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APPLIED ECONOMETRICS PAPERS

ISSN 2084-4573

14-03

Accidents of company cars. A full service leasing company's perspective

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December 2014

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Abstract

In this article we deal with insurance claims on company cars. Company cars are granted to employees as working tools or as perks. Usually end car users are not directly involved in insurance payment so they may be not interested in reducing number of accidents or damages of a car. This may cause a moral hazard. Based on evidences from Poland, we analyse the market of car leasing companies with respect to the claim liquidations. Then, using a sample gathered from one of the Polish full service leasing companies we build a hurdle negative binomial regression model to explain factors influencing the probability of a claim and number of accidents. We especially concentrate on those predictors which are related to increased damage rate because of the moral hazard.

Keywords: accidents, operational leasing, full service leasing, insurance, hurdle negative binomial regression

JEL: C25, D22, L89

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December 19, 2014

1. Introduction

Services of full service leasing companies are very popular in Poland. Clients of such companies are other companies which are interested in long-term rental of car fleet. The main reason for this is comfort of not taking care of all issues related to car maintenance. It is very practical for many companies to get focused as much as possible on their core activities, not on car check-ups, tyres change, insurance matters and in case of an accident - towing and replacement car providing. End users of such cars are those other companies' employees. Some of them are granted cars as a working tool, for example sales representatives. Some of them are granted cars as perks, for example higher management.

Company cars like ordinary cars are subject to traffic accidents which have to be later liquidated and costs are usually covered from the insurance policy. What complicates the matter is the fact that end users are the ones who commit accidents but they generally do not pay for them so they are usually not as much interested in accident avoidance as in case of private cars. Leasing companies which have to pay for the insurance and have to liquidate the damage have no influence on end users. In such setting a moral hazard may occur. End users of company cars will usually be more careless since a claim will generate no additional costs for them, like losing an inurance policy discount, when comparing to personal owned cars.

The problem of moral hazard in automotive insurance has a long history in the scientific literature. It occurs when activities of insured increase a probalitity of a claim. It may be related to many different aspects of insurance, for example Cummins and Tennyson (1996) analyzed automobile bodily injury liability from that perspective. They found in their study correlation between acceptability degree of specific dishonesty types in insurance claiming and level of body injury liability claims frequency. Artis et al (1999) dealt with fraud, which is also a type of moral hazard, in the Spanish market of automobile insurance. They built a discrete choice model to relate insured and claim characteristics with probability of fraud.

Apart of fraudulent behaviour, one of the focus is to determine factors that influence increased probability of violations of traffic laws and as a result - damages and injuries. Yagil (1998) described age and gender from that perspective. It was proven that such characteristics generate significant differences between groups at the stage of importance of traffic laws perception. Forward (2009) analyzes psychological factors such as denial of negative consequences.

Much attention is also given to the analysis of behaviour of drivers of fleet vehicles. Some groups of researchers indicate that company car drivers are generally at a greater risk of accident involvement (Newnam, Watson, Murray 2002; Sullman, Meadows, Pajo 2002), not only due to their exposure to accidents measured in mileage but also because of time and scheduling pressures and other factors (Stradling, Meadows, Beatty 2000). Newnam et al (2002) observed that people tend to report higher crash involvement rates when driving a work vehicle compared to their personal vehicle and are less likely to engage in vehicle checking practices in their work vehicle compared to their private car. Stuckey, LaMontagne, Sim (2007) described market of occupational light vehicles from the perspective of health and safety. Among potential determinants of crash they distinguished such vehicle characteristics as age, type, model, engine capacity, fuel type, mass, weight, size, condition, odometer reading and color. Davey, Wishart, Freeman, Watson (2007) dealt with factors influencing driving violations among Australian organizational fleet drivers. Angers, Desjardins, Dionne, Guertin (2006) proposed a parametric model to rate insurance of fleet vehicles. A recent review of the literature in the field of driving safety in light vehicle fleet can be found in Newnam and Watson (2011).

Researchers concentrate mostly either on drivers as a general population or narrow the study to those users of fleet vehicles who are professionals and driving is essentially their work. We go a step further and distinguish two types of drivers: similarly as in previous researches - (1) professionals and (2) those who were granted a company car as a perk. The second group usually consists of unskilled drivers and their usage of a vehicle is not related to their everyday duties at work.

2. Road safety conditions and business model of the full service leasing company on the Polish market

In this section we will present business relations between a leasing company, its clients and car users. We will concentrate on the issue of claims generation and liquidation. We will begin by giving a short note on driving safety conditions in Poland.

