Demand for intelligent vehicle safety systems in Europe

Risto Ööni

VTT Technical Research Centre of Finland, P.O. Box 1000, FI-02044 VTT, Finland
E-mail: risto.oorni@vtt.fi

Abstract: The demand for four intelligent vehicle safety systems (IVSSs) – emergency braking, speed alert, blind spot monitoring and lane keeping support – is analysed by constructing their demand curves (demand as a function of product price) based on data available from user interviews and a literature study. The study also provides a method for constructing linear and exponential demand curves of the systems from data gathered from user interviews. The estimated linear and exponential demand curves were tested by least-squares fitting to the data collected from user interviews. The mean absolute error was consistently larger for all of the systems studied here when using the linear instead of exponential model. This suggests that the exponential model reflects more accurately the demand for IVSSs than does the linear model.

1 Introduction

1.1 Intelligent vehicle safety systems

Intelligent vehicle safety systems (IVSSs) are seen as an important tool for improving road safety in Europe. First, the importance of advanced driver assistance systems in improving road safety has been highlighted in The First Intelligent Car Report [1] published by the European Commission. The impacts of IVSSs have also been analysed in various studies such as the European Socio-economic Impact Assessment of Stand-alone and Cooperative Intelligent Vehicle Safety Systems (eIMPACT) project Socio-economic Impact Assessment of Stand-alone and Co-operative IVSS in Europe [2] and a study carried out by Netherlands Organisation for Applied Scientific Research and VTT Technical Research Centre of Finland in 2008 [3]. The eIMPACT project analysed the safety, environmental and traffic impacts of 13 IVSSs (electronic stability control (ESC), full speed range adaptive cruise control, emergency braking, pre-crash protection of vulnerable road users, lane change assistant, lane-keeping support, night vision warning, driver drowsiness monitoring and warning, eCall, intersection safety system, wireless local danger warning and speed alert) on the European level.

Some IVSSs such as blind spot monitoring, eCall (European in-vehicle emergency call system), ESC, emergency braking, lane keeping support, obstacle and collision warning (including adaptive cruise control) and speed alert have been identified as priority systems for deployment by the European eSafety Forum and its successor the iMobility Forum [4, 5]. Short definitions of the priority systems are provided elsewhere [4, 5] by the iMobility Forum.

User awareness and demand for a group of selected IVSSs were analysed in eSafety Challenge consumer studies in 2009 [6] and 2011 [7] as part of the European eSafety initiative. A similar study [8] was carried out later as part of the iMobility Challenge project [9]. A summary of priority iMobility systems aiming to improve safety and having an in-vehicle component covered by the eSafety Challenge and iMobility Challenge studies is presented in Table 1. The Safety Challenge study in 2011 was answered by 5000 respondents in 10 European countries (500 respondents/country) and the eSafety Challenge study in 2009 by 1000 respondents in five European countries (200 respondents/country). The iMobility Challenge study on car users’ awareness and demand in 2014 involved 5000 respondents in five European countries (1000 respondents/country).

The eSafety Challenge consumer study published in 2009 covered five IVSSs (ESC, blind spot monitoring, lane support system, warning and emergency braking system and speed alert). One of the main objectives was to gather information on user awareness and demand for the systems included in the study. However, the results showed only the distribution of answers to questions concerning users’ willingness to pay, with no detailed analysis of demand. This was also the case with the eSafety Challenge consumer study in 2011 and the iMobility Challenge study on car users’ awareness and demand. However, the data provided by the three studies can be analysed further to give a more accurate picture of market demand.

From the systems listed in Table 1 we selected four IVSSs for further analysis. First, we selected the systems covered by the eSafety Challenge consumer studies and the latest iMobility Challenge study (emergency braking and speed alert). We then chose two IVSSs covered by the eSafety Challenge consumer studies in 2009 and 2011, but not made mandatory under European regulation (lane keeping support and blind spot monitoring). For systems covered by both the eSafety Challenge study of 2009 and iMobility Challenge study of 2014, data from latter is used in the analysis.

Four systems covered by the iMobility Challenge study of 2013 are not analysed here. The tyre pressure monitoring system is already mandatory in new type-approved passenger car models in the EU [10]. Real-time traffic and travel information (RTTI), eco-driving assistance and start–stop assistance are outside the scope of this paper with its focus on IVSSs. One system (ESC) covered by the eSafety Challenge consumer study of 2009 is not analysed in this paper because it is mandatory in new passenger cars in the EU [10].

