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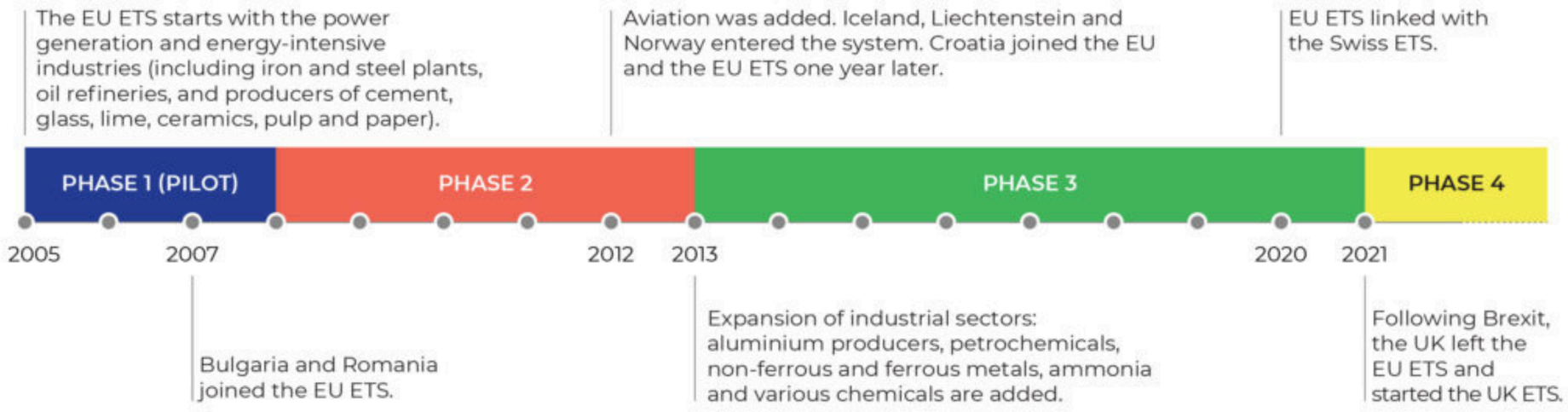
Econometrics Project

EU ETS Spot Volume Modeling and Forecasting

Politecnico di Milano

Table Of Contents

Introduction



The dataset

Main dataset: **EU ETS allowances transactions volumes**

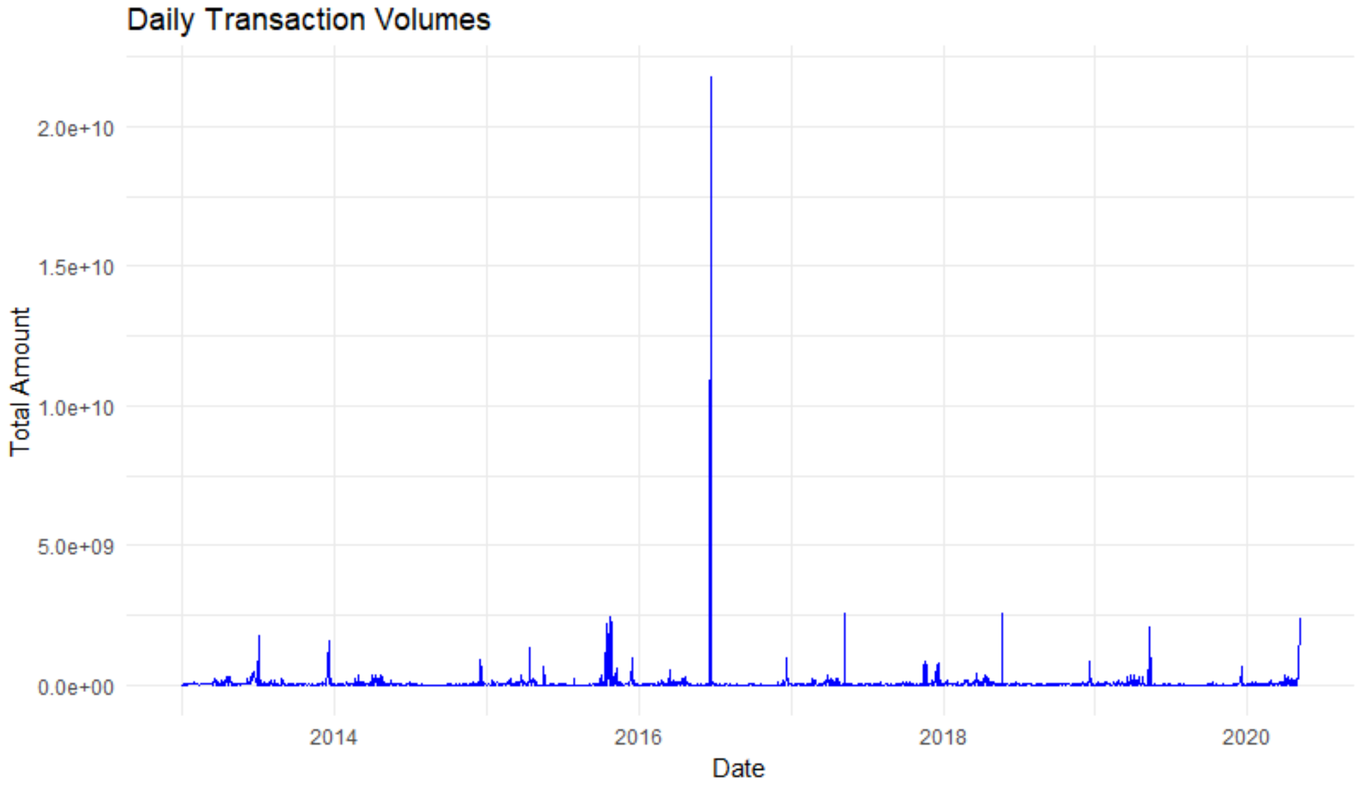
- Daily data from third phase of EU ETS
- In-sample data: from 01-01-2013 to 12-09-2019
- Out-of-sample data: from 13-03-2019 to 05-05-2020

