}(i) = f(i) \cdot c(i)$ Standard third party

18. $\pi^{FR}(i) = f(i) \cdot c(i) + \varepsilon^{FR}(i)$ French scheme

and

19. $\varepsilon^{FR}(i) = \left[f(i) - f\right] \cdot \left[F - c(i)\right]$

20. $\pi^{IT}(i) = f(i) \cdot c(i) + \varepsilon^{IT}(i)$ Italian scheme

and

21. $\varepsilon^{IT}(i) = \sum_{j=1}^{i} w(j) \cdot \left[f(i) - f(j)\right] \cdot \left[c(j) - c(i)\right]$

Note that to derive eq. 21 from eq. 13, besides the various assumptions already mentioned, without any further loss of generality we have ordered companies according to their average costs, so that $c(i) < c(j)$ if $i<j$.

If frequencies are the same across all companies ($f(i) = f$ for all i), then the ε terms are zero both in the French and in the Italian schemes. The three schemes hence yield the same π for all companies.

If costs are the same across companies ($c(i)=c$ for all i), then it is immediate that $\varepsilon(i)$ is zero in the Italian scheme for all companies. Looking at eq.19, we see that for $\varepsilon(i)$ to be equal to zero in the French scheme, we need the further condition that F be fixed at the same value as average cost, i.e. $F=c$.

Aggregate expected claim costs are the same in the two DR schemes, since settlements amongst companies sum up to zero. We can hence look at the French scheme, knowing that the results for the aggregate hold also for the Italian scheme.

The aggregate pure premium in the French scheme is the weighted average of the terms $\pi^{FR}(i)$ in eq. 18.

22. $\Pi^{FR} \equiv \sum_i w(i) \cdot f(i) \cdot c(i) + \sum_i w(i) \cdot \varepsilon^{FR}(i)$

The first addendum is the average pure premium under TP (see eq. 17). The second is the given by the following expression:

23. $\sum_i w(i) \cdot \left[F - c(i)\right] \cdot \left[f(i) - f\right] \equiv -\mathrm{cov}(c, f)$

Noting that $f = \sum_i w(i) \cdot f(i)$, eq. 23 is the definition of the covariance (with a minus sign) between costs and frequencies, if F is fixed at actual average cost, i.e: $F = \sum_i w(i) \cdot c(i)$. Hence, when the correlation (whose numerator is this covariance) is zero, aggregate costs are the same as under TP.

When the correlation is positive, costs are lower (because of the minus sign), and vice versa.

As concerns the Italian scheme, note that, by construction, the most efficient company is *i=1*. Therefore in eq. 21, $\varepsilon^{IT}(1) = 0$ and the pure premium is equal to that of TP. Instead the least efficient company will be *i=N*, if *N* is the number of companies. For this company, in eq. 21 the summation is over the whole range of companies indexed by *j*. It can be shown that for such company, the following relation holds:[26]

24. $\varepsilon^{IT}(N) = -\mathrm{cov}(c, f) + \varepsilon^{FR}(N)$

Then, if *cov(c,f)=0*, the pure premium of the least efficient company is the same as in the French scheme (as is shown in tab. 5).

Pulling things together, when *cov(c,f)=0*, aggregate costs are the same in all three schemes; in the Italian scheme the most efficient company has the same expected claim costs as under TP, while the least efficient has the same costs as in the French scheme. The result of the simulation, that the intermediate company is closer to TP under the Italian scheme than under the French scheme, should not be surprising (see tab. 5). This helps understanding why in all our simulations the Italian scheme, being based on a finer system of bilateral settlements, generally yields less arbitrary results, relative to TP, than the French scheme.

These considerations prove or give the basis for proving all the propositions in the text from 1 to 8. Propositions 9 and 10, as well as proposition 14, will not be given a proof, because they are rather straightforward, though tedious, extensions of the previous ones and would add little insight relative to the numerical exercises.

As regards propositions 11 to 13, concerning costs linked to the portfolio mix, we have to go back to equations 1 to 13 in the first part of this Appendix. If costs depend only on the characteristics of the cars that are hit (more or less expensive to repair), then $c^r(i) = c$ for all *i,* where c is a constant across all firms. Instead, the terms $c^v(i)$ differ across companies. To make a clear point, in the text we have disregarded possible differences in frequency, i.e.: $f^r(i) = f^v(i) = f$.

Under these assumptions, eq. 3 for TP becomes:

25. $\pi^{TP}(i) = f \cdot c$

In both DR scheme, we instead get:

26. $\pi^{DR}(i) = f \cdot c^v(i)$

TP produces flat costs (and prices), while DR schemes induces differential treatment for the different categories of policyholders-clients. With the same logic, it is straightforward to show that the opposite is true when costs depend only on the characteristics of the cars that cause the collision (Proposition 13 of the main text).

[26] This is obtained by adding and subtracting weighted averages (f and F) in the two terms in square brackets in eq. 21and then noting that two of the four resulting separate summations over *i* are equal to zero.