Time Series Analysis

Basics of Time Series Analysis: Data Example

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Bitcoin Price: Trend Analysis

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About This Lesson

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Trend Estimation: Bitcoin Price

```
# Trend Estimation for original time series
library(mgcv)
time.pts <- c(1:length(mydates))
time.pts <- c(time.pts - min(time.pts))/max(time.pts)
# Local Polynomial Trend Estimation
loc.fit <- loess(pricebtc~time.pts)
loc.tsbtc <- xts(fitted(loc.fit),mydates)
# Splines Trend Estimation
gam.fit <- gam(pricebtc~s(time.pts))
fit.tsbtc <- xts(fitted(gam.fit),mydates)

# Display BTC data & fitted trend
plot(tsbtc,main='BTC-USD')
lines(fit.tsbtc,lwd=2,col="red")
lines(loc.tsbtc,lwd=2,col="brown")
```

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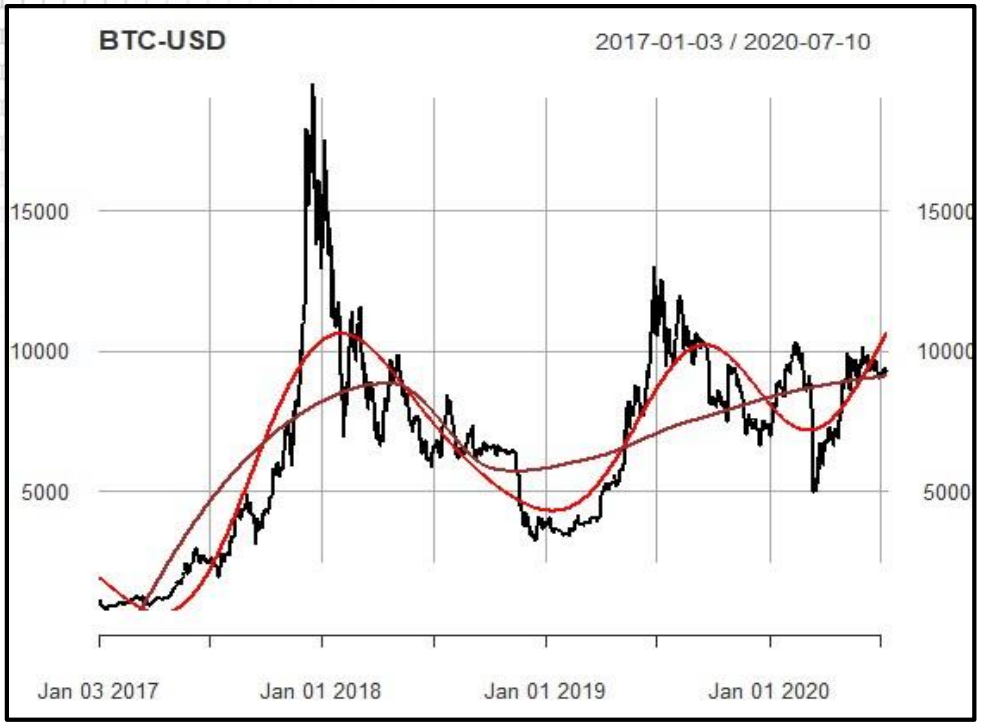
Trend Estimation: Bitcoin Price



The splines regression captures the non-linear trend better than polynomial smoothing.

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Volatility Estimation: Log Difference Data

```
# Volatility Estimation for the log-difference time series
diff.ts.sq <- diff.ts^2
gam.fit.dif.sq <- gam(diff.ts.sq~s(time.pts[-1]))
summary(gam.fit.dif.sq)
difprice.fit.gam <- fitted(gam.fit.dif)
fit.tsbtc.dif <- xts(difprice.fit.gam,mydates[-1])

# Display BTC log diff data squared & estimated volatility
plot(dlbtc^2,main='BTC-USD - Log Difference Squared',ylim=c(0,0.06))
lines(fit.tsbtc.dif,lwd=2,col="purple")
```

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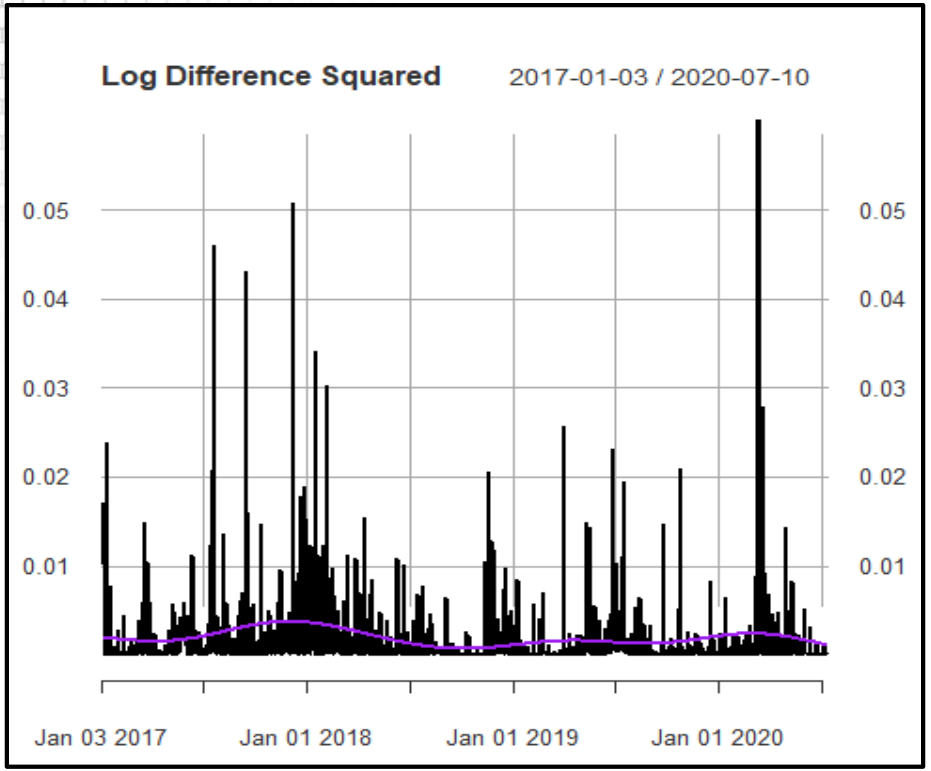
Trend Estimation: Log Difference Data



