MTO Minor, DRCOND

The time series comprises all accidents which resulted in minor injury. The data were aggregated to monthly time series from January 1992 to December 1998. So there are $n = 84$ observations. May 1996 corresponds to observation #53 in this series. There are 16 time series corresponding to the variables for hour window (11PM, 12AM, 1AM, 2AM), weekgroup (SunWed, ThuSat) and driver condition (sober, drunk). The codes used and their defintions are given in the table below.

#	Code	Definition
1	PM11SS	11PM SunWed Sober
2	AM12SS	12AM SunWed Sober
3	AM1SS	1AM SunWed Sober
4	AM2SS	2AM SunWed Sober
5	PM11TS	11PM ThuSat Sober
6	AM12TS	12AM ThuSat Sober
7	AM1TS	1AM ThuSat Sober
8	AM2TS	2AM ThuSat Sober
9	PM11SD	11PM SunWed Drunk
10	AM12SD	12AM SunWed Drunk
11	AM1SD	1AM SunWed Drunk
12	AM2SD	2AM SunWed Drunk
13	PM11TD	11PM ThuSat Drunk
14	AM12TD	12AM ThuSat Drunk
15	AM1TD	1AM ThuSat Drunk
16	AM2TD	2AM ThuSat Drunk

May 1996 corresponds to observation #53 in this series. A step intervention model defined by,

$$z_t = \mu + \delta_1 \xi_t + N_t$$

where N_t is the error term. Based on the pre-intervention data we assume initially that N_t is normal and independent, so ordinary multiple linear regression can be used. The intervention series are defined by,

$$\xi_t = \begin{cases} 0 & t < 53 \\ 1 & t \geq 53 \end{cases}$$

The pre-intervention series is fairly short so the following two-step approach to the ARIMA identification of the error term N_t will be used. In the first stage the model in eqn. (1) is fit using standard regression. Then the residuals, the estimated values, $\hat{N}_t$, are obtained and the residual autocorrelation of these residuals is examined. This approach should be expected to work well and is indeed theoretically superior to the alternative approach of basing the model identification on the pre-intervention residuals. The reason for this is that in the estimates of the autocorrelations of $\hat{N}_t$ are first-order efficient as are the estimates in the pre-intervention approach. However since the sample size is larger, this approach provides better estimates.

Regression Results

In the residual autocorrelation, a small amount of positive autocorrelation is detected. Hence these initial regression estimates of the intervention are statistically efficient but due to the small amount of positive autocorrelation, their significance is a little overstated. An ARIMA intervention will be below and it will be shown that there are only minor changes in the results below.

		Estimate	SE	TStat	PValue
PM11SS	1	3.71154	0.274609	13.5157	0.
	ξ	-0.524038	0.444917	-1.17783	0.24227

		Estimate	SE	TStat	PValue
AM12SS	1	5.57692	0.345906	16.1226	0.
	ξ	**-1.45192**	**0.560432**	**-2.59072**	**0.0113332**

		Estimate	SE	TStat	PValue
AM1SS	1	3.5	0.305851	11.4435	0.
	ξ	-0.5625	0.495535	-1.13514	0.259625

		Estimate	SE	TStat	PValue
AM2SS	1	5.73077	0.354199	16.1795	0.
	ξ	**-1.82452**	**0.573869**	**-3.17933**	**0.00208331**

		Estimate	SE	TStat	PValue
PM11TS	1	6.59615	0.370879	17.7852	0.
	ξ	**-3.34615**	**0.600893**	**-5.56863**	**3.16511×10^{-7}**

		Estimate	SE	TStat	PValue
AM12TS	1	9.75	0.49226	19.8066	0.
	ξ	**-4.875**	**0.797552**	**-6.11246**	**3.16273×10^{-8}**

		Estimate	SE	TStat	PValue
AM1TS	1	3.98077	0.274993	14.4759	0.
	ξ	0.237981	0.44554	0.53414	0.59469

		Estimate	SE	TStat	PValue
AM2TS	1	6.98077	0.392441	17.7881	0.
	ξ	-0.574519	0.635828	-0.903577	0.368867