In conclusion, there is a clear need to analyse the demand for systems identified as priority systems by the European iMobility Forum, for which data are available from earlier studies, but which are not mandatory by regulation. For these systems, deployment is essentially based on conditions of market supply and demand.

1.2 Demand

In terms of economics, demand can be understood as the quantities of products buyers are willing and able to purchase at various prices [11]. An important feature of demand is its relation to price. The elasticity of demand can be defined as the change of quantity...
demanded (in per cent) divided by the change in price (in per cent) [11]. The elasticity of demand is affected by product type – whether the product is a necessity or a luxury good, the availability of substitutes and the proportion of product price of the total expenditure of the consumer [11]. Goods for which the absolute value of the price elasticity of demand is more than 1 are considered to have relative elasticity of demand [11]. Goods for which the absolute value of price elasticity of demand is <1 are considered to have relative inelasticity of demand [11].

Analysing the demand for the systems provides information that can be used to understand the behaviour of buyers of new cars (potential users of the systems) and the dynamics of deployment of a new system. Moreover, demand is also affected by the share of consumers (car users) who are willing to purchase the product.

| Table 1 | iMobility priority systems [4, 5] covered by eSafety Challenge [6, 7] and iMobility Challenge [8] consumer studies (only iMobility priority systems aiming to improve safety and having an in-vehicle component) |
|---|---|---|---|---|
| iMobility priority system | Covered by eSafety Challenge consumer study 2009 | Covered by eSafety Challenge consumer study 2011 | Covered by iMobility Challenge study on car users’ awareness and demand in 2014 |
| blind spot monitoring | yes | yes | yes |
| dynamic navigation | yes | yes | yes |
| eCall | yes | yes* | yes |
| emergency braking | yes | yes, included as ‘warning and emergency braking system’ | yes | yes |
| extended environmental information (extended floating car data) | yes | yes | yes |
| lane keeping support | yes | yes | yes |
| obstacle and collision warning (including adaptive cruise control (ACC)) | yes | yes | yes |
| RTTI | yes | yes | yes |
| speed alert | yes | yes | yes |

*ESC was on the list of iMobility priority systems, but has been removed. The system is now mandatory in new car models and is considered no longer to need the support of the iMobility Forum.

Table 2 | Car users’ self-reported willingness to pay for systems [compare 6–8] |
<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>Share of car users willing to pay extra for the system</td>
<td>Amount users are willing to pay (only respondents who reported they would be willing to pay for the system)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes, %</td>
<td>No, %</td>
<td>Dk/n, %</td>
<td>100&lt;300€, %</td>
</tr>
<tr>
<td>eSafety Challenge consumer study 2009</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ESC</td>
<td>41</td>
<td>43</td>
<td>16</td>
</tr>
<tr>
<td>blind spot monitoring</td>
<td>36</td>
<td>53</td>
<td>12</td>
</tr>
<tr>
<td>lane support system</td>
<td>24</td>
<td>65</td>
<td>12</td>
</tr>
<tr>
<td>warning and emergency braking system</td>
<td>44</td>
<td>44</td>
<td>12</td>
</tr>
<tr>
<td>speed alert</td>
<td>29</td>
<td>65</td>
<td>6</td>
</tr>
<tr>
<td>eSafety Challenge consumer study 2011</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ESC</td>
<td>67</td>
<td>22</td>
<td>11</td>
</tr>
<tr>
<td>advanced emergency braking</td>
<td>56</td>
<td>30</td>
<td>14</td>
</tr>
<tr>
<td>blind spot monitoring</td>
<td>51</td>
<td>34</td>
<td>15</td>
</tr>
<tr>
<td>speed alert</td>
<td>33</td>
<td>57</td>
<td>10</td>
</tr>
<tr>
<td>lane support system</td>
<td>40</td>
<td>46</td>
<td>14</td>
</tr>
<tr>
<td>adaptive headlights</td>
<td>59</td>
<td>29</td>
<td>12</td>
</tr>
</tbody>
</table>

