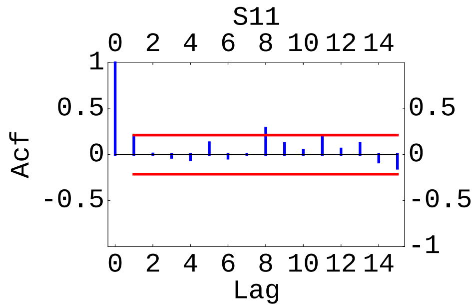
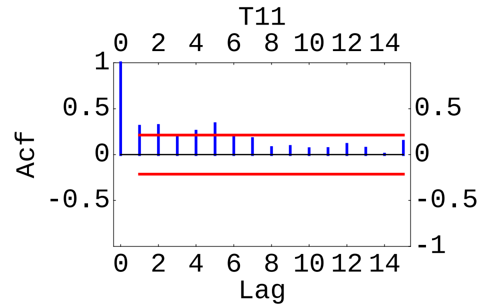
LPS Impaired

The LPS impaired driving charges time series are comprised of $n = 85$ monthly observations beginning May 1992 and ending May 1999. Ten time series were created corresponding the two weekgroup variables SunWed and ThuSat and the five hour one hour periods beginning at 11PM, 12AM, 1AM, 2AM and 3AM. For brevity we will refer to these time series using the codes S11, S12, S1, S2, S3, T11, T12, T1, T2 and T3. We are primarily interested in testing to see if a change occurred starting effective with May 1996, the 49th observation.

Autocorrelation Function

Many of the series have significant autocorrelations. A two-step approach will be used to develop the intervention analysis model. First the intervention model will be fit using ordinary regression. Then the residuals from this model will be used to identify the ARIMA noise component. Finally the model will be refit using exact maximum likelihood.


S11
Acf
Lag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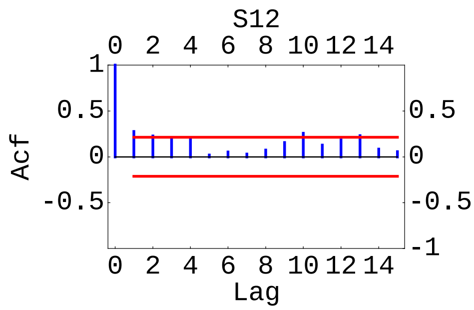
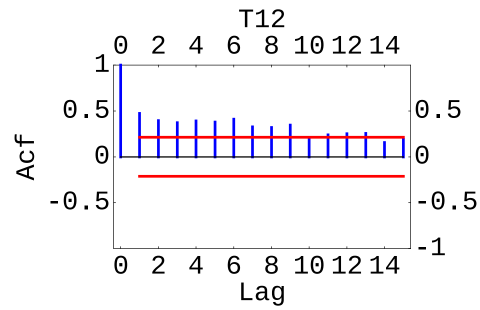
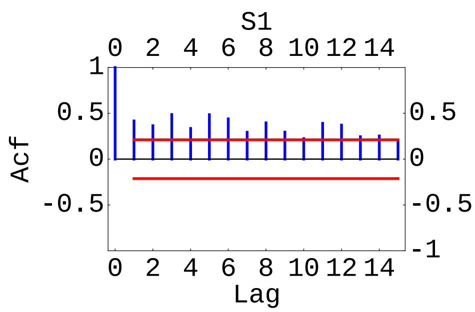
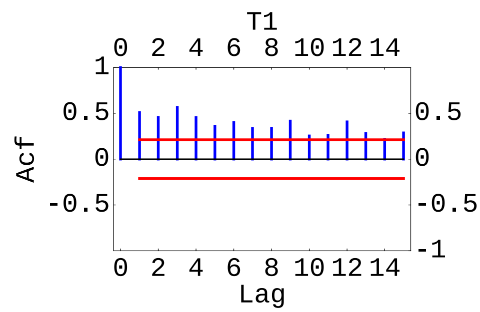
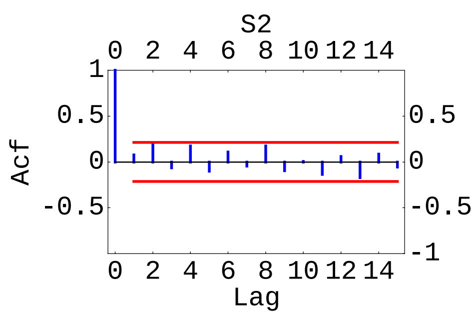
Acf
Lag

