Driver age and vehicle engine size effects on fault and severity in young motorcyclists accidents

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Abstract

This paper reports a study of the combined effect of driver age and engine size on accident severity and at-fault risk of young riders of two-wheelers. Data from the national accident database of Greece are used to calculate accident severity and relative fault risk rates. The induced exposure technique is applied due to the lack of exposure data. A log-linear analysis is then used to examine first- and second-order effects within three-variable groups. Accident severity modelling revealed a significant second-order interaction between severity, driver age and two-wheeler engine size. On the contrary, no second-order effects were identified in fault risk modelling. Moreover, a significant effect of driver age on accident fault risk was identified. The effect of engine size was not significant.

Key words: driver age, two-wheeler engine size, accident severity, at-fault risk, induced exposure, log-linear analysis

1. Introduction

Riders of mopeds and motorcycles have a high rate of injuries, compared to other groups of road users. There are many reasons for this, but safety regulations have focused on three measures to reduce the risks: (1) Driver training, (2) Occupant protection (helmets, protective clothes), and (3) Engine size restrictions. This paper reports a study based on Greek data, designed to evaluate the effects of engine size on the accident involvement and accident severity of young riders of mopeds and motorcycles.

Legislation in several countries restricts learners or novice riders from driving two-wheelers exceeding a certain cubic capacity (usually 200 or 250 cc). According to one study (Langley et al., 2000), there was no evidence that learners and restricted license holders who did not comply with the cubic capacity requirement were at increased risk. Moreover, according to the same study, there was no consistent pattern of risk increase as cubic capacity increased. It has been suggested that any benefit of restrictions on cubic capacity has been eroded by refinements in the performance of two-wheelers with smaller capacities the recent years.

On the other hand, other studies (Namdaran, 1988, Quddus et al. 2002) suggest that increased cubic capacity is one of the most important risk factors (disproportionately high in the 200+ cc category). Finally, a study (Brorsson, Ifver, 1984) examining wobbling in modern two-wheelers, a source of serious personal injuries, suggests that the phenomenon occurs at moderate to high speeds (average speed reported was 118 km/h) and is higher among drivers who make heavy use of the engine's power, implying that the risk of wobbling is higher for "heavy" two-wheelers.

It is obvious from the above that research on the role of two-wheeler engine size in road accidents where young drivers are involved has not provided any unanimous conclusions. Consequently, an attempt was made to further explore the impact of driver age and engine size on two-wheeler road accidents. More precisely, the objective of this research is to evaluate the combined effect of driver age and engine size on the road safety of young drivers of two-wheeler vehicles. In particular, accident severity and relative at-fault accident risk among different driver age and two-wheeler engine size groups are investigated. The "induced exposure" approach was adopted to overcome the lack of exposure data. Furthermore, a log-linear analysis was performed in order to test the significance of first- and second-order effects among various combinations of driver age and engine size categories in relation to two-wheeler accident severity and at-fault risk rates.

For the purposes of this analysis Greece has been chosen as an appropriate case, as two-wheeler traffic and related accidents constitute a major issue of road safety. A large sample of injury road accident data in Greece has been extracted from the national database, which contains disaggregate data covering a period of fifteen years (1985-2000) and totalling 107.000 two-wheelers involved in injury road accidents.

For the purposes of the analysis, five groups of young two-wheeler drivers were chosen (15-17, 18-20, 21-24, 25-34, >35) allowing for both statistically significant samples and sufficient level of detail. Drivers of all other ages fall outside the scope of this research and were put into one single group (>35). Additionally, on the basis of the same criteria (sufficient sample and level of detail) five distinct engine size categories of two-wheeler vehicles were defined, concerning both mopeds (< 50 cc) and motorcycles (50-115 cc, 116-269 cc, 270-730 and >730 cc).

2. Methodological approach

2.1. Frequency, severity and risk in road accident analyses

Accident risk analysis, correlating accident and casualties data with exposure information, is by far the most appropriate methodology for identifying parameters affecting road safety. However, while vehicle-kilometres of travel appear to be the most widely used measure of exposure, it is difficult to collect such data on other than a system-wide basis. Ideally speaking, vehicle-kilometres of travel for different types of motorists in different types of vehicles on different roadways (and so forth) ought to be measured and would provide the most accurate denominator for different accident rates. In reality, such measurements are not always possible (Lyles et al., 1991).

