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RIN MARKET:
price behavior and its forecast

Wyatt Thompson, Seth Meyer, and Pat Westhoff (2010):

“**RIN prices** are analogous to **quota rent** or the price of carbon”

MARKET OF EMISSIONS

RIN MARKET

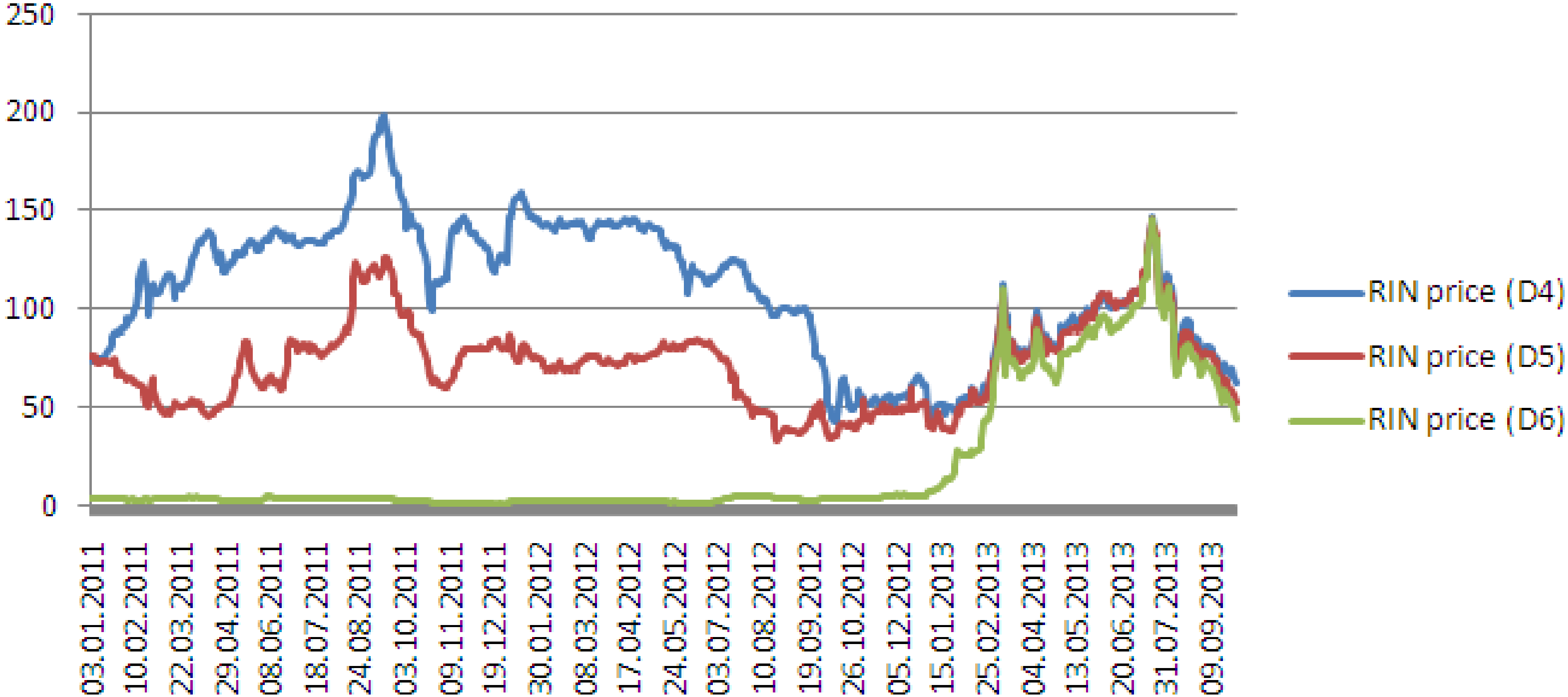
The target is to research the RIN price behavior and to forecast this price.