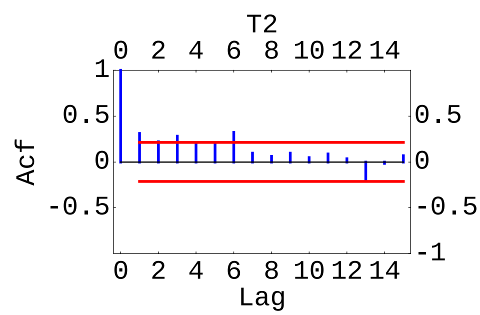

S12
Acf
Lag

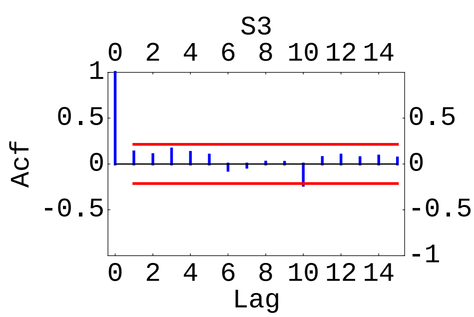

T12
Acf
Lag

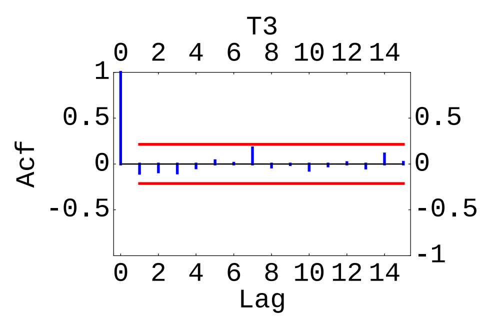

S1
Acf
Lag


T1
Acf
Lag


S2
Acf
Lag


T2
Acf
Lag


S3
Acf
Lag


T3
Acf
Lag

Intervention Analysis

May 1996 corresponds to observation #49 in this series. A step intervention model defined by,

$$z_t = \mu + \delta\,\xi_t + N_t \qquad (1)$$

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,

$$\xi_t = \begin{cases} 0 & t < 49 \\ 1 & t \geq 49 \end{cases}$$

The term N_t represents the disturbance or error term and it has been tentatively identified as Gaussian white noise, that is $N_t = a_t$, where $a_t \sim \text{NID}(0,\ \sigma^2)$.

