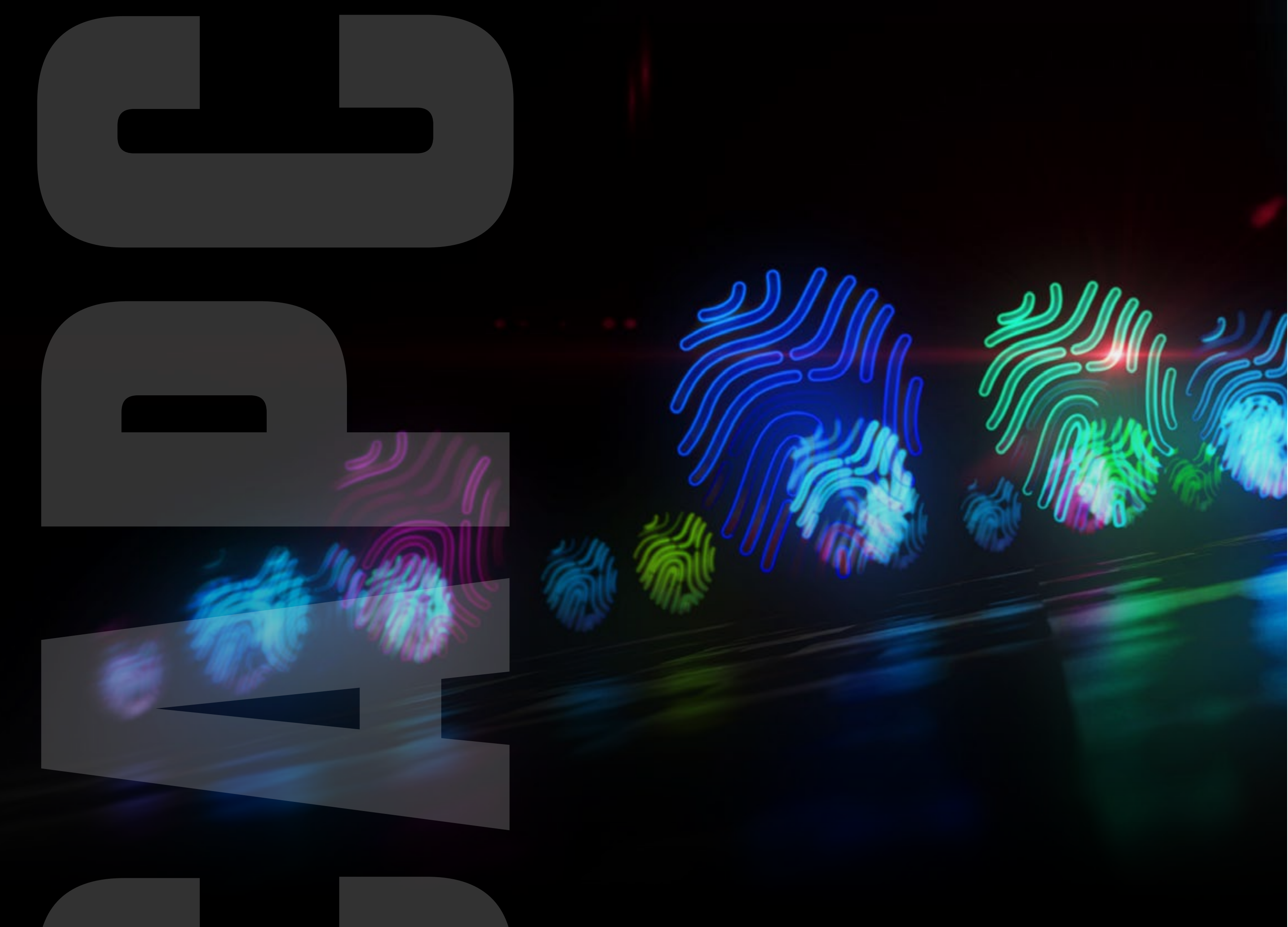

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USING RISK ANALYTICS TO PREVENT ACCIDENTS BEFORE THEY OCCUR – THE FUTURE OF INSURANCE[1]

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ABSTRACT

While insurance was originally devised as a safety net that steps in to compensate for financial losses after an accident has occurred, the information generated by sensors and digital devices now offers insurance companies the opportunity to transform their business by considering prevention. We discuss a new form of risk analytics based on big data and algorithmic prediction in the insurance sector to determine whether accidents could indeed be prevented before they occur, as some now claim is possible. We will use the example of motor insurance where risk analytics is more advanced. Finally, we draw conclusions about insurance's new preventive role and the effect it may have on the policyholders' behavior.