According to Central Statistical Office data of 2011, the Polish car fleet accounted for 18 125 thousand passenger vehicles, 100 thousand buses and 3 131 thousand lorries and road tractors. Compared to population of Poland it gives 470 passenger cars and 628 motor vehicles per 1 000 inhabitants. Age structure of passenger cars reflects decreasing interest in new cars registrations and very popular import of used vehicles (about 275 and 655 thousand respectively). Approximately 72% of passenger cars account for vehicles above 10 years and less than 11% of cars is aged under 5 years.

Polish police data show that there were 40 065 road accidents and 366 520 collisions in 2011. These events entailed 4 189 deaths and 49 501 injuries. Above 80% of accidents were caused by drivers mostly due to excessive speeding (9 179 events), violating the right of way (8 572 events) and disrespect for the pedestrians rights (4 515 events).

One can observe a quite significant impact of fleet vehicles on both areas. At the end of 2011 Car Fleet Management companies took care of 145 thousand vehicles. Their demand on new cars fueled local sales and made almost 52% of the total market activity. According to report from 2009, there were

1 100 thousand cars on Polish roads, owned by companies. Despite the fact that it made 8% of the total Polish car fleet, their drivers caused about 30% of all accidents. There are multiple reasons for this state - one of them may be the fact that drivers pay much less attention to fleet vehicle maintenance, another - it is seldom supervised whether the driver is rested enough to stay behind the wheel. Additionally, it is not a common practice to value and award careful drivers. Moreover, 2006 survey reveals that only 543 of 1 770 of injured company car drivers were professionals employed as drivers.

The business model of a leasing company is usually constructed in the following way. A firm which wants to outsource its fleet signs a contract with an operational leasing company. The contract usually consists of such information as number of cars, their brands and models plus some additional services like car check-ups, tyres change or car repairs. In case of an accident operational leasing company provides towing and replacement car when necessary. A client of the operational leasing company usually pays a bulk amount for a particular service *regardless* of the actual cost the cars generated, i.e. number of repairs, number of towings etc. This operational risk is on the full service leasing company's side. What is more, the full service leasing company has to insure its cars and signs a separate policy with the insurance company. What should be underlined is the fact that the insurance company has its own rules for setting the cost of policy. One of the factors that has an influence on the price is the accident history. Usually the higher the number of accidents in the past the higher the price.

For example in Poland in case of individual clients, each year without an accident reduces the cost of policy by 10% and each year with an accident increases the price by 10% (with some lower and upper limits). So individual clients, who are usually at the same time users of cars and potential accident movers, are essentially interested in *not* causing accidents.

In case of company cars the situation is quite different. It is a full service leasing company which is interested in reducing number of accidents and accidents are caused by end users who are the other company's employees. So we have three parties here: (1) operational leasing company, (2) company which outsources the fleet and (3) end user of cars (employees). A leasing company transfers the insurance policy cost on its clients, but have seemingly no influence on end users who cause the accidents and cannot minimize the cost. From the end user perspective, he or she is not interested in avoiding the accidents since he or she does not pay for them, is not directly affected by the increase of the insurance policy cost in case of accident etc.

Full service leasing companies and outsourcing companies try to defend themselves from this inconvenient situation by numerous ways. One of them is the possibility of buying a car after the leasing period. End users are informed that after the leasing period (in Poland usually 3 years or certain mileage) they are entitled to buy the car they were using for a reduced price. The reasoning behind that is as follows. When the end user knows that he or she will be able to buy a car on preferable conditions, he or she will take care of it and try to avoid accidents since accidents decrease the value of the car which may later belong to him or her.

3. Research hypotheses

In this article we will try to validate the following hypotheses.

Hypothesis 1. Cars which are granted as perks are more likely to be subject to damage than cars which are given as working tools. In both cases end users do not pay the insurance cost and in both cases end users are evaluated by the company based on their everyday performance at work. In the case of a perk, activities related to a car are unrelated to duties at work, so it does not influence the worker's assesment. So the employee does not have an incentive to avoid damages. On the contrary, professional drivers, who need a car to perform their duties, are subject to evaluation also with respect to their working tool. What is more, a liquidation of a claim takes time and causes breaks at work. Those factors will diminish damage rate.

Hypothesis 2. End users will try to avoid damages if they perceive their car as valueable. As we mentioned, after the leasing period the end user is allowed to buy a car that he or she used. If the worker perceives a car as worth taking, he or she will have an incentive to avoid damages. We will try to asses how efficient this mechanism is and what are possible pitfalls.

