Variance comparison

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```
library(changepoint)
```

```
## Loading required package: zoo
```

```
##
## Attaching package: 'zoo'
```

```
## The following objects are masked from 'package:base':
##
##     as.Date, as.Date.numeric
```

```
## Successfully loaded changepoint package version 2.2.2
##  NOTE: Predefined penalty values changed in version 2.2.  Previous penalty values with a postfix 1 i
```

```
library(zoo)
library(tseries)
library(dplyr)
```

```
##
## Attaching package: 'dplyr'
```

```
## The following objects are masked from 'package:stats':
##
##     filter, lag
```

```
## The following objects are masked from 'package:base':
##
##     intersect, setdiff, setequal, union
```

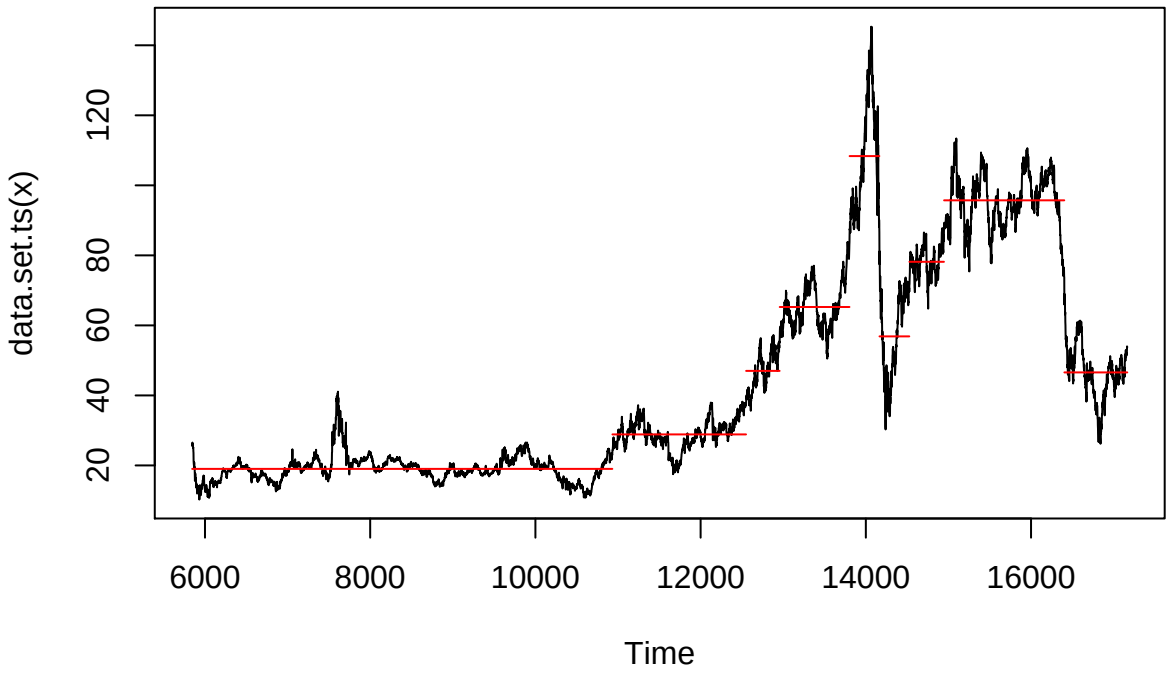
```
library(ggplot2)
library(knitr)

load("wti_project.Rda")
```

```
cpt.1 = cpt.mean(wti.ts, method="PELT", penalty = "Manual", pen.value = 10000, minseglen = 250)

#cpt.1 = cpt.mean(wti.ts, method="PELT", penalty = "SIC", minseglen = 250)