1. INTRODUCTION

We are in a new era. We have measurement sensors that can capture data without interruption, we have huge storage capacities, and we have created algorithms that allow for the analysis of information with unprecedented speed. All this promises to transform the insurance business, with consequences that many observers have no hesitation in defining as "disruptive".

The insurance industry has always been eager for information, predominantly because it is through processing of information that the industry can assess future risks. While it is obvious that no one can predict with absolute certainty what might happen in the future, good information combined with suitable mathematical models can make it possible to construct expectations about what might happen. It is on the reliability of these expectations that the insurance industry bases its business model.

However, the transformation that is taking place within the insurance sector as a consequence of the enormous potential of information processing made possible by digital technologies and the algorithmic techniques of data mining is not simply an improvement in the reliability of the loss expectations on which prices of insurance policies depend. The change actually has more to do with the kind of expectations that can be constructed and how they impact on the social role of insurance.

While insurance was originally devised as a safety net that steps in to compensate for financial losses after an accident has occurred, the information generated by sensors and digital devices now offers insurance companies the chance to step in before that accident occurs. As a result, the function of insurance becomes increasingly proactive. This means that the premium paid by the policyholder contributes not only to the compensation of losses in the pool to which the policyholder belongs, but also to risk prevention; to maintaining early-

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warning signals pertaining to the risk being insured. The question is not, therefore, only how much information do we have, but also how information can help us improve safety and prevent accidents from happening – and how this can be managed actuarially by insurance companies when they feed this information back to policyholders.

In this paper, we will analyze how the perspective of traditional insurance changes in an IoT-based (internet of things) society and how this will affect the development of the sector in future. We shall start with some general observations about the development of a new form of risk analytics based on big data and algorithmic predictions in the insurance sector and then focus on one branch of insurance in particular – that of motor insurance – where risk analytics is more advanced, in terms of both technical experimentation and of insurance practice. Finally, we shall draw conclusions about insurance's new preventive role and the effect it may have on the behavior of policyholders.

2. RISK ANALYTICS WITH BIG DATA

The availability of huge data flows provided by current technologies has given rise to a new discipline known as "risk analytics", which allows data science and big data to be combined with risk analysis.

Risk analysis is a well-established discipline, which investigates the occurrence of adverse phenomena that do not take place frequently but that can have devastating consequences for all humans directly or indirectly. For example, storms, floods, and earthquakes do not only cause loss of life and destruction, but they can also have enormous impacts on communities and their future generations. Risk analysis builds upon solid methodological principles that have much in common with the foundations of insurance. Accidents, whose coverage is included in an insurance contract, are rare phenomena and when a contract is underwritten it is unclear whether they will or will not occur. Insurance is based on a treaty of honor, such that the insurer will compensate the insured not for the peril, but for the occurrence of an adverse event.

When analyzing risks in general, not just insurance, the main concern is how to find the causes of accidents and how to mitigate hazards. The paucity of data is the main stumbling block in risk analysis. As adverse events are occasional, there is not a sufficient statistical mass of data to apply traditional mathematical instruments to that can guide decision-making. A classic example is the law of large numbers, which relies on repeatedly observing a phenomenon and allowing for the extrapolation of its expected behavior into the future. For this main reason, risk analysis has developed its own methodology over the years, adapted to the scarcity of data.

With the greater availability of information, the challenges for risk analysis are different from the traditional ones. Risk analytics is about discovering which part of the data can inform and anticipate the occurrence of a claim, and how to find this value. Most of the data is, in fact, uninformative or repetitive, so that there is no indication of any anomalous behavior. However, a small part of the data stream, and especially the segment immediately before an accident, can offer the opportunity to discover a warning indicator that may be useful in the future to foresee that an accident is about to occur. Those few seconds may be essential to saving lives and enhancing protection.

2.1 Low-frequency phenomena in insurance

Insurance is intended to compensate for losses caused by events that are unlikely to occur, but which can cause serious damage. So, in general, insurance provides protection to organizations and individuals by allowing them to overcome the financial consequences of accidents.

