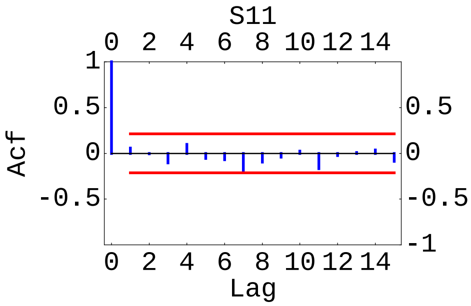
LPS Assaults

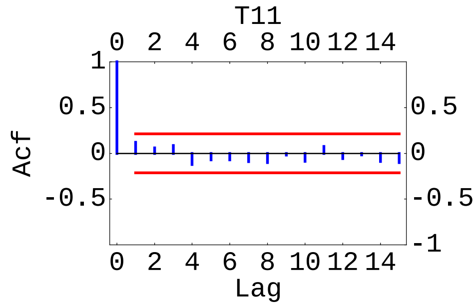
Introduction

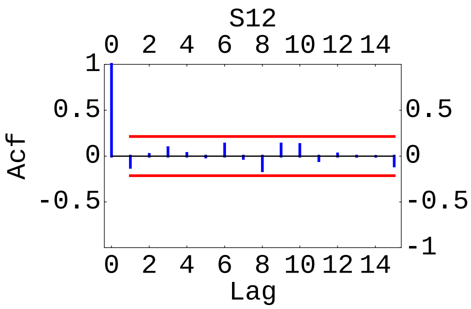
The LPS assault time series are comprised of $n = 85$ monthly observations beginning May 1992 and ending May 1999. Ten time series were created corresponding the two weekgroup variables SunWed and ThuSat and the five hour one hour periods beginning at 11PM, 12AM, 1AM, 2AM and 3AM. For brevity we will 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.

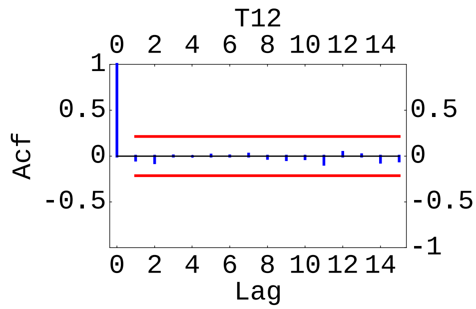
Autocorrelation Function

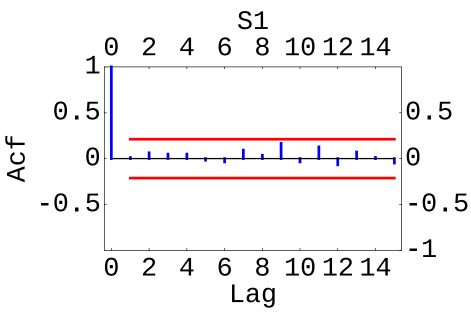
There does not seem to be any strong autocorrelations at either lag one or lag twelve across the entire series, $n = 85$. So we can model the intervention using regression and check that there is no autocorrelation remaining in the residuals.

