6 Appendix

6.2 Z-test for EAclr3 models

Timeline	Response	Distribution	Covariate	Estimate	Std. Error	z value	Pr(>|z|)
Start of the week	EAclr3	NB	ν intercept	-2.511	0.265	-9.477	< 0.01
			EngineCapacity	-0.353	0.15	-2.36	0.018
			BMS	0.47	0.014	33.78	< 0.01
			σ	0.384			
		PO	ν intercept	-2.82	0.148	-19.08	< 0.01
			EngineCapacity	-0.109	0.073	-1.51	0.132
			BMS	0.436	0.008	50.48	< 0.01
	NumH	EQNB	μ intercept	-7.831	0.148	-53.014	< 0.01
			EngineCapacity	0.122	0.069	1.773	0.038
			ν	0.233	0.058	3.987	< 0.01
			κ	1.508			
		QP	μ intercept	-7.793	0.102	-76.574	< 0.01
			EngineCapacity	0.152	0.048	3.179	< 0.01
			ν	0.242	0.036	6.779	< 0.01
End of the week	NumH	EQNB	μ intercept	-7.723	0.143	-54.010	< 0.01
			EngineCapacity	0.090	0.069	1.314	0.094
			EAclr3	0.036	0.033	1.088	0.138
			κ	1.547			
		QP	μ intercept	-7.678	0.100	-76.690	< 0.01
			EngineCapacity	0.120	0.048	2.496	0.013
			EAclr3	0.034	0.024	1.399	0.162

Table 9: Z-tests for EAclr3 count models and claim count models using EAclr3 predictions and observations as covariates

6.3 Cross-validation for EAclr3 models

Timeline	Response	Dist.	Fold 1		Fold 2		Fold 3		Fold 4		Fold 5	
			BMS	Bench.	BMS	Bench.	BMS	Bench.	BMS	Bench.	BMS	Bench.
Start of the week	EBrak3	NB	2.8609	< 4.1925	0.9839	< 1.2060	0.3999	< 0.7137	0.1835	< 0.1974	0.1314	> 0.1095
		NB†	2.9260	< 4.2204	0.9765	< 1.1803	0.4060	< 0.6890	0.2015	> 0.1955	0.1529	> 0.1032
		PO	2.9076	< 4.2021	0.9808	< 1.1851	0.3998	< 0.6953	0.1991	> 0.1879	0.1458	> 0.0999
		PO†	2.9446	< 4.2204	1.0107	< 1.1803	0.4081	< 0.6890	0.2137	> 0.1955	0.1645	> 0.1032
		MVNB	4.0402		1.1396		1.1706		8.2612		11.1971	
		MVNB†	4.0401		1.1435		0.8644		10.1639		10.2338	
	NumH	EQNB	0.4460	< 0.4536	0.1115	< 0.1116	0.4963	< 0.5016	0.5034	< 0.5076	0.4700	< 0.4737
		EQNB†	0.4550	< 0.4592	0.1119	< 0.1119	0.4991	< 0.5023	0.5075	< 0.5101	0.4724	< 0.4755
		QP	0.4393	< 0.4467	0.1115	< 0.1116	0.4897	< 0.4951	0.4945	< 0.4995	0.4632	< 0.4674
		QP†	0.4498	< 0.4551	0.1118	< 0.1118	0.4923	< 0.4963	0.5001	< 0.5038	0.4669	< 0.4711
End of the week	NumH	EQNB	0.4476	< 0.4536	0.1116	< 0.1116	0.5009	< 0.5016	0.5071	< 0.5076	0.4733	< 0.4737
		EQNB†	0.4538	< 0.4592	0.1118	< 0.1119	0.5018	< 0.5023	0.5097	< 0.5101	0.4749	< 0.4755
		QP	0.4408	< 0.4467	0.1115	< 0.1116	0.4945	< 0.4951	0.4989	< 0.4995	0.4670	< 0.4674
		QP†	0.4495	< 0.4551	0.1117	< 0.1118	0.4957	< 0.4963	0.5033	< 0.5038	0.4706	< 0.4711

† denotes distributions without traditional rating factors ($\mathbf{X}_i$).