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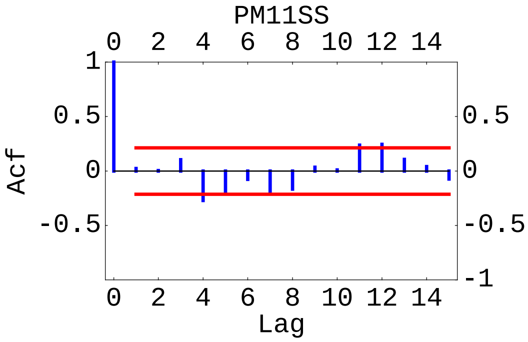
	ξ	−0.574519	0.635828	−0.903577	0.368867

Residual Autocorrelation Analysis

The residual autocorrelation from the regression model are examined and used to select tentative ARIMA models.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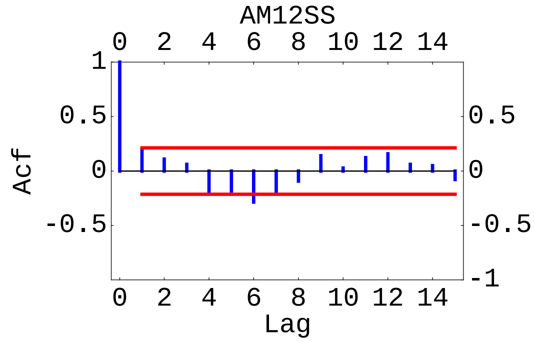
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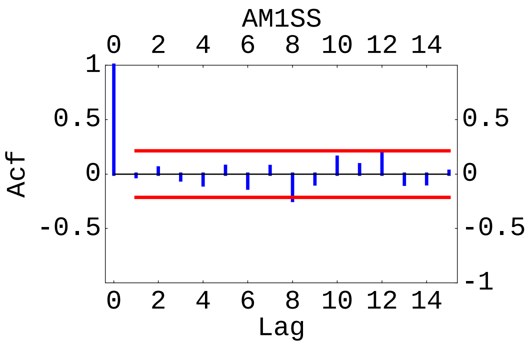
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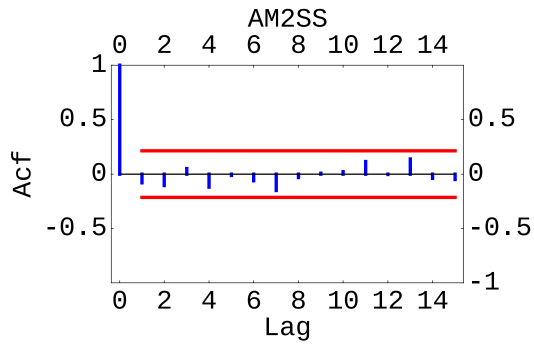