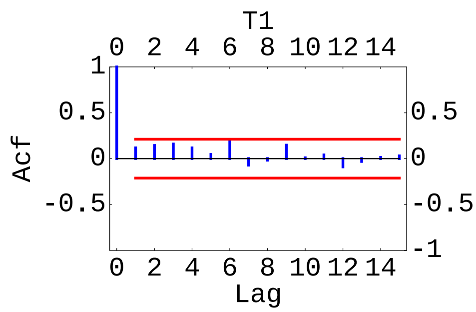

S11
0 2 4 6 8 10 12 14
1
0.5
0
-0.5
-1
Acf
Lag

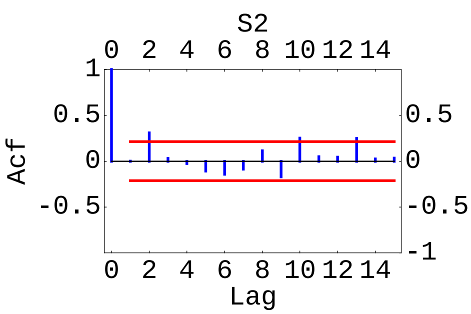

T11
0 2 4 6 8 10 12 14
1
0.5
0
-0.5
-1
Acf
Lag

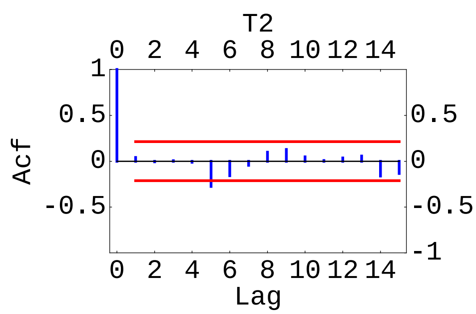

S12
0 2 4 6 8 10 12 14
1
0.5
0
-0.5
-1
Acf
Lag

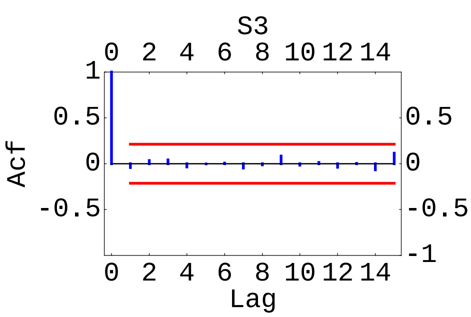

T12
0 2 4 6 8 10 12 14
1
0.5
0
-0.5
-1
Acf
Lag

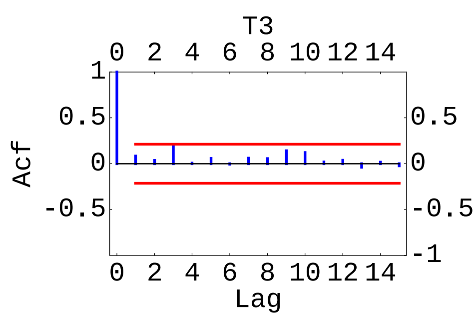

S1
0 2 4 6 8 10 12 14
1
0.5
0
-0.5
-1
Acf
Lag


T1
0 2 4 6 8 10 12 14
1
0.5
0
-0.5
-1
Acf
Lag


S2
0 2 4 6 8 10 12 14
1
0.5
0
-0.5
-1
Acf
Lag


T2
0 2 4 6 8 10 12 14
1
0.5
0
-0.5
-1
Acf
Lag


S3
0 2 4 6 8 10 12 14
1
0.5
0
-0.5
-1
Acf
Lag


T3
0 2 4 6 8 10 12 14
1
0.5
0
-0.5
-1
Acf
Lag

Intervention Analysis

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

$$z_t = \mu + \delta \xi_t + N_t \tag{1}$$

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

		Estimate	SE	TStat	PValue
S11	1	3.0625	0.308224	9.93595	8.88178×10^{-16}
	ξ	0.126689	0.46717	0.271184	0.786923

		Estimate	SE	TStat	PValue
S12	1	4.14583	0.373477	11.1006	0.
	ξ	**-0.848536**	**0.566073**	**-1.49899**	**0.137671**

		Estimate	SE	TStat	PValue
S1	1	3.72917	0.334674	11.1427	0.
	ξ	-0.810248	0.507261	-1.5973	0.113999

		Estimate	SE	TStat	PValue
S2	1	2.35417	0.293271	8.02728	5.74141×10^{-12}
	ξ	**0.835023**	**0.444506**	**1.87854**	**0.0638179**

		Estimate	SE	TStat	PValue
S3	1	1.66667	0.190058	8.76926	1.89182×10^{-13}
	ξ	-0.153153	0.288068	-0.531657	0.596384

		Estimate	SE	TStat	PValue
T11	1	3.79167	0.392325	9.6646	3.10862×10^{-15}
	ξ	0.478604	0.594641	0.804861	0.423199

		Estimate	SE	TStat	PValue
T12	1	5.70833	0.840903	6.78833	1.57354×10^{-9}
	ξ	-0.221847	1.27454	-0.17406	0.862242