Table 10: 5-fold mean squared error cross-validation for EBrak3 models

Timeline	Response	Dist.	Fold 1		Fold 2		Fold 3		Fold 4		Fold 5	
			BMS	Bench.	BMS	Bench.	BMS	Bench.	BMS	Bench.	BMS	Bench.
Start of the week	EBrak3	NB	3.9046	< 5.0578	0.8858	> 0.6088	0.5747	< 0.9311	0.2338	> 0.2101	0.0856	< 0.1141
		NB†	3.9848	< 5.0829	0.7765	> 0.5532	0.5504	< 0.9128	0.2500	> 0.2055	0.1066	> 0.1048
		PO	3.9395	< 5.0691	0.8207	> 0.5608	0.4910	< 0.9178	0.2165	> 0.1992	0.1242	> 0.1030
		PO†	3.9021	< 5.0829	0.8393	> 0.5532	0.4995	< 0.9128	0.2196	> 0.2055	0.1388	> 0.1048
		MVNB	4.9237		0.6527		1.1922		4.6459		11.9269	
		MVNB†	4.9258		0.6447		0.9806		5.5079		10.6218	
	NumH	EQNB	0.4465	< 0.4536	0.1116	< 0.1116	0.4951	< 0.5016	0.5030	< 0.5076	0.4697	< 0.4737
		EQNB†	0.4418	< 0.4467	0.1115	< 0.1116	0.4867	< 0.4951	0.4935	< 0.4995	0.4619	< 0.4674
		QP	0.4418	< 0.4467	0.1115	< 0.1116	0.4867	< 0.4951	0.4935	< 0.4995	0.4619	< 0.4674
		QP†	0.4491	< 0.4551	0.1117	< 0.1118	0.4891	< 0.4963	0.4985	< 0.5038	0.4653	< 0.4711
End of the week	NumH	EQNB	0.4527	< 0.4536	0.1116	< 0.1116	0.5014	< 0.5016	0.5075	< 0.5076	0.4737	< 0.4737
		EQNB†	0.4577	< 0.4592	0.1118	< 0.1119	0.5022	< 0.5023	0.5101	< 0.5101	0.4753	< 0.4755
		QP	0.4534	< 0.4551	0.1117	< 0.1118	0.4961	< 0.4963	0.5037	< 0.5038	0.4710	< 0.4711

† denotes distributions without traditional rating factors ($\mathbf{X}_i$).

Table 11: 5-fold mean squared error cross-validation for EAclr3 models

6.4 Total claim count simulation

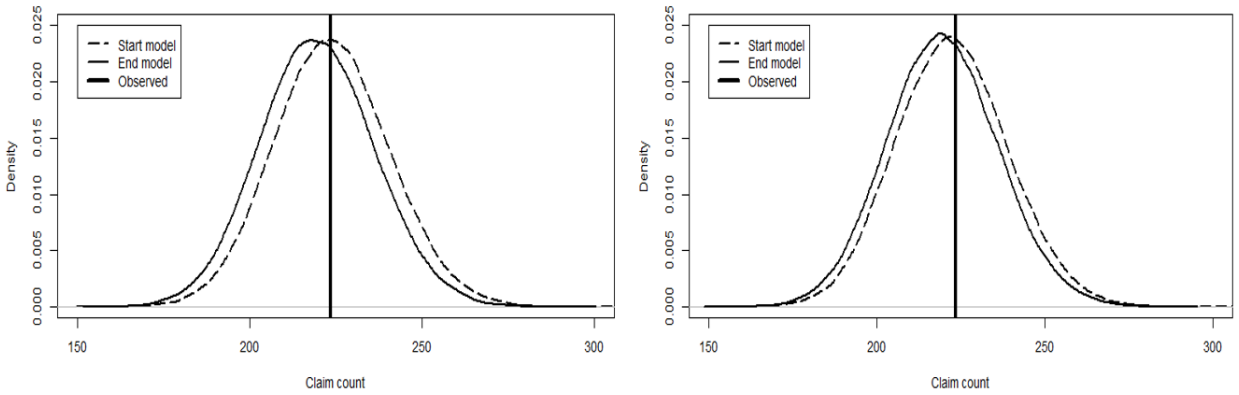

Figure 9: Total claim counts distribution of the extended test dataset. EAclr3 Negative Binomial model with traditional factors (left) and without traditional factors (right)

