Scandinaviafinal

Sulyok

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library(readr)  
library(ggplot2)  
#######mobility data  
#gmr <- read\_csv("Global\_Mobility\_Report(3).csv", col\_types = cols(date #= col\_date(format = "%Y-%m-%d")))  
  
  
#library(data.table)  
#library(ggplot2)  
  
######### Loading country data  
  
#countries <- fread("http://download.geonames.org/export/dump/countryInf#o.txt", skip = "ISO3", na.strings = "")  
#names(countries)[c(1,5, 9)] <- c("geo", "Country.Region", "Continent")  
#countries$lang <- sapply(strsplit(sapply(strsplit(countries$Languages, #","), `[`, 1), "-"), `[`, 1)  
#countries$translated <- "Coronavirus"  
  
############## Obtaining the case numbers  
  
#jhu\_url <- paste0("https://raw.githubusercontent.com/CSSEGISandData/COV#ID-19/master/csse\_covid\_19\_data/",  
 # "csse\_covid\_19\_time\_series/time\_series\_covid19\_deaths#\_global.csv")  
#CaseData <- fread(jhu\_url, check.names = TRUE)  
#CaseData$Province.State[ CaseData$Province.State=="" ] <- #CaseData$Country.Region[ CaseData$Province.State=="" ]  
#CaseData <- melt(CaseData, id.vars = 1:4, variable.name = "Date", #variable.factor = FALSE)  
#CaseData$Date <- as.Date( substring(CaseData$Date, 2), format = #"%m.%d.%y" )  
#CaseData <- CaseData[ , .(CumCaseNumber = sum(value)), #.(Country.Region, Date)][order(Country.Region, Date)]  
#CaseData <- CaseData[ ,.(date = Date[-1], CumCaseNumber = #CumCaseNumber[-1], IncCaseNumber = diff(CumCaseNumber)),  
 # .(Country.Region)]  
  
#CaseData[Country.Region=="US"]$Country.Region <- "United States"  
#CaseData <- merge(CaseData,countries[,c("Country.Region", "geo", #"Continent")])  
#CaseData$country\_region<-CaseData$Country.Region  
  
#CaseData$IncCaseNumber<-ifelse(CaseData$IncCaseNumber<0, 0, #CaseData$IncCaseNumber )  
#write.csv(CaseData, "CaseNumbersdeaths0610.csv")  
#levels(factor(gmr$country\_region))  
#levels(factor(CaseData$country\_region))  
  
  
###stringency  
  
#stringency<-fread("https://raw.githubusercontent.com/OxCGRT/covid-polic#y-tracker/master/data/OxCGRT\_latest.csv")  
#stringency$Date<-as.Date(as.character(stringency$Date), "%Y%m%d")  
#stringency<-stringency[,c(1,5,35)]  
#stringency$Country.Region<-factor(stringency$CountryName)  
#stringency$date<-stringency$Date  
#write.csv(stringency, "stringency0610.csv")   
  
#allmerged<-merge(gmr, CaseData, by=c("country\_region", "date"))  
#all<-allmerged  
#all$NumDate <- as.numeric(all$date)-min(as.numeric(all$date))  
#data<- subset(all, is.na(all$sub\_region\_1)==TRUE)  
#data$IncCaseNumber<-ifelse(data$IncCaseNumber<0, 0, data$IncCaseNumber #)  
  
  
#data<-data[-c(1,3:8, 18)]  
#summary(data)  
#data<-na.omit(data)  
  
  
###scandinavia  
  
  
  
#data<-subset(data, data$Country.Region=="Sweden" | #data$Country.Region=="Norway"   
 # | data$Country.Region=="Denmark" | #data$Country.Region=="Finland" )   
#  
#data$IncCaseNumber<-ifelse(data$Country.Region=="Norway", #data$IncCaseNumber/5.432295, data$IncCaseNumber)   
#data$IncCaseNumber<-ifelse(data$Country.Region=="Sweden", #data$IncCaseNumber/10.115730, data$IncCaseNumber)   
#data$IncCaseNumber<-ifelse(data$Country.Region=="Denmark", #data$IncCaseNumber/5.797559, data$IncCaseNumber)   
#data$IncCaseNumber<-ifelse(data$Country.Region=="Finland", #data$IncCaseNumber/5.542988, data$IncCaseNumber)  
#data$Country.Region<-factor(data$Country.Region)  
  
  
  
####add stringency  
#stringencysc<-subset(stringency, stringency$Country.Region=="Sweden" | #stringency$Country.Region=="Norway"   
 # | stringency$Country.Region=="Denmark" | #stringency$Country.Region=="Finland" )   
#summary(stringencysc)  
#data<-merge(data, stringencysc, by=c("Country.Region", "date"))  
#write.csv(data, "Scandinaviadata0910.csv")  
data <- read\_csv("Scandinaviadata1010.csv", col\_types = cols(Date = col\_date(format = "%Y-%m-%d"), date = col\_date(format = "%Y-%m-%d")))

## Warning: Missing column names filled in: 'X1' [1]

data$Country.Region<-factor(data$Country.Region)  
data<-data[,-1]  
  
############subset it to the first wave of the pandemics##########  
library(dplyr)

##   
## Attaching package: 'dplyr'

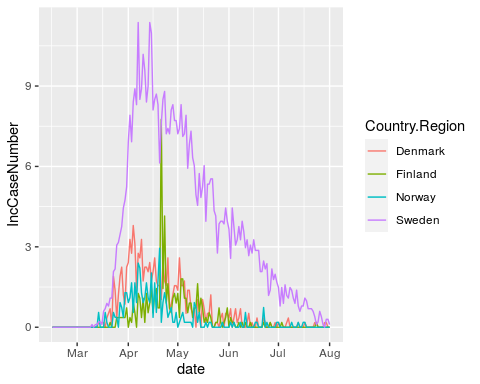
## The following objects are masked from 'package:stats':  
##   
## filter, lag

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

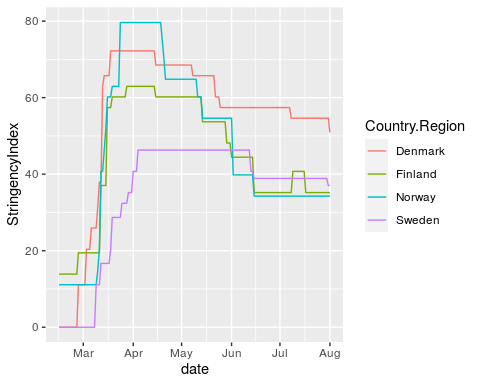
data<-data %>%  
 filter(date<= "2020-08-01")  
  
  
#####visualization  
library(dunn.test)  
dunn.test(data$StringencyIndex, data$Country.Region)

## Kruskal-Wallis rank sum test  
##   
## data: x and group  
## Kruskal-Wallis chi-squared = 109.7447, df = 3, p-value = 0  
##   
##   
## Comparison of x by group   
## (No adjustment)   
## Col Mean-|  
## Row Mean | Denmark Finland Norway  
## ---------+---------------------------------  
## Finland | 6.214210  
## | 0.0000\*  
## |  
## Norway | 5.867537 -0.318785  
## | 0.0000\* 0.3749  
## |  
## Sweden | 10.40134 4.187136 4.487131  
## | 0.0000\* 0.0000\* 0.0000\*  
##   
## alpha = 0.05  
## Reject Ho if p <= alpha/2

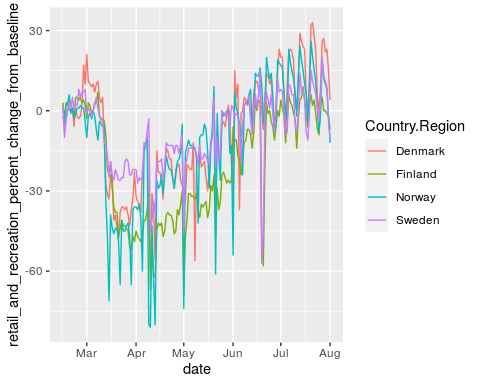
ggplot(data, aes(date, IncCaseNumber, group=Country.Region, color=Country.Region)) +geom\_line()



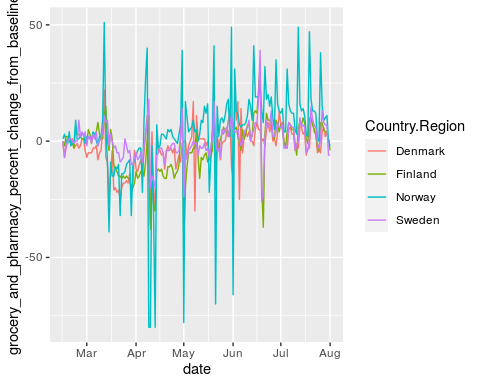
ggplot(data, aes(date, StringencyIndex, group=Country.Region, color=Country.Region)) +geom\_line()



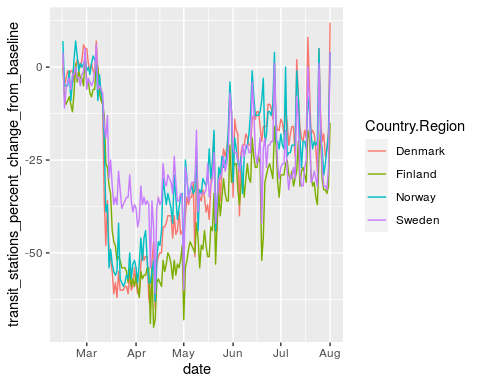
ggplot(data, aes(date, retail\_and\_recreation\_percent\_change\_from\_baseline, group=Country.Region, color=Country.Region)) +geom\_line()



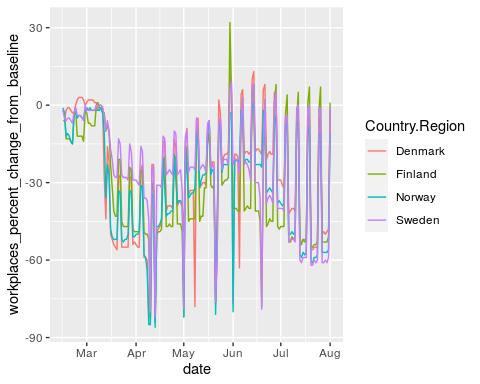
ggplot(data, aes(date, grocery\_and\_pharmacy\_percent\_change\_from\_baseline, group=Country.Region, color=Country.Region)) +geom\_line()



ggplot(data, aes(date, transit\_stations\_percent\_change\_from\_baseline, group=Country.Region, color=Country.Region)) +geom\_line()



ggplot(data, aes(date, workplaces\_percent\_change\_from\_baseline, group=Country.Region, color=Country.Region)) +geom\_line()



########################################correlations############################  
  
######## contemp deaths correlations ################################  
  
contemp<-function(x) {  
 dat<-subset(data, data$Country.Region==x)  
 corfun<-function(y){cor.test(dat$IncCaseNumber, y, exact = FALSE, method = "spearman")$estimate}  
 cc<-as.data.frame(lapply(dat[c(3:8,15)], corfun))  
cc$Country.Region<-x  
a<-cc  
}  
  
results<-NULL  
d<-NULL  
  
for( Country.Region in unique(data$Country.Region) ) {  
 d<-contemp(Country.Region)  
 results<-rbind(results, data.frame(d))  
 }  
resultscont<-results  
resultscont

## retail\_and\_recreation\_percent\_change\_from\_baseline  
## rho -0.6550493  
## rho1 -0.6882424  
## rho2 -0.4477755  
## rho3 -0.5619375  
## grocery\_and\_pharmacy\_percent\_change\_from\_baseline  
## rho -0.3211588  
## rho1 -0.4749231  
## rho2 -0.2171913  
## rho3 -0.3682491  
## parks\_percent\_change\_from\_baseline  
## rho -0.01212918  
## rho1 -0.14482163  
## rho2 -0.11094341  
## rho3 0.08841806  
## transit\_stations\_percent\_change\_from\_baseline  
## rho -0.7475825  
## rho1 -0.6883330  
## rho2 -0.6258268  
## rho3 -0.6616414  
## workplaces\_percent\_change\_from\_baseline  
## rho -0.4566174  
## rho1 -0.2197137  
## rho2 -0.4463374  
## rho3 -0.2828698  
## residential\_percent\_change\_from\_baseline StringencyIndex Country.Region  
## rho 0.6626439 0.8046733 Denmark  
## rho1 0.5995370 0.7379897 Finland  
## rho2 0.6404789 0.7116445 Norway  
## rho3 0.4495201 0.8692746 Sweden

summary(resultscont)