		Estimate	SE	TStat	PValue
T1	1	6.54167	0.38298	17.0809	0.
	ξ	**-1.89302**	**0.580477**	**-3.26114**	**0.00161083**

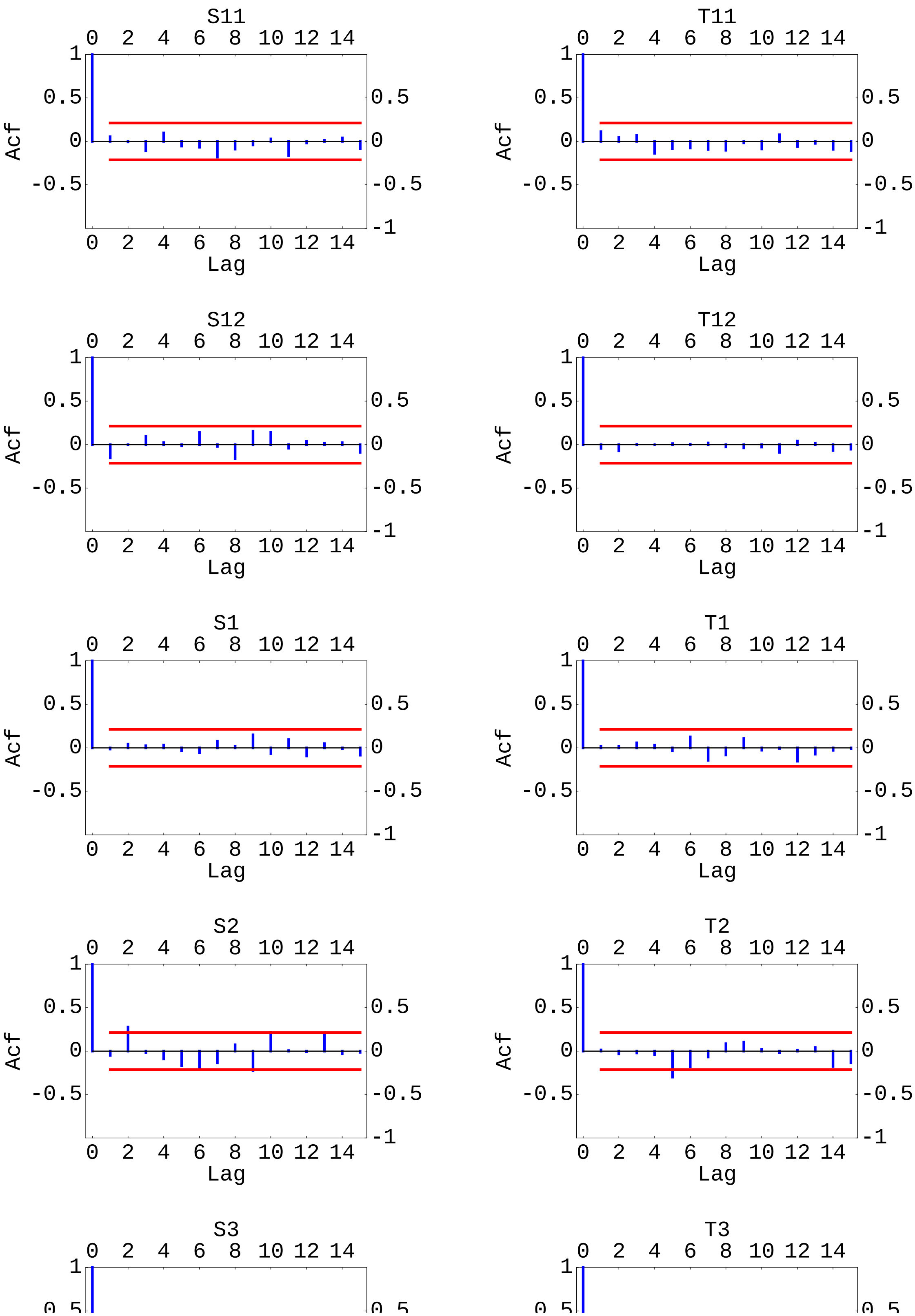
		Estimate	SE	TStat	PValue
T2	1	4.97917	0.41123	12.108	0.
	ξ	**0.939752**	**0.623295**	**1.50772**	**0.135424**