In the case of car insurance, for example, liability insurance is mandatory to prevent a driver who causes damage to third parties from being unable to face the losses caused to others. In automobile insurance, the annual accident frequency for each policy does not usually exceed 10% in developed economies, a level that is much lower if only the frequency of at-fault accidents is considered. For this reason, if an observer selects a surveillance window for a group of drivers lasting less than one year, then the vast majority do not experience any accidents. This characteristic, known as "low frequency", makes analysis difficult because the event of interest is not observed. No occurrence, despite massive data being intensively collected, means no information revealing patterns of accident occurrence.

However, new algorithms in risk analytics are aimed at handling these cases, something known technically as "rarity", which means that the usual focus of machine learning is changed from looking at the most frequent data values to the less frequent measurements. The most difficult part of dealing with rare data is how to be certain about the absence of measurement error in the analysis of event occurrence. For example, a traditional puzzle for automobile insurance is to distinguish between drivers that have no accidents because they do not use the car and those who are exceptionally good drivers.

2.2 How does intensive data collection impact on insurance?

In recent years, the increasing use of sensors and digital devices has paved the way for an intense collection of data that insurance companies can process, using suitable algorithmic techniques, to enhance risk analysis [Bohn (2018)]. Yet, it would be misleading to assert that big data leads to data-driven insurance, since insurance has always been data-driven, as actuarial mathematicians know only too well. What has changed, then, is not the presence of data, but the quantity of data available and, even more importantly, the nature of the data with which the insurance industry can work.

The specificity of risk analytics is to be found, we believe, in the fact that it not only allows risk assessment itself to be improved, but that it also allows risks to be assessed differently. This is because digital data offer insurance companies the unprecedented opportunity of profiling their clients, while traditional statistics had to make do with defining the "average customer". Although such a profile does not completely replace the average, it certainly contributes to redefining the classical pricing procedures used by insurance companies, especially when the available data is behavioral data.

That is why the insurance industry has been talking about UBI (usage-based insurance) for several years now. UBI is a form of insurance whose price depends on the individual user's behavior, as in the case of telematics third-party liability motor insurance, which we shall discuss shortly. The aim here is to manage to set a price that is no longer based on the statistical properties of a given segment of policyholders, but on the real behavior of the individual who belongs to that given segment of policyholders. In this way, the aforementioned "low frequency" problem is partly compensated for by an increasingly personalized prediction of risk exposure.

Yet, if the way we predict the future changes, the way we insure also changes, and that could have more far-reaching social consequences that still remain largely unexplored [Cevolini and Esposito (2020)]. Before proceeding to illustrate telematics motor insurance in greater detail, we would like to give brief consideration to two crucial issues on which the impact of UBI could be more disruptive: adverse selection and information asymmetry.

2.2.1 ADVERSE SELECTION

Adverse selection is a classical problem for the insurance industry. And, although extremely complex mathematical techniques have been developed to tackle the problem, it has remained unsolved and is quite possibly unsolvable. The problem for insurance companies is that they have to predict which individuals, among all those who apply to take out insurance coverage, will lodge a claim that causes the company to make the kind of loss that could be far greater than the premium received. In this respect, the paradox underlying the question of adverse selection is that the insurance company would prefer to insure only those customers who do not need any insurance. Since exactly who they are is a question that the company can only answer with the wisdom of hindsight, insurance is a risky business.

The possibility of getting to know their policyholders better, using the profiles that can be drawn up for each of them, offers insurance companies the opportunity of implementing what is known in the insurance jargon as "cream skimming" [Cather (2018)]: the company can discriminate between its more and its less virtuous clients, offering the former proportionately more attractive premiums. This could improve the efficiency of the insurance business, i.e., the company's loss ratio, but it also raises several thorny issues.

Policyholders who are more exposed to given risks, regardless of their own intentions, may find themselves facing insurance premiums that they cannot afford. The result is that they might have to go without insurance coverage, losing out on the social, as well as economic, opportunities offered by that coverage.

There is also the fear that the data that is in the possession of the insurance company could be used for the purposes of price optimization, i.e., to increase the premiums paid by those clients who are prepared to pay more than their risk demands. In that case, the increase in the premium would not correspond to a real increase in the policyholder's exposure to risk, and the price of the policy could be considered unfair.