## retail\_and\_recreation\_percent\_change\_from\_baseline  
## Min. :-0.6882   
## 1st Qu.:-0.6633   
## Median :-0.6085   
## Mean :-0.5883   
## 3rd Qu.:-0.5334   
## Max. :-0.4478   
## grocery\_and\_pharmacy\_percent\_change\_from\_baseline  
## Min. :-0.4749   
## 1st Qu.:-0.3949   
## Median :-0.3447   
## Mean :-0.3454   
## 3rd Qu.:-0.2952   
## Max. :-0.2172   
## parks\_percent\_change\_from\_baseline  
## Min. :-0.14482   
## 1st Qu.:-0.11941   
## Median :-0.06154   
## Mean :-0.04487   
## 3rd Qu.: 0.01301   
## Max. : 0.08842   
## transit\_stations\_percent\_change\_from\_baseline  
## Min. :-0.7476   
## 1st Qu.:-0.7031   
## Median :-0.6750   
## Mean :-0.6808   
## 3rd Qu.:-0.6527   
## Max. :-0.6258   
## workplaces\_percent\_change\_from\_baseline  
## Min. :-0.4566   
## 1st Qu.:-0.4489   
## Median :-0.3646   
## Mean :-0.3514   
## 3rd Qu.:-0.2671   
## Max. :-0.2197   
## residential\_percent\_change\_from\_baseline StringencyIndex Country.Region   
## Min. :0.4495 Min. :0.7116 Length:4   
## 1st Qu.:0.5620 1st Qu.:0.7314 Class :character   
## Median :0.6200 Median :0.7713 Mode :character   
## Mean :0.5880 Mean :0.7809   
## 3rd Qu.:0.6460 3rd Qu.:0.8208   
## Max. :0.6626 Max. :0.8693

write.csv(resultscont, "resultscovidcontemcorrtillaugust.csv")  
  
#####contemp pvalues  
  
contemp<-function(x) {  
 dat<-subset(data, data$Country.Region==x)  
 corfun<-function(y){cor.test(dat$IncCaseNumber, y, exact = FALSE, method = "spearman")$p.value}  
 cc<-as.data.frame(lapply(dat[c(3:8,15)], corfun))  
cc$Country.Region<-x  
a<-cc  
}  
  
results<-NULL  
d<-NULL  
  
for( Country.Region in unique(data$Country.Region) ) {  
 d<-contemp(Country.Region)  
 results<-rbind(results, data.frame(d))  
 }  
resultscontp<-results  
resultscontp

## retail\_and\_recreation\_percent\_change\_from\_baseline  
## 1 4.402765e-22  
## 2 4.719693e-25  
## 3 1.458491e-09  
## 4 1.879390e-15  
## grocery\_and\_pharmacy\_percent\_change\_from\_baseline  
## 1 2.068052e-05  
## 2 6.850848e-11  
## 3 4.941827e-03  
## 4 8.396211e-07  
## parks\_percent\_change\_from\_baseline  
## 1 0.87562721  
## 2 0.06029578  
## 3 0.15473570  
## 4 0.25297862  
## transit\_stations\_percent\_change\_from\_baseline  
## 1 1.717069e-31  
## 2 4.626550e-25  
## 3 1.965529e-19  
## 4 1.213186e-22  
## workplaces\_percent\_change\_from\_baseline  
## 1 4.383181e-10  
## 2 4.101630e-03  
## 3 1.669001e-09  
## 4 1.942231e-04  
## residential\_percent\_change\_from\_baseline StringencyIndex Country.Region  
## 1 9.943957e-23 1.177064e-39 Denmark  
## 2 7.163678e-18 2.473346e-30 Finland  
## 3 1.515862e-20 6.210270e-27 Norway  
## 4 8.743811e-10 5.632757e-53 Sweden

summary(resultscontp)

## retail\_and\_recreation\_percent\_change\_from\_baseline  
## Min. :0.000e+00   
## 1st Qu.:0.000e+00   
## Median :9.000e-16   
## Mean :3.646e-10   
## 3rd Qu.:3.646e-10   
## Max. :1.458e-09   
## grocery\_and\_pharmacy\_percent\_change\_from\_baseline  
## Min. :0.000e+00   
## 1st Qu.:6.300e-07   
## Median :1.076e-05   
## Mean :1.241e-03   
## 3rd Qu.:1.251e-03   
## Max. :4.942e-03   
## parks\_percent\_change\_from\_baseline  
## Min. :0.0603   
## 1st Qu.:0.1311   
## Median :0.2039   
## Mean :0.3359   
## 3rd Qu.:0.4086   
## Max. :0.8756   
## transit\_stations\_percent\_change\_from\_baseline  
## Min. :0.000e+00   
## 1st Qu.:3.500e-25   
## Median :6.089e-23   
## Mean :4.917e-20   
## 3rd Qu.:4.923e-20   
## Max. :1.966e-19   
## workplaces\_percent\_change\_from\_baseline  
## Min. :0.000e+00   
## 1st Qu.:1.000e-09   
## Median :9.711e-05   
## Mean :1.074e-03   
## 3rd Qu.:1.171e-03   
## Max. :4.102e-03   
## residential\_percent\_change\_from\_baseline StringencyIndex   
## Min. :0.000e+00 Min. :0.000e+00   
## 1st Qu.:0.000e+00 1st Qu.:0.000e+00   
## Median :0.000e+00 Median :1.237e-30   
## Mean :2.186e-10 Mean :1.553e-27   
## 3rd Qu.:2.186e-10 3rd Qu.:1.554e-27   
## Max. :8.744e-10 Max. :6.210e-27   
## Country.Region   
## Length:4   
## Class :character   
## Mode :character   
##   
##   
##

pconts<-as.vector(as.matrix(resultscontp[-8]))  
dim(pconts)<-c(4,7)  
adjustedpconts<-p.adjust(pconts, method="holm")  
dim(adjustedpconts)<-c(4,7)  
adjustedpconts

## [,1] [,2] [,3] [,4] [,5] [,6]  
## [1,] 8.365254e-21 1.654441e-04 0.8756272 4.464378e-30 5.698135e-09 2.088231e-21  
## [2,] 1.064106e-23 9.591188e-10 0.2411831 1.064106e-23 2.460978e-02 1.146188e-16  
## [3,] 1.604340e-08 2.470914e-02 0.4642071 3.341399e-18 1.669001e-08 2.728552e-19  
## [4,] 2.819085e-14 7.556590e-06 0.5059572 2.426372e-21 1.359562e-03 1.049257e-08  
## [,7]  
## [1,] 3.178073e-38  
## [2,] 6.183364e-29  
## [3,] 1.490465e-25  
## [4,] 1.577172e-51

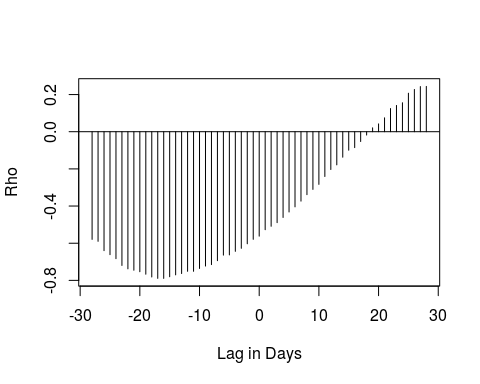
write.csv(adjustedpconts, "adjustedpscontemp.csv")  
################################crosscorrelations##############################  
  
crosscorr<-function(x) {  
 dat<-subset(data, data$Country.Region==x)  
 ccfspear<-function(y){ ccfspearmanx <- sapply( -28:28, function(l) cor.test(y, Hmisc::Lag(dat$IncCaseNumber,l),method = "spearman", use = "complete.obs", exact=FALSE)$estimate)  
 }  
 cc<-as.data.frame(lapply(dat[c(3:8,15)], ccfspear))  
 ccabs<-abs(cc)  
a<-as.data.frame(lapply(ccabs[1:7], which.max))  
b<-as.data.frame(lapply(cc[1:7], max ))  
c<-as.data.frame(lapply(cc[1:7], min))  
e<-ifelse(abs(b)<abs(c), c, b)  
names(e) <-c("V1", "V2", "V3", "V4", "V5", "V7", "Stringrho")  
a$Country.Region<-x  
a<-data.frame(cbind(a,e))  
}  
  
results<-NULL  
d<-NULL  
  
for( Country.Region in unique(data$Country.Region) ) {  
 d<-crosscorr(Country.Region)  
 results<-rbind(results, data.frame(d))  
 }  
  
results$retail\_and\_recreation\_percent\_change\_from\_baseline<-results$retail\_and\_recreation\_percent\_change\_from\_baseline-29  
  
results$grocery\_and\_pharmacy\_percent\_change\_from\_baseline<- results$grocery\_and\_pharmacy\_percent\_change\_from\_baseline-29  
  
results$parks\_percent\_change\_from\_baseline<- results$parks\_percent\_change\_from\_baseline-29  
  
results$transit\_stations\_percent\_change\_from\_baseline<-results$transit\_stations\_percent\_change\_from\_baseline-29  
  
results$workplaces\_percent\_change\_from\_baseline<-results$workplaces\_percent\_change\_from\_baseline-29  
  
results$residential\_percent\_change\_from\_baseline<-results$residential\_percent\_change\_from\_baseline-29  
  
results$StringencyIndex<-results$StringencyIndex-29  
  
  
resultscross<-results  
resultscross

## retail\_and\_recreation\_percent\_change\_from\_baseline  
## 1 -12  
## 2 -10  
## 3 -10  
## 4 -16  
## grocery\_and\_pharmacy\_percent\_change\_from\_baseline  
## 1 -13  
## 2 -10  
## 3 -23  
## 4 -16  
## parks\_percent\_change\_from\_baseline  
## 1 -28  
## 2 -28  
## 3 -27  
## 4 -28  
## transit\_stations\_percent\_change\_from\_baseline  
## 1 -7  
## 2 -10  
## 3 -10  
## 4 -9  
## workplaces\_percent\_change\_from\_baseline  
## 1 -7  
## 2 -14  
## 3 -7  
## 4 -6  
## residential\_percent\_change\_from\_baseline StringencyIndex Country.Region  
## 1 -7 -1 Denmark  
## 2 -13 -9 Finland  
## 3 -7 -4 Norway  
## 4 -13 8 Sweden  
## V1 V2 V3 V4 V5 V7 Stringrho  
## 1 -0.7097023 -0.5583271 -0.4492658 -0.8012100 -0.5043611 0.7152830 0.8185356  
## 2 -0.7687906 -0.6214340 -0.4886539 -0.7896003 -0.3575777 0.7244655 0.8214278  
## 3 -0.6717035 -0.5383987 -0.5341764 -0.6996249 -0.5000778 0.6845225 0.7239340  
## 4 -0.7892603 -0.5140142 -0.5197385 -0.7724239 -0.3287594 0.6220724 0.9262336

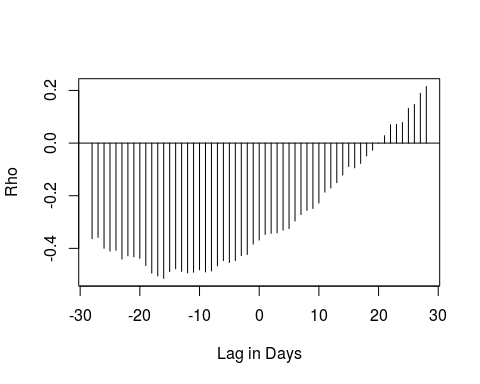
summary(resultscross)

## retail\_and\_recreation\_percent\_change\_from\_baseline  
## Min. :-16   
## 1st Qu.:-13   
## Median :-11   
## Mean :-12   
## 3rd Qu.:-10   
## Max. :-10   
## grocery\_and\_pharmacy\_percent\_change\_from\_baseline  
## Min. :-23.00   
## 1st Qu.:-17.75   
## Median :-14.50   
## Mean :-15.50   
## 3rd Qu.:-12.25   
## Max. :-10.00   
## parks\_percent\_change\_from\_baseline  
## Min. :-28.00   
## 1st Qu.:-28.00   
## Median :-28.00   
## Mean :-27.75   
## 3rd Qu.:-27.75   
## Max. :-27.00   
## transit\_stations\_percent\_change\_from\_baseline  
## Min. :-10.0   
## 1st Qu.:-10.0   
## Median : -9.5   
## Mean : -9.0   
## 3rd Qu.: -8.5   
## Max. : -7.0   
## workplaces\_percent\_change\_from\_baseline  
## Min. :-14.00   
## 1st Qu.: -8.75   
## Median : -7.00   
## Mean : -8.50   
## 3rd Qu.: -6.75   
## Max. : -6.00   
## residential\_percent\_change\_from\_baseline StringencyIndex Country.Region   
## Min. :-13 Min. :-9.00 Length:4   
## 1st Qu.:-13 1st Qu.:-5.25 Class :character   
## Median :-10 Median :-2.50 Mode :character   
## Mean :-10 Mean :-1.50   
## 3rd Qu.: -7 3rd Qu.: 1.25   
## Max. : -7 Max. : 8.00   
## V1 V2 V3 V4   
## Min. :-0.7893 Min. :-0.6214 Min. :-0.5342 Min. :-0.8012   
## 1st Qu.:-0.7739 1st Qu.:-0.5741 1st Qu.:-0.5233 1st Qu.:-0.7925   
## Median :-0.7392 Median :-0.5484 Median :-0.5042 Median :-0.7810   
## Mean :-0.7349 Mean :-0.5580 Mean :-0.4980 Mean :-0.7657   
## 3rd Qu.:-0.7002 3rd Qu.:-0.5323 3rd Qu.:-0.4788 3rd Qu.:-0.7542   
## Max. :-0.6717 Max. :-0.5140 Max. :-0.4493 Max. :-0.6996   
## V5 V7 Stringrho   
## Min. :-0.5044 Min. :0.6221 Min. :0.7239   
## 1st Qu.:-0.5011 1st Qu.:0.6689 1st Qu.:0.7949   
## Median :-0.4288 Median :0.6999 Median :0.8200   
## Mean :-0.4227 Mean :0.6866 Mean :0.8225   
## 3rd Qu.:-0.3504 3rd Qu.:0.7176 3rd Qu.:0.8476   
## Max. :-0.3288 Max. :0.7245 Max. :0.9262