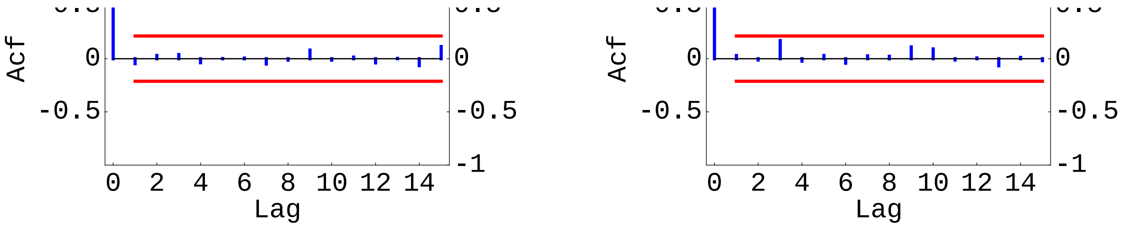
		Estimate	SE	TStat	PValue
T3	1	3.04167	0.314055	9.68514	2.66454×10^{-15}
	ξ	**1.1205**	**0.476008**	**2.35394**	**0.0209387**

Using a one-sided test, the intervention parameter is significant at 10% for S12 and T2 and it is significant at 5% for S2, T1 and T3. The intervention is especially strong for T1 and T3.