#length(cpt.1@cpts)
plot(cpt.1)
```



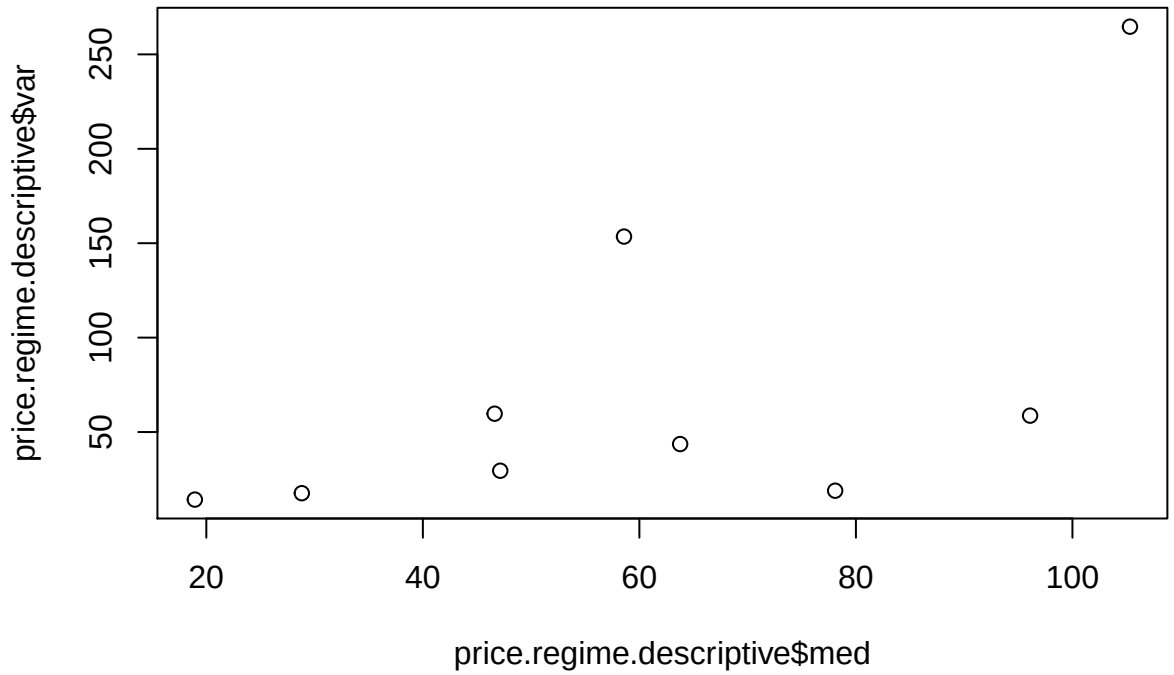

```
regimes <- cpt.1@cpts
regime.index <- NULL

for (i in 1:length(regimes)){
  ifelse(i == 1,
         regime.index.iter <- rep.int(i, times = length(1:regimes[i])),
         regime.index.iter <- rep.int(i, times = length((regimes[i-1]+1):regimes[i])))
  regime.index <- c(regime.index, regime.index.iter)
}

wti.regimes <- cbind(wti.ts, regime.index) %>% as.data.frame()
colnames(wti.regimes) <- c("close", "regime")
wti.regimes$regime <- as.factor(wti.regimes$regime)
```

```
price.regime.descriptive <- wti.regimes %>%
  group_by(regime) %>%
  summarize(med = median(close), var = var(close))

plot(x = price.regime.descriptive$med, y = price.regime.descriptive$var, type = "p")
```




