Software testing of the **eventstudies** package in R

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1 Introduction

An event study analysis measures the impact of firm-specific and economy-wide events on the value of a firm or on the economy. The package consists of various estimation models such as market model, augmented market model, excess returns model, and constant mean returns model. These models are used to estimate stock price abnormal returns. In the following sections, we test the **eventstudies** package by replicating the standard event study approach applied on daily financial returns data in Doron and Gregory (2014) and Chen and Siems (2004).

2 Replication I: Effect of terrorism on global capital markets

Chen and Siems (2004) apply standard event study approach to assess the effects of terrorism on global capital markets. This section explains how eventstudies package replicates the study for the sample of 33 global capital markets. The response of the global capital markets to the September 11, 2001 terrorist attack is evaluated using the package. The event study approach applied by the authors uses constant mean returns model to estimate abnormal returns. The *constantMeanReturns* model from the package is used to reproduce the abnormal returns. To replicate 11-day CAR for the event, the window is set at 10. The estimation period starts 30 days prior to the event i.e. -30:-11. Due to different time zones across the global markets analysed, each market is analysed separately using the package functions.

```
                                        # For each market with
                                        # different time zones
library(eventstudies)

## Loading required package:  zoo

##
## Attaching package:  'zoo'

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

## Loading required package:  xts
```

```r
data(TerrorIndiceReturns)
data(TerrorAttack)
```

The `TerrorIndiceReturns` object is a *zoo* object which is a time series of daily returns on global capital market indices. These are measured in per cent, i.e. a value of +4 is returns of +4%. Each column in the zoo object refers to returns from a specific market. The column names in the zoo object refer to the names of the global markets.

The `TerrorAttack` is a *dataframe* with two columns. The first column is the name of the capital market affected by the terrorist attack. The second column is the event date, which varies for different capital markets due to varying time zones.

```r
TerrorIndiceCAR <- lapply(1: ncol(TerrorIndiceReturns), function(x){

                                        # 10-day window around the event
     event <- phys2eventtime(na.omit(TerrorIndiceReturns[ , x,
                                                          drop = FALSE]),
                             TerrorAttack,
                             10)

                                        # Estimate ARs
     esMean <- constantMeanReturn(event$z.e[which(attributes(event$z.e)$index
                                                  %in% -30:-11), ],
                                  residual = FALSE)
     ar <- event$z.e - esMean
     ar <- window(ar, start = 0, end = 10)

                                        # CAR
     car <- remap.cumsum(ar, base = as.numeric(ar[1, 1]))
     names(car) <- colnames(TerrorIndiceReturns[ , x,
                                                 drop = FALSE])
     return(car)
 })
names(TerrorIndiceCAR) <- colnames(TerrorIndiceReturns)

                                        # Compile for all indices
TerrorIndiceCAR <- do.call(cbind, TerrorIndiceCAR)

                                        # 11-day CAR
TerrorIndiceCAR[11, ]
```

```
##        S.P500       Dow      NYSE    NASDAQ   Toronto    Mexico    London
## 10 -3.832794 -7.897366 -3.981837 -9.993519 -9.110412 -6.53973 -8.602633
##       Germany Eurostoxx50    France     Spain Switzerland   Austria     Italy
## 10 -10.45718   -7.596024 -9.518721 -10.6724   -7.292201 -7.894399 -15.21462
##       Belgium Amsterdam Portugal  Helsinki    Norway    Sweden     Tokyo
## 10 -9.219016 -10.82756 1.698079 -5.500048 -12.39281 -4.691903 -3.603373
##      HongKong   S.Korea     India   Jakarta Singapore Kualalampur Australia
```

```
## 10 -5.231521 -16.64571 -17.02777 -9.933654 -17.98219   -14.55417 -8.597988
##          NZL  Pakistan     Saudi    Israel     Jberg
## 10 -5.635766 -12.42189 -11.32466 -7.81159 -12.59022
                                        # 6-day CAR
TerrorIndiceCAR[6, ]
## 	S.P500       Dow      NYSE    NASDAQ  Toronto    Mexico    London   Germany
## 5 -7.72379 -10.56695 -8.094739 -10.13781 -7.01292 -13.17444 -4.533527 -8.063819
##   Eurostoxx50    France     Spain Switzerland   Austria     Italy   Belgium
## 5   -5.940704 -8.707865 -9.426443   -5.967055 -4.428614 -13.98185 -8.510382
##   Amsterdam  Portugal  Helsinki    Norway   Sweden      Tokyo  HongKong
## 5 -8.521101 -6.875878 -4.802975 -9.894391 -4.96208 -0.5636291 -5.570385
##     S.Korea     India   Jakarta Singapore Kualalampur Australia       NZL
## 5 -11.81901 -11.77841 -4.91951 -13.74157   -10.50214 -6.814062 -7.101218
##   Pakistan     Saudi    Israel     Jberg
## 5 -10.3741 -5.320904 -11.03399 -12.09548
```

