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Innovative motor insurance schemes: A review of current practices and emerging challenges

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ABSTRACT

The objective of this paper is to provide a review of the most popular and often implemented methodologies related to Usage-based motor insurance (UBI). UBI schemes, such as Pay-as-you-drive (PAYD) and Pay-how-you-drive (PHYD), are a new innovative concept that has recently started to be commercialized around the world. The main idea is that instead of a fixed price, drivers have to pay a premium based on their travel and driving behaviour. Despite the fact that it has been implemented only for a few years, it appears to be a very promising practice with a significant potential impact on traffic safety as well as on traffic congestion mitigation and pollution emissions reduction. To this end, the existing literature on UBI schemes is reviewed and research gaps are identified Findings show that there is a multiplicity and diversity of several research studies accumulated in modern literature examining the correlation between PAYD (based on driver's travel behaviour and exposure) and PHYD (based on driving behaviour) schemes and crash risk in order to determine crash risk. Moreover, there is evidence that UBI implementation would eliminate the cross-subsidies phenomenon, which implies less insurance costs for less risky and exposed drivers. It would also provide a strong motivation for drivers to improve their driving behaviour, differentiate their travel behaviour and reduce their degree of exposure by receiving feedback and monitoring their driving preferences and performance, which would result in crash risk reduction both totally and individually. The paper finally discussed the current and emerging challenges on this research field.

1. Introduction

Current pricing policy of motor insurance companies around the world which is to charge a lump sum for each user has been for long considered unfair and inefficient (Butler et al., 1988). Drivers with similar characteristics, such as age, gender, etc. pay approximately the same premiums regardless of the distance they drive a year. Bordoff and Noel (2008) compared this approach to a restaurant with an unlimited food policy for a fixed charge per person, which encourages people to eat more. Respectively, current insurance pricing policy encourages driving more kilometres annually, does not punish aggressive driving behaviour and, on the other hand, it does not encourage prudent driving behaviour. But, above all, this implies increased number of crashes, congestion conditions, carbon emissions, local pollution and oil dependence. Current pricing system is unfair because it literally forces drivers with low mileage per year and safer driving behaviour to subsidize the insurance costs for drivers who drive annually more kilometres and in a less safe manner. On the top of that, the research finding that people with lower income drive fewer kilometres leads to the conclusion that existing policies promote social inequities (Litman, 2002).

It should be highlighted that within this review the authors will refer to travel behaviour of the driver as her/his strategic choices (at real-time or not) concerning which type of road network is using and at what time is driving in order to fulfil her/his travel needs. These choices are directly linked to her/his exposition to traffic accident risk, through her/his mileage, the road network type chosen and the related traffic conditions, the period of time chosen to drive and the related weather conditions. Insurance charging systems based on Travel Behaviour are often called Pay As You Drive (PAYD) Usage Based Insurance schemes. On the other hand, this review will refer to driving behaviour of the driver as her/his operational choices at real time in handling her/his vehicle within the existing traffic conditions. These choices are directly linked to the probability of getting involved in a traffic accident, based on the way s/he is

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driving, e.g. by speeding, harsh braking, harsh accelerating, harsh cornering, being distracted by her/his mobile phone, etc. Insurance charging systems based on Driving Behaviour are often called Pay How You Drive (PHUD) Usage Based Insurance schemes.

In general, each driver could be assigned a probability of crash involvement based on his/her driving behaviour. Charging all drivers a lump sum leads to assume that the crash probability is equal across the entire population of drivers. Evidently, this does not from a user optimum and socially equitable approach, as drivers with lower crash risk are forced to "subsidize" those with higher. In other words, less risky drivers are forced to "buy" higher probability of crash risk than actually exists, unlike risky drivers who "buy" less.

An innovative insurance policy could have a significant effect on safety depending on its design (Zantema et al., 2008). Since it could be possible to sort different driving styles on a continuum scale from high to low risk (Sagberg et al., 2015), and therefore create a safety scoring scale, it is a feasible solution to differentiate premiums to reflect safety, more specifically by charging higher fees for unsafe road categories and night-time driving, most effectively and apply it to all drivers. The insurance policy based on vehicle use (Usage Based Insurance or otherwise UBI) includes Pay-As-You-Drive Systems (PAYD) and Pay-How-You-Drive (PHYD). PAYD system is charging premiums based on total travel behaviour characteristics such as mileage and road network used while PHYD is based on individual driving behaviour measuring parameters such as speed, harsh acceleration, hard braking etc. The main data source for the aforementioned parameters are the automotive diagnostic systems, OBD (On-Board Diagnostics), installed in the vehicle and/or the Smartphone held by drivers, sending all necessary information in a central database via mobile network.

