The Buy-off Value of Privacy with PAYD Insurance

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Abstract
The disclosure of context sensitive personal information is required in the use of Pay-As-You-Drive (PAYD) insurance. Since elevated privacy concerns have a negative effect on people’s intention to use PAYD insurance, these privacy sacrifice require to be compensated. A way to compensate these privacy concerns is by the means of monetary rewards. This study examined the buy-off value of privacy concerns related to the use of PAYD insurance. Our findings indicate that consumers are willing to sell their privacy for a minor financial compensation per month. Hereby, consumers perceive their privacy of behavior and action as more valuable than privacy of location and space. Regarding privacy of data and image, the buy-off value seems to be dependent on the one who exploits their data; the data holder or an external party. Further research to the value of privacy for other CSMS is recommended.

Keywords: PAYD, Pay-as-you-drive Insurance, Mobile Insurance, Value Privacy, Privacy Concern

1. Introduction
The rapid integration of mobile technology in today’s society, cleared the path for Context Sensitive Mobile Services (CSMS). CSMS requires users to disclose extensive sets of personal information, such as data on GPS-location, behavioral patterns and social networks. This could result in elevated privacy concerns since literature [1] shows us that the sensitivity of disclosed personal data has a significant positive effect on related privacy concerns.

In the last few years, privacy concerns associated with the consumer use of mobile technologies, have been subject of many research papers. A number of privacy studies empirically verified the negative effect of privacy concerns on the intention of use online and mobile services [2], [3]. As the disclosure of personal information is often necessary in obtaining online and mobile services, privacy concerns could inhibit people’s intention to use them as well.

Literature by Hann, Hui, Lee & Png [4] states that these concerns can be compensated by offering benefits such as monetary rewards or convenience. Li et al. [5] further operationalized these compensating benefits as ‘monetary benefits’ and ‘perceived usefulness’. The compensating effect of monetary benefits on privacy concerns implies that individuals consider a utilitarian trade-off between privacy concerns and monetary benefits in the disclosure of privacy sensitive information and suggests that privacy is expressible in monetary terms. Although, literature to e-commerce related privacy concerns endorsed this statement and proved the compensating effect of ‘monetary benefits’ for privacy concerns in an e-commerce environment [6] [7], this effect has never been validated for the use of CSMS. CSMS requires users to disclose more sensitive sets of personal information, involving other types and amounts of privacy [1]. Therefore this paper investigates the buy-off value of privacy for CSMS.
The case of Pay-As-You-Drive (PAYD) insurance is selected to examine the buy-off value of privacy. PAYD insurance is an automobile insurance whereby the premium is dependent on the actual car-use. Hereby, most common used indicators for car-use are mileages, and driving behavior. Both indicators involve contextual user specific information which qualifies PAYD insurance as a CSMS. Based on the presented information, the following scientific research question will be answered in this article:

*How much monetary benefits are required to buy-off PAYD related privacy concerns?*

In order to answer this question, the paper is structured as follows. Section 2 will describe the theoretical background on privacy needed to develop a clear consistent approach to determine the buy-off value for privacy. Based on the privacy theory section 3 provides the methodology of the conjoint experiment. Section 4 provides the results of the conjoint experiment and section 5 provides the conclusions and discussion on the findings of the article.

2. **Theory on privacy**

Within literature a unified single account of privacy has yet to emerge. Multiple scholar attempted to define the concept of privacy but broad scientific consensus stays out [8]. This paper will further interpret Clarke’s [9] definition of privacy as “an interest that individuals have in sustaining a ‘personal space’ free from interference by other people and organizations”.

2.1. **Types of privacy**

In addition, Clarke [9] was the first privacy scholar, who categorized privacy in a logical, structured and coherent way [10]. He drilled down to a deeper level in which privacy turned out not to be just a single interest, but rather has several dimensions. Clarke defined four categories of privacy, including privacy of the person, privacy of personal data, privacy of personal behavior and privacy of personal communication.

As technologies continue to develop, the concept of privacy has to develop alongside it. As a result of technological developments Clarke [9] noted that with the intertwining of computing and communications, privacy of personal communications and personal data became closely linked. The term ‘information privacy’ refers to the combination of privacy of communications and data privacy” [9]. Despite the utility of these four categories, Finn [10] claims that potential privacy issues of recent technological advances could not be covered adequately. Technologies such as whole body image scanners, RFID-enabled travel documents, unmanned aerial vehicles, advanced DNA enhancements, second-generation biometrics and connect mobile services raise additional privacy issues. Therefore, Finn [10] expanded Clarke’s categorization to seven types of privacy. Just like in Clarke’s categorization those types of privacy may have a certain overlap, depending on the privacy issue.

