main.R Markup

This program Performs a Prediction of MKT_TOTAL_VAL

First Header	Second Header
File Name	main.R
Author	K. Rajesh Jagannath
Uses	functions_MKT_VAL.R
Uses	Assessors_yearly_data_ETL_MKT_VAL.R
Uses	Buffer_parcels_ETL_MKT_VAL.R
Uses	streetcarbuffer_parcels/gis_shape_files/StreetCar
Final Springboard Project submitted	4/30/2017

```r
# Libraries used
library(dplyr)
```

```
## Warning: package 'dplyr' was built under R version 3.2.5
```

```
##
## 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
```

```r
library(tidyr)
```

```
## Warning: package 'tidyr' was built under R version 3.2.5
```

```r
library(ggplot2)
library(readr)
library(stringr)
library(scales)
```

```
##
## Attaching package: 'scales'
```

```
## The following objects are masked from 'package:readr':
##
##     col_factor, col_numeric
```

```r
library(mixtools)
```

```
## mixtools package, version 1.0.4, Released 2016-01-11
## This package is based upon work supported by the National Science Foundation under Grant No. SES-0518
```

```r
library(readxl)
library(lubridate)
```

```
## Warning: package 'lubridate' was built under R version 3.2.5
```

```
##
## Attaching package: 'lubridate'
## The following object is masked from 'package:base':
##
##     date
```

```r
library(reshape2)
```

```
##
## Attaching package: 'reshape2'

## The following object is masked from 'package:tidyr':
##
##     smiths
```

```r
library(forecast)
```

```
## Warning: package 'forecast' was built under R version 3.2.5

## Loading required package: zoo

## Warning: package 'zoo' was built under R version 3.2.5

##
## Attaching package: 'zoo'

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

## Loading required package: timeDate

## This is forecast 7.2
```

```r
library(TSclust)
```

```
## Loading required package: wmtsa

## Warning: package 'wmtsa' was built under R version 3.2.5

## Loading required package: pdc

## Loading required package: cluster

## Warning: package 'cluster' was built under R version 3.2.5
```

```r
library(sqldf)
```

```
## Loading required package: gsubfn

## Loading required package: proto

## Loading required package: RSQLite

## Loading required package: DBI

## Warning: package 'DBI' was built under R version 3.2.5
```

```r
library(ClustOfVar)
library(digest)
library(zoo)
library(maptools)
```

```
## Loading required package: sp

## Warning: package 'sp' was built under R version 3.2.5
## Checking rgeos availability: FALSE
##      Note: when rgeos is not available, polygon geometry     computations in maptools depend on gpcli
##      which has a restricted licence. It is disabled by default;
##      to enable gpclib, type gpclibPermit()
```

```r
library(rgdal)
```

```
## Warning: package 'rgdal' was built under R version 3.2.5
```

```
## rgdal: version: 1.1-10, (SVN revision 622)
##  Geospatial Data Abstraction Library extensions to R successfully loaded
##  Loaded GDAL runtime: GDAL 1.11.4, released 2016/01/25
##  Path to GDAL shared files: /Library/Frameworks/R.framework/Versions/3.2/Resources/library/rgdal/gdal
##  Loaded PROJ.4 runtime: Rel. 4.9.1, 04 March 2015, [PJ_VERSION: 491]
##  Path to PROJ.4 shared files: /Library/Frameworks/R.framework/Versions/3.2/Resources/library/rgdal/pr
##  Linking to sp version: 1.2-3
```

```r
# set the sed for repeatability


set.seed(100)
```

options(scipen=12)

```r
# Set variables

#
# Analysis is done on non_buffer_zone as well as CORE, CENTER and EDGE buffer zones
# set skip_non_buffer = 1 to skip directly to CORE, CENTER and EDGE analysis
# used for bring up and debug only
skip_non_buffer = 0
#
# Choose a smaller sample  for non buffer zone : skip_1500 = 1 for dev
# Choose about 1500 samples don't skip : for analysis
# used for debug and bring up only
skip_1500 = 0
```

```r
print(" Setting current working directory ")
```

```
## [1] " Setting current working directory "
```

```r
# set the working dir
setwd("/Users/rajesh/Desktop/Coursera/SpringBoardGithub/Streetcar0719")
```

```r
print(" sourcing functions ")
```

```
## [1] " sourcing functions "
```

```r
setwd("/Users/rajesh/Desktop/Coursera/SpringBoardGithub/Streetcar0719/taxinfoTimeSeries")
source ('/Users/rajesh/Desktop/Coursera/SpringBoardGithub/Streetcar0719/taxinfoTimeSeries/functions_MKT_

 setwd("/Users/rajesh/Desktop/Coursera/SpringBoardGithub/Streetcar0719")







print( "Reading in  8 years of parcel data 1/4 Million observations X 8 years")
```

```
## [1] "Reading in  8 years of parcel data 1/4 Million observations X 8 years"
```

```r
print(" Performing Extraction, Transformation and Loading ... ")
```

```
## [1] " Performing Extraction, Transformation and Loading ... "
```

```r
# Here we read in 8 years data for 250,000 - 275,000 parcels for all of Cincinnati
# Extraction Transformation and Cleaning is done here
source('taxinfoTimeSeries/Assessors_yearly_data_ETL_MKT_VAL.R')
```

```
## [1] "Processing the year : 2007"
## [1] "df_taxinfo_2007"
## [1] "Processing the year : 2008"
## [1] "df_taxinfo_2008"
## [1] "Processing the year : 2009"
## [1] "df_taxinfo_2009"
## [1] "Processing the year : 2010"
## [1] "df_taxinfo_2010"
## [1] "Processing the year : 2011"
## [1] "df_taxinfo_2011"
## [1] "Processing the year : 2012"
## [1] "df_taxinfo_2012"
## [1] "Processing the year : 2013"
## [1] "df_taxinfo_2013"
## [1] "Processing the year : 2014"
## [1] "df_taxinfo_2014"
## [1] "Processing the year : 2015"
## [1] "df_taxinfo_2015"
## [1] "processing df_taxinfo_2007$MKT_LAND_VAL"
```

```
## Warning: NAs introduced by coercion
```

```
## [1] "processing df_taxinfo_2007$MKT_IMPR_VAL"
```

```
## Warning: NAs introduced by coercion
```

```
## [1] "processing df_taxinfo_2007$MKT_TOTAL_VAL"
```

```
## Warning: NAs introduced by coercion
```

```
## [1] "processing df_taxinfo_2007$ANNUAL_TAXES"
```

```
## Warning: NAs introduced by coercion
```

```
## [1] "processing df_taxinfo_2007$TAXES_PAID"
```

```
## Warning: NAs introduced by coercion
```

```
## [1] "processing df_taxinfo_2007$DELQ_TAXES"
```

```
## Warning: NAs introduced by coercion
```

```
## [1] "processing df_taxinfo_2007$ACRES"
```

```
## Warning: NAs introduced by coercion
```

```
## [1] "processing df_taxinfo_2007$SALE_AMOUNT"
```

```
## Warning: NAs introduced by coercion
```

```
## [1] "processing df_taxinfo_2007$NEW_CONS_FLAG"
## [1] "processing df_taxinfo_2007$FORECL_FLAG"
## [1] "processing df_taxinfo_2008$MKT_LAND_VAL"

## Warning: NAs introduced by coercion

## [1] "processing df_taxinfo_2008$MKT_IMPR_VAL"

## Warning: NAs introduced by coercion

## [1] "processing df_taxinfo_2008$MKT_TOTAL_VAL"

## Warning: NAs introduced by coercion

## [1] "processing df_taxinfo_2008$ANNUAL_TAXES"

## Warning: NAs introduced by coercion

## [1] "processing df_taxinfo_2008$TAXES_PAID"

## Warning: NAs introduced by coercion

## [1] "processing df_taxinfo_2008$DELQ_TAXES"

## Warning: NAs introduced by coercion

## [1] "processing df_taxinfo_2008$ACRES"

## Warning: NAs introduced by coercion

## [1] "processing df_taxinfo_2008$SALE_AMOUNT"

## Warning: NAs introduced by coercion

## [1] "processing df_taxinfo_2008$NEW_CONS_FLAG"
## [1] "processing df_taxinfo_2008$FORECL_FLAG"
## [1] "processing df_taxinfo_2009$MKT_LAND_VAL"

## Warning: NAs introduced by coercion

## [1] "processing df_taxinfo_2009$MKT_IMPR_VAL"

## Warning: NAs introduced by coercion

## [1] "processing df_taxinfo_2009$MKT_TOTAL_VAL"

## Warning: NAs introduced by coercion

## [1] "processing df_taxinfo_2009$ANNUAL_TAXES"

## Warning: NAs introduced by coercion

## [1] "processing df_taxinfo_2009$TAXES_PAID"

## Warning: NAs introduced by coercion

## [1] "processing df_taxinfo_2009$DELQ_TAXES"

## Warning: NAs introduced by coercion

## [1] "processing df_taxinfo_2009$ACRES"

## Warning: NAs introduced by coercion

## [1] "processing df_taxinfo_2009$SALE_AMOUNT"

## Warning: NAs introduced by coercion

## [1] "processing df_taxinfo_2009$NEW_CONS_FLAG"
## [1] "processing df_taxinfo_2009$FORECL_FLAG"
## [1] "processing df_taxinfo_2010$MKT_LAND_VAL"
## Warning: NAs introduced by coercion

## [1] "processing df_taxinfo_2010$MKT_IMPR_VAL"

## Warning: NAs introduced by coercion

## [1] "processing df_taxinfo_2010$MKT_TOTAL_VAL"

## Warning: NAs introduced by coercion

## [1] "processing df_taxinfo_2010$ANNUAL_TAXES"

## Warning: NAs introduced by coercion

## [1] "processing df_taxinfo_2010$TAXES_PAID"

## Warning: NAs introduced by coercion

## [1] "processing df_taxinfo_2010$DELQ_TAXES"

## Warning: NAs introduced by coercion

## [1] "processing df_taxinfo_2010$ACRES"

## Warning: NAs introduced by coercion

## [1] "processing df_taxinfo_2010$SALE_AMOUNT"

## Warning: NAs introduced by coercion

## [1] "processing df_taxinfo_2010$NEW_CONS_FLAG"
## [1] "processing df_taxinfo_2010$FORECL_FLAG"
## [1] "processing df_taxinfo_2011$MKT_LAND_VAL"

## Warning: NAs introduced by coercion

## [1] "processing df_taxinfo_2011$MKT_IMPR_VAL"

## Warning: NAs introduced by coercion

## [1] "processing df_taxinfo_2011$MKT_TOTAL_VAL"

## Warning: NAs introduced by coercion

## [1] "processing df_taxinfo_2011$ANNUAL_TAXES"

## Warning: NAs introduced by coercion

## [1] "processing df_taxinfo_2011$TAXES_PAID"

## Warning: NAs introduced by coercion

## [1] "processing df_taxinfo_2011$DELQ_TAXES"

## Warning: NAs introduced by coercion

## [1] "processing df_taxinfo_2011$ACRES"

## Warning: NAs introduced by coercion

## [1] "processing df_taxinfo_2011$SALE_AMOUNT"

## Warning: NAs introduced by coercion

## [1] "processing df_taxinfo_2011$NEW_CONS_FLAG"
## [1] "processing df_taxinfo_2011$FORECL_FLAG"
## [1] "processing df_taxinfo_2012$MKT_LAND_VAL"

## Warning: NAs introduced by coercion
## [1] "processing df_taxinfo_2012$MKT_IMPR_VAL"

## Warning: NAs introduced by coercion

## [1] "processing df_taxinfo_2012$MKT_TOTAL_VAL"

## Warning: NAs introduced by coercion

## [1] "processing df_taxinfo_2012$ANNUAL_TAXES"

## Warning: NAs introduced by coercion

## [1] "processing df_taxinfo_2012$TAXES_PAID"

## Warning: NAs introduced by coercion

## [1] "processing df_taxinfo_2012$DELQ_TAXES"

## Warning: NAs introduced by coercion

## [1] "processing df_taxinfo_2012$ACRES"

## Warning: NAs introduced by coercion

## [1] "processing df_taxinfo_2012$SALE_AMOUNT"

## Warning: NAs introduced by coercion

## [1] "processing df_taxinfo_2012$NEW_CONS_FLAG"
## [1] "processing df_taxinfo_2012$FORECL_FLAG"
## [1] "processing df_taxinfo_2013$MKT_LAND_VAL"

## Warning: NAs introduced by coercion

## [1] "processing df_taxinfo_2013$MKT_IMPR_VAL"

## Warning: NAs introduced by coercion

## [1] "processing df_taxinfo_2013$MKT_TOTAL_VAL"

## Warning: NAs introduced by coercion

## [1] "processing df_taxinfo_2013$ANNUAL_TAXES"

## Warning: NAs introduced by coercion

## [1] "processing df_taxinfo_2013$TAXES_PAID"

## Warning: NAs introduced by coercion

## [1] "processing df_taxinfo_2013$DELQ_TAXES"

## Warning: NAs introduced by coercion

## [1] "processing df_taxinfo_2013$ACRES"

## Warning: NAs introduced by coercion

## [1] "processing df_taxinfo_2013$SALE_AMOUNT"

## Warning: NAs introduced by coercion

## [1] "processing df_taxinfo_2013$NEW_CONS_FLAG"
## [1] "processing df_taxinfo_2013$FORECL_FLAG"
## [1] "processing df_taxinfo_2014$MKT_LAND_VAL"

## Warning: NAs introduced by coercion

## [1] "processing df_taxinfo_2014$MKT_IMPR_VAL"
## Warning: NAs introduced by coercion

## [1] "processing df_taxinfo_2014$MKT_TOTAL_VAL"

## Warning: NAs introduced by coercion

## [1] "processing df_taxinfo_2014$ANNUAL_TAXES"

## Warning: NAs introduced by coercion

## [1] "processing df_taxinfo_2014$TAXES_PAID"

## Warning: NAs introduced by coercion

## [1] "processing df_taxinfo_2014$DELQ_TAXES"

## Warning: NAs introduced by coercion

## [1] "processing df_taxinfo_2014$ACRES"

## Warning: NAs introduced by coercion

## [1] "processing df_taxinfo_2014$SALE_AMOUNT"

## Warning: NAs introduced by coercion

## [1] "processing df_taxinfo_2014$NEW_CONS_FLAG"
## [1] "processing df_taxinfo_2014$FORECL_FLAG"
## [1] "processing df_taxinfo_2015$MKT_LAND_VAL"

## Warning: NAs introduced by coercion

## [1] "processing df_taxinfo_2015$MKT_IMPR_VAL"

## Warning: NAs introduced by coercion

## [1] "processing df_taxinfo_2015$MKT_TOTAL_VAL"

## Warning: NAs introduced by coercion

## [1] "processing df_taxinfo_2015$ANNUAL_TAXES"

## Warning: NAs introduced by coercion

## [1] "processing df_taxinfo_2015$TAXES_PAID"

## Warning: NAs introduced by coercion

## [1] "processing df_taxinfo_2015$DELQ_TAXES"

## Warning: NAs introduced by coercion

## [1] "processing df_taxinfo_2015$ACRES"

## Warning: NAs introduced by coercion

## [1] "processing df_taxinfo_2015$SALE_AMOUNT"

## Warning: NAs introduced by coercion

## [1] "processing df_taxinfo_2015$NEW_CONS_FLAG"
## [1] "processing df_taxinfo_2015$FORECL_FLAG"

## Warning: NAs introduced by coercion

## Warning: NAs introduced by coercion

## Warning: NAs introduced by coercion
## Warning: NAs introduced by coercion

## Warning: NAs introduced by coercion

## Warning: NAs introduced by coercion

## Warning: NAs introduced by coercion

## Warning: NAs introduced by coercion

## Warning: NAs introduced by coercion

## Warning: NAs introduced by coercion

## Warning: NAs introduced by coercion

## Warning: NAs introduced by coercion
## Warning: Setting row names on a tibble is deprecated.
```

```
print( "Reading Buffer zone Parcel information ")
```

```
## [1] "Reading Buffer zone Parcel information "
```

```
print(" Performing Extraction, Transformation and Loading ... ")
```

```
## [1] " Performing Extraction, Transformation and Loading ... "
```

```
# here we read in and clean up the Parcels of the Buffer
# extraction , Transormaton and Cleaning is done in this file
source('taxinfoTimeSeries/Buffer_parcels_ETL_MKT_VAL.R')
```

```
## [1] "Processing the zone : CENTER"
## [1] "df_buffer_CENTER"
## [1] "Processing the zone : EDGE"
## [1] "df_buffer_EDGE"
## [1] "Processing the zone : CORE"
## [1] "df_buffer_CORE"
```

```
setwd("/Users/rajesh/Desktop/Coursera/SpringBoardGithub/Streetcar0719")
```

```
if(skip_non_buffer == 0) {


  print(" NON BUFFER ZONE : Hierarchical Clustering ")
  # Begin Hierarchical Clustering of parcel ids

  # For illustartive purposes we choose first 10 columns
  Clustvar <-hclustvar(taxinfo.matrix_no_na[, 1:10])
  plot(Clustvar)

  print(" NON BUFFER ZONE : 100 random samples  Hierarchical Clustering ")

  #then random 100 columns
  n <- ncol(taxinfo.matrix_no_na)
  taxinfo.matrix_shuffled <- taxinfo.matrix_no_na[,sample(n) ]
  #0.01248  is 2500 values
```

```
train_indices <- 1:round(0.00042226 * n)
train <- taxinfo.matrix_shuffled[,train_indices ]


Clustvar100 <-hclustvar(train)
plot(Clustvar100)
rect.hclust(Clustvar100,k=12, border="red")
part100 <- cutreevar(Clustvar100,12)

plot(Clustvar100$height)

print(" NON BUFFER ZONE : 100 random samples  Stability graph ")



#stab100 <- stability(Clustvar100,B = 60, graph = TRUE)

if(skip_1500 == 0) {
  #Now let's get some  random PARCEL_IDs
  # About 1500 should do

  n <- ncol(taxinfo.matrix_no_na)
  taxinfo.matrix_shuffled <- taxinfo.matrix_no_na[,sample(n) ]
  #0.0051699 of 241748 observations is 1249
  train_indices <- 1:round(0.0051699 * n)
  train <- taxinfo.matrix_shuffled[,train_indices ]



  Clustvar1500 <-hclustvar(train)
  plot(Clustvar1500)
  rect.hclust(Clustvar1500,k=12, border="red")


  #####
  # B is the Boot strapping sample and we determine the stability
  # Evaluates the stability of partitions obtained from a hierarchy of p variables. This hierarchy is
  # with hclustvar and the stability of the partitions of 2 to p-1 clusters is evaluated with a
  # bootstrap approach. The boostrap approch is the following: hclustvar is applied to B bootstrap
  # samples of the n rows. The partitions of 2 to p-1 clusters obtained from the B bootstrap hierarch
  # are compared with the partitions from the initial hierarchy . The mean of the corrected Rand
  # indices is plotted according to the number of clusters. This graphical representation helps in th
  # determination of a suitable numbers of clusters.

  #stab1500 <- stability(Clustvar1500,B = 5, graph = TRUE)


  # Could not get a graph : Make a rough partition of 12 clusters

  part1500 <- cutreevar(Clustvar1500,12)
  plot(Clustvar1500$height)

  a <- part1500$var
} else {
  part100 <- cutreevar(Clustvar100,12)
  plot(Clustvar100$height)

  a <- part100$var

}
#Remove xs from Parcel ids


train_cl1  <- as.data.frame(row.names(a$cluster1), stringsAsFactors = FALSE)
train_cl2  <- as.data.frame(row.names(a$cluster2), stringsAsFactors = FALSE)
train_cl3  <- as.data.frame(row.names(a$cluster3), stringsAsFactors = FALSE)
train_cl4  <- as.data.frame(row.names(a$cluster4), stringsAsFactors = FALSE)
train_cl5  <- as.data.frame(row.names(a$cluster5), stringsAsFactors = FALSE)
train_cl6  <- as.data.frame(row.names(a$cluster6), stringsAsFactors = FALSE)
train_cl7  <- as.data.frame(row.names(a$cluster7), stringsAsFactors = FALSE)
train_cl8  <- as.data.frame(row.names(a$cluster8), stringsAsFactors = FALSE)
train_cl9  <- as.data.frame(row.names(a$cluster9), stringsAsFactors = FALSE)
train_cl10 <- as.data.frame(row.names(a$cluster10), stringsAsFactors = FALSE)
train_cl11 <- as.data.frame(row.names(a$cluster11), stringsAsFactors = FALSE)
train_cl12 <- as.data.frame(row.names(a$cluster12), stringsAsFactors = FALSE)


# Remove X's from the PARCEL IDs
train_cl1  <- apply(train_cl1,2, function(y) as.character(gsub("X", "", y)))
train_cl2  <- apply(train_cl2,2, function(y) as.character(gsub("X", "", y)))
train_cl3  <- apply(train_cl3,2, function(y) as.character(gsub("X", "", y)))
train_cl4  <- apply(train_cl4,2, function(y) as.character(gsub("X", "", y)))
train_cl5  <- apply(train_cl5,2, function(y) as.character(gsub("X", "", y)))
train_cl6  <- apply(train_cl6,2, function(y) as.character(gsub("X", "", y)))
train_cl7  <- apply(train_cl7,2, function(y) as.character(gsub("X", "", y)))
train_cl8  <- apply(train_cl8,2, function(y) as.character(gsub("X", "", y)))
train_cl9  <- apply(train_cl9,2, function(y) as.character(gsub("X", "", y)))
train_cl10 <- apply(train_cl10,2, function(y) as.character(gsub("X", "", y)))
train_cl11 <- apply(train_cl11,2, function(y) as.character(gsub("X", "", y)))
train_cl12 <- apply(train_cl12,2, function(y) as.character(gsub("X", "", y)))




# Use Holt-Winters  for Simple Exponential Smoothing
for ( clst in c(seq(1:12))) {
  forecast_clusters(clst,a, taxinfo.matrix_uniq)

}




# we create 5 models of regressions
# 1st order - a + T              ( linear)
# 2nd order a + bT + cT^2        ( quadratic)
# 3rd order a = bT + cT^2 + dT^3 ( cubic)
# 4th order and
# 5th order as well

print("NON BUFFER ZONE : Plotting Actuals vs. Fitted for models in clusters")
print("NON BUFFER ZONE : Evaluating 12 Clusters with 1st, 2nd, 3rd and 4th and 5th order polynomial r
print("NON BUFFER ZONE : Years 2007-2014 serve as training data")
print("NON BUFFER ZONE : Years 2015-2018 serve as test data for validation")


for( poly_order in c(seq(1:5))){

  for ( clst in c(seq(1:12))) {

    df_mape_train_clusters <- plot_act_pred_trg(clst,a, taxinfo.matrix[c(1:6),], poly_order)
    df_mape_test_clusters  <- plot_act_pred_test(clst,a, taxinfo.matrix[c(1:6),], taxinfo.matrix[c(7:

    if (clst == 1) {
      # df_mape_train_clst_poly <- df_mape_train_clusters["mape"]
      df_actpred_train_clst_poly <- df_mape_train_clusters["act_pred"]
      df_mape_test_clst_poly <- df_mape_test_clusters["mape"]


    }
    else {


      #df_mape_train_clst_poly <- bind_rows(df_mape_train_clst_poly, df_mape_train_clusters["mape"])
      df_actpred_train_clst_poly <- bind_rows(df_actpred_train_clst_poly, df_mape_train_clusters["act_


      df_mape_test_clst_poly  <- bind_rows(df_mape_test_clst_poly,  df_mape_test_clusters["mape"])
    }
  }

  if (poly_order == 1) {
    #df_mape_train_all <- df_mape_train_clst_poly
    df_actpred_train_all <- df_actpred_train_clst_poly


    df_mape_test_all  <- df_mape_test_clst_poly

  }
  else
  {
    #df_mape_train_all <- bind_rows(df_mape_train_all, df_mape_train_clst_poly)
    df_actpred_train_all <- bind_rows(df_actpred_train_all, df_actpred_train_clst_poly)

    df_mape_test_all <- bind_rows(df_mape_test_all, df_mape_test_clst_poly)


  }
  }

  print("NON BUFFER ZONE : Computing MAPE - Mean Absolute Percentage error")

  # Chart the actuals and predicted for the different clusters

  print("NON BUFFER ZONE: Plotting the Actual vs. Fitted for Training set ")


  for( poly_order in c(seq(1:5))){

    plot_actpred_chart(df_actpred_train_all, " Non BUFFER ZONE training set ", poly_order)


  } # poly_order


  # Evaluate the Mean Absolute Percentage error(MAPE)
  # Training data
  # Years 2007-2012
  #plot_mape_chart(df_mape_train_all, "non Buffer zone : training data")

  # Evaluate the MAPE for
  # Testing data
  # years 2013-2014

  plot_mape_chart(df_mape_test_all, "non Buffer zone : test data")

  print("NON BUFFER ZONE :  Plotting MKT_TOT_VAL source and predicted data")
  print("NON BUFFER ZONE :  Creating df_final_mkt_val data frame for later Visualization")


  for( poly_order in c(seq(1:5))){

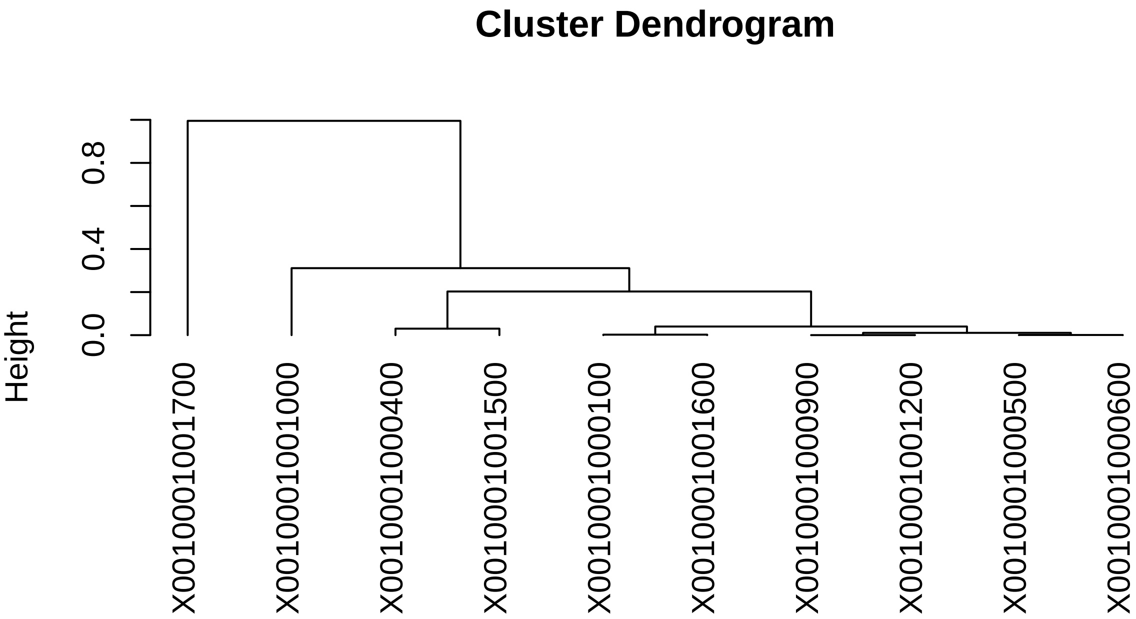
    # facet the clusters on a single plot
    # visualize  fitted and predicted

    df_final_mkt_val_non_bfr_zone <- non_linear_regresion_model(a, taxinfo.matrix, poly_order, 12, "non
    if ( poly_order == 1) {
      df_final_mkt_val <- df_final_mkt_val_non_bfr_zone
    }
    else{ df_final_mkt_val <- bind_rows(df_final_mkt_val, df_final_mkt_val_non_bfr_zone )}

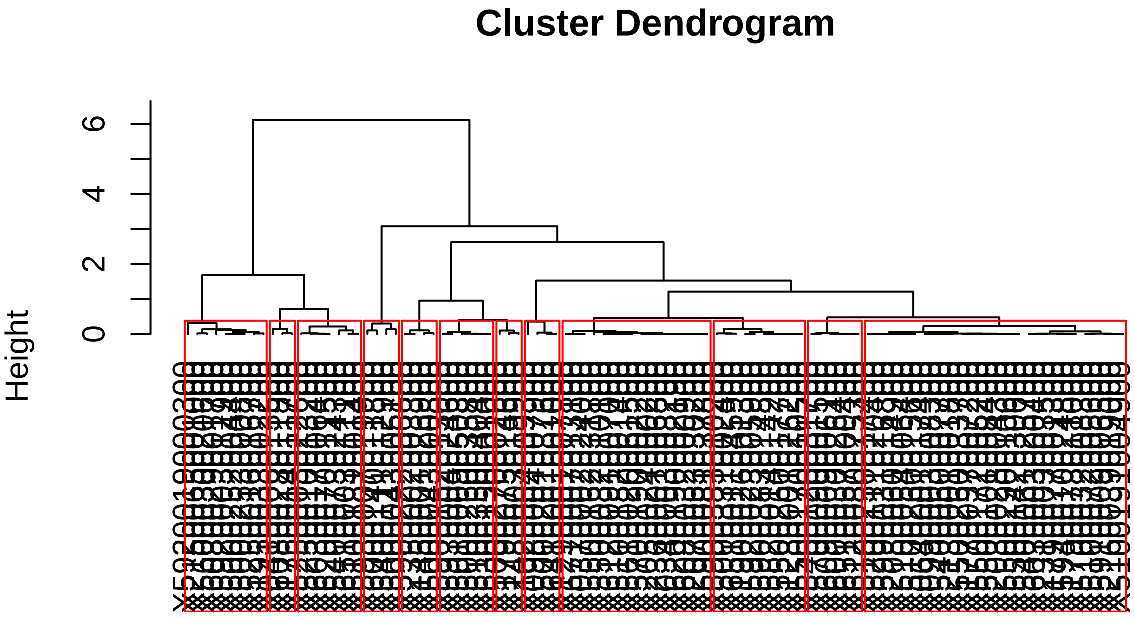

  }

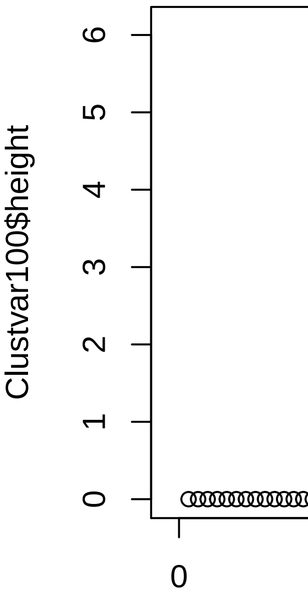
} # skip_non_buffer_zone
```

```
## [1] " NON BUFFER ZONE : Hierarchical Clustering "
```

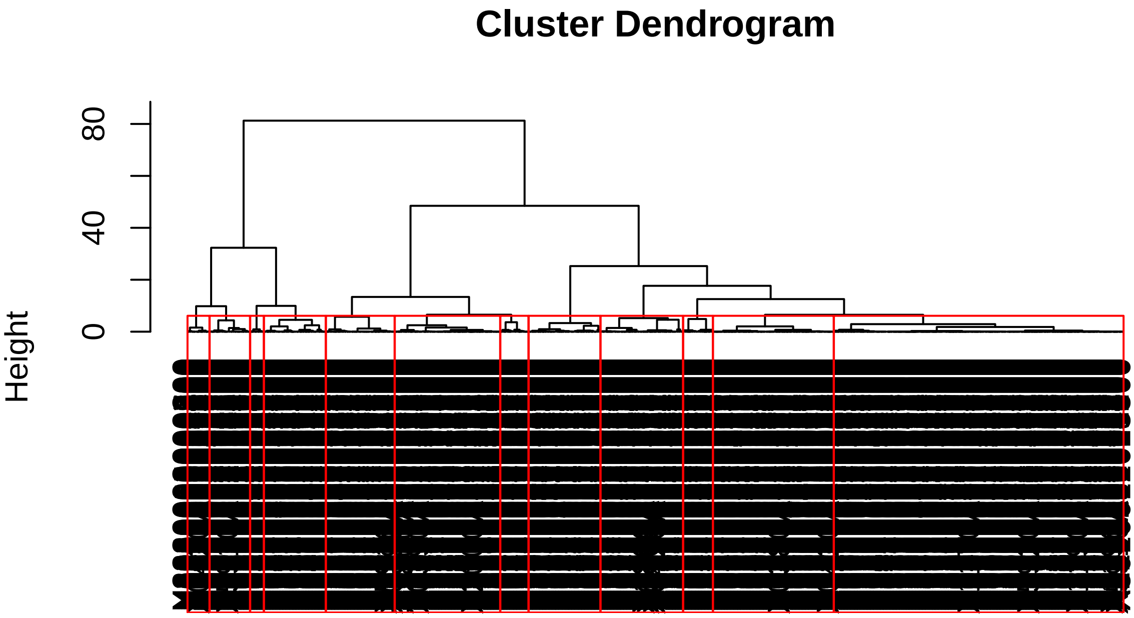


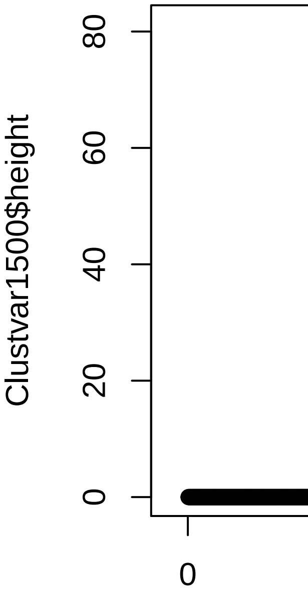
```
## [1] " NON BUFFER ZONE : 100 random samples  Hierarchical Clustering "
```

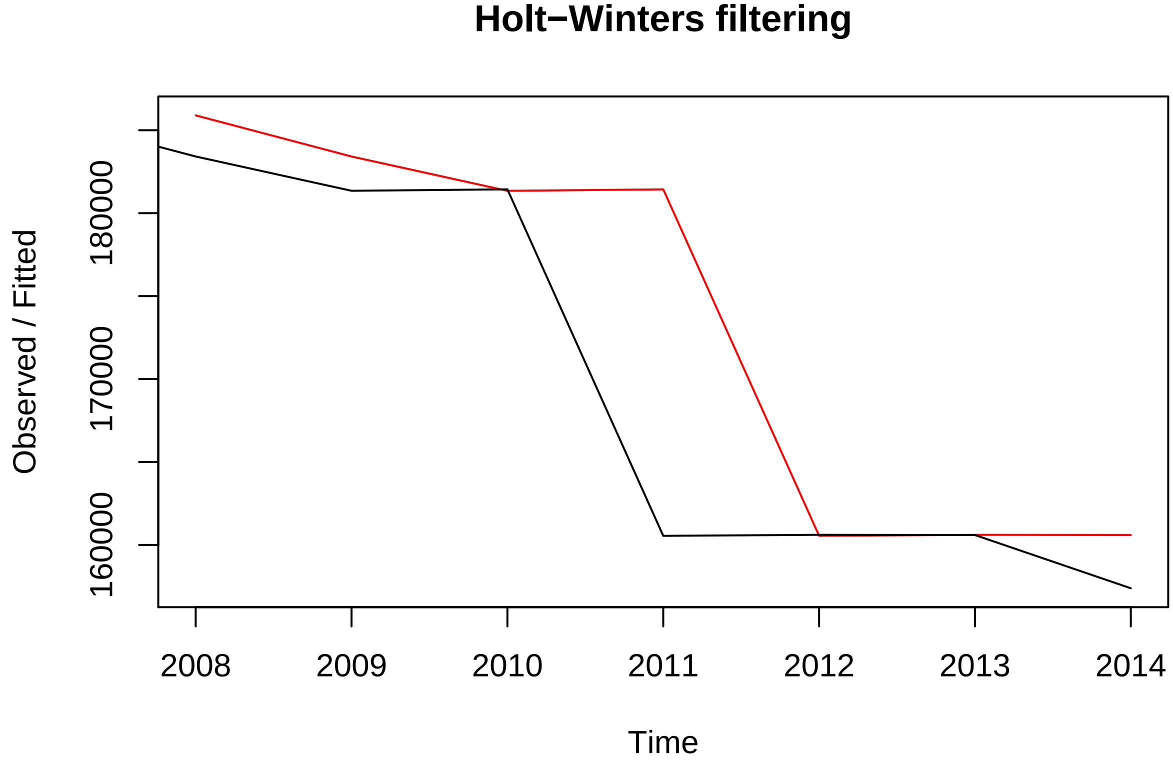


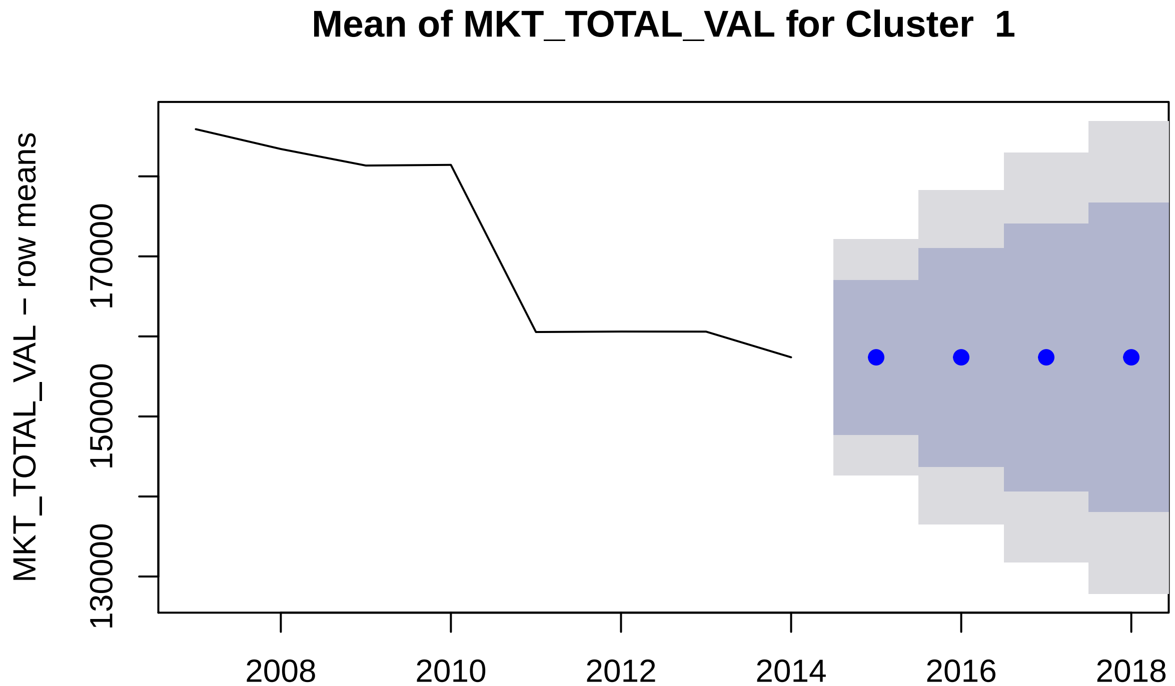


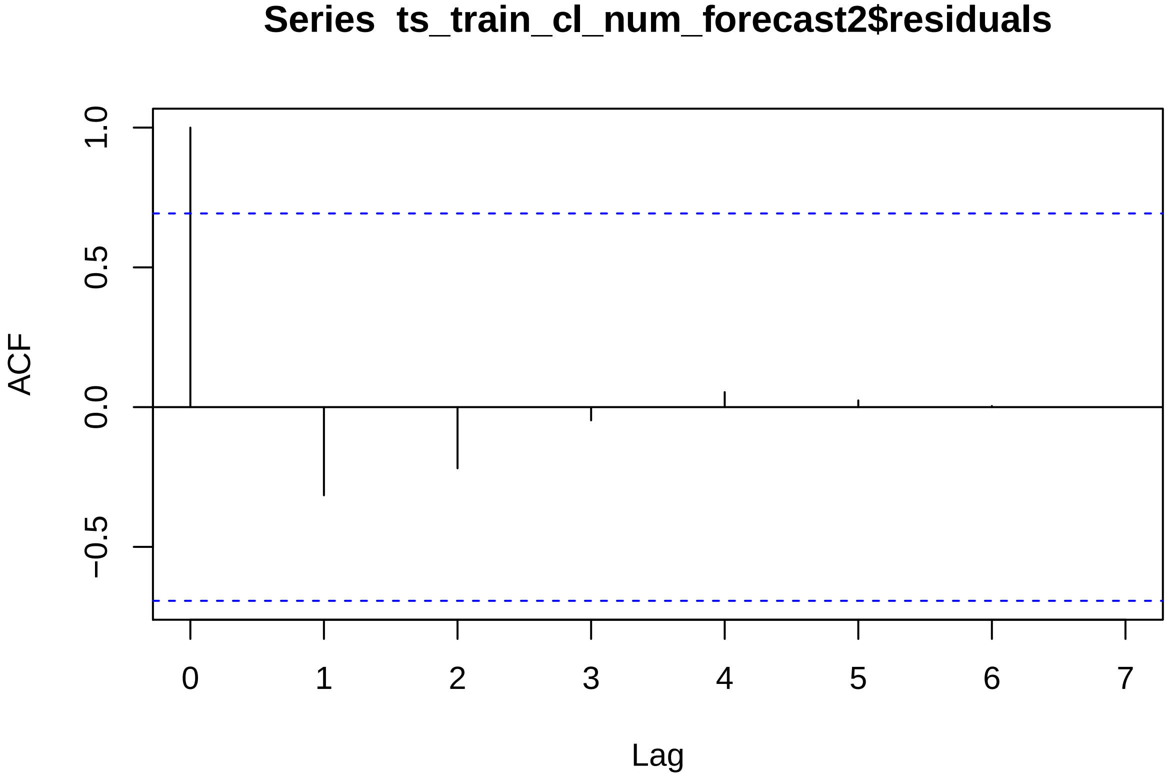
```
## [1] " NON BUFFER ZONE : 100 random samples  Stability graph "
```