The quasi-induced method of measuring exposure has been widely examined in international literature and found to be promising for determining relative at-fault accident rates in which not-at-fault accidents serve as an indicator of exposure. The approach relies on the assumption that the "innocent victim" in two-vehicle accidents represents a random sample of the driver-vehicle combinations that are present on the roadway system under specified conditions.

The induced exposure technique is based on the assumption that in every road accident in which two vehicles are involved there is one driver responsible for the accident and one innocent driver involved selected at random from the total population of drivers. Consequently, the innocent driver can be considered as a sample of the total population of drivers and reflects the exposure of any specific driver population defined on the basis of certain characteristics (Haight, 1973, Hodge, Richardson, 1985, Koornstra, 1973). The basic requirement for the use of this method is the identification of the driver who provoked the accident. Accident rates are stated in terms of the ratio of "at-fault" drivers with certain characteristics (age, sex, vehicle or network type, etc.) to "innocent" drivers with the same characteristics. The relative ratio, which is the ratio of two accident rates, indicates the tendency of a group of drivers to be at-fault inan accident. A ratio higher than 1 shows that drivers are overrepresented as the guilty party in accidents. When investigating relative risk among many groups, it is usual to set the at-fault risk of either the lower-risk group or the smaller-risk-error group equal to 1 and calculate relative risk of each one of the other groups in relation to this group.

Use of the induced exposure technique is limited by the fact that it concerns only drivers and not all road users (passengers and pedestrians) and that it requires the identification of "at-fault" and "innocent" drivers. Additionally, this method concerns mainly accidents in which at least two vehicles were involved whereas its use in single-vehicle accidents is not recommended (Lardelli et al. 2003, Evans 1990).

2.2. Log-linear analysis for multidimensional Tables

This research seeks to associate accident severity and at-fault risk to driver age and two-wheeler engine size. The analysis aims at investigating the combined effects of driver age and engine size on accident parameters. Therefore, no direct conclusions can be extracted through the calculation of accident rates, especially when effects are examined separately. In order to statistically validate the results and determine the significance of all possible interactions, the analysis of three-dimensional Tables through a log-linear modelling approach was attempted.

A three-dimensional Table of i rows, j columns and k layers can be decomposed in row effects, column effects, layer effects and their interaction (i×j, j×k, i×k and i×j×k). The second-order interaction (i×j×k) is the most interesting since, if this value is significant, then there is a significant interaction of driver age and engine size with regard to accident severity or at-fault risk. If (and only if) not, then the separate effects can be further analysed and interpreted (Goodman, 1973). The log-linear analysis uses an additive model that incorporates main effects and interactions between variables (1:age, 2:engine size and 3:accident fault) in the following form:

$$\text{Log } F_{ijk} = u + u_{1(i)} + u_{2(j)} + u_{3(k)} + u_{1(i)} + u_{12(ij)} + u_{13(ik)} + u_{23(jk)} + u_{123(ijk)}$$

Where F_{ijk} are the expected cell frequencies and u are parameters to be estimated. The above formula for a three-dimensional Table corresponds to a saturated log-linear model, containing all possible three-way and lower order effects. Moreover, it should be underlined that the models considered are hierarchical, meaning that whenever a higher order effect is included in the model, the lower order effects composed from variables in the higher effect are also included (Everitt, 1977, Kim et al., 1998).

The hypotheses of the analysis are those of mutual independence, which specifies that there are no associations of any kind between the three variables, or in other words that there are no first-order interactions between any pair of variables and no conjoint three-variable interaction:

$$H_0: u_{12}=0, u_{13}=0, u_{23}=0, u_{123}=0$$

Main effect parameters are measured as deviations of row, column or layer means of log-frequencies from the overall mean. Each of the u parameters represents a deviation from the grand mean due to that effect (Hays, 1981). For example, $u_{1(j)}$ are age effects with a separate parameter estimate for each age group. The term $u_{12(ij)}$ represents the interaction between driver age and engine size with a separate parameter estimate for each pair of categories. Estimates of the parameters in the fitted model are obtained as functions of the logarithms of cell frequencies and the form of such estimates is very similar to those used for the parameters in analysis of variance models. It should be noted though that no dependent variable in the usual sense is designated in a log-linear model.