Outline

1. *RIN price*
2. *Univariate GARCH*
3. *Linear interpolation*
4. *Multivariate GARCH*

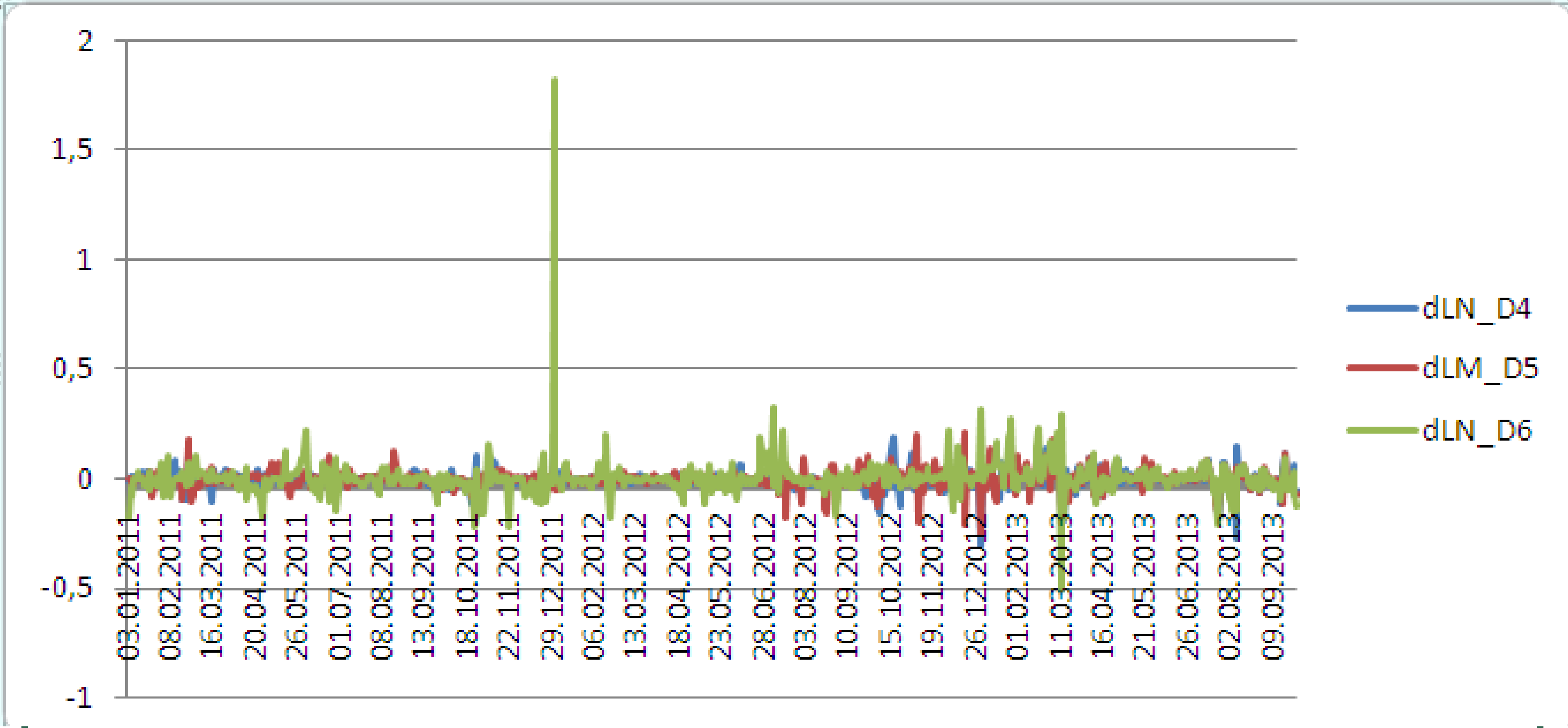
RIN price

3.01.2011 - 30.09.2013



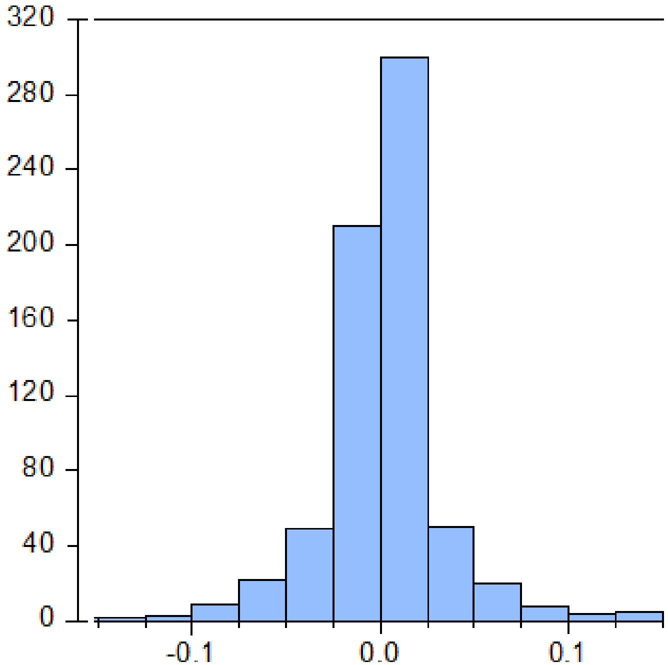
D4 - biomass-based diesel D5 - advanced biofuels D6 - cellulosic biofuels