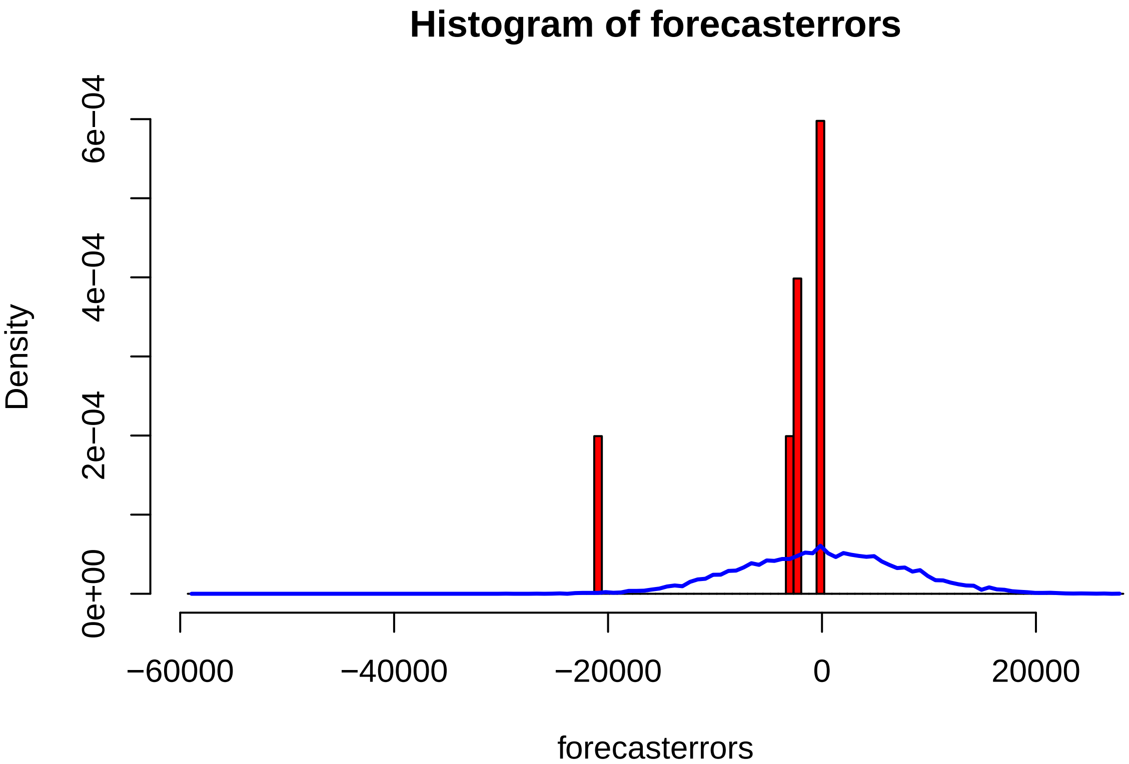

Cluster Dendrogram
Height
80
40
0

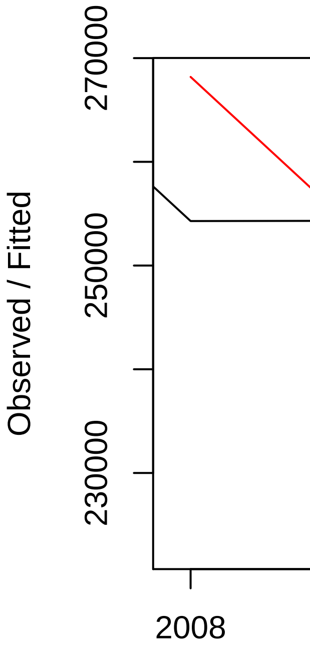

80
60
40
20
0
Clustvar1500$height
0

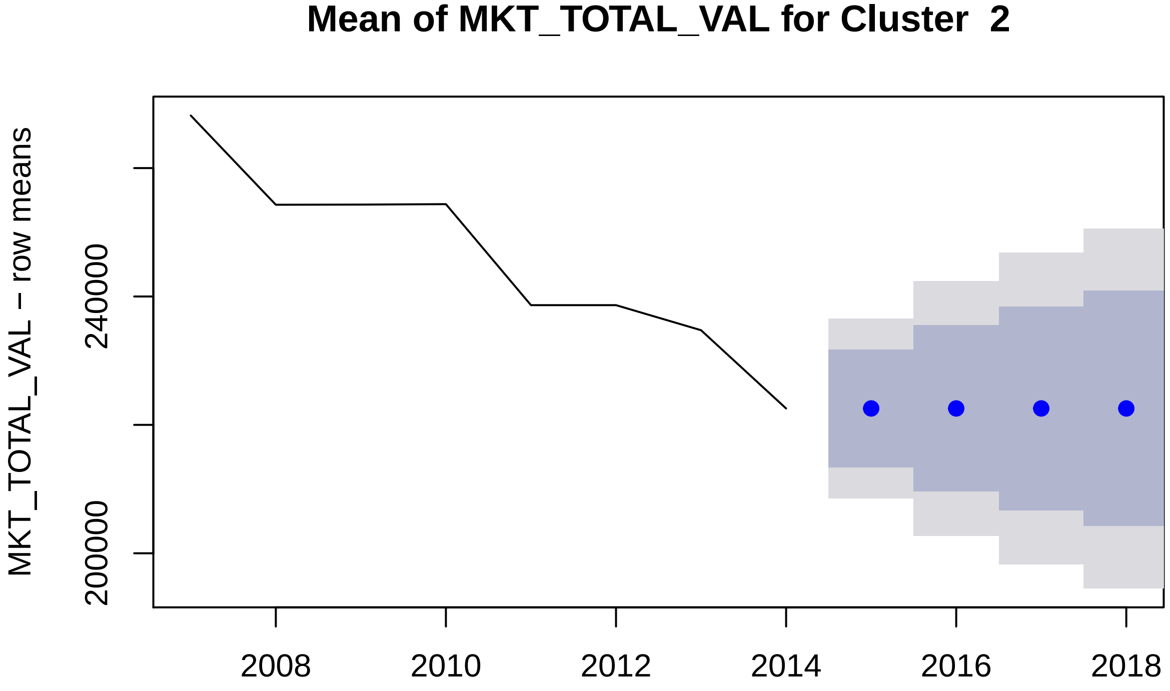

Holt−Winters filtering
Observed / Fitted
180000
170000
160000
2008
2009
2010
2011
2012
2013
2014
Time

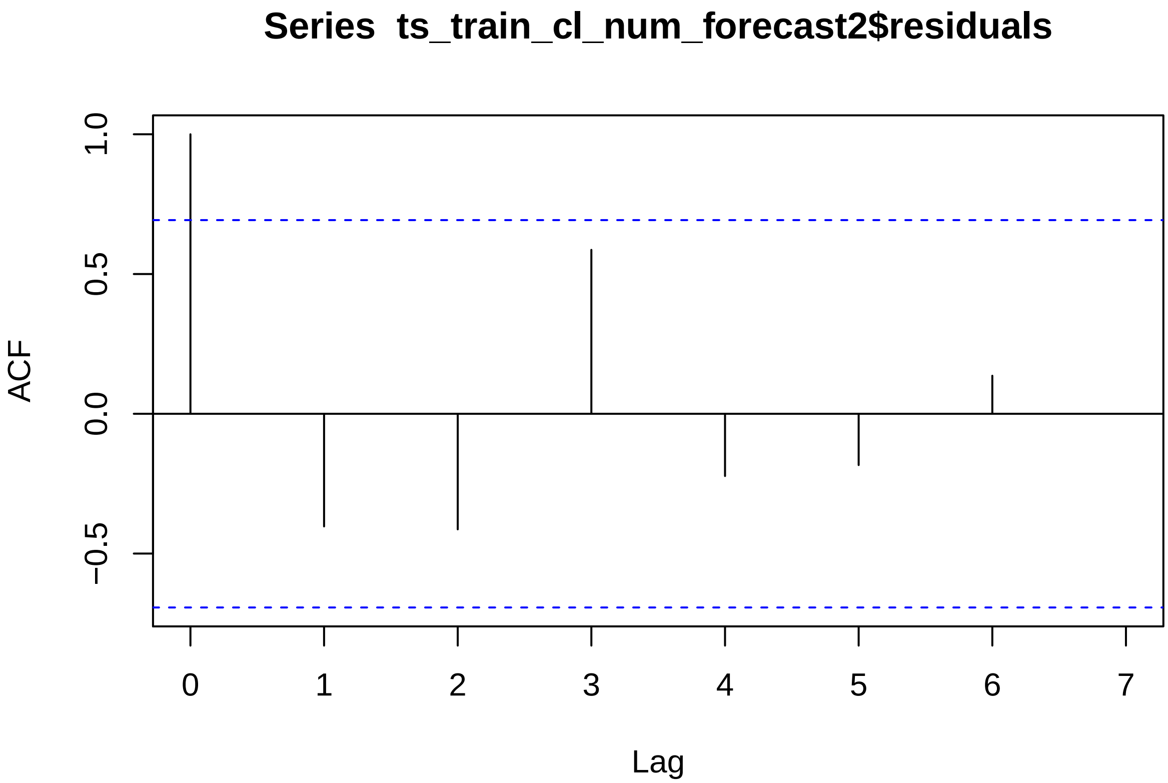

Mean of MKT_TOTAL_VAL for Cluster 1
MKT_TOTAL_VAL – row means
130000
150000
170000
2008
2010
2012
2014
2016
2018

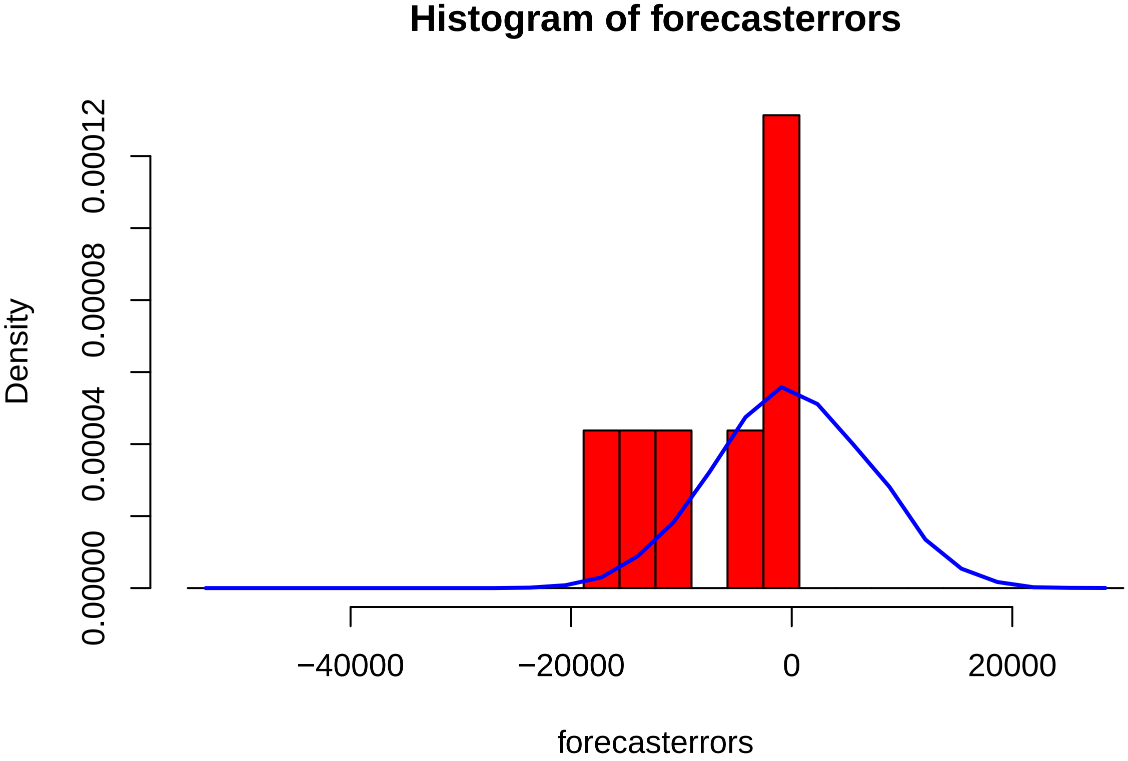

Series ts_train_cl_num_forecast2$residuals
ACF
−0.5
0.0
0.5
1.0
0
1
2
3
4
5
6
7
Lag

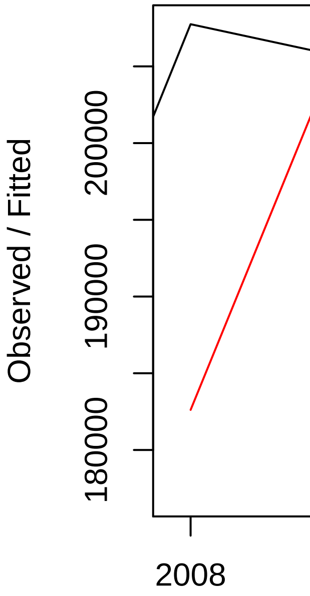

Histogram of forecasterrors
Density
0e+00
2e−04
4e−04
6e−04
−60000
−40000
−20000
0
20000
forecasterrors


Observed / Fitted
270000
250000
230000
2008

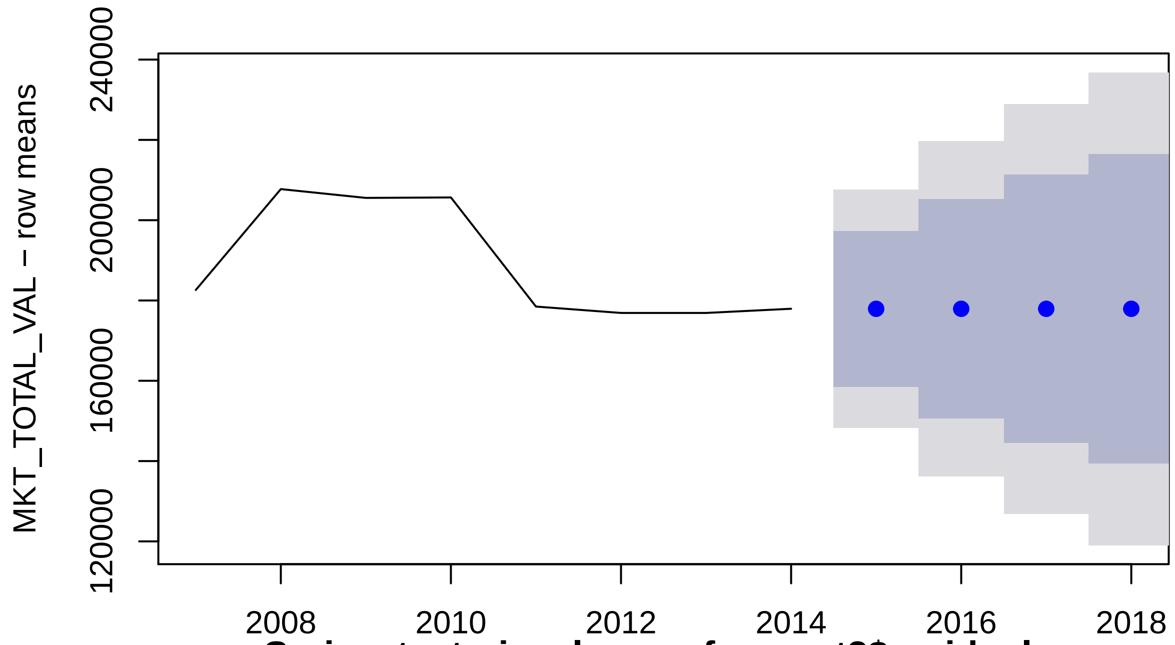

Mean of MKT_TOTAL_VAL for Cluster 2
MKT_TOTAL_VAL − row means
200000
240000
2008
2010
2012
2014
2016
2018


Series ts_train_cl_num_forecast2$residuals
ACF
1.0
0.5
0.0
−0.5
0
1
2
3
4
5
6
7
Lag

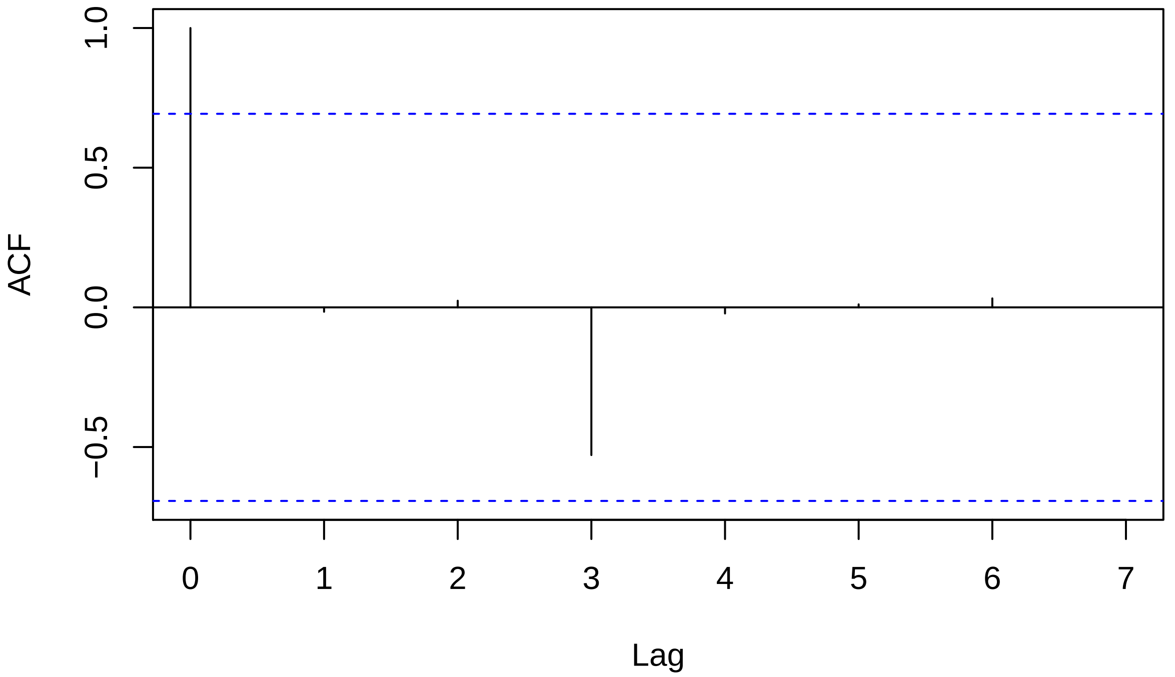

Histogram of forecasterrors
Density
0.00000
0.00004
0.00008
0.00012
−40000
−20000
0
20000
forecasterrors

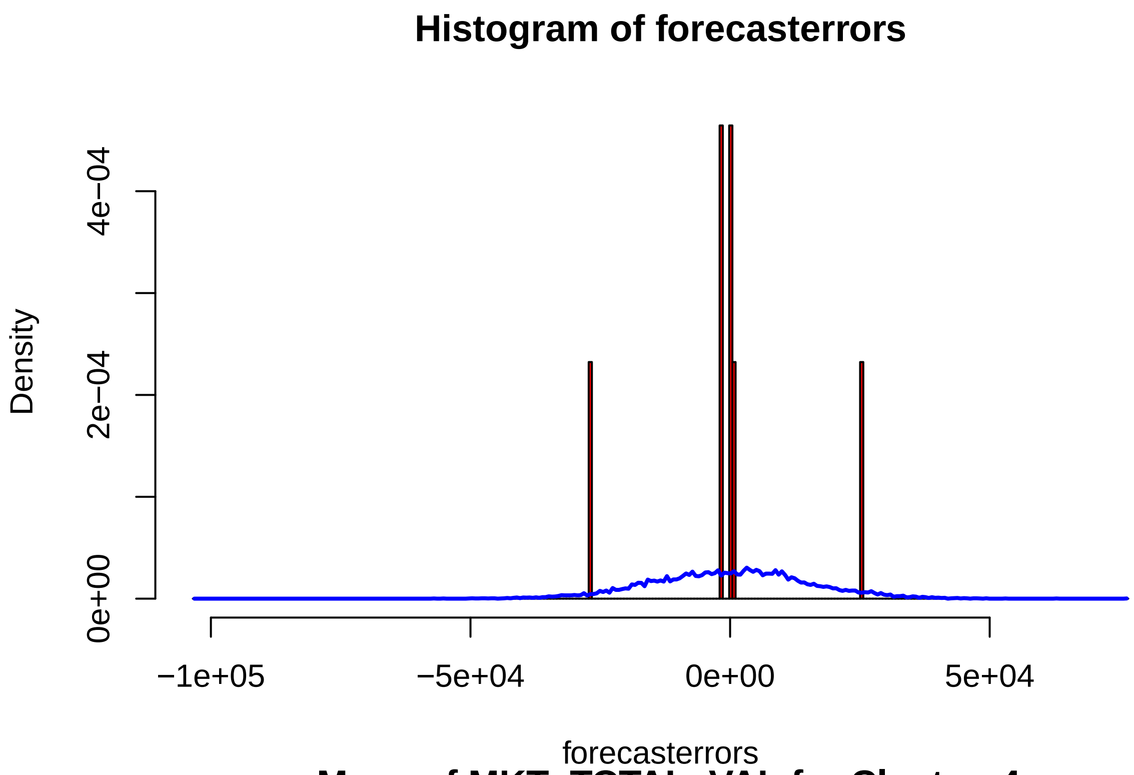

Observed / Fitted
180000
190000
200000
2008

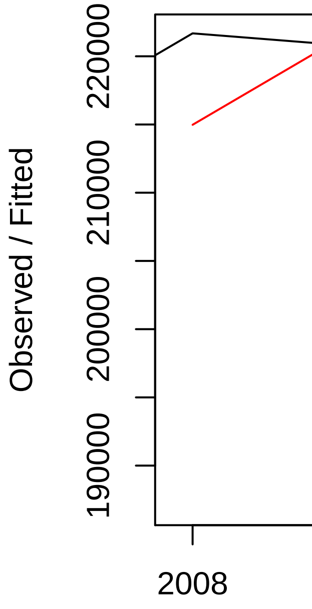
Mean of MKT_TOTAL_VAL for Cluster 3

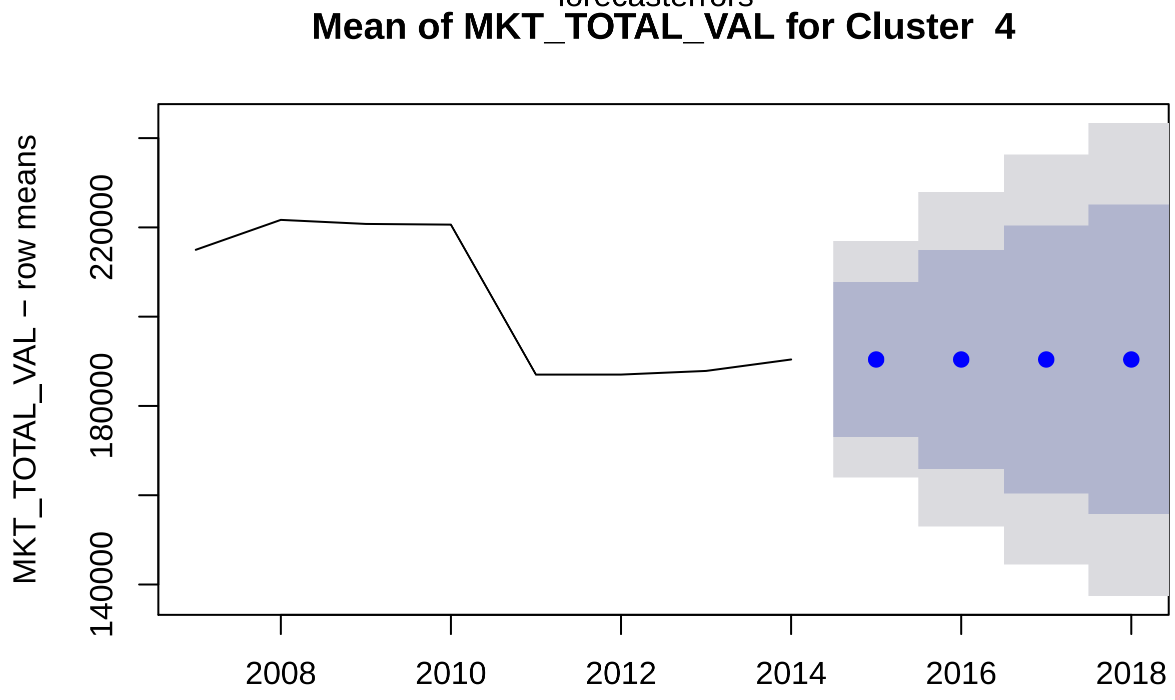


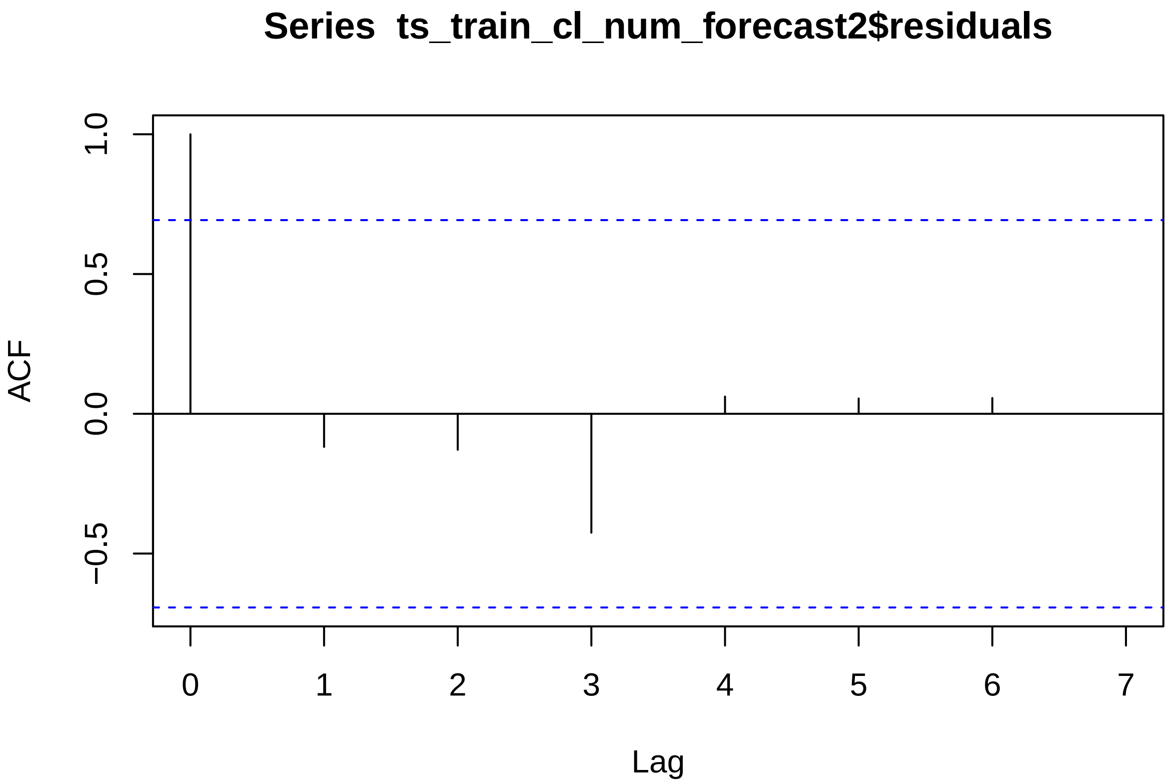
Series ts_train_cl_num_forecast2$residuals

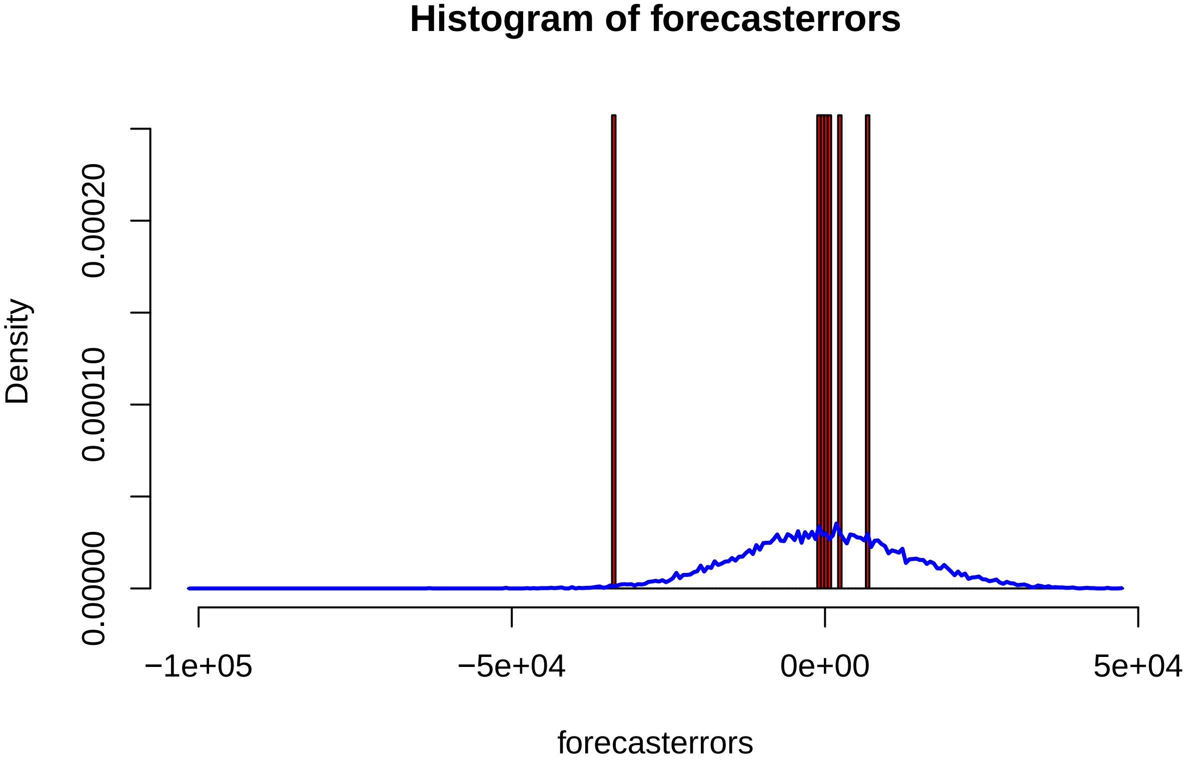


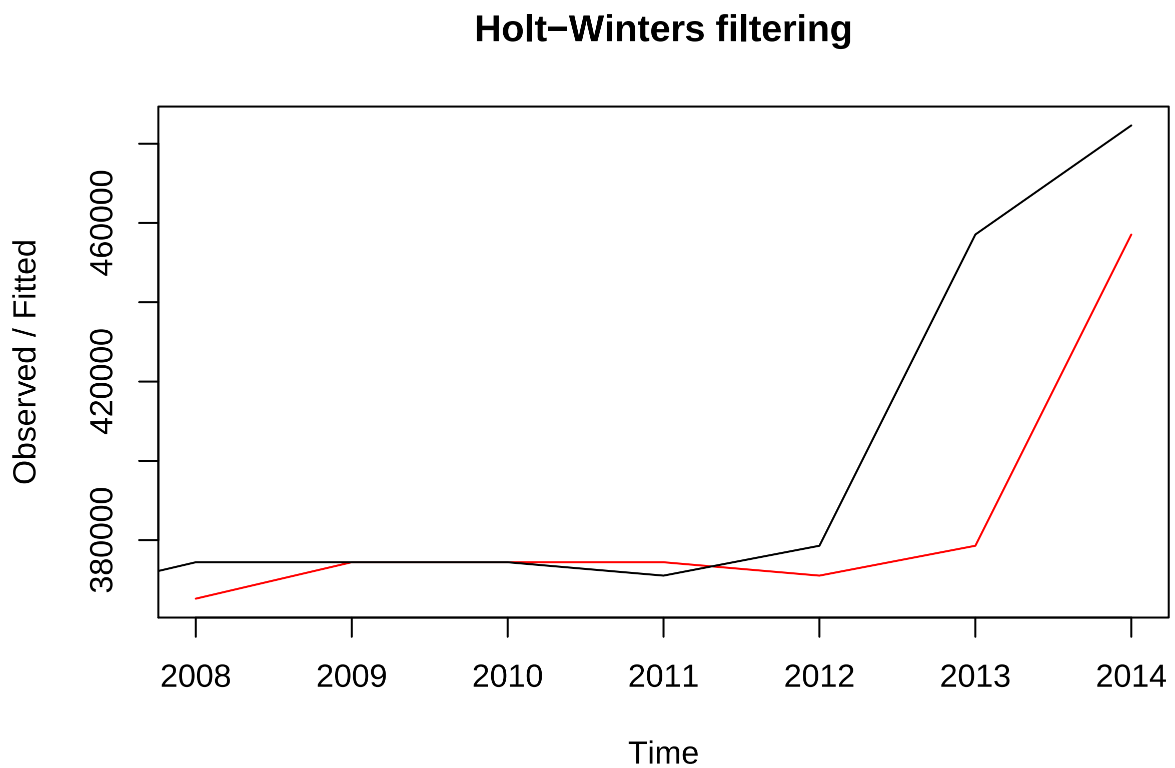

Histogram of forecasterrors
Density
0e+00
2e−04
4e−04
−1e+05
−5e+04
0e+00
5e+04
forecasterrors

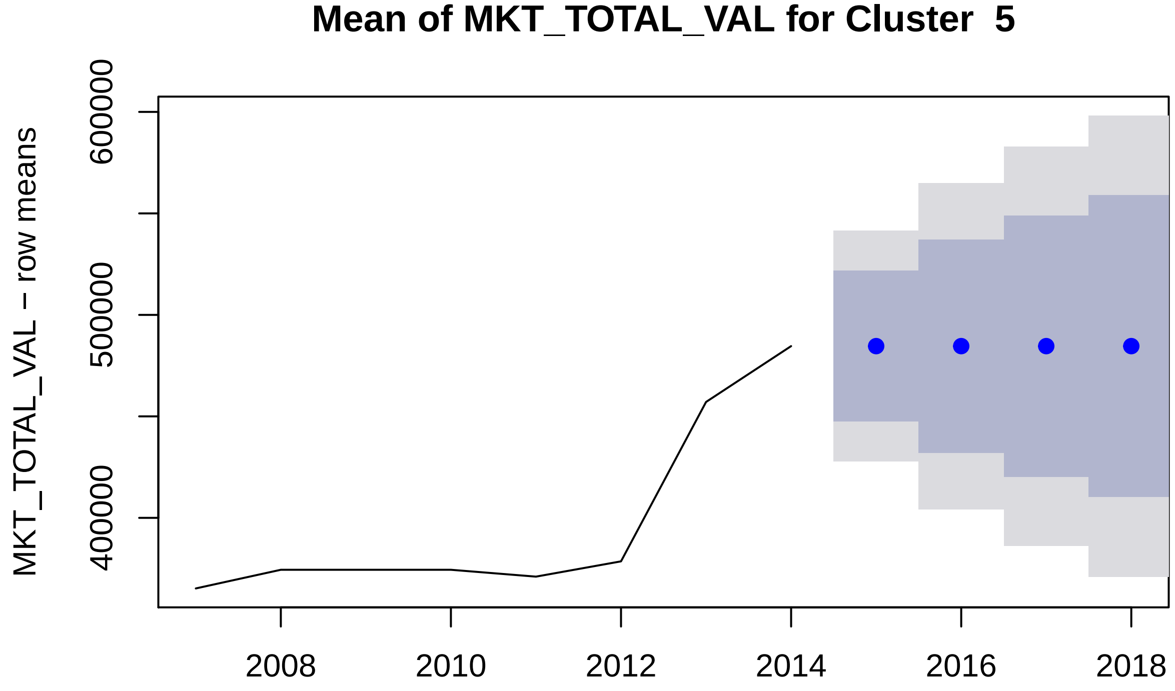

Observed / Fitted
190000
200000
210000
220000
2008

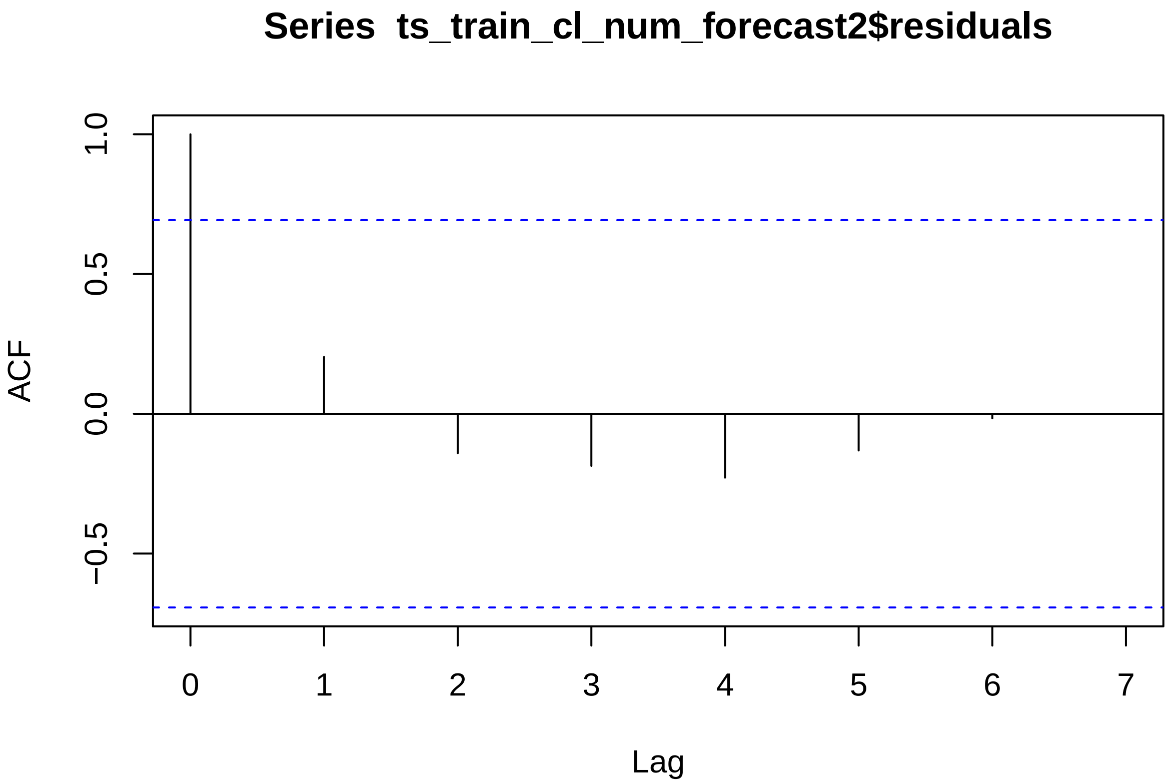

Mean of MKT_TOTAL_VAL for Cluster 4
MKT_TOTAL_VAL − row means
140000
180000
220000
2008
2010
2012
2014
2016
2018

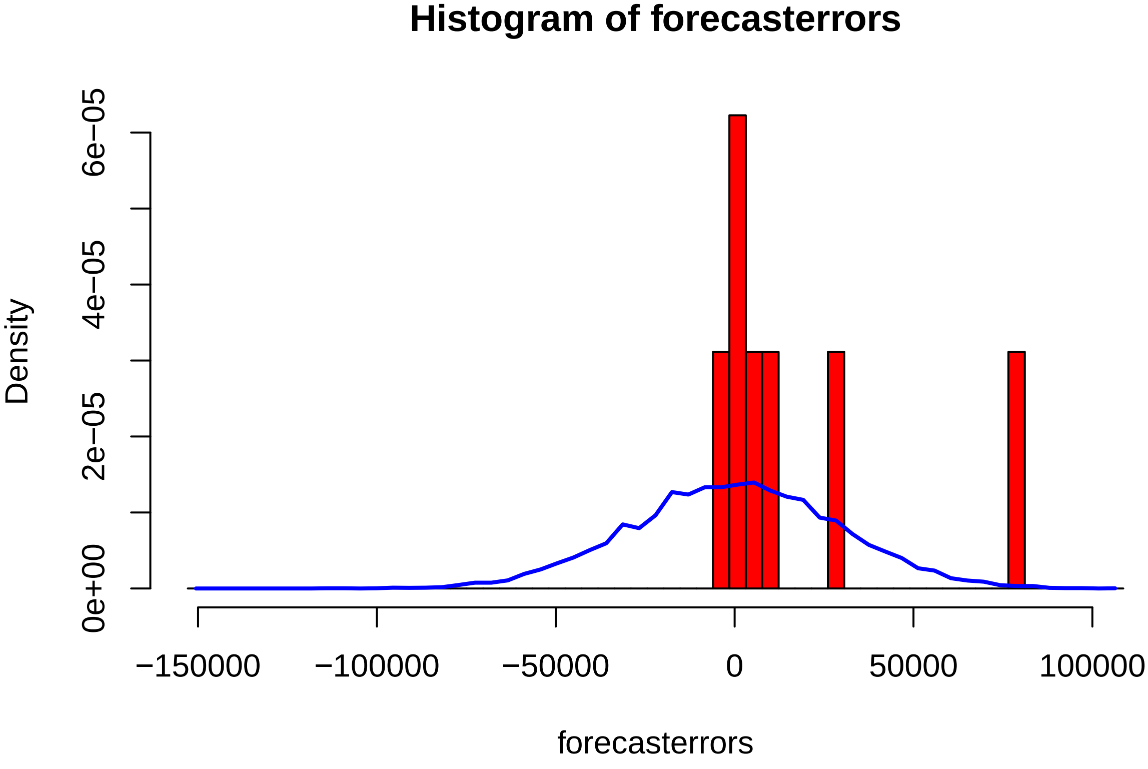

Series ts_train_cl_num_forecast2$residuals
ACF
1.0
0.5
0.0
−0.5
0
1
2
3
4
5
6
7
Lag

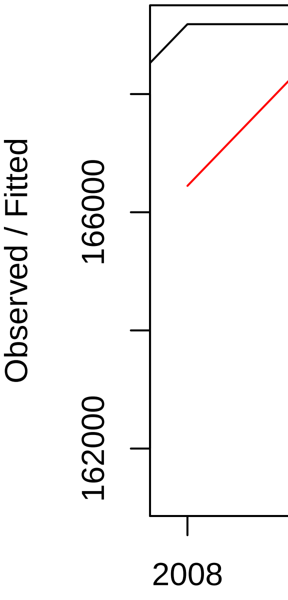

Histogram of forecasterrors
Density
0.00000
0.00010
0.00020
−1e+05
−5e+04
0e+00
5e+04
forecasterrors