From the best-fitting log-linear model, the parameter estimates and their statistical significance are determined. The ultimate test is whether the Table generated by the model closely fits the observed Table. A log-likelihood ratio goodness-of-fit statistic G^2 is used to accept or reject the model (Everitt, 1977).

2.3. Preliminary data quality processing

A series of preliminary tests was conducted before embarking on the main analysis. It was detected that the distribution of exposure by vehicle type obtained by applying the "innocent vehicles" distribution was inconsistent with the results of previous research on traffic data in Greece. In order to identify the cause of bias, the "innocent vehicles" distribution by vehicle type was calculated for three different options: when the "at-fault vehicle" was a passenger car, when the "at-fault vehicle" was a truck and when the "at-fault vehicle" was a two-wheeler. Results are presented in Table 1.

*** Table 1 to be inserted here ***

It is quite interesting that a different "innocent vehicle" distribution is obtained for different "at-fault vehicle" types, implying that the "innocent vehicles" distribution is unsuitable as a measure of exposure by vehicle type. The differences observed can be attributed to inaccurate data recording. More precisely, there seems to be a bias in determining the "at-fault driver" by vehicle type, in favour of two-wheeler vehicles and probably in favour of the lighter vehicle in general. However, it can be observed that there is a degree of consistency among two-wheeler categories. In particular, the relative proportions among two-wheeler vehicle type groups, as presented in Table 1, are similar in all "innocent vehicle" distributions, regardless of the "at-fault vehicle" type. This means that, even though accident fault by vehicle type was not always recorded accurately, the policemen collecting data considered all two-wheeler vehicles as a homogenous group and no bias among two-wheeler vehicle categories was caused.

3. Results

3.1. Accident severity

Table 2 presents the frequencies of fatalities among young two-wheelers for the period 1998-2001 in Greece.

*** Table 2 to be inserted here ***

It is interesting to notice that the relationship between accident severity and driver age for lower capacity two-wheelers (<115 cc) is convex (i.e. decrease with age in the younger riders groups (<21) and increase with age in the older riders groups (>21)). On the other hand, accident severity rates for higher capacity two-wheelers (>115 cc) decrease with age for all age groups. It is quite interesting that the highest severity rate is observed in the >35 age and <115 cc engine size group, which contradicts the general impression that driving heavy motorcycles increases accident severity.

One can therefore detect a variation in the effect of age on accident severity for different engine size categories, indicating a combined age-engine size effect. However, these results provide no information on the significance of effects of the various sub-categories and their interaction. The above issues can be further investigated and clarified through log-linear analysis.

A hierarchical log-linear model was fitted to the absolute values presented in Table 2. In this case, accident severity was expressed through a binary variable (drivers killed, drivers involved but not killed). The parameters estimated and the related levels of statistical significance are presented in

Table 3. A backward stepwise procedure rejected none of the effects, confirming that the saturated model is the best-fitting model for describing the structural relationship between the three variables.

*** Table 3 to be inserted here ***

It should be noted that three-way effects (severity*age*engine size) were found to be significant with a chi-square likelihood ratio of 101.8 with 16 degrees of freedom. However, it is quite interesting to notice that this overall significance arises from the significance of only two particular effects, those concerning the interactions of the 15-17 and 18-20 age groups respectively with the <49 cc engine size group.

Moreover, as expected from the hierarchical modelling, all two-way effects (severity*age, severity*engine size and age*engine size) were found to be statistically significant with a chi-square value of 3,606.6 with 40 degrees of freedom. As shown in Table 3, the overall significance of both driver age and engine size effects on accident severity arises from the significance of almost all the sub-categories effects.

3.2. Relative at-fault accident risk

Only two-vehicle accidents, where at least one two-wheeler vehicle was involved, were considered for the calculation of fault risk rates. From the results presented in Table 4, it appears that the effect of age on at-fault accident risk is important in all engine size groups. In general, risk decreases as age increases in all engine sizes for the <35 age groups. It should be noted that the increase of at-fault risk in the >35 age groups is probably due to the presence of elderly drivers within the group. Since this paper focuses on young motorcyclists, results concerning the >35 age groups were not further analysed.