The dataset

Auxiliary datasets:

- Brent oil daily prices
- ICE future daily prices
- Coal daily prices
- VIX index

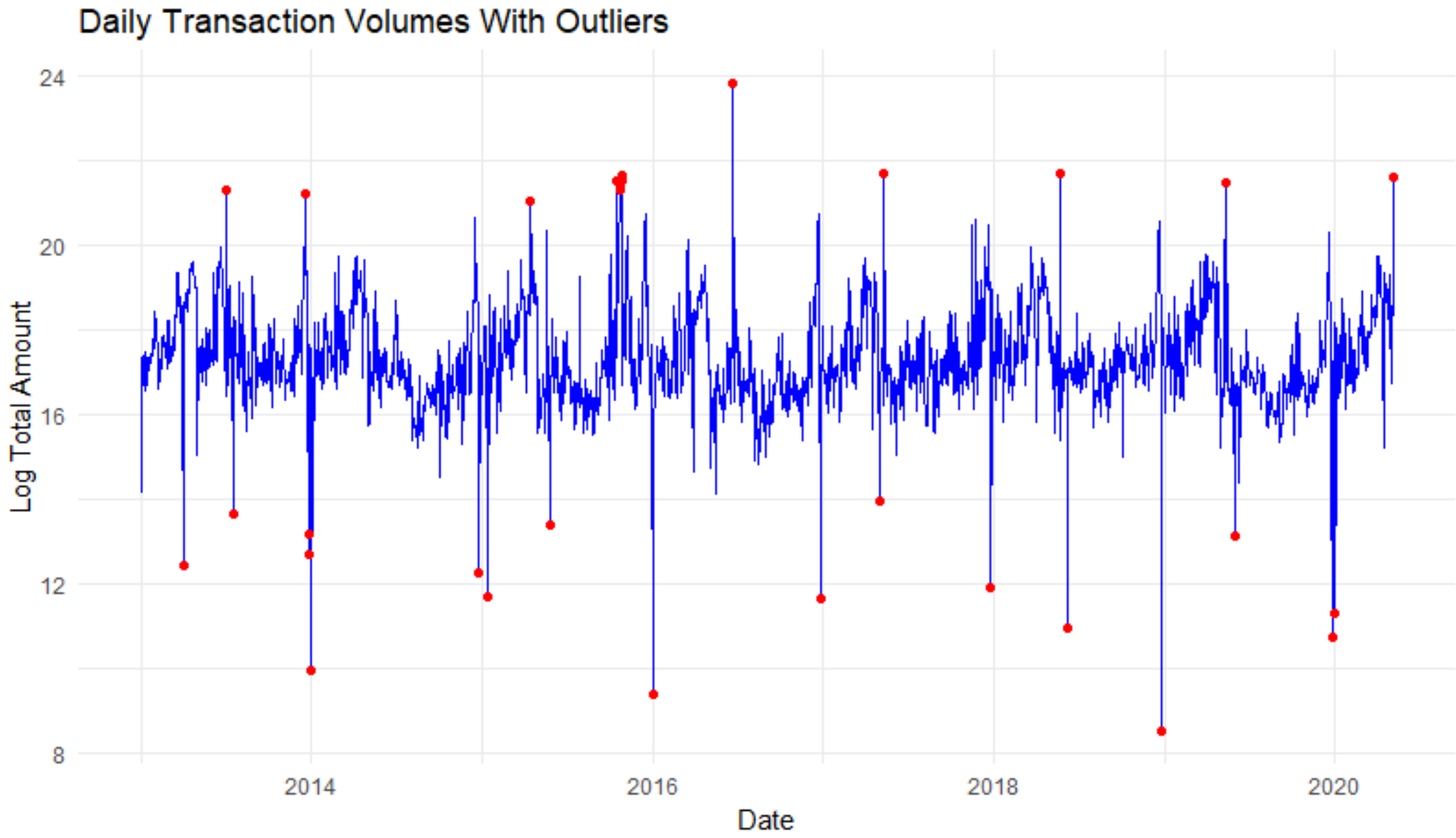
Data cleaning



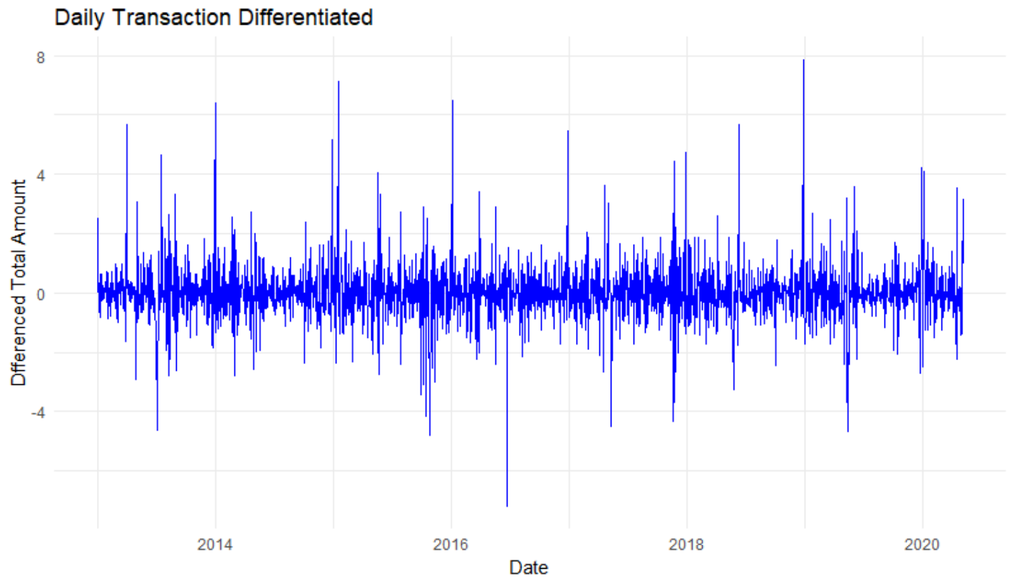
The dataset seems pretty difficult to handle: we do the do followings to obtain better results

- Delete observations relative to the weekends
- Take the logarithm of the data
- Delete observations that are very distant from the mean
- Differentiate once the logarithmic series
- Use an arctan transformation