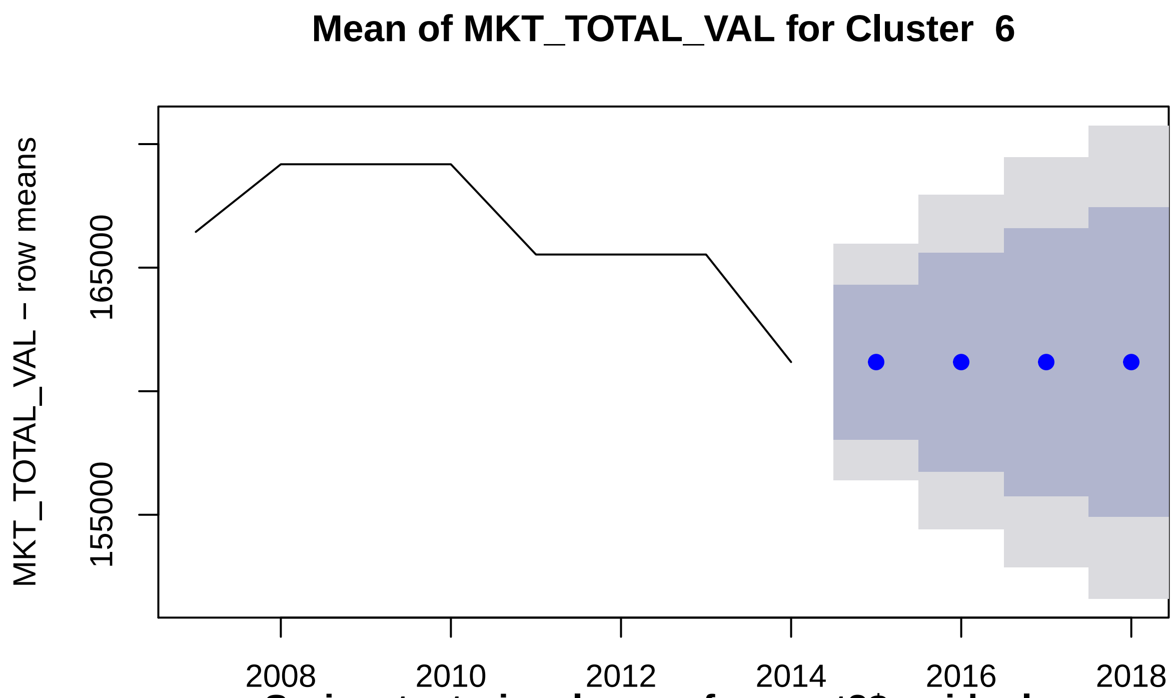

Holt−Winters filtering
Observed / Fitted
380000
420000
460000
2008
2009
2010
2011
2012
2013
2014
Time

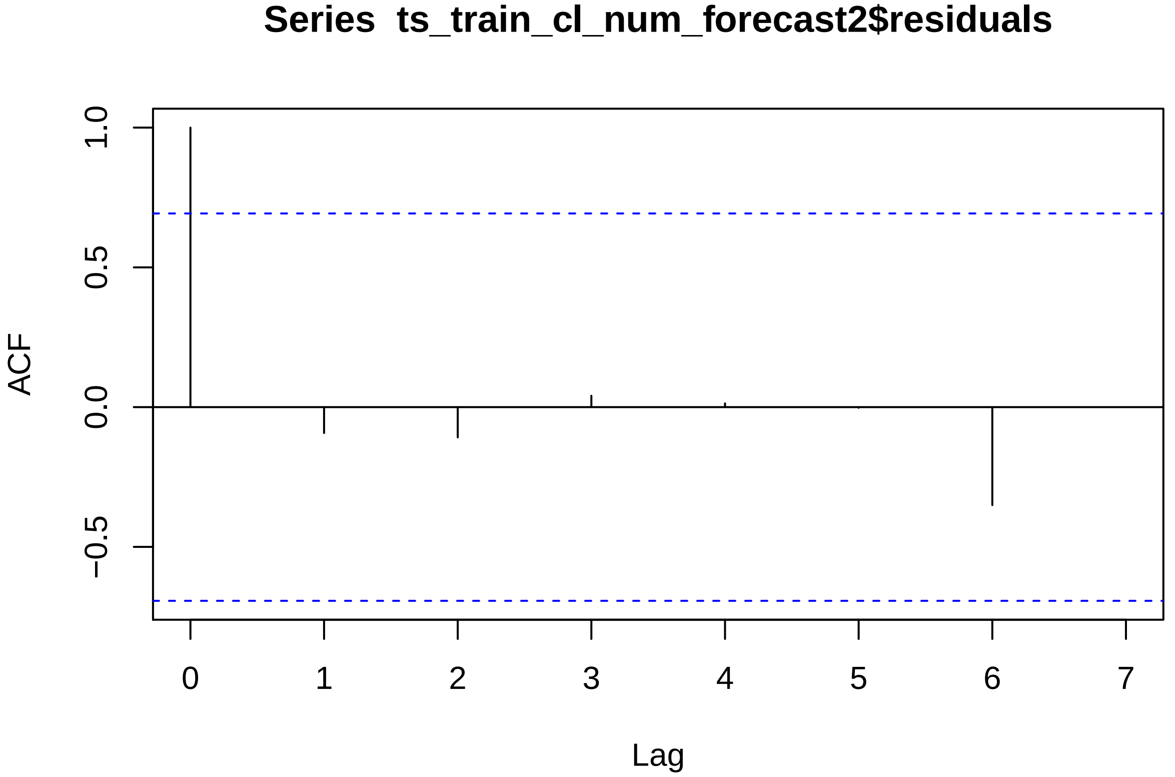

Mean of MKT_TOTAL_VAL for Cluster 5
MKT_TOTAL_VAL − row means
400000
500000
600000
2008
2010
2012
2014
2016
2018

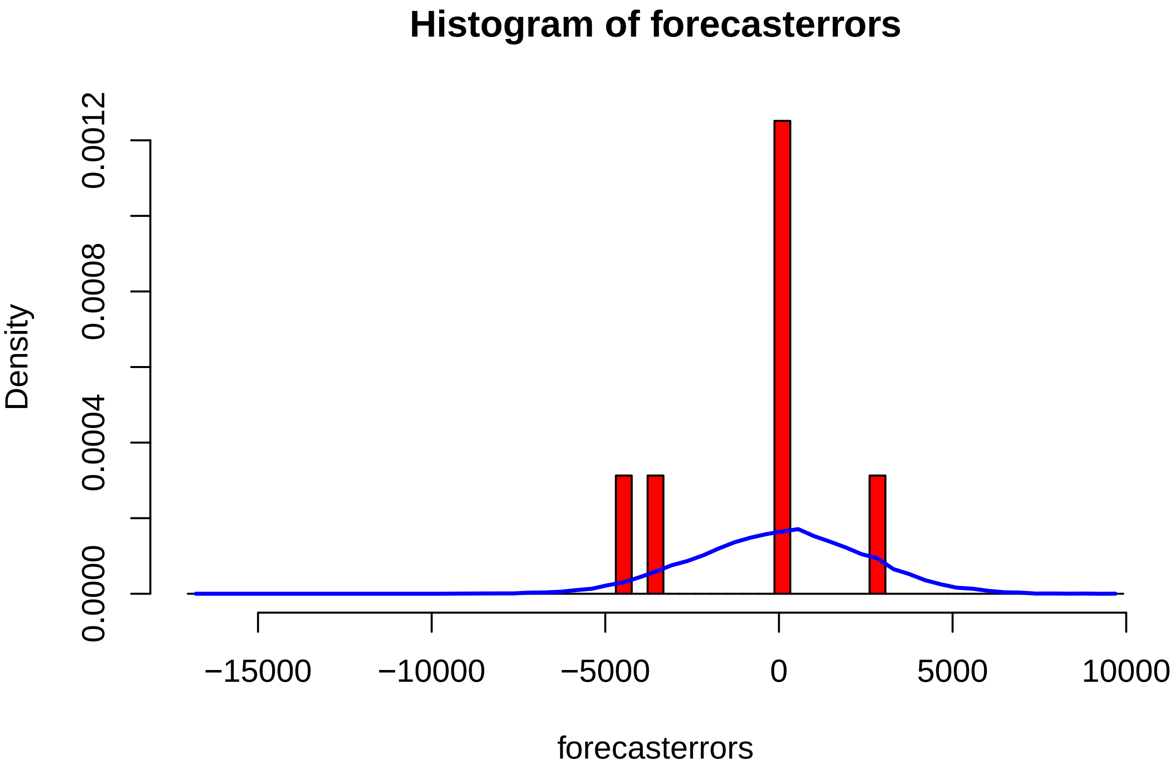

Series ts_train_cl_num_forecast2$residuals
ACF
1.0
0.5
0.0
−0.5
0
1
2
3
4
5
6
7
Lag

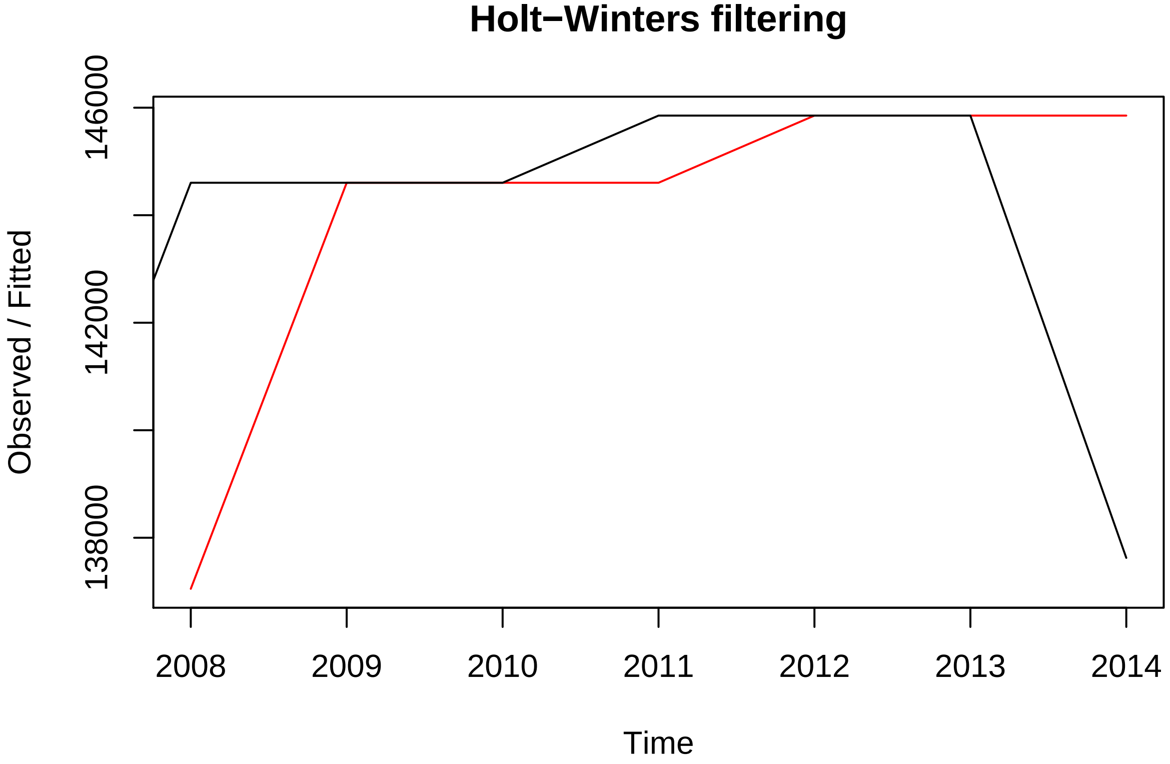

Histogram of forecasterrors
Density
6e−05
4e−05
2e−05
0e+00
−150000
−100000
−50000
0
50000
100000
forecasterrors

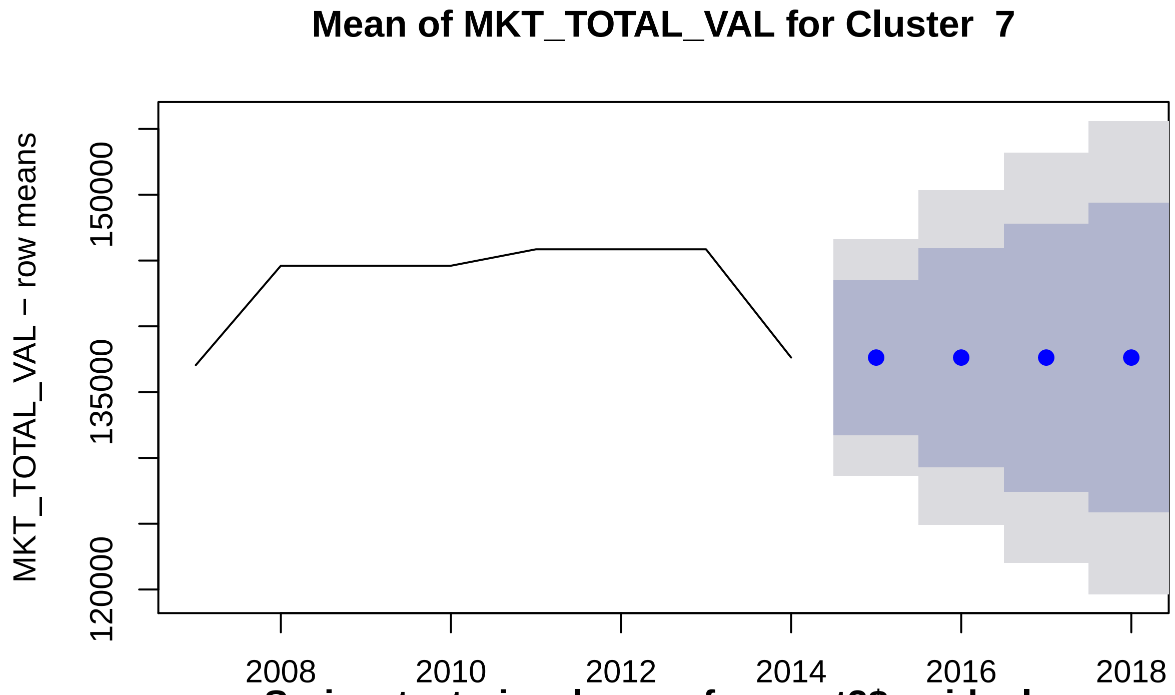

Observed / Fitted
166000
162000
2008

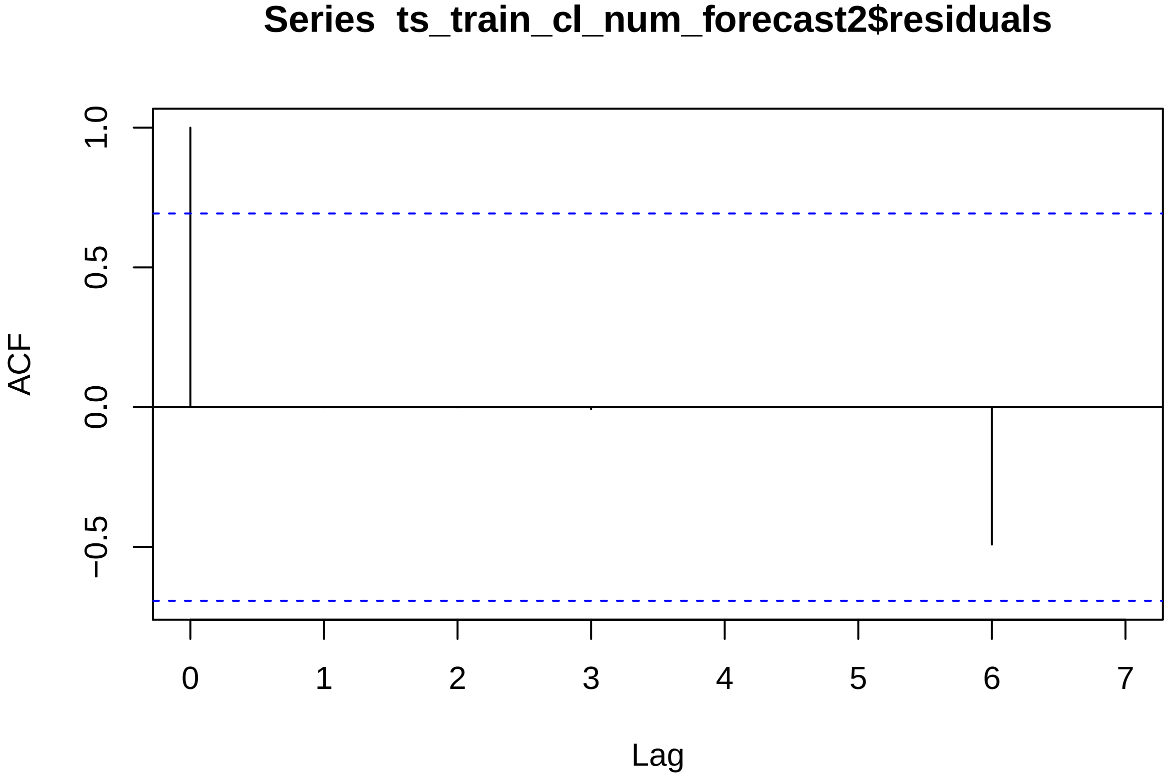

Mean of MKT_TOTAL_VAL for Cluster 6

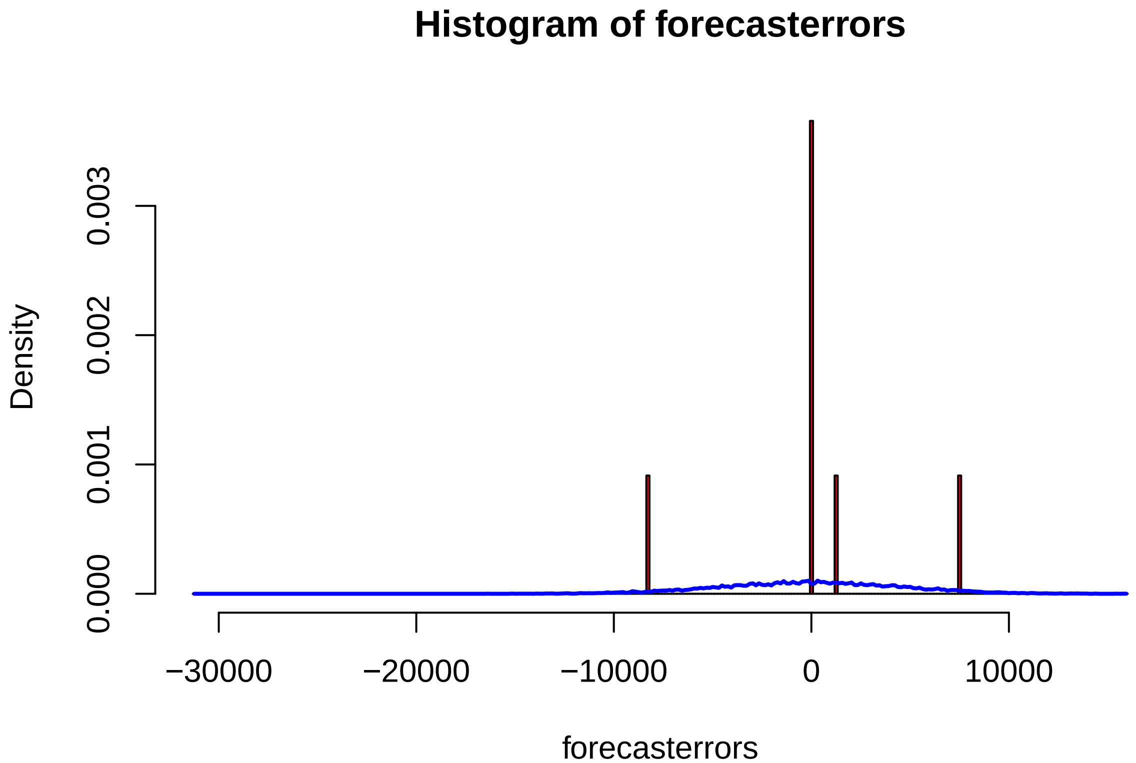

Series ts_train_cl_num_forecast2$residuals

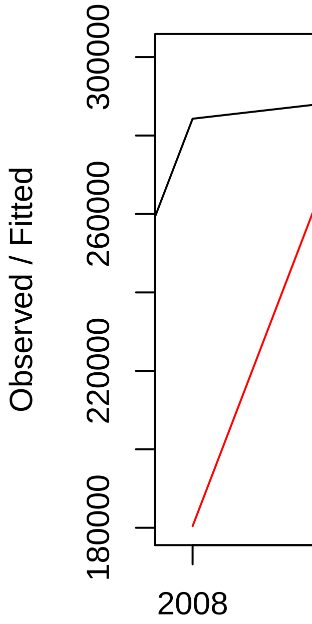

Histogram of forecasterrors
Density
0.0000
0.0004
0.0008
0.0012
−15000
−10000
−5000
0
5000
10000
forecasterrors

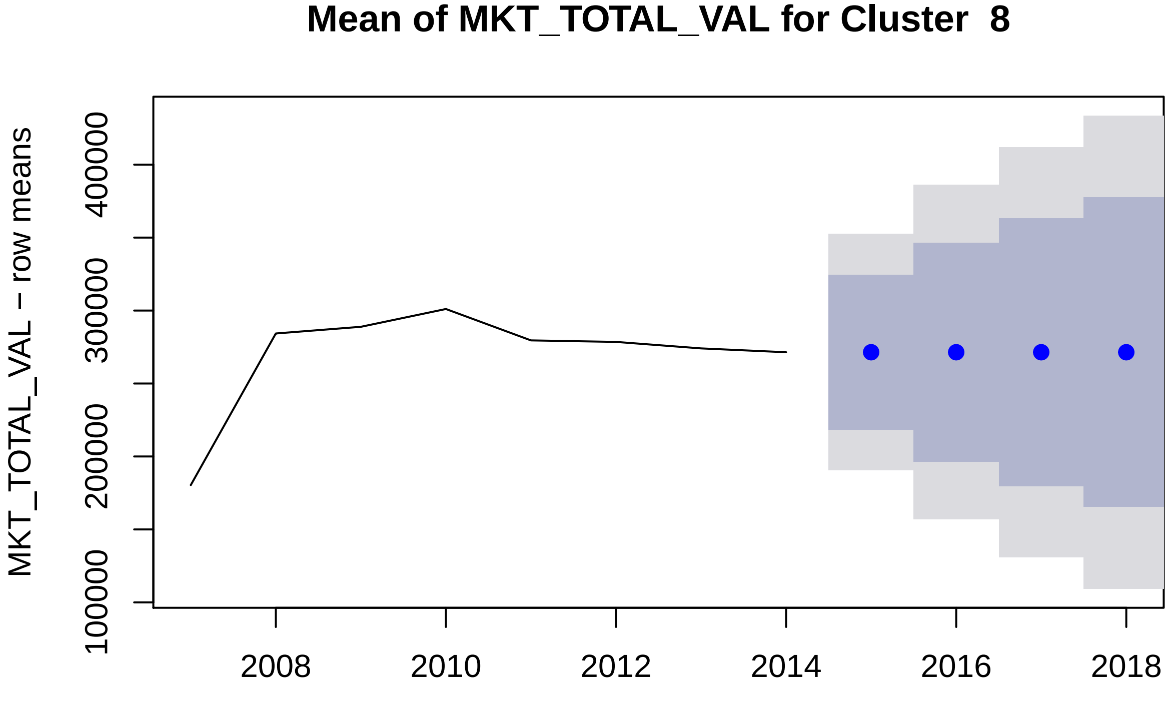

Holt−Winters filtering
Observed / Fitted
138000
142000
146000
2008
2009
2010
2011
2012
2013
2014
Time

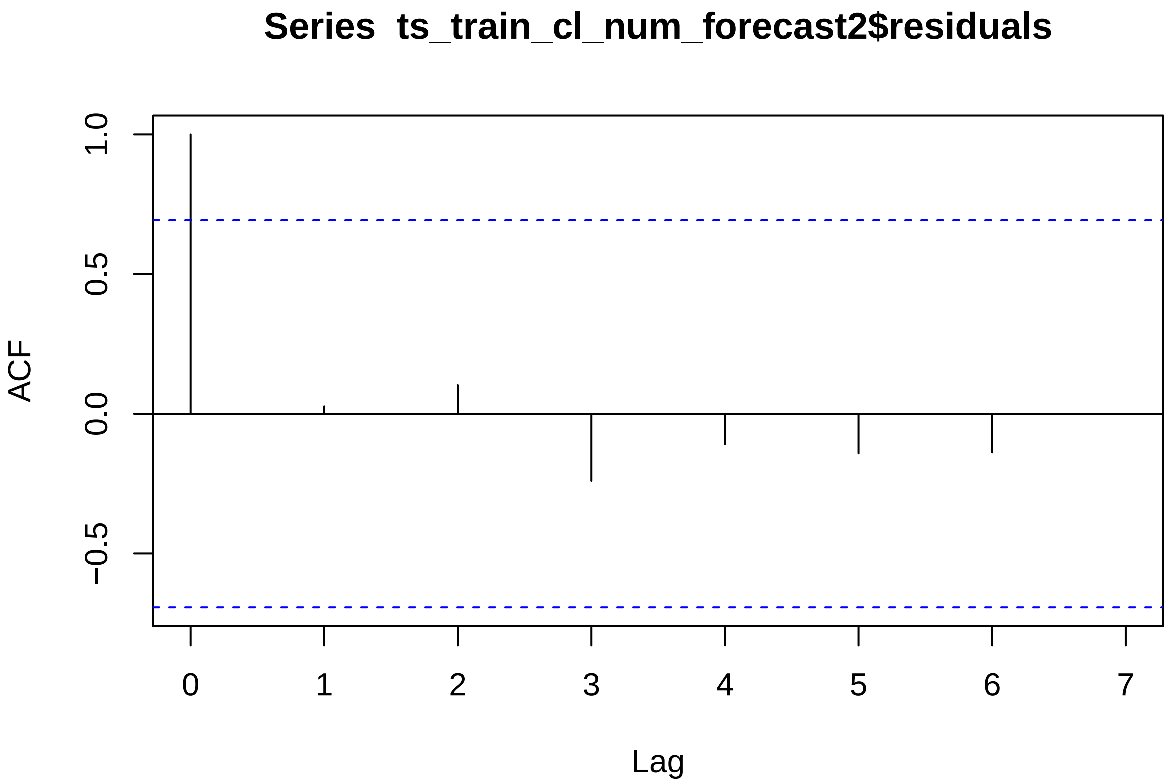

Mean of MKT_TOTAL_VAL for Cluster 7
MKT_TOTAL_VAL – row means
120000
135000
150000
2008
2010
2012
2014
2016
2018

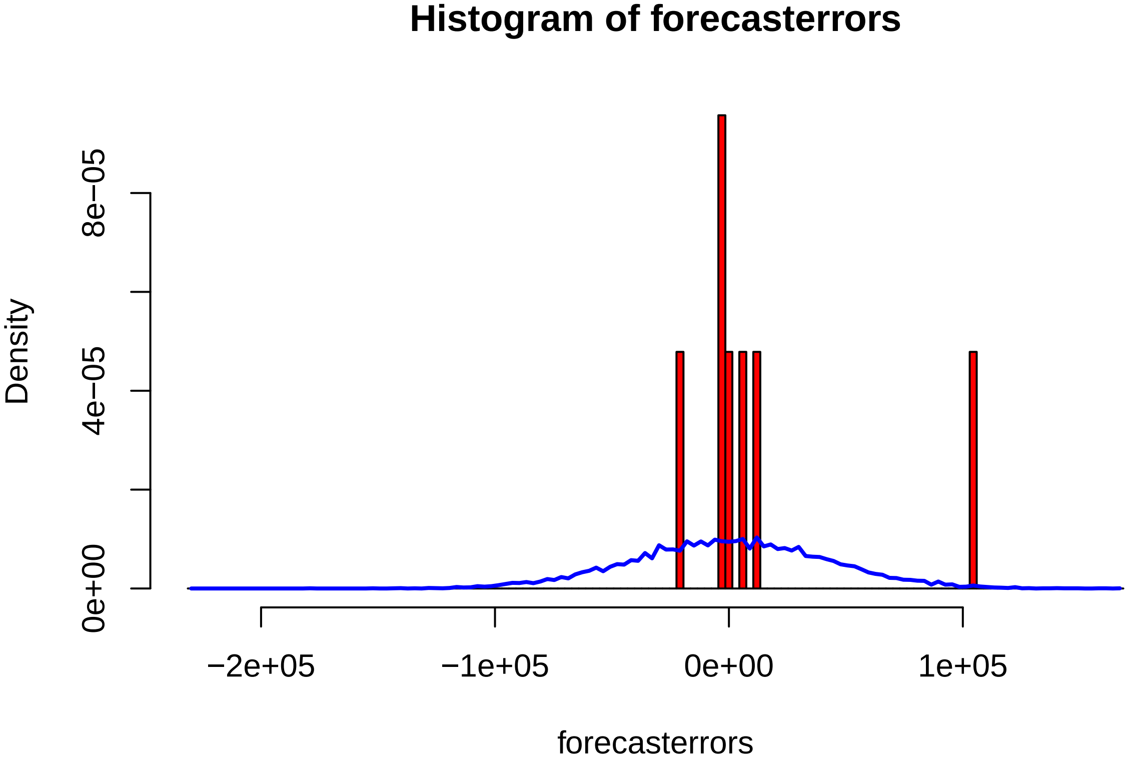

Series ts_train_cl_num_forecast2$residuals
ACF
−0.5
0.0
0.5
1.0
0
1
2
3
4
5
6
7
Lag

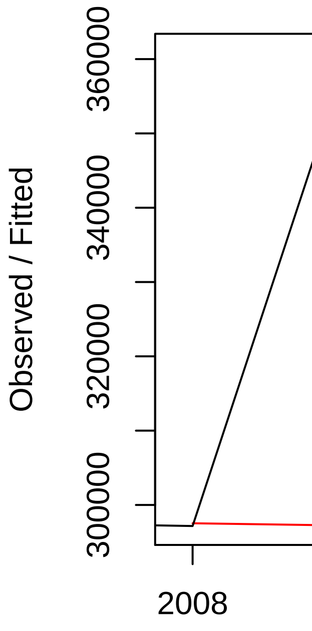

Histogram of forecasterrors
Density
0.000
0.001
0.002
0.003
−30000
−20000
−10000
0
10000
forecasterrors

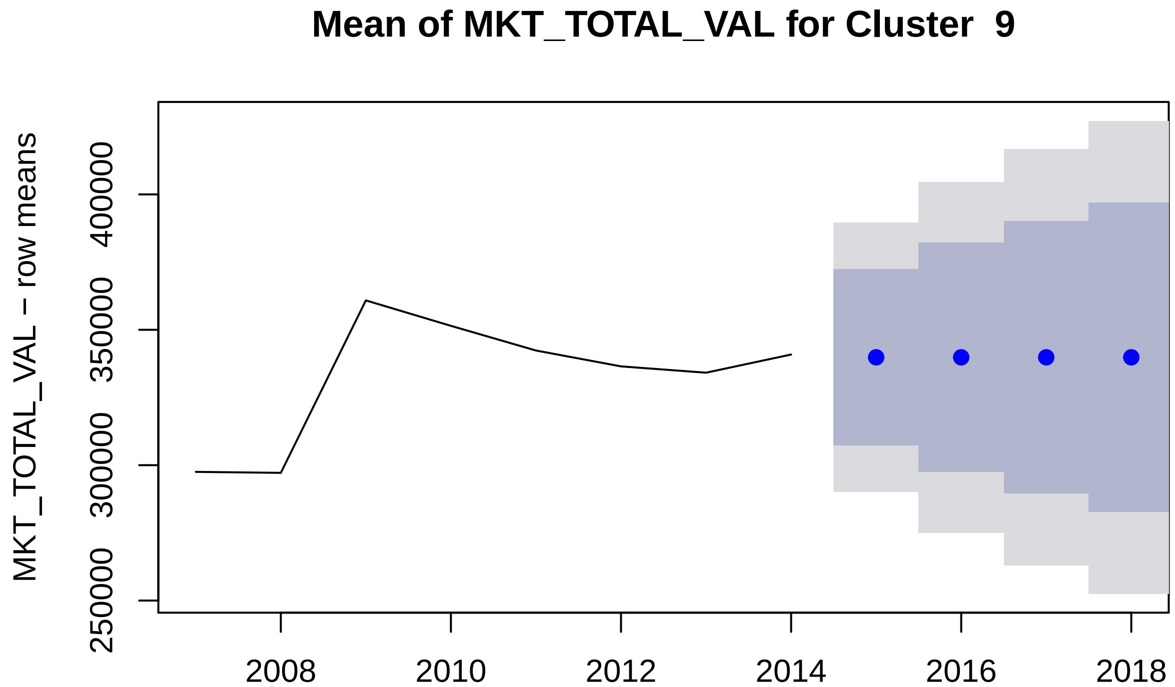

Observed / Fitted
180000
220000
260000
300000
2008

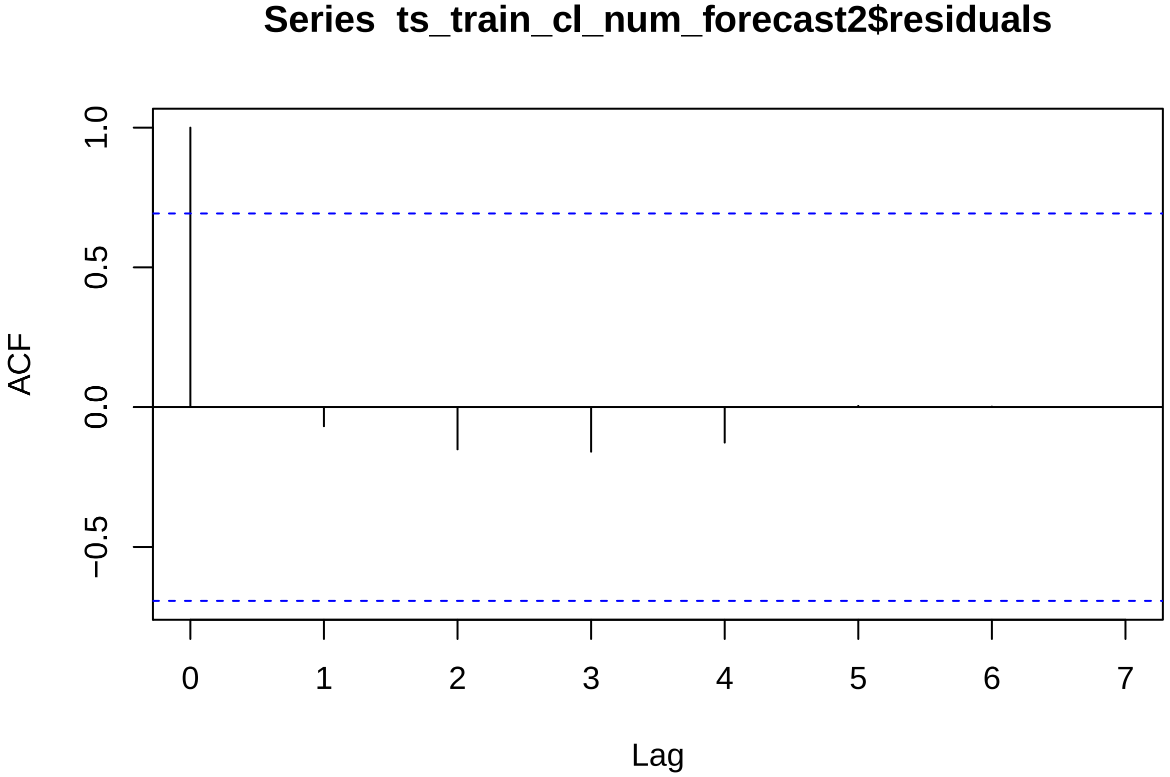

Mean of MKT_TOTAL_VAL for Cluster 8
MKT_TOTAL_VAL – row means
100000
200000
300000
400000
2008
2010
2012
2014
2016
2018

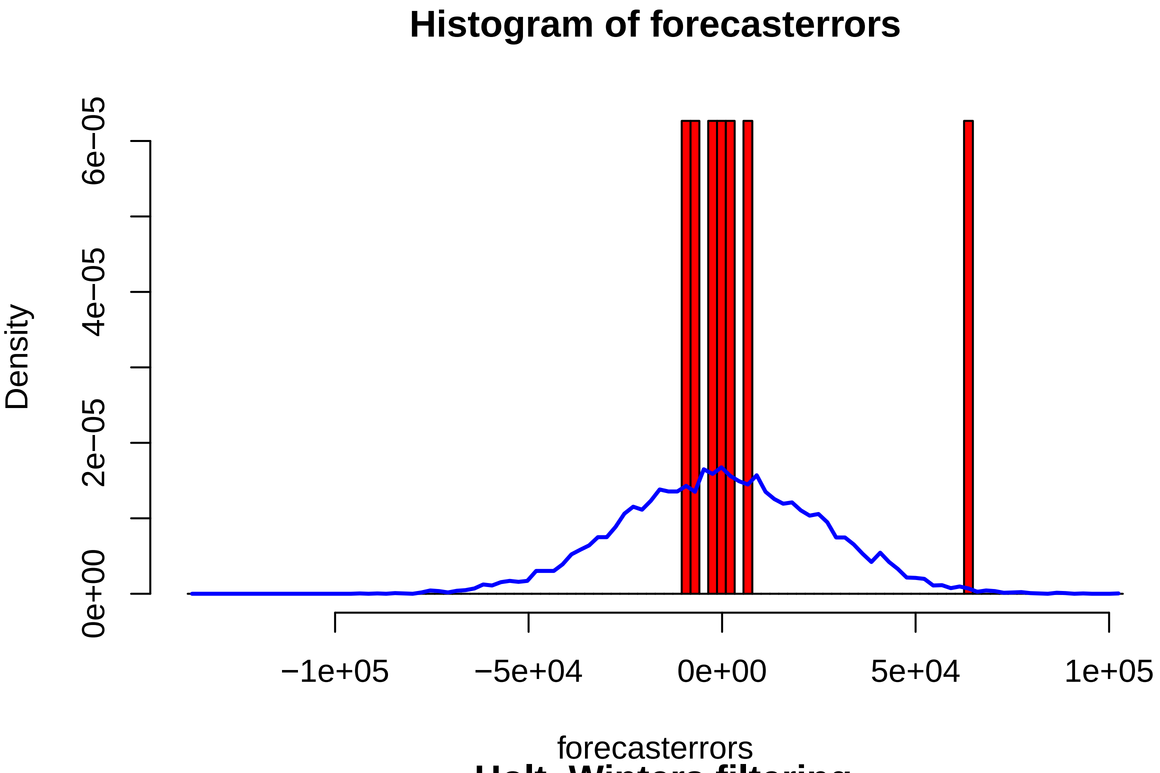

Series ts_train_cl_num_forecast2$residuals
ACF
1.0
0.5
0.0
−0.5
0
1
2
3
4
5
6
7
Lag

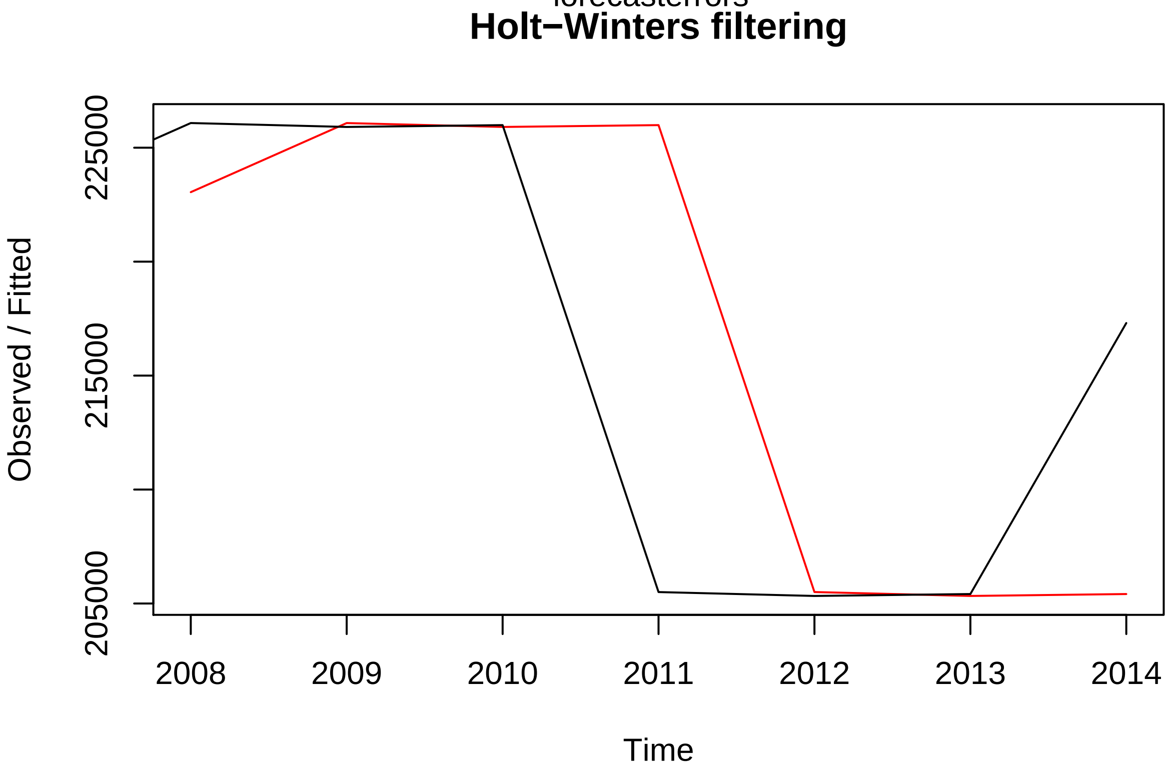

Histogram of forecasterrors
Density
8e−05
4e−05
0e+00
−2e+05
−1e+05
0e+00
1e+05
forecasterrors