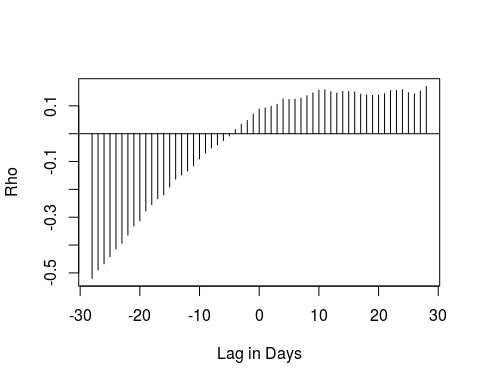
write.csv(resultscross, "resultscovidcrosscorrtillaugust.csv")  
  
  
crosscorrfun<- function(x) {  
 datx<-subset(data, data$Country.Region==x)  
 ccfspear<-function(y){ ccfspearmanx <- sapply( -28:28, function(l) cor.test(y, Hmisc::Lag(datx$IncCaseNumber,l),method = "spearman", use = "complete.obs", exact=FALSE)$estimate )  
 plot(-28:28,ccfspearmanx,type="h", ylab="Rho", xlab="Lag in Days")  
 abline(h=0)  
 print(ccfspearmanx)  
 print(summary(ccfspearmanx))  
 which.max(abs(ccfspearmanx))-29}  
 lapply(datx[c(3:8,15)], ccfspear)  
}  
  
crosscorrfun("Sweden")



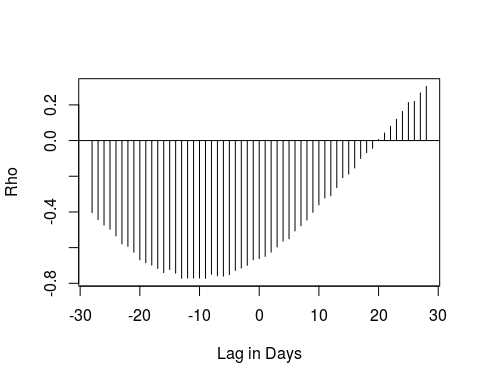
## rho rho rho rho rho rho   
## -0.57930933 -0.58983364 -0.63999763 -0.66161254 -0.68310515 -0.71959200   
## rho rho rho rho rho rho   
## -0.73781649 -0.74528425 -0.75329217 -0.76673967 -0.78161634 -0.78904235   
## rho rho rho rho rho rho   
## -0.78926027 -0.78040902 -0.77026484 -0.76309264 -0.75105809 -0.75102619   
## rho rho rho rho rho rho   
## -0.73584782 -0.72303221 -0.71512828 -0.69393194 -0.66405693 -0.66280794   
## rho rho rho rho rho rho   
## -0.64369968 -0.62732973 -0.60298763 -0.57902011 -0.56193753 -0.52719377   
## rho rho rho rho rho rho   
## -0.50886114 -0.48926057 -0.46142010 -0.43196257 -0.40440117 -0.37348086   
## rho rho rho rho rho rho   
## -0.33876612 -0.31043141 -0.28330976 -0.24094090 -0.20327251 -0.17835232   
## rho rho rho rho rho rho   
## -0.13719645 -0.09952250 -0.08557601 -0.05266237 -0.01786260 0.02094077   
## rho rho rho rho rho rho   
## 0.04213598 0.07485909 0.12474050 0.14130128 0.15590117 0.20712853   
## rho rho rho   
## 0.22734400 0.24293893 0.24385056   
## Min. 1st Qu. Median Mean 3rd Qu. Max.   
## -0.7893 -0.7196 -0.5619 -0.4197 -0.1372 0.2439



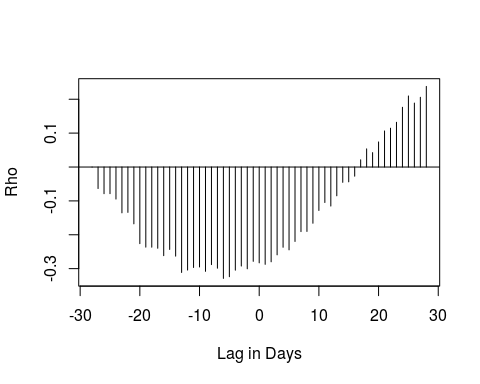
## rho rho rho rho rho   
## -0.3632098000 -0.3581707613 -0.3996135055 -0.4103113308 -0.4071171913   
## rho rho rho rho rho   
## -0.4405216176 -0.4281273827 -0.4321002570 -0.4380730573 -0.4653524469   
## rho rho rho rho rho   
## -0.4939536831 -0.5044256535 -0.5140142345 -0.4884339015 -0.4775096790   
## rho rho rho rho rho   
## -0.4876679279 -0.4932040139 -0.4903911752 -0.4814132432 -0.4894619106   
## rho rho rho rho rho   
## -0.4857573931 -0.4662846411 -0.4464576872 -0.4537839391 -0.4464792013   
## rho rho rho rho rho   
## -0.4277581135 -0.4231076961 -0.3836383271 -0.3682490821 -0.3469136524   
## rho rho rho rho rho   
## -0.3429744216 -0.3409423016 -0.3309094755 -0.3245856648 -0.2964065987   
## rho rho rho rho rho   
## -0.2715749671 -0.2557473637 -0.2484480817 -0.2276633435 -0.1863850782   
## rho rho rho rho rho   
## -0.1703626848 -0.1504366274 -0.1216390510 -0.0890861486 -0.0940693054   
## rho rho rho rho rho   
## -0.0774189894 -0.0487567910 -0.0271023103 -0.0002403631 0.0280941281   
## rho rho rho rho rho   
## 0.0695438337 0.0712505331 0.0782901564 0.1316880514 0.1467521109   
## rho rho   
## 0.1888822656 0.2152496247   
## Min. 1st Qu. Median Mean 3rd Qu. Max.   
## -0.5140 -0.4465 -0.3582 -0.2805 -0.1216 0.2152



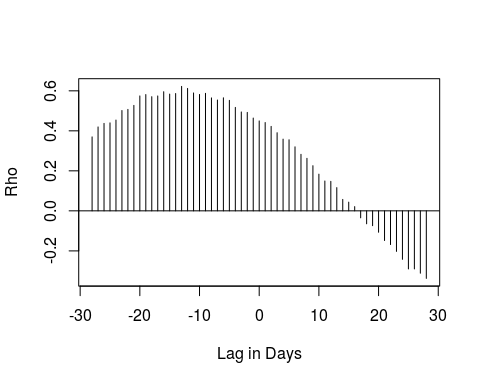
## rho rho rho rho rho rho   
## -0.519738536 -0.489593065 -0.467459421 -0.441850045 -0.414333026 -0.393822369   
## rho rho rho rho rho rho   
## -0.364200982 -0.331684928 -0.313067584 -0.277940853 -0.254966573 -0.233891423   
## rho rho rho rho rho rho   
## -0.219938366 -0.191969472 -0.163127026 -0.148103884 -0.134567277 -0.115995368   
## rho rho rho rho rho rho   
## -0.090231669 -0.070102087 -0.051430644 -0.040169942 -0.024858152 -0.007947301   
## rho rho rho rho rho rho   
## 0.014564771 0.033694423 0.047408302 0.070461925 0.088418065 0.092553917   
## rho rho rho rho rho rho   
## 0.098166124 0.105345423 0.125061185 0.122807731 0.123873055 0.127713292   
## rho rho rho rho rho rho   
## 0.136560523 0.146756413 0.156515816 0.158026745 0.151135328 0.145533218   
## rho rho rho rho rho rho   
## 0.151744983 0.151634366 0.149831122 0.141740383 0.139335119 0.137618648   
## rho rho rho rho rho rho   
## 0.139041172 0.143599318 0.154664005 0.155610745 0.157895759 0.147614444   
## rho rho rho   
## 0.142948814 0.153391358 0.169815628   
## Min. 1st Qu. Median Mean 3rd Qu. Max.   
## -0.51974 -0.16313 0.08842 -0.02772 0.14360 0.16982



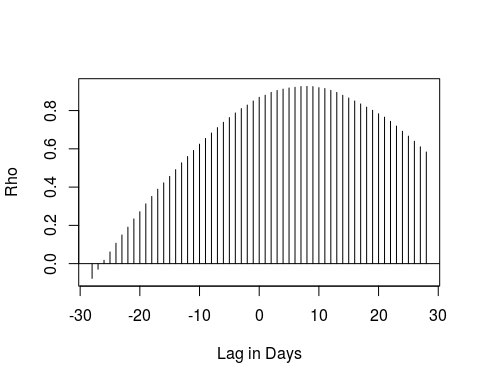
## rho rho rho rho rho rho   
## -0.404303578 -0.442631329 -0.473692320 -0.496379241 -0.534485197 -0.578693614   
## rho rho rho rho rho rho   
## -0.592950919 -0.625736605 -0.668513771 -0.684978445 -0.697915223 -0.716444955   
## rho rho rho rho rho rho   
## -0.739880524 -0.722830331 -0.743179462 -0.772091654 -0.770538110 -0.769921696   
## rho rho rho rho rho rho   
## -0.770556921 -0.772423867 -0.750043211 -0.758112497 -0.760042480 -0.751531946   
## rho rho rho rho rho rho   
## -0.727682501 -0.714732892 -0.699252284 -0.668187450 -0.661641442 -0.649205112   
## rho rho rho rho rho rho   
## -0.625424344 -0.595935637 -0.563673835 -0.550347663 -0.506336416 -0.478230441   
## rho rho rho rho rho rho   
## -0.444791932 -0.402443705 -0.360384246 -0.322034944 -0.309405129 -0.263520997   
## rho rho rho rho rho rho   
## -0.208550481 -0.187721384 -0.153536435 -0.100628155 -0.067515980 -0.043768296   
## rho rho rho rho rho rho   
## 0.006059952 0.042231430 0.079448245 0.119375392 0.163023019 0.213310355   
## rho rho rho   
## 0.219378188 0.267323406 0.303500245   
## Min. 1st Qu. Median Mean 3rd Qu. Max.   
## -0.7724 -0.7147 -0.5503 -0.4367 -0.2086 0.3035



## rho rho rho rho rho   
## -0.0002570584 -0.0635451481 -0.0787501796 -0.0787295213 -0.0946279116   
## rho rho rho rho rho   
## -0.1352884324 -0.1339428566 -0.1677160045 -0.2261557250 -0.2365189050   
## rho rho rho rho rho   
## -0.2366588419 -0.2397587317 -0.2616134634 -0.2432584875 -0.2630924950   
## rho rho rho rho rho   
## -0.3112262453 -0.3042372269 -0.2965463287 -0.2950773690 -0.3079413195   
## rho rho rho rho rho   
## -0.2880897211 -0.2986870875 -0.3287593670 -0.3237661072 -0.3044585742   
## rho rho rho rho rho   
## -0.2922426253 -0.3003731741 -0.2784444282 -0.2828697954 -0.2872818559   
## rho rho rho rho rho   
## -0.2797800041 -0.2592522730 -0.2368948659 -0.2445020193 -0.2197381704   
## rho rho rho rho rho   
## -0.1906682073 -0.1901864094 -0.1659763052 -0.1282938790 -0.1047318833   
## rho rho rho rho rho   
## -0.1152238023 -0.0849403748 -0.0452757988 -0.0437256868 -0.0270761323   
## rho rho rho rho rho   
## 0.0212825216 0.0535716230 0.0424682035 0.0740737534 0.1064860602   
## rho rho rho rho rho   
## 0.1146184621 0.1320086758 0.1763037211 0.2096977248 0.1887114878   
## rho rho   
## 0.2057939454 0.2379384401   
## Min. 1st Qu. Median Mean 3rd Qu. Max.   
## -0.32876 -0.27978 -0.19019 -0.13567 -0.04373 0.23794



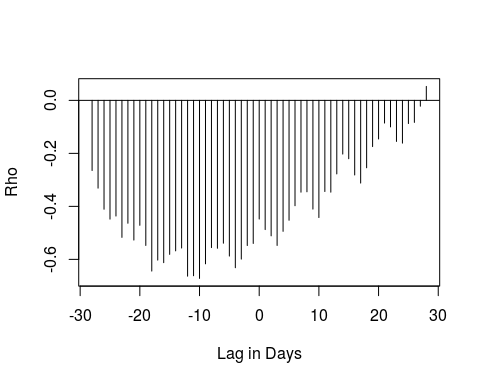
## rho rho rho rho rho rho   
## 0.36963536 0.41942056 0.43722825 0.43982576 0.45387424 0.50156129   
## rho rho rho rho rho rho   
## 0.50715616 0.52717387 0.57443658 0.58122708 0.57061329 0.57427171   
## rho rho rho rho rho rho   
## 0.59551229 0.58356245 0.58648028 0.62207241 0.61187763 0.58934390   
## rho rho rho rho rho rho   
## 0.58178452 0.58738686 0.56455828 0.55397177 0.56508917 0.55224830   
## rho rho rho rho rho rho   
## 0.51703851 0.49426453 0.49199592 0.46383201 0.44952006 0.44148327   
## rho rho rho rho rho rho   
## 0.42218761 0.39058740 0.35851253 0.35530892 0.31999629 0.28257914   
## rho rho rho rho rho rho   
## 0.26258478 0.22566938 0.18340840 0.14928296 0.14735561 0.11619345   
## rho rho rho rho rho rho   
## 0.05721569 0.04355098 0.02120474 -0.03484341 -0.06464330 -0.07409790   
## rho rho rho rho rho rho   
## -0.10685408 -0.14813953 -0.16843469 -0.20260929 -0.24222830 -0.29033138   
## rho rho rho   
## -0.29026185 -0.31170444 -0.33760726   
## Min. 1st Qu. Median Mean 3rd Qu. Max.   
## -0.33761 0.05722 0.42219 0.29601 0.55397 0.62207