2.2.2 INFORMATION ASYMMETRY

Information asymmetry is another area where digital data could have a disruptive impact. This, too, is a classic problem for the insurance industry: policyholders typically have access to plenty of information that they have no interest in disclosing to their insurance companies, since it might lead to an increase in their premiums or even to the companies refusing to offer them insurance coverage. When this information is missing, it increases the uncertainty that the companies have to manage.

The pervasiveness of digital technologies promises to revolutionize this situation completely. The continuous stream of digital traces that we leave when we use our mobile telephones or when surfing the web generates an impressive amount of data, which can help insurance companies learn a lot about their customers. To these digital traces we can also add the behavioral data that wearable devices like a FitBit watch or a black box installed in a car can transmit in real time, which an insurance company can process to get a better-focused idea of the individual it is dealing with.

There would appear to be multiple advantages from having access to such data. Firstly, insurance companies can make a more accurate estimate of the risks they run when they decide to sell a policy to a given individual. Secondly, they can use the information available to them to mitigate their moral hazard. Customers who know that they are being monitored or tracked are dissuaded from behaving imprudently. Finally, the data transmitted by digital devices and generated by online activity can improve a company's capacity for fraud detection.

These benefits, however, do not come without costs. The idea of being constantly monitored and traced immediately raises a whole host of concerns about individual privacy. The sensation that we are living in a regime of "dataveillance" is very strong, but our fears are often mitigated by the incentives that accompany it. If, for example, an insurance company offers the policyholder who is prepared to transmit their data a not so insignificant discount on the price of their policy, they might be more willing to being monitored (we shall return to this issue later in the paper).

The fear remains, however, that such data might end up having some unexpected penalizing strings attached. If the data, once processed, lead to pessimistic predictions the premium may go up when the policy comes up for renewal. If the policyholder wants to avoid running this risk they can opt to not disclose their data, although that would mean losing out on the incentives. When it comes to it, privacy comes at a cost.

We should also add that the policyholder typically does not have access to the mathematical procedures used to process the data they have transmitted to their insurance company. Algorithms are notoriously opaque and their implementation is automated. Since policyholders have the right to know how their risk exposure is evaluated, a legal guarantee of a certain degree of algorithmic accountability is considered indispensable.[2] However, how that accountability can actually be implemented, by whom, and with what consequences remains unclear. Overturning the information asymmetry thus still remains an open problem that demands further investigation.

3. MOTOR INSURANCE TELEMATICS RATEMAKING

After these rather general considerations, we now want to tackle a particular case of usage-based insurance: third-party liability motor insurance based on telematics data.[3] In our opinion, this is an extremely interesting branch of insurance, since this approach to insurance can associate the more abstract theoretical considerations with empirical research based on tangible practices. In the next section, we shall provide a brief overview of the developments of telematics motor insurance and present the leading telematics solutions available on the insurance market today.

3.1 A brief history of pay-as-you-drive and pay-how-you-drive insurance

The first interesting thing to mention is that the technology of telematics was not developed for insurance purposes, but that it was the insurance industry that – with a certain delay – discovered the technology's potential for improving the insurance business. The same applies to all the other digital technologies that are used in one way or another these days in the insurance industry value chain. It could be said, then, that the insurance industry has co-opted technologies that were originally intended for other purposes, and that could explain – at least in part – why the insurance industry was relatively late in setting its own digitalization in motion.

It has always been known that telematics data furnish vital information for evaluating driver behavior, however, it was not until the 1990s that the hypothesis that this information can also be used for insurance purposes first surfaced in actuarial literature. And it is only since the beginning of this century that some insurance companies have started offering third-party liability motor insurance policies based on telematics data to calibrate the insurance premium to the actual usage of the vehicle by the driver. In short, these were policies of the pay-per-mile type: when the policy came up for renewal, the driver was allocated a discount based quite simply on the number of kilometres driven [Litman (2005)].

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[2] GDPR (General Data Protection Regulation, E.U. n. 2016/679), art. 22.

[3] Telematics allow for real-time information collection about vehicle location, safety metrics, and engine diagnostics.

At a later stage, insurance companies experimented with a variety of technological solutions for increasing both the volume and the variety of the data to be used for understanding driving behavior and establishing a probabilistic model of how it relates to future claims. Three technologies have been used in the course of the last twenty years: the black box installed in the vehicle, OBD (on-board diagnostic) systems, and the pairing of mobile phones with a smart tag attached to the windscreen. The first and the last of these are the ones that have had the greatest bearing on the development of usage-based motor insurance policies.