How much would you pay for the system for your next car? (users who had heard about the system or had used it personally) |
<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>Nothing, %</td>
<td>&lt;100€, %</td>
<td>101–200€, %</td>
<td>201–300€, %</td>
<td>301–400€, %</td>
<td>401–500€, %</td>
<td>501–600€, %</td>
<td>601–1000€, %</td>
<td>Do not know, %</td>
<td>Respondents, n</td>
</tr>
<tr>
<td>iMobility Challenge study on car users’ awareness and demand 2014</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>emergency braking</td>
<td>23</td>
<td>16</td>
<td>13</td>
<td>11</td>
<td>7</td>
<td>6</td>
<td>2</td>
<td>2</td>
<td>11</td>
</tr>
<tr>
<td>eco-driving assistance</td>
<td>29</td>
<td>16</td>
<td>13</td>
<td>10</td>
<td>5</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>19</td>
</tr>
<tr>
<td>RTTI</td>
<td>28</td>
<td>22</td>
<td>13</td>
<td>8</td>
<td>5</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>20</td>
</tr>
<tr>
<td>start-stop assistance</td>
<td>43</td>
<td>15</td>
<td>9</td>
<td>7</td>
<td>4</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>19</td>
</tr>
<tr>
<td>speed alert</td>
<td>35</td>
<td>23</td>
<td>12</td>
<td>8</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>16</td>
</tr>
<tr>
<td>tyre pressure monitoring system</td>
<td>31</td>
<td>24</td>
<td>13</td>
<td>7</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>19</td>
</tr>
</tbody>
</table>

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A literature study was performed to identify studies with information on the demand for IVSSs and car users’ willingness to pay for the systems. However, only a few European studies were found that covered the systems chosen for analysis.

User willingness to pay for an advisory intelligent speed adaptation (ISA) system was studied several years ago in the UK as part of the Lancashire ISA trial; the authors concluded that participants in the study were willing to pay about £100 [12]. User acceptance of and willingness to pay for eco-driving systems was studied recently by Trommer and Höffl [13] as part of the eCoMove project (Cooperative Mobility Systems and Services for Energy Efficiency). The study focused on the perceived usefulness of three eco-driving assistance systems (ecoTripPlanning, ecoDrivingSupport and ecoPostTripAnalysis). Although these systems do not primarily aim to improve safety, one of them is clearly a driver assistance system for which the results may be more or less comparable with driver assistance systems aiming to improve safety. The conclusion of this paper is highlighted in the abstract: “The paper will show that, in general, car drivers welcomed the deployment of eco-driving assistance systems and rate them as useful. It similarly demonstrates that the acceptance of additional costs for the user is very low.”

Limited willingness to pay is also highlighted in the results of an industry study performed by Bosch and aimed at buyers of new cars whose current vehicle was no more than 3 years old [14]. The study was carried out between June and October 2012 in Germany, France and Italy and included 2261 responses to an online questionnaire and 120 individual in-depth interviews. Although the majority of respondents were interested in systems such as automatic emergency braking, blind spot monitoring or lane keeping support, only a minority (2–20%) were interested in the systems if they were provided at extra cost.

1.4 Structure of the paper

Section 1 describes the systems selected for analysis in this paper and the data on users’ willingness to pay, available from earlier studies, followed by a description of this paper’s objectives. Section 3 documents the methods used to measure users’ willingness to pay, the mathematical methods used to estimate demand curves for the systems and the literature study. Section 4 outlines the study results. The last two sections of this paper cover the discussion and conclusions.

2 Objectives

The objective of this paper is to analyse the demand for four IVSSs – emergency braking, speed alert, blind spot monitoring and lane keeping support – by constructing their demand curves (demand as a function of product price) based on data available elsewhere [6–8] and presented in Table 2. In addition to constructing the demand curves, a literature study takes into account the existing research on the topic.

3 Methods

3.1 Analysis of willingness to pay

There are different methods to study and estimate consumers’ willingness to pay for a given product. A summary of these methods [15] mentions four main approaches, namely, direct surveys, indirect surveys, laboratory experiments and analysis of market data. The method used in this paper to measure consumers’ willingness to pay is based on a direct survey in which the respondents were asked whether they would be willing to pay and how much. The clear advantages of this approach are its cost-effectiveness and possibility to collect data and perform an analysis within a relatively short time frame [15]. Its known limitations include the validity of the results obtained from a survey, and the fact that self-reported willingness to pay in a survey does not always reflect real purchasing behaviour or the observed choice behaviour [15].