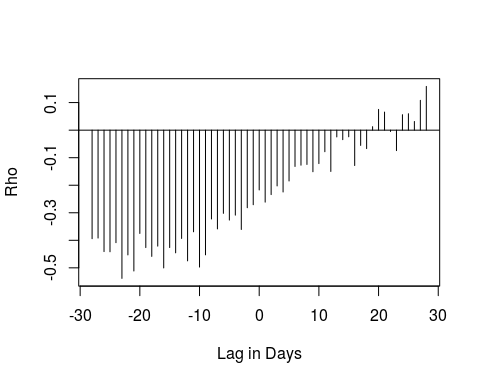
## rho rho rho rho rho rho   
## -0.07705037 -0.02920329 0.01762354 0.06105216 0.10691428 0.14963715   
## rho rho rho rho rho rho   
## 0.19053842 0.23381016 0.27138365 0.31246841 0.35101676 0.38890312   
## rho rho rho rho rho rho   
## 0.42226958 0.45601850 0.49121632 0.52686870 0.55970107 0.59151369   
## rho rho rho rho rho rho   
## 0.62439169 0.65424731 0.68282864 0.71078515 0.73871964 0.76341557   
## rho rho rho rho rho rho   
## 0.78750694 0.81030083 0.82875346 0.85008401 0.86927456 0.88019478   
## rho rho rho rho rho rho   
## 0.89495813 0.90491431 0.91216936 0.91786333 0.92163933 0.92542135   
## rho rho rho rho rho rho   
## 0.92623363 0.92503753 0.91945296 0.91504113 0.90531292 0.89478661   
## rho rho rho rho rho rho   
## 0.87984903 0.86572782 0.85025150 0.83443394 0.81796754 0.80146229   
## rho rho rho rho rho rho   
## 0.78331009 0.76545604 0.74367196 0.71890169 0.69181600 0.66644785   
## rho rho rho   
## 0.63975902 0.61052463 0.58351962   
## Min. 1st Qu. Median Mean 3rd Qu. Max.   
## -0.07705 0.49122 0.73872 0.63932 0.86927 0.92623

## $retail\_and\_recreation\_percent\_change\_from\_baseline  
## rho   
## -16   
##   
## $grocery\_and\_pharmacy\_percent\_change\_from\_baseline  
## rho   
## -16   
##   
## $parks\_percent\_change\_from\_baseline  
## rho   
## -28   
##   
## $transit\_stations\_percent\_change\_from\_baseline  
## rho   
## -9   
##   
## $workplaces\_percent\_change\_from\_baseline  
## rho   
## -6   
##   
## $residential\_percent\_change\_from\_baseline  
## rho   
## -13   
##   
## $StringencyIndex  
## rho   
## 8

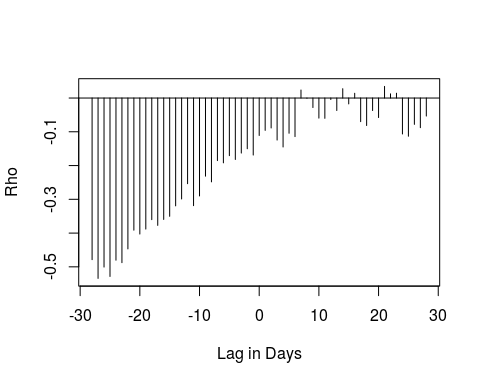
crosscorrfun("Norway")



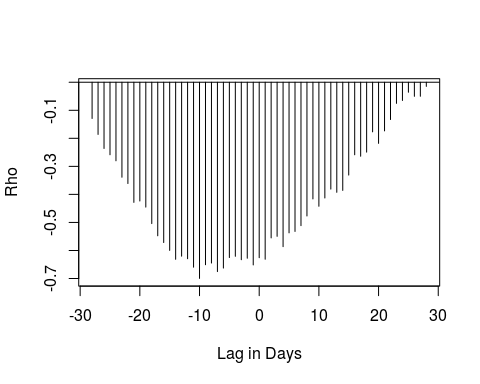
## rho rho rho rho rho rho   
## -0.26471343 -0.33125309 -0.41077742 -0.44813515 -0.43642460 -0.51695911   
## rho rho rho rho rho rho   
## -0.46364788 -0.52706623 -0.47140773 -0.54738965 -0.64406795 -0.60264355   
## rho rho rho rho rho rho   
## -0.61234209 -0.58102776 -0.56784776 -0.55712894 -0.66329589 -0.66171440   
## rho rho rho rho rho rho   
## -0.67170354 -0.61672343 -0.55545078 -0.55804643 -0.53896978 -0.58750119   
## rho rho rho rho rho rho   
## -0.63146471 -0.59888004 -0.54766618 -0.53985728 -0.44777553 -0.48744146   
## rho rho rho rho rho rho   
## -0.51113812 -0.54739263 -0.49422952 -0.45232430 -0.39758729 -0.34647147   
## rho rho rho rho rho rho   
## -0.34508127 -0.41029715 -0.44214663 -0.34396272 -0.34638350 -0.27753435   
## rho rho rho rho rho rho   
## -0.20272018 -0.22025200 -0.28152035 -0.31211480 -0.25439730 -0.17442108   
## rho rho rho rho rho rho   
## -0.14568786 -0.08577268 -0.10019705 -0.15497959 -0.16145167 -0.08753247   
## rho rho rho   
## -0.08317034 -0.02208626 0.05262289   
## Min. 1st Qu. Median Mean 3rd Qu. Max.   
## -0.67170 -0.55545 -0.44814 -0.40768 -0.27753 0.05262



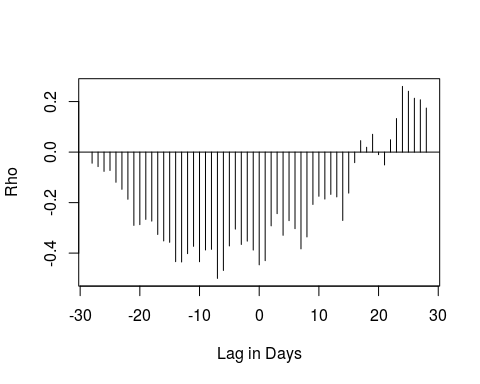
## rho rho rho rho rho rho   
## -0.394199031 -0.391833011 -0.441031343 -0.441674495 -0.408712864 -0.538398735   
## rho rho rho rho rho rho   
## -0.453092782 -0.511530218 -0.375163553 -0.426402850 -0.458523065 -0.421178523   
## rho rho rho rho rho rho   
## -0.500417236 -0.426372161 -0.445516906 -0.393306740 -0.474740851 -0.369158054   
## rho rho rho rho rho rho   
## -0.497319982 -0.452882451 -0.322657596 -0.358665609 -0.302201369 -0.326561565   
## rho rho rho rho rho rho   
## -0.308716127 -0.360750976 -0.281811930 -0.270847102 -0.217191261 -0.261442107   
## rho rho rho rho rho rho   
## -0.234074695 -0.202592227 -0.224594217 -0.184617073 -0.131934612 -0.127278698   
## rho rho rho rho rho rho   
## -0.124614489 -0.151104679 -0.121422818 -0.078336721 -0.150090601 -0.024616922   
## rho rho rho rho rho rho   
## -0.034580789 -0.024153074 -0.128503875 -0.055508747 -0.067052869 0.012579712   
## rho rho rho rho rho rho   
## 0.075274659 0.065578790 -0.004785988 -0.074345441 0.056095932 0.059623701   
## rho rho rho   
## 0.031378543 0.108245578 0.158826472   
## Min. 1st Qu. Median Mean 3rd Qu. Max.   
## -0.53840 -0.40871 -0.26144 -0.23524 -0.07435 0.15883



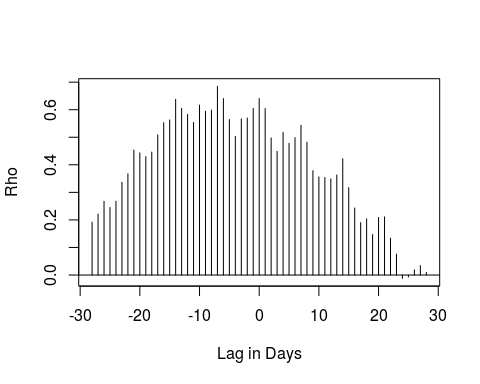
## rho rho rho rho rho   
## -0.4787215201 -0.5341763637 -0.5006475960 -0.5284806815 -0.4802483862   
## rho rho rho rho rho   
## -0.4876182287 -0.4468202877 -0.3913642313 -0.4028073172 -0.3881387763   
## rho rho rho rho rho   
## -0.3601641573 -0.3771506893 -0.3595400772 -0.3502775197 -0.3194061557   
## rho rho rho rho rho   
## -0.2989272974 -0.2536945487 -0.3187171394 -0.2900158116 -0.2314598509   
## rho rho rho rho rho   
## -0.2483434235 -0.1852936052 -0.1919594827 -0.1706425189 -0.1819900095   
## rho rho rho rho rho   
## -0.1629836891 -0.1501897615 -0.1688075972 -0.1109434135 -0.0958194634   
## rho rho rho rho rho   
## -0.0886739883 -0.1244618564 -0.1449902212 -0.1043314653 -0.1142912090   
## rho rho rho rho rho   
## 0.0237462005 -0.0009382429 -0.0281901725 -0.0594806148 -0.0601539096   
## rho rho rho rho rho   
## -0.0044032518 -0.0369687680 0.0276207845 -0.0174307810 0.0141391011   
## rho rho rho rho rho   
## -0.0699103747 -0.0813654666 -0.0370248799 -0.0577760879 0.0344366042   
## rho rho rho rho rho   
## 0.0124137296 0.0142812769 -0.1064765227 -0.1131335215 -0.0779999320   
## rho rho   
## -0.0878222728 -0.0533649836   
## Min. 1st Qu. Median Mean 3rd Qu. Max.   
## -0.53418 -0.31941 -0.14499 -0.18961 -0.05948 0.03444



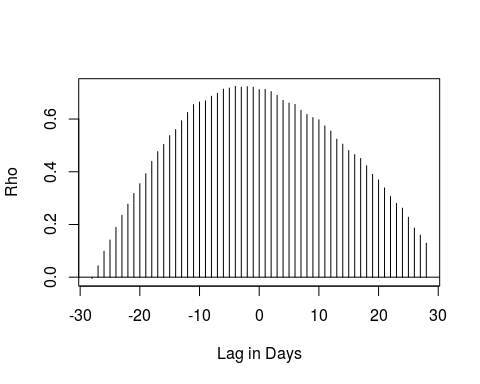
## rho rho rho rho rho rho   
## -0.12922398 -0.18609411 -0.23623083 -0.25862111 -0.28017430 -0.33877496   
## rho rho rho rho rho rho   
## -0.36122726 -0.42850711 -0.42355209 -0.44527517 -0.50406949 -0.54761312   
## rho rho rho rho rho rho   
## -0.57170047 -0.59973218 -0.63147906 -0.62032578 -0.62943848 -0.65966576   
## rho rho rho rho rho rho   
## -0.69962489 -0.65093081 -0.64487605 -0.67527745 -0.66285183 -0.62521305   
## rho rho rho rho rho rho   
## -0.62081337 -0.63296976 -0.62766446 -0.65156346 -0.62582679 -0.63128092   
## rho rho rho rho rho rho   
## -0.55516335 -0.54962181 -0.58637685 -0.53715916 -0.53218879 -0.51146487   
## rho rho rho rho rho rho   
## -0.47695893 -0.41620210 -0.44234734 -0.41283441 -0.38111380 -0.39252154   
## rho rho rho rho rho rho   
## -0.38579420 -0.33107585 -0.25869311 -0.26387231 -0.24930608 -0.17692400   
## rho rho rho rho rho rho   
## -0.21794177 -0.17350813 -0.13296672 -0.07529993 -0.06495495 -0.03559398   
## rho rho rho   
## -0.05013140 -0.04996326 -0.01477274   
## Min. 1st Qu. Median Mean 3rd Qu. Max.   
## -0.69962 -0.62081 -0.44235 -0.41887 -0.25862 -0.01477