The seven types of privacy as defined by Finn [10] will be used to assess the value of privacy for the case of PAYD insurance and brief introduction is given in following section for each of them.

**Privacy of the person** involves the right to keep body functions and body characteristics private.

**Privacy of behavior and action** covers the ability to behave in public, semi-public or one’s private space without having actions monitored or controlled by others.

**Privacy of personal communication** includes the aim to avoid interception of communication.

**Privacy of data and image** includes concerns about making sure that individuals’ data is not automatically available to other individuals and organizations and that people can “exercise a substantial degree of control over that data and its use”.

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**Privacy of thoughts and feelings** involves the right not to share their thoughts or feelings or to have those thoughts and feeling revealed. **Privacy of location and space** covers the right to move about in public or semi-public space without being identified, tracked, or monitored. **Privacy of association (including group privacy)** involves the right to associate with whomever people wish, without being monitored.

3. Methodology

Conjoint analysis is a statistical approach, often used in market research to determine customer preferences [11]–[13]. “It is a utilitarian methodology in which respondents value different alternatives or profiles (options) by making implicit trade-offs, from which their preferences are obtained” [11]. Based on these implicit trade-offs, perceived utilities by the respondents can be estimated per profile characteristic. By involving financial dimensions in the composition of these profiles, the willingness to pay might also be an output of the conjoint analysis [12].

Mainly two types of conjoint analysis can be distinguished; rating based and choice-based (stated choice) conjoint analysis[12]. With rating based conjoint analysis, respondent are required to rate several options on a Likert scale. Choice based conjoint analysis requires participants just to choose an option from a choice-set of two or more options. Hereby choice based conjoint analysis is a more representative method of analysis to real-life choices and more suitable to measure respondents’ preference between unfamiliar innovative options and current situations [14]. Therefore stated-choice conjoint models are used to determine the buy-off value of PAYD related privacy concerns.

3.1. Privacy and PAYD insurance

Theory from previous sections shows us that privacy is not just a single interest but has several dimensions [9]. In order to measure privacy only on its relevant dimensions, this section identifies all involved types of privacy for the case of PAYD insurance. **Privacy of location and space** is another aspect hat is potentially undermined with the use of PAYD insurance. By sharing one’s location with insurers, a breach on privacy of location and space could be experienced. **Privacy of behavior and action** can be negatively impacted by PAYD insurance services, in that people’s behavior and travel activities can be reconstructed or aggregated from collected information from GPS-trackers and in-car motion sensors. **Privacy of data and image** can be negatively affected by all data collecting systems. “The relative (in)security of personal information on databases represents a threat to personal data protection.” [10] All unintended use of any type of personal data through PAYD insurance will involve the harm of privacy of data and image.

3.2. Conjoint attributes and attribute levels

In order to value individuals’ privacy in monetary units, privacy is operationalized into attributes. Hereby, the attribute levels are composed in such a way that one level involves privacy harm and the other level involves no privacy harm. The outcomes of the conjoint analysis provide a utility participants derive for every attribute level. By involving an economic attribute these derived utilities will be converted to monetary terms, providing the buy-off value for privacy.

The three types of privacy involved in the use of PAYD insurance are operationalized to attributes; privacy of location and space, privacy of behavior and action and privacy of data and image. An overview on the privacy related attributes is provided in table 1. The **privacy of location and space** is operationalized through the attribute kilometer registration. Automatic kilometer registration through GPS-trackers continuously discloses one’s location, harming their privacy of location and space. In contrast one’s location details, and location
privacy is not disclosed through manual kilometer registration via a web platform. **Privacy of behavior and action** is operationalized through the registration of road behavior. Road behavior could be registered by means of an in-car motion (G-force) sensor which measures acceleration, deceleration and abrupt steering. Since insurers gain insight in users’ behavior with the registration of road behavior the privacy of behavior and action is harmed. The collection of car users’ data, provides insurers with valuable datasets. Besides the calculation of car insurance premiums, these dataset could be used for several secondary purposes. The use of users’ car use, for both internal and external purposes, harms the **privacy of data and image**. Hereby, internal harm of privacy of data and image is operationalized by the option to offer relevant additional insurances based on personal information. The external harm of privacy of data and image is operationalized by offering relevant third party advertisement based on personal information.

The **economic attribute** is defined as the saving consumer will obtain with respect to their current car insurance policy. Three attribute levels are included to check for non-linear utility functions. The values of the attribute levels are composed proportional to the average Dutch car insurance premium, which amounts €34.00 - per month [15]. Hereby a maximum saving of approximately 50% for PAYD insurances is assumed (0, 10, 20 euro).