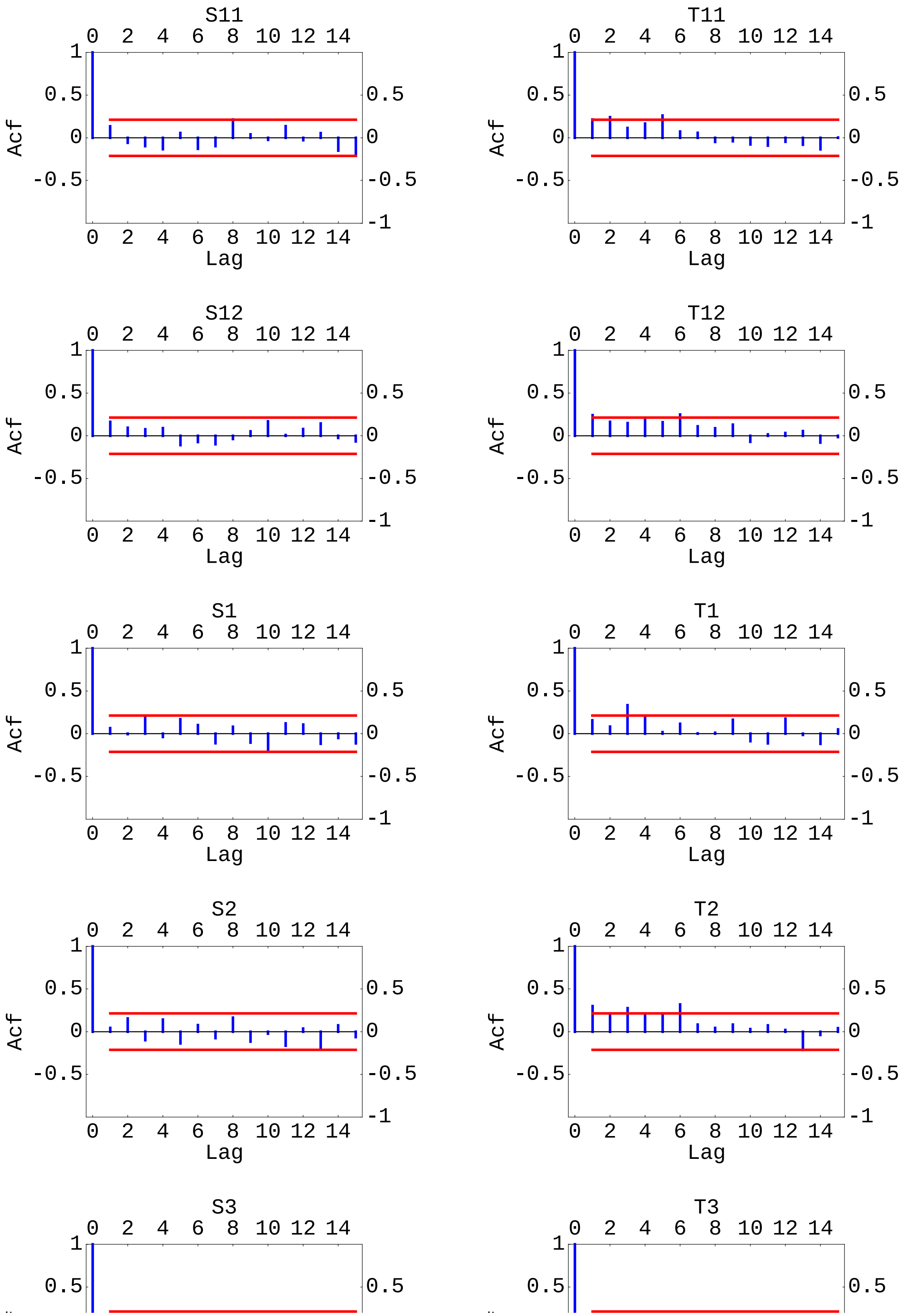
Parameter Estimates

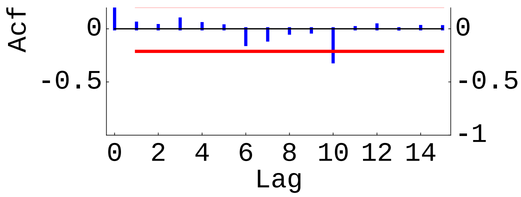
Using a one-sided test, the intervention parameter is significant at <5% for S12, S1, S2, S3, T1 and T12.