## rho rho rho rho rho rho   
## -0.04404126 -0.05744236 -0.07636311 -0.07277058 -0.11953288 -0.14726936   
## rho rho rho rho rho rho   
## -0.18675763 -0.29023899 -0.28727571 -0.26651423 -0.27321697 -0.32621181   
## rho rho rho rho rho rho   
## -0.35171941 -0.35718365 -0.43380464 -0.43510299 -0.40206898 -0.37314851   
## rho rho rho rho rho rho   
## -0.43410542 -0.38760563 -0.38498130 -0.50007778 -0.46859779 -0.37152989   
## rho rho rho rho rho rho   
## -0.30489699 -0.36567267 -0.35248958 -0.38781374 -0.44633736 -0.42984363   
## rho rho rho rho rho rho   
## -0.29200015 -0.24376092 -0.32940761 -0.27142934 -0.30322478 -0.38318930   
## rho rho rho rho rho rho   
## -0.33592196 -0.20730111 -0.17494005 -0.18597066 -0.16747153 -0.17735771   
## rho rho rho rho rho rho   
## -0.27071770 -0.16231381 -0.04175350 0.04530478 0.01913456 0.07043809   
## rho rho rho rho rho rho   
## -0.01006744 -0.05082591 0.04884732 0.13285675 0.26011527 0.24091120   
## rho rho rho   
## 0.21320115 0.20710714 0.17429306   
## Min. 1st Qu. Median Mean 3rd Qu. Max.   
## -0.50008 -0.36567 -0.27072 -0.20228 -0.05744 0.26012



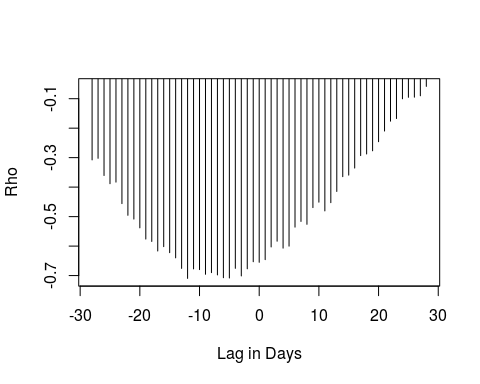
## rho rho rho rho rho rho   
## 0.191764095 0.220891056 0.267702014 0.244916045 0.267718574 0.336616667   
## rho rho rho rho rho rho   
## 0.367276554 0.453331410 0.443302605 0.429594285 0.446053837 0.508370428   
## rho rho rho rho rho rho   
## 0.553163221 0.562876135 0.637635267 0.605094428 0.583050186 0.553913218   
## rho rho rho rho rho rho   
## 0.616821828 0.594186269 0.598444071 0.684522536 0.640546819 0.564259405   
## rho rho rho rho rho rho   
## 0.502898975 0.566526985 0.569757730 0.604568756 0.640478897 0.604284680   
## rho rho rho rho rho rho   
## 0.497536224 0.448569075 0.517733688 0.478069187 0.498662440 0.543538332   
## rho rho rho rho rho rho   
## 0.482127805 0.378784586 0.355947414 0.353907362 0.348432013 0.362885532   
## rho rho rho rho rho rho   
## 0.422170391 0.317244717 0.243416809 0.190237301 0.203785283 0.146896663   
## rho rho rho rho rho rho   
## 0.209059812 0.210967212 0.133712487 0.075429392 -0.012304571 -0.006983246   
## rho rho rho   
## 0.018591240 0.034207834 0.009708521   
## Min. 1st Qu. Median Mean 3rd Qu. Max.   
## -0.0123 0.2434 0.4433 0.3916 0.5629 0.6845



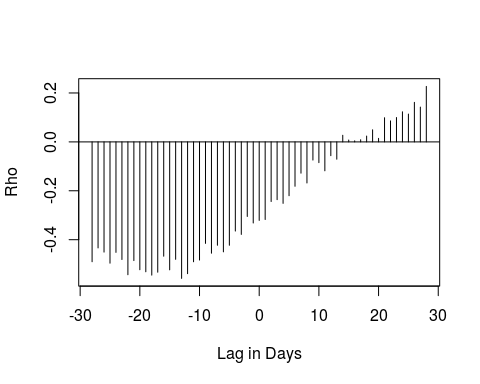
## rho rho rho rho rho rho   
## -0.004560304 0.043295024 0.098436848 0.141070592 0.189034876 0.235067427   
## rho rho rho rho rho rho   
## 0.277233532 0.317979136 0.354755166 0.392779626 0.439413533 0.476422664   
## rho rho rho rho rho rho   
## 0.503775445 0.537140873 0.559988310 0.593784330 0.625006180 0.654715241   
## rho rho rho rho rho rho   
## 0.664755406 0.669428133 0.686717952 0.697621227 0.713819793 0.717711140   
## rho rho rho rho rho rho   
## 0.723933967 0.721511183 0.723002601 0.720818150 0.711644471 0.712628863   
## rho rho rho rho rho rho   
## 0.704220063 0.690025675 0.670652454 0.660595648 0.655629188 0.633037311   
## rho rho rho rho rho rho   
## 0.617531705 0.605631692 0.597196232 0.573964066 0.554699361 0.523766490   
## rho rho rho rho rho rho   
## 0.504816185 0.480650132 0.465199929 0.450368883 0.422608533 0.390063572   
## rho rho rho rho rho rho   
## 0.369363959 0.338848057 0.306902608 0.280005200 0.261921958 0.227650488   
## rho rho rho   
## 0.186786321 0.159555533 0.129078312   
## Min. 1st Qu. Median Mean 3rd Qu. Max.   
## -0.00456 0.31798 0.52377 0.47999 0.66476 0.72393

## $retail\_and\_recreation\_percent\_change\_from\_baseline  
## rho   
## -10   
##   
## $grocery\_and\_pharmacy\_percent\_change\_from\_baseline  
## rho   
## -23   
##   
## $parks\_percent\_change\_from\_baseline  
## rho   
## -27   
##   
## $transit\_stations\_percent\_change\_from\_baseline  
## rho   
## -10   
##   
## $workplaces\_percent\_change\_from\_baseline  
## rho   
## -7   
##   
## $residential\_percent\_change\_from\_baseline  
## rho   
## -7   
##   
## $StringencyIndex  
## rho   
## -4

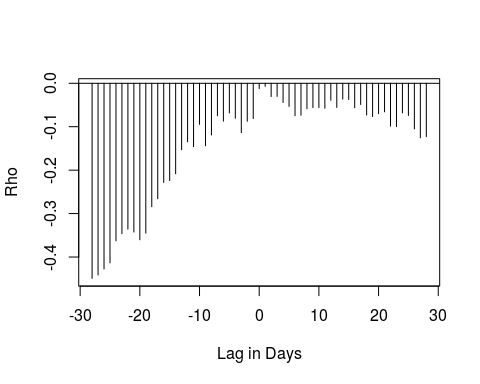
crosscorrfun("Denmark")



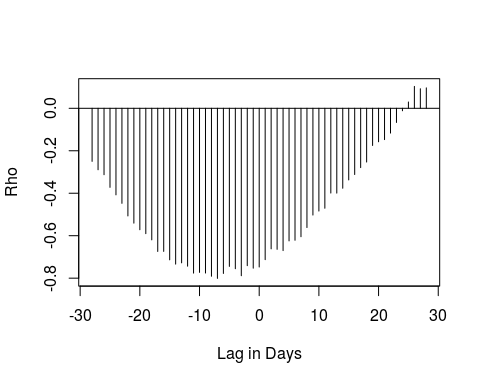
## rho rho rho rho rho rho   
## -0.30757229 -0.30217286 -0.36053723 -0.38838750 -0.38303426 -0.45594211   
## rho rho rho rho rho rho   
## -0.49558065 -0.50840297 -0.53815042 -0.57624850 -0.58433387 -0.61676356   
## rho rho rho rho rho rho   
## -0.60190366 -0.62238777 -0.64003523 -0.67579832 -0.70970231 -0.67745635   
## rho rho rho rho rho rho   
## -0.67986511 -0.69575350 -0.69011206 -0.69791517 -0.70737695 -0.70832995   
## rho rho rho rho rho rho   
## -0.67553431 -0.70139305 -0.67710531 -0.65320448 -0.65504933 -0.64600609   
## rho rho rho rho rho rho   
## -0.60300241 -0.58350748 -0.60701482 -0.60024762 -0.53575370 -0.51642533   
## rho rho rho rho rho rho   
## -0.52619337 -0.46942970 -0.45100144 -0.48067198 -0.45276102 -0.41469717   
## rho rho rho rho rho rho   
## -0.36449212 -0.35925729 -0.33531567 -0.29303219 -0.28756400 -0.27678390   
## rho rho rho rho rho rho   
## -0.24582739 -0.20968983 -0.17622462 -0.16717296 -0.10028241 -0.09516831   
## rho rho rho   
## -0.09477002 -0.08999119 -0.05820233   
## Min. 1st Qu. Median Mean 3rd Qu. Max.   
## -0.7097 -0.6460 -0.5164 -0.4741 -0.3353 -0.0582



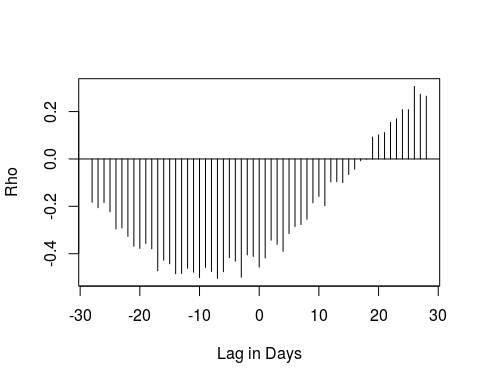
## rho rho rho rho rho rho   
## -0.490235372 -0.433693807 -0.450740482 -0.496072748 -0.451903368 -0.481040169   
## rho rho rho rho rho rho   
## -0.543336116 -0.485374228 -0.522949127 -0.531221709 -0.544945794 -0.532976644   
## rho rho rho rho rho rho   
## -0.467604756 -0.523312855 -0.480408245 -0.558327054 -0.539029140 -0.490264660   
## rho rho rho rho rho rho   
## -0.483317628 -0.415106126 -0.455332132 -0.422761409 -0.449744931 -0.422826619   
## rho rho rho rho rho rho   
## -0.364639479 -0.378479288 -0.305049326 -0.331750113 -0.321158840 -0.317419223   
## rho rho rho rho rho rho   
## -0.243905097 -0.236326179 -0.251456476 -0.220156530 -0.181618370 -0.127956985   
## rho rho rho rho rho rho   
## -0.168101925 -0.074391757 -0.084862123 -0.118314126 -0.056453818 -0.070901053   
## rho rho rho rho rho rho   
## 0.027079790 0.007585119 0.004393042 0.008818114 0.023819854 0.049416338   
## rho rho rho rho rho rho   
## 0.014331729 0.098832274 0.085915276 0.099605624 0.123057961 0.113659547   
## rho rho rho   
## 0.161600011 0.142224783 0.226885060   
## Min. 1st Qu. Median Mean 3rd Qu. Max.   
## -0.558327 -0.480408 -0.317419 -0.251548 0.004393 0.226885



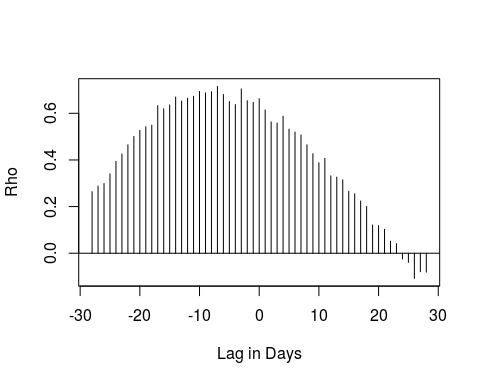
## rho rho rho rho rho rho   
## -0.449265795 -0.441553999 -0.427656664 -0.413446667 -0.362754328 -0.346291886   
## rho rho rho rho rho rho   
## -0.335847341 -0.342569483 -0.360282552 -0.345228122 -0.284150034 -0.265840099   
## rho rho rho rho rho rho   
## -0.228358801 -0.223935842 -0.208346610 -0.152873841 -0.134835410 -0.145834131   
## rho rho rho rho rho rho   
## -0.094537335 -0.143924275 -0.118925220 -0.074835547 -0.087165400 -0.068294560   
## rho rho rho rho rho rho   
## -0.080443400 -0.113688102 -0.087402624 -0.081161928 -0.012129181 -0.007135103   
## rho rho rho rho rho rho   
## -0.030563692 -0.030176081 -0.044293437 -0.053254333 -0.074728149 -0.073600993   
## rho rho rho rho rho rho   
## -0.058583394 -0.055955636 -0.055849648 -0.057416491 -0.038996543 -0.055581849   
## rho rho rho rho rho rho   
## -0.036494534 -0.037323950 -0.056244277 -0.048780196 -0.072967730 -0.076492205   
## rho rho rho rho rho rho   
## -0.069837010 -0.065706033 -0.098678705 -0.099536012 -0.068020259 -0.074009624   
## rho rho rho   
## -0.104951777 -0.125562939 -0.122836725   
## Min. 1st Qu. Median Mean 3rd Qu. Max.   
## -0.449266 -0.208347 -0.087165 -0.144301 -0.057417 -0.007135