In the first case, the insurance company asks the policyholder to allow a black box to be installed in their vehicle. By coupling its readings with a GPS tracker system, the black box transmits very accurate data about driving behavior, such as speeding, cornering, braking, swerving, tailgating, lane-changing, road type, and time of driving. The company then builds these data into its actuarial procedures for the purpose of better explaining variance, i.e,. the fact that, within a given pool of policyholders with identical statistical properties, some individuals perform better than average, while others perform worse.

It is only in the last few years that the mobile phone has become an alternative to the black box, launching the concept of "mobile telematics". Instead of installing a black box in the vehicle, the driver downloads an app to their smartphone, which is paired with a smart tag attached to the windscreen. This enables multiple sensors – an accelerometer, a gyroscope, the GPS, a magnetometer, and a barometer – to be combined together, whose data are reprocessed to establish the policyholder's driving behavior.

One major advantage of mobile telematics is that it can feed all the information about each individual trip back to the driver, through the app. In this way, the driver can view the roads they have driven along, the number of kilometers driven, and the precise points where any critical events occurred (e.g., a forbidden U-turn, breaking the speed limit, or a dangerous lane change).

On the basis of these technologies, insurance companies have developed two different usage-based insurance solutions: pay-as-you-drive (PAYD) and pay-how-you-drive (PHYD) insurance policies. In the first case, when the policy comes up for renewal, the premium is calibrated to the number of kilometers actually driven, the type of road, and the time spent driving. Those who only use their cars at the weekend, on rural roads, and returning home before it gets dark are less exposed to the risk of accidents than a sales representative who drives hundreds of kilometers every day on urban roads and motorways and returns home late in the evening – so the argument goes.

In the second case, that of PHYD, the telematics data are used to define the policyholder's driving style. To do this, the driver's behavior is rated using a points system. Those who break the speed limit, drive at night, change direction suddenly, or break without warning are penalized.

Insurance companies normally distinguish between three clusters: "evolved" (those who are very prudent), "intermediate", and "reckless" drivers. For their part, policyholders receive feedback in the form of a score: a very high score is a sign of prudence; a very low one a sign of imprudence. The discount that will be applied when the policy comes up for renewal depends on this score, as does access to such incentives as vouchers for buying goods and services, or a cashback when filling up with fuel. Pay-how-you-drive policies obviously also take the amount of kilometers driven into account, so are implicitly pay-as-you-drive policies.

3.2 Insurers' innovations: Current challenges to creating usage-based insurance

Insurers are convinced that the collection of telematics data provides them with information about their policyholders that is both valuable and useful, and this seems to be the case. Recent studies [Gao et al. (2019), Guillen et al. (2019), Wüthrich (2017)] confirm that telematics data perfectly substitute traditional pricing factors, namely, the indicators that were traditionally recorded when underwriting an insurance contract (age, address, type of vehicle, and so on). In addition, some studies [Barry and Charpentier (2020), Geyer et al. (2020)] have found that with just a few weeks of monitoring drivers with telematics devices it is relatively simple to classify drivers.

For these reasons, although with great prudence, it is expected that insurers will gradually include driving style indicators in motor insurance rates. That will allow prices to be adapted and personalized. Competition between insurers means that each of them will use their own tools, and the predictive capacity of each of these telemetry-based pricing factors will typically not be revealed to competitors. Some kind of regulation for this "algorithmic competition" will also be required.

There are multiple challenges to usage-based insurance, however. Firstly, how would you incorporate personalized insurance pricing into rental vehicle platforms, where the provision of the service includes insurance and could be adapted to the user's driving style. Secondly, how would you communicate new ways of adapting prices, also considering real-time pricing.

Recent studies [Guillen et al. (2021)] propose that the insurance be made up of two blocks: i) a base premium that depends on some general characteristics of the vehicle and the driving area, and ii) a variable premium based on the distance traveled and the driving style. A recent research innovation in insurance allows for the recording of "near-misses", i.e., events such as sudden braking or acceleration that may indicate the presence of an imminent danger, even if it did not end in an accident. In this case, the challenge is to decide whether these events should be penalized or how their absence should be rewarded.

The main challenge for the insurance companies, however, seems to be related to moving from pure compensation for what has already happened to a service provision, giving feedback to drivers on how they improve their style at the wheel. We will cover this issue below.