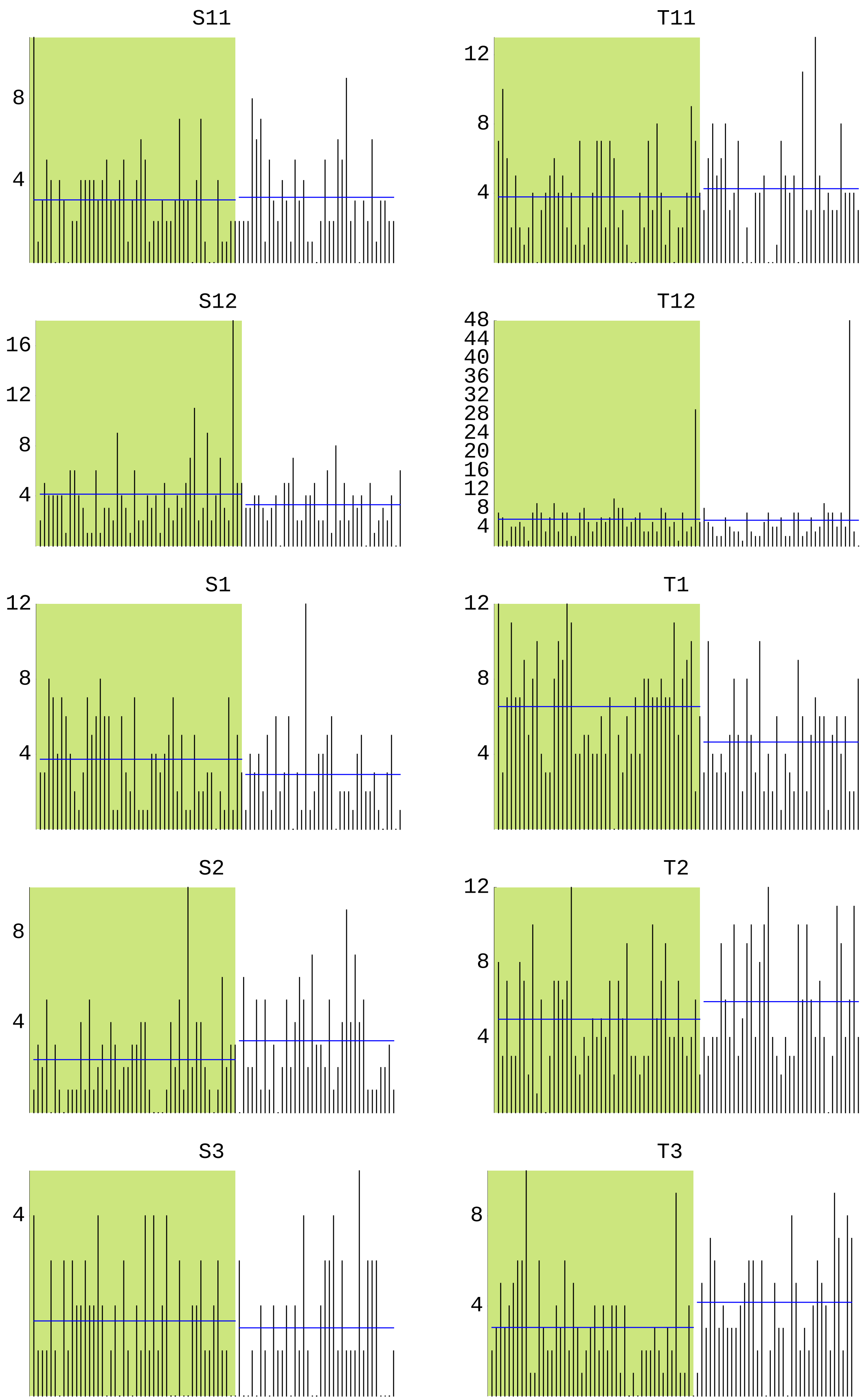
■ Residual Autocorrelation Analysis

The autocorrelation in the residuals is examined particularly at lag one and lag twelve. Everything looks reasonable.





■ Visualization of Intervention


S11
T11
S12
T12
S1
T1
S2
T2
S3
T3

Logged Data

The IA graphics indicated some strong outliers present especially for T12 and S12. The models were refit using a logarithmic transformation, $Y = \log_2(X + 1)$.

		Estimate	SE	TStat	PValue
S11	1	1.81152	0.117815	15.376	0.
	ξ	0.0623211	0.17857	0.349001	0.727972

		Estimate	SE	TStat	PValue
S12	1	2.17771	0.10731	20.2936	0.
	ξ	**-0.243936**	**0.162648**	**-1.49978**	**0.137465**

		Estimate	SE	TStat	PValue
S1	1	2.05043	0.120043	17.0809	0.
	ξ	**-0.327416**	**0.181947**	**-1.79951**	**0.0755716**

		Estimate	SE	TStat	PValue
S2	1	1.51989	0.118814	12.7923	0.
	ξ	**0.344939**	**0.180084**	**1.91544**	**0.0588807**

		Estimate	SE	TStat	PValue
S3	1	1.23009	0.114479	10.7451	0.
	ξ	-0.117828	0.173514	-0.679068	0.498984

		Estimate	SE	TStat	PValue
T11	1	2.01823	0.137384	14.6904	0.
	ξ	0.106145	0.208231	0.509745	0.611583

		Estimate	SE	TStat	PValue
T12	1	2.57308	0.113033	22.764	0.
	ξ	**-0.220464**	**0.171322**	**-1.28684**	**0.201728**

		Estimate	SE	TStat	PValue
T1	1	2.79222	0.0956368	29.1961	0.
	ξ	**-0.43482**	**0.144955**	**-2.99968**	**0.0035669**

		Estimate	SE	TStat	PValue
T2	1	2.42798	0.104299	23.2791	0.
	ξ	**0.200226**	**0.158084**	**1.26658**	**0.208848**

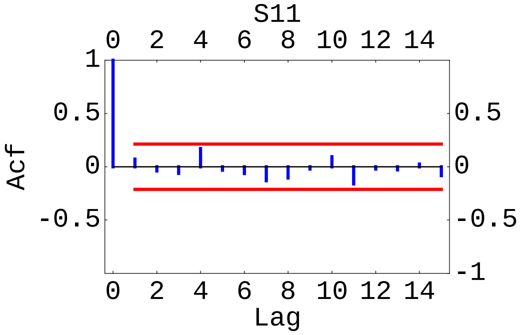
		Estimate	SE	TStat	PValue
T3	1	1.82001	0.112327	16.2029	0.
	ξ	**0.38055**	**0.170252**	**2.23522**	**0.0280885**

Using a one-sided test, the intervention parameter is significant at 10% for S12, T12 and T2 and it is significant at 5% for S2, T1 and T3. The intervention is especially strong for T1 and T3. The logarithmic transformation has improved the sensitivity of the analysis.