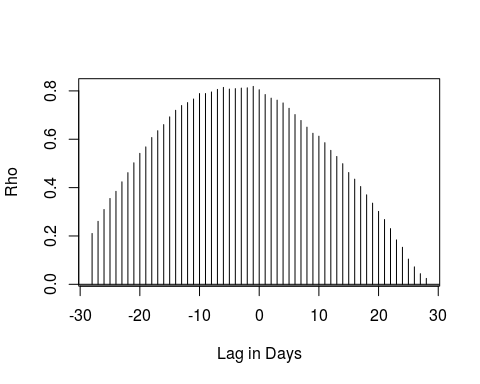
## rho rho rho rho rho rho   
## -0.25005969 -0.28961838 -0.31293746 -0.37246523 -0.40784148 -0.44779826   
## rho rho rho rho rho rho   
## -0.50712261 -0.54103951 -0.57212558 -0.59048704 -0.61971701 -0.67432601   
## rho rho rho rho rho rho   
## -0.67406074 -0.71372514 -0.73392310 -0.72798296 -0.74366335 -0.77636364   
## rho rho rho rho rho rho   
## -0.77288831 -0.77599291 -0.79105478 -0.80121005 -0.77782245 -0.74471545   
## rho rho rho rho rho rho   
## -0.75563253 -0.78858300 -0.74121444 -0.75301780 -0.74758251 -0.71292710   
## rho rho rho rho rho rho   
## -0.66205352 -0.66432028 -0.67022749 -0.62456894 -0.62163083 -0.60489917   
## rho rho rho rho rho rho   
## -0.56174541 -0.50285195 -0.48401988 -0.47079628 -0.39925328 -0.39958047   
## rho rho rho rho rho rho   
## -0.37660136 -0.33747847 -0.31198850 -0.27949639 -0.25319624 -0.17526185   
## rho rho rho rho rho rho   
## -0.15778442 -0.14760834 -0.11692181 -0.06680798 -0.01174773 0.02960782   
## rho rho rho   
## 0.10298955 0.09186993 0.09611606   
## Min. 1st Qu. Median Mean 3rd Qu. Max.   
## -0.8012 -0.7280 -0.5617 -0.4859 -0.3120 0.1030



## rho rho rho rho rho   
## -0.1827683545 -0.2059605858 -0.1837319071 -0.2230835694 -0.2957692922   
## rho rho rho rho rho   
## -0.2913469325 -0.3271137995 -0.3686520254 -0.3778278954 -0.3565459695   
## rho rho rho rho rho   
## -0.3795959475 -0.4726210086 -0.4276153233 -0.4425664941 -0.4848968760   
## rho rho rho rho rho   
## -0.4835558674 -0.4615205093 -0.4781539151 -0.5010658343 -0.4581281850   
## rho rho rho rho rho   
## -0.4750916289 -0.5043610815 -0.4764521596 -0.4168991272 -0.4317117439   
## rho rho rho rho rho   
## -0.4994546375 -0.4054102064 -0.4114790513 -0.4566174187 -0.4177681537   
## rho rho rho rho rho   
## -0.3428992647 -0.3604576978 -0.3902138089 -0.3149993124 -0.2852026192   
## rho rho rho rho rho   
## -0.2768969037 -0.2547734382 -0.1847712441 -0.1580122176 -0.1978529615   
## rho rho rho rho rho   
## -0.0966841995 -0.0957737313 -0.1002239355 -0.0654355289 -0.0432133379   
## rho rho rho rho rho   
## -0.0075649468 -0.0009969653 0.0927052928 0.1014143711 0.1111698288   
## rho rho rho rho rho   
## 0.1540243932 0.1697273395 0.2081639521 0.2079579926 0.3063352987   
## rho rho   
## 0.2735875868 0.2650520548   
## Min. 1st Qu. Median Mean 3rd Qu. Max.   
## -0.50436 -0.42762 -0.29577 -0.23129 -0.09577 0.30634



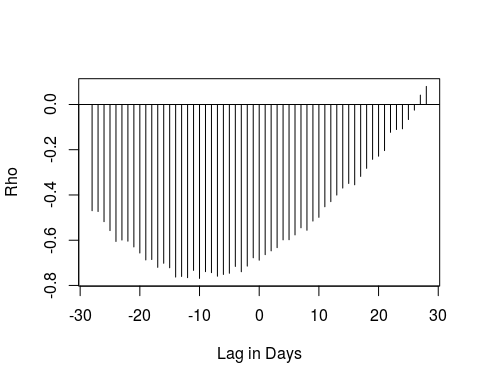
## rho rho rho rho rho rho   
## 0.26400281 0.28841371 0.29887072 0.34038077 0.39394271 0.42586248   
## rho rho rho rho rho rho   
## 0.46477134 0.50063910 0.52686160 0.54210773 0.54902318 0.63297400   
## rho rho rho rho rho rho   
## 0.61963061 0.63607030 0.66961380 0.65230509 0.66437973 0.67275757   
## rho rho rho rho rho rho   
## 0.69350919 0.68766653 0.69257849 0.71528304 0.68033824 0.65030489   
## rho rho rho rho rho rho   
## 0.63737748 0.70451334 0.65394788 0.64674800 0.66264391 0.61419168   
## rho rho rho rho rho rho   
## 0.56316871 0.55818696 0.58780862 0.53219592 0.51955806 0.50722276   
## rho rho rho rho rho rho   
## 0.46482297 0.42695342 0.38779208 0.40670073 0.33183996 0.32658623   
## rho rho rho rho rho rho   
## 0.31464698 0.26602174 0.25500518 0.22402237 0.20020949 0.12118835   
## rho rho rho rho rho rho   
## 0.11880772 0.10247371 0.05191935 0.04153709 -0.02470349 -0.03898582   
## rho rho rho   
## -0.10785780 -0.07916408 -0.08095810   
## Min. 1st Qu. Median Mean 3rd Qu. Max.   
## -0.1079 0.2660 0.5006 0.4238 0.6374 0.7153



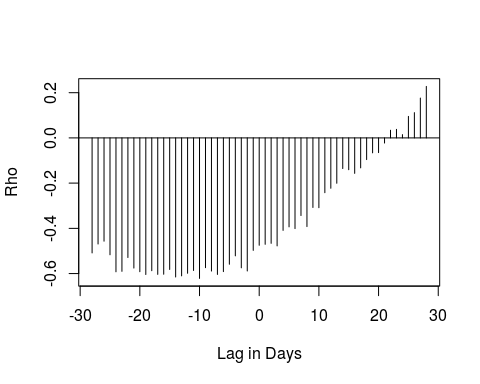
## rho rho rho rho rho rho rho   
## 0.21025028 0.26056257 0.30944885 0.35501890 0.38458440 0.42382462 0.46184571   
## rho rho rho rho rho rho rho   
## 0.50256295 0.54163527 0.56831826 0.60713039 0.63526301 0.66047944 0.69253721   
## rho rho rho rho rho rho rho   
## 0.71971782 0.73942901 0.75162095 0.76643202 0.78892355 0.78912197 0.79550340   
## rho rho rho rho rho rho rho   
## 0.80602737 0.81433955 0.80745805 0.80930150 0.81147744 0.81262422 0.81853559   
## rho rho rho rho rho rho rho   
## 0.80467331 0.78490532 0.76992317 0.76164391 0.75009302 0.72792062 0.70202301   
## rho rho rho rho rho rho rho   
## 0.67762177 0.64997241 0.62475902 0.61264158 0.58573754 0.55396260 0.52878646   
## rho rho rho rho rho rho rho   
## 0.49887296 0.46230905 0.43489698 0.40449531 0.37012995 0.33570754 0.30162341   
## rho rho rho rho rho rho rho   
## 0.26795923 0.23046290 0.18371084 0.15312377 0.10432906 0.07220518 0.04388722   
## rho   
## 0.02448259   
## Min. 1st Qu. Median Mean 3rd Qu. Max.   
## 0.02448 0.37013 0.60713 0.54503 0.76164 0.81854

## $retail\_and\_recreation\_percent\_change\_from\_baseline  
## rho   
## -12   
##   
## $grocery\_and\_pharmacy\_percent\_change\_from\_baseline  
## rho   
## -13   
##   
## $parks\_percent\_change\_from\_baseline  
## rho   
## -28   
##   
## $transit\_stations\_percent\_change\_from\_baseline  
## rho   
## -7   
##   
## $workplaces\_percent\_change\_from\_baseline  
## rho   
## -7   
##   
## $residential\_percent\_change\_from\_baseline  
## rho   
## -7   
##   
## $StringencyIndex  
## rho   
## -1

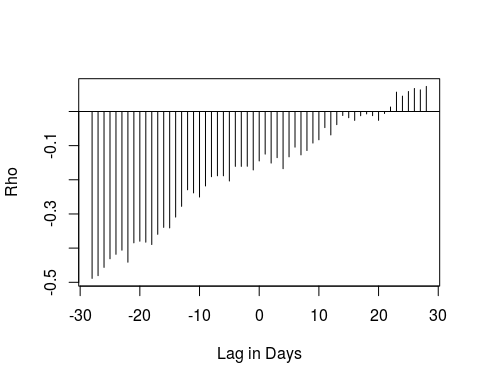
crosscorrfun("Finland")



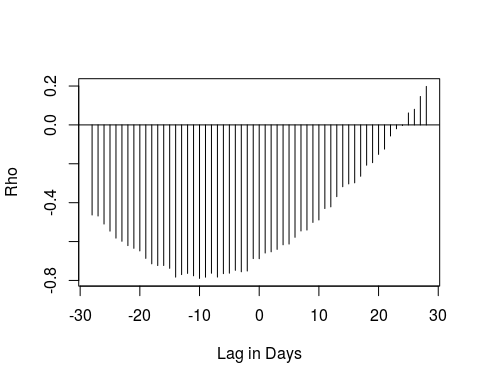
## rho rho rho rho rho rho   
## -0.46960722 -0.47311529 -0.51809673 -0.55742645 -0.60557515 -0.59917061   
## rho rho rho rho rho rho   
## -0.60420864 -0.62963697 -0.65648843 -0.68724702 -0.68537906 -0.71994935   
## rho rho rho rho rho rho   
## -0.70188776 -0.72178400 -0.76290021 -0.76027930 -0.76551352 -0.73331265   
## rho rho rho rho rho rho   
## -0.76879058 -0.73889739 -0.74338997 -0.75910435 -0.75132824 -0.74606494   
## rho rho rho rho rho rho   
## -0.71587596 -0.73939750 -0.71440327 -0.67769479 -0.68824235 -0.66386103   
## rho rho rho rho rho rho   
## -0.64698445 -0.63281468 -0.59840641 -0.59789994 -0.57648833 -0.54514179   
## rho rho rho rho rho rho   
## -0.55598888 -0.51529375 -0.49881990 -0.45211450 -0.42942304 -0.40036039   
## rho rho rho rho rho rho   
## -0.36947019 -0.34914640 -0.35502094 -0.31796364 -0.28223909 -0.24240159   
## rho rho rho rho rho rho   
## -0.22858469 -0.20377810 -0.12313542 -0.11063003 -0.10756800 -0.06654455   
## rho rho rho   
## -0.02498166 0.04142224 0.07996073   
## Min. 1st Qu. Median Mean 3rd Qu. Max.   
## -0.76879 -0.71440 -0.59841 -0.51699 -0.36947 0.07996



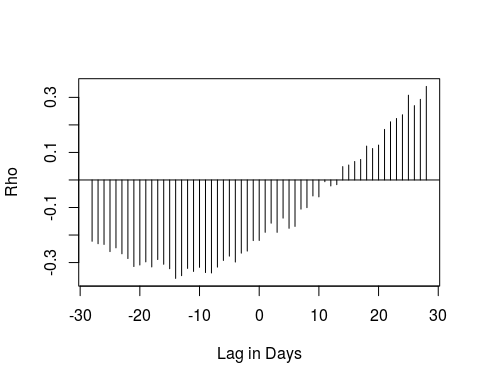
## rho rho rho rho rho rho   
## -0.50876413 -0.46934774 -0.45680345 -0.51694240 -0.59231584 -0.59027366   
## rho rho rho rho rho rho   
## -0.52904149 -0.57571630 -0.59177190 -0.60418997 -0.58742799 -0.60363754   
## rho rho rho rho rho rho   
## -0.60302296 -0.58191226 -0.61523802 -0.61026018 -0.59875492 -0.58639018   
## rho rho rho rho rho rho   
## -0.62143397 -0.57405394 -0.58899775 -0.60385545 -0.59141295 -0.55886353   
## rho rho rho rho rho rho   
## -0.52171073 -0.57465054 -0.58862543 -0.49746718 -0.47492311 -0.47064396   
## rho rho rho rho rho rho   
## -0.46642487 -0.47764188 -0.40914041 -0.39356428 -0.40112018 -0.34345196   
## rho rho rho rho rho rho   
## -0.39217222 -0.30772606 -0.30869412 -0.24233556 -0.22281214 -0.20066425   
## rho rho rho rho rho rho   
## -0.13554500 -0.14064581 -0.15683261 -0.13256387 -0.09588720 -0.06613551   
## rho rho rho rho rho rho   
## -0.06508645 -0.02277873 0.03389411 0.03777852 0.01451909 0.09518735   
## rho rho rho   
## 0.11173577 0.17623763 0.22780733   
## Min. 1st Qu. Median Mean 3rd Qu. Max.   
## -0.6214 -0.5874 -0.4706 -0.3714 -0.1568 0.2278