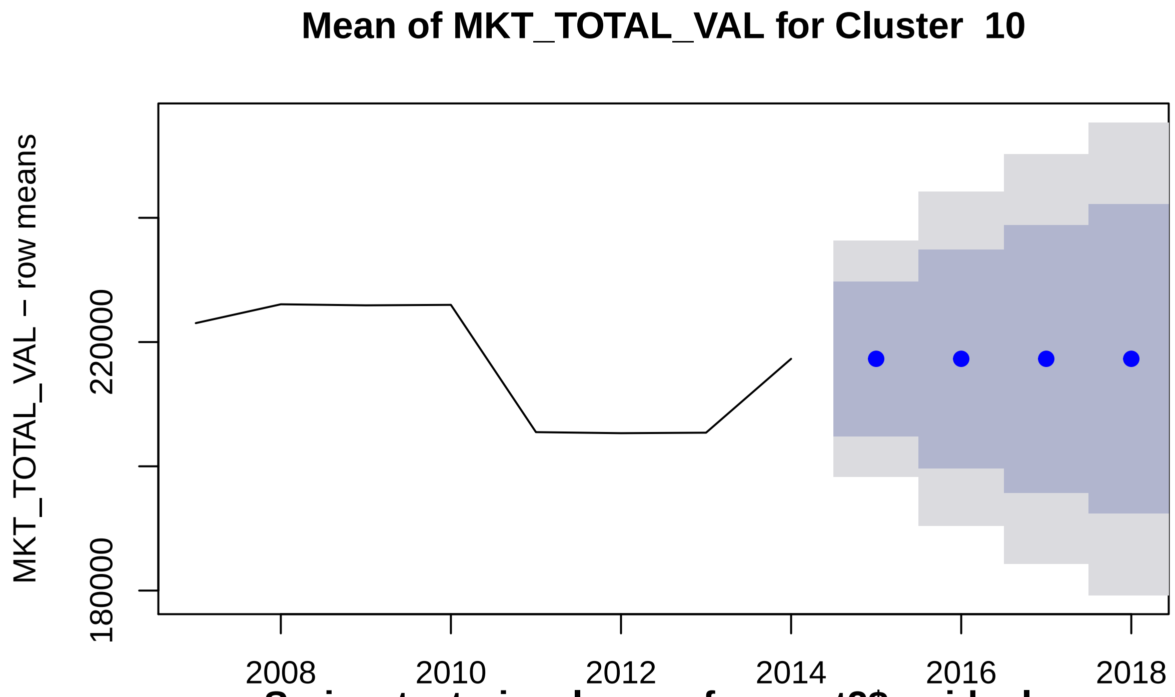

Observed / Fitted
360000
340000
320000
300000
2008

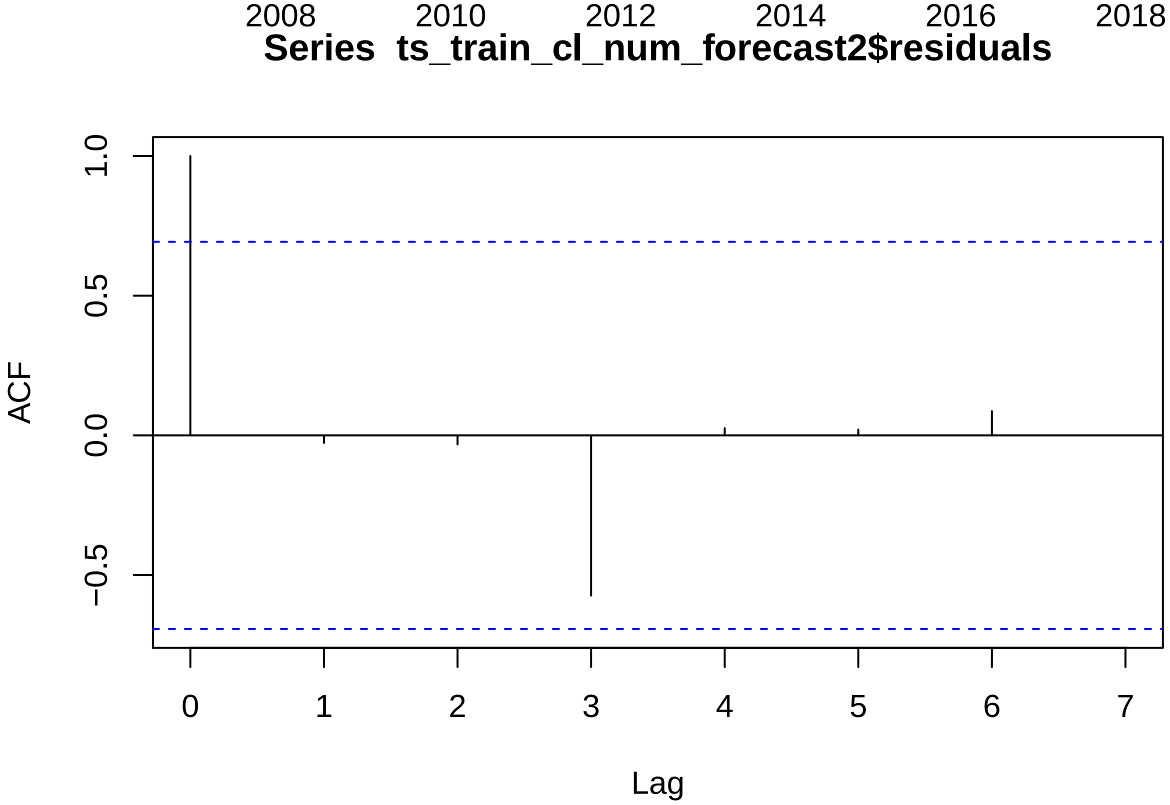

Mean of MKT_TOTAL_VAL for Cluster 9
MKT_TOTAL_VAL – row means
250000
300000
350000
400000
2008
2010
2012
2014
2016
2018

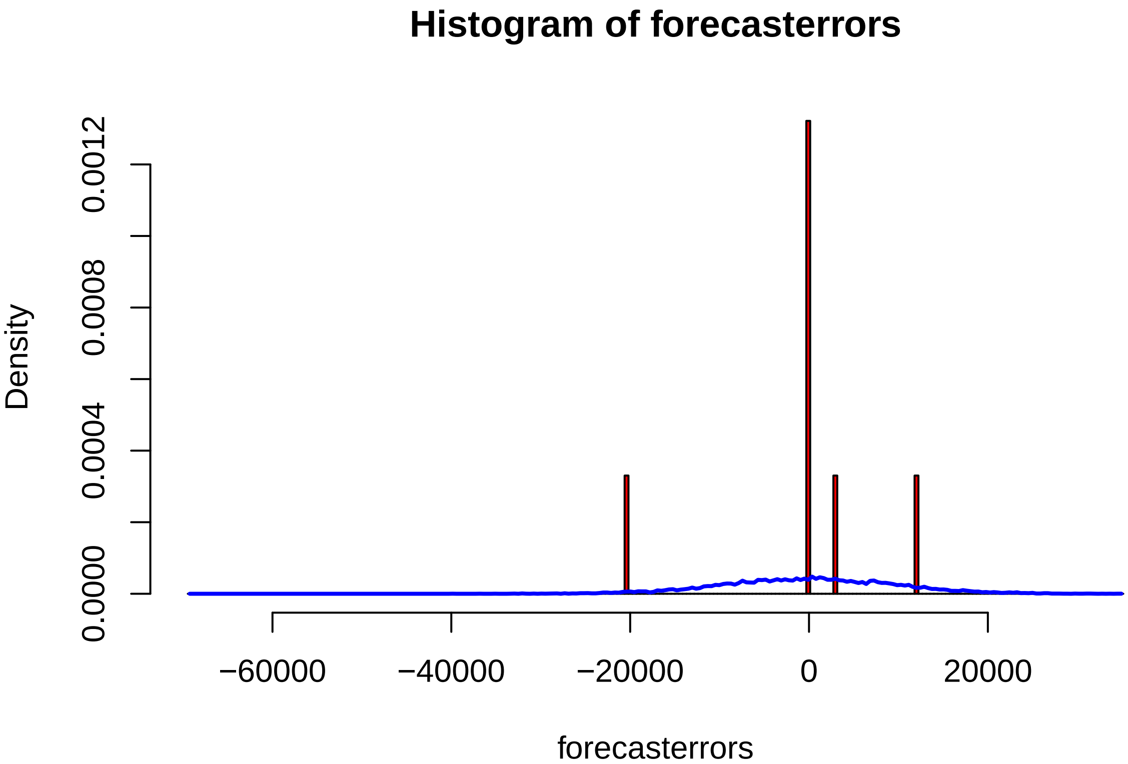

Series ts_train_cl_num_forecast2$residuals
ACF
−0.5
0.0
0.5
1.0
0
1
2
3
4
5
6
7
Lag

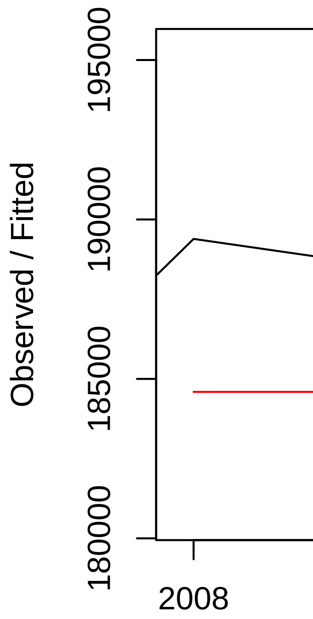

Histogram of forecasterrors
Density
0e+00
2e−05
4e−05
6e−05
−1e+05
−5e+04
0e+00
5e+04
1e+05
forecasterrors

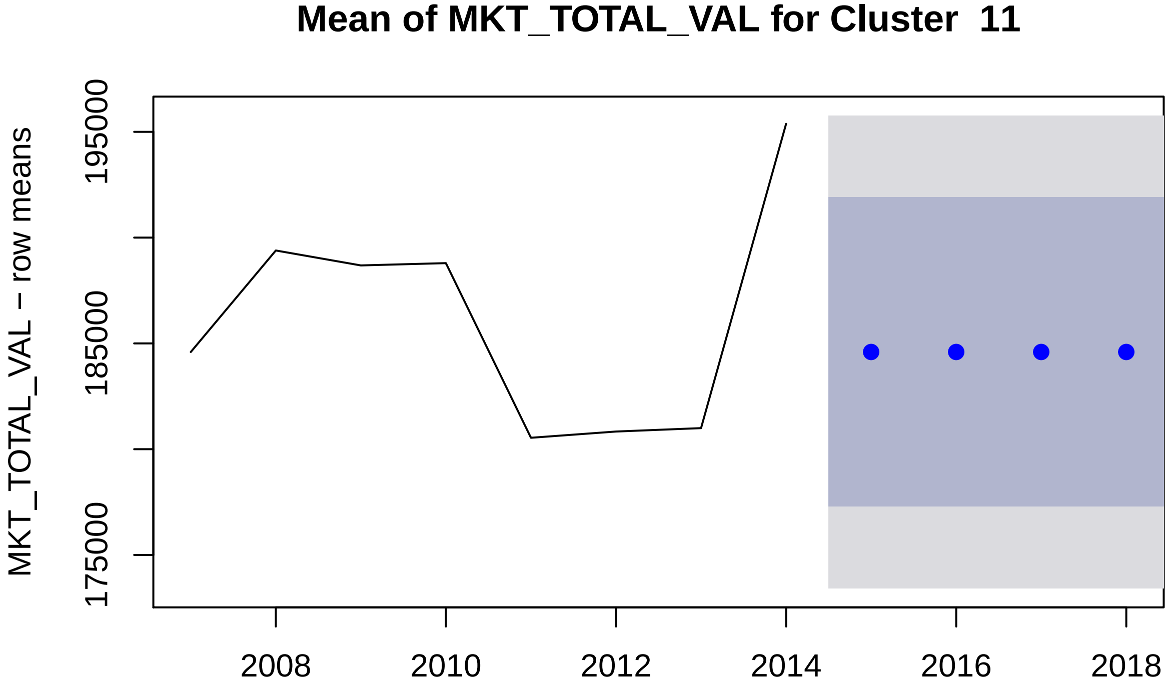

Holt−Winters filtering
Observed / Fitted
205000
215000
225000
2008
2009
2010
2011
2012
2013
2014
Time


Mean of MKT_TOTAL_VAL for Cluster 10
MKT_TOTAL_VAL – row means
180000
220000
2008
2010
2012
2014
2016
2018

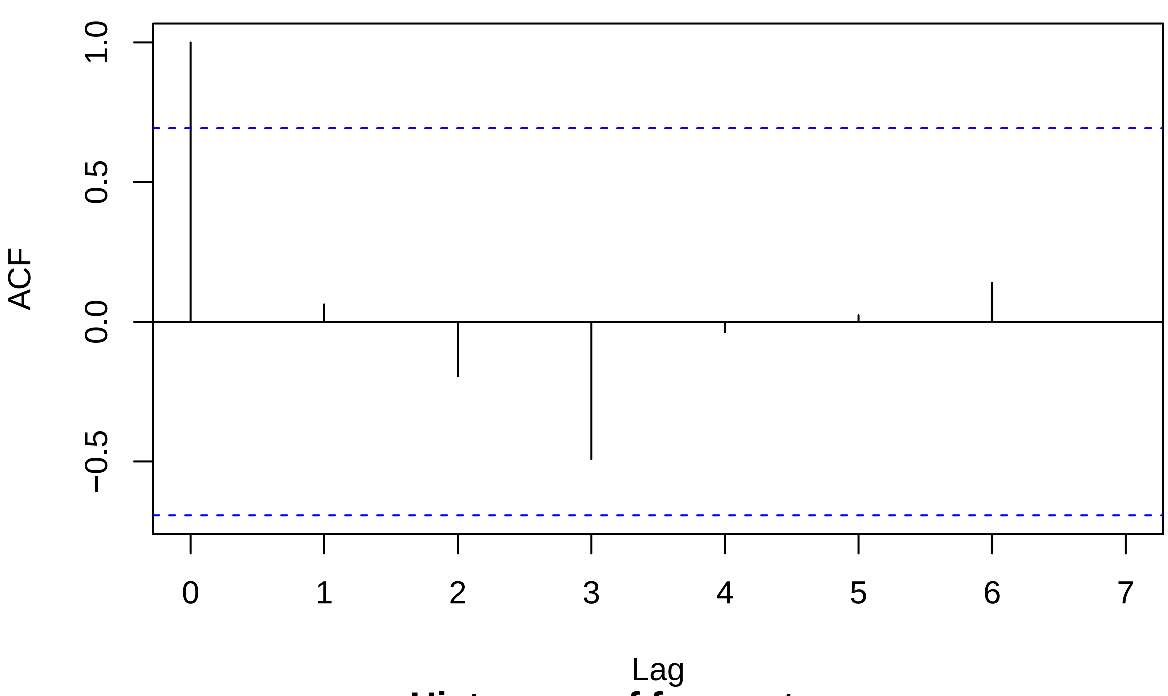

Series ts_train_cl_num_forecast2$residuals
ACF
−0.5
0.0
0.5
1.0
0
1
2
3
4
5
6
7
Lag


Histogram of forecasterrors
Density
0.0000
0.0004
0.0008
0.0012
−60000
−40000
−20000
0
20000
forecasterrors

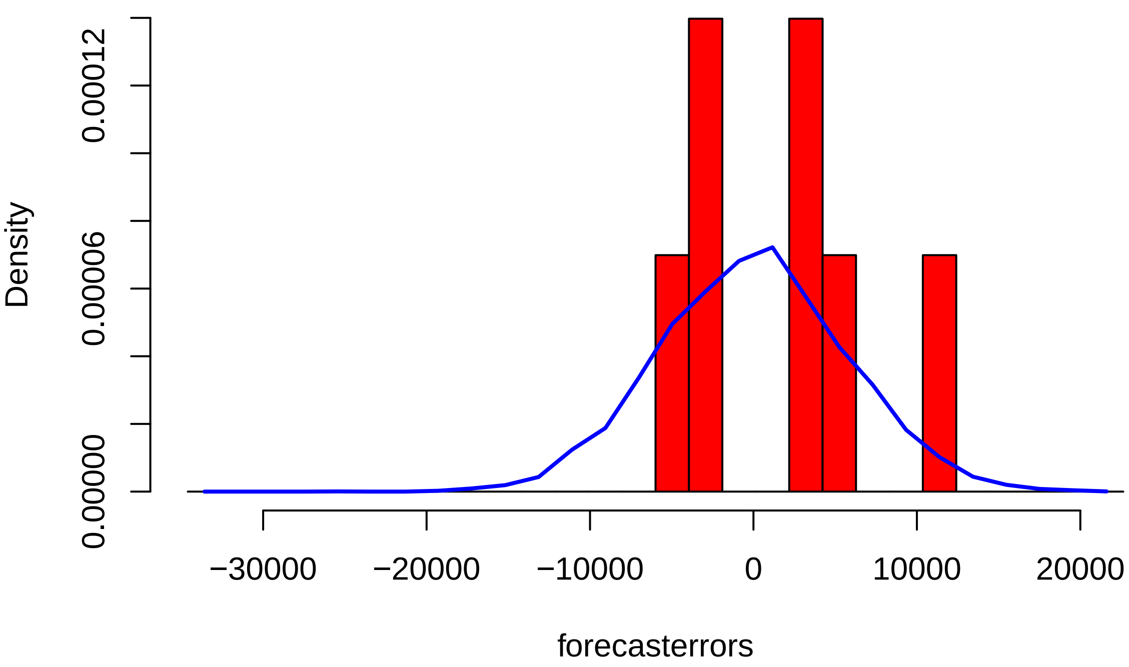

Observed / Fitted
180000
185000
190000
195000
2008

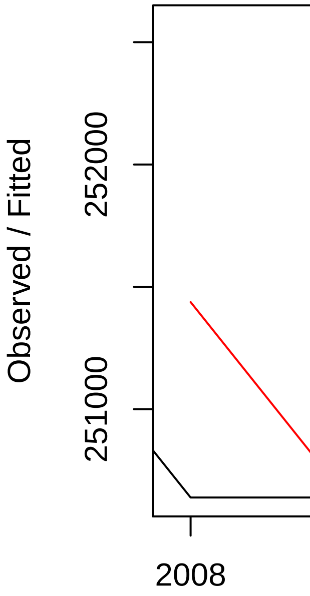

Mean of MKT_TOTAL_VAL for Cluster 11
MKT_TOTAL_VAL − row means
175000
185000
195000
2008
2010
2012
2014
2016
2018

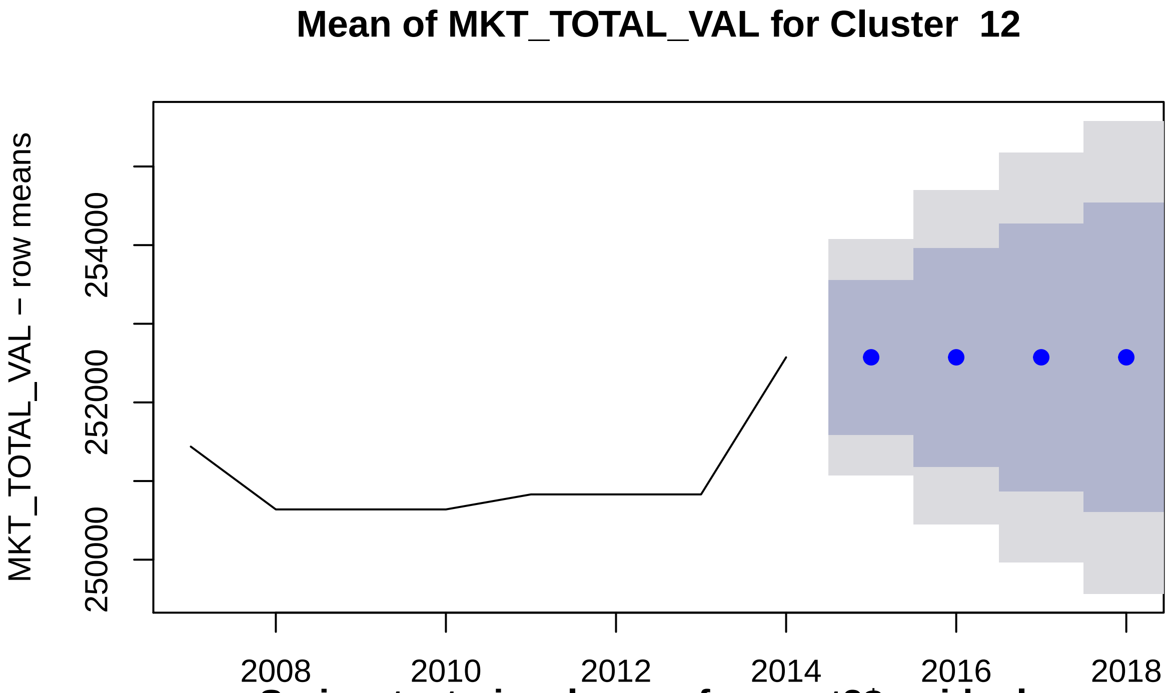
Series ts_train_cl_num_forecast2$residuals