There are periods of high volatility, for example, around the time when the Covid-19 crisis hit.

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Is there seasonality in bitcoin price?

```
# Trend & Seasonality Estimation for original time series
month = as.factor(format(mydates,"%b"))
gam.fit.seastr.1 = gam(pricebtc~s(time.pts)+month)
summary(gam.fit.seastr.1)
fitseastr.tsbtc=xts(fitted(gam.fit.seastr.1),mydates)

# Display BTC data & fitted trend
plot(tsbtc,main='BTC-USD')
lines(fit.tsbtc,lwd=2,col="red")
lines(fitseastr.tsbtc,lwd=2,col="blue")
```

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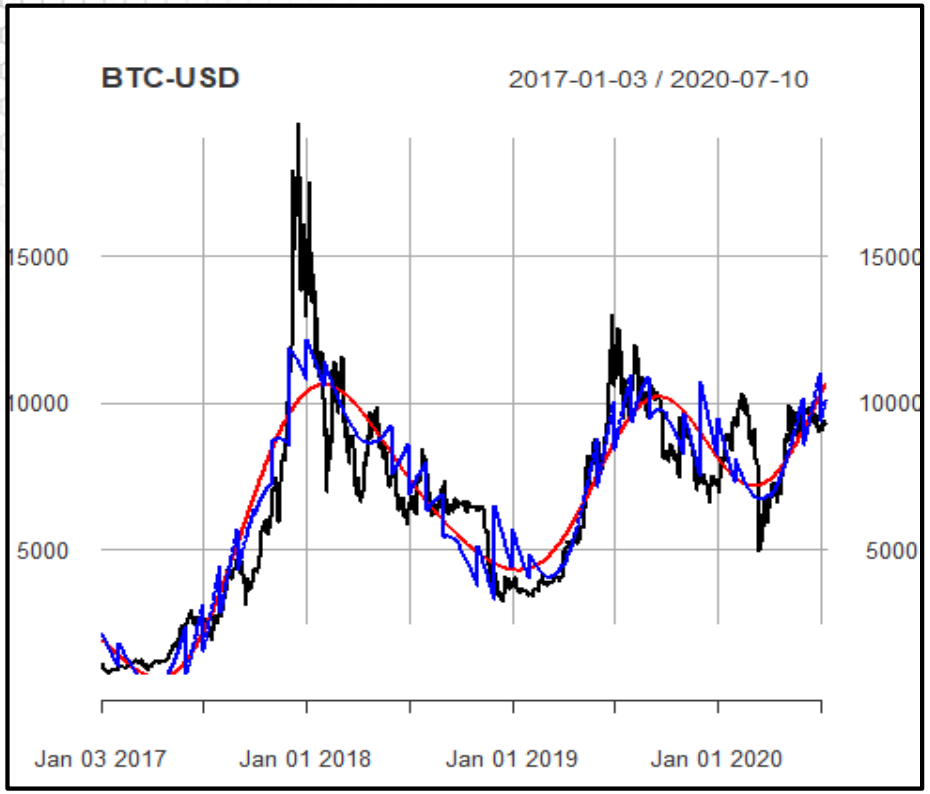
Seasonality-Trend Fit



The seasonality-trend fit does not improve the fit

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Is there seasonality in bitcoin price? (cont'd)

```
             Estimate Std. Error t value Pr(>|t|)
(Intercept)  8983.119    316.928  28.344  < 2e-16 ***
monthAug    -5134.697    594.228  -8.641  < 2e-16 ***
monthDec    -2076.101    562.765  -3.689 0.000235 ***
monthFeb      175.596    341.353   0.514 0.607055
monthJan     -686.117    456.271  -1.504 0.132896
monthJul    -3456.104    480.353  -7.195 1.07e-12 ***
monthJun    -1717.843    359.092  -4.784 1.92e-06 ***
monthMar      132.447    234.800   0.564 0.572797
monthMay       -2.937    238.603  -0.012 0.990181
monthNov    -5369.489    643.311  -8.347  < 2e-16 ***
monthOct    -6776.517    679.619  -9.971  < 2e-16 ***
monthSep    -6587.166    663.760  -9.924  < 2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.'

Approximate significance of smooth terms:
              edf Ref.df     F p-value
s(time.pts) 8.981      9 593.9  <2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.'

R-sq.(adj) =  0.819   Deviance explained = 82.2%
GCV = 2.1048e+06  Scale est. = 2.0705e+06  n = 1285
```

Some seasonality effects are statistically significant given the nonparametric trend included in the model

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Findings

- There is a nonlinear trend in the Bitcoin price over the past few years
- The differencing of the log-time series is stationary, with time-varying volatility
- There seems to be a statistically significant seasonality in the Bitcoin price, however the trend and seasonality fit together does not seem to fit the observed variations in the price

Summary

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