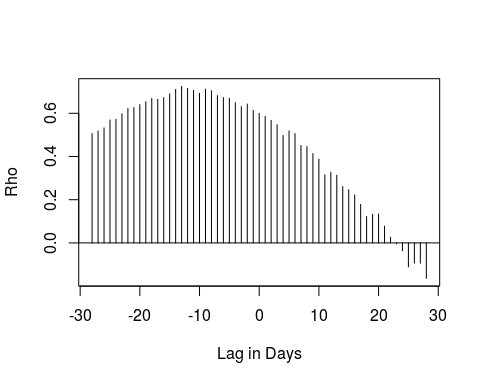
## rho rho rho rho rho rho   
## -0.488653861 -0.480663330 -0.456408099 -0.431185487 -0.418116291 -0.406015353   
## rho rho rho rho rho rho   
## -0.441289560 -0.384527363 -0.379812556 -0.382599238 -0.389516845 -0.359564458   
## rho rho rho rho rho rho   
## -0.339270097 -0.340861520 -0.309136284 -0.277736335 -0.229262732 -0.238356776   
## rho rho rho rho rho rho   
## -0.250469235 -0.218077629 -0.190927563 -0.188254162 -0.188310132 -0.203492630   
## rho rho rho rho rho rho   
## -0.160684268 -0.160732680 -0.160359434 -0.171185332 -0.144821631 -0.124760388   
## rho rho rho rho rho rho   
## -0.151038800 -0.135166211 -0.167502883 -0.132768440 -0.104441020 -0.127061629   
## rho rho rho rho rho rho   
## -0.114339088 -0.092444282 -0.082928177 -0.047241240 -0.068683458 -0.038527857   
## rho rho rho rho rho rho   
## -0.011809536 -0.018265384 -0.026133970 -0.012460432 -0.007215971 -0.012274500   
## rho rho rho rho rho rho   
## -0.025986661 -0.005930242 0.013162868 0.056659147 0.044974011 0.058481321   
## rho rho rho   
## 0.067397472 0.063338861 0.073417843   
## Min. 1st Qu. Median Mean 3rd Qu. Max.   
## -0.48865 -0.30914 -0.16036 -0.17403 -0.02613 0.07342



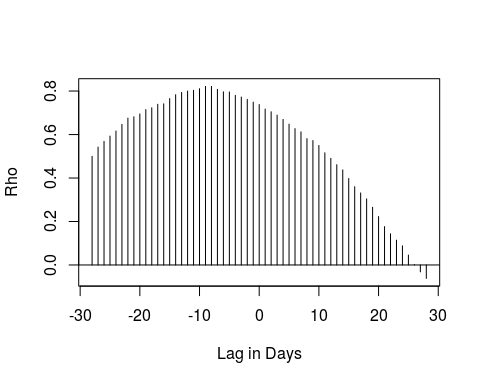
## rho rho rho rho rho rho   
## -0.463332562 -0.468586900 -0.509880158 -0.546423675 -0.582343591 -0.598664819   
## rho rho rho rho rho rho   
## -0.620966426 -0.634858795 -0.648150225 -0.686610727 -0.714619640 -0.723513937   
## rho rho rho rho rho rho   
## -0.723242662 -0.737766455 -0.783056979 -0.770151597 -0.763978696 -0.776204916   
## rho rho rho rho rho rho   
## -0.789600256 -0.783389856 -0.763036478 -0.782783126 -0.765181924 -0.762733542   
## rho rho rho rho rho rho   
## -0.748076773 -0.755477016 -0.751573173 -0.687757983 -0.688333025 -0.659033594   
## rho rho rho rho rho rho   
## -0.652851889 -0.640211395 -0.616734225 -0.612966718 -0.578183802 -0.545558354   
## rho rho rho rho rho rho   
## -0.540787444 -0.501668581 -0.488978704 -0.430155217 -0.421542138 -0.369029481   
## rho rho rho rho rho rho   
## -0.318000504 -0.303492296 -0.297931235 -0.264138828 -0.207344862 -0.194233355   
## rho rho rho rho rho rho   
## -0.151642985 -0.124528164 -0.057011306 -0.019871928 -0.003282827 0.061558756   
## rho rho rho   
## 0.080372049 0.146344382 0.198153522   
## Min. 1st Qu. Median Mean 3rd Qu. Max.   
## -0.7896 -0.7235 -0.5987 -0.5008 -0.3180 0.1982



## rho rho rho rho rho rho   
## -0.222777485 -0.231608754 -0.234219582 -0.260275343 -0.246557766 -0.268209109   
## rho rho rho rho rho rho   
## -0.285484894 -0.314549355 -0.308900948 -0.297556804 -0.315904437 -0.289027291   
## rho rho rho rho rho rho   
## -0.306275186 -0.322418677 -0.357577740 -0.347662754 -0.321256395 -0.332251168   
## rho rho rho rho rho rho   
## -0.317326430 -0.336327722 -0.337833186 -0.316538878 -0.292344784 -0.276698254   
## rho rho rho rho rho rho   
## -0.298089375 -0.265875788 -0.258300922 -0.220174466 -0.219713749 -0.190099743   
## rho rho rho rho rho rho   
## -0.157006191 -0.190284674 -0.138563720 -0.175607294 -0.168773406 -0.105970965   
## rho rho rho rho rho rho   
## -0.100506573 -0.058045795 -0.061443858 -0.006374716 -0.021704197 -0.017025330   
## rho rho rho rho rho rho   
## 0.048530623 0.054263956 0.067051432 0.074495326 0.122996425 0.114130439   
## rho rho rho rho rho rho   
## 0.126654860 0.183646886 0.211305529 0.223274318 0.236806346 0.307814683   
## rho rho rho   
## 0.269944460 0.292782806 0.339828928   
## Min. 1st Qu. Median Mean 3rd Qu. Max.   
## -0.35758 -0.29756 -0.21971 -0.12491 0.04853 0.33983



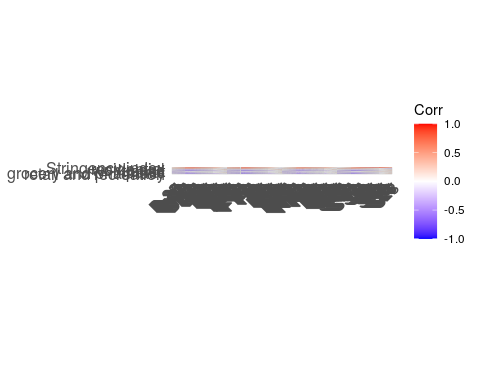
## rho rho rho rho rho rho   
## 0.506114004 0.518029571 0.532562384 0.569045442 0.572462875 0.597671461   
## rho rho rho rho rho rho   
## 0.621887371 0.626417250 0.640418038 0.653458821 0.669271601 0.664359149   
## rho rho rho rho rho rho   
## 0.672770423 0.690119677 0.710669938 0.724465545 0.715266599 0.705750630   
## rho rho rho rho rho rho   
## 0.692383863 0.711882147 0.704300230 0.681722093 0.672469278 0.669993858   
## rho rho rho rho rho rho   
## 0.649182726 0.630754593 0.642760800 0.613253433 0.599536955 0.585964949   
## rho rho rho rho rho rho   
## 0.567259294 0.547338925 0.497791172 0.518553518 0.505772362 0.450811260   
## rho rho rho rho rho rho   
## 0.446260898 0.413392084 0.387516897 0.315304565 0.326544613 0.313448585   
## rho rho rho rho rho rho   
## 0.260771542 0.246225850 0.222389144 0.178500500 0.121791902 0.132074157   
## rho rho rho rho rho rho   
## 0.133695929 0.077394959 0.026177448 -0.004153261 -0.036492936 -0.111083736   
## rho rho rho   
## -0.093782822 -0.094100636 -0.164432588   
## Min. 1st Qu. Median Mean 3rd Qu. Max.   
## -0.1644 0.2608 0.5473 0.4461 0.6535 0.7245



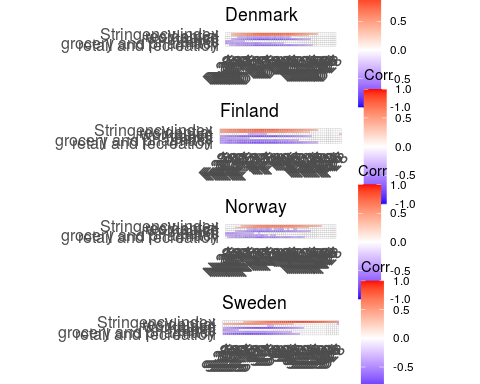
## rho rho rho rho rho rho   
## 0.499814673 0.542172235 0.568549855 0.593009844 0.616338905 0.646682615   
## rho rho rho rho rho rho   
## 0.675538530 0.681707898 0.694591881 0.714623945 0.723145810 0.739223521   
## rho rho rho rho rho rho   
## 0.741215426 0.765478010 0.783199012 0.793473586 0.799970511 0.803534908   
## rho rho rho rho rho rho   
## 0.810758852 0.821427792 0.821163478 0.807918962 0.796499439 0.795790468   
## rho rho rho rho rho rho   
## 0.780313625 0.772535137 0.761693774 0.748963891 0.737989683 0.717287235   
## rho rho rho rho rho rho   
## 0.704731333 0.689163954 0.669407847 0.647844829 0.627274918 0.612249424   
## rho rho rho rho rho rho   
## 0.581157926 0.572298946 0.549745252 0.516074011 0.490457214 0.461287837   
## rho rho rho rho rho rho   
## 0.437424959 0.397697313 0.359935395 0.331439163 0.304057237 0.265468197   
## rho rho rho rho rho rho   
## 0.222629586 0.176351074 0.143272242 0.114140065 0.087976278 0.045494807   
## rho rho rho   
## 0.001714858 -0.031788897 -0.061824012   
## Min. 1st Qu. Median Mean 3rd Qu. Max.   
## -0.06182 0.43743 0.64668 0.55562 0.74896 0.82143

## $retail\_and\_recreation\_percent\_change\_from\_baseline  
## rho   
## -10   
##   
## $grocery\_and\_pharmacy\_percent\_change\_from\_baseline  
## rho   
## -10   
##   
## $parks\_percent\_change\_from\_baseline  
## rho   
## -28   
##   
## $transit\_stations\_percent\_change\_from\_baseline  
## rho   
## -10   
##   
## $workplaces\_percent\_change\_from\_baseline  
## rho   
## -14   
##   
## $residential\_percent\_change\_from\_baseline  
## rho   
## -13   
##   
## $StringencyIndex  
## rho   
## -9

#########pvalues crosscorr  
crosscorr<-function(x) {  
 dat<-subset(data, data$Country.Region==x)  
 ccfspear<-function(y){ ccfspearmanx <- sapply( -28:28, function(l) cor.test(y, Hmisc::Lag(dat$IncCaseNumber,l),method = "spearman", use = "complete.obs", exact=FALSE)$p.value)  
 }  
 cc<-lapply(dat[c(3:8,15)], ccfspear)  
}  
  
results<-NULL  
d<-NULL  
  
for( Country.Region in unique(data$Country.Region) ) {  
 d<-crosscorr(Country.Region)  
 results<-rbind(results, data.frame(d))  
}  
results<-as.vector(as.matrix(results))  
resultsadj<-p.adjust(results, method="holm")  
dim(resultsadj)<-c(228, 7)  
a<-as.data.frame(resultsadj)  
colnames(a)<-c("retail and recreation", "grocery and pharmacy", "parks", "transit", "workplace", "residential", "Stringency index")  
a$country<-rep(c("Denmark", "Finland","Norway", "Sweden"),each=57)  
a$day<-rep(c(-28:28), times=4)  
a$country\_lag<- with(a, paste0(country, day), collapse="-")  
a<-a[,-c(8:9)]  
write.csv(resultsadj, "crosscorrallpsadj.csv")  
  
  
rownames(a)<-a$country\_lag  
a<-a[-8]  
a<-as.matrix(a)  
  
###producing crosscorr heatmap#################  
crosscorr<-function(x) {  
 dat<-subset(data, data$Country.Region==x)  
 ccfspear<-function(y){ ccfspearmanx <- sapply( -28:28, function(l) cor.test(y, Hmisc::Lag(dat$IncCaseNumber,l),method = "spearman", use = "complete.obs", exact=FALSE)$estimate)  
 }  
 cc<-lapply(dat[c(3:8,15)], ccfspear)  
}  
  
results<-NULL  
d<-NULL  
  
for( Country.Region in unique(data$Country.Region) ) {  
 d<-crosscorr(Country.Region)  
 results<-rbind(results, data.frame(d))  
}  
  
  
colnames(results)<-c("retail and recreation", "grocery and pharmacy", "parks", "transit", "workplace", "residential", "Stringency index")  
results$country<-rep(c("D", "F","N", "S"),each=57)  
results$day<-rep(c(-28:28), times=4)  
results$country\_lag<- with(results, paste0(country, day), collapse="-")  
results<-results[,-c(8:9)]  
  
rownames(results)<-results$country\_lag  
results<-results[-8]  
results<-as.matrix(results)  
library(ggcorrplot)  
ggcorrplot(results)



resultsden<-results[1:57, 1:7]  
aden<-a[1:57, 1:7]  
den<-ggcorrplot(resultsden, p.mat = aden, insig = "blank") +  
 ggtitle("Denmark") +  
ggsave("denmarkcross.pdf", width = 20, height = 5)   
  
resultsfin<-results[58:114, 1:7]  
afin<-a[58:114, 1:7]  
fin<-ggcorrplot(resultsfin, p.mat = afin, insig = "blank") +  
 ggtitle("Finland") +  
ggsave("finlandcrossc.pdf", width = 20, height = 5)   
  
  
resultsnor<-results[115:171, 1:7]  
anor<-a[115:171, 1:7]  
nor<-ggcorrplot(resultsnor, p.mat = anor, insig = "blank") +  
 ggtitle("Norway") +  
ggsave("Norwaycrossc.pdf", width = 20, height = 5)   
  
  
resultssweden<-results[172:228, 1:7]  
aswe<-a[172:228, 1:7]  
swe<-ggcorrplot(resultssweden, p.mat = aswe, insig = "blank") +  
 ggtitle("Sweden") +  
ggsave("swedencrossc.pdf", width = 20, height = 5)   
  
  
library(ggpubr)  
ccfplotall<-ggarrange(den, fin, nor, swe, ncol=1, nrow = 4)  
ccfplotall



ggsave("crosscorrallheat.pdf", width = 15, height = 10)   
ggsave("crosscorrallheat.png", width = 15, height = 10)   
  