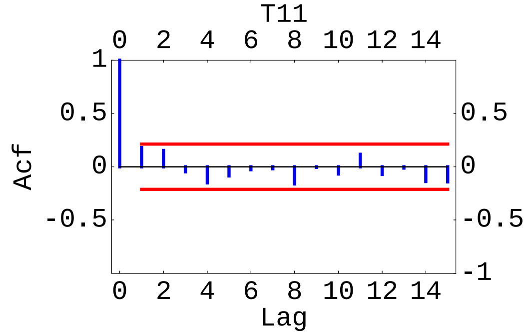
■ Residual Autocorrelation Analysis

The autocorrelation in the residuals is examined particularly at lag one and lag twelve. There appears to be significant positive autocorrelation at lag one for T11 and negative lag one autocorrelation for S12 and negative lag 12 autocorrelation for T1. As a rule positive autocorrelation implies that the regression significance levels are too low, ie. the significance is overstated and negative autocorrelation implies the reverse. Thus we may expect that after fitting models with autocorrelated error the already statistically significant results for S12 and T1 would be increased. The result for T11 would remain statistically not significant.

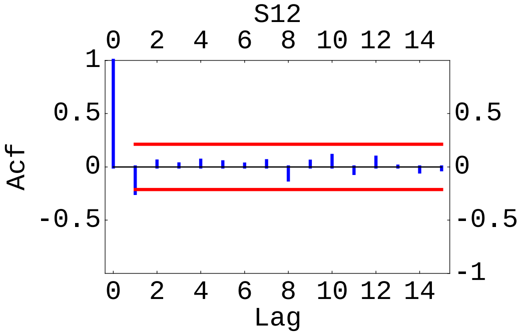
S11



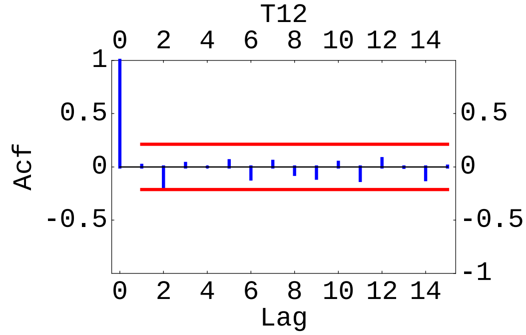
T11



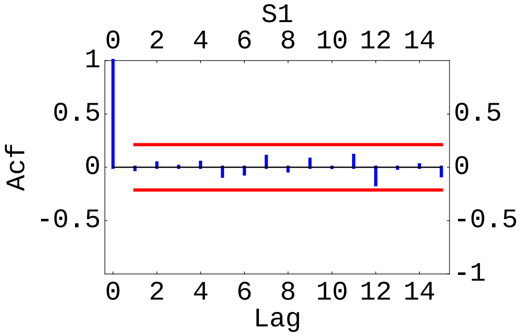
S12



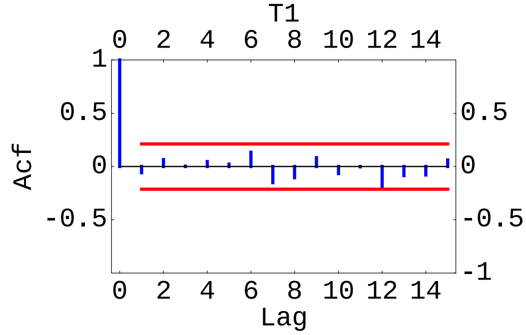
T12



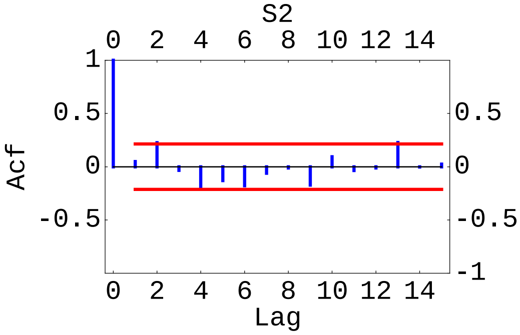
S1



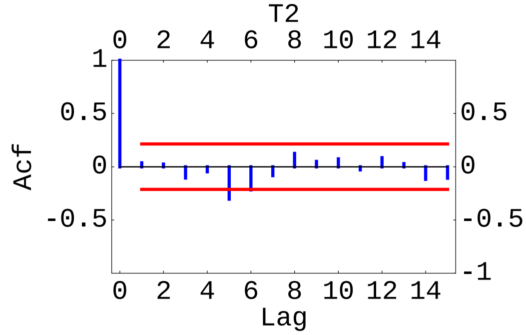
T1



S2

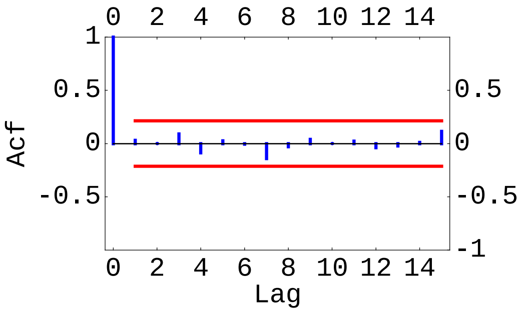


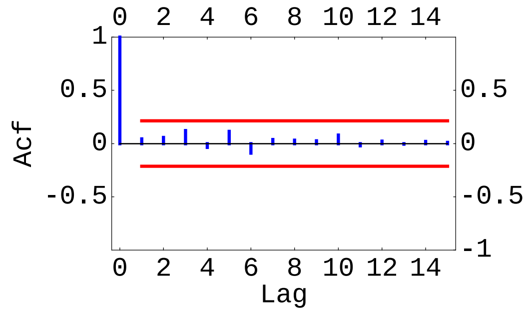
T2



S3

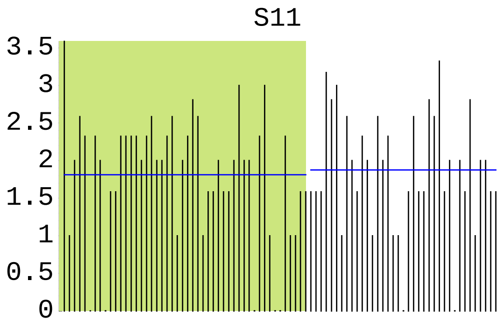
T3

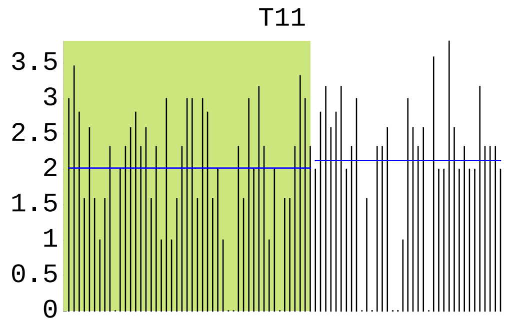


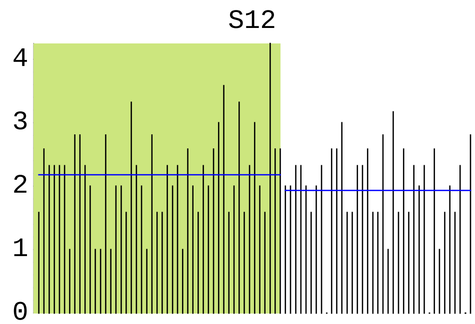


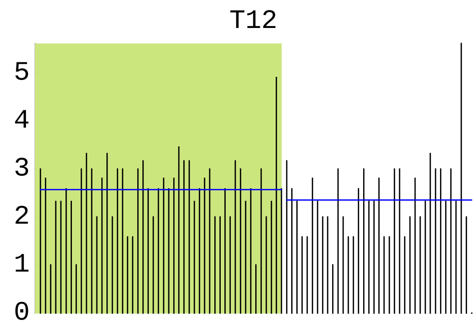
■ Visualization of Logged Data Intervention Analysis