3.2 Data collection

The analysis of demand for IVSSs is based on data collected in the iMobility Challenge study 2014 [8] and the earlier eSafety Challenge consumer study carried out in 2009 [6]. The data of the iMobility Challenge study 2014 was collected in five EU member states (Czech Republic, Finland, Germany, the Netherlands and Spain), and at least 1000 responses were received from each member state. The data collection was performed by a consortium of marketing research companies with a standardised Internet survey, and the sample of respondents was taken from their national panels. The survey was answered by active car users who had been driving more than 1500 km during the last 12 months and who were 18–74 years old. The respondents were first asked about driving related background information, car ownership and purchasing patterns. The selected systems were then covered in the next part. Only systems which were at least somewhat familiar for the respondent were studied with detailed questions. Information on socio-economic background (age, income and so on) was collected from the last part of the survey. The aim of the data collection was to obtain a sample which would be representative in terms of demographic variables such as age and sex. The average age of respondents was 47 years. Slightly more men (56%) than women (44%) answered the survey. More information on the characteristics of the sample in the iMobility Challenge study of 2014 can be found elsewhere [8], as are the descriptions of the analysed in-vehicle safety systems used in the iMobility Challenge 2014 survey [8].

“Emergency braking: advanced emergency braking systems warn you about the danger of potential collisions, and when there is no reaction to the warning activate the brakes together with systems such as seat-belt pretension to avoid or mitigate a crash.”

“Speed alert: the system alerts the driver with audio, visual and/or haptic (driver needs to apply more pressure on the acceleration pedal) feedback when the speed exceeds a limit set by the driver or the legal fixed speed limit.”

The data of the eSafety Challenge study in 2009 [6] were collected with computer-assisted telephone interviews by a marketing research company. In total, 1000 interviews were carried out in five EU member states (France, Germany, Italy, Poland and the United Kingdom, 200 interviews each). The target group of the study were European citizens having a driving license and using their own car, somebody else’s car or a company car. The aim of the data collection was to obtain a representative sample of both male and female respondents. The detailed descriptions of the systems used during the interviews are not available in the report of the study.

3.3 Estimation of demand curve

The method used for estimating the demand curves for the systems is essentially based on regression analysis; both linear and exponential regression techniques are applied. The linear model (1) was used for two reasons: first, linear models are commonly used to approximate different functions within a limited range. Second, the linear model fulfils the condition that the demand must either be zero or approach zero with high values of price. The exponential model (4) was used for three reasons: first, it can be used for modelling a non-linear relationship with only two parameters, which can be estimated with the method of least squares and change of variables. Second, the function (4) decreases monotonically for all non-negative values of price with appropriate parameter values. Third, the value
of the function approaches zero with high or very high values of price, which is consistent with the real-life behaviour of demand as a function of price.

However, the data available in Table 2 is not suitable for regression analysis as such. First, the willingness to pay is presented using price ranges instead of individual price values. Second, the figures in the table represent the share of users willing to pay some specific amount, but this does not as such represent demand as a function of price. In other words, the respondents willing to buy the system for price A would likely be willing to buy it also for any amount less than A. For this reason, specific procedures are required before regression analysis can be applied.

In the consumer surveys described in Table 1, the respondents were allowed to select whether or not they would be willing to pay for a given system, and to select a price range within which they would be willing to pay. The price ranges selected by consumers cannot be directly used in traditional regression analysis as they are ranges and not points. Therefore a simplification is needed to obtain a dataset suitable for regression analysis. First, we can assume that the price ranges selected by respondents can be reduced to their middle points on the x-axis (Fig. 1).

Second, we make a transformation from the shares of respondents willing to purchase the system to the demand–cost space by summing the percentages \( Y_{(n+1)} \) “backwards”. This is justifiable because we can assume that the users who have indicated willingness to pay \( Y_{(n+1)} \) for the product would also be willing to buy it at any lower price (Fig. 2).

The demand as a function of price can be estimated from the data described in Fig. 2. This is achieved by fitting a demand function to the points described in Fig. 2 using the least-squares method. In this paper, both linear and exponential models are used for the demand as a function of price.

First, fitting a straight line with equation

\[
Q = \alpha_0 P + \alpha_1
\]

to a group of \( k \) points can be done with the least-squares method.

\[
Y_{k(k+1)} = \sum_{n=1}^{N} a \times Y_{n(n+1)}
\]

Note: percentages are directly related to number of respondents/units!
in (2) and (3). It is then possible to reverse the transformation

\[ Y_k = \alpha_0 + \frac{\alpha_1}{k} \]

Second, the exponential model for the demand of a system can be expressed with equation

\[ Q = \beta_0 e^{\beta_1 P} \]

where \( Q \) is the expected value of the number of units demanded at price \( P \) and \( \beta_0 \) and \( \beta_1 \) are the parameters of the model to be estimated with regression analysis. The linear least-squares method cannot be directly applied to a non-linear model; however, applying it is possible following the transformation

\[ a = \ln A \quad (q = \ln Q) \]

which means taking logarithms of both sides of (4) [16]. After the transformation expressed in (6), (4) becomes

\[ \ln Q = \ln (\beta_0 e^{\beta_1 P}) \]

\[ q = \ln (\beta_0) + \ln (e^{\beta_1 P}) = \ln (\beta_0) + \beta_1 P = \beta_1 P + \ln (\beta_0) \]