<table>
<thead>
<tr>
<th>Privacy type</th>
<th>Attribute</th>
<th>Level 1 (no privacy harm)</th>
<th>Level 2 (privacy harm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Privacy of location and space</td>
<td>Kilometer registration</td>
<td>Manual (web platform)</td>
<td>Automatic (in-car GPS)</td>
</tr>
<tr>
<td>Privacy of behavior and action</td>
<td>Registration road behavior</td>
<td>No</td>
<td>Yes (in-car motion sensor)</td>
</tr>
<tr>
<td>Privacy of data and image</td>
<td>Additional insurance offerings</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>Third party advertisement</td>
<td>No</td>
<td>Yes</td>
</tr>
</tbody>
</table>

### Table 1: Conjoint attributes and attribute levels

3.3. **Conjoint choice-sets**

Now the attributes and attribute levels are defined, choice-sets can be composed. In a choice-set, two or more options (profiles) are combined and the participant has to pick the one he prefers. The optimal number of choice-sets (length of the questionnaire) and options (profiles) within a choice-set, in a stated-choice experiment, is dependent on the amount and complexity of the information participants have to handle [16]. Hereby, scientific literature provides no fixed optimal designs or rules.

Since the subject of this stated-choice experiment, PAYD insurances, is still quite uncommon and abstract, two options per choice-set are provided in the stated-choice experiment. In addition, respondents were asked whether they prefer the PAYD insurance policy or their current car policy. The number of composed choice-sets is fixed to the minimum of 12.

A balanced composition of choice-sets and related attribute levels is crucial in conjoint analysis [17]. Therefore Ngene software is used for generating balanced experimental designs for the stated choice experiment.

3.4. **Sampling**

In order to reach the population of interest, Dutch private car owners, the questionnaire is hard copy conducted at the car ferry service of Schoonhoven (The

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1 Ngene 1.1.2 User Manual & Reference Guide
Netherlands). In order to reach the most representative target group, the survey is conducted on a Friday (24-10-2014). After approval of the ferry service, car owners were requested to fill in an anonymous, hard copy questionnaire. The questionnaire is designed through discussion with ICT and statistical experts at the Delft University of Technology. After the draft was completed the survey was pre-tested with three random participants. Subsequent, an adjusted survey was conducted.

The hard-copy survey responses were translated to an Excel dataset. Both descriptive statistical tools in Excel and SPSS software are used to test the responses on validity and representativeness. The representativeness of the conjoint experiment is tested with background questions on gender, average mileage, age and education. 48% of the sample was male compared to 49% in the population [18]. Consequently, 52% was female compared to 51% in the population. The difference on gender between the sample and the population is negligible and therefore representative. The average mileage respondents in the sample drive is 55 kilometers per year compared with 37 kilometer for the average car owner in the Netherlands [19]. This difference is probably explainable by the data collection method. The conjoint survey is conducted at a car ferry, a location were active drivers can be found. This way the probability to reach low mileage drivers is smaller.

Table 3: Respondents background information [age]

<table>
<thead>
<tr>
<th></th>
<th>Sample [%]</th>
<th>Dutch pop. [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unknown</td>
<td>1%</td>
<td>NA</td>
</tr>
<tr>
<td>18-25</td>
<td>34%</td>
<td>13%</td>
</tr>
<tr>
<td>25-35</td>
<td>22%</td>
<td>15%</td>
</tr>
<tr>
<td>35-45</td>
<td>14%</td>
<td>17%</td>
</tr>
<tr>
<td>45-55</td>
<td>11%</td>
<td>19%</td>
</tr>
<tr>
<td>55-65</td>
<td>14%</td>
<td>16%</td>
</tr>
<tr>
<td>65-75</td>
<td>4%</td>
<td>12%</td>
</tr>
<tr>
<td>75+</td>
<td>0%</td>
<td>8%</td>
</tr>
</tbody>
</table>

The sample shows a clear overrepresentation of low age and high educated (academic) people [20]. Except for this overrepresentation the distribution of the sample matches the population distribution quite well. However, due to this overrepresentation the outcomes of this experiment cannot blind be generalized to the population and have to be interpret with care.

4. Conjoint analysis result

Biogeme software is used to analyze the choice behavior of the respondents [21]. This program requires a dataset and a model-file. The dataset includes all predefined choice-sets and all respondents’ choices from the questionnaire. The model-file includes a syntax program language to provide the Biogeme engine with the correct instructions.

The results of the conjoint experiment present that participant structurally prefer their current car insurance over a PAYD insurance since a disutility is derived from PAYD insurances corresponding with a buy-off value of 9,54 euro. Further results show that respondents are willing to sell their privacy for a minor financial compensation per month. The utilities and buy-off values that are found in the conjoint experiment are presented in table 4 per type of privacy. Significant values, by a confidence interval of 95%, are labeled with a star (*). Except for the estimated coefficient for the attribute kilometer registration, all estimated coefficient in the conjoint experiment appear to be significant. Since the estimated coefficient for the
attribute kilometer registration has a p-value of 0.07, it is considered as significant for further analysis of the results.