*** Table 4 to be inserted here ***

The 21 - 34 age group has the lowest risk compared to other age groups for all engine sizes, while the significant degree of overlap between confidence intervals does not always allow distinguishing the 21-24 and the 25-34 age groups. Some inconsistencies concerning the highest engine size (>730 cc) should be considered with care, given the limited existing data, which lead to very wide confidence intervals. The relative probability of being at fault in an accident of drivers in the 15-17 age group is considerably higher than for other age groups.

In order to verify the significance of the relative at-fault risk rates and investigate interactions between variables, a log-linear model was fitted to the fault frequency data. It is quite interesting to notice that no second-order interaction between at-fault accident risk, driver age and engine size was identified (chi-square value for this effect is equal to 14.9 which is non significant for 16 degrees of freedom). On the other hand, first-order effects present an important overall significance, with a chi-square value equal to

6,991.3 for 40 degrees of freedom. However, the backward stepwise analysis rejected the fault risk*engine size effect, resulting in a best-fitting model including only two first-order effects (fault risk*age and age*engine size effects), as shown in Table 5.

*** Table 5 to be inserted here ***

The lack of second-order interaction implies that (a) the interaction between accident fault and driver age is the same at all engine size categories, and (b) the interaction between accident fault and two-wheeler engine size is the same for all age categories. It is obvious that engine size has no direct significant effect on at-fault accident risk. However, it is strongly related to driver age, which in turn has a significant effect on fault risk. This can be explained as follows: even if all drivers drove the same type of two-wheeler vehicle, the distribution of accident fault by driver age would differ to a significant degree. In fact though, not all drivers drive the same two-wheelers because engine size is significantly associated with driver age.

4. Discussion

Data from the national accident database of Greece were used for the investigation of the combined effect of driver age and two-wheeler engine size on accident severity and at-fault risk of young drivers of two-wheelers. The combined application of induced exposure technique and log-linear analysis allows for the identification of the combined effect of driver and vehicle related safety parameters, especially when related exposure data are not available.

Age plays a dominant role in both severity and at-fault risk of two-wheelers. The analysis showed that, among "light" two-wheelers, both accident severity and at-fault risk decrease with age in the lower age groups and increase with age in the higher age groups. It is quite interesting to notice that young drivers of age 15-17 years are by far the highest risk group.

Engine size was found to significantly affect accident severity but not at-fault risk. Engine size impact on severity was found important in the higher capacity vehicles (>730) as expected. It is interesting to notice that the lowest accident severity rates for lower capacity two-wheelers (<115 cc) were found for riders of 21-24 years old. Increased severity was found not only when younger drivers use higher capacity vehicles, but also when older drivers use lower capacity vehicles.

Further analysis of the combined effect of driver age and engine size showed a second order interaction between variables only for accident severity but not for at-fault risk. Application of log-linear analysis suggests that the effect of driver age on accident severity varies significantly in different engine size categories. Interactions of the 15-17 and 18-20 age groups with the <49 cc engine size groups were those with the most significant impact on accident severity, possibly explained by the combination of inadequate behaviour of those inexperienced drivers and limited vehicle performance during the accident.

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Table 1. "Innocent" drivers distribution by vehicle type for different types of "at-fault" vehicle

	"At-fault" vehicle type					
	Passenger car		Truck		Two wheel	
"Innocent" vehicle distribution	%	*relative ratio*	%	*relative ratio*	%	*relative ratio*
Passenger car	39,3		34,6		62,0	
Truck <3,5 t	7,3		12,5		11,9	
Truck >3,5 t	3,4		6,4		3,3	
Bus	1,6		2,9		2,5	
Two wheel <49 cc	17,9	*15,81*	14,7	*15,75*	6,8	*15,71*
Two wheel 50-115 cc	10,8	*9,53*	10,4	*11,17*	4,4	*10,18*
Two wheel 116-269 cc	9,2	*8,11*	7,4	*7,95*	3,3	*7,66*
Two wheel 270-730 cc	6,1	*5,40*	5,2	*5,55*	2,2	*5,08*
Two wheel >730 cc	1,1	*1,00*	0,9	*1,00*	0,4	*1,00*
Other	3,3		5,1		3,0	
	100,0		100,0		100,0	

Table 2. Two-wheel driver fatalities frequencies and accident severity rates.