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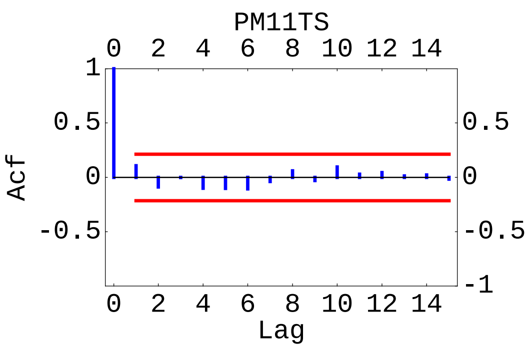
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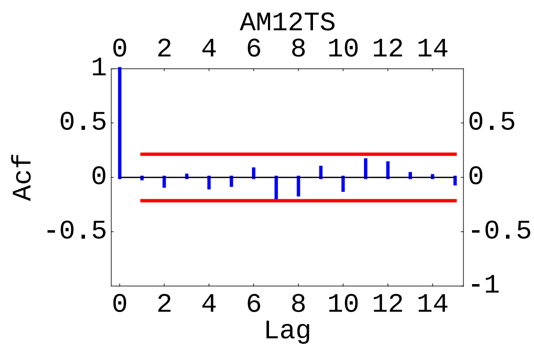
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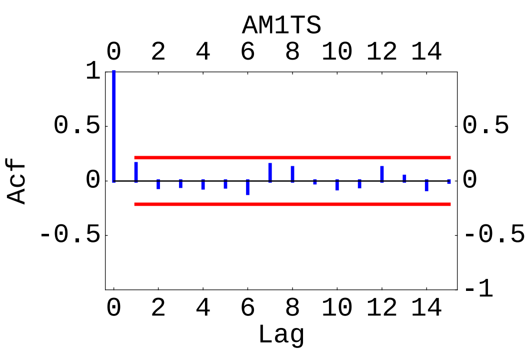
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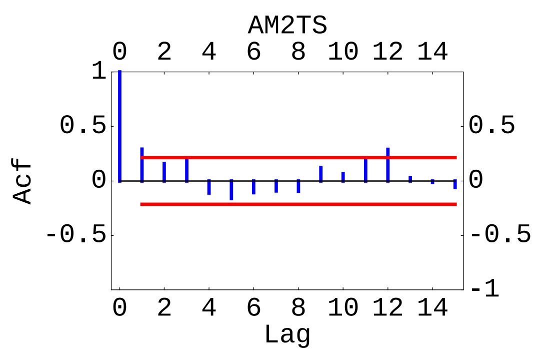
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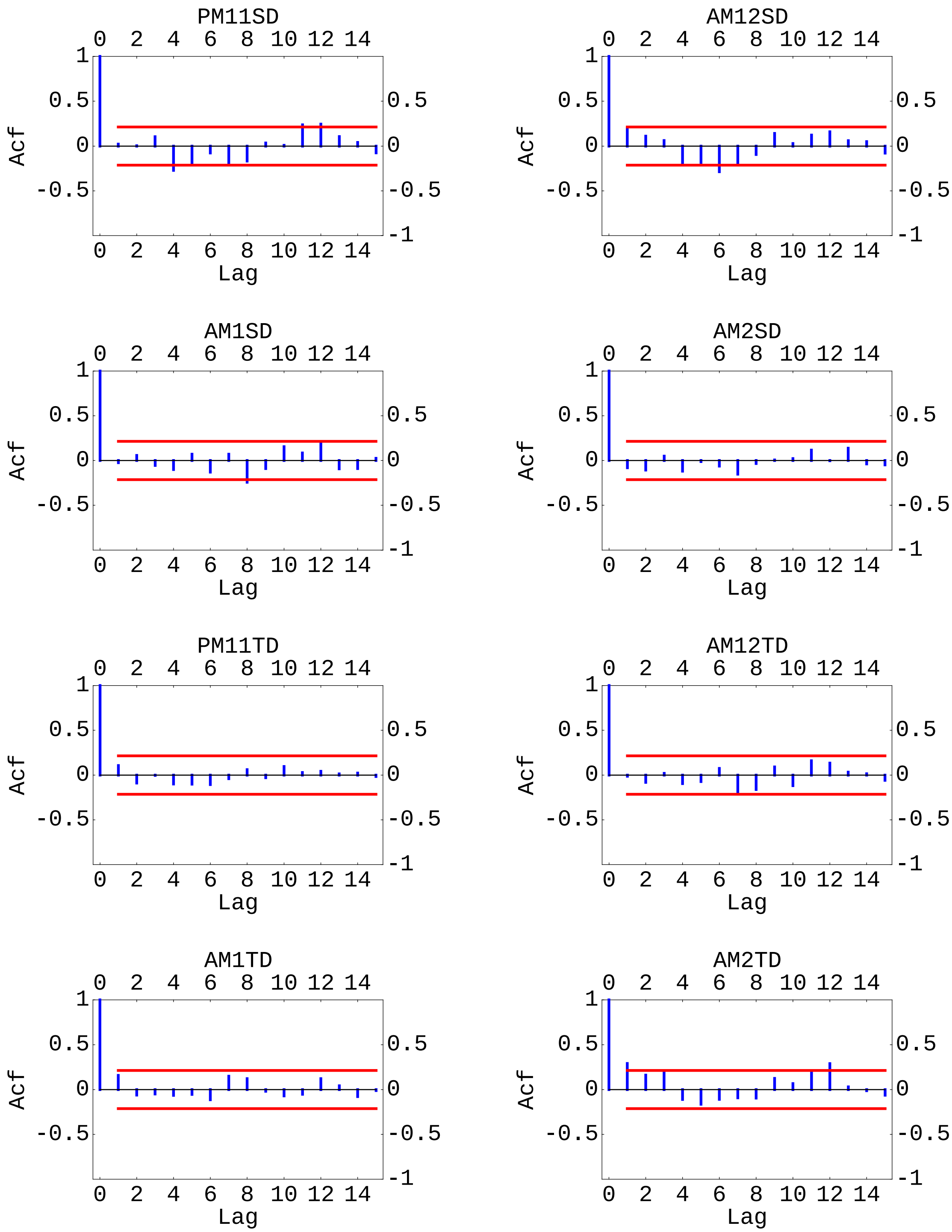


ARIMA Modelling

Based on the residual autocorrelations of the regression, the following ARIMA models are suggested.