Although privacy of behavior and action appears to have the highest value for the respondents, all buy-off values are of comparable order size. Hereby, respondents are willing to sell their privacy of location and space through continuously disclosing the GPS-location of their car for a financial compensation of €2.27 per month. Privacy of behavior and actions appears to have slightly higher buy-off value since respondents are willing to continuously provide insight in their car-acceleration, car-deceleration and steering behavior, for a financial compensation of €2.98 per month.

Regarding the privacy of data and image two buy-off values are determined, relative to the internal and external (secondary) use of personal information. Hereby, secondary use is operationalized as the unauthorized use of personal information for personalized advertisement. Respondents are willing to sell their privacy of data image for third party advertisement for a financial compensation of €2.77 per month. In contrast to the external use of personal information, respondents are willing to pay a monthly contribution of €2.91 for internal (insurance related) personalized advertisement. However, these outcomes cannot blind be generalized to the entire population, it can be concluded that respondents derive more disutility from external use of personal information than internal use.

5. Discussion, Conclusion and Limitation

Our findings indicate that consumers are willing to sell privacy with PAYD insurance for a minor financial compensation per month. Hereby, consumers perceive their privacy of behavior and action as more valuable than privacy of location and space. Regarding privacy of data and image, the buy-off value seems to be dependent on the one who exploits their data; the data holder or an external party. While the use of consumers’ information for personalized advertisement by the data holder appears to be beneficial, personalized advertisement by third parties is perceived as adversely. These results validate previous research to the compensating effect of monetary benefits on privacy concerns even for CSMS.

The findings of this study have another contribution to literature on privacy. The limitation of previous quantitative research in the determination of the buy-off value for privacy, lies mainly in their inclusive construct for privacy. They considered privacy as a unified term, disregarding its plurality and typology. This study is the first attempt in literature in which the buy-off value for different types of privacy is determined. As this study proves, is the buy-off value of privacy varying for different types of privacy, supporting its plurality. A plural approach on privacy could provide a more detailed method for future technology acceptance studies. Emerging trends, such as the ongoing digitalization, quantified-self, internet of things and big data require the disclosure of

<table>
<thead>
<tr>
<th>Type of privacy</th>
<th>Involved attribute level</th>
<th>Utility</th>
<th>Buy-off value per month (PAYD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Privacy of location and space</td>
<td>Automatic kilometer registration (GPS)</td>
<td>-0.288</td>
<td>€2.27</td>
</tr>
<tr>
<td>Privacy of behavior and action</td>
<td>Registration road behavior</td>
<td>-0.378*</td>
<td>€2.98</td>
</tr>
<tr>
<td>Privacy of data and image (internal)</td>
<td>Additional insurance offerings</td>
<td>0.369*</td>
<td>-€2.91</td>
</tr>
<tr>
<td>Privacy of data and image (external)</td>
<td>Third party advertisement</td>
<td>-0.351*</td>
<td>€2.77</td>
</tr>
</tbody>
</table>
different sets of personal and contextual information. Consequently, different types of privacy may be involved affecting consumer adoption to another extent. For instance, biometric technologies could cause other types of privacy harm and may result in higher resistance than advanced communication technologies. Therefore, it is recommended to include a plural construct of privacy in future technology acceptance studies.

The type and amount of information involved, the accessibility and availability of personal information to other entities, and the consumer awareness on potential threats of disclosing personal data are key determinants for the involved types and buy-off values of privacy. The extent to which buy-off values differ per type of privacy and mobile service is still unclear and further research is recommended to evaluation the value of privacy for other mobile (insurance) services. A comparison between the values of privacy for different service may result in interesting insights for the field privacy literature.

Finally, the findings of this study are however bound to a number of important limitations. The main downside of this survey is its representativeness. High educated people and people in the age-interval of 18-35 are overrepresented. Hereby, analysis shows us that significant difference exist between younger (<41,5 year) and older (>41,5) people, and lower and higher educated people, with respect to their perceived (dis)utility with the monitoring of road behavior and their price sensitivity. Because the older age group is underrepresented, this may suggest that the population is less price sensitive and more willing to monitor their road behavior, than the sample shows us. Another limitation of the conjoint experiment is that the conjoint analysis assumes that interaction effects between the attributes are not involved. However, when people share more information with their insurers, like location and road behavior, their privacy of data and image has logically more value. This interaction effect has been ignored in the conjoint analysis. It is recommended to further research the buy-off values of privacy with statistical models which include this interaction effect.

6. References