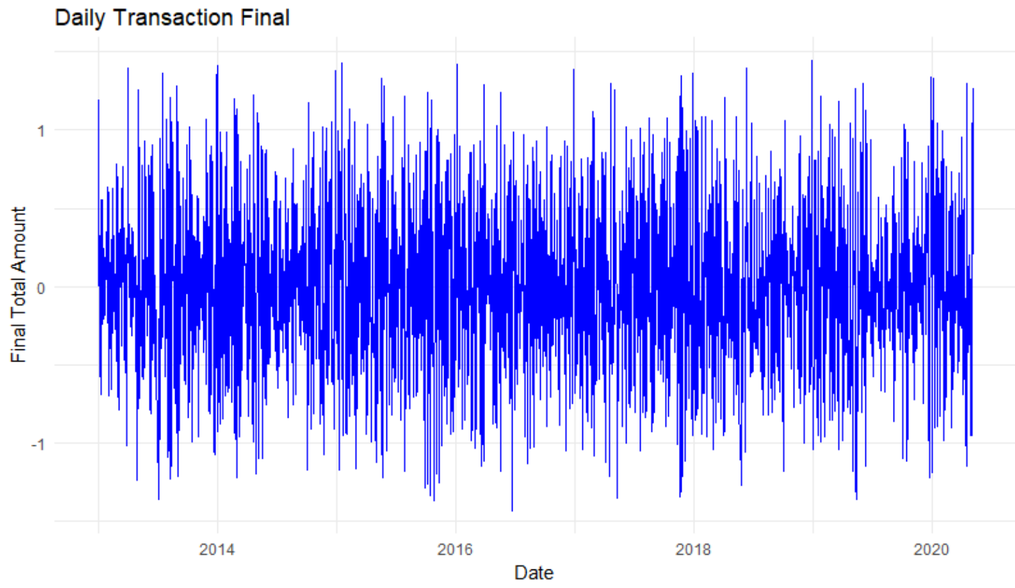
Data cleaning



Data cleaning



Differentiated time series



Final time series

Data cleaning

ADF/KPSS TESTS	**Logarithmic time series**	**Differentiated time series**	**Final time series**
KPSS	0.22	0.03	0.02
ADF	-0.93	-57.80	-60.56