■ Model Identification

#	Code	ARIMA(p,d,q)
1	PM11SS	$(0,0,0)(0,0,1)_{12}$
2	AM12SS	$(0,0,0)(0,0,1)_{12}$
3	AM1SS	$(0,0,0)(0,0,1)_{12}$
4	AM2SS	$(0,0,0)(0,0,1)_{12}$
5	PM11TS	$(0,0,0)(0,0,0)_{12}$
6	AM12TS	$(0,0,0)(0,0,0)_{12}$
7	AM1TS	$(0,0,1)(0,0,1)_{12}$
8	AM2TS	$(0,0,3)(0,0,1)_{12}$
9	PM11SD	$(0,0,0)(0,0,1)_{12}$
10	AM12SD	$(1,0,0)(0,0,1)_{12}$
11	AM1SD	$(0,0,0)(0,0,1)_{12}$
12	AM2SD	$(0,0,0)(0,0,0)_{12}$
13	PM11TD	$(0,0,0)(0,0,1)_{12}$
14	AM12TD	$(0,0,0)(0,0,1)_{12}$
15	AM1TD	$(0,0,1)(0,0,1)_{12}$
16	AM2TD	$(0,0,3)(0,0,1)_{12}$

■ 1. PM11SS $(0, 0, 0)(0, 0, 1)_{12}$

	Estimate	SE	P-Value
μ	3.728	0.261	0
δ	-0.592	0.479	0.217
Θ_1	-0.269	0.105	0.01

There is almost no change is the regression parameter and it is still not significant at 10% on a one-sided test.

■ 2. AM12SS $(0, 0, 0)(0, 0, 1)_{12}$

	Estimate	SE	P-Value
μ	5.543	0.309	0
δ	**-1.377**	**0.592**	**0.02**
Θ_1	-0.167	0.108	0.121

Due to the small positive autocorrelation at the seasonal lag, the significance level has increased from 1% to 2%. But since the seasonal coefficient is not significant, the previous model will be used.

■ 3. AM1SS $(0, 0, 0)(0, 0, 1)_{12}$

	Estimate	SE	P-Value
μ	3.534	0.285	0
δ	-0.592	0.532	0.266
Θ_1	-0.232	0.106	0.029

Only minor change from coefficient of -0.592 from previous estimate of -0.5625. Still not significant at 10%.

■ 4. AM2SS (0, 0, 0) (0, 0, 1)$_{12}$

	Estimate	SE	P-Value
μ	5.731	0.274	0
δ	-1.825	0.566	0.001
Θ_1	0.004	0.109	0.969

The seasonal autocorrelation parameter is not significant, so the original model will be used.

■ 5. AM1TS (0, 0, 1) (0, 0, 1)$_{12}$

	Estimate	SE	P-Value
μ	3.993	0.295	0
δ	0.141	0.554	0.799
θ_1	-0.186	0.107	0.083
Θ_1	-0.2	0.107	0.061

Due to the positive autocorrelation the significance level has increased to 80% from 60% and the intervention coefficient has been reduced to 0.141 from 0.238. The ARIMA parameters are close to significance at 5% so we keep this model.

■ 8. AM2TS (0, 0, 3) (0, 0, 1)$_{12}$

	Estimate	SE	P-Value
μ	3.993	0.295	0
δ	0.141	0.554	0.799
θ_1	-0.186	0.107	0.083
Θ_1	-0.2	0.107	0.061

Due to the positive autocorrelation the significance level has increased to 64% from 37% and the intervention coefficient has been slightly reduced.