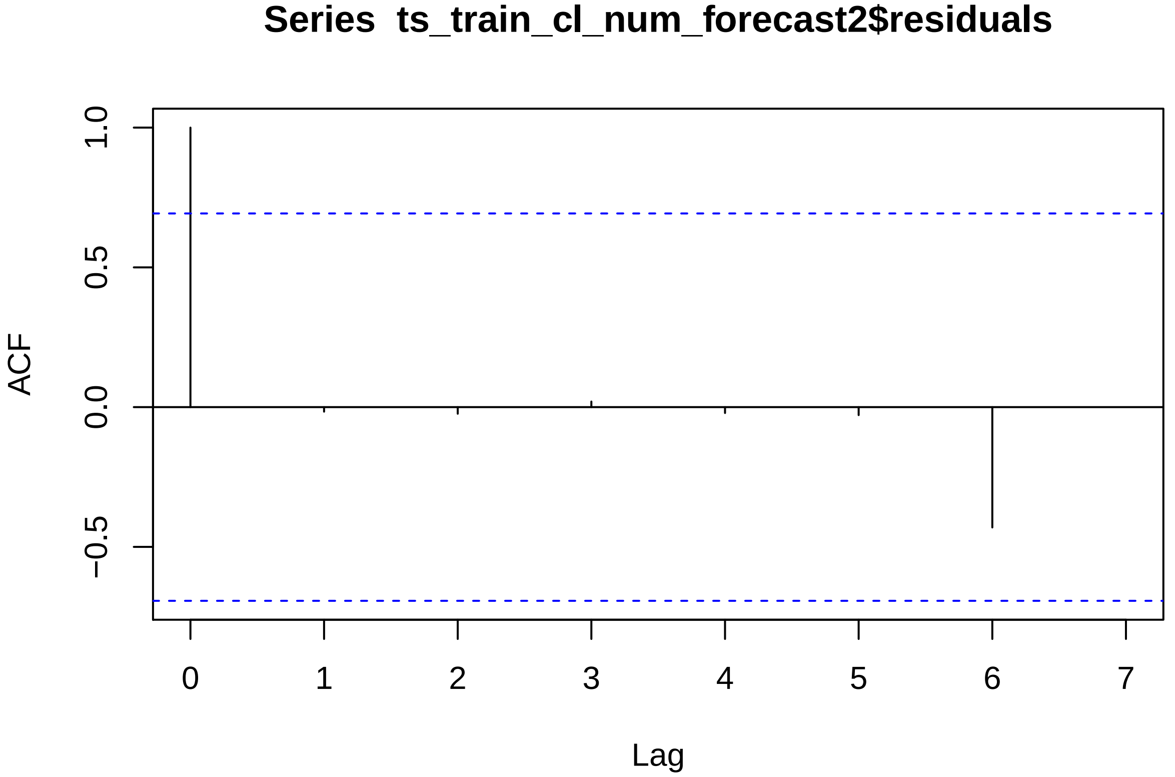


Histogram of forecasterrors









```
## [1] "NON BUFFER ZONE : Plotting Actuals vs. Fitted for models in clusters"
## [1] "NON BUFFER ZONE : Evaluating 12 Clusters with 1st, 2nd, 3rd and 4th and 5th order polynomial reg
## [1] "NON BUFFER ZONE : Years 2007-2014 serve as training data"
## [1] "NON BUFFER ZONE : Years 2015-2018 serve as test data for validation"

## Warning in window.default(x, ...): 'end' value not changed

## Warning in window.default(x, ...): 'end' value not changed
## Warning in window.default(x, ...): 'end' value not changed

## Warning in window.default(x, ...): 'end' value not changed

## Warning in window.default(x, ...): 'end' value not changed

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## Warning in window.default(x, ...): 'end' value not changed

## Warning in window.default(x, ...): 'end' value not changed

## Warning in window.default(x, ...): 'end' value not changed

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## Warning in window.default(x, ...): 'end' value not changed

## Warning in window.default(x, ...): 'end' value not changed

## Warning in window.default(x, ...): 'end' value not changed

## Warning in window.default(x, ...): 'end' value not changed

## Warning in window.default(x, ...): 'end' value not changed

## Warning in window.default(x, ...): 'end' value not changed

## Warning in window.default(x, ...): 'end' value not changed

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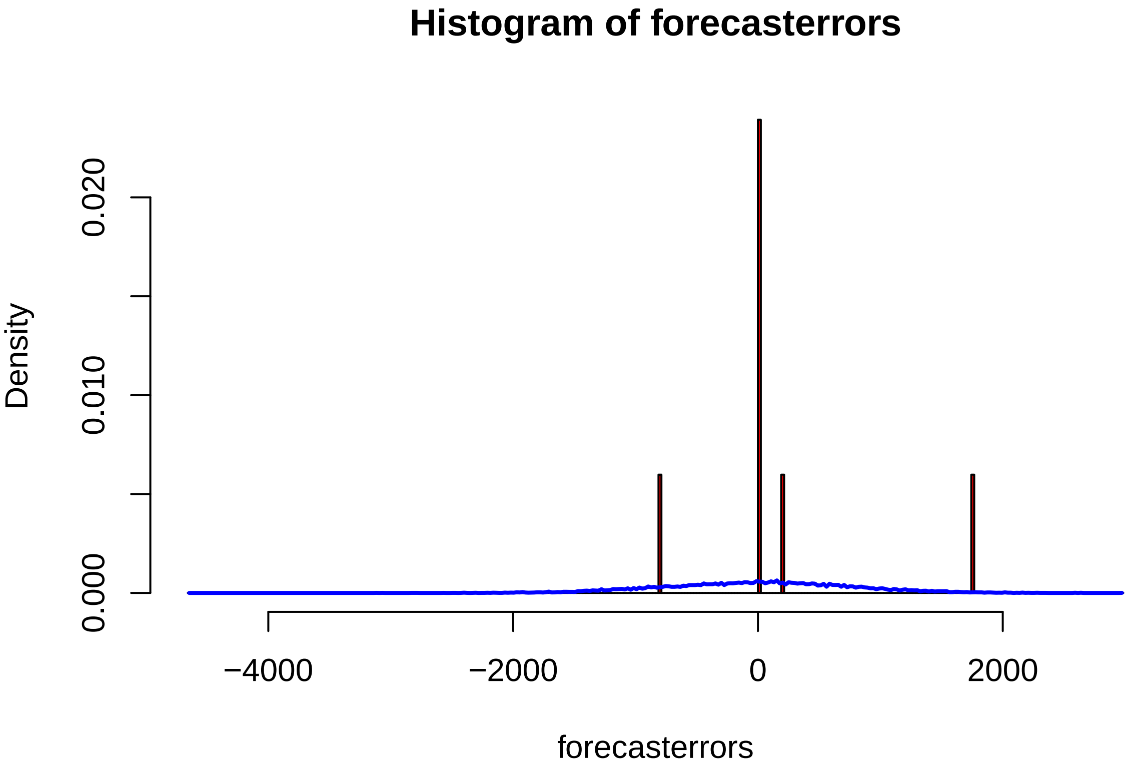
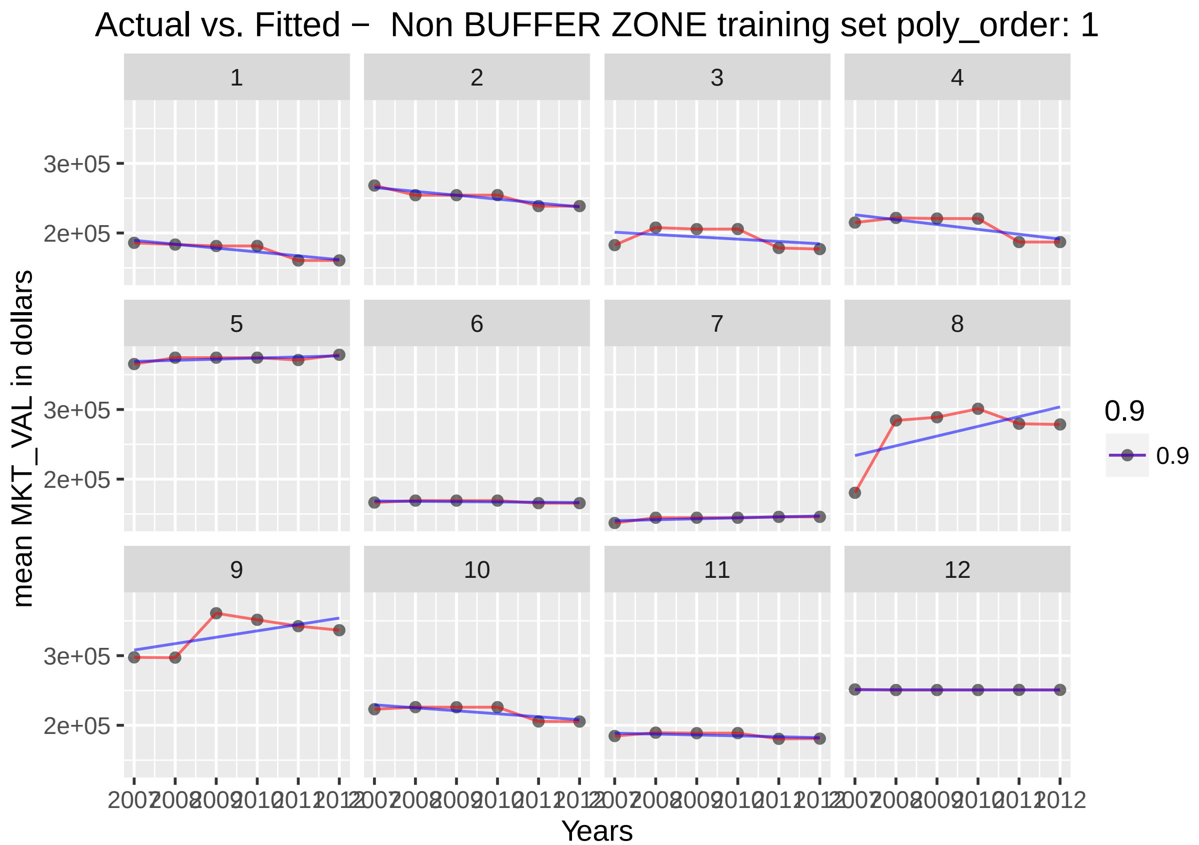
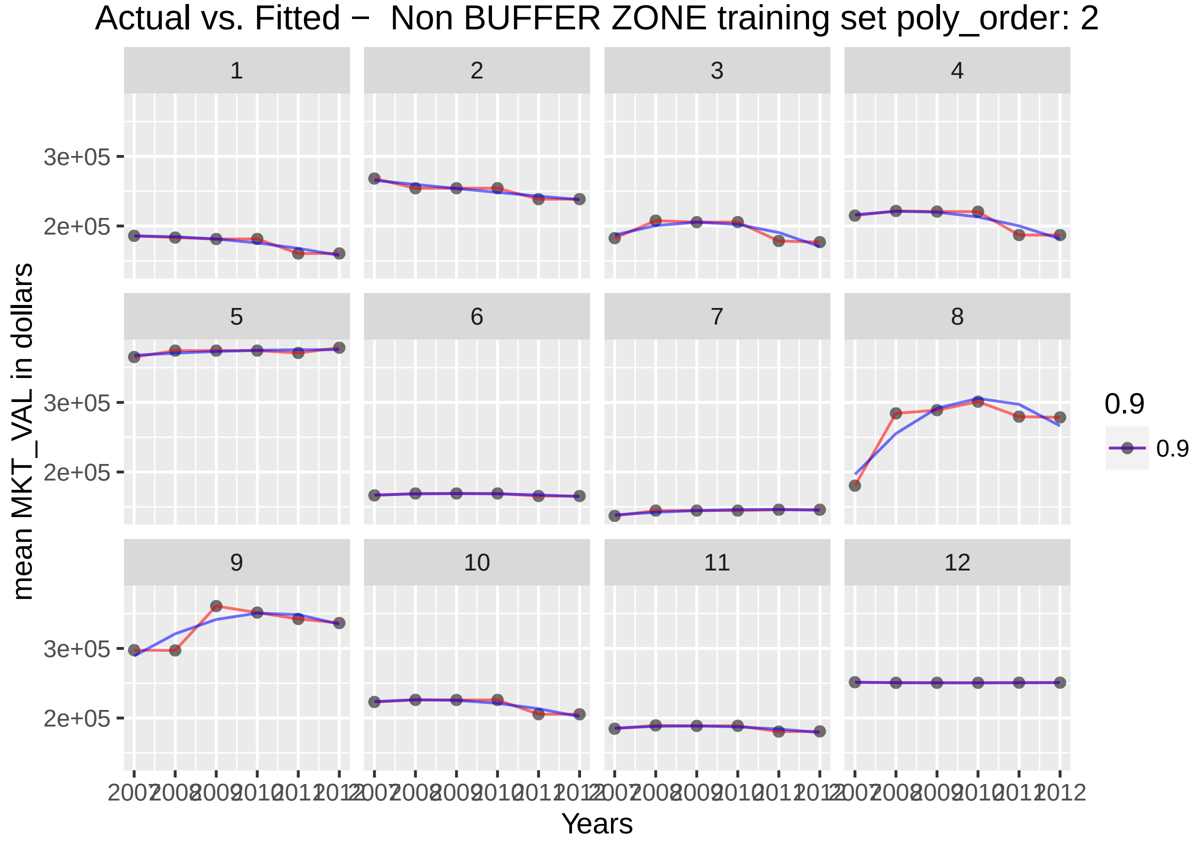
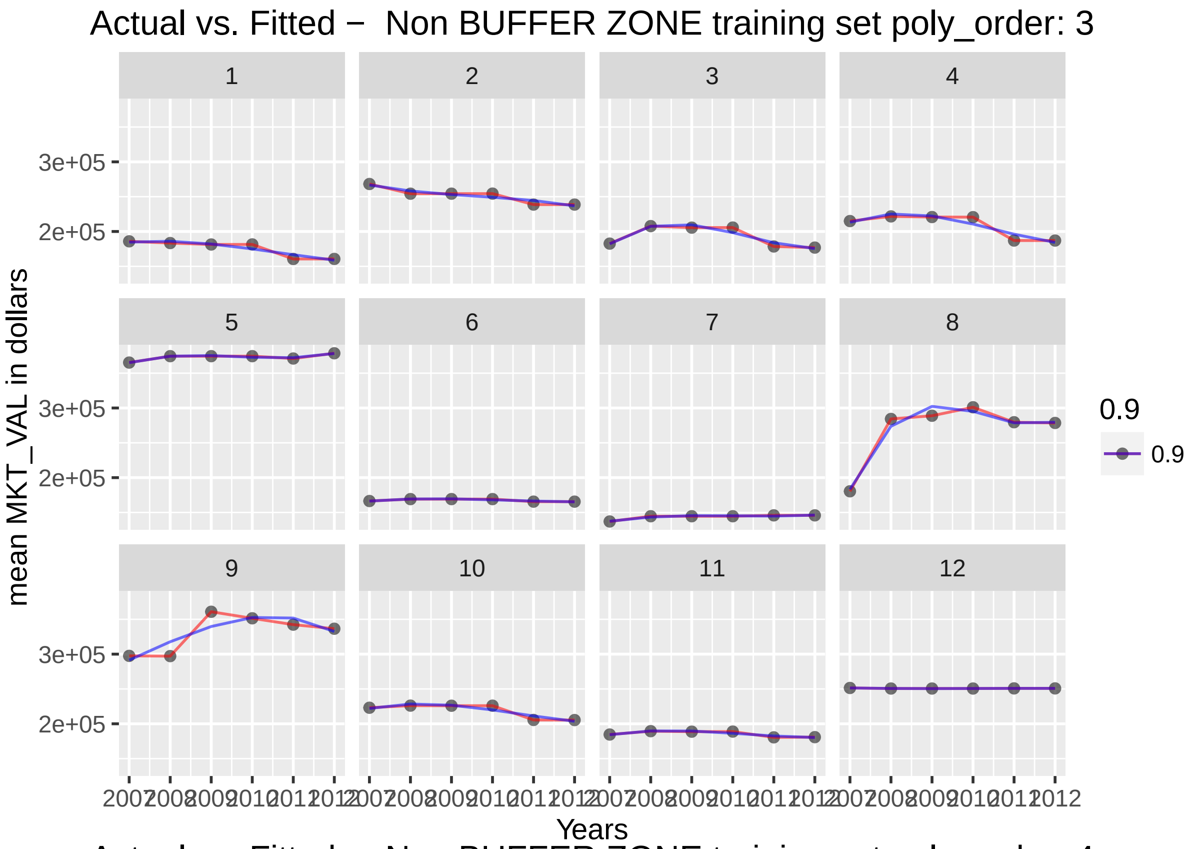
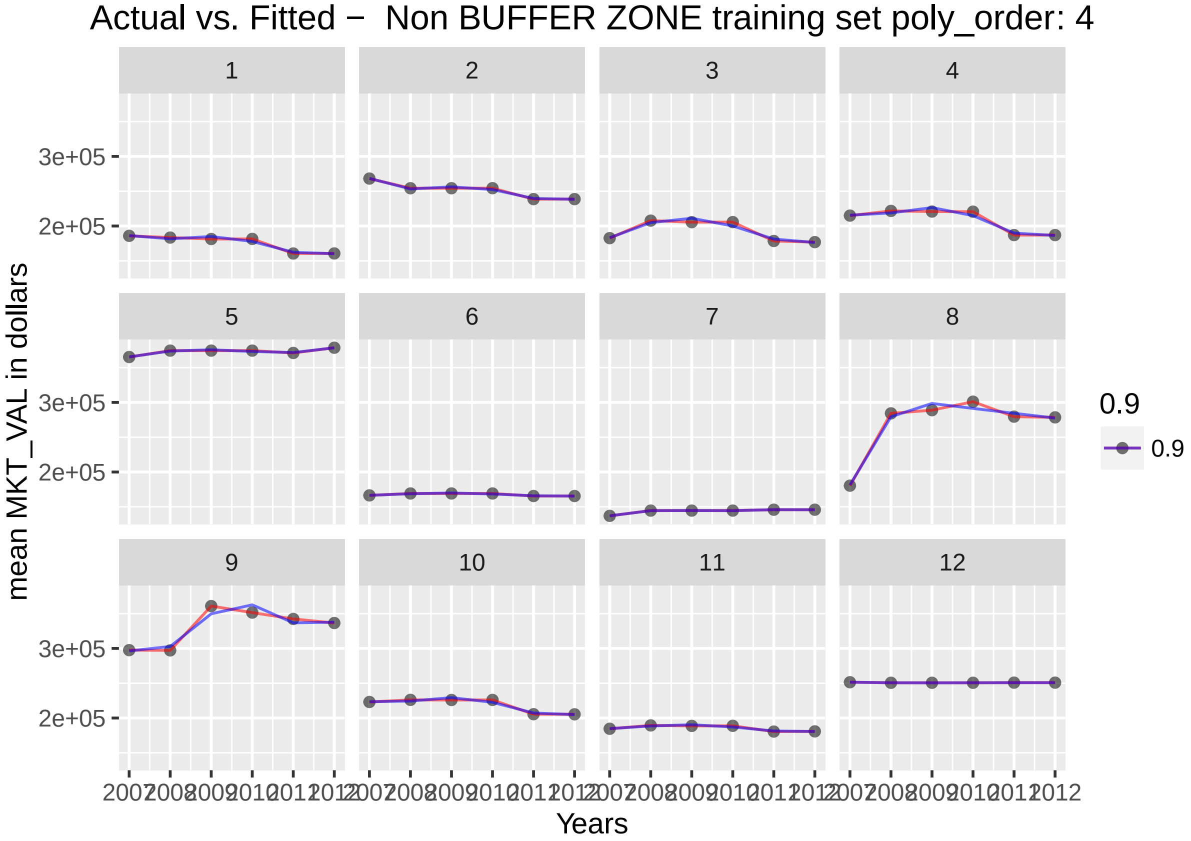


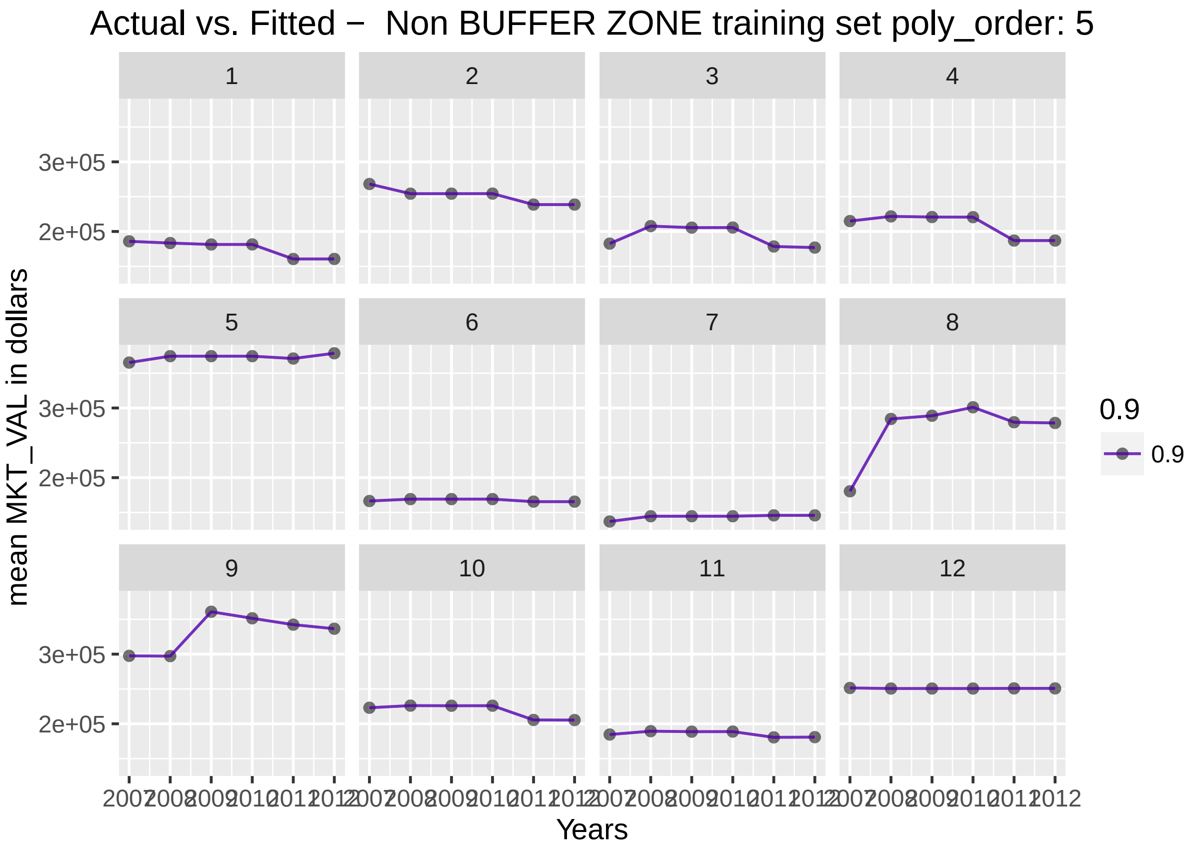
```
## [1] "NON BUFFER ZONE : Computing MAPE - Mean Absolute Percentage error"
## [1] "NON BUFFER ZONE: Plotting the Actual vs. Fitted for Training set "
```

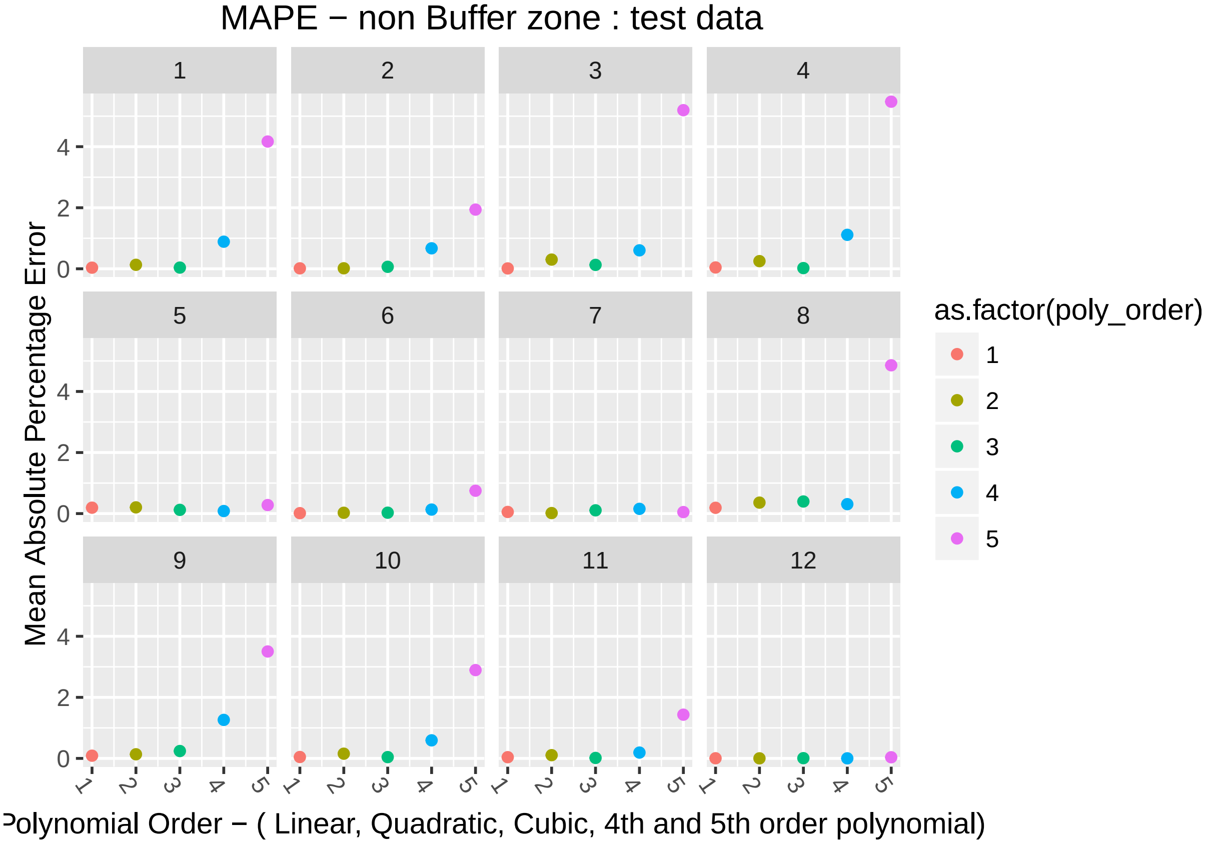

Actual vs. Fitted − Non BUFFER ZONE training set poly_order: 1
1
2
3
4
5
6
7
8
9
10
11
12
3e+05
2e+05
mean MKT_VAL in dollars
2007
2008
2009
2010
2011
2012
Years
0.9
0.9


Actual vs. Fitted − Non BUFFER ZONE training set poly_order: 2
1
2
3
4
5
6
7
8
9
10
11
12
3e+05
2e+05
mean MKT_VAL in dollars
2007
2008
2009
2010
2011
2012
Years
0.9
0.9

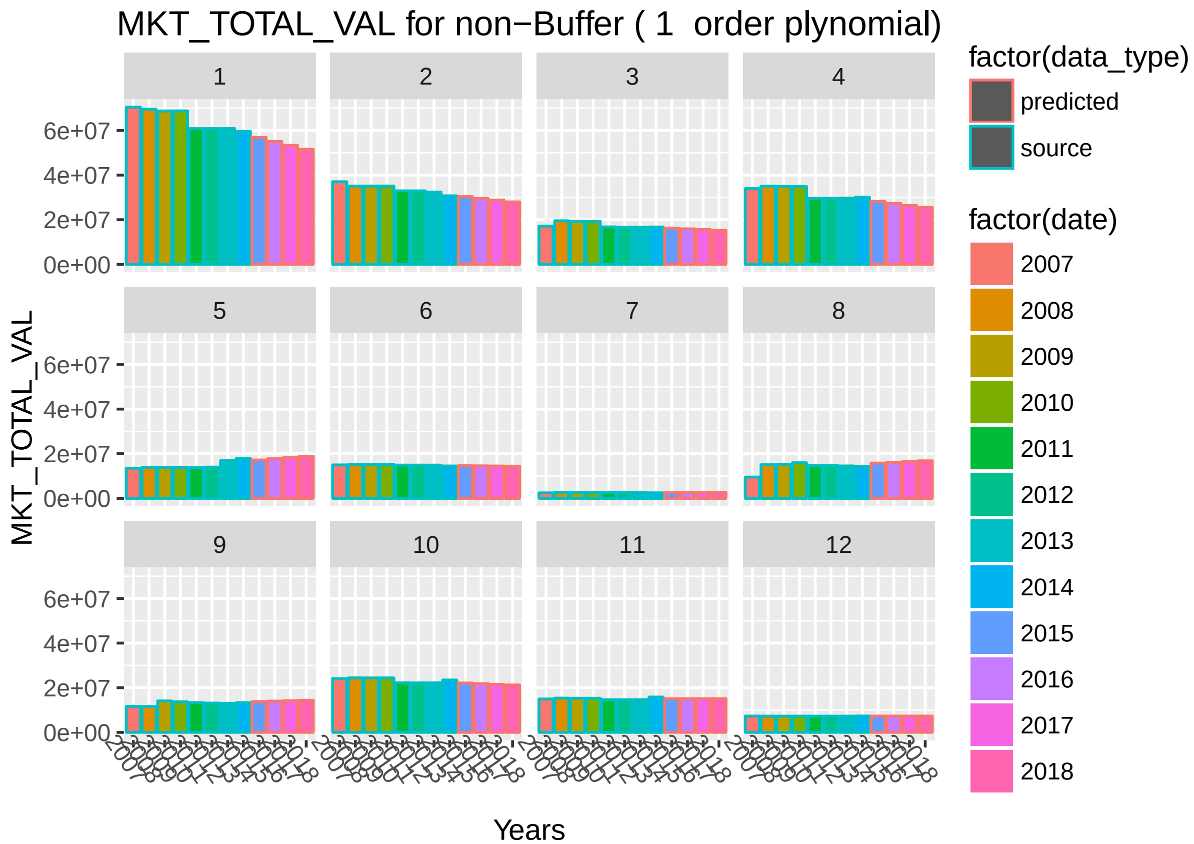

Actual vs. Fitted − Non BUFFER ZONE training set poly_order: 3

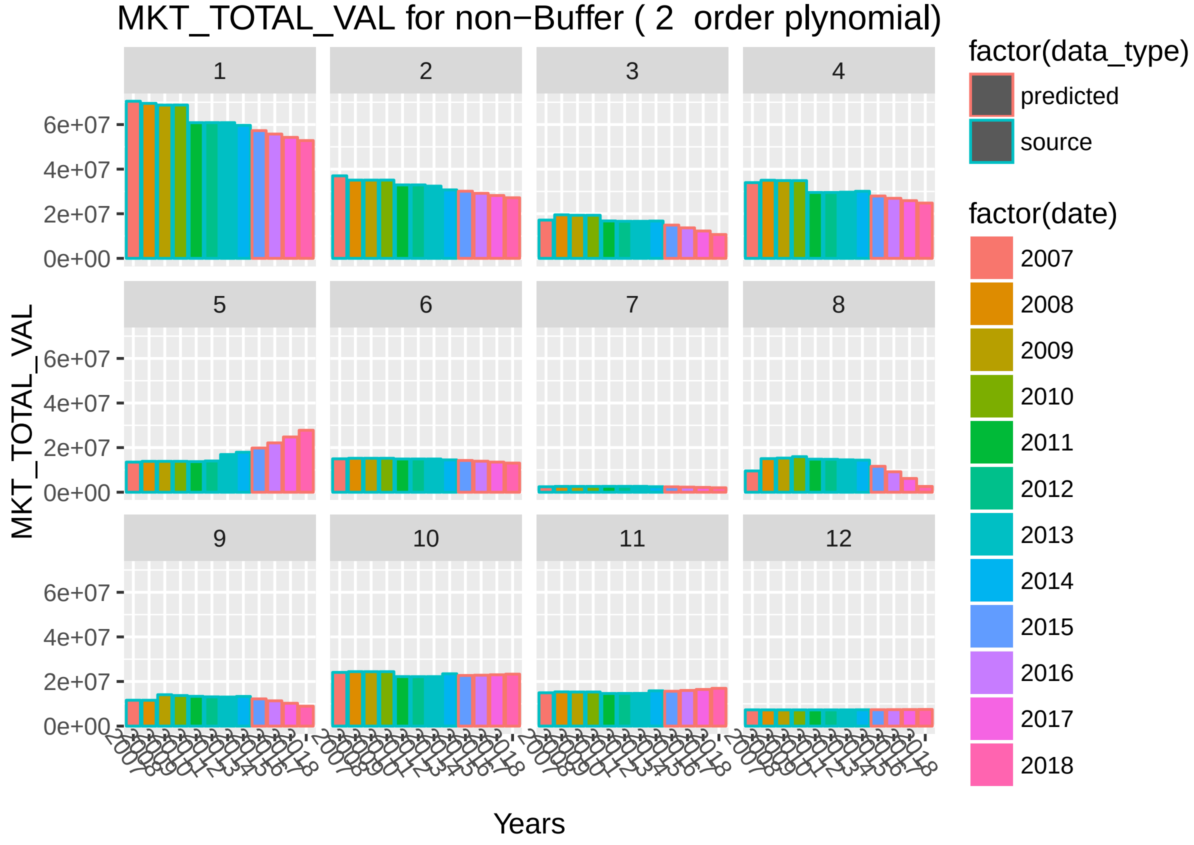

Actual vs. Fitted − Non BUFFER ZONE training set poly_order: 4

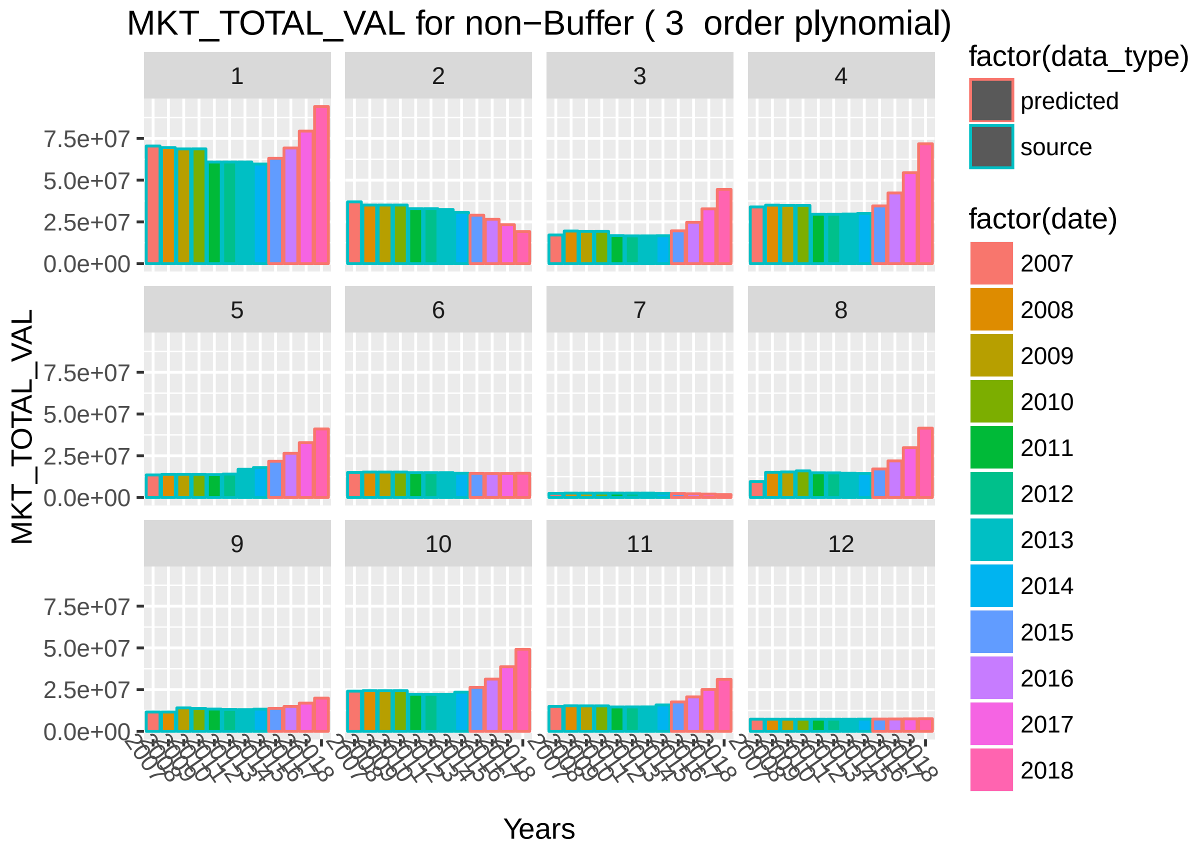




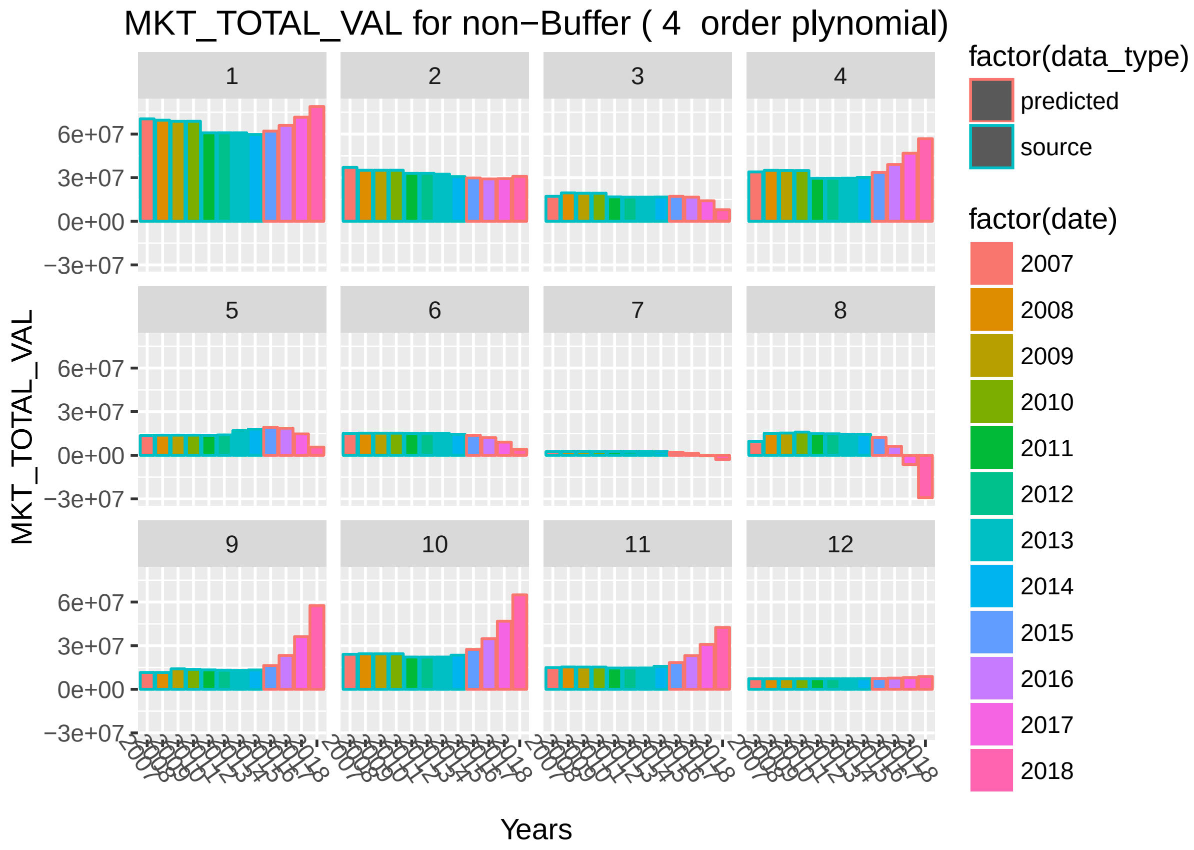
```
## [1] "NON BUFFER ZONE :  Plotting MKT_TOT_VAL source and predicted data"
## [1] "NON BUFFER ZONE :  Creating df_final_mkt_val data frame for later Visualization"
```


MKT_TOTAL_VAL for non−Buffer (1 order plynomial)

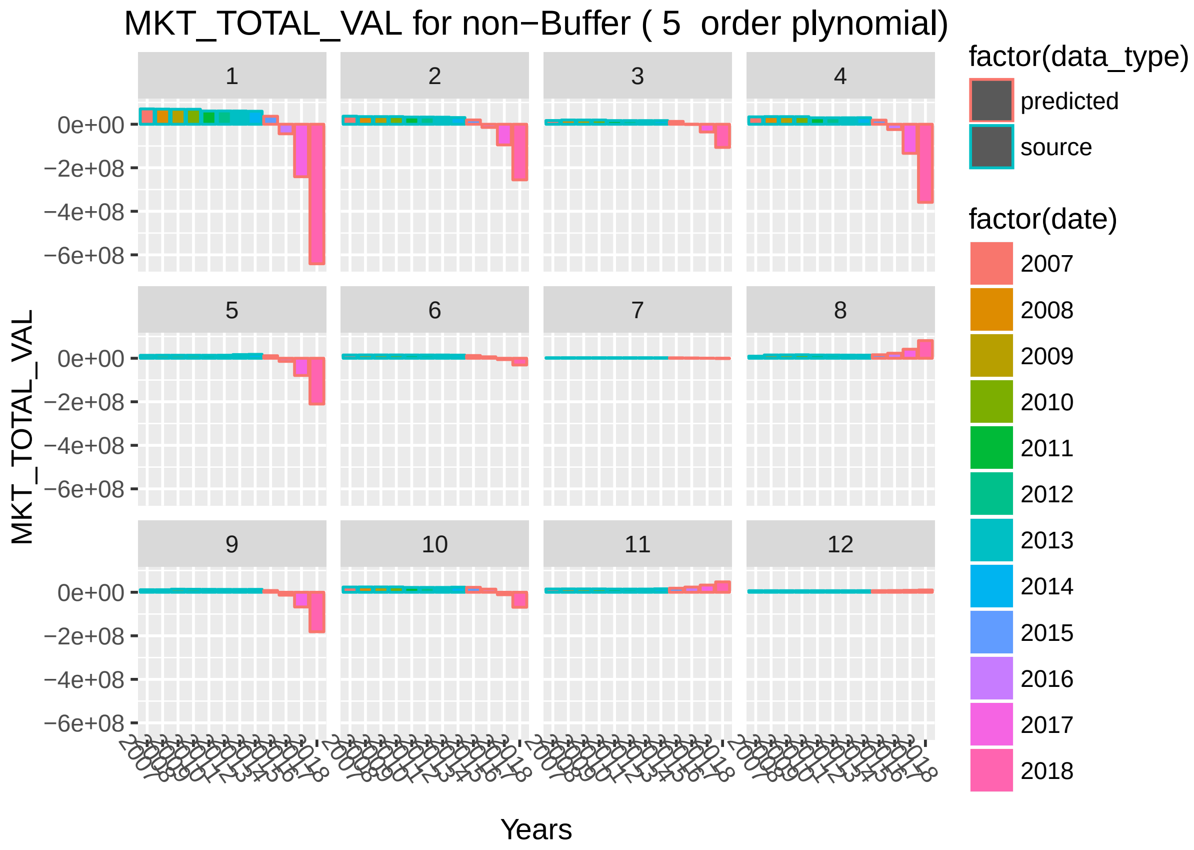

MKT_TOTAL_VAL for non−Buffer (2 order plynomial)



```
## Warning: Stacking not well defined when ymin != 0
```



```
## Warning: Stacking not well defined when ymin != 0
```



```r
print("BUFFER ZONE: Training and test data set ")
```

```
## [1] "BUFFER ZONE: Training and test data set "
```

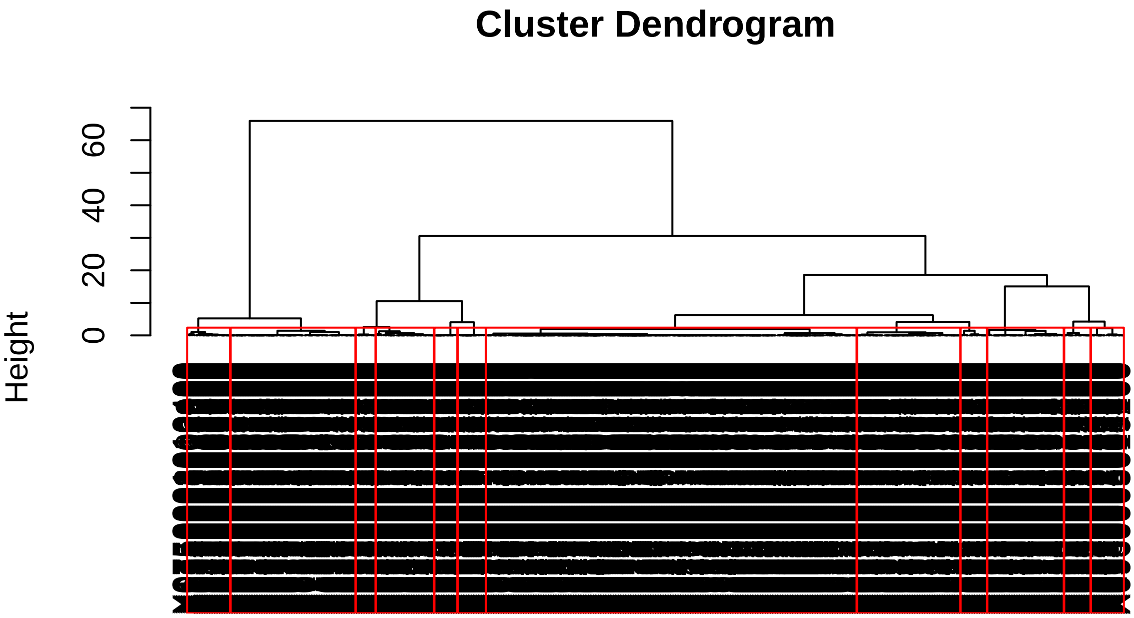
```r
######
# EDGE
######

print("EDGE BUFFER ZONE :  Training Data - Dendogram")
```

```
## [1] "EDGE BUFFER ZONE :  Training Data - Dendogram"
```

```r
#then random 100 columns
n <- ncol(taxinfo_EDGE.matrix_no_na)
taxinfo_EDGE.matrix_shuffled <- taxinfo_EDGE.matrix_no_na[,sample(n) ]
#0.7   is 813 values
train_indices <- 1:round(0.7 * n)
train <- taxinfo_EDGE.matrix_shuffled[,train_indices ]

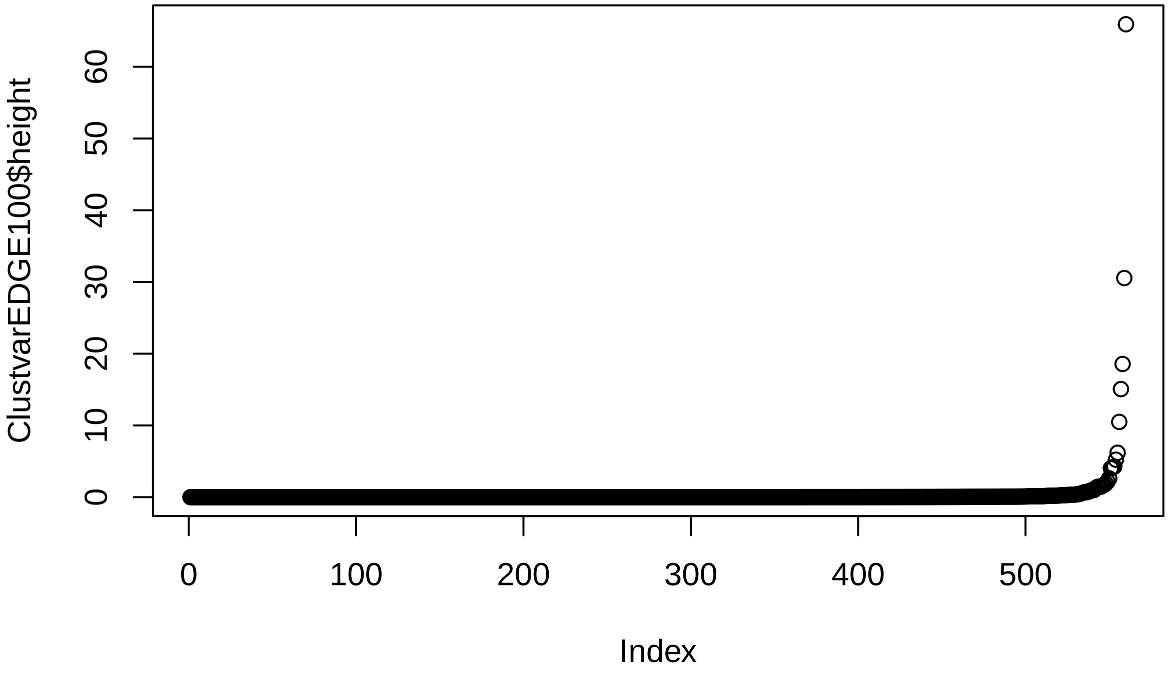

ClustvarEDGE100 <-hclustvar(train)
plot(ClustvarEDGE100)
rect.hclust(ClustvarEDGE100,k=12, border="red")
```



```
partEDGE100 <- cutreevar(ClustvarEDGE100,12)


a_EDGE <- partEDGE100$var

plot(ClustvarEDGE100$height)
```

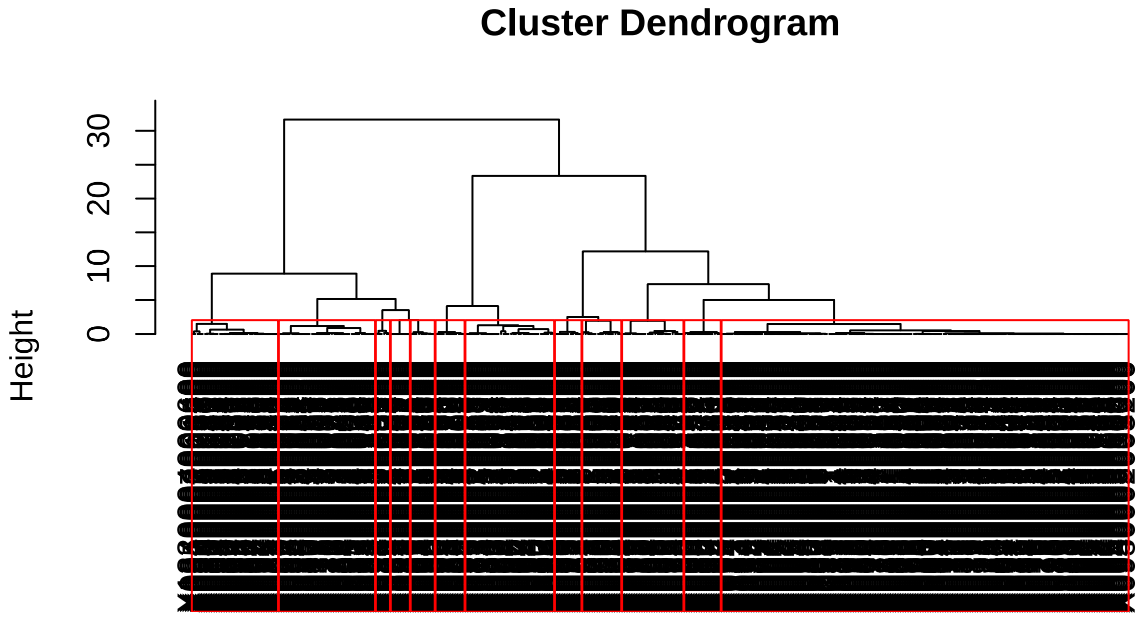


```
######
# CENTER
######
print("CENTER BUFFER ZONE :  Training Data - Dendogram")
```

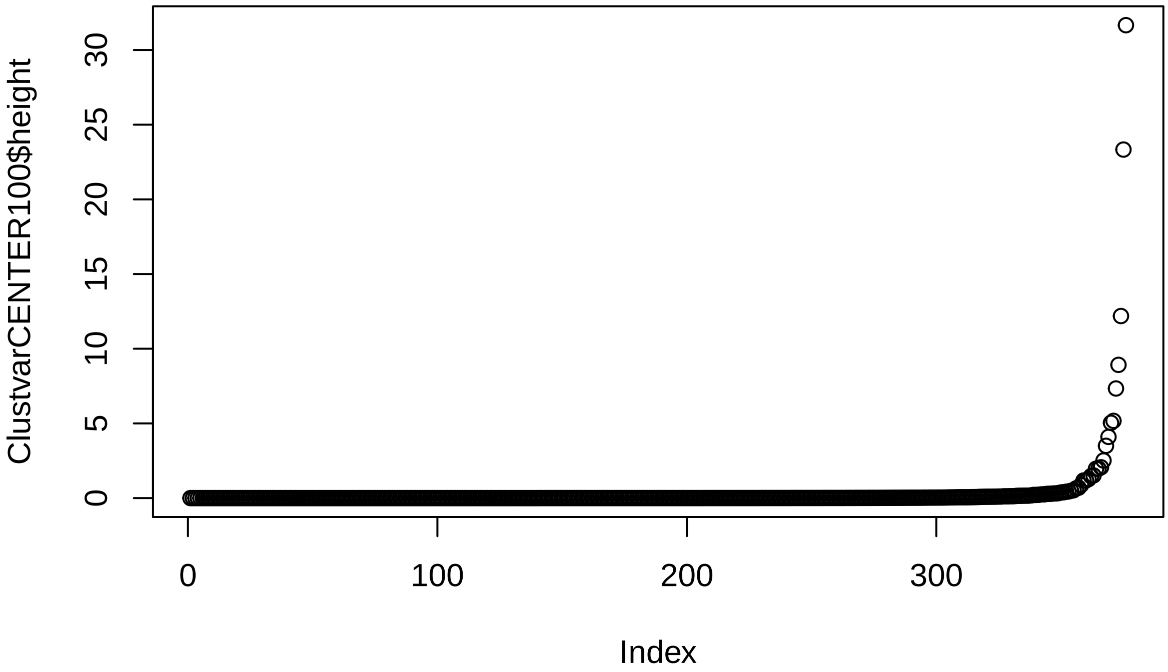
```
## [1] "CENTER BUFFER ZONE :  Training Data - Dendogram"
```

```
#then random 100 columns
n <- ncol(taxinfo_CENTER.matrix_no_na)
taxinfo_CENTER.matrix_shuffled <- taxinfo_CENTER.matrix_no_na[,sample(n) ]
#0.7   is 561 values
train_indices <- 1:round(0.7 * n)
train <- taxinfo_CENTER.matrix_shuffled[,train_indices ]


ClustvarCENTER100 <-hclustvar(train)
plot(ClustvarCENTER100)
rect.hclust(ClustvarCENTER100,k=12, border="red")
```



```
partCENTER100 <- cutreevar(ClustvarCENTER100,12)
a_CENTER <- partCENTER100$var
plot(ClustvarCENTER100$height)
```



```
#stab100 <- stability(Clustvar100,B = 60, graph = TRUE)

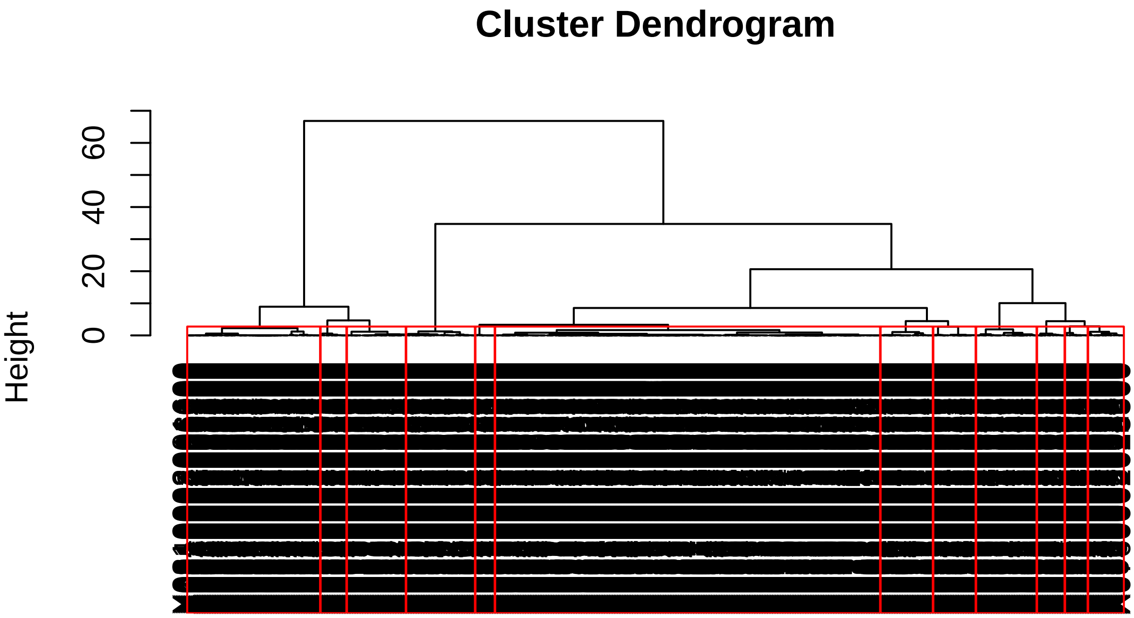
######
# CORE
######

print("CORE BUFFER ZONE :  Training Data - Dendogram")
```

```
## [1] "CORE BUFFER ZONE :  Training Data - Dendogram"
```

```
#then random 100 columns
n <- ncol(taxinfo_CORE.matrix_no_na)
taxinfo_CORE.matrix_shuffled <- taxinfo_CORE.matrix_no_na[,sample(n) ]
#0.7   is 561 values
train_indices <- 1:round(0.7 * n)
train <- taxinfo_CORE.matrix_shuffled[,train_indices ]

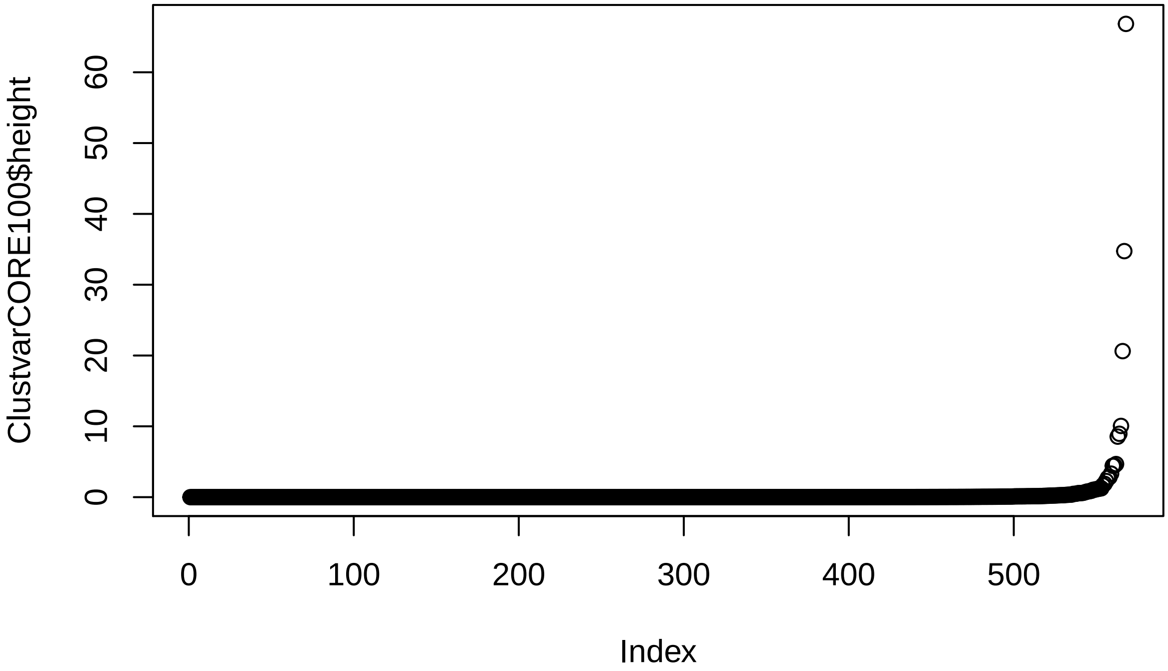

ClustvarCORE100 <-hclustvar(train)
plot(ClustvarCORE100)
rect.hclust(ClustvarCORE100,k=12, border="red")
```



```
partCORE100 <- cutreevar(ClustvarCORE100,12)

a_CORE <-partCORE100$var

plot(ClustvarCORE100$height)
```



```
#stab100 <- stability(Clustvar100,B = 60, graph = TRUE)

print("BUFFER_ZONE: About to plot actuals and fitted")
```

```
## [1] "BUFFER_ZONE: About to plot actuals and fitted"
```

```
for( poly_order in c(seq(1:5))){
```

```
for ( clst in c(seq(1:12))) {



  df_mape_train_CORE_parcels   <- plot_act_pred_trg(clst,a_CORE,  taxinfo_CORE.matrix[c(1:6),], poly_
  df_mape_train_CENTER_parcels <- plot_act_pred_trg(clst,a_CENTER,  taxinfo_CENTER.matrix[c(1:6),], po
  df_mape_train_EDGE_parcels   <- plot_act_pred_trg(clst,a_EDGE,  taxinfo_EDGE.matrix[c(1:6),], poly_




  df_mape_test_CORE_parcels   <- plot_act_pred_test(clst,a_CORE,  taxinfo_CORE.matrix[c(1:6),], taxin
  df_mape_test_CENTER_parcels <- plot_act_pred_test(clst,a_CENTER,  taxinfo_CENTER.matrix[c(1:6),],ta
  df_mape_test_EDGE_parcels   <- plot_act_pred_test(clst,a_EDGE,  taxinfo_EDGE.matrix[c(1:6),],taxinf




  if (clst == 1) {

    df_mape_train_CORE_clst_poly <- df_mape_train_CORE_parcels["mape"]
    df_mape_train_CENTER_clst_poly <- df_mape_train_CENTER_parcels["mape"]
    df_mape_train_EDGE_clst_poly <- df_mape_train_EDGE_parcels["mape"]

    df_actpred_train_CORE_clst_poly <- df_mape_train_CORE_parcels["act_pred"]
    df_actpred_train_CENTER_clst_poly <- df_mape_train_CENTER_parcels["act_pred"]
    df_actpred_train_EDGE_clst_poly <- df_mape_train_EDGE_parcels["act_pred"]



    df_mape_test_CORE_clst_poly <- df_mape_test_CORE_parcels["mape"]
    df_mape_test_CENTER_clst_poly <- df_mape_test_CENTER_parcels["mape"]
    df_mape_test_EDGE_clst_poly <- df_mape_test_EDGE_parcels["mape"]