Drivers killed						
Engine size	<49 cc	50-115 cc	116-269 cc	270-730 cc	>730 cc	Total
Age						
15-17 έτη	29	73	19	3	2	**126**
18-20 έτη	32	106	62	28	13	**241**
21-24 έτη	41	108	90	86	29	**354**
25-34 έτη	57	154	116	125	69	**521**
>35	184	238	83	43	34	**582**
Total	**343**	**679**	**370**	**285**	**147**	**1.824**
Drivers not killed						
Engine size	<49 cc	50-115 cc	116-269 cc	270-730 cc	>730 cc	Total
Age						
15-17 έτη	811	1.756	329	46	7	**2.949**
18-20 έτη	1.104	3.479	1.153	382	81	**6.199**
21-24 έτη	961	4.073	2.155	1.601	395	**9.185**
25-34 έτη	1.400	5.695	3.228	2.691	1.055	**14.069**
>35	1.936	4.684	2.195	1.177	545	**10.537**
Total	**6.212**	**19.687**	**9.060**	**5.897**	**2.083**	**42.939**
Drivers killed per 1000 drivers involved						
Engine size	<49 cc	50-115 cc	116-269 cc	270-730 cc	>730 cc	Total
Age						
15-17 έτη	35	40	*is*	*is*	*is*	**41**
18-20 έτη	28	30	51	*is*	*is*	**37**
21-24 έτη	41	26	40	51	68	**37**
25-34 έτη	39	26	35	44	61	**36**
>35	87	48	36	35	59	**52**
Total	**52**	**33**	**39**	**46**	**66**	**41**

is: insufficient sample

Table 3. Parameter estimates and significance for the best-fitted accident severity model with second-order interaction)

LOG-LINEAR ANALYSIS - Accident severity, driver age, two-wheel engine size					
Variable			Coefficient	Std.Error	Z-Value
Killed*Age*Engsize	15-17	<49	0,273	0,100	2,721 *
		50-115	0,067	0,088	0,756
		116-269	0,030	0,108	0,276
		270-730	0,013	0,190	0,071
	18-21	<49	0,246	0,072	3,425 *
		50-115	0,091	0,053	1,722
		116-269	-0,058	0,061	-0,947
		270-730	-0,114	0,086	-1,325
	21-24	<49	-0,058	0,064	-0,911
		50-115	0,047	0,047	0,999
		116-269	-0,044	0,053	-0,831
		270-730	-0,066	0,067	-0,977
	24-34	<49	-0,087	0,056	-1,541
		50-115	-0,007	0,042	-0,172
		116-269	-0,013	0,048	-0,275
		270-730	-0,038	0,063	-0,596
Klilled*Age	15-17		-0,167	0,079	-2,116 *
	18-20		-0,035	0,040	-0,853
	21-24		0,079	0,033	2,356 *
	25-34		0,124	0,030	4,158 *
Killed*Engsize		<49	0,084	0,035	2,395 *
		50-115	0,220	0,028	7,747 *
		116-269	0,084	0,034	2,449 *
		270-730	-0,020	0,054	-0,376
Age*Engsize	15-17	<49	1,005	0,100	10,015 *
		50-115	0,853	0,088	9,694 *
		116-269	0,164	0,108	1,519
		270-730	-0,945	0,190	-4,965 *
	18-21	<49	-0,008	0,072	-0,114
		50-115	0,165	0,053	3,136 *
		116-269	0,158	0,061	2,569 *
		270-730	-0,058	0,086	-0,672
	21-24	<49	-0,573	0,064	-8,991 *
		50-115	-0,365	0,047	-7,728 *
		116-269	0,038	0,053	0,713
		270-730	0,595	0,067	8,833 *
	24-34	<49	-0,692	0,056	-12,260 *
		50-115	-0,499	0,042	-11,916 *
		116-269	-0,112	0,048	-2,335 *
		270-730	0,563	0,063	8,933 *
Killed			1,467	0,023	62,984 *
Age	15-17		-1,490	0,079	-18,906 *
	18-20		-0,274	0,040	-6,779 *
	21-24		0,344	0,033	10,319 *
	25-34		0,822	0,030	27,616 *
Engsize		<49	0,173	0,035	4,912 *
		50-115	1,167	0,028	41,025 *
		116-269	0,355	0,034	10,402 *
		270-730	-0,374	0,054	-6,966 *

* *indicates a significant effect*

Model with all second- and first-order effects

Table 4. Two-wheel driver fault frequencies and relative fault rates.