■ 9. PM11SD (0, 0, 0) (0, 0, 1)$_{12}$

	Estimate	SE	P-Value
μ	3.851	0.261	0
δ	-0.592	0.48	0.217
Θ_1	-0.269	0.105	0.01

Very minor impact of the size or significance of the intervention coefficient.

■ 10. AM12SD (1, 0, 0) (0, 0, 1)$_{12}$

	Estimate	SE	P-Value
μ	5.665	0.367	0
δ	-1.356	0.701	0.053
ϕ_1	0.183	0.107	0.088
Θ_1	-0.151	0.108	0.161

Due to the small positive autocorrelation, the signficance level has increased from 0.01% to 0.053% on a two-sided test. The coefficient in the intervention has decreased in absolute magnitude form -1.45 to -1.35. Since the ARIMA parameters are not significant at the 5% level the original model will be used in our visualization below.

■ 13. PM11TD (0, 0, 0) (0, 0, 1)$_{12}$

	Estimate	SE	P-Value
μ	7.059	0.303	0
δ	-3.344	0.614	0
Θ_1	-0.037	0.109	0.733

The ARIMA parameter is not significant, so the original model will be used.

■ 14. AM12TD (0, 0, 0) (0, 0, 1)$_{12}$

	Estimate	SE	P-Value
μ	10.397	0.43	0
δ	-4.908	0.841	0
Θ_1	-0.119	0.108	0.27

The ARIMA parameter is not significant, so the original model will be used.

■ 15. AM1TD (0, 0, 1) (0, 0, 1)$_{12}$

	Estimate	SE	P-Value
μ	4.082	0.295	0
δ	0.141	0.554	0.8
Θ_1	-0.186	0.107	0.083
Θ_1	-0.2	0.107	0.061

The coefficient of the intervention has changed from 0.238 to 0.141 has its significance level is now 80%. The ARIMA coefficients are both close to being significant at 5%. We keep this model.

■ 16. AM2TD (0, 0, 3) $(0, 0, 1)_{12}$

	Estimate	SE	P-Value
μ	6.867	0.587	0
δ	-0.479	1.02	0.639
θ_1	-0.253	0.104	0.015
θ_2	-0.183	0.105	0.083
θ_3	-0.311	0.104	0.003
Θ_1	-0.248	0.106	0.019

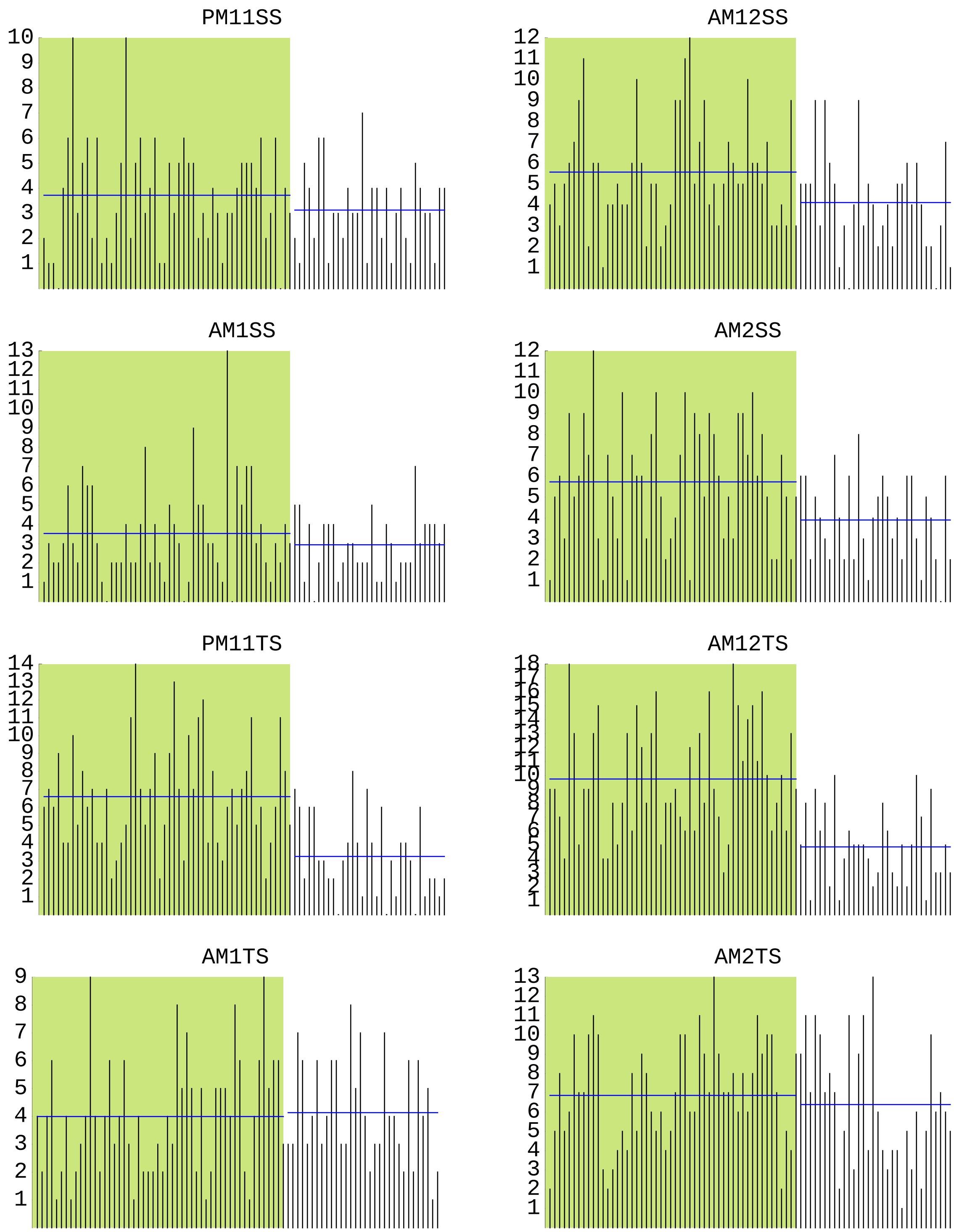
The coefficient of the intervention has changed from -0.575 to -0.479 has its significance level is now 64%. The ARIMA coefficients are jointly significant at 5%. We keep this model.