```
summary(lm(var ~ med, data = price.regime.descriptive))
```

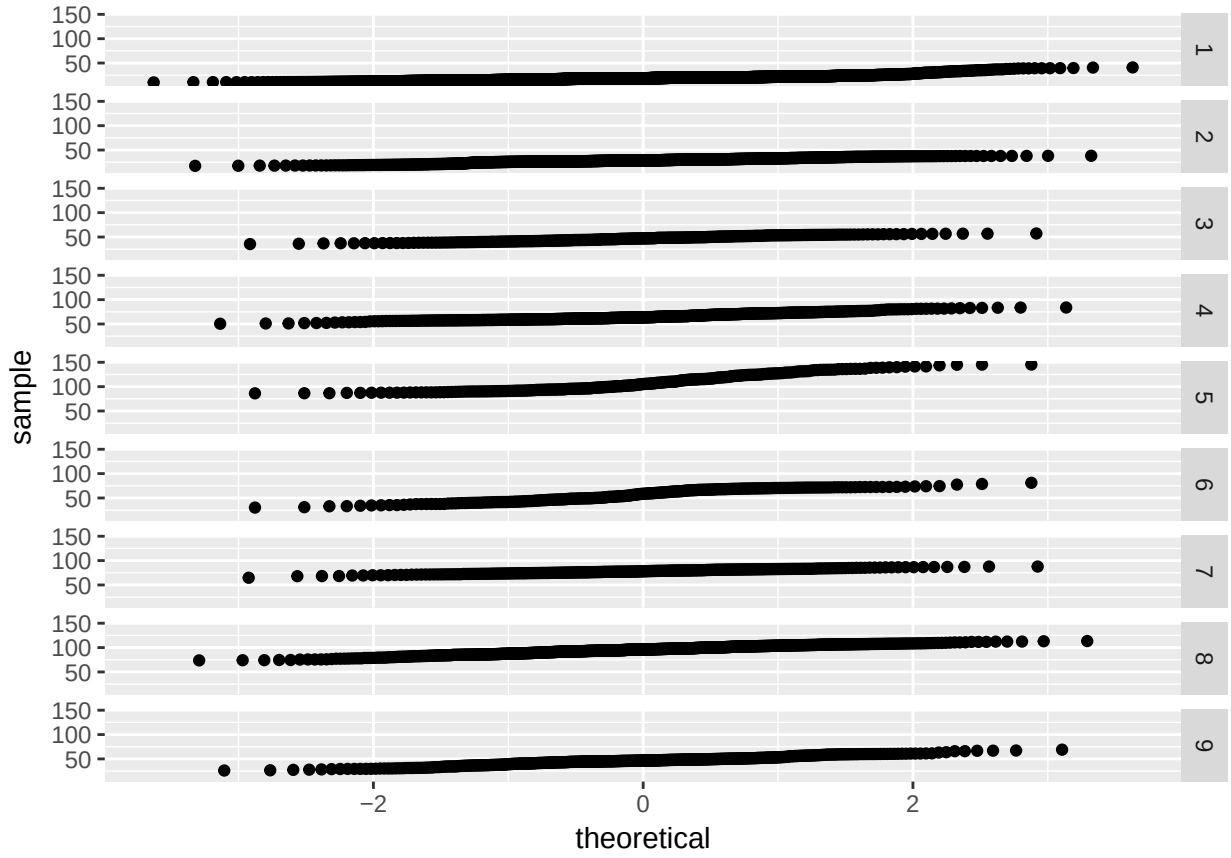
```
##
## Call:
## lm(formula = var ~ med, data = price.regime.descriptive)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -85.760 -35.751  -0.006  14.071 111.861
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept) -33.3214    57.1329  -0.583   0.5780
## med           1.7674     0.8623   2.050   0.0796 .
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 70.58 on 7 degrees of freedom
## Multiple R-squared:  0.375,  Adjusted R-squared:  0.2858
## F-statistic: 4.201 on 1 and 7 DF,  p-value: 0.07958
```