4. Results of modelling

4.1. Data overview

Data used in the study come from one of the Polish full service leasing companies and consists of 4626 observations (cars) with the total number of 4847 claims from time period 01/08/2007 – 10/09/2012. The leasing company does not know who is the end user of a car, so no personal characteristics are avaiable to it. It only knows what company is leasing a car. So in fact the research must be based on car characteristics. But we will later show that knownig the business practices, much can be deduced from car features.

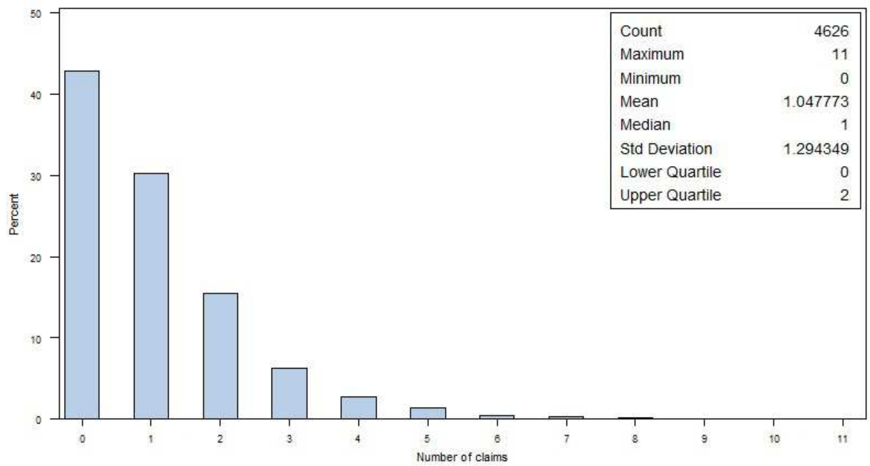
Such approach has a long history in scientific literature and proved to be efficient. Hall, Garwood, Mossakowski (1969) processed insurance claim data and studied relation between claim rates of private cars (i.e. number of claims per policy year) and such characteristics as age of car, its make and size of the engine. Robertson and Baker (1976) analysed fatal crashes and concluded that the larger the vehicle the higher death rate among pedestrians and the smaller the vehicle the higher the death rate among occupants who participated in an accident. Krishan and Carnhan (1985) noted the influence of the size of the vehicle on the probability of the injury during the accident. They observed that the smaller the car the higher the probability but also pointed out that there is a strong influence of the age of the driver. Hellinga, McCartt, Haire (2007) using questionnaire data, established, among others, the perception of safe cars for young drivers. Safe cars are generally those which are large. Broughton (2008) also dealt with relation between type of a car and death rate in accidents. He grouped cars into predefined categories like minis, superminis, small/medium/large/luxury saloons, sports cars, 4x4s and people carriers and also analysed influence of the year of the registration of a car.

The construction of our dataset involved some relevant steps which have to be described in order to provide better understanding of the problem. First of all, it makes sense to get familiar with the background of data collection. To make it all work, full service leasing company has to take care of its fleet with the support of a few databases. We are interested only in some of them - mostly regarding car description and insurance covered events. The set of data consists of cars which have been leased for at least three years, their description and count of accidents which took place during the first three years of their usage. Since we will model number of accidents, our observation must be comparable. Say 4 accidents during 1 year is not the same as 4 accidents during full 3 year contract. The choice of analysed period is based on the popularity of such a contract length among the customers. For the cars we decided to analyze, we had 19788 claims at command. As in our research we want to explain factors influencing the probability of a claim and number of accidents, we have to take into account only those events that have been caused by our drivers during first three years of a car history. As a result we are modelling dataset including 4847 events.

Variables used in our study may be divided into two categories. First group consists of controlling variables which influence number of damages, but are not related to the moral hazard implied by the business model of car outsourcing: horspower, fuel type and engine capacity. Second group is related to perceived value of a car and its purpose: manufacturer and class of a car. We have also an offset variable - rolling rhythm.

1. *Number of claims* - this is our explained variable. Almost 43% of the vehicles survived three first years of their usage without any harm. Median and average number of claims was at the level of 1. Distribution of this variable is presented in Figure 1.