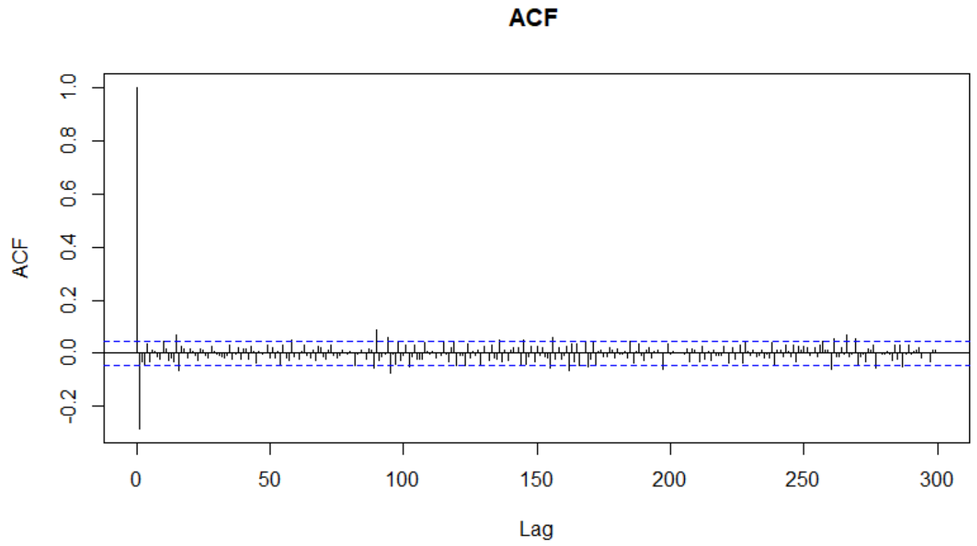
ARCH effect

ARCH LM-test; Null hypothesis: no ARCH effects

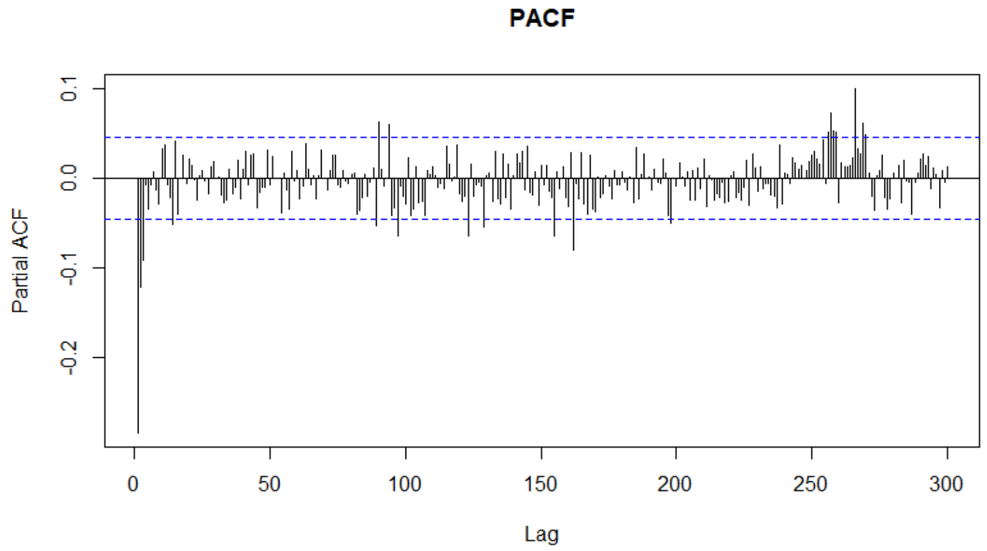
Chi-squared = 39.146, df = 12, p-value = 9.957e-05

We have evidence of ARCH effect

Model selection



Maximum MA order: 1



Maximum AR order: 3

Optimal model selection

Model	k	$\hat{L}$	BIC
AR(0)	3	-1653.0	1.7743
AR(1)	4	-1547.3	1.6656
AR(2)	5	-1509.8	1.6296
AR(3)	6	-1498.9	1.6221
MA(1)	4	-1500.7	1.6159
ARMA(1,1)	5	-1494.4	1.6132
ARMA(2,1)	6	-1494.3	1.6172
ARMA(3,1)	7	-1492.1	1.6189
GARCH(1,1)	5	-1607.0	1.7332
AR(1)-GARCH(1,1)	6	-1511.8	1.6359
AR(2)-GARCH(1,1)	7	-1470.0	1.5953
MA(1)-GARCH(1,1)	7	-1461.30	1.5820
ARMA(1,1)-GARCH(1,1)	7	-1454.1	1.5783
ARMA(2,1)-GARCH(1,1)	8	-1453.5	1.5817
ARMA(3,1)-GARCH(1,1)	9	-1450.6	1.5826

- We compare different model orders and choose the one minimizing the BIC
- The selected model is the ARMA(1,1)-GARCH(1,1) model

Exogenous variables

	A	B	C
μ	0.00797	0.00715	0.00748
	(1.5115)	(1.5273)	(1.5918)
ϕ_1	0.1878***	0.18784***	0.18772***
	(3.8754)	(4.1207)	(4.1086)
θ_1	-0.62732***	-0.63334***	-0.63277***
	(-16.7109)	(-19.7662)	(-19.5837)
α_0	0.03508***	0.0341**	0.03392**
	(2.8485)	(2.4525)	(2.4725)
α_1	0.12911***	0.12696***	0.12854***
	(4.7835)	(4.5189)	(4.5959)
β_1	0.75122***	0.7561***	0.75568***
	(12.2784)	(10.9682)	(11.0859)
γ_1		-0.00515	
		(-0.2094)	
γ_2		-0.00556	
		(-0.5802)	
γ_3		0.00388	
		(0.7524)	
γ_4		1.13573*	1.18295*
		(1.6942)	(1.7538)

A = ARMA(1,1) - GARCH(1,1)

B = ARMAX(1,1,4) - GARCH(1,1)

C = ARMAX(1,1,1) - GARCH(1,1)