```
kable(price.regime.descriptive)
```

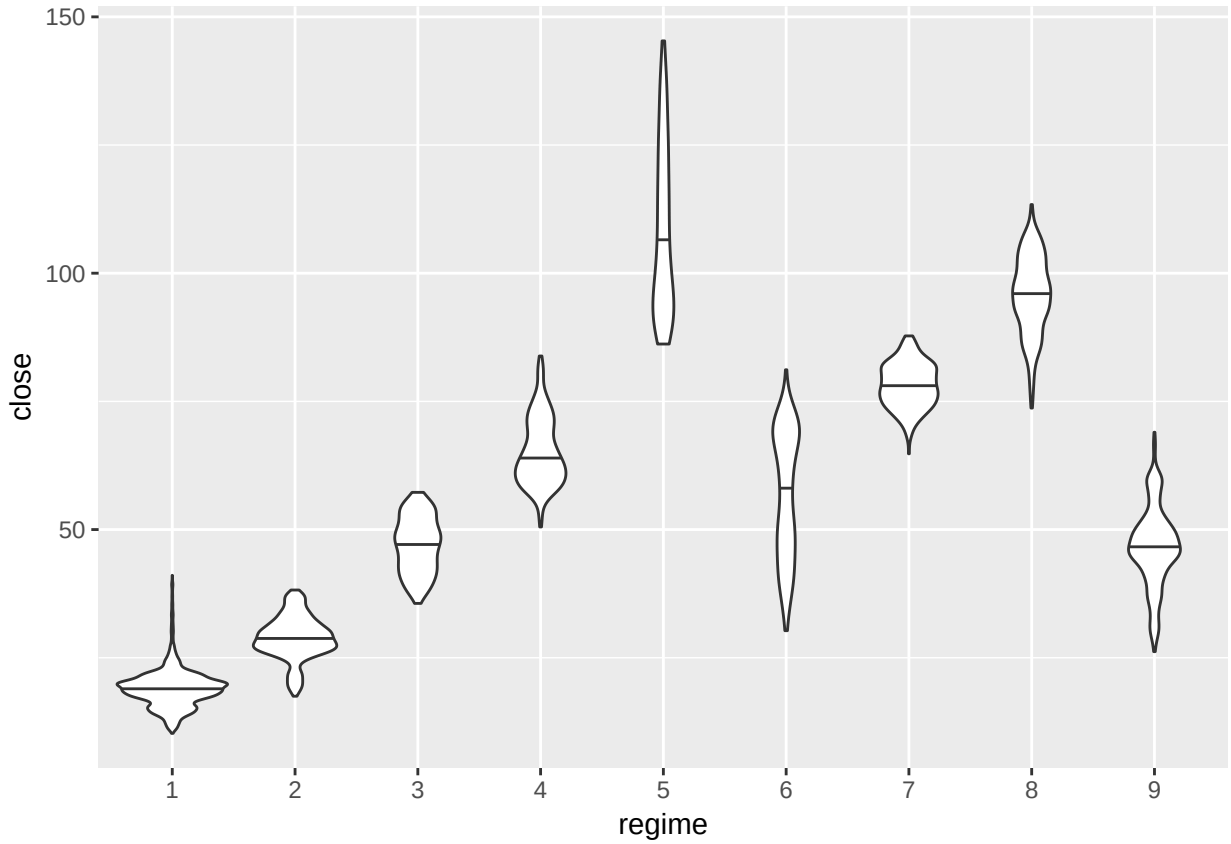
regime	med	var
1	18.940	14.22440
2	28.820	17.61040
3	47.150	29.50349
4	63.765	43.62747
5	105.315	264.67635
6	58.580	153.52032
7	78.085	18.92845
8	96.090	58.67639

regime	med	var
9	46.630	59.71733

```
ggplot(wti.regimes, aes(sample = close)) + stat_qq() + facet_grid(regime ~ .)
```




```
ggplot(wti.regimes, aes(x = regime, y = close)) + geom_violin(draw_quantiles = 0.5) #+ geom_boxplot()
```



https://en.wikipedia.org/wiki/F-test_of_equality_of_variances

```
wti.regimes.ret <-  cbind(wti.regimes[31:nrow(wti.regimes),], wti.df$return)
colnames(wti.regimes.ret) <- c("close", "regime", "returns")

barlets.test.price <- bartlett.test(x = wti.regimes$close, g = wti.regimes$regime)
barlets.test.price
```

```
##
##  Bartlett test of homogeneity of variances
##
## data:  wti.regimes$close and wti.regimes$regime
## Bartlett's K-squared = 3164, df = 8, p-value < 2.2e-16
```

```
barlets.test.return <- bartlett.test(x = wti.regimes.ret$returns, g = wti.regimes.ret$regime, na.action
barlets.test.return
```

```
##
##  Bartlett test of homogeneity of variances
##
## data:  wti.regimes.ret$returns and wti.regimes.ret$regime
## Bartlett's K-squared = 844.89, df = 8, p-value < 2.2e-16
```

The Fligner Killeen test is a non-parametric test for homogeneity of group variances. This test indicates that the variances are indeed different scross the 9 regimes.