  }
  else {

    #df_mape_train_CORE_clst_poly <- bind_rows(df_mape_train_CORE_clst_poly,     df_mape_train_CORE_p
    #df_mape_train_CENTER_clst_poly <- bind_rows(df_mape_train_CENTER_clst_poly,     df_mape_train_CE
    #df_mape_train_EDGE_clst_poly <- bind_rows(df_mape_train_EDGE_clst_poly,     df_mape_train_EDGE_p



    df_actpred_train_CORE_clst_poly <- bind_rows(df_actpred_train_CORE_clst_poly,     df_mape_train_C
    df_actpred_train_CENTER_clst_poly <- bind_rows(df_actpred_train_CENTER_clst_poly, df_mape_train_C
    df_actpred_train_EDGE_clst_poly <- bind_rows(df_actpred_train_EDGE_clst_poly,     df_mape_train_E
    df_mape_test_CORE_clst_poly <- bind_rows(df_mape_test_CORE_clst_poly,     df_mape_test_CORE_parcel
    df_mape_test_CENTER_clst_poly <- bind_rows(df_mape_test_CENTER_clst_poly,     df_mape_test_CENTER_
    df_mape_test_EDGE_clst_poly <- bind_rows(df_mape_test_EDGE_clst_poly,     df_mape_test_EDGE_parcel



  }
}


if (poly_order == 1) {


  #df_mape_train_CORE_all   <- df_mape_train_CORE_clst_poly
  #df_mape_train_CENTER_all <- df_mape_train_CENTER_clst_poly
  #df_mape_train_EDGE_all   <- df_mape_train_EDGE_clst_poly

  df_actpred_train_CORE_all   <- df_actpred_train_CORE_clst_poly
  df_actpred_train_CENTER_all <- df_actpred_train_CENTER_clst_poly
  df_actpred_train_EDGE_all   <- df_actpred_train_EDGE_clst_poly






  df_mape_test_CORE_all   <- df_mape_test_CORE_clst_poly
  df_mape_test_CENTER_all <- df_mape_test_CENTER_clst_poly
  df_mape_test_EDGE_all   <- df_mape_test_EDGE_clst_poly



}
else
{

  # df_mape_train_CORE_all <- bind_rows(df_mape_train_CORE_all, df_mape_train_CORE_clst_poly)
  # df_mape_train_CENTER_all <- bind_rows(df_mape_train_CENTER_all, df_mape_train_CENTER_clst_poly)
  # df_mape_train_EDGE_all <- bind_rows(df_mape_train_EDGE_all, df_mape_train_EDGE_clst_poly)

  df_actpred_train_CORE_all <- bind_rows(df_actpred_train_CORE_all, df_actpred_train_CORE_clst_poly)
  df_actpred_train_CENTER_all <- bind_rows(df_actpred_train_CENTER_all, df_actpred_train_CENTER_clst_
  df_actpred_train_EDGE_all <- bind_rows(df_actpred_train_EDGE_all, df_actpred_train_EDGE_clst_poly)




  df_mape_test_CORE_all <- bind_rows(df_mape_test_CORE_all, df_mape_test_CORE_clst_poly)
  df_mape_test_CENTER_all <- bind_rows(df_mape_test_CENTER_all, df_mape_test_CENTER_clst_poly)
  df_mape_test_EDGE_all <- bind_rows(df_mape_test_EDGE_all, df_mape_test_EDGE_clst_poly)
  }



}
```

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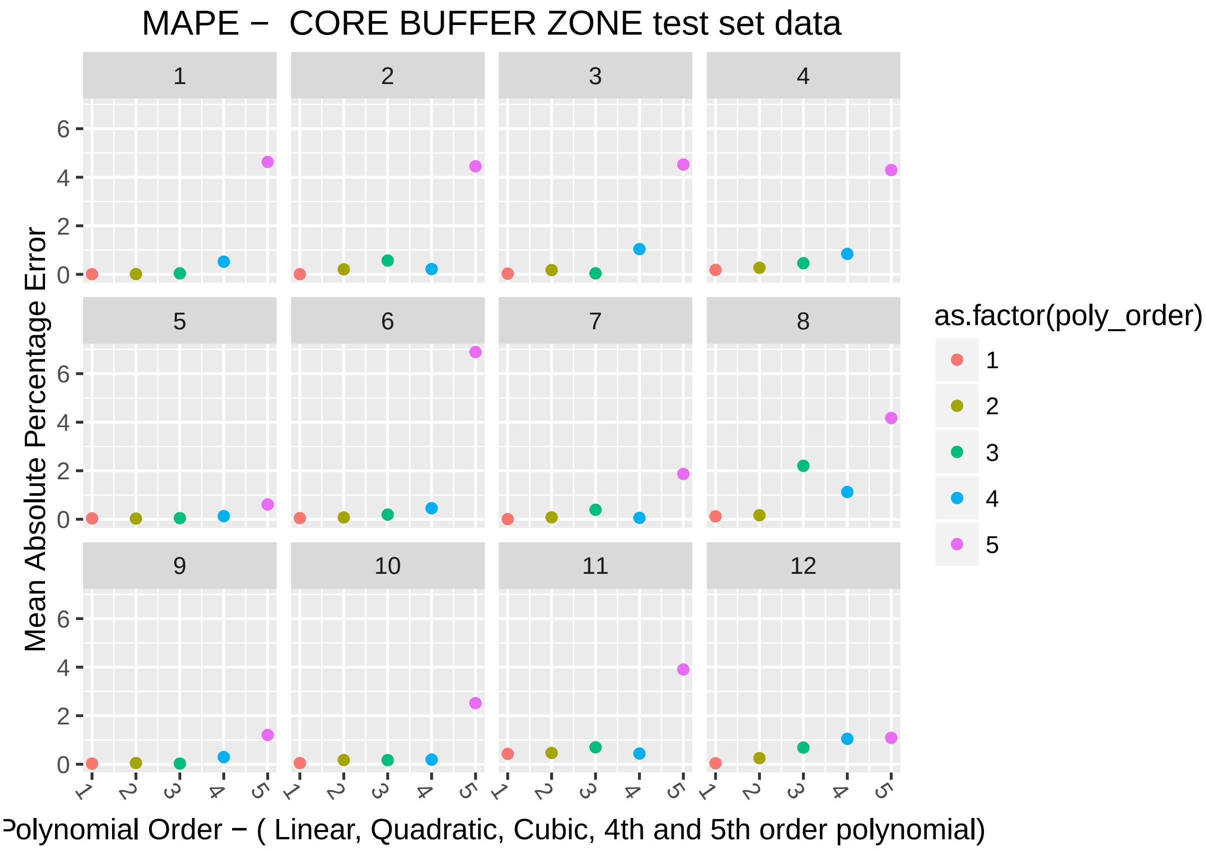
```

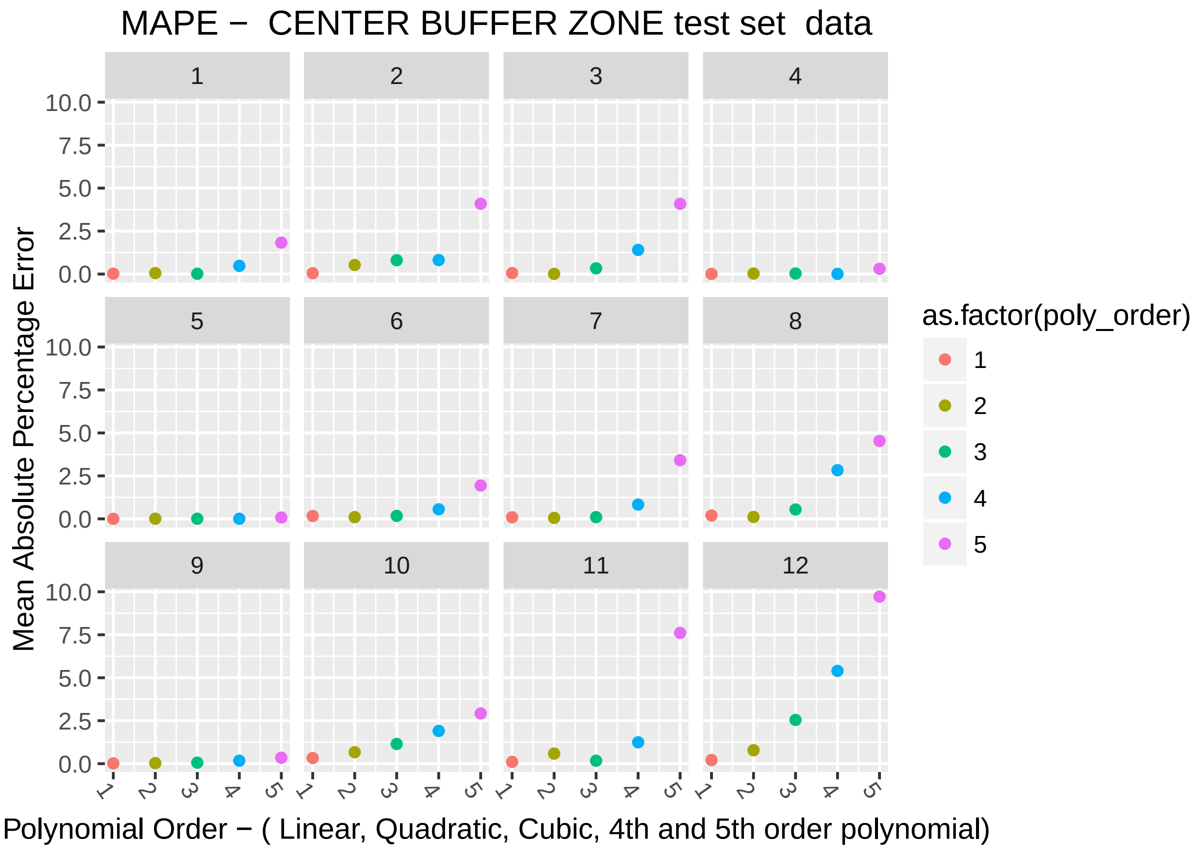
```r
# print("BUFFER ZONE: Plotting the Actual vs. Fitted for Training set ")
#
#
# for( poly_order in c(seq(1:5))){
#
#   plot_actpred_chart(df_actpred_train_CORE_all, " CORE BUFFER ZONE training set ",poly_order)
#   plot_actpred_chart(df_actpred_train_CENTER_all, " CENTER BUFFER ZONE training set", poly_order)
#   plot_actpred_chart(df_actpred_train_EDGE_all, " EDGE BUFFER ZONE training set ", poly_order)
#
# } # poly_order

print("BUFFER ZONE: Plotting the mape charts ")
```

```
## [1] "BUFFER ZONE: Plotting the mape charts "
```

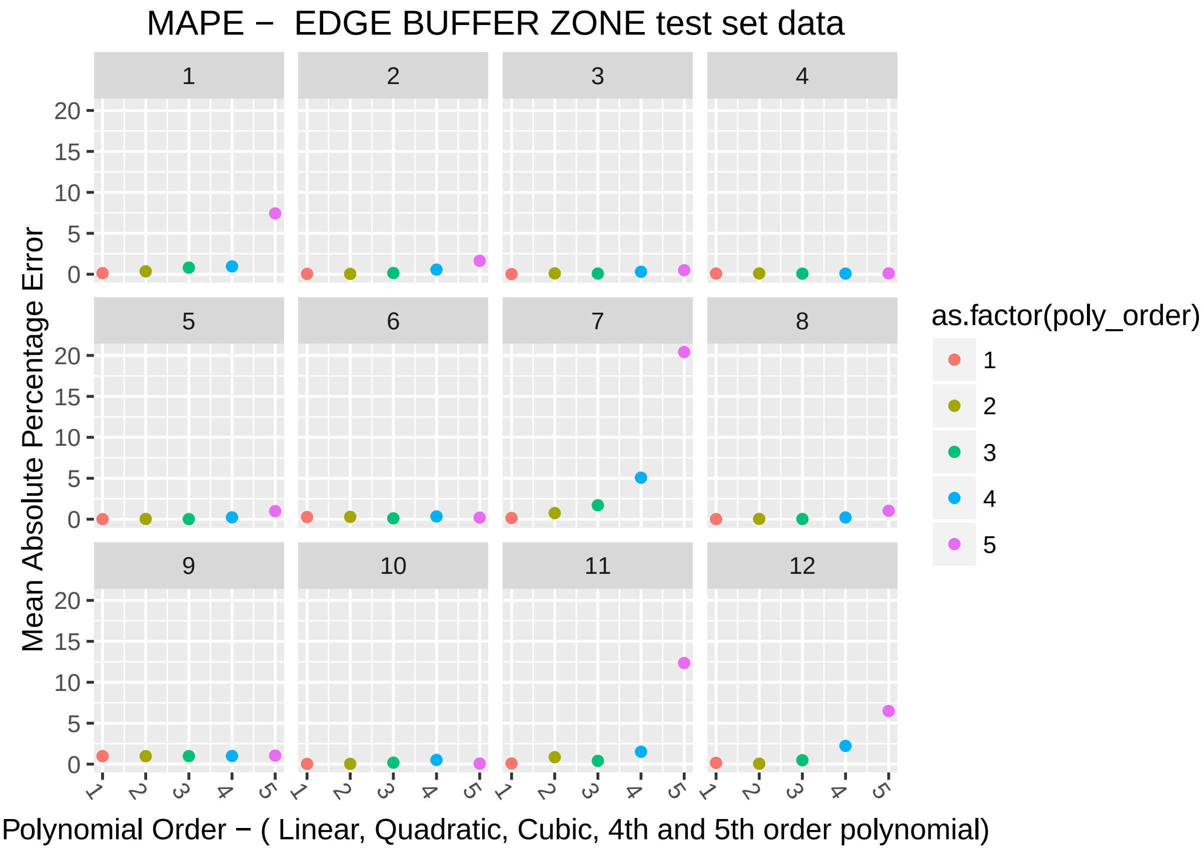
```r
# Plot the mape chart for the buffer zones


# plot_mape_chart(df_mape_train_CORE_all, " CORE BUFFER ZONE training set data")
# plot_mape_chart(df_mape_train_CENTER_all, " CENTER BUFFER ZONE training set  data")
# plot_mape_chart(df_mape_train_EDGE_all, " EDGE BUFFER ZONE training set data")
#



plot_mape_chart(df_mape_test_CORE_all, " CORE BUFFER ZONE test set data")
```



```
plot_mape_chart(df_mape_test_CENTER_all, " CENTER BUFFER ZONE test set  data")
```



```
plot_mape_chart(df_mape_test_EDGE_all, " EDGE BUFFER ZONE test set data")
```

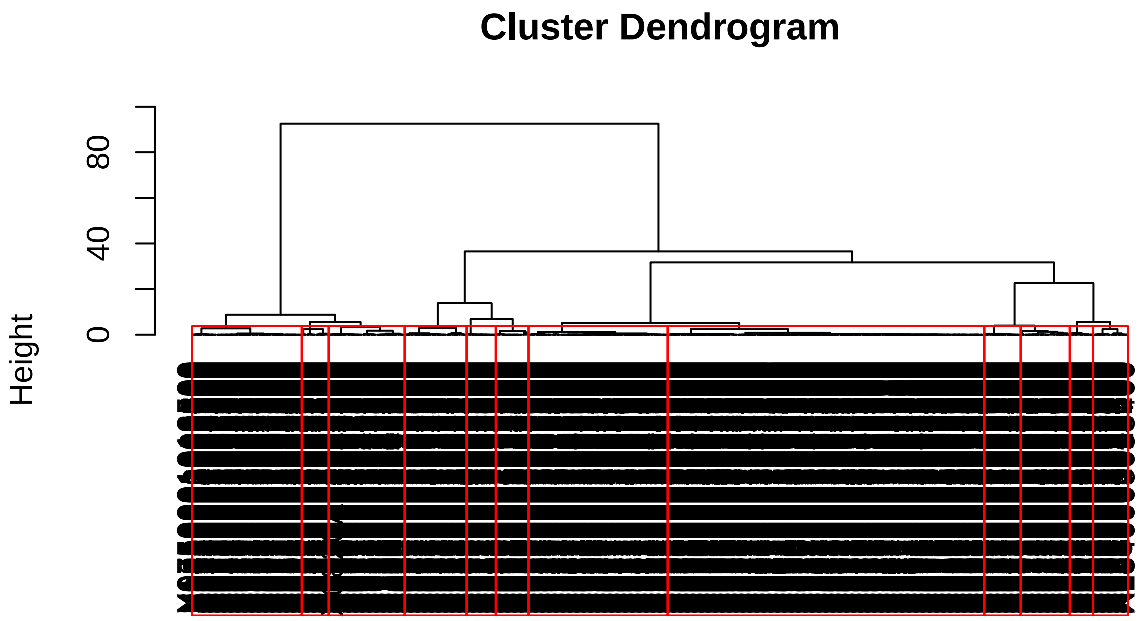


```
# Write out to csv files
write.csv(df_mape_test_CORE_all, file = "test_set_mape_CORE.csv" )
write.csv(df_mape_test_CENTER_all, file = "test_set_mape_CENTER.csv" )
write.csv(df_mape_test_EDGE_all, file = "test_set_mape_EDGE.csv" )

print( "BUFFER_ZONE : Faceting over  clusters for each zone")
```

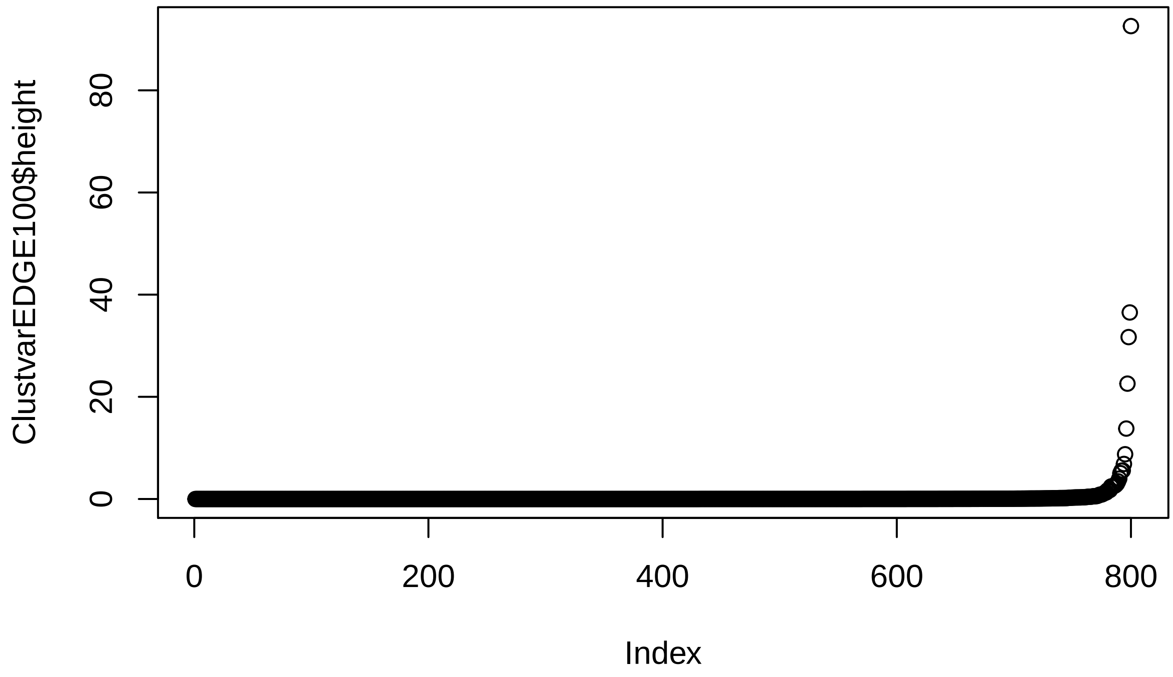
```
## [1] "BUFFER_ZONE : Faceting over  clusters for each zone"
```

```
# facet the clusters on a single plot
# visualize  fitted and predicted



######
# EDGE
######

# here  all of the  Buffer zone parcel ids are partitioned into clusters

# Find the number of observations
n <- ncol(taxinfo_EDGE.matrix_no_na)
# Shuffle it
ntaxinfo_EDGE.matrix_shuffled <- taxinfo_EDGE.matrix_no_na[,sample(n) ]
train_indices <- 1:round(1.0 * n)
train <- taxinfo_EDGE.matrix_shuffled[,train_indices ]

# perform Clurtering of Vars / dimension reduction
ClustvarEDGE100 <-hclustvar(train)
```

```
# plot the dendogram
plot(ClustvarEDGE100)
rect.hclust(ClustvarEDGE100,k=12, border="red")
```

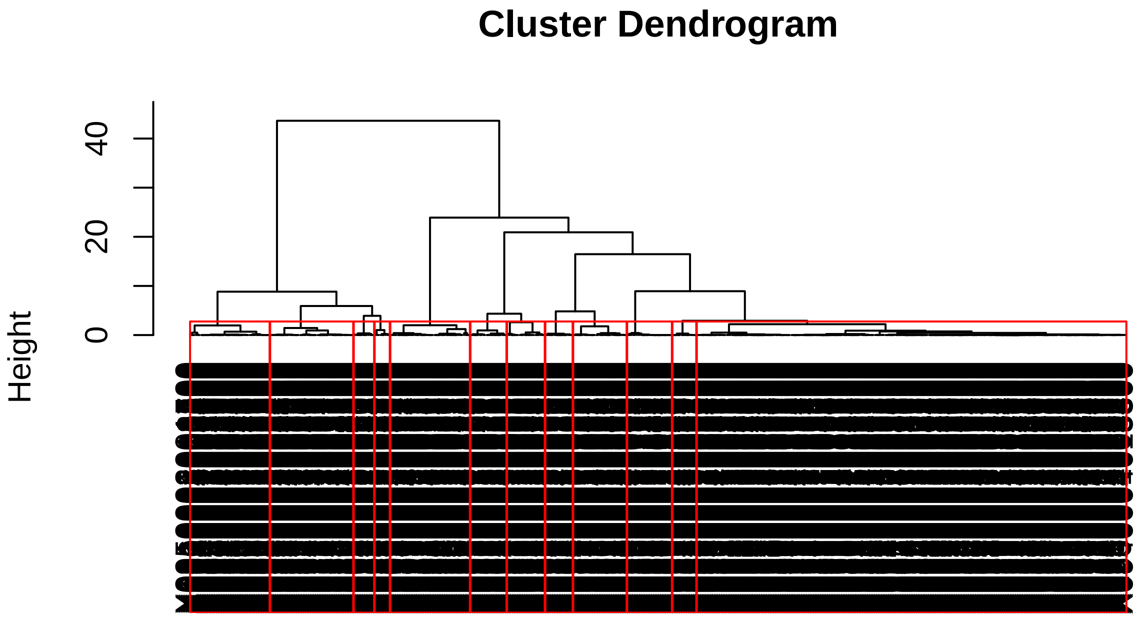


```
partEDGE100 <- cutreevar(ClustvarEDGE100,12)

a_EDGE <- partEDGE100$var
# Height of ClustVarEDGE is plotted
plot(ClustvarEDGE100$height)
```

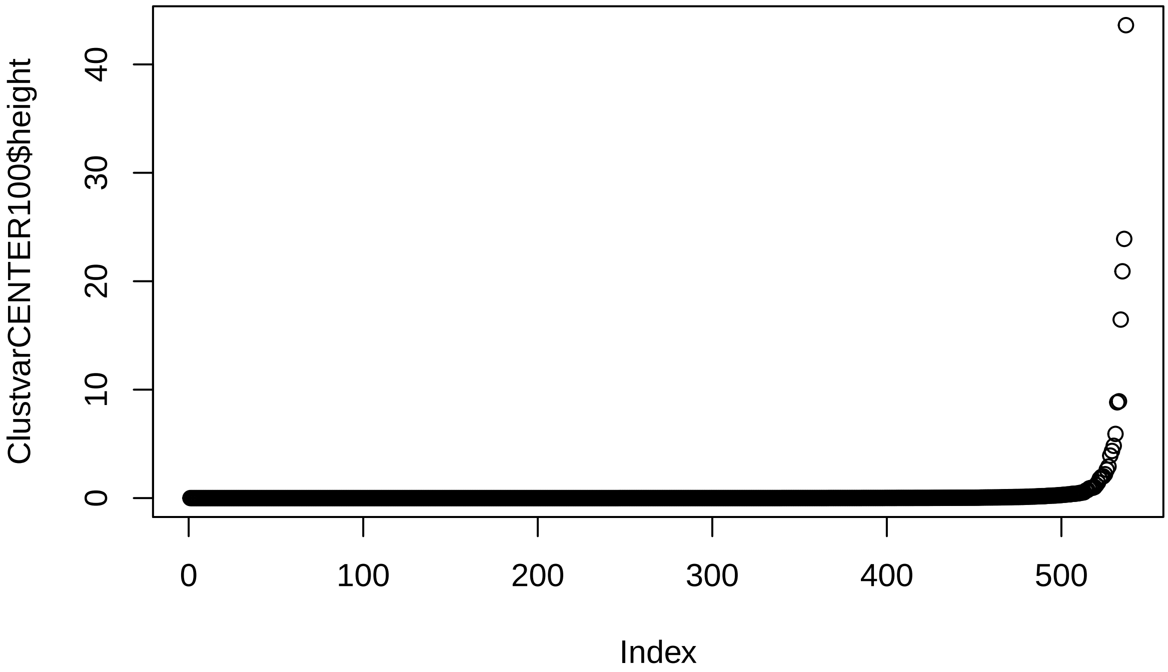


```
######
# CENTER
######
```

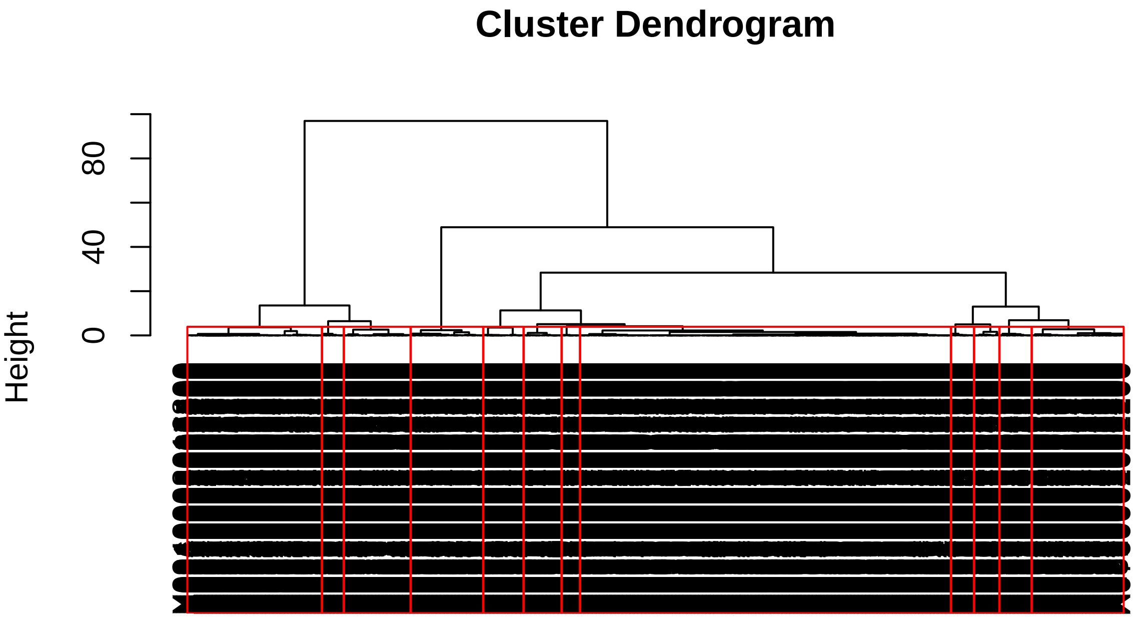
```
# Find the number of observations and shuffle it
n <- ncol(taxinfo_CENTER.matrix_no_na)
taxinfo_CENTER.matrix_shuffled <- taxinfo_CENTER.matrix_no_na[,sample(n) ]
#Take all of the observations
train_indices <- 1:round(1.0 * n)
train <- taxinfo_CENTER.matrix_shuffled[,train_indices ]

# create a dendogram
ClustvarCENTER100 <-hclustvar(train)
plot(ClustvarCENTER100)
rect.hclust(ClustvarCENTER100,k=12, border="red")
```



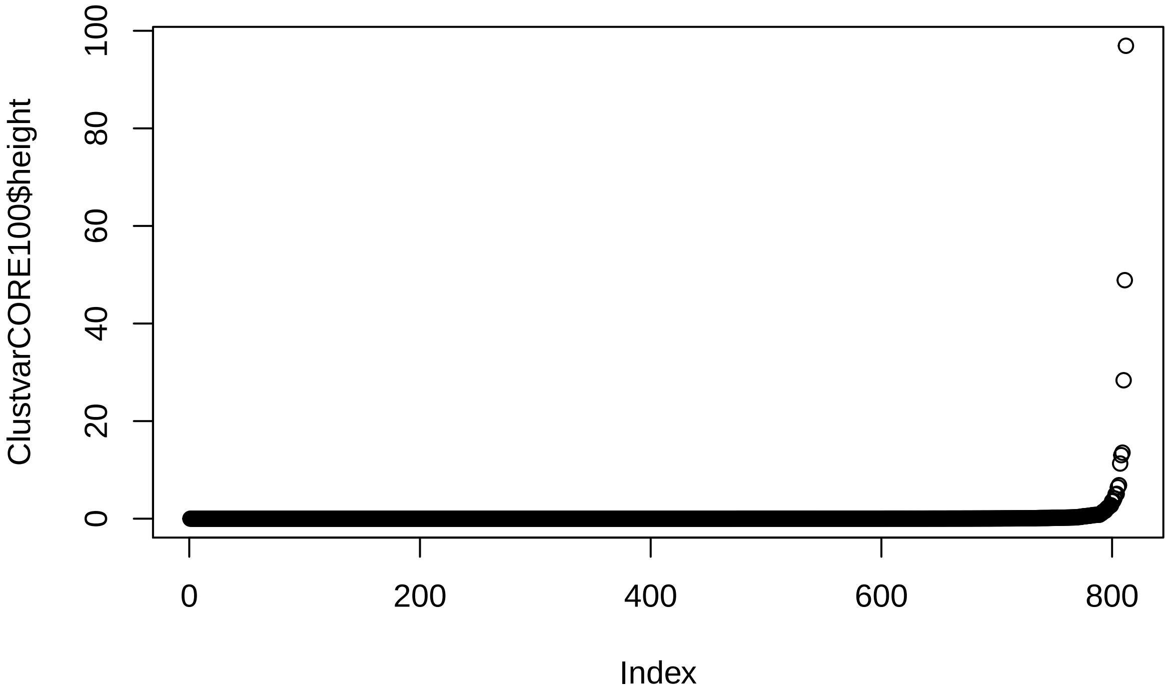
```
partCENTER100 <- cutreevar(ClustvarCENTER100,12)

a_CENTER <- partCENTER100$var

# plot the height
plot(ClustvarCENTER100$height)
```



```
######
# CORE
######


#Take all of the observations and shuffle them
n <- ncol(taxinfo_CORE.matrix_no_na)
taxinfo_CORE.matrix_shuffled <- taxinfo_CORE.matrix_no_na[,sample(n) ]

train_indices <- 1:round(1.0 * n)
train <- taxinfo_CORE.matrix_shuffled[,train_indices ]

# Perform Dimension reduction
ClustvarCORE100 <-hclustvar(train)
plot(ClustvarCORE100)
partCORE100 <- cutreevar(ClustvarCORE100,12)
rect.hclust(ClustvarCORE100,k=12, border="red")
```



```
a_CORE <-partCORE100$var

plot(ClustvarCORE100$height)
```



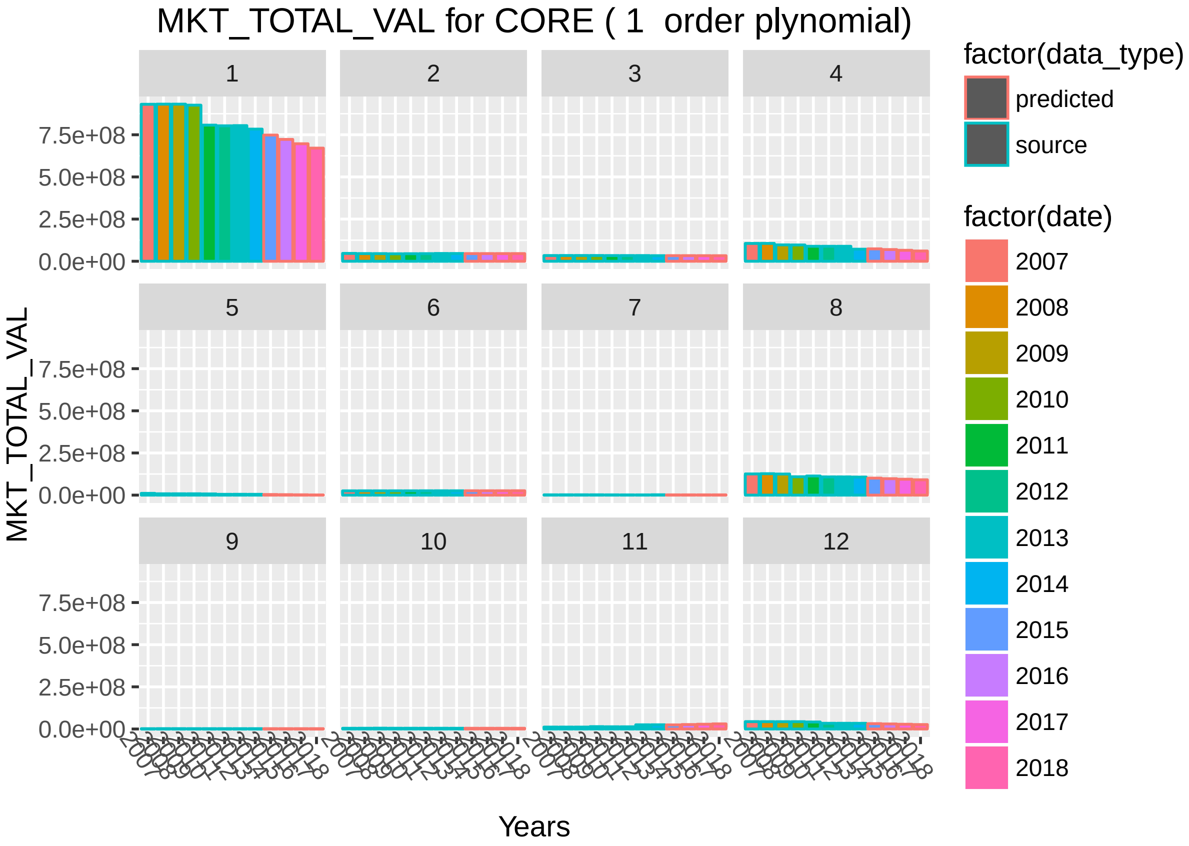
```
#stab100 <- stability(Clustvar100,B = 60, graph = TRUE)
print("BUFFER_ZONE Completed dendograms for all the parcels")
```

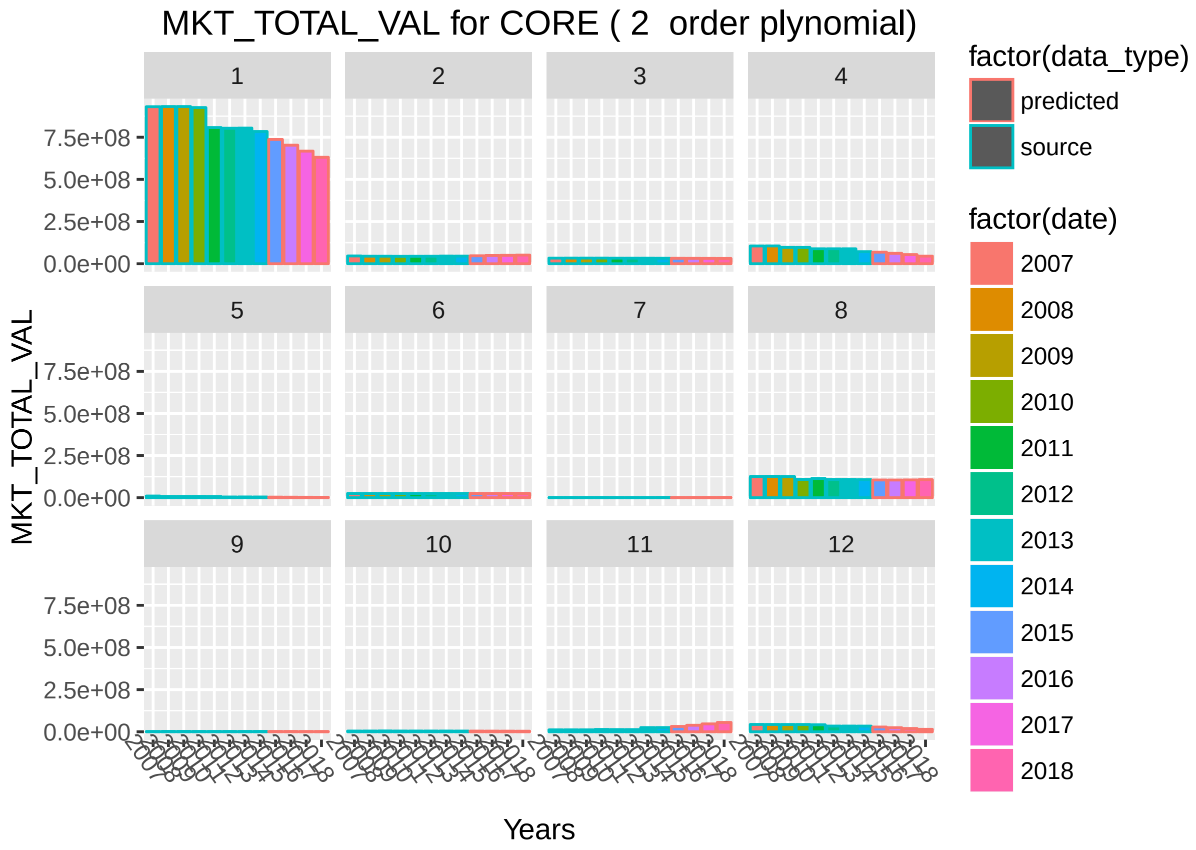
```
## [1] "BUFFER_ZONE Completed dendograms for all the parcels"
```

```
print("BUFFER_ZONE - Source Data and Predicted in the same plot")
```

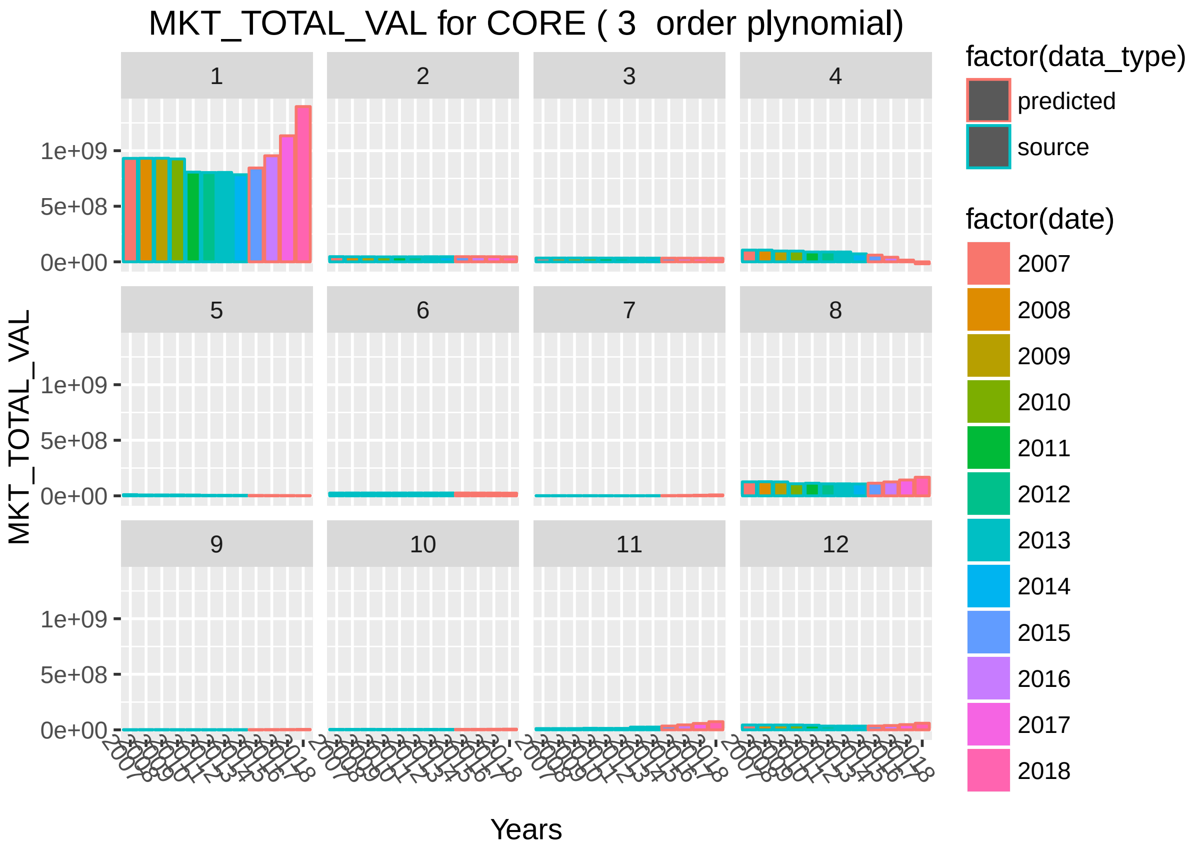
```
## [1] "BUFFER_ZONE - Source Data and Predicted in the same plot"
```

```
for( poly_order in c(seq(1:5))){

  # facet the clusters on a single plot
  # visualize  source and predicted

  df_final_mkt_val_core <- non_linear_regresion_model(a_CORE, taxinfo_CORE.matrix, poly_order,12, "CORE
  if (( poly_order == 1) && (skip_non_buffer == 1)) {
    df_final_mkt_val <- df_final_mkt_val_core
  } else
  { df_final_mkt_val <- bind_rows(df_final_mkt_val, df_final_mkt_val_core )}
}
```