Figure 1: Number of claims distribution



2. *Horsepower* - the most popular cars are ones with the 90 HP engine. The minimal power was 60 HP, maximal - 306 HP. The average power was about 107 HP, the median was at the level of 105 HP.
3. *Class* - it is a car segment based on similarity between models and some universal car market rules. We differ following classes, which are represented by following cars:

(a) A - small cars - Opel Corsa, Fiat Panda, Renault Clio

(b) B - medium class - Ford Focus, Renault Megane, Toyota Auris

(c) C - upper medium class - Ford Mondeo, Volkswagen Passat, Opel Insignia

(d) D - upper class - BMW 5 series, Volvo XC90, Audi A5

(e) MPV - multi personal vans - Volkswagen Sharan, Ford Galaxy, Kia Carnival

(f) LVA - large vans - Ford Transit, Volkswagen Transporter, Fiat Ducato

(g) SVA - small vans - Citroen Berlingo, Volkswagen Caddy, Renault Kangoo

We merged LVA and SVA into one class "vans". We also merged A, B and MPV into "lower class"

4. *Fuel type* - there are two main fuel types: petrol and diesel. More popular is the latter. There are 1221 petrol engine cars and 3405 diesel engine cars.

5. *Engine capacity* - this variable is measured in cm^3. The most popular engine capacity is 1560 cm^3. The minimal capacity was 996 cm^3, maximal - 3956 cm^3. The average capacity was about 1659 cm^3, the median - 1598 cm^3.

6. *Rolling rhythm* - it is a contractual mileage divided by the contract length and is expressed in thousands of kilometres per month. Companies which outsource their fleet must declare what is the expected

Table 1: Distribution of claims types.

Type of claim	Claim details	Total
MOD with unknown perpetrator	When moving	2775
With another car	Rear-end collision	505
MOD with unknown perpetrator	Collision with an object	495
MOD with unknown perpetrator	Collision with an animal	269
With another car	When entering the traffic	177
With another car	Right of way violation	162
With another car	When making an U-turn	140
With another car	When changing the lane	139

intensivity of the usage of a car. The most popular option is 2500 km per month.

7. *Manufacturer* - this variable represents car manufacturers. There are 10 most popular car manufacturers which form separate categories. The most popular car manufacturer is Ford (1005 cars) and least popular - Audi (97 cars).

In table 1 we present ten most popular claim types included in the dataset. Their sum makes more than 96% of all the accidents taken into the analysis. Since we want to model the behaviour of end users of company's cars, we excluded those damages which were not caused by its employees.

4.2. Statistical models

Since our explained variable is a count variable (number of accidents) a natural choice of a statistical model is a count regression. We base our description on Winkelmann (2008). There are plenty of variants of count regression. A natural and first choice is usually Poisson regression which assumes that explained variable has Poisson distribution $P(y_i = k) = \frac{\lambda_i^k e^{-\lambda_i}}{k!}$ and parameter λ_i is a function of linear combination of explanatory variables $\lambda = \exp(\mathbf{x}_i^T \beta)$.

This first and natural choice is later tested against some alternatives in order to verify whether standard Poisson regression assumptions are violated.

Poisson regression assumes that expected value and variance are equal $Ey_i = Vary_i = \lambda_i$. In practice it often does not hold and the variance is higher.

This phenomenon is called overdispersion. If overdispersion is present, then a negative binomial regression is often selected. It assumes (Negbin II Model) the following functions for expected value and variance: $Ey_i = \lambda_i$ and $Vary_i = \lambda_i + \sigma^2 \lambda_i^2$ and following probability density function $f(y_i) = \frac{\Gamma(\sigma^{-2}+y_i)}{\Gamma(\sigma^{-2})\Gamma(y_i+1)} \left(\frac{\sigma^{-2}}{\exp(\mathbf{x}_i^T \beta)+\sigma^{-2}} \right)^{\sigma^{-2}} \left(\frac{\exp(\mathbf{x}_i^T \beta)}{\exp(\mathbf{x}_i^T \beta)+\sigma^{-2}} \right)^{y_i}$ Next issue that is also frequently present in practice is excess zeros problem. Real life datasets have far more zeros than standard Poisson or negative binomial regression assume. This fact may be modelled by hurdle Poisson regression or hurdle negative binomial regression.

The first step is to model a binary fact $y_i > 0$ vs. $y_i = 0$ using for example logistic regression. In other words we model the probability of the fact whether there were any events ($y_i > 0$). Then we model number of events y_i provided that there were any events ($y_i > 0$) by Poisson or negative binomial regression, but truncated at zero $f(y_i)|(y_i > 0) = f(y_i)/(1 - P(y_i = 0))$. Here we assume two separate decision taking mechanisms: first describes decision to produce any events, and second determines number of events provided that in first step the decision was positive.