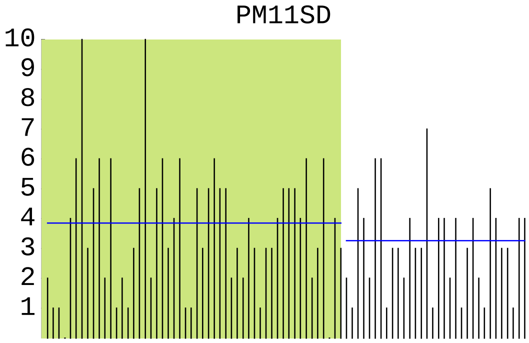
Final Intervention Parameter Estimates

The table below gives the estimates of the overall mean μ and the step-intevention parameter δ for the final selected model for each series. For each series μ is the upper entry and δ is the lower entry. Intervention coefficients which are significant at 1% are indicated by bold font for the row label..

	Estimate	SD
PM11SS	3.72755 -0.591876	0.260549 0.47898
AM12SS	5.57692 -1.45192	0.345906 0.560432
AM1SS	3.53423 -0.591831	0.285165 0.532366
AM2SS	5.73077 -1.82452	0.354199 0.573869
PM11TS	3.99335 0.140668	0.295139 0.553715
AM12TS	9.75 -4.875	0.49226 0.797552
AM1TS	3.98077 0.237981	0.274993 0.44554
AM2TS	6.86714 -0.478591	0.586985 1.01992
PM11SD	3.85133 -0.591876	0.26092 0.479662
AM12SD	5.66476 -1.35557	0.367241 0.700847
AM1SD	3.5 -0.5625	0.305851 0.495535
AM2SD	5.73077 -1.82452	0.354199 0.573869
PM11TD	6.59615 -3.34615	0.370879 0.600893
AM12TD	9.75 -4.875	0.49226 0.797552
AM1TD	4.08239 0.140668	0.295307 0.553906
AM2TD	6.86714 -0.478591	0.586985 1.01992