Equation (7) is of form \( y = kx + b \). When there is a dataset with pairs of \( \ln Q \) and \( P \), it is possible to apply the least-squares method defined in (2) and (3). It is then possible to reverse the transformation

\[ q = \beta_1 P + \ln (\beta_0) \]

\[ e^q = e^{\beta_1 P + \ln (\beta_0)} = e^{\beta_1 P} \times e^{\ln (\beta_0)} = \beta_0 \times e^{\beta_1 P} \]

The calculations for estimating the demand curves were made using an open-source software tool (GNU Octave).

3.6 Literature study

A brief literature review was carried out to identify studies that would provide information on users’ awareness and demand for the systems under analysis or applications that are closely related.

4 Demand for IVSSs

4.1 Linear model

The parameters estimated for the linear model and the calculated mean absolute error (difference between the output of the model and \( y_{(k+1)} \) (Fig. 2) are shown in Table 3.

The results obtained for data from the iMobility Challenge study of 2014 are illustrated in Figs. 3 and 4. The figures show both \( y_{(k+1)} \) obtained from the processed questionnaire results and the output of the linear model for emergency braking and speed alert.

The results obtained for data from the eSafety Challenge study of 2009 are illustrated in Figs. 5 and 6. The figures show both \( y_{(k+1)} \) obtained from the processed study results and the output of the linear model for blind spot monitoring and the lane support system.
4.2 Exponential model

The parameters estimated for the exponential model and the calculated mean absolute error (difference between the output of the model and \( Y_{k+1} \)) (Fig. 2) are shown in Table 4.

The results obtained for data from the iMobility Challenge study of 2014 are illustrated in Figs. 7 and 8. The figures show both \( Y_{k+1} \) obtained from the processed questionnaire results and the output of the exponential model for emergency braking and speed alert. The results obtained for data from the eSafety Challenge study of 2009 are illustrated in Figs. 9 and 10. The figures show both \( Y_{k+1} \) obtained from the processed study results and the output of the linear model for blind spot monitoring and the lane support system.

<table>
<thead>
<tr>
<th>System</th>
<th>( \beta_0 ) [% of users]</th>
<th>( \beta_1 ) [% of users]</th>
<th>Mean absolute error [% of users]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Results for data from the eSafety Challenge consumer study 2009</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>blind spot monitoring</td>
<td>164</td>
<td>-0.00352</td>
<td>0.583</td>
</tr>
<tr>
<td>lane support system</td>
<td>133</td>
<td>-0.00288</td>
<td>3.5</td>
</tr>
<tr>
<td>warning and emergency braking</td>
<td>123</td>
<td>-0.00235</td>
<td>2.25</td>
</tr>
<tr>
<td>speed alert</td>
<td>140</td>
<td>-0.00316</td>
<td>4.64</td>
</tr>
<tr>
<td>Results for data from the iMobility Challenge study 2014</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>emergency braking</td>
<td>85.7</td>
<td>-0.00478</td>
<td>2.32</td>
</tr>
<tr>
<td>speed alert</td>
<td>82.2</td>
<td>-0.00765</td>
<td>1.66</td>
</tr>
</tbody>
</table>

The mean absolute error (Tables 3 and 4) is consistently larger for all of the systems studied in this paper when using the linear model instead of the exponential model. This applies to the results of the eSafety Challenge consumer study carried out in 2009 and the iMobility Challenge consumer study done in 2014. This suggests that the exponential model reflects more accurately the demand for IVSSs than does the linear model — at least within the price ranges covered by the eSafety Challenge and iMobility Challenge surveys. However, the results of these studies are not fully comparable because they were largely obtained in different EU member states, and the exact descriptions of the systems used in the eSafety Challenge interviews in 2009 were not available.
It is also worth noting that the exponential model fits relatively well the demand for blind spot monitoring, emergency braking and speed alert as seen in Figs. 7–9. This conclusion is supported by the mean absolute error being close to 3% or less for the systems (Table 4).