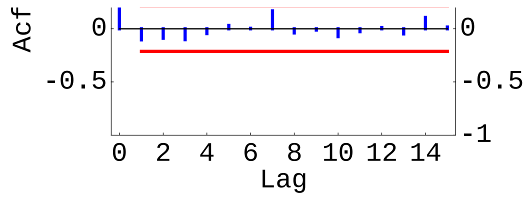
Series		Estimate	SE	TStat	PValue
S11	1	3.70833	0.313341	11.8348	0.
	ξ	**-1.19482**	**0.474926**	**-2.5158**	**0.0138033**
S12	1	5.58333	0.396049	14.0976	0.
	ξ	**-2.09685**	**0.600285**	**-3.49308**	**0.000768253**
S1	1	9.89583	0.553203	17.8883	0.
	ξ	**-5.97691**	**0.83848**	**-7.12827**	**3.43187×10^{-10}**
S2	1	6.0625	0.405999	14.9323	0.
	ξ	**-1.00845**	**0.615367**	**-1.63877**	**0.105046**
S3	1	1.79167	0.318729	5.62128	2.47785×10^{-7}
	ξ	**1.45158**	**0.483092**	**3.00476**	**0.00351374**
T11	1	7.04167	0.484278	14.5405	0.
	ξ	**-2.39302**	**0.734013**	**-3.26019**	**0.00161564**
T12	1	11.2708	0.595437	18.9287	0.
	ξ	**-5.10867**	**0.902494**	**-5.66062**	**2.10084×10^{-7}**
T1	1	19.6042	0.952457	20.5827	0.
	ξ	**-11.2258**	**1.44362**	**-7.77612**	**1.81282×10^{-11}**
T2	1	10.2708	0.607125	16.9172	0.
	ξ	-1.10867	0.92021	-1.2048	0.231704
T3	1	4.08333	0.403061	10.1308	4.44089×10^{-16}
	ξ	-0.191441	0.610913	-0.313369	0.754786

■ Residual Autocorrelation Analysis and ARIMA Identification

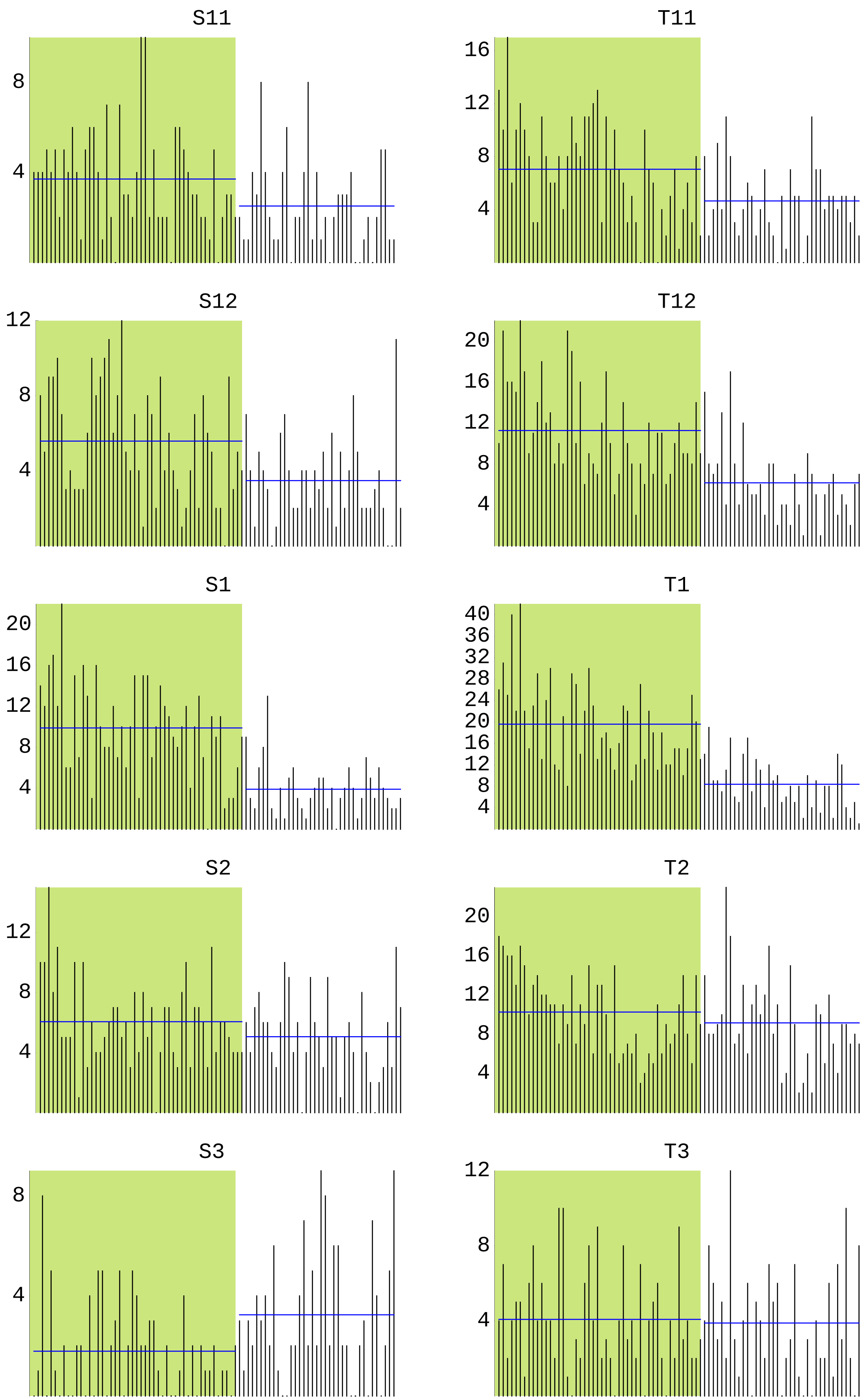
The autocorrelation in the residuals is examined particularly at lag one and lag twelve. Everything looks reasonable except perhaps for T3 has a large negative autocorrelation at lag one.