Intervention Visualization

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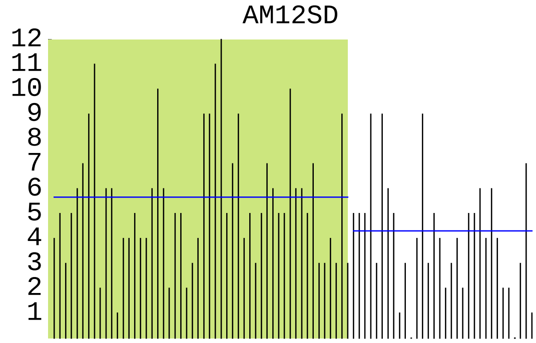
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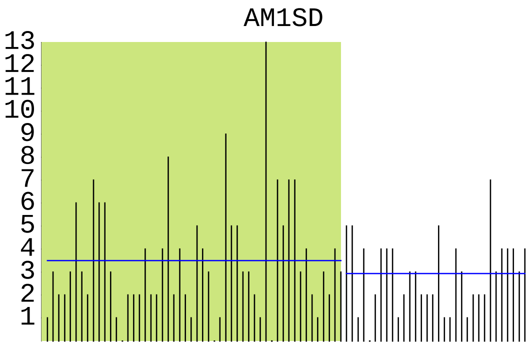
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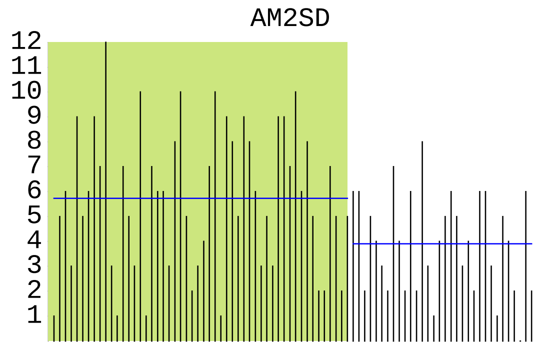
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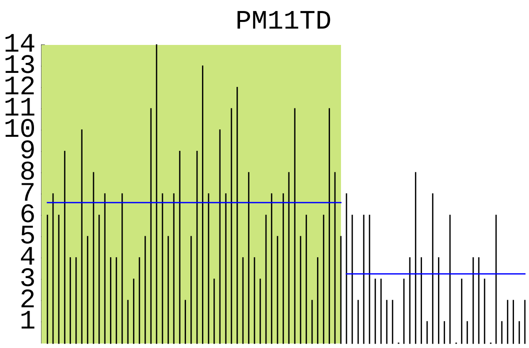
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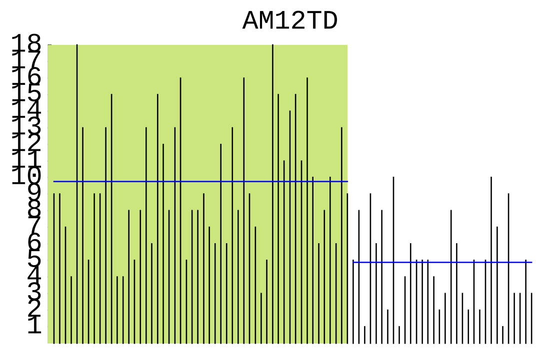
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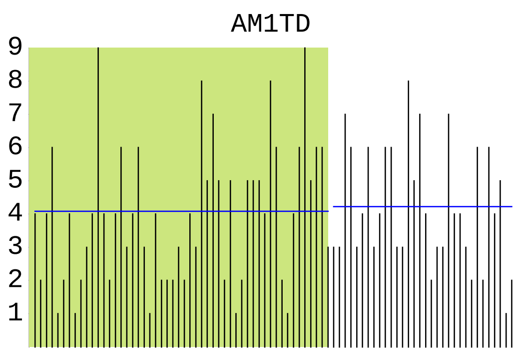
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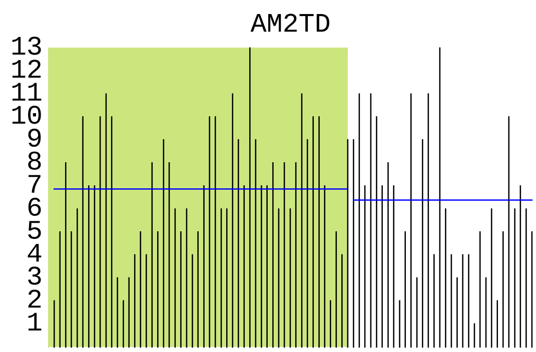
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