Returns

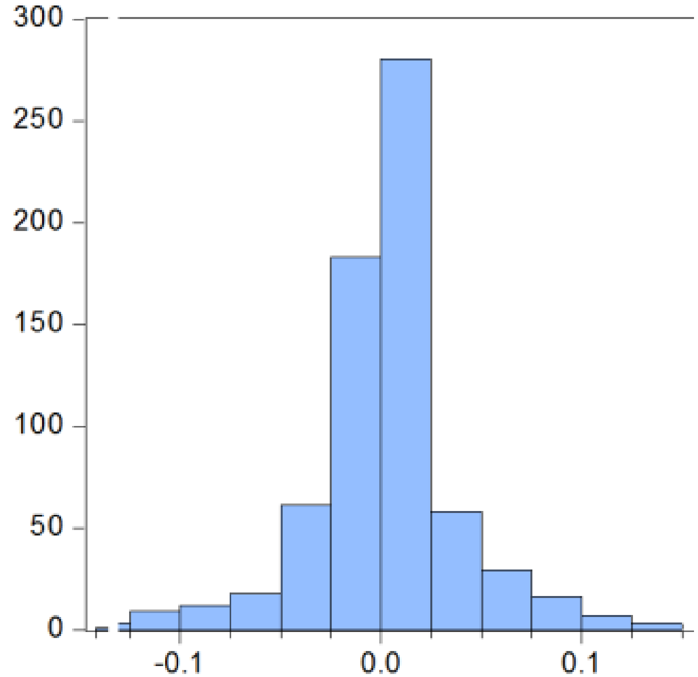


$$r_t = \ln(P_t) - \ln(P_{t-1})$$

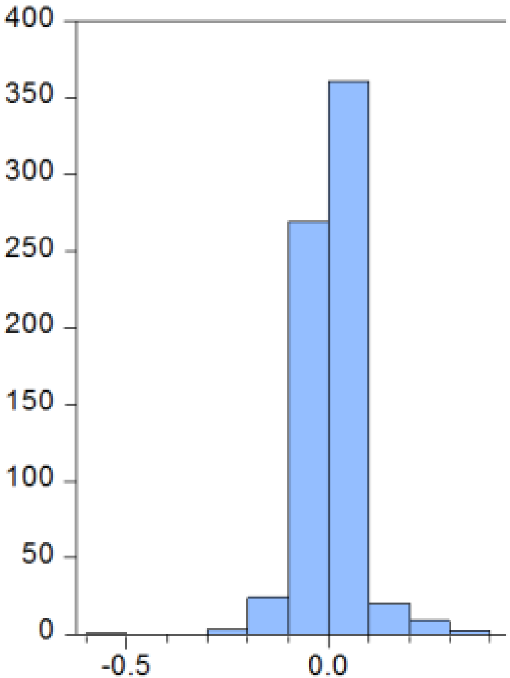
Distribution



dlnD4return



dlnD5return



dlnD6return

Omid Sabbaghi and Navid Sabbaghi (2011) :