The main advantages of UBI schemes compared to the conventional solution offered so far are (Sugarman, 1994; Litman, 2004a,b):

- Each user will pay as and how he drives, not based on other unfair characteristics such as age, type of car, etc., which do not necessarily reflect the chance of being involved in a crash.
- The need for cross-subsidies (cross-subsidies phenomenon) will be lower and result in a lower and more affordable cost of insurance premiums which would lead to a smaller number of uninsured vehicles.
- This method itself is an incentive for users to improve their driving performance and consequently reduce the number of crashes in which someone causes or gets involved in. It also enables someone to monitor his/her behaviour while driving thus eliminating behaviours that increase the likelihood of causing a crash.
- The implementation of this approach will help reduce the total number of crashes leading ultimately to significantly upgraded road safety.
- With regards to the social benefits, this method will assist driving behaviour improvement and thus reduce pollutants emission, saturation, energy consumption and will generally upgrade transportation system.

An additional benefit offered by UBI schemes is user's feedback on driving behaviour (Toledo et al., 2008) by receiving statistical reports after or while driving such as the percentage of speeding, number of harsh acceleration/braking events, time driving during risky hours, fuel consumption etc. In this way, UBI may also serve as a mechanism to raise drivers' awareness and change (improve) their driving behaviour. First, because the economic incentive will be strong for him. The premiums will be very high especially for risky drivers so the motivation to drive safer will be very powerful. The same would apply to less risky drivers as well since premiums cost will be reduced because of their good performance. Second, the ability to monitor and compare their own performance from now onwards will assist towards their performance improvement. It is generally shown that (Birrell et al., 2014) an in-vehicle smart driving system, e.g. a smartphone application pointing out frequent mistakes a driver makes while driving, which is developed and designed based on drivers' requirements information can lead to significant improvements in driving behaviours.

A study in the Netherlands showed that, if PAYD were to be implemented, total crash reduction could be reduced more than 5% leading to 60 less fatalities as well as 1000 less injured each year in the Netherlands (Zantema et al., 2008). Research in other countries outside Europe on differentiating premiums indicates the same percentage of 5% mileage reduction on average although driving during low and medium risk hours was only significantly reduced (Reese and Pash-Brimmer, 2009).

The usage-based insurance market was at the starting point of 4.5 million subscribers in 2013, mainly from the United Kingdom, Italy and the US, out of the 1 billion insured vehicles worldwide. This number is expected to be around 100 million by 2020 showing that UBI is a very promising insurance concept (Ptolemus Consulting Group, 2016) and is projected to grow to approximately 50% of the world's vehicles by 2030. UBI is already becoming mainstream in the US and Italy which currently represents 25 to 33% of new business among insurance companies that telematics is their priority (Ptolemus Consulting Group, 2016). Taking also into account the fact that most vehicle manufacturers will have adopted UBI by 2020 (Ptolemus Consulting Group, 2016), it is expected to be rapidly adopted worldwide in the future. Therefore, the future direction is to gradually replace the current homogenized insurance pricing policy with a fairly personalized pricing. As stated above, the development of technology and overcoming impediments that could not be overtaken before make this feasible.

Papers within this research were selected so that the following research questions can be addressed. The papers selected to be reviewed herein discuss the importance of UBI application and its influence on traffic safety, with emphasis on quantitative analysis. They also include the most innovative data collection methods and the indicators used in models developed for data analysis. The following research questions were targeted:

1) Which are the current types of Motor Insurance Schemes, the requirements in data collection and analysis and the most often used techniques to confront with the input parametrization issue?
2) How is UBI anticipated to enhance traffic safety?
3) What could be the evolution of UBI models and which are the future challenges emerging?

The results of this research are presented and discussed in the following sections of this paper.

Papers selected for presentation and discussion within this research were searched in a large set of scientific peer reviewed Journals contained at the ScienceDirect and Google Scholar databases, filtered for papers published in 1970 and after when the concept of UBI was initially discussed and with emphasis on those with quantitative analysis. Papers that were not contributing in addressing the research questions raised above were excluded.

2. Driver's travel and driving behaviour data collection

Until recently, the high cost of real-time driving data recording systems, data programs, cloud computing services, the inability to accumulate and exploit massive data bases (Big Data) for transport and traffic management purposes (De Romph, 2013; Lee, 2014), as well as the low penetration rate of Smartphones and social net-