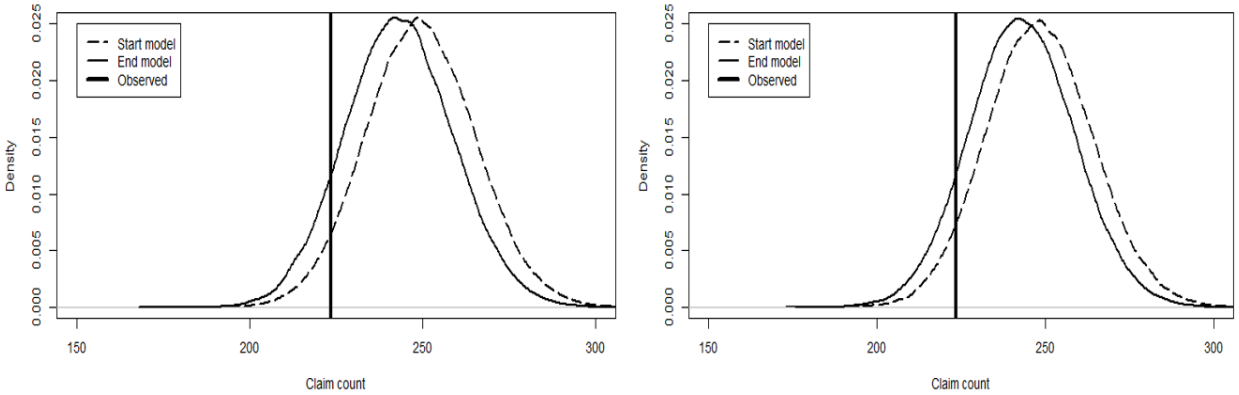

Figure 10: Total claim counts distribution of the extended test dataset. EAclr3 Poisson model with traditional factors (left) and without traditional factors (right)

6.5 Detailed pricing scheme using EAclr3 models

Driver	Week (j)	EAclr3	$\ell_{i,j-1}$	$\nu_{i,j}$	$\overline{C} \cdot \mu_{i,j}^{(-)}$	$\overline{C} \cdot \mu_{i,j}^{(+)}$	$\overline{C} \cdot A_{i,j-1}$	$P_{i,j}$	$P_{i,j}^{(b)}$
Profile 1	1	0	0	0.02	1.95	1.90	0	1.95	1.90
	2	1	-1	0.01	1.95	1.97	-0.05	1.90	1.90
	3	0	7.43	0.65	2.26	1.90	0.02	2.29	1.90
	4	0	6.43	0.41	2.14	1.90	-0.36	1.78	1.90
	5	2	5.43	0.25	2.06	2.05	-0.23	1.83	1.90
	6	0	9	1.36	2.67	1.90	-0.02	2.65	1.90
	7	1	8	0.85	2.37	1.97	-0.76	1.61	1.90
	8	0	9	1.36	2.67	1.90	-0.40	2.27	1.90
Profile 2	1	0	0	0.02	1.95	1.90	0	1.95	1.90
	2	0	-1	0.01	1.95	1.90	-0.05	1.90	1.90
	3	0	-2	0.01	1.95	1.90	-0.04	1.90	1.90
	4	0	-3	0	1.95	1.90	-0.04	1.90	1.90
	5	0	-3	0	1.95	1.90	-0.04	1.90	1.90
	6	0	-3	0	1.95	1.90	-0.04	1.90	1.90
	7	0	-3	0	1.95	1.90	-0.04	1.90	1.90
	8	0	-3	0	1.95	1.90	-0.04	1.90	1.90