- exclude zero returns
- estimate t-GARCH(1,1)

Suppose that the zero return means that maybe at that day it was no trade

ARCH test

Ljung-Box test

$$H_0: a_0 = a_1 = a_2 = \cdots = a_m = 0$$

$$e_t^2 = a_0 + a_1 e_{t-1}^2 + \cdots + a_m e_{t-m}^2 + u_t$$

u_t is a white noise error process

N is the length of the observed time series

g is a number of parameters in a model

$$H_0: p_0 = p_1 = p_2 = \cdots = p_m = 0$$

$$Q(m) = N(N+2) \sum_{h-1}^{m} \frac{p_h^2}{N-h} \in \chi_{m-g}^2$$

m is a number of the first lags of the sample autocorrelation function of the e_t series

m		ARCH-test	Ljung-Box(e)	Ljung-Box(e^2)
5	H	1	1	1
	pValue	3.1969e-04	7.1106e-10	2.6498e-05
	ARCHstat/Qstat	23.1236	51.4150	28.7044
	CriticalValue	11.0705	11.0705	11.0705
10	H	1	1	1
	pValue	1.5027e-04	9.7649e-10	6.9474e-08
	ARCHstat/Qstat	34.5279	62.9997	53.1621
	CriticalValue	18.3070	18.3070	18.3070
15	H	1	1	1
	pValue	0.0024	6.5791e-10	9.4227e-07
	ARCHstat/Qstat	35.0978	74.6389	56.6460
	CriticalValue	24.9958	24.9958	24.9958

Univariate GARCH

$$r_t = \varphi_0 + \varphi_1 r_{t-1} + V_t$$

$$V_t = \sqrt{h_t}u_t \quad u_t \sim t(n)$$

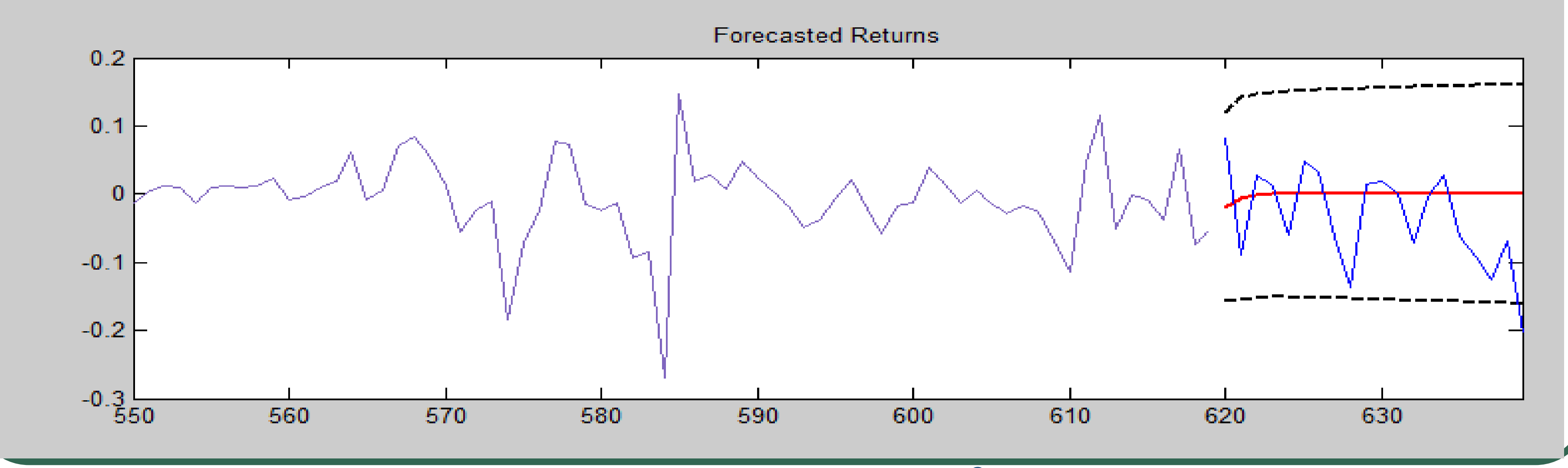
$$h_t = \gamma + \alpha V_{t-1}^2 + \beta h_{t-1}$$