■ Visualization


S11
T11
S12
T12
S1
T1
S2
T2
S3
T3

ARIMA Modelling

Based on the residual autocorrelations of the regression, the following ARIMA models are suggested for the error term N_t.

Model Identification

Dataset	ARIMA(p, d, q)
S11	(0, 0, 1)
S12	(0, 0, 1)
S1	(0, 0, 0)
S2	(0, 0, 0)
S3	(0, 0, 0)
T11	(0, 0, 2)
T12	(0, 0, 1)
T1	$(0, 0, 1)\,(0, 0, 1)_{12}$
T2	(0, 0, 3)
T3	(0, 0, 0)

These ARIMA model specifications are then used in a full joint exact maximum likelihood estimation of the intervention models. The results are summarized below. As expected there are only some minor changes in the significance level. The intervention parameter δ only changes slightly.

S11 (0, 0, 1)

The intervention is still statistically significant at 5% on a one-sided test. The magnitude of the intervention parameter has not changed.

	Estimate	SE	P-Value
μ	3.704	0.265	0
δ	**-1.19**	**0.531**	**0.025**
θ_1	-0.15	0.107	0.162

S12 (0, 0, 1)

The intervention is still statistically significant at 5% on a one-sided test. The magnitude of the intervention parameter has changed very slightly.

	Estimate	SE	P-Value
μ	5.574	0.333	0
δ	**-2.075**	**0.668**	**0.002**
θ_1	-0.146	0.107	0.174

T11 (0, 0, 2)

The intervention is still statistically significant at about 1% on a one-sided test. The magnitude of the intervention parameter has changed very slightly.

	Estimate	SE	P-Value
μ	7.014	0.482	0
δ	**-2.304**	**0.952**	**0.016**
θ_1	-0.183	0.106	0.083
θ_2	-0.214	0.106	0.043

- **T12 (0, 0, 1)**

The intervention is still statistically highly significant. The magnitude of the intervention parameter has changed very slightly.

	Estimate	SE	P-Value
μ	12.227	0.53	0
δ	**-4.958**	**1.06**	**0**
θ_1	-0.2	0.106	0.06

- **T1 (0, 0, 1) (0, 0, 1)$_{12}$**

The intervention is still statistically highly significant. The magnitude of the intervention parameter has changed slightly.

	Estimate	SE	P-Value
μ	19.396	1.024	0
δ	**-10.432**	**1.833**	**0**
θ_1	-0.191	0.106	0.072
Θ_1	-0.275	0.104	0.008

- **T2 (0, 0, 3)**

The intervention parameter has only slightly changed and it remains not significant at the 10% level.

	Estimate	SE	P-Value
μ	10.293	0.652	0
δ	-1.067	1.274	0.402
θ_1	-0.242	0.107	0.024
θ_2	-0.145	0.109	0.183
θ_3	-0.15	0.107	0.161