

Assessing the Effect of Five Gasoline Properties on Exhaust Emissions from Light-Duty Vehicles certified to Tier-2 Standards

Analysis of Data from EPA Phase 3

(EPAct/V2/E-89)

Appendix J.4

Final Model Fitting

Particulate Matter (PM) (Bag 1)

No. Observations:	910
No. Vehicles:	15
No. censored measurements:	45
No. missing measurements:	0
No. measurements removed:	1
Model Type:	Tobit regression

J.4.1 Model Fitting based on the 11-term design model.

Models fit for PM (Bag 1): (Grand Intercept not fit by Tobit models).

Model Term	Notation	Model					
		Full	FM2 ¹	FM3	FM4	FM5	FM6
etOH	Z_e	•	•	•	•	•	•
Arom	Z_a	•	•	•	•	•	•
RVP	Z_r	•	•	•	•	•	×
T50	Z_5	•	•	•	•	•	•
T90	Z_9	•	•	•	•	•	•
etOH × etOH	ZZ_{ee}	•	×				
T50 × T50	ZZ_{55}	•	•	•	•	•	•
etOH × Arom	ZZ_{ea}	•	•	•	×		
etOH × RVP	ZZ_{er}	•	•	×			
etOH × T50	ZZ_{e5}	•	×				
etOH × T90	ZZ_{e9}	•	•	•	•	×	

PM (Bag 1): Model fitting history, starting with the 11-term design model.

Fit Parameters			Test with respect to Previous Model		
Model	$p-I^I$	$-2\ln L$	Dev.	d	$\Pr > \chi^2$
Full Model	11	2789.671			
FM2	9	2790.118	0.447	2	0.800
FM3	8	2791.074	0.956	1	0.328
FM4	7	2793.414	2.34	1	0.126
FM5	6	2796.069	2.655	1	0.103
FM6 ²	5	2796.308	0.239	1	0.625

¹ Total number of terms excludes the intercept, as the Tobit models do not fit intercepts.

² Best fit with respect to the 17-term extended model.

PM (Bag 1): Coefficients and Tests of Effect for the Full and Reduced Models, with respect to the 11-term design model.

Effect	<i>Full Model</i>					<i>Reduced Model (FM6)</i>				
	Estimate	Std. Err.	d.f.	χ^2 - value	$\text{Pr}>\chi^2$	Estimate	Std. Err.	d.f.	χ^2 - value	$\text{Pr}>\chi^2$
Intercept ¹						0.6559				
Z_e	0.1365	0.05030	1	7.35	0.0067	0.1582	0.04130	1	14.7	0.00010
Z_a	0.3840	0.03510	1	119.96	<.0001	0.3833	0.03480	1	121	<.0001
Z_r	-0.0227	0.04000	1	0.32	0.57					
Z_5	0.0338	0.05050	1	0.45	0.50	0.0550	0.04310	1	1.63	0.20
Z_9	0.2965	0.03510	1	71.48	<.0001	0.2923	0.03440	1	72.2	<.0001
ZZ_{ee}	-0.0401	0.06750	1	0.35	0.55					
ZZ_{55}	0.0700	0.05050	1	1.92	0.166	0.0935	0.03420	1	7.46	0.0063
ZZ_{ea}	0.0508	0.03430	1	2.19	0.139					
ZZ_{er}	0.0295	0.03500	1	0.71	0.40					
ZZ_{e5}	-0.0482	0.07230	1	0.44	0.51					
ZZ_{e9}	0.0503	0.03440	1	2.14	0.14					
σ_{veh}^2 ¹						0.4251				
σ_{ε}^2	1.0321					1.0359				

¹ Not fit by Tobit model; calculated manually from individual vehicle intercepts.

J.4.2 Model Fitting based on the 17-term extended model.

Models fit for PM (Bag 1): (Grand Intercept not fit by Tobit models).