In the above example, `TerrorIndiceCAR` gives the CAR and for all the 33 global markets analysed. As the results reported in Table 2 on Page No. 358 in Chen and Siems (2004), we report the 11-day CAR and 6-day CAR. The window can be adjusted to compute CAR at other frequencies as well.

3 Replication II: Market response to earnings' announcements

Doron and Gregory (2014) examine the reaction of 670 firms around their earnings announcements. The firms belong to the service and technology sector. In the exercise, they define 'surprise' as unexpected deviation of the realised earnings from the forecast. According to the 'surprise' variable, authors categorise firms into – good (higher-than-expected earnings), bad(lower-than-expected earnings), and medium (earnings as expected). The event study analysis is conducted separately for each category of firms.

In order to estimate abnormal returns, authors use 'naive benchmark model', which is defined as *excessReturns* model in the eventstudies package. In the data provided, the S&P market index levels are individually matched for calender dates of each firm. Thus, the abnormal returns are estimated separately for each firm.

The event is already defined in the returns data provided by authors and thus, daily returns before and after the event are already known. Therefore, instead of using the event study wrapper function, we apply individual functions to compute cumulated average returns (CARs).

```
                                        # For each market with
                                        # different time zones
data(KGStockReturns)
data(KGMarketReturns)
data(KGSurpriseCategory)
```

The KGStockReturns is a *zoo* object, which is a time series of daily stock price returns of firms categorised as good, bad, and medium. Again, these are measured in per cent. Each column in the zoo object refers to returns for a specific firm. The column names in the zoo object refer to the names of the firms.

The KGMarketReturns is a *zoo* object with time series of returns from S&P 500 index. These index returns are individually matched for calender dates of each firm.

The KGSurpriseCategory is a *dataframe* in which the firms are categorised into the three above-mentioned categories. It is used to apply event study approach separately for each category of firms.

```
es.categories <- function(stock, market, surprise, option){
                                        # Categorising returns for
                                        # each category

    surprise <- surprise[which(surprise$Category %in% option), ]
    stock <- stock[ , which(names(stock) %in%
                             as.character(surprise$Company))]
    market <- market[ , which(names(market) %in%
                               as.character(surprise$Company))]

                                        # ARs
    ar <- lapply(1:NCOL(stock), function(x){
                     output <- excessReturn(stock[ , x],
                                            market[ , x])
                     return(output)
                 })
    names(ar) <- names(stock)
    ar <- do.call("merge", ar)

                                        # CARs
    car <- lapply(1:NCOL(ar), function(x){
                      tmp <- remap.cumsum(z = ar[ , x],
                                          base = as.numeric(ar[1, x]))
                      return(tmp)
                  })
    names(car) <- names(ar)
    car <- do.call("merge", car)

                                        # CAARs
    caar <- round(apply(car, 1, mean), 10)

    return(list(ar, car, caar))
}

                                        # Calling for each category
                                        # Good
```

```
goodCompanies <- es.categories(KGStockReturns, KGMarketReturns,
                               KGSurpriseCategory, "good")
                                        # Medium
mediumCompanies <- es.categories(KGStockReturns, KGMarketReturns,
                                 KGSurpriseCategory, "medium")
                                        # Bad
badCompanies <- es.categories(KGStockReturns, KGMarketReturns,
                              KGSurpriseCategory, "bad")
```

In the above example, `goodCompanies`, `mediumCompanies`, and `badCompanies` provide a list of abnormal returns (ARs), cumulated abnormal returns (CARs) and cumulated average abnormal returns (CAARs) for each corresponding category of firms as reported in the Doron and Gregory (2014) in Section 7.5.

References

Chen AH, Siems TF (2004). "The effects of terrorism on global capital markets." *European Journal of Political Economy*, **20**(1), 349–366.

Doron K, Gregory G (2014). *Event studies for financial research – A comprehensive guide.* Palgrave Macmillan.