3.3 Customers' perspectives

So far, we have considered the novelty implicit in user-based insurance in general, and in telematics motor insurance in particular. The question that also needs to be addresses is how policyholders view the fact that their behaviors are being evaluated by their insurance companies. Furthermore, how does the social role of insurance change as a consequence when behavioral tariffs start to play a leading role in pricing?

3.3.1 PRIVACY

As we mentioned above, the inversion of information asymmetry might further aggravate the issue of privacy. If we consider the case of telematics motor insurance policies, the situation appears to be somewhat different from the one typically discussed in ethical or legal debates, and in a certain sense also far less critical than would appear to be the case.[4]

Let us start with a rather prosaic observation: the fact that there are millions of connected vehicles in the world today with which a pay-as-you-drive (PAYD) or a pay-how-you-drive (PHYD) policy is associated demonstrates that substantial numbers of policyholders have no problem transmitting the data about their driving behavior. It would appear, then, that the incentives play a decisive role here.

Drivers who give their consent to installing a black box in their vehicles get an immediate discount (known as the "flat discount") when they buy the policy, a discount that can go as high as 25% of the insurance premium. To this should also be added the other incentives we already mentioned (vouchers or cash-back), together with a further discount when the policy comes up for renewal, calculated on the basis of the score accumulated by the policyholder during the previous period. All these incentives increase policyholders' motivation to share their data.

Privacy nevertheless remains an issue, since the data are used to produce predictions that could be penalizing in fields that have no direct relationship with the data. One classic example of such a case in motor insurance is the use of credit scoring. Policyholders who are some months behind on their mortgage payments may find themselves paying an increased third-party motor insurance premium without anything changing in their actual driving behavior. This is because credit scoring functions very well as a variable proxy for predicting the risk of car accidents. In order to avoid questions of this kind arising, many insurance companies that sell PAYD or PHYD policies guarantee their clients that their behavioral data will not be passed on to data brokers, but will be used exclusively to calculate the cost of the motor insurance policy.

3.3.2 COACHING

Another new feature introduced to insurance by behavior-based tariffs is the possibility to provide policyholders with feedback, information that ought to help them understand whether and when their behavior exposes them to risks that they would do better to avoid. When discussing this, the latest literature talks about "coaching". It would be ideal if policyholders could be trained to become increasingly prudent, thus reducing not only the rate of accidents, but also their insurance premiums.

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[4] This is also the emerging result of an ongoing empirical research on third-party liability motor insurance based on telematics data that is carried out by one of the authors of this article (Alberto Cevolini) and Elena Esposito, PI of the ERC PREDICT (ERC-2018-ADG, n. 833749) research project on "The future of prediction: the social consequences of algorithmic forecast in insurance, medicine and policing."

From a strictly operational standpoint, the problem is that it is very hard to find indicators capable of giving a reliable reading about whether and to what extent this feedback affects drivers' behavior. Once a driver is set in their way of driving, it is not very easy for them to change it. And if they do, it is hard to pinpoint the exact reason – have they learned their lesson, or are they doing this just to pay less premium, or even whether this is just a temporary change.

One thing is certain: the most complete benefit can be had from the potential of pay-how-you-drive policies, especially those associated with an app installed on the driver's mobile phone, but only if the insurance companies manage to implement proactivity, which depends on their ability to achieve an effective coaching process with their policyholders. This is certainly one of the most important aims of behavior-based policies.

4. RISK MITIGATION AND PREVENTION WITH RISK ANALYTICS

Risk mitigation and prevention is one of the main functions of risk analytics: allowing insurance companies to identify which risk indicators are relevant and preparing high-dimensional risk maps in which the probability of occurrence can be presented through more than one component. The abundance of data enables risk to be measured through different dimensions.

For example, a moving vehicle's speed can be recorded together with the distance between it and the vehicle in front, the time elapsed since the start of the journey, instantaneous acceleration or deceleration, and even fuel consumption and the turning angle of the wheels. All these components provide information about the vehicle's condition and the driver's behavior and habits. The use of the mobile phone can be recorded as well, since it has been proven to be a major cause of distraction and is associated with greater accident rates. Consequently, the most recent methodological advances seek to combine both individual traits and cross effects, showing the combination of several risk components.

