

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.6

Final Model Fitting

Particulate Matter (PM) (Bag 3)

No. Observations:	871
No. Vehicles:	15
No. censored measurements:	82
No. missing measurements:	2
No. measurements removed:	1
Model Type:	Tobit regression

J.6.1 Model Fitting based on the 11-term design model.

Models fit for PM (Bag 3): (Grand Intercept not fit by Tobit models).

Model Term	Notation	Model					
		Full	FM1 ¹	FM2	FM3	FM4	FM5
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}	•	×				

¹ Indicates "Full minus 1," etc.

PM (Bag 3): Model fitting history, starting with the 11-term design model.

Fit Parameters			Test with respect to Previous Model		
Model	$p-1^1$	$-2\ln L$	Dev.	d	$\Pr > \chi^2$
Full Model	11	3224.082			
FM1	10	3224.175	0.093	1	0.760
FM2	9	3224.623	0.448	1	0.503
FM3	8	3224.86	0.237	1	0.626
FM4	7	3225.436	0.576	1	0.448
FM5	6	3226.131	0.695	1	0.404

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 3): 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 (FM5)</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						-0.3539				
Z_e	-0.0003	0.0656	1	0.000000	1.00	0.0173	0.0579	1	0.090	0.77
Z_a	0.0170	0.0457	1	0.140	0.71	0.0216	0.0455	1	0.220	0.64
Z_r	-0.1082	0.0522	1	4.30	0.038	-0.1098	0.0499	1	4.840	0.03
Z_5	0.0079	0.0658	1	0.010	0.90	0.0167	0.0616	1	0.070	0.79
Z_9	-0.0337	0.0457	1	0.54	0.46					
ZZ_{ee}	-0.0593	0.0879	1	0.46	0.50					
ZZ_{55}	-0.0527	0.0658	1	0.64	0.42					
ZZ_{ea}	0.0975	0.0447	1	4.76	0.029	0.1023	0.0441	1	5.390	0.02
ZZ_{er}	-0.0402	0.0456	1	0.78	0.38					
ZZ_{e5}	-0.1885	0.0943	1	4.00	0.046	-0.1218	0.0455	1	7.170	0.01
ZZ_{e9}	0.0136	0.0448	1	0.090	0.76					
σ_{veh}^2 ¹						0.1178				
σ_{ε}^2						1.3431				

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

J.6.2 Model Fitting based on the 17-term extended model.

Models fit for PM (Bag 3): (Grand Intercept not fit by Tobit models).

Model Term	Notation	Model							
		Full	FM4 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 4,” etc.

PM (Bag 3): Model fitting history, starting with the 17-term extended model.

Fit Parameters			Test with respect to Previous Model		
Model	$p-I^I$	$-2\ln L$	Dev.	d	$\Pr > \chi^2$
Full Model	17	3215.611			
FM4	13	3215.883	0.272	4	0.992
FM5	12	3216.627	0.744	1	0.388
FM6	11	3217.959	1.332	1	0.248
FM7	10	3219.173	1.214	1	0.271
FM8	9	3220.762	1.589	1	0.207
FM9	8	3222.431	1.669	1	0.196
FM10	7	3222.609	0.178	1	0.673

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 3): 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	-0.0434	0.0810	1	0.29	0.59	-0.0212	0.0613	1	0.12	0.73
Z_a	-0.0024	0.0552	1	0.0000	0.97	0.0186	0.0455	1	0.17	0.68
Z_r	-0.1395	0.0754	1	3.42	0.06	-0.1275	0.0507	1	6.33	0.012
Z_5	-0.0311	0.1081	1	0.080	0.77	-0.0411	0.0687	1	0.36	0.55
Z_9	0.0031	0.0593	1	0.000000	0.96					
ZZ_{ee}	-0.0751	0.0919	1	0.67	0.41					
ZZ_{55}	-0.1023	0.0750	1	1.86	0.17					
ZZ_{ea}	0.0544	0.0748	1	0.53	0.47	0.0849	0.0450	1	3.57	0.059
ZZ_{er}	-0.0742	0.0506	1	2.15	0.14					
ZZ_{e5}	-0.1512	0.0970	1	2.43	0.12	-0.0824	0.0500	1	2.71	0.10
ZZ_{e9}	0.0399	0.0617	1	0.42	0.52					
ZZ_{ar}	-0.1631	0.0944	1	2.99	0.08	-0.1062	0.0566	1	3.53	0.060
ZZ_{a5}	-0.0107	0.1016	1	0.010	0.92					
ZZ_{a9}	0.0892	0.0515	1	3.01	0.08					
ZZ_{59}	-0.0241	0.0670	1	0.13	0.72					
ZZ_{r9}	0.00020	0.0582	1	0.000000	1.00					
σ_{veh}^2 ¹										
σ_{ε}^2	1.3351					1.3405				

¹ Not fit by Tobit model.