  
  
####modelling###############################################################  
  
data <- read\_csv("Scandinaviadata1010.csv", col\_types = cols(Date = col\_date(format = "%Y-%m-%d"), date = col\_date(format = "%Y-%m-%d")))

## Warning: Missing column names filled in: 'X1' [1]

data$Country.Region<-factor(data$Country.Region)  
data<-data[,-1]  
  
library(dplyr)  
datat<-data %>%  
 filter(date<= "2020-08-01")  
datav<-data %>%  
 filter(date> "2020-08-01")  
  
library(dlnm)

## This is dlnm 2.4.2. For details: help(dlnm) and vignette('dlnmOverview').

datat$cb1 <- crossbasis(datat$grocery\_and\_pharmacy\_percent\_change\_from\_baseline , lag=28, argvar=list(fun="bs"),arglag=list(df=5), group=datat$Country.Region)

## Warning in (function (fun = NULL, df = NULL, knots = NULL, ...) : default knots placement along lags has changed since version 2.0.0.  
## See 'file.show(system.file('Changesince200',package='dlnm'))'.  
## See also help(logknots) for setting the knots  
## consistently with the previous versions

datat$cb2 <- crossbasis(datat$retail\_and\_recreation\_percent\_change\_from\_baseline , lag=28, argvar=list(fun="bs"),arglag=list(df=5), group=datat$Country.Region)

## Warning in (function (fun = NULL, df = NULL, knots = NULL, ...) : default knots placement along lags has changed since version 2.0.0.  
## See 'file.show(system.file('Changesince200',package='dlnm'))'.  
## See also help(logknots) for setting the knots  
## consistently with the previous versions

datat$cb4 <- crossbasis(datat$transit\_stations\_percent\_change\_from\_baseline , lag=28, argvar=list(fun="bs"),arglag=list(df=5), group=datat$Country.Region)

## Warning in (function (fun = NULL, df = NULL, knots = NULL, ...) : default knots placement along lags has changed since version 2.0.0.  
## See 'file.show(system.file('Changesince200',package='dlnm'))'.  
## See also help(logknots) for setting the knots  
## consistently with the previous versions

datat$cb5 <- crossbasis(datat$workplaces\_percent\_change\_from\_baseline , lag=28, argvar=list(fun="bs"),arglag=list(df=5), group=datat$Country.Region)

## Warning in (function (fun = NULL, df = NULL, knots = NULL, ...) : default knots placement along lags has changed since version 2.0.0.  
## See 'file.show(system.file('Changesince200',package='dlnm'))'.  
## See also help(logknots) for setting the knots  
## consistently with the previous versions

datat$cb6 <- crossbasis(datat$residential\_percent\_change\_from\_baseline , lag=28, argvar=list(fun="bs"),arglag=list(df=5), group=datat$Country.Region)

## Warning in (function (fun = NULL, df = NULL, knots = NULL, ...) : default knots placement along lags has changed since version 2.0.0.  
## See 'file.show(system.file('Changesince200',package='dlnm'))'.  
## See also help(logknots) for setting the knots  
## consistently with the previous versions

datat$cb7 <- crossbasis(datat$StringencyIndex , lag=28, argvar=list(fun="bs"),arglag=list(df=5), group=datat$Country.Region)

## Warning in (function (fun = NULL, df = NULL, knots = NULL, ...) : default knots placement along lags has changed since version 2.0.0.  
## See 'file.show(system.file('Changesince200',package='dlnm'))'.  
## See also help(logknots) for setting the knots  
## consistently with the previous versions

#make data identical to the dataset with crossbasis (deleting the first 28 observations in all countries)  
datam<-datat %>%  
 group\_by(Country.Region) %>%  
 slice(-c(1:28))  
  
  
  
  
  
#change ref category?  
library(mgcv)

## Loading required package: nlme

##   
## Attaching package: 'nlme'

## The following object is masked from 'package:dplyr':  
##   
## collapse

## This is mgcv 1.8-31. For overview type 'help("mgcv-package")'.

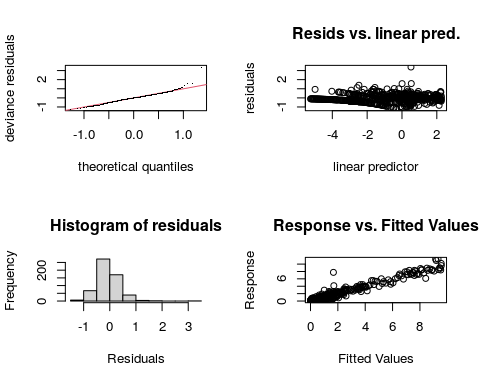
fitplain<-gam(IncCaseNumber ~s(NumDate, by=Country.Region) + Country.Region, data=datam, family="tw")  
summary(fitplain)

##   
## Family: Tweedie(p=1.011)   
## Link function: log   
##   
## Formula:  
## IncCaseNumber ~ s(NumDate, by = Country.Region) + Country.Region  
##   
## Parametric coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) -1.09545 0.09251 -11.841 < 2e-16 \*\*\*  
## Country.RegionFinland -1.00024 0.21755 -4.598 5.35e-06 \*\*\*  
## Country.RegionNorway -0.84249 0.16670 -5.054 5.97e-07 \*\*\*  
## Country.RegionSweden 2.07218 0.09720 21.318 < 2e-16 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Approximate significance of smooth terms:  
## edf Ref.df F p-value   
## s(NumDate):Country.RegionDenmark 7.188 8.090 49.60 <2e-16 \*\*\*  
## s(NumDate):Country.RegionFinland 5.493 6.526 37.32 <2e-16 \*\*\*  
## s(NumDate):Country.RegionNorway 6.225 7.278 33.81 <2e-16 \*\*\*  
## s(NumDate):Country.RegionSweden 8.419 8.888 134.56 <2e-16 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## R-sq.(adj) = 0.948 Deviance explained = 92.4%  
## -REML = 324.21 Scale est. = 0.18302 n = 561

AIC(fitplain)

## [1] 961.4624

gam.check(fitplain)

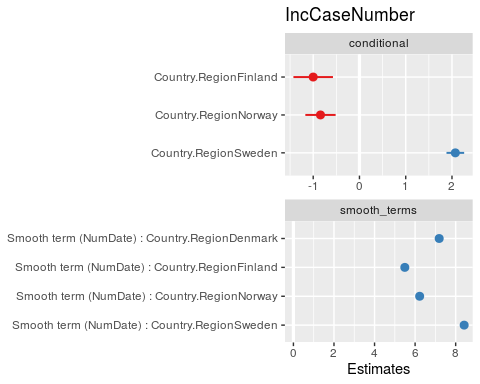


##   
## Method: REML Optimizer: outer newton  
## full convergence after 10 iterations.  
## Gradient range [-5.781186e-07,1.935972e-08]  
## (score 324.2111 & scale 0.1830178).  
## Hessian positive definite, eigenvalue range [0.9541455,39508.9].  
## Model rank = 40 / 40   
##   
## Basis dimension (k) checking results. Low p-value (k-index<1) may  
## indicate that k is too low, especially if edf is close to k'.  
##   
## k' edf k-index p-value  
## s(NumDate):Country.RegionDenmark 9.00 7.19 0.97 0.47  
## s(NumDate):Country.RegionFinland 9.00 5.49 0.97 0.47  
## s(NumDate):Country.RegionNorway 9.00 6.22 0.97 0.46  
## s(NumDate):Country.RegionSweden 9.00 8.42 0.97 0.45

library(sjPlot)

## Registered S3 methods overwritten by 'lme4':  
## method from  
## cooks.distance.influence.merMod car   
## influence.merMod car   
## dfbeta.influence.merMod car   
## dfbetas.influence.merMod car

plot\_model(fitplain)



tab\_model(fitplain)

IncCaseNumber

Predictors

Estimates

CI

p

(Intercept)

-1.10

-1.28 – -0.91

<0.001

Country.RegionFinland

-1.00

-1.43 – -0.57

<0.001

Country.RegionNorway

-0.84

-1.17 – -0.52

<0.001

Country.RegionSweden

2.07

1.88 – 2.26

<0.001

Smooth term (NumDate) :Country.RegionDenmark

7.19

<0.001

Smooth term (NumDate) :Country.RegionFinland

5.49

<0.001

Smooth term (NumDate) :Country.RegionNorway

6.22

<0.001

Smooth term (NumDate) :Country.RegionSweden

8.42

<0.001

Observations

561

R2

0.948

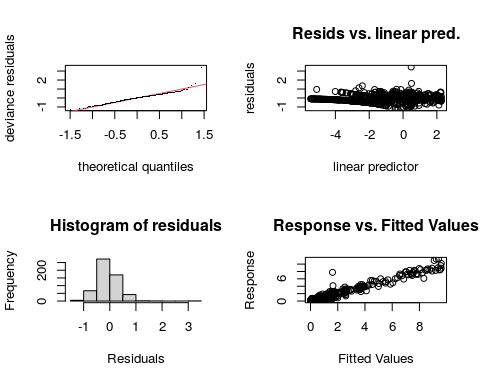
fitwithout<-gam(IncCaseNumber ~s(NumDate, by=Country.Region) + s(StringencyIndex, by=Country.Region) + Country.Region, data=datam, family=Tweedie(p=1.011))  
summary(fitwithout)

##   
## Family: Tweedie(1.011)   
## Link function: log   
##   
## Formula:  
## IncCaseNumber ~ s(NumDate, by = Country.Region) + s(StringencyIndex,   
## by = Country.Region) + Country.Region  
##   
## Parametric coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) -2.0862 0.5462 -3.820 0.00015 \*\*\*  
## Country.RegionFinland 0.0152 0.5955 0.026 0.97964   
## Country.RegionNorway 0.4688 0.7648 0.613 0.54022   
## Country.RegionSweden 3.2255 0.5736 5.623 3.06e-08 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Approximate significance of smooth terms:  
## edf Ref.df F p-value   
## s(NumDate):Country.RegionDenmark 7.141 8.084 9.178 5.73e-12 \*\*\*  
## s(NumDate):Country.RegionFinland 4.416 5.410 17.318 < 2e-16 \*\*\*  
## s(NumDate):Country.RegionNorway 6.260 7.454 4.621 6.41e-05 \*\*\*  
## s(NumDate):Country.RegionSweden 8.498 8.923 59.084 < 2e-16 \*\*\*  
## s(StringencyIndex):Country.RegionDenmark 1.000 1.000 3.438 0.06424 .   
## s(StringencyIndex):Country.RegionFinland 1.000 1.000 0.051 0.82151   
## s(StringencyIndex):Country.RegionNorway 6.804 6.954 3.255 0.00718 \*\*   
## s(StringencyIndex):Country.RegionSweden 1.000 1.001 0.915 0.33951   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## R-sq.(adj) = 0.95 Deviance explained = 93%  
## GCV = 0.2219 Scale est. = 0.23516 n = 561

AIC(fitwithout)

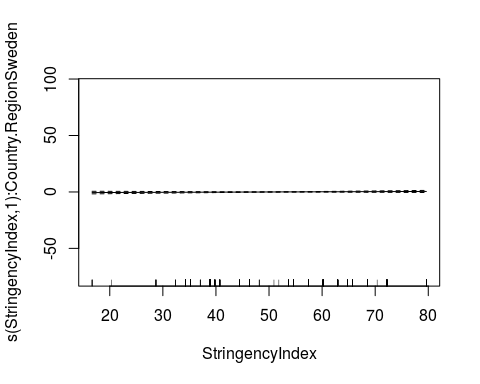
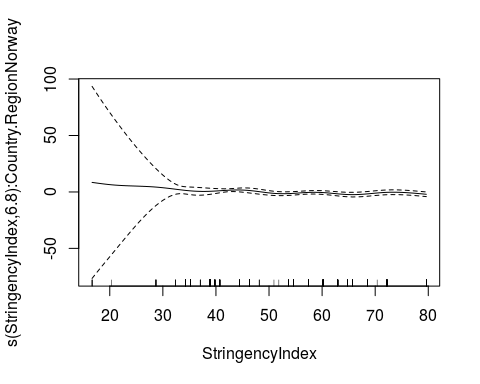