Testing which model fits data better is usually performed by Vuong test.

What is more, one of our explained variables is rolling rhythm which may be treated as a measure of exposure. A typical approach is to include this variable after the logarithm transformation and restricting its parameter to be equal to 1. We follow this method in our models.

4.3. Statistical validity of results

We used R package for estimation. We excluded information about engine capacity because it was strongly correlated with horsepower. We decided to leave horsepower since it is more informative, especially with information on fuel type. Solely capacity may be misleading - diesel engine has less horsepower than petrol engine with the same capacity.

As described in previous section, we started with Poisson regression. Then we tested for overdispersion and compared Poisson regression to negative binomial regression. The result of the Vuong test is presented in table 2.

Table 2: Vuong test for comparison of Poisson regression with negative binomial regression.

```
> vuong(regular_poisson,negative_binomial)
Vuong Non-Nested Hypothesis Test-Statistic: -11.90374
(test-statistic is asymptotically distributed N(0,1) under the
 null that the models are indistinguishable)
in this case:
model2 > model1, with p-value 5.658156e-33
```

So we reject the hull hypothesis that Poisson regression is closer to the real distribution of the data and state that negative binomial is closer.

Then we test for excess zeros problem. We built hurdle negative binomial regression and compared it, by Vuong test, to negative binomial regression from previous the step. The result of the corresponding Vuong test is presented in table 3.

Table 3: Vuong test for comparison of negative binomial regression with hurdle negative binomial regression.

```
> vuong(negative_binomial,hurdle_negative_binomial)
Vuong Non-Nested Hypothesis Test-Statistic: -2.994773
(test-statistic is asymptotically distributed N(0,1) under the
 null that the models are indistinguishible)
in this case:
model2 > model1, with p-value 0.001373246
```

So we reject the hull hypothesis that negative binomial regression is closer to the real distribution of the data and state that hurdle negative binomial is closer.

In the rest of the article we will focus on results from hurdle negative binomial regression. Results are presented in table 4.

4.4. Interpretation and business implications

We will shortly describle results related to controlling variables and then deal in details with variables related to moral hazard.

Horsepower variable is significant (with positive sign) in binomial part which means that the higher the horsepower the higher probability of generating any accident. Cars with more horsepower allow more dynamic driving, achieving greater speed and acceleration which increases probability of an accident. Cars with more horsepower have usually also greater dimensions which increases for example probability of scour during a maneuver on a

Table 4: Estimates of hurdle negative binomial regression model.

```
Call:
hurdle(formula = Claims ~ offset(exposure) + HP + Diesel + C + D + vans +
    audi + bmw + citroen + opel + peugeot + renault + skoda + toyota +
    volkswagen, data = dane, dist = "negbin")

Pearson residuals:
    Min      1Q  Median      3Q     Max
-1.0833 -0.8043 -0.1921  0.4811  9.5183

Count model coefficients (truncated negbin with log link):
             Estimate Std. Error z value Pr(>|z|)
(Intercept) -7.732169   0.174990 -44.186  < 2e-16 ***
HP           0.001137   0.001504   0.756 0.449458
Diesel      -0.161086   0.068434  -2.354 0.018579 *
C            0.172750   0.086761   1.991 0.046469 *
D            0.442148   0.208742   2.118 0.034162 *
vans        -0.009887   0.120391  -0.082 0.934549
audi        -0.547501   0.204266  -2.680 0.007355 **
bmw         -0.324690   0.194327  -1.671 0.094753 .
citroen     -0.345460   0.150176  -2.300 0.021428 *
opel        -0.702098   0.099016  -7.091 1.33e-12 ***
peugeot     -0.458309   0.131967  -3.473 0.000515 ***
renault     -0.481836   0.104598  -4.607 4.09e-06 ***
skoda       -0.649437   0.102780  -6.319 2.64e-10 ***
toyota      -0.822997   0.099859  -8.242  < 2e-16 ***
volkswagen  -0.362374   0.123650  -2.931 0.003383 **
Log(theta)   0.356927   0.165501   2.157 0.031033 *
Zero hurdle model coefficients (binomial with logit link):
             Estimate Std. Error z value Pr(>|z|)
(Intercept) -7.552003   0.188466 -40.071  < 2e-16 ***
HP           0.003669   0.001670   2.197 0.028044 *
Diesel      -0.026243   0.076712  -0.342 0.732275
C           -0.073454   0.098241  -0.748 0.454647
D            0.470315   0.258055   1.823 0.068374 .
vans        -0.385507   0.114454  -3.368 0.000757 ***
audi        -0.274682   0.244301  -1.124 0.260861
bmw         -0.317445   0.244711  -1.297 0.194554
citroen     -0.277657   0.156424  -1.775 0.075894 .
opel        -0.642906   0.109833  -5.853 4.81e-09 ***
peugeot     -0.777036   0.143200  -5.426 5.76e-08 ***
renault     -0.588489   0.114635  -5.134 2.84e-07 ***
skoda       -0.575970   0.115647  -4.980 6.34e-07 ***
toyota      -0.491705   0.109732  -4.481 7.43e-06 ***
volkswagen  -0.315331   0.147282  -2.141 0.032274 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Theta: count = 1.4289
Number of iterations in BFGS optimization: 25
Log-likelihood: -6402 on 31 Df
```