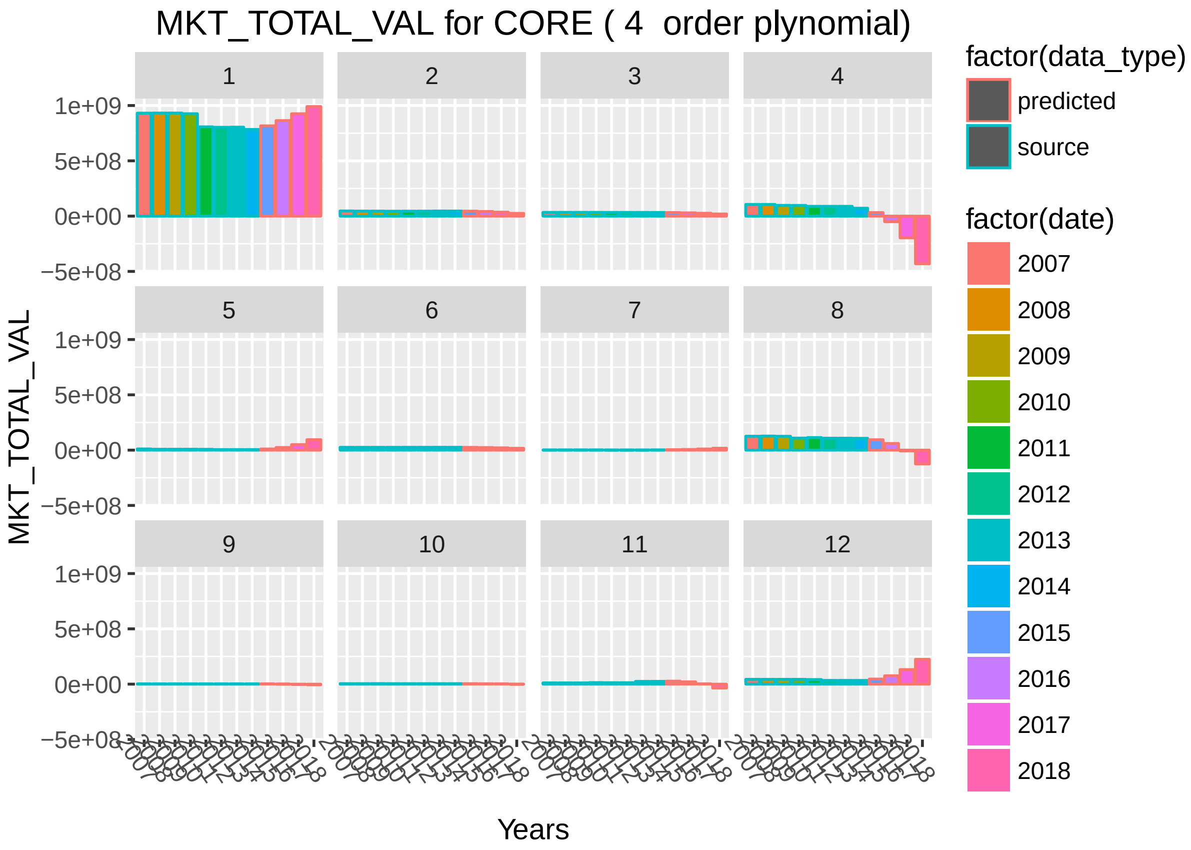




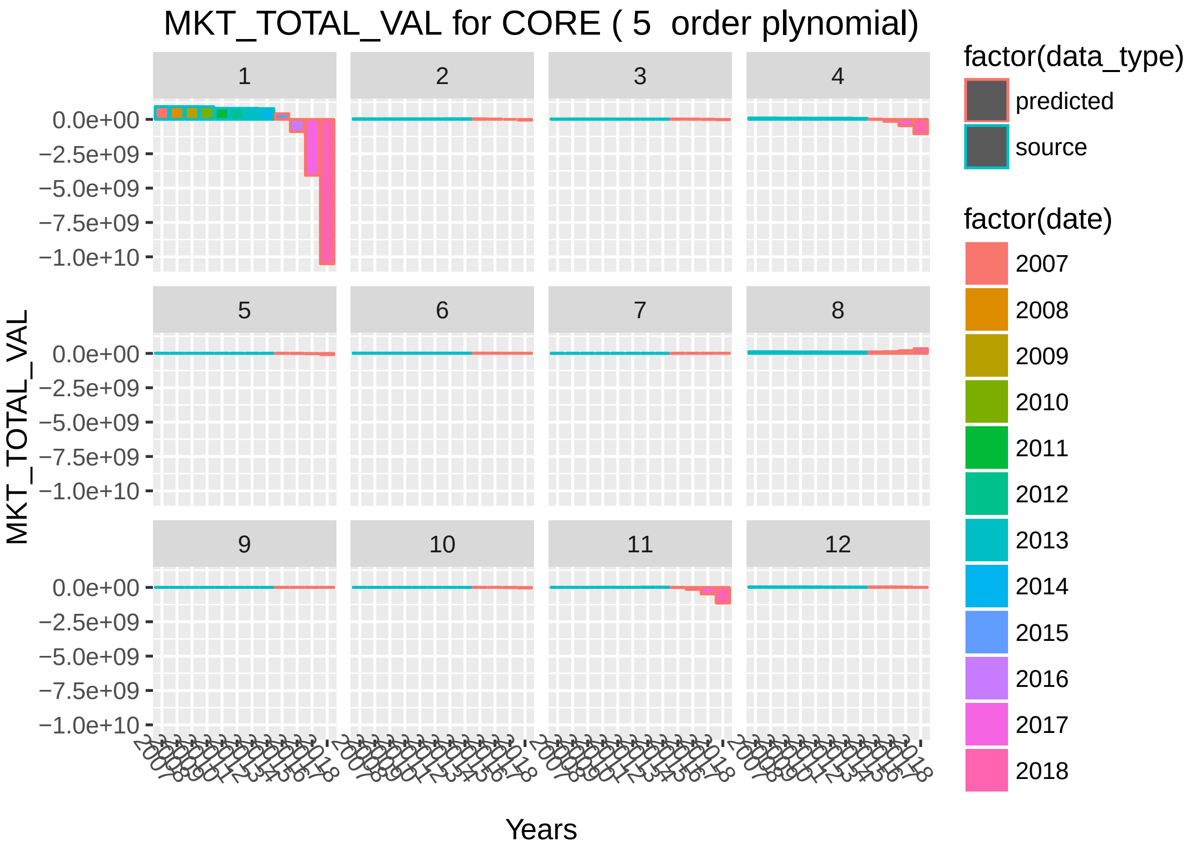
```
## Warning: Stacking not well defined when ymin != 0
```



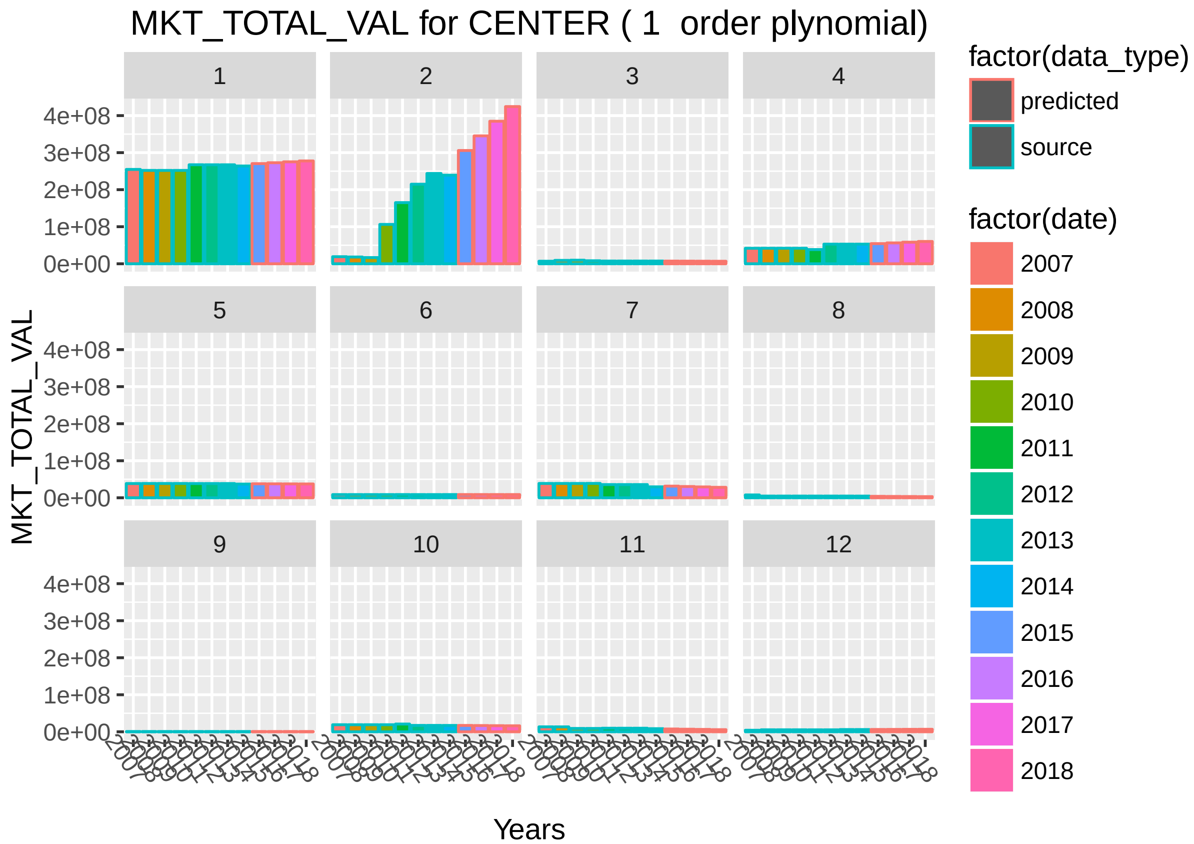
```
## Warning: Stacking not well defined when ymin != 0
```

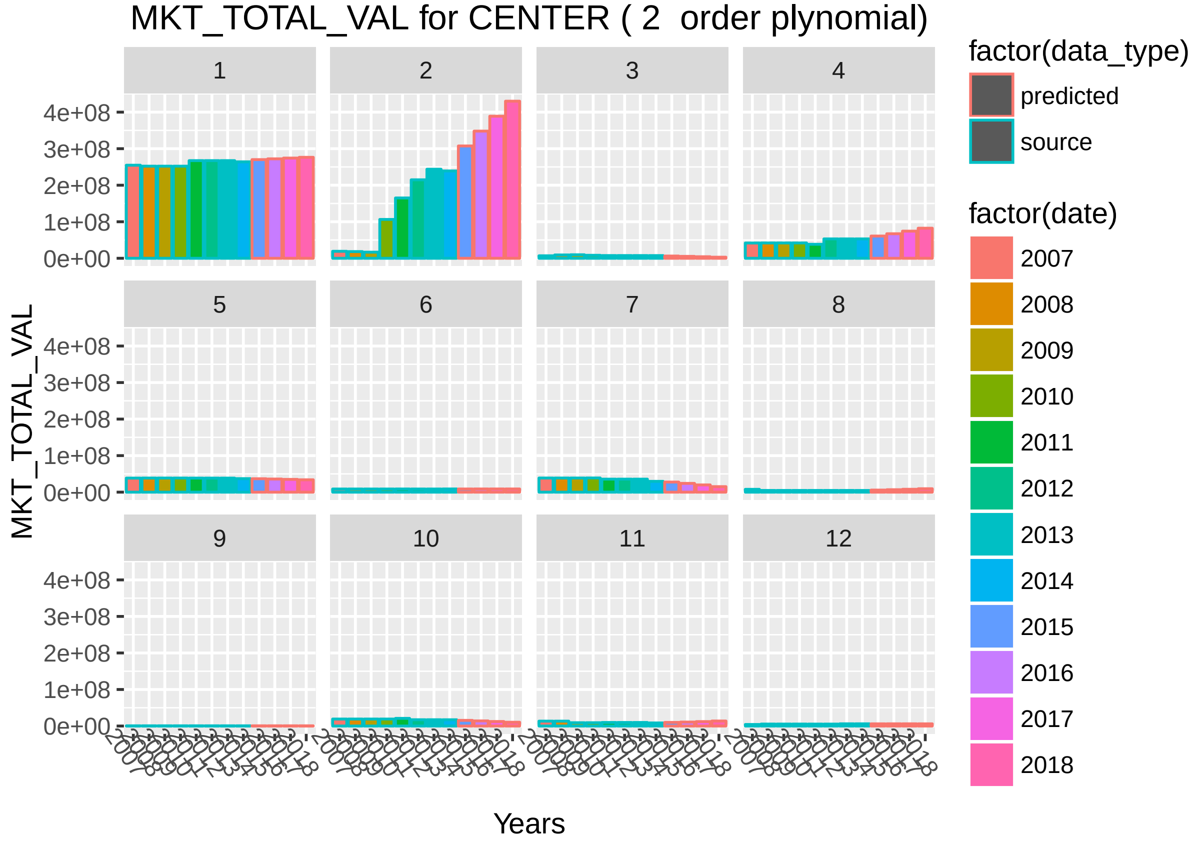


```
## Warning: Stacking not well defined when ymin != 0
```

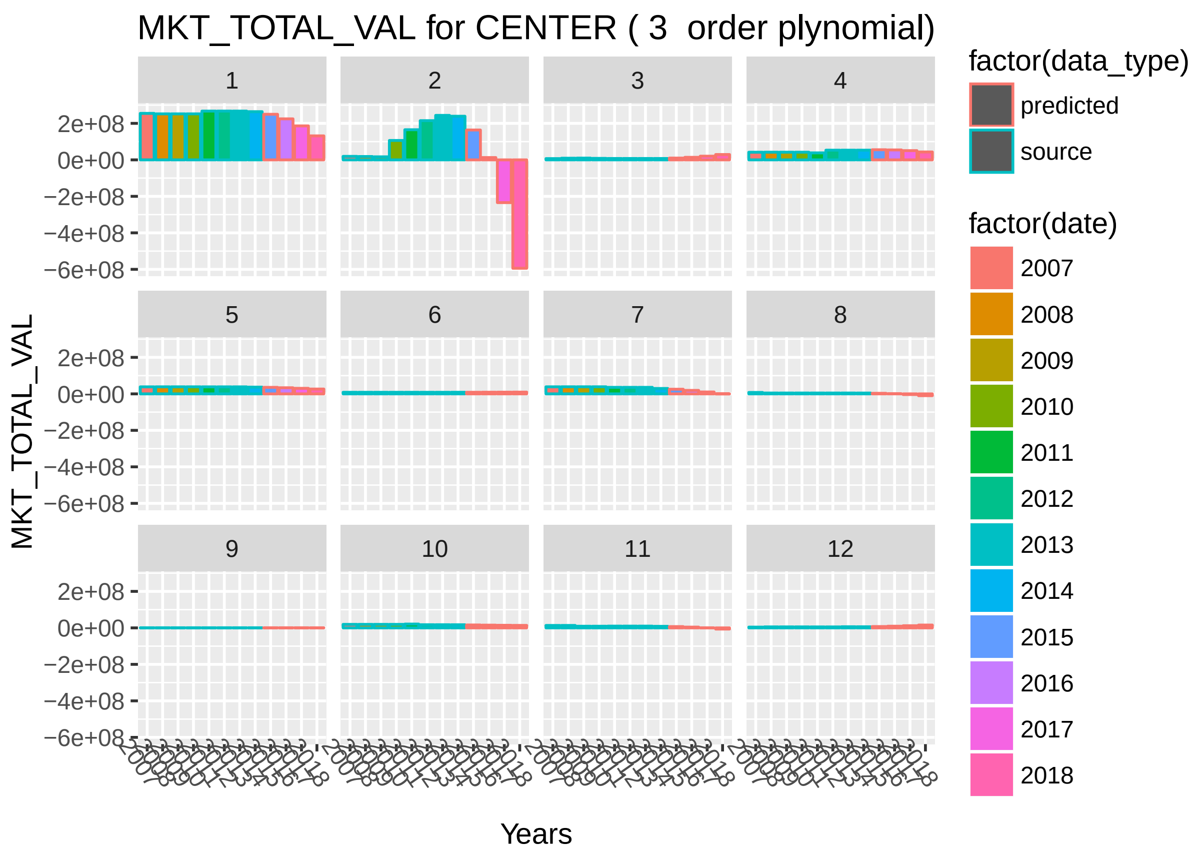


```
for( poly_order in c(seq(1:5))){

  # facet the clusters on a single plot
  # visualize  source and predicted

  df_final_mkt_val_center <- non_linear_regresion_model(a_CENTER, taxinfo_CENTER.matrix, poly_order,12,
  df_final_mkt_val <- bind_rows(df_final_mkt_val, df_final_mkt_val_center )
}
```

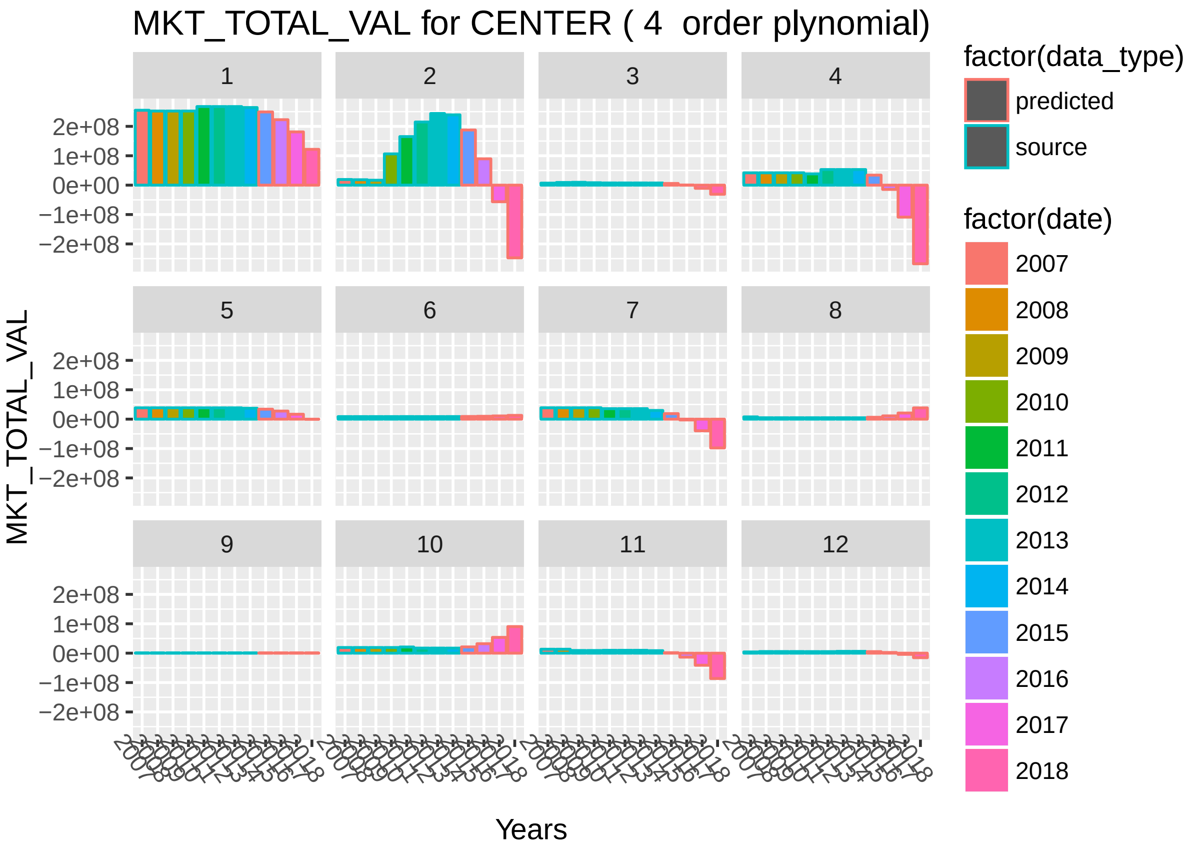




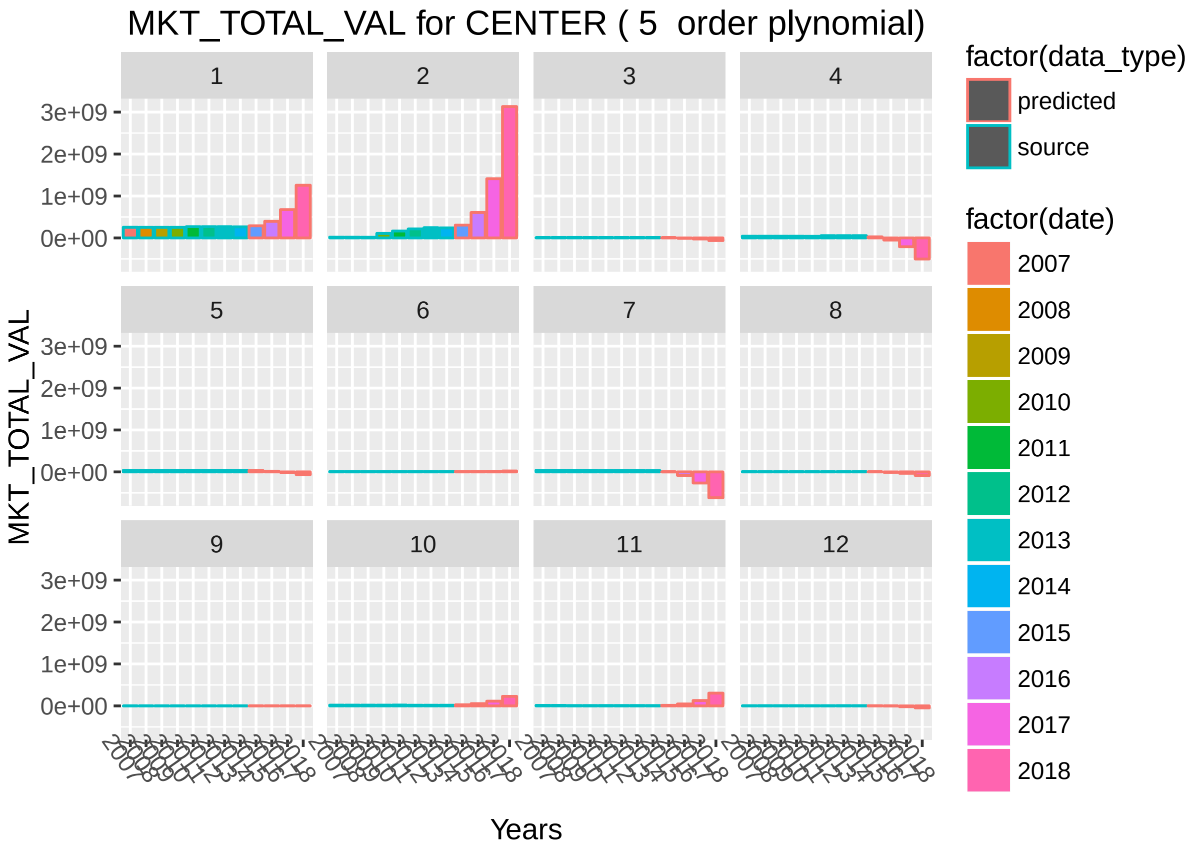
```
## Warning: Stacking not well defined when ymin != 0
```



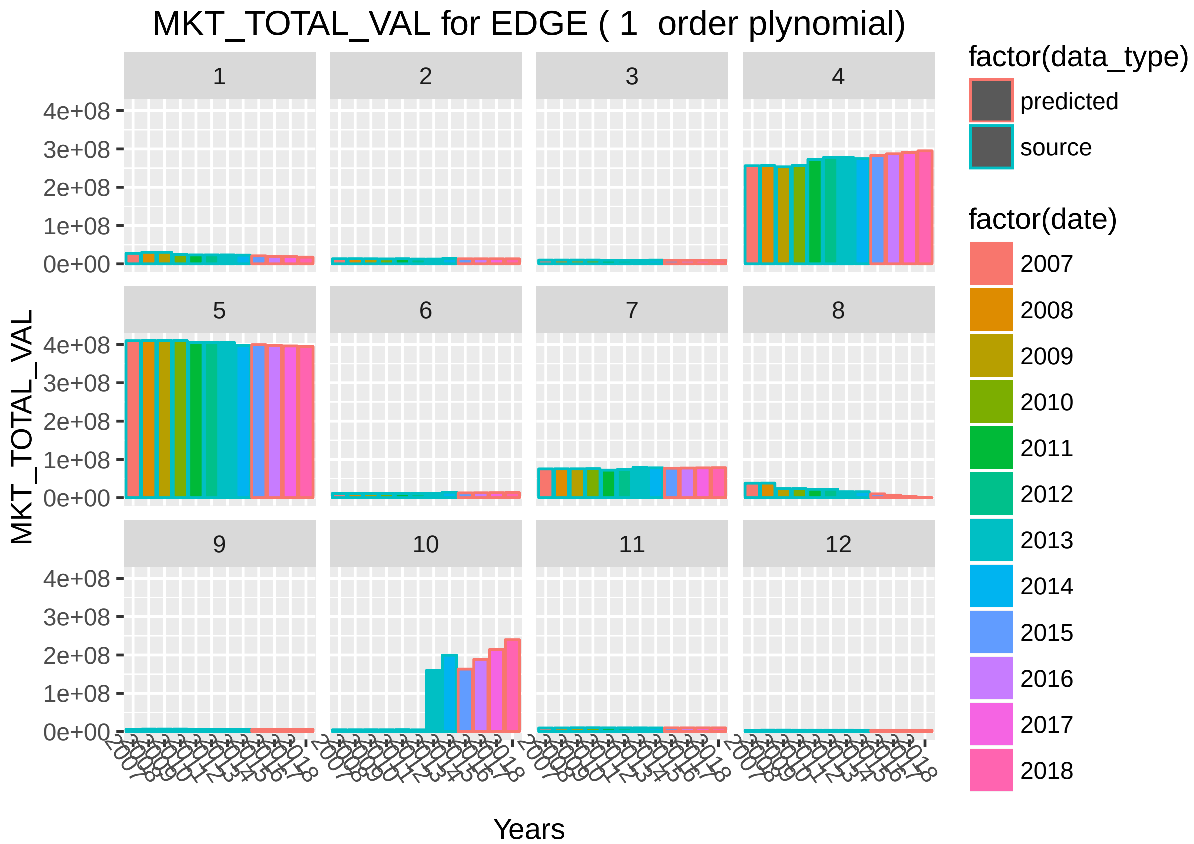
```
## Warning: Stacking not well defined when ymin != 0
```

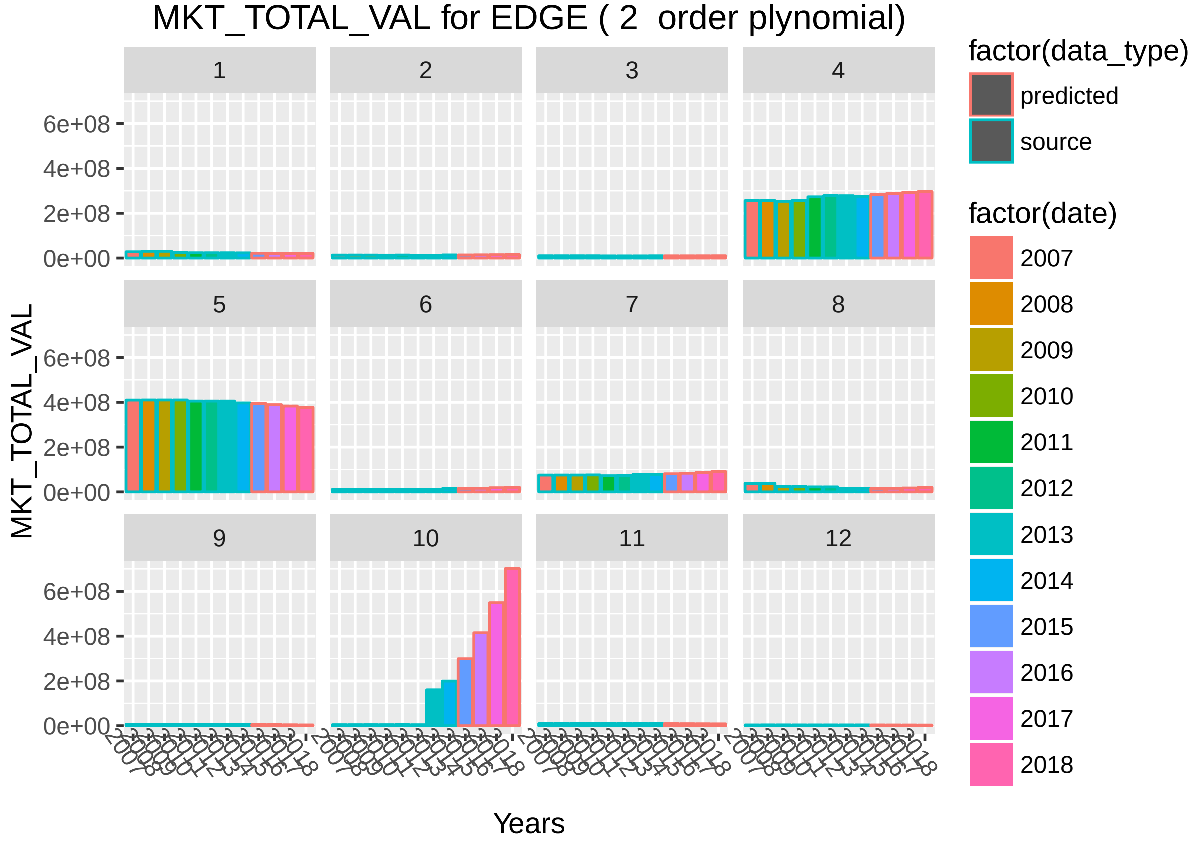


```
## Warning: Stacking not well defined when ymin != 0
```

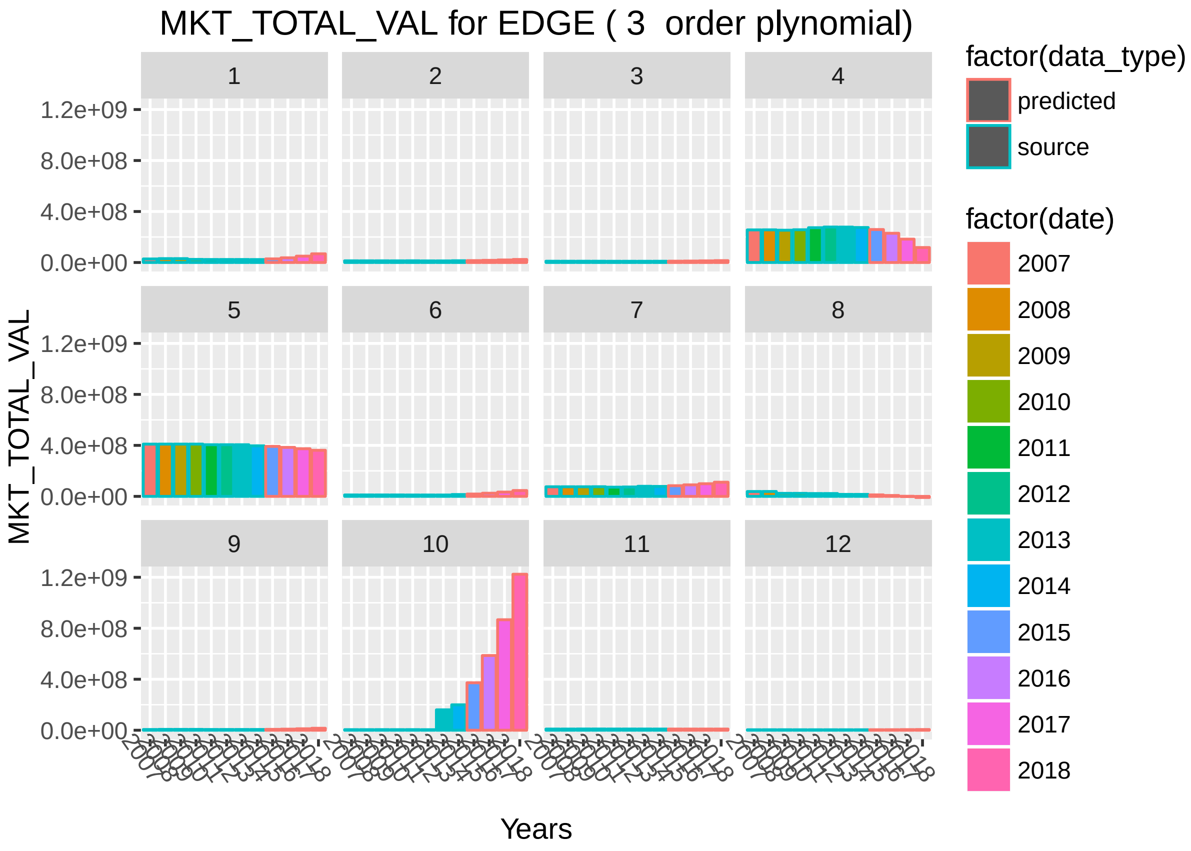


```
for( poly_order in c(seq(1:5))){

  # facet the clusters on a single plot
  # visualize  source and predicted
  df_final_mkt_val_edge <- non_linear_regresion_model(a_EDGE, taxinfo_EDGE.matrix, poly_order,12, "EDGE
  df_final_mkt_val <- bind_rows(df_final_mkt_val, df_final_mkt_val_edge )

}
```

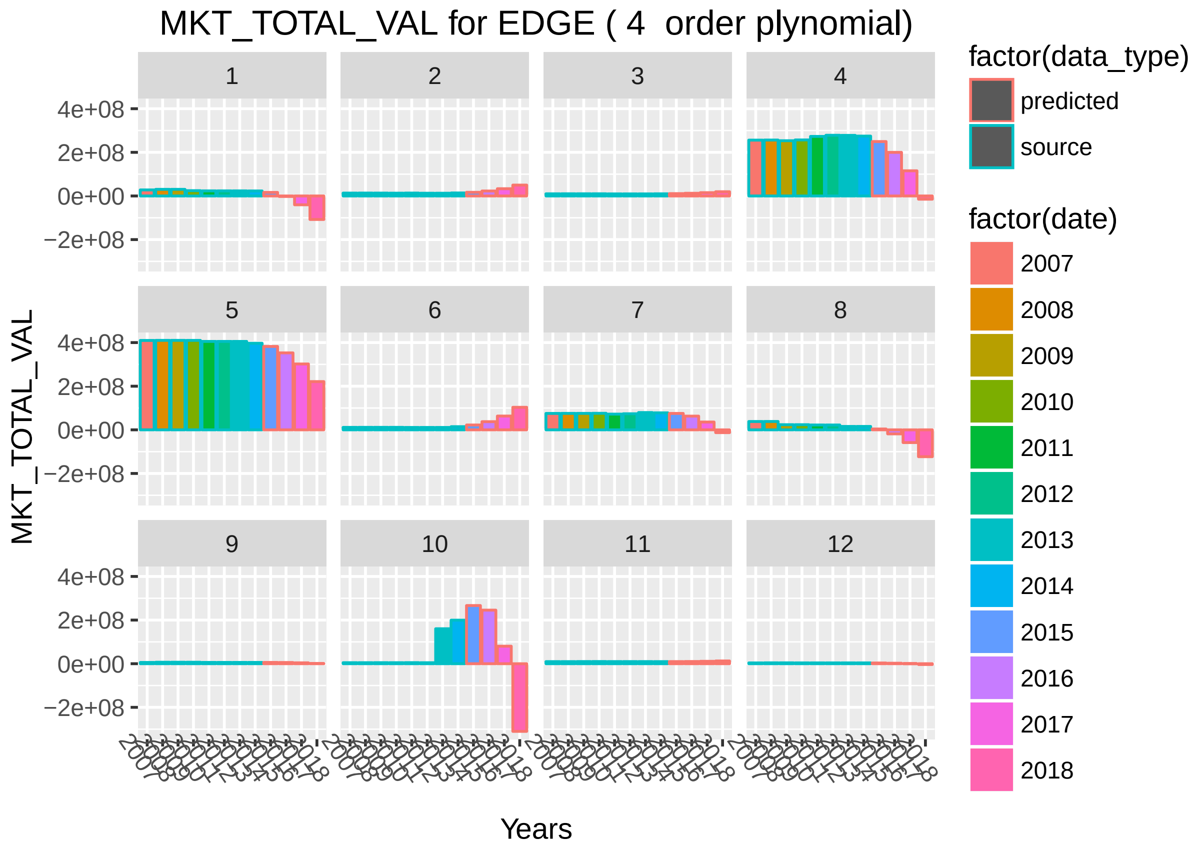




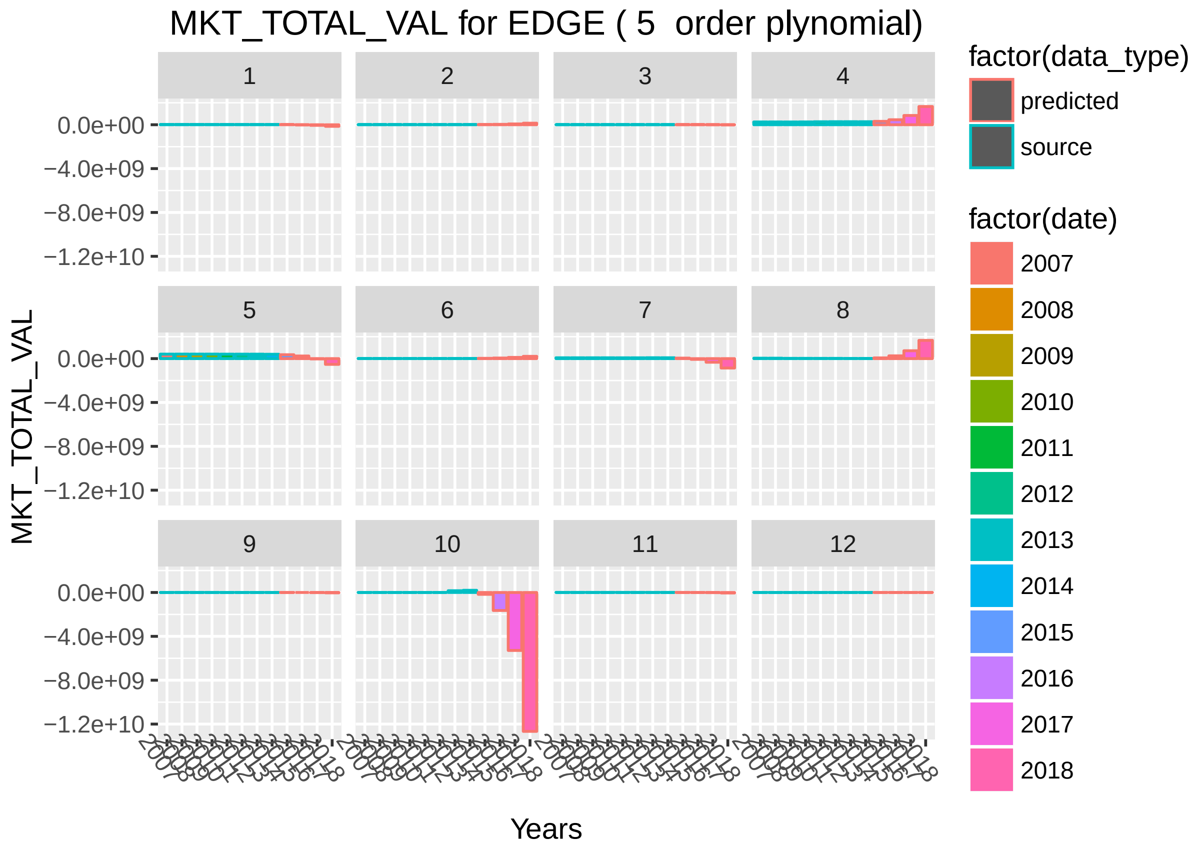
```
## Warning: Stacking not well defined when ymin != 0
```



```
## Warning: Stacking not well defined when ymin != 0
```



```
## Warning: Stacking not well defined when ymin != 0
```

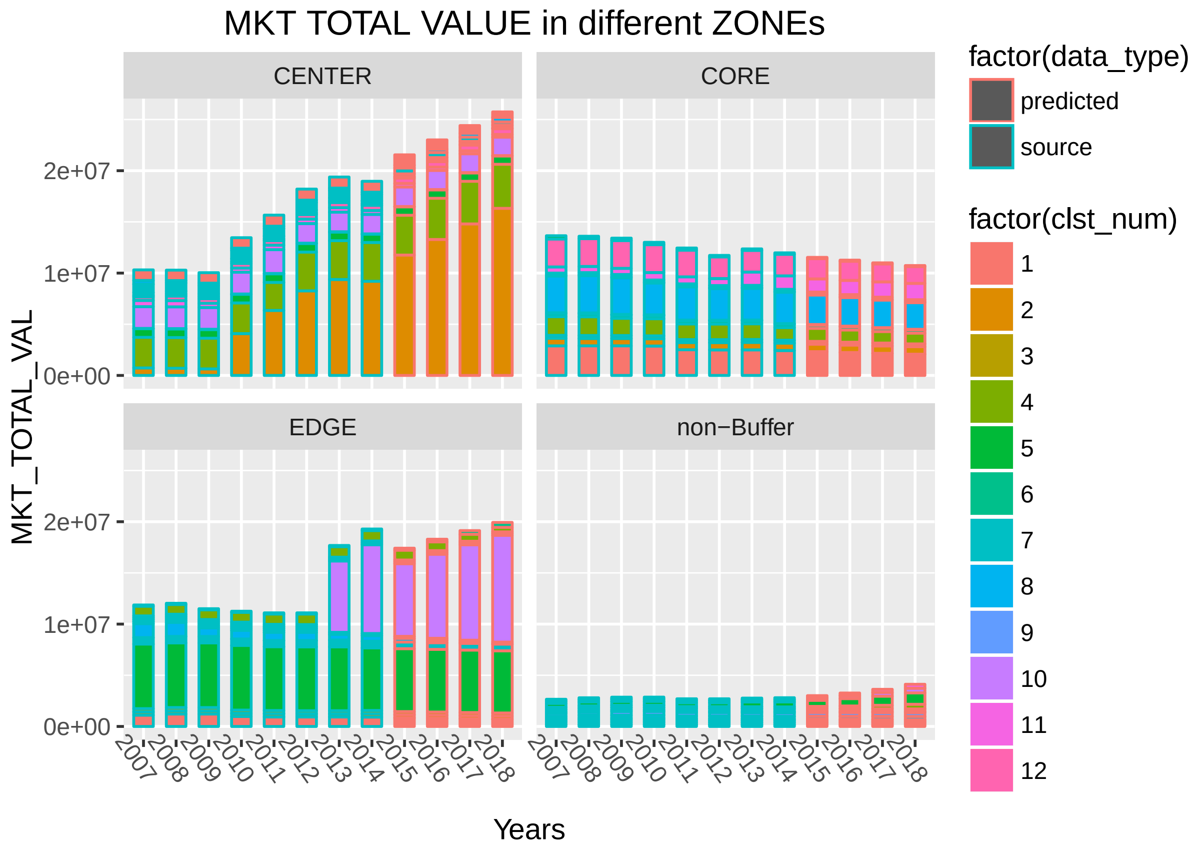


```
# For the plots below we need to make the zone a factor
df_final_mkt_val$zone <- as.factor(df_final_mkt_val$zone)
df_final_mkt_val$data_type <- as.factor(df_final_mkt_val$data_type)
df_final_mkt_val$date <- as.factor(df_final_mkt_val$date)


# Also find the mkt_total/ cluster = ( mkt_val_mean/cluster  * num_parcel_ids/cluster)
df_final_mkt_val <- df_final_mkt_val %>% mutate(mkt_total = mkt_val * num_parcel_ids)

# Write out to csv files
write.csv(df_final_mkt_val, file = "final_mkt_val.csv" )



print(" ZONE UNDER STUDY : Final plot ")
```

```
## [1] " ZONE UNDER STUDY : Final plot "
```