At-fault drivers						
Engine size	>49cc	50-115cc	116-269cc	270-730cc	>730 cc	**Total**
Age						
15-17	1.841	771	253	109	7	**2.981**
18-20	2.185	1.200	893	597	62	**4.937**
21-24	2.029	1.288	1.489	1.155	189	**6.150**
25-34	2.337	1.735	1.749	1.413	330	**7.564**
>35	2.874	1.354	843	457	108	**5.636**
Total	**11.266**	**6.348**	**5.227**	**3.731**	**696**	**27.268**

Innocent drivers						
Engine size	>49cc	50-115cc	116-269cc	270-730cc	>730 cc	**Total**
Age						
15-17	3.880	1.477	501	220	14	**6.092**
18-20	5.719	3.113	2.391	1.393	140	**12.756**
21-24	5.666	3.738	4.065	3.065	488	**17.022**
25-34	6.874	4.893	4.967	3.819	863	**21.416**
>35	7.470	3.565	2.364	1.215	315	**14.929**
Total	**29.609**	**16.786**	**14.288**	**9.712**	**1.820**	**72.215**

Relative Fault Risk Rates and confidence intervals										
Engine size	>49cc		50-115cc		116-269cc		270-730cc		>730 cc	
Age										
15-17	**1,40**	1,35	**1,54**	1,47	**1,54**	1,42	**1,44**	1,27	**1,46**	0,78
		1,44		1,62		1,67		1,61		2,14
18-20	**1,12**	1,09	**1,14**	1,10	**1,14**	1,09	**1,25**	1,18	**1,30**	1,09
		1,15		1,18		1,19		1,31		1,50
21-24	**1,05**	1,02	**1,02**	0,98	**1,12**	1,08	**1,10**	1,05	**1,13**	1,02
		1,08		1,06		1,16		1,14		1,24
25-34	**1,00**	0,97	**1,05**	1,02	**1,08**	1,04	**1,08**	1,04	**1,12**	1,03
		1,03		1,08		1,11		1,12		1,21
>35	**1,13**	1,10	**1,12**	1,08	**1,09**	1,04	**1,10**	1,03	**1,00**	0,88
		1,16		1,16		1,14		1,16		1,12

Table 5. Parameter estimates and significance for the best-fitted accident fault risk model no second-order interaction)

LOG-LINEAR ANALYSIS - Accident fault risk, driver age, two-wheel engine size					
Variable			Coefficient	Std.Error	Z-Value
Guilty*Age	15-17		-0,1188	0,0383	-3,1038 *
	18-20		-0,0068	0,0170	-0,3992
	21-24		0,0394	0,0135	2,9151 *
	25-34		0,0489	0,0126	3,8682 *
Age*Eng.size	15-17	<49	0,9961	0,0394	25,2571 *
		50-115	0,6825	0,0410	16,6631 *
		116-269	-0,0757	0,0454	-1,6669
		270-730	-0,4172	0,0531	-7,8539 *
	18-21	<49	0,0256	0,0191	1,3404
		50-115	0,0262	0,0207	1,2670
		116-269	0,0852	0,0222	3,8390 *
		270-730	0,1030	0,0251	4,0986 *
	21-24	<49	-0,5176	0,0162	-31,9638 *
		50-115	-0,3484	0,0177	-19,7020 *
		116-269	0,1045	0,0182	5,7489 *
		270-730	0,3255	0,0204	15,9253 *
	24-34	<49	-0,6313	0,0152	-41,5942 *
		50-115	-0,3459	0,0163	-21,2143 *
		116-269	0,0041	0,0172	0,2387
		270-730	0,2552	0,0194	13,1863 *
Guilty			0,4624	0,0108	42,9034 *
Age	15-17		-1,2906	0,0383	-33,7273 *
	18-20		-0,0405	0,0170	-2,3845 *
	21-24		0,4610	0,0135	34,0718 *
	25-34		0,7420	0,0126	58,6867 *
Eng.size		<49	1,2687	0,0116	109,1470 *
		50-115	0,6645	0,0123	53,8976 *
		116-269	0,3260	0,0135	24,2408 *
		270-730	-0,1631	0,0156	-10,4535 *

** indicates a significant effect*

Model with no second-order interaction and no fault-engine size interaction