Most errors in the results are expected to arise from the method used to measure willingness to pay and the methods applied to collect the dataset. Errors may also be caused by random variation related to low number of respondents or non-perfect representativeness of the sample. First, the respondents of the surveys may over- or under-report their willingness to pay. Second, the eSafety Challenge and iMobility Challenge surveys covered only their own samples of EU member states. It is possible or even likely that the results would be slightly different for data collected in all EU member states and weighted appropriately. Third, the study did not consider differences in preference of car users for buying a new or pre-owned car. It is likely that those intending to buy a new car have more disposable income and are therefore more willing and able to pay for in-vehicle safety systems than the general population of car users. There could thus be a slight bias towards underestimating the prices buyers of new cars would be willing to pay for the systems under analysis. On the other hand, respondents of direct surveys tend to overestimate the amounts they would be willing to pay for a given product.

When the number of data points is large, one can assume that various errors are normally distributed. This assumption is commonly made in regression analysis, but it is not the case here. Thus any techniques based on assuming normality for calculation of confidence intervals were considered difficult to apply as such. First, the transformation performed for the data to obtain the parameters of the exponential model for demand may affect the distributions of errors, and assuming normal distribution is then not necessarily possible. Second, the number of data points used to perform the regression analysis was very low because of the nature of the data available for analysis.

The analysis focused on demand for the systems, but no analysis was performed to ascertain how their supply on the new car market is changing or will change as a function of price. This means that the equilibrium point between supply and demand cannot be provided as such.

First, the transformation performed for the data to obtain the parameters of the exponential model for demand may affect the distributions of errors, and assuming normal distribution is then not necessarily possible. Second, the number of data points used to perform the regression analysis was very low because of the nature of the data available for analysis.

The analysis focused on demand for the systems, but no analysis was performed to ascertain how their supply on the new car market is changing or will change as a function of price. This means that the equilibrium point between supply and demand cannot be established solely from information about demand. Analysis of the supply side was identified as a highly relevant research topic, but was considered beyond the scope of this paper. The supply curves of the systems are very possibly affected by the strategic decisions and business strategies of car manufacturers, factors affecting the cost of production such as the experience curve effect [17], and changes in technology.

6 Conclusions

The results of the study indicate that most car users are not willing to pay more than about €200 for a speed alert system as an additional cost. For emergency braking, this amount is somewhat higher (about €300). This can be verified by calculating the price not more than 20% of car users would be willing to pay by taking (4), dividing both sides by $\beta_0$, taking the natural logarithm of both sides, dividing both sides by $\beta_1$ and using parameter values from Table 4. These results for emergency braking and speed alert should be understood as approximate, but their magnitude is most likely correct; even though they are based on imperfect data, they were obtained without any sophisticated statistical analysis and the amounts may be somewhat higher for car users preferring a new car as their next vehicle. The results for blind spot monitoring and lane support system are based on the eSafety Challenge study. The corresponding amounts car users would be willing to pay for these systems indicated by the exponential model were higher – about €600 for blind spot monitoring and €700 for the lane support system. However, it should be noted that the results of iMobility Challenge study: they are based on a dataset collected with partly different methods 5 years earlier in 2009 and in slightly different EU member states than those covered by the iMobility Challenge study.

The exponential model fits clearly better than the linear model to the demand estimated from car users’ self-reported willingness to pay for in-vehicle safety systems. The results suggest that the demand for the systems may increase rapidly once the price paid by the consumer has dropped to a certain level. In other words, the same change – in terms of absolute price – may have very different impacts when the price paid by the user decreases. The linear model can be used for estimating the relationship between price and demand for IVSSs, but only within a small range from a point at which the slope of the line is known or can be estimated. The exponential model used in this paper can be used to calculate the price elasticity at various points along the demand curve. However, the model does not assume that the price elasticity is constant within the relevant range.

This paper also presented a practical method for estimating the parameters for demand curves for in-vehicle ITS applications and discussed possible sources of error. Analysing the demand for the systems provides useful information which can be used to estimate the impacts of various policy measures related to in-vehicle ITS. Although the method presented here has certain advantages such as a limited amount of resources and time needed to implement it, it also has clear limitations such as the potential difference between the self-reported willingness to pay and actual markets and purchasing decisions. This means that the method can be trusted to provide estimates for the parameters described in this paper and their approximately correct magnitudes, but not their exact values.

7 Acknowledgments

The work was performed as part of the iMobility Challenge project supported by the European Commission as part of the 7th Framework Programme. The author wishes to thank the Finnish Transport Safety Agency and Ministry of Transport and Communications for their support, Mrs. Adelaide Lönngren for editing the language and everyone else involved in making this work possible.

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