```
fligner.test(x = wti.regimes$close, g = wti.regimes$regime)
```

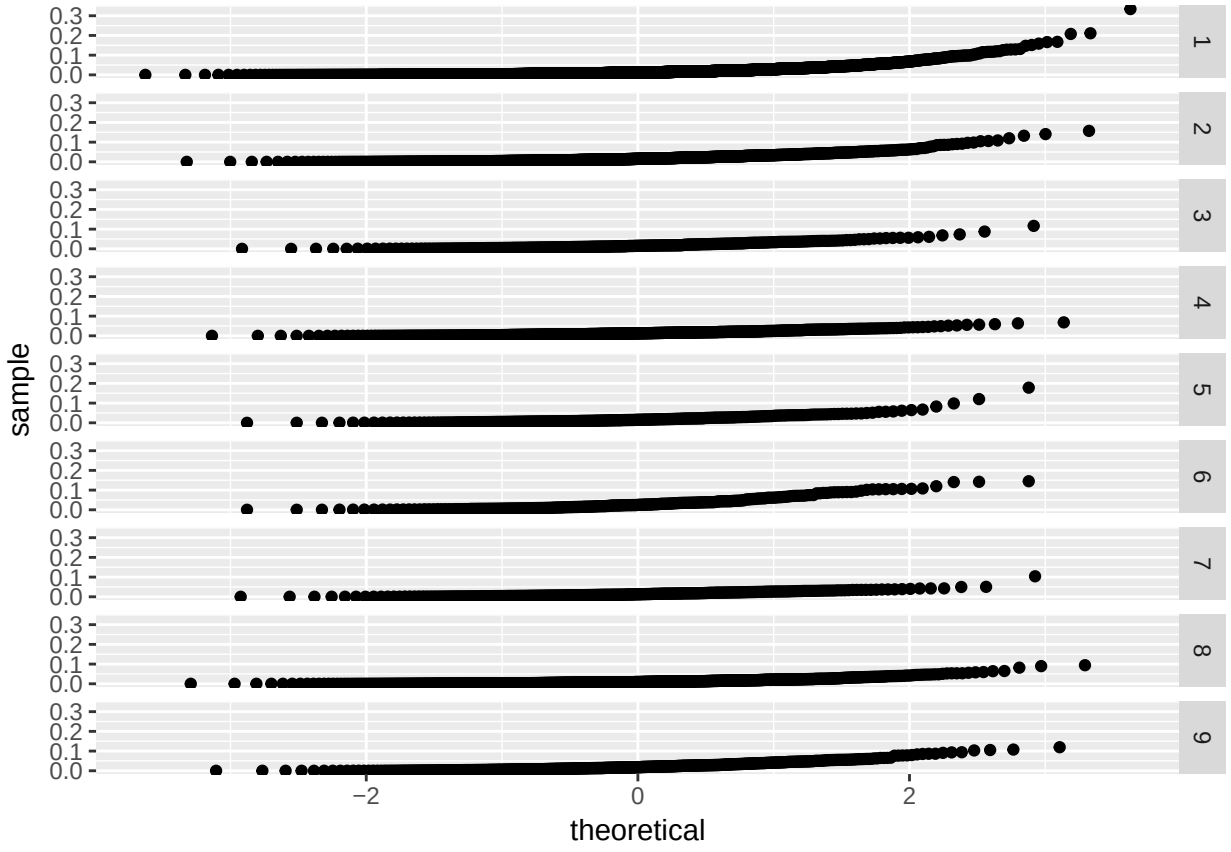
```
##
##  Fligner-Killeen test of homogeneity of variances
```