$$r_t = \varphi_0 + \varphi_1 r_{t-1} + \varphi_2 D + V_t$$

$$D = \begin{cases} 1 & if\ t = 190 \\ 0 & otherwise \end{cases}$$

$$V_t = \sqrt{h_t}u_t \quad u_t \sim t(n)$$

$$h_t = \gamma + \alpha V_{t-1}^2 + \beta h_{t-1}$$



Linear interpolation

$$y = y_a + (y_b - y_a)\frac{x - x_a}{x_b - x_a}$$

$$r_t = r_{t-1} + (r_{t+1} - r_{t-1})\frac{t - (t-1)}{(t+1) - (t-1)} = \frac{1}{2}(r_{t+1} + r_{t-1})$$

Quantity of zeros and their percentage

series of returns	before		after	
	number	percentage	number	percentage
D4 RIN	71	10	7	1
D5 RIN	122	18	18	3
D6 RIN	104	15	26	4

Multivariate GARCH

$$r_t = \varphi_0 + \varphi_1 r_{t-1} + \varphi_2 D + V_t$$

$$D = \{d_{it}\}$$

$$d_{3t} = \begin{cases} 1 & if\ t = 252 \\ 0 & otherwise \end{cases}$$

$$u_t = D_t^{-1/2} V_t \qquad u_t \sim t(n)$$

$$R_t = P_t Q_t P_t$$

$$P_t = diag\left(diag(Q_t)^{-\frac{1}{2}}\right) = diag\left(\left[q_{11,t}^{-\frac{1}{2}}, q_{22,t}^{-\frac{1}{2}}, q_{33,t}^{-\frac{1}{2}}\right]\right)$$

$$Q_t = (1 - \delta_1 - \delta_2)S + \delta_1 u_{t-1} u'_{t-1} + \delta_2 Q_{t-1}$$

$$D_t = diag\left(h_t^{\frac{1}{2}}\right)$$

$$h_t = [h_{1t}, h_{2t}, h_{3t}]'$$

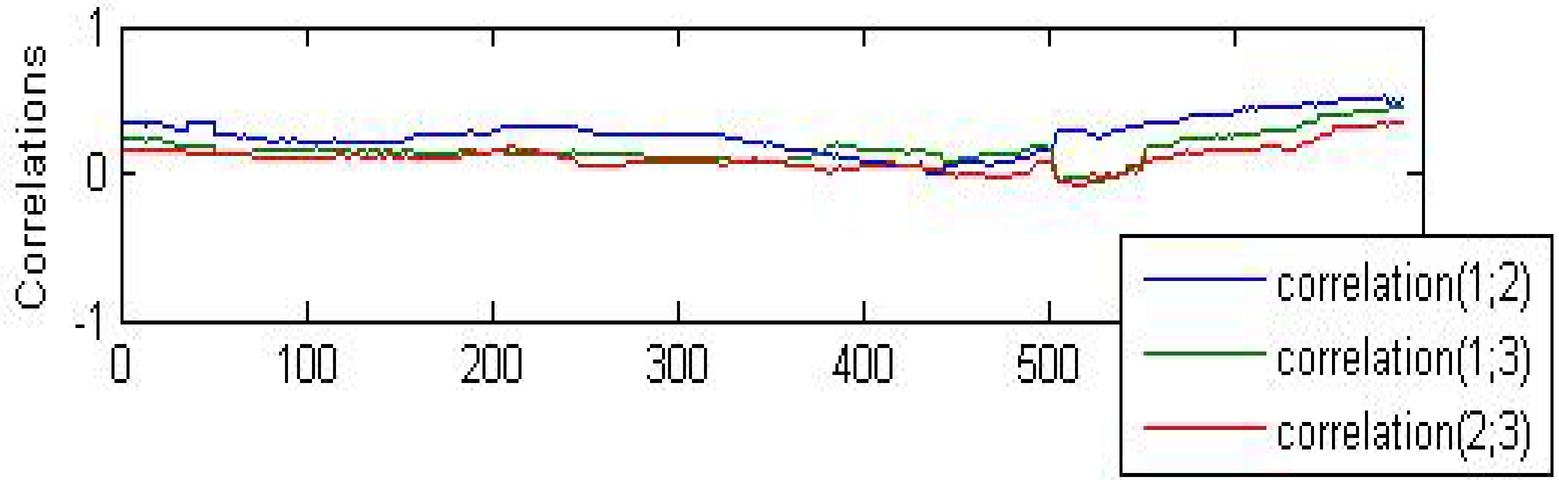
$$h_{i,t} = \gamma + \alpha_i V_{i,t-1}^2 + \beta_i h_{i,t-1}$$