4.1 Intensive data analysis to find early-warning indicators

Interdependence between the factors that provide data flows makes it difficult to find synthetic indicators that serve as early warnings of accident risk. As suggested recently, intensive data analysis methods, combined with predictive risk techniques, may lead to new risk measures. A good example is the use of quantile and distributional regressions, which make it possible to calculate assessments, a figure from 0 to 100, for each driver, by placing drivers at their risk level in real time while considering observational circumstances simultaneously. For example, it is not the same to exceed the speed limit for about 10 kilometres for someone who drives 200 kilometres a day as for someone who drives an average of 25 kilometres a day. In both cases, the type of driving area or the experience of the driver can also be taken into account. The search for reliable early-warning indicators is, however, of the outmost importance for achieving effective loss prevention and, in this respect, risk analytics plays a crucial role.

4.2 Defining the benefits of preventing losses

In the preceding sections, we mentioned that the task of insurance companies has always been to ensure a correct transfer of risk, that is to say that the premiums paid by policyholders are sufficient to cover compensation for accidents. However, current risk analytics go beyond premium calculations (drivers who are statistically proven to have a greater risk of having an accident pay more) and a radical change is needed for insurance.

In years to come, we will see a new way of approaching insurance, which apart from being a risk transfer mechanism will also provide safekeeping services. For this reason, more research is needed to evaluate how much a policyholder is willing to pay for prevention and security. In such an equation, it is obvious that insurers will seek profit margins equal to, or greater than, those obtained by the actuarial balance provided in a traditional insurance pricing-coverage system. In addition, researchers should be able to design methods to evaluate the absence of presence, which means that no accident occurs.

That service, accident prevention, should be profitable for both consumers and insurers. As yet, there are not many studies that help in this direction and they will be extremely necessary [Eling and Kraft (2020)]. How much are citizens willing to pay to prevent their houses from burning? How much will drivers pay to obtain elements of judgment that can modify driving behaviors to improve and reduce the probability of suffering an accident? Is there room for considering the cost of traffic accidents and whether this is also a matter of public health and economic policy?

The latter, if it were true, would open the door to subsidizing preventive assessments. In fact, our hypothesis is that a cost-benefit analysis considering i) costs of gathering detailed telematics data, and ii) the benefit of saving lives and diminishing traffic accidents, is an urgent matter. The experience of using radar and cameras to detect speeding drivers and to deter all others is an example of how new technologies have an enormous impact on the reduction of accident rates [Cohn et al. (2020)].

5. CONCLUSION

The aforementioned considerations about the preventive role played by insurance in the future have an implication that we find intriguing, one that is evident especially, though not only, in telematics motor insurance (another case is health insurance based on the use of wearables). As we know, insurance was not invented to reduce our exposure to risks. Precautionary measures, such as wearing a seat belt or avoiding the use of the car completely for getting around, are more useful for this purpose. Instead, the original function of insurance has always been to free policyholders from worrying about the financial consequences of any possible future damage. This form of relief is particularly useful, because it encourages individuals to venture and profit from opportunities that would otherwise be unavailable. In this sense, insurance was born, paradoxically, to multiply risks, not to reduce them.

Behavior-based policies and their proactive vocation are bringing profound changes to this social function of insurance. Individuals are now being asked to keep their behavior under control, so as to avoid potential future damage. In an extreme scenario, the ideal of a moral hazard reduced to zero would lead to a form of self-imposed inhibition: in order to avoid any unpleasant events, individuals would give up doing anything at all (in our specific case, using the car). But that would mean that there would no longer be any need for insurance coverage.

In fact, adapting the policy in proportion to the driver's exposure to risks actually avoids an extreme scenario of this kind. Nevertheless, behavioral tariffs are based on the principle that the premium depends on the decisions made by policyholders – and policyholders are aware of this. Their decisions, in turn, depend on their readiness to pay an insurance premium that might be substantially higher than what they would pay (or not pay) if they were to forego decisions that expose them to certain dangers.

This leaves several questions unanswered: what will change in the social role of insurance in the future when it implements proactive functions alongside the usual financial compensation for unpredictable claims? What restrictions will be imposed on policyholders and what opportunities will open up to them when they interact with insurance companies and provide data not only to reduce the classical information asymmetry, but also to make the activity of prevention possible? Lastly, how will actuarial calculations change when the historical data about claims is integrated with the historical data about prevention and the number of claims is reduced, as is to be expected? For actuarial mathematics and the socioeconomic sciences, there is evidently still a great deal of research to be done.

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