```
##
## data:  wti.regimes$close and wti.regimes$regime
## Fligner-Killeen:med chi-squared = 2193.9, df = 8, p-value <
## 2.2e-16
```

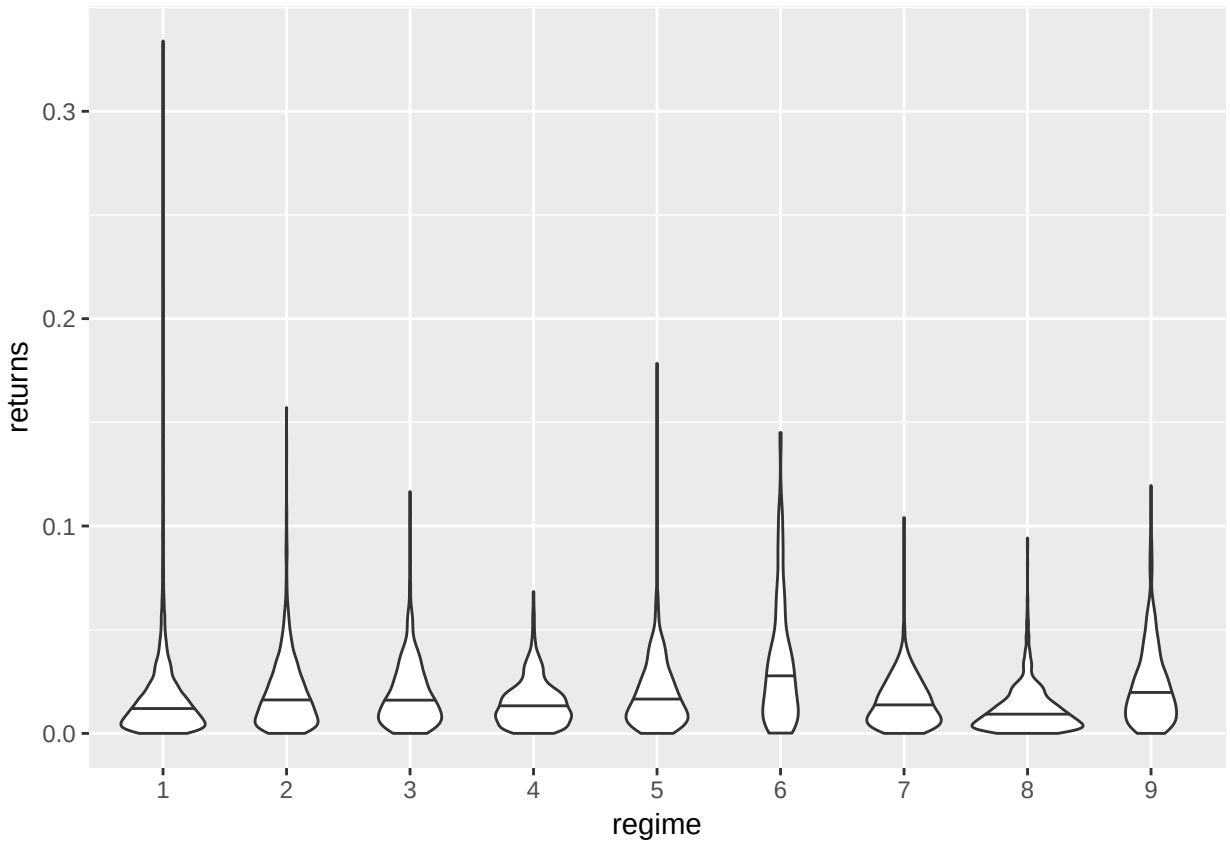
```
fligner.test(x = wti.regimes.ret$returns, g = wti.regimes.ret$regime, na.action =  na.omit)
```

```
##
##  Fligner-Killeen test of homogeneity of variances
##
## data:  wti.regimes.ret$returns and wti.regimes.ret$regime
## Fligner-Killeen:med chi-squared = 416.43, df = 8, p-value <
## 2.2e-16
```

```
ggplot(wti.regimes.ret, aes(sample = returns)) + stat_qq() + facet_grid(regime ~ .)
```




```
ggplot(wti.regimes.ret, aes(x = regime, y = returns)) + geom_violin(draw_quantiles = 0.5) #+ geom_boxpl
```


0.3
0.2
0.1
0.0
returns
1
2
3
4
5
6
7
8
9
regime