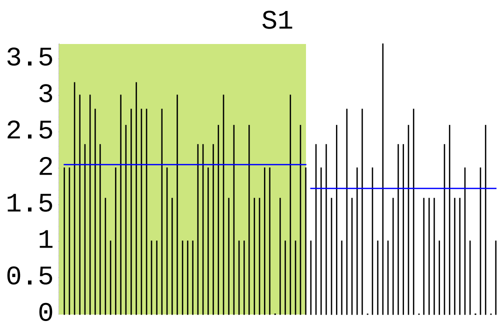
We examine the logarithmically transformed series and the intervention effect on a log scale.

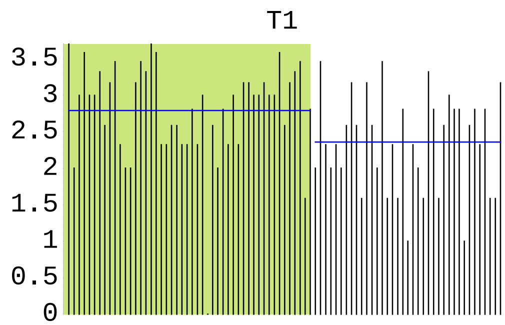

S11
3.5
3
2.5
2
1.5
1
0.5
0

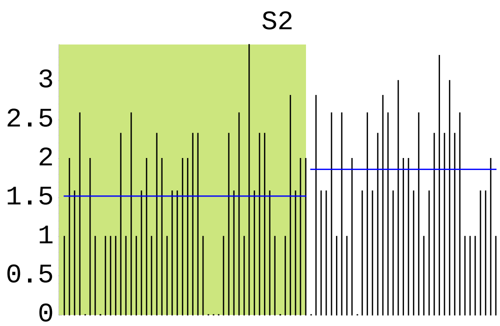

T11
3.5
3
2.5
2
1.5
1
0.5
0

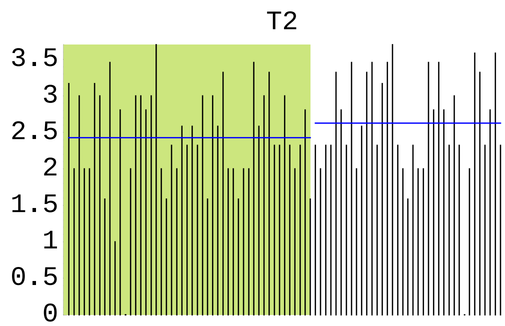

S12
4
3
2
1
0

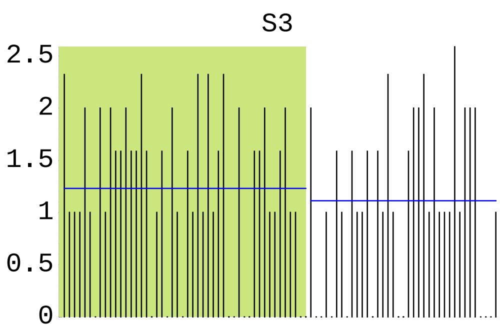

T12
5
4
3
2
1
0

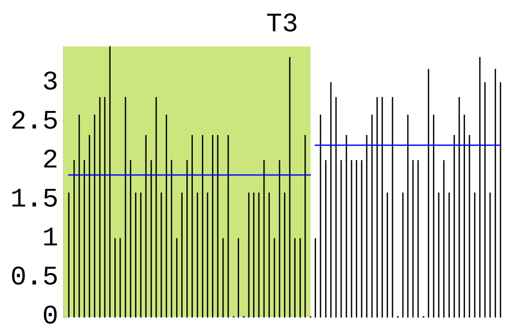

S1
3.5
3
2.5
2
1.5
1
0.5
0


T1
3.5
3
2.5
2
1.5
1
0.5
0


S2
3
2.5
2
1.5
1
0.5
0


T2
3.5
3
2.5
2
1.5
1
0.5
0


S3
2.5
2
1.5
1
0.5
0


T3
3
2.5
2
1.5
1
0.5
0