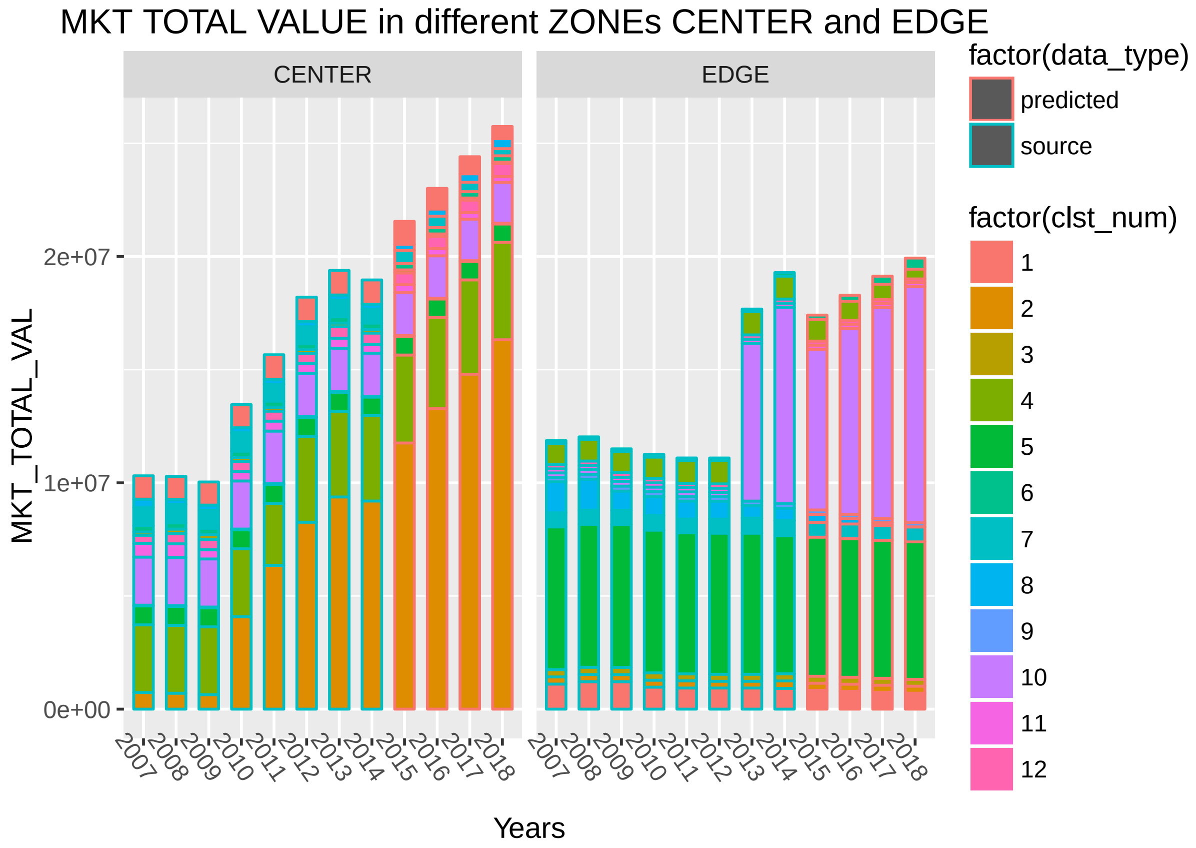
```
n3 <- NULL
# Data Layer
#title <- paste0("MKT TOTAL VALUE  in different ZONEs ")

title <- paste0("MKT TOTAL VALUE in different ZONEs ")


n3 <-(ggplot)
#
# # Data + Aesthetics Mapping
```

```
#n3 <- ggplot(df_final_mkt_val,aes(y = mkt_total, x = factor(date), fill = factor(clst_num), color=fact
n3 <- ggplot(df_final_mkt_val,aes(y = mkt_val, x = factor(date), fill = factor(clst_num), color=factor(

#n3 <-   ggplot(df_final_mkt_val,aes(y = mkt_val, x = date ))
#
# # Data + aes + Geometries
n3 <- n3 + geom_bar(stat="identity", width = 0.6)
#n3 <- n3 + geom_line()
#
# # Data + Aesthetic Mapping +  Geom + Facets
# #n <- n + facet_grid(. ~ Department.Title )
#
# #Data + Aesthetics + Geoms + Facets + Statistics
# # ... add a linear regression model here
#n3 <- n3 + geom_smooth(method="gam" )
# #Data + Aesthetics + Geoms + Facets + Statistics + Co-ordinates
# #n <- n + scale_y_discrete(limits=c("00000","120000"), breaks=seq(00000,120000,10000))
n3 <- n3 + scale_x_discrete()
n3 <- n3 + xlab("Years")
n3 <- n3 + ylab("MKT_TOTAL_VAL  ")
#
# #Data + Aesthetics + Geoms + Facets + Statistics + Co-ordinates + Theme
n3 <- n3 + theme(axis.text.x = element_text(angle=305))
#
n3 <- n3 + ggtitle(title)
n3 <- n3 +facet_wrap( ~ zone)
print(n3)
```



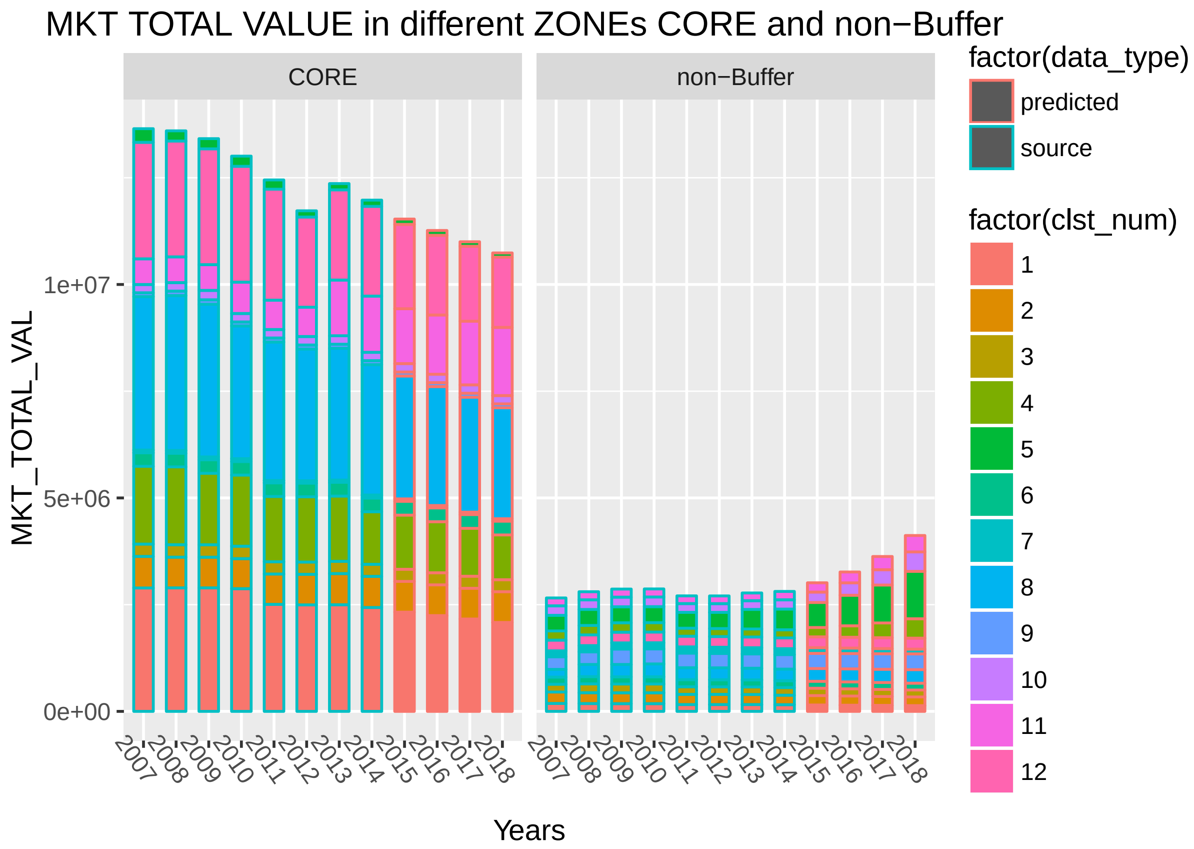
```
## Split it
df_fin_1 <- df_final_mkt_val %>% filter((zone %in% c("CORE","non-Buffer")))

df_fin_2 <- df_final_mkt_val %>% filter((zone %in% c("CENTER","EDGE")))


n3 <- NULL
# Data Layer

title <- paste0("MKT TOTAL VALUE in different ZONEs CENTER and EDGE ")


n3 <-(ggplot)
#
# # Data + Aesthetics Mapping
#n3 <- ggplot(df_final_mkt_val,aes(y = mkt_total, x = factor(date), fill = factor(clst_num), color=fact
n3 <- ggplot(df_fin_2,aes(y = mkt_val, x = factor(date), fill = factor(clst_num), color=factor(data_typ

#n3 <-   ggplot(df_final_mkt_val,aes(y = mkt_val, x = date ))
#
# # Data + aes + Geometries
n3 <- n3 + geom_bar(stat="identity", width = 0.6)
#n3 <- n3 + geom_line()
#
# # Data + Aesthetic Mapping +  Geom + Facets
# #n <- n + facet_grid(. ~ Department.Title )
#
```

```
# #Data + Aesthetics + Geoms + Facets + Statistics
# # ... add a linear regression model here
#n3 <- n3 + geom_smooth(method="gam" )
# #Data + Aesthetics + Geoms + Facets + Statistics + Co-ordinates
# #n <- n + scale_y_discrete(limits=c("00000","120000"), breaks=seq(00000,120000,10000))
n3 <- n3 + scale_x_discrete()
n3 <- n3 + xlab("Years")
n3 <- n3 + ylab("MKT_TOTAL_VAL  ")
#
# #Data + Aesthetics + Geoms + Facets + Statistics + Co-ordinates + Theme
n3 <- n3 + theme(axis.text.x = element_text(angle=305))
#
n3 <- n3 + ggtitle(title)
n3 <- n3 +facet_wrap( ~ zone)
print(n3)
```



```
n3 <- NULL
# Data Layer
#title <- paste0("MKT TOTAL VALUE  in different ZONEs ")

title <- paste0("MKT TOTAL VALUE in different ZONEs CORE and non-Buffer ")


n3 <-(ggplot)
#
# # Data + Aesthetics Mapping
#n3 <- ggplot(df_final_mkt_val,aes(y = mkt_total, x = factor(date), fill = factor(clst_num), color=fact
```

```r
n3 <- ggplot(df_fin_1,aes(y = mkt_val, x = factor(date), fill = factor(clst_num), color=factor(data_typ

#n3 <-   ggplot(df_final_mkt_val,aes(y = mkt_val, x = date ))
#
# # Data + aes + Geometries
n3 <- n3 + geom_bar(stat="identity", width = 0.6)
#n3 <- n3 + geom_line()
#
# # Data + Aesthetic Mapping +  Geom + Facets
# #n <- n + facet_grid(. ~ Department.Title )
#
# #Data + Aesthetics + Geoms + Facets + Statistics
# # ... add a linear regression model here
#n3 <- n3 + geom_smooth(method="gam" )
# #Data + Aesthetics + Geoms + Facets + Statistics + Co-ordinates
# #n <- n + scale_y_discrete(limits=c("00000","120000"), breaks=seq(00000,120000,10000))
n3 <- n3 + scale_x_discrete()
n3 <- n3 + xlab("Years")
n3 <- n3 + ylab("MKT_TOTAL_VAL  ")
#
# #Data + Aesthetics + Geoms + Facets + Statistics + Co-ordinates + Theme
n3 <- n3 + theme(axis.text.x = element_text(angle=305))
#
n3 <- n3 + ggtitle(title)
n3 <- n3 +facet_wrap( ~ zone)
print(n3)
```



```
# Identify clusters with growth in CENTER
cluster_max_val_parcels_CENTER <- remove_char_X(rownames(partCENTER100$var[[2]]))
# Identify clusters with decline in CENTER
cluster_declining_val_parcels_CENTER <- remove_char_X(rownames(partCENTER100$var[[1]]))

# Identify clusters with growth
cluster_max_val_parcels_EDGE <- remove_char_X(rownames(partEDGE100$var[[8]]))
# Identify clusters with growth
cluster_declining_val_parcels_EDGE <- remove_char_X(rownames(partEDGE100$var[[7]]))

# Cluster1  in Core  showing declinging trend
cluster_max_val_parcels_CORE <- remove_char_X(rownames(partCORE100$var[[1]] ))
# Cluster1  in Core  showing declinging trend
cluster_growing_val_parcels_CORE <- remove_char_X(rownames(partCORE100$var[[11]]))


cluster_max_val_parcels_NON_BFR <- remove_char_X(rownames(part1500$var[[5]]))


##############

# PLOTS on the MAP for EDGE

##############
library(ggmap)


###############
#Street Car Line : Convert shape files to data
###############
shp_file_streetcar <- readOGR('/Users/rajesh/Desktop/Coursera/SpringBoardGithub/StreetCar0719/streetcar
                              layer="StreetCar"     )
```

```
## OGR data source with driver: ESRI Shapefile
## Source: "/Users/rajesh/Desktop/Coursera/SpringBoardGithub/StreetCar0719/streetcarbuffer_parcels/gis_
## with 25 features
## It has 11 fields
```

```
proj4string(shp_file_streetcar)
```

```
## [1] "+proj=lcc +lat_1=38.73333333333333 +lat_2=40.03333333333333 +lat_0=38 +lon_0=-82.5 +x_0=600000
```

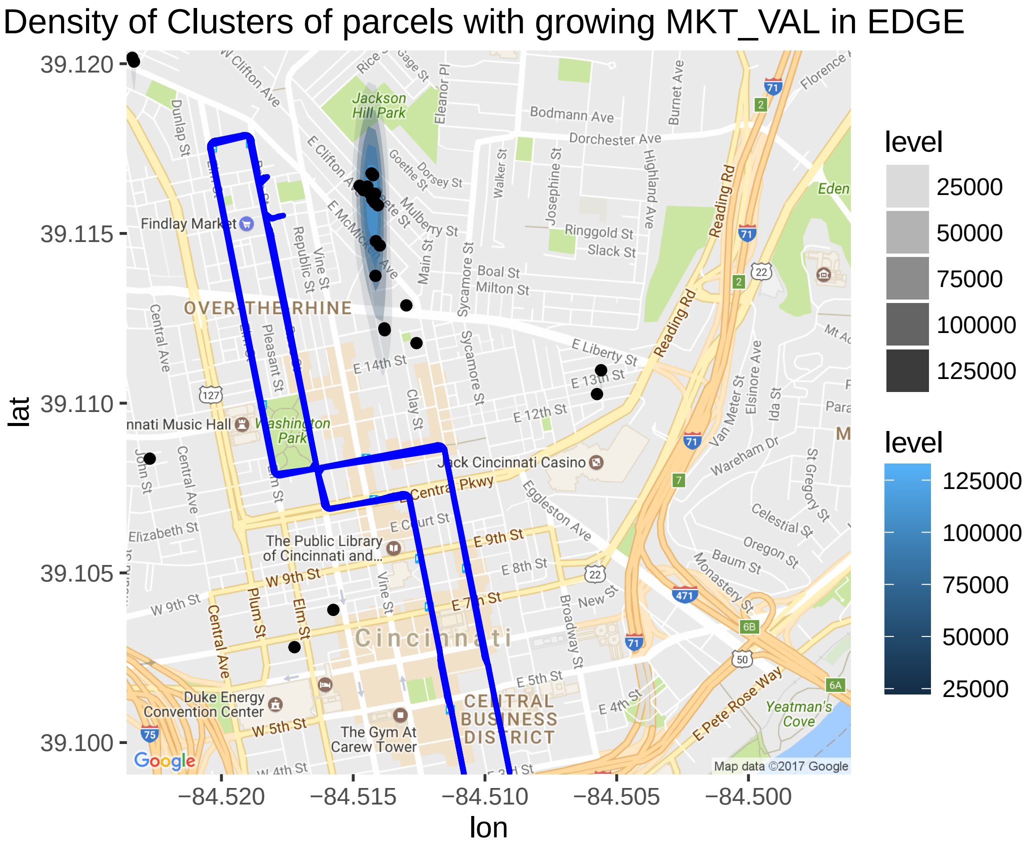
```
shp_file_streetcar <- spTransform(shp_file_streetcar, CRS("+proj=longlat +datum=WGS84"))

# convert to a data.frame for use with ggplot2/ggmap and plot
data <- fortify(shp_file_streetcar)

##############

# PLOTS on the MAP for EDGE

##############

myMap <- get_map(location="1208 Sycamore st, Cincinnati,OH", source="google", maptype="roadmap", crop=F
## Map from URL : http://maps.googleapis.com/maps/api/staticmap?center=1208+Sycamore+st,+Cincinnati,OH&
```

```
## Information from URL : http://maps.googleapis.com/maps/api/geocode/json?address=1208%20Sycamore%20st
```

```
title <- paste0("Density of Clusters of parcels with growing MKT_VAL in EDGE ")

# Growth
df_cluster_max_val_EDGE <- as.data.frame(cluster_max_val_parcels_EDGE)
colnames(df_cluster_max_val_EDGE)<- c("PARCEL_ID")
df_cluster_max_val_EDGE <- semi_join(df_buffer_EDGE,df_cluster_max_val_EDGE, by="PARCEL_ID")

CinciCAGISDensityMap <- ggmap(myMap)
CinciCAGISDensityMap <- CinciCAGISDensityMap + stat_density2d(aes(x = as.numeric(cent_long), y = as.nume
CinciCAGISDensityMap <- CinciCAGISDensityMap  + geom_point(data = df_cluster_max_val_EDGE, aes(x = as.nu
CinciCAGISDensityMap <- CinciCAGISDensityMap + geom_polygon(aes(x = long, y = lat, group = group ), data
                                                     alpha = 1.0, size = 1.0, fill = 'red', colo

CinciCAGISDensityMap <- CinciCAGISDensityMap + ggtitle(title)
print(CinciCAGISDensityMap)
```

```
## Warning: Removed 2 rows containing non-finite values (stat_density2d).
```

```
## Warning: Removed 2 rows containing missing values (geom_point).
```

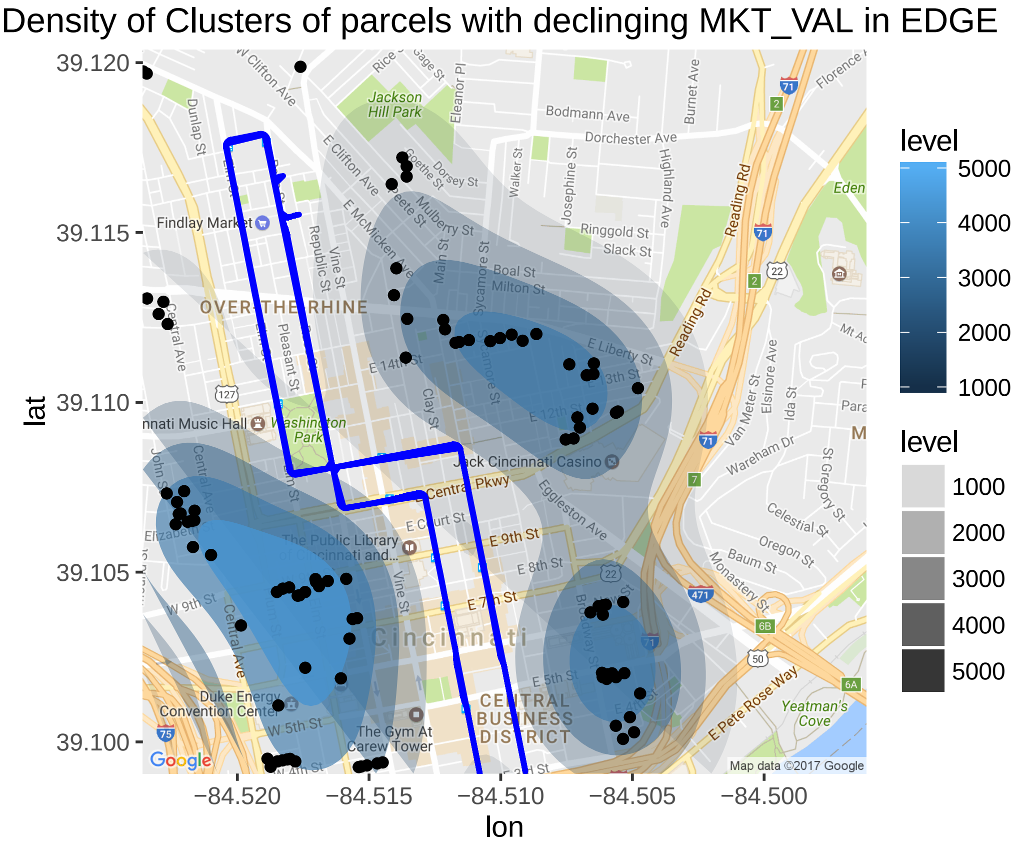


```
#Decline
myMap <- get_map(location="1208 Sycamore st, Cincinnati,OH", source="google", maptype="roadmap", crop=F
```

```
## Map from URL : http://maps.googleapis.com/maps/api/staticmap?center=1208+Sycamore+st,+Cincinnati,OH&
## Information from URL : http://maps.googleapis.com/maps/api/geocode/json?address=1208%20Sycamore%20st
```

```
title <- paste0("Density of Clusters of parcels with declinging MKT_VAL in EDGE ")

df_cluster_declining_val_EDGE <- as.data.frame(cluster_declining_val_parcels_EDGE)
colnames(df_cluster_declining_val_EDGE)<- c("PARCEL_ID")
df_cluster_declining_val_EDGE <- semi_join(df_buffer_EDGE,df_cluster_declining_val_EDGE, by="PARCEL_ID"

CinciCAGISDensityMap <- ggmap(myMap)
CinciCAGISDensityMap <- CinciCAGISDensityMap + stat_density2d(aes(x = as.numeric(cent_long), y = as.nume
CinciCAGISDensityMap <- CinciCAGISDensityMap  + geom_point(data = df_cluster_declining_val_EDGE, aes(x =
CinciCAGISDensityMap <- CinciCAGISDensityMap + geom_polygon(aes(x = long, y = lat, group = group ), data
                                                            alpha = 1.0, size = 1.0, fill = 'red', colo

CinciCAGISDensityMap <- CinciCAGISDensityMap + ggtitle(title)
print(CinciCAGISDensityMap)
```

```
## Warning: Removed 20 rows containing non-finite values (stat_density2d).

## Warning: Removed 20 rows containing missing values (geom_point).
```

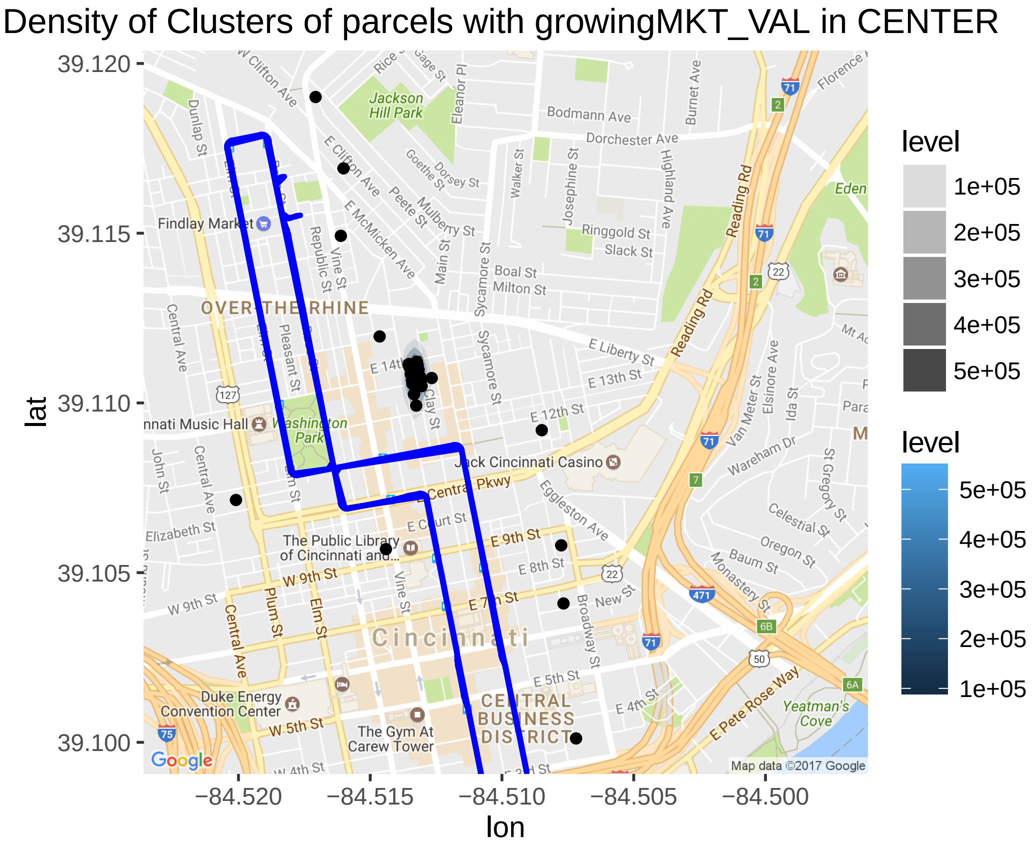


```
# plot on MAPS for CENTER

df_cluster_max_val_CENTER <- as.data.frame(cluster_max_val_parcels_CENTER)
colnames(df_cluster_max_val_CENTER)<- c("PARCEL_ID")
df_cluster_max_val_CENTER <- semi_join(df_buffer_CENTER,df_cluster_max_val_CENTER, by="PARCEL_ID")

myMap <- get_map(location="1208 Sycamore st, Cincinnati,OH", source="google", maptype="roadmap", crop=F

## Map from URL : http://maps.googleapis.com/maps/api/staticmap?center=1208+Sycamore+st,+Cincinnati,OH&
## Information from URL : http://maps.googleapis.com/maps/api/geocode/json?address=1208%20Sycamore%20st
```

```
title <- paste0("Density of Clusters of parcels with growingMKT_VAL in CENTER ")

CinciCAGISDensityMap <- ggmap(myMap)
CinciCAGISDensityMap <- CinciCAGISDensityMap + stat_density2d(aes(x = as.numeric(cent_long), y = as.nume
CinciCAGISDensityMap <- CinciCAGISDensityMap  + geom_point(data = df_cluster_max_val_CENTER, aes(x = as

CinciCAGISDensityMap <- CinciCAGISDensityMap + ggtitle(title)
CinciCAGISDensityMap <- CinciCAGISDensityMap + geom_polygon(aes(x = long, y = lat, group = group ), data
                                                        alpha = 1.0, size = 1.0, fill = 'red', colo
print(CinciCAGISDensityMap)
```

```
## Warning: Removed 1 rows containing non-finite values (stat_density2d).
```

```
## Warning: Removed 1 rows containing missing values (geom_point).
```



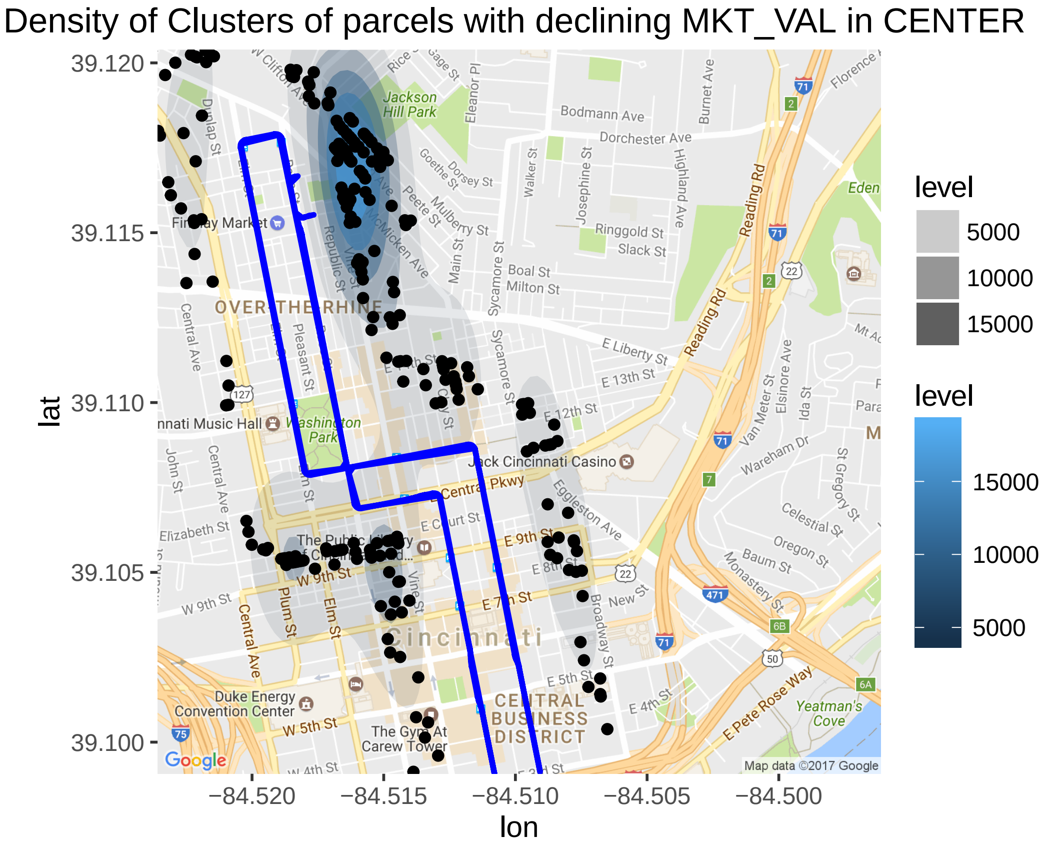
```
# Cluster 1 has declining values
df_cluster_declining_val_CENTER <- as.data.frame(cluster_declining_val_parcels_CENTER)
colnames(df_cluster_declining_val_CENTER)<- c("PARCEL_ID")
df_cluster_declining_val_CENTER <- semi_join(df_buffer_CENTER,df_cluster_declining_val_CENTER, by="PARCE

myMap <- get_map(location="1208 Sycamore st, Cincinnati,OH", source="google", maptype="roadmap", crop=F
```

```
## Map from URL : http://maps.googleapis.com/maps/api/staticmap?center=1208+Sycamore+st,+Cincinnati,OH&
## Information from URL : http://maps.googleapis.com/maps/api/geocode/json?address=1208%20Sycamore%20st
```

```
title <- paste0("Density of Clusters of parcels with declining MKT_VAL in CENTER ")
```

```
CinciCAGISDensityMap <- ggmap(myMap)
CinciCAGISDensityMap <- CinciCAGISDensityMap + stat_density2d(aes(x = as.numeric(cent_long), y = as.nume
CinciCAGISDensityMap <- CinciCAGISDensityMap  + geom_point(data = df_cluster_declining_val_CENTER, aes(

CinciCAGISDensityMap <- CinciCAGISDensityMap + ggtitle(title)
CinciCAGISDensityMap <- CinciCAGISDensityMap + geom_polygon(aes(x = long, y = lat, group = group ), data
                                                          alpha = 1.0, size = 1.0, fill = 'red', colo
print(CinciCAGISDensityMap)
```

```
## Warning: Removed 18 rows containing non-finite values (stat_density2d).

## Warning: Removed 18 rows containing missing values (geom_point).
```

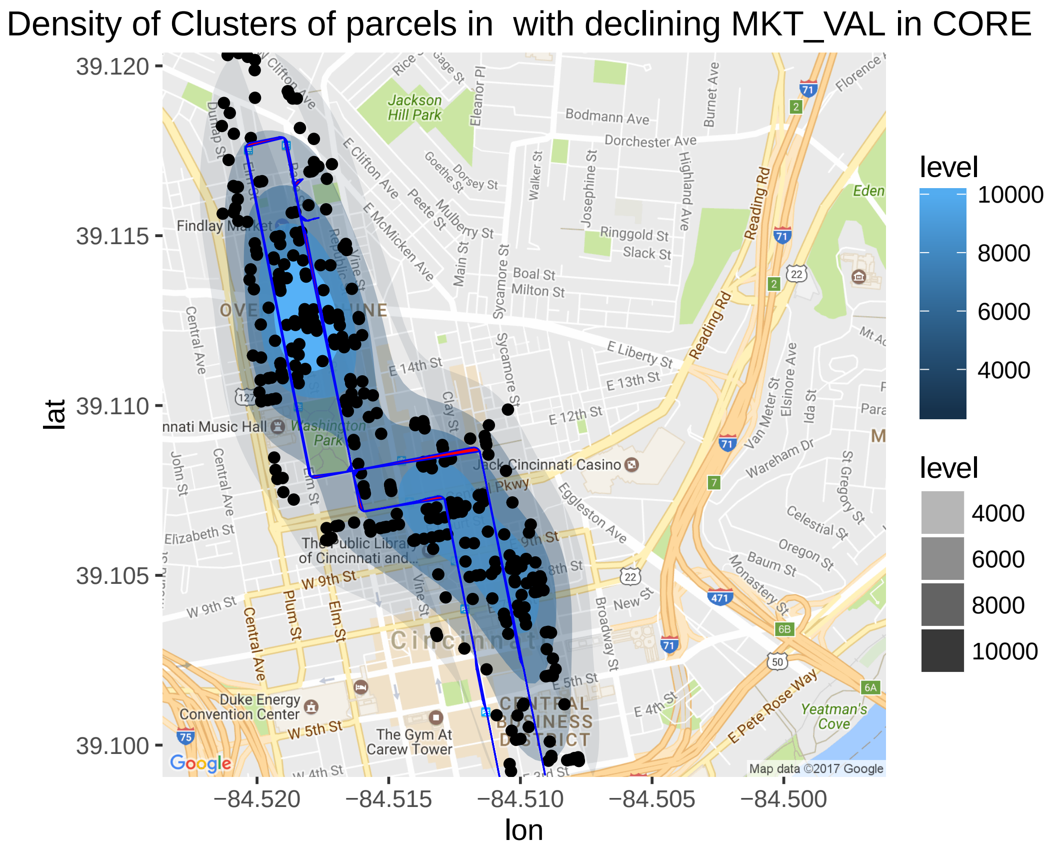


```
# plot on MAPS for CORE

df_cluster_max_val_CORE <- as.data.frame(cluster_max_val_parcels_CORE)
colnames(df_cluster_max_val_CORE)<- c("PARCEL_ID")
df_cluster_max_val_CORE <- semi_join(df_buffer_CORE,df_cluster_max_val_CORE, by="PARCEL_ID")
myMap <- get_map(location="1208 Sycamore st, Cincinnati,OH", source="google", maptype="roadmap", crop=F
```

```
## Map from URL : http://maps.googleapis.com/maps/api/staticmap?center=1208+Sycamore+st,+Cincinnati,OH&
## Information from URL : http://maps.googleapis.com/maps/api/geocode/json?address=1208%20Sycamore%20st
```

```
title <- paste0("Density of Clusters of parcels in  with declining MKT_VAL in CORE ")

CinciCAGISDensityMap <- ggmap(myMap)
CinciCAGISDensityMap <- CinciCAGISDensityMap + stat_density2d(aes(x = as.numeric(cent_long), y = as.nume
CinciCAGISDensityMap <- CinciCAGISDensityMap  + geom_point(data = df_cluster_max_val_CORE, aes(x = as.nu
CinciCAGISDensityMap <- CinciCAGISDensityMap + ggtitle(title)
CinciCAGISDensityMap <- CinciCAGISDensityMap + geom_polygon(aes(x = long, y = lat, group = group ), data
                                                            alpha = 1.0, size = 0.3, fill = 'red', colo
print(CinciCAGISDensityMap)
```

```
## Warning: Removed 2 rows containing non-finite values (stat_density2d).

## Warning: Removed 2 rows containing missing values (geom_point).
```

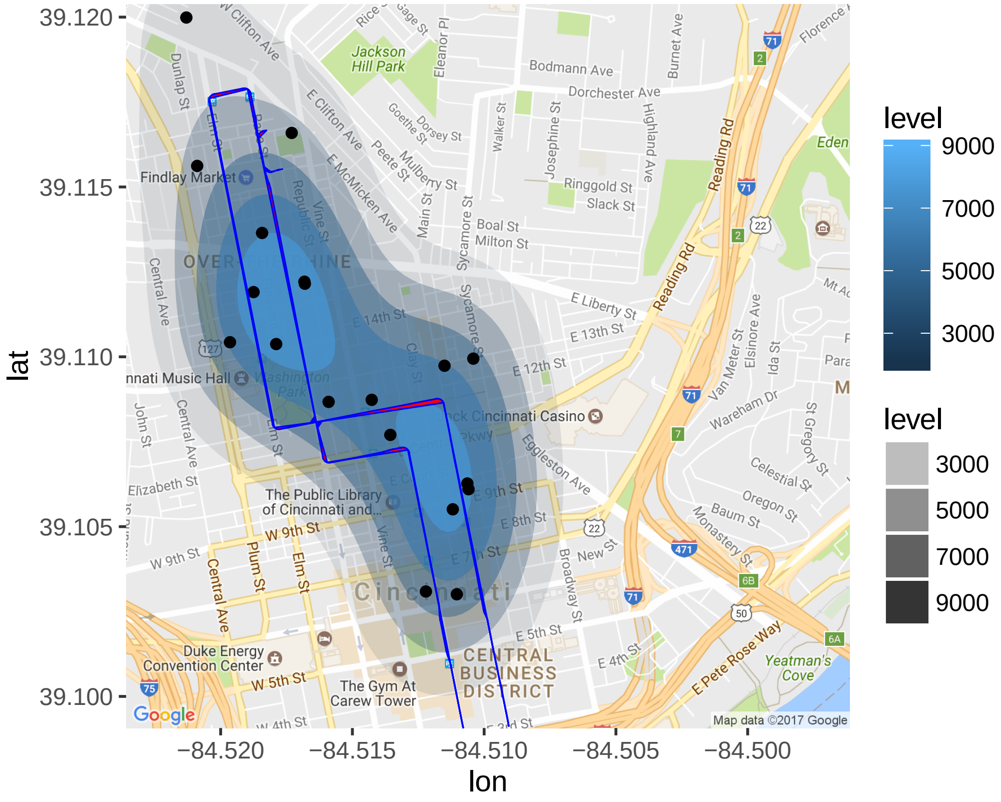


```
df_cluster_growing_val_CORE <- as.data.frame(cluster_growing_val_parcels_CORE)
colnames(df_cluster_growing_val_CORE)<- c("PARCEL_ID")
df_cluster_max_val_CORE <- semi_join(df_buffer_CORE,df_cluster_growing_val_CORE, by="PARCEL_ID")
myMap <- get_map(location="1208 Sycamore st, Cincinnati,OH", source="google", maptype="roadmap", crop=F
```

```
## Map from URL : http://maps.googleapis.com/maps/api/staticmap?center=1208+Sycamore+st,+Cincinnati,OH&
## Information from URL : http://maps.googleapis.com/maps/api/geocode/json?address=1208%20Sycamore%20st
```

```
title <- paste0("Density of Clusters of parcels with increasing MKT_VAL in CORE ")
CinciCAGISDensityMap <- ggmap(myMap)
CinciCAGISDensityMap <- CinciCAGISDensityMap + stat_density2d(aes(x = as.numeric(cent_long), y = as.nume
CinciCAGISDensityMap <- CinciCAGISDensityMap  + geom_point(data = df_cluster_max_val_CORE, aes(x = as.nu
CinciCAGISDensityMap <- CinciCAGISDensityMap + ggtitle(title)
CinciCAGISDensityMap <- CinciCAGISDensityMap + geom_polygon(aes(x = long, y = lat, group = group ), data
                                                            alpha = 1.0, size = 0.3, fill = 'red', colo
print(CinciCAGISDensityMap)
```

Density of Clusters of parcels with increasing MKT_VAL in CORE



lat
39.120
39.115
39.110
39.105
39.100
lon
−84.520
−84.515
−84.510
−84.505
−84.500
level
9000
7000
5000
3000
level
3000
5000
7000
9000
Findlay Market
OVER-THE-RHINE
Washington Park
Jackson Hill Park
Horseshoe Cincinnati Casino
The Public Library of Cincinnati and...
Duke Energy Convention Center
The Gym At Carew Tower
Cincinnati
CENTRAL BUSINESS DISTRICT
Reading Rd
Eden
Yeatman's Cove
E Pete Rose Way
Google
Map data ©2017 Google