parking. For example in Poland the cost of insurance policy for individual clients depends strongly on engine capacity.

Type of fuel is significant in truncated part - diesel engines are less dynamic that petrol ones so accidents are less likely to happen.

Now we will move to core part that is the analysis of the influence of the class and brand on the likelihood of an accident. We will start with verifying hypothesis 1 which states that car which are granted as perks are more likely to be subject to a damage than cars which are granted as working tool. We used the following idea. Operational leasing company does not have a direct information on the purpose of the car (working tool or perk), but it may be to some extend deduced from the car type. Vans are big cars and are never given as perks. Their purpose is to transport goods and people so we may assume that vans drivers are professionals who perform their work with those cars. On the contrary, vehicles from class C and D are quite expensive personal cars. In Poland they are almost always granted to higher management as perks. As far as class A and B (small cars) is concerned - it is hard to state the real purpose. They may be as well perks granted to lower level management or as working tools for example to sales representatives. So this group is a mixture of perks and working tools.

In the model we chose small class cars category as the reference one.

A far as vans are concerned, they have significant and highly negative parameter in logit part and insignificant in truncated part. It means that the probability of having any damage is significantly lower than for small cars class, but they have essentially the same number of accidents provided that any happened. As we mentioned, vans are never granted to employees as perks and are always related to performing a certain function essential to the activity of a particular firm, mostly the transport of goods or people. Here we managed to support partially hypothesis 1.

As far as cars from class C (upper medium) and D (upper) are concerned, we may observe that in the logit part, parameters are significant and positive at D class, which means that the probability of having any accident is statistically higher than for small personal cars. In truncated part, both parameters are significant and positive and class D has the highest parameter. It means that provided that any damage happened, upper class cars have generally more accidents and the higher the class the higher number of accidents. Again, as we mentioned, cars from class C and D are quite expensive and are almost always granted to higher management as perks. So we managed to support hypothesis 1 here.

In case of cars from A and B it is hard to state from the leasing company perspective, the real purpose of the car so the results are inconclusive here.

In our analysis we have also a series of variables related to the manufacturers and majority of them are significant. They are also significant jointly in both parts of the model. We chose Volkswagen as a reference category. This variable is related to reputation of those manufacturers as good cars makers and to quality to price ratio which influences willingness to buy a car after the contract. So we managed to support hypothesis 2 here.

It is also worth to look at truncated and logit part jointly. If an employee has a car and unfortunatelly had an accident, he or she may start to perceive this car as not valuable, because of this first accident. So next accidents are more likely to happen. We may observe this phenomenom for class D.

5. Summary and directions for future work

In our analysis we showed that number of car accidents and probability of an accident are related the purpose of granting a car to a customer - a perk or a working tool. Cars granted as working tools are generally less likely to have any accident. On the contrary, upper class cars which are given as perks to higher management are more frequently subject to a damage and have generally more accidents.

Also the perception of the value of a car which is expressed as a car manufacturer has an influence on the level of care the end user puts into the car exploatation. Brands which are perceived as having high reputation are less likely to have any damage and number of damages is lower provided that any happens.

What is more, the greater the horsepower the higher probability of an accident. This result may be used by operational leasing companies and companies that are their clients. In case of a certain, fixed budget on cars used as perks, it is better to buy cars with less horse power but from higher segment, apart from D. The value of the car remains fixed but number of accidents will drop.

In our research we used information only from the operational leasing company. It would be worth to gain some feedback from its clients, especially on their policy of granting cars in order to calculate some additional variables related to car accident occurrence. Such cooperation could not only reduce costs for both business partners but also improve drivers' safety.

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