Table 12: Pricing scheme with a EAclr3 bonus-malus model for profiles 1 and 2

6.6 Gini index

Baseline \ Alternative		EBrak3				Benchmark				Max
		NB	NB†	PO	PO†	NB3	NB†	PO	PO†	
EBrak3	NB		0.12	-0.11	0.11	0.08	0.09	-0.07	0.09	0.12
	NB†	-0.09		-0.08	-0.03	-0.07	0.02	-0.07	-0.02	**0.02**
	PO	0.12	0.12		0.12	0.09	0.10	0.09	0.11	0.12
	PO†	-0.08	0.03	-0.09		-0.07	0.03	-0.07	-0.00	0.03
Benchmark	NB	-0.05	0.12	-0.05	0.12		0.13	-0.13	0.14	0.14
	NB†	-0.04	0.01	-0.04	0.16	-0.11		-0.11	-0.08	0.16
	PO	0.11	0.12	-0.05	0.13	0.14	0.14		0.14	0.14
	PO†	-0.04	0.05	-0.04	0.10	-0.12	0.08	-0.11		0.10

† denotes distributions without traditional rating factors ($\mathbf{X}_i$).

Table 13: Gini indices for EBrak3 bonus-malus models and benchmark models

Baseline \ Alternative		EAclr3				Benchmark				Max
		NB	NB†	PO	PO†	NB3	NB†	PO	PO†	
EAclr3	NB		0.11	-0.10	0.10	0.06	0.08	-0.08	0.09	0.11
	NB†	-0.09		-0.08	-0.11	-0.08	0.00	-0.08	-0.03	**0.00**
	PO	0.12	0.12		0.13	0.08	0.10	0.06	0.10	0.13
	PO†	-0.07	0.12	-0.09		-0.09	0.07	-0.08	0.01	0.12
Benchmark	NB	-0.03	0.12	-0.05	0.13		0.13	-0.13	0.14	0.14
	NB†	-0.04	0.02	-0.05	-0.06	-0.11		-0.11	-0.08	0.02
	PO	0.11	0.13	-0.04	0.13	0.14	0.14		0.14	0.14
	PO†	-0.04	0.05	-0.05	-0.07	-0.12	0.08	-0.11		0.08

† denotes distributions without traditional rating factors ($\mathbf{X}_i$).

Table 14: Gini indices for EAclr3 bonus-malus models and benchmark models

Baseline \ Alternative		EBrak3				EAclr3				Benchmark				Max
		NB	NB†	PO	PO†	NB3	NB†	PO	PO†	NB	NB†	PO	PO†	
EBrak3	NB		0.12	-0.11	0.11	0.10	0.11	-0.05	0.11	0.08	0.09	-0.07	0.09	0.12
	NB†	-0.09		-0.08	-0.03	-0.05	0.00	-0.04	-0.06	-0.07	0.02	-0.07	-0.02	**0.02**
	PO	0.12	0.12		0.12	0.13	0.12	0.12	0.12	0.09	0.10	0.09	0.11	0.13
	PO†	-0.08	0.03	-0.09		-0.05	0.06	-0.04	-0.12	-0.07	0.03	-0.07	-0.00	0.06
EAclr3	NB	-0.07	0.09	-0.09	0.10		0.11	-0.10	0.10	0.06	0.08	-0.08	0.09	0.11
	NB†	-0.06	0.02	-0.06	0.12	-0.09		-0.08	-0.11	-0.08	0.00	-0.08	-0.03	0.12
	PO	0.08	0.10	-0.09	0.10	0.12	0.12		0.13	0.08	0.10	0.06	0.10	0.13
	PO†	-0.06	0.09	-0.06	0.14	-0.07	0.12	-0.09		-0.09	0.07	-0.08	0.01	0.14
Benchmark	NB	-0.05	0.12	-0.05	0.12	-0.03	0.12	-0.05	0.13		0.13	-0.13	0.14	0.14
	NB†	-0.04	0.01	-0.04	0.16	-0.04	0.02	-0.05	-0.06	-0.11		-0.11	-0.08	0.16
	PO	0.11	0.12	-0.05	0.13	0.11	0.13	-0.04	0.13	0.14	0.14		0.14	0.14
	PO†	-0.04	0.05	-0.04	0.10	-0.04	0.05	-0.05	-0.07	-0.12	0.08	-0.11		0.10

† denotes distributions without traditional rating factors ($\mathbf{X}_i$).

Table 15: Gini indices for bonus-malus models (EBrak3 and EAclr3) and benchmark models