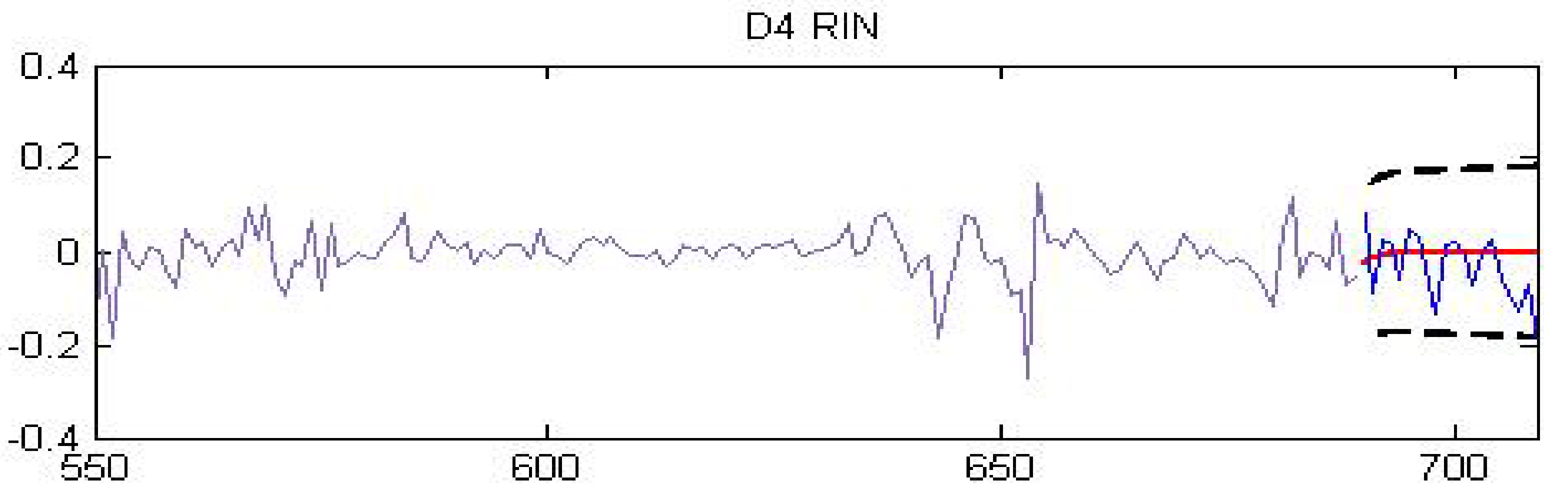
r_t is a $k \times 3$ matrix f returns

V_t is $k \times 3$ matrix of errors

R_t is the correlation matrix

Q_t is an unstandardized correlation matrix


Correlations
1
0
-1
0
100
200
300
400
500
correlation(1;2)
correlation(1;3)
correlation(2;3)


D4 RIN
0.4
0.2
0
-0.2
-0.4
550
600
650
700

Conclusion

1. to estimate separately for the price forecast
2. positive correlation of all RIN series


Thank You !