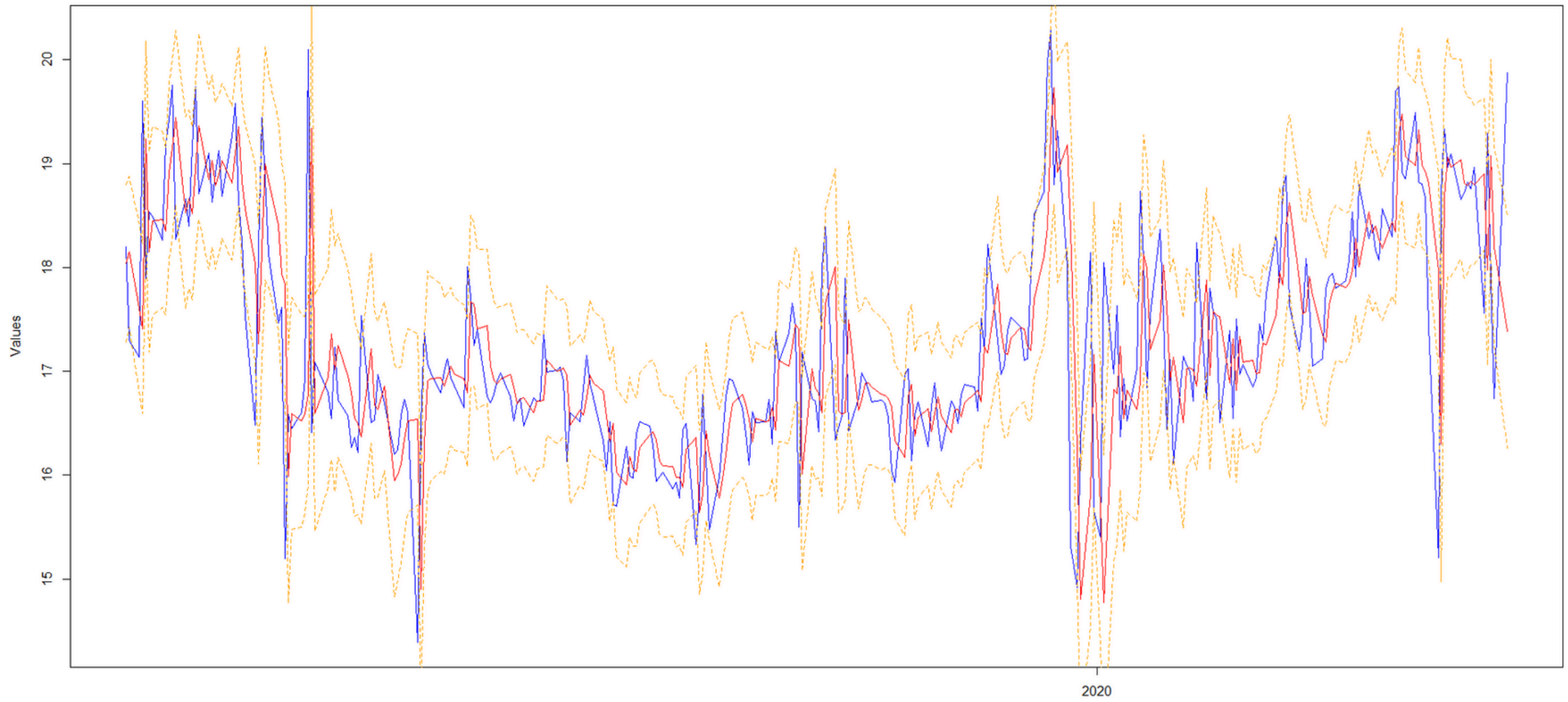
γ_1=future daily price differences

γ_2=Brent oil daily price differences

γ_3=VIX daily differences

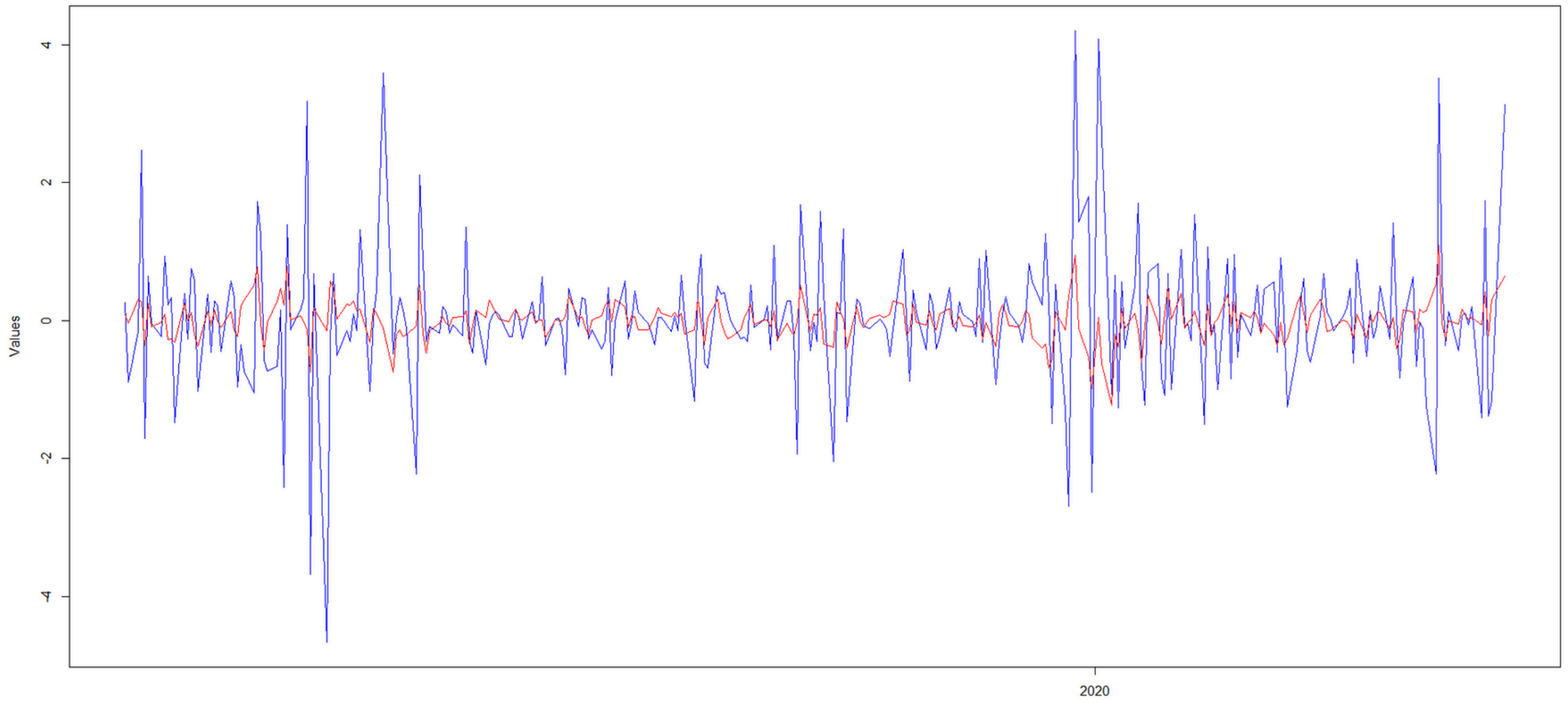
γ_4=coal daily price differences

Forecasting



Real data and predicted data with their 90% confidence interval

Forecasting



Real data and predicted daily differences

Forecasting metrics results

Set	MAPE	Pct	MAE	MSE
Volume	77.72%	63.17%	34509452	5.539e+15
Log Volume	3.08%	63.17%	0.534	0.635

Table 4: Performance metrics for the volume time series and the log-volume time series

Conclusions

- Our model performance seems good but is not able to perform well in different scenarios, especially if there are peaks in log scale differences

- Although the same parametric model class used in previous literature to predict EU ETS prices seems to work for volumes, the same cannot be said for the exogenous variables, which don’t seem to be highly significant in our case

Bibliography

[1] Christiansen, A.C., A. Arvanitakis, K. Tangen, and H. Hasselknippe (2005). ”Price determinants in the EU emissions trading scheme”. In: Climate Policy 5.1, pp. 15–30.

[2] Mansanet-Bataller, M., A. Pardo, and E. Valor (2007). ”CO2 Prices, Energy andWeather”.
In: The Energy Journal 28.3, pp. 73–92.

[3] Paolella, M.S. and L. Taschini (2008). ”An econometric analysis of emission allowance prices”. In: Journal of Banking Finance 32.10, pp. 2022–2032.

[4] Ljungqvist, Palmqvist (2013). ”Price and Volatility Prediction in the EU ETS Market”