Model Term	Notation	Model							
		Full	FM3 ¹	FM5	FM6	FM7	FM8	FM9	FM10
etOH	Z_e	•	•	•	•	•	•	•	•
Arom	Z_a	•	•	•	•	•	•	•	•
RVP	Z_r	•	•	•	•	•	•	•	×
T50	Z_5	•	•	•	•	•	•	•	•
T90	Z_9	•	•	•	•	•	•	•	•
etOH × etOH	ZZ_{ee}	•	×						
T50 × T50	ZZ_{55}	•	•	•	•	•	•	•	•
etOH × Arom	ZZ_{ea}	•	•	•	•	•	•	×	
etOH × RVP	ZZ_{er}	•	×						
etOH × T50	ZZ_{e5}	•	•	×					
etOH × T90	ZZ_{e9}	•	•	•	•	•	•	•	•
T90 × T90	ZZ_{99}	•	•	•	•	×			
Arom × RVP	ZZ_{ar}	•	•	•	×	•	•	•	•
Arom × T50	ZZ_{a5}	•	×						
Arom × T90	ZZ_{a9}	•	•	•	•	•	•	•	•
T50 × T90	ZZ_{59}	•	•	×					
RVP × T90	ZZ_{r9}	•	•	•	•	•	×		

¹ Indicates “Full minus 3,” etc.

PM (Bag 1): Model fitting history, starting with the 17-term extended model.

Fit Parameters			Test with respect to Previous Model		
Model	$p-l^1$	$-2\ln L$	Dev.	d	$\Pr > \chi^2$
Full Model	17	2804.455			
FM3	14	2804.778	0.323	3	0.956
FM5	12	2805.586	0.808	2	0.668
FM6	11	2806.743	1.157	1	0.282
FM7	10	2809.264	2.521	1	0.112
FM8	9	2811.736	2.472	1	0.116
FM9	8	2813.991	2.255	1	0.133
FM10 ²	7	2814.388	0.397	1	0.529

¹ Total number of terms excludes the intercept, as the Tobit Models do not fit intercepts.
² Best fit with respect to the 17-term extended model.

PM (Bag 1): Coefficients and Tests of Effect for the Full and Reduced Models, with respect to the 17-term extended model.

Effect	<i>Full Model</i>					<i>Reduced Model (FM10)</i>				
	Estimate	Std. Err.	d.f.	χ^2 - value	$\text{Pr}>\chi^2$	Estimate	Std. Err.	d.f.	χ^2 - value	$\text{Pr}>\chi^2$
Intercept ¹										
Z_e	0.1512	0.0628	1	5.80	0.016	0.1807	0.0425	1	18.0	<.0001
Z_a	0.4355	0.0428	1	104	<.0001	0.3792	0.0351	1	116.6	<.0001
Z_r	-0.0619	0.0585	1	1.12	0.2897					
Z_5	0.0047	0.0837	1	0.00000	0.96	0.1004	0.0470	1	4.6	0.0326
Z_9	0.3494	0.0459	1	58.0	<.0001	0.3034	0.0353	1	74.0	<.0001
ZZ_{ee}	-0.0213	0.0712	1	0.090	0.7653					
ZZ_{55}	0.0790	0.0582	1	1.84	0.17	0.0806	0.0346	1	5.4	0.0198
ZZ_{ea}	0.0682	0.0579	1	1.39	0.24					
ZZ_{er}	0.0119	0.0392	1	0.090	0.76					
ZZ_{e5}	-0.0452	0.0752	1	0.36	0.55					
ZZ_{e9}	0.1018	0.0478	1	4.53	0.033	0.0647	0.0349	1	3.4	0.0636
ZZ_{ar}	-0.0602	0.0731	1	0.68	0.41					
ZZ_{a5}	-0.0340	0.0788	1	0.19	0.67					
ZZ_{a9}	0.0551	0.0399	1	1.91	0.17	0.0665	0.0380	1	3.1	0.0804
ZZ_{59}	0.0389	0.0520	1	0.560	0.45					
ZZ_{r9}	-0.0558	0.0452	1	1.53	0.22					
σ_{veh}^2 ¹										
σ_{ε}^2						1.0443				
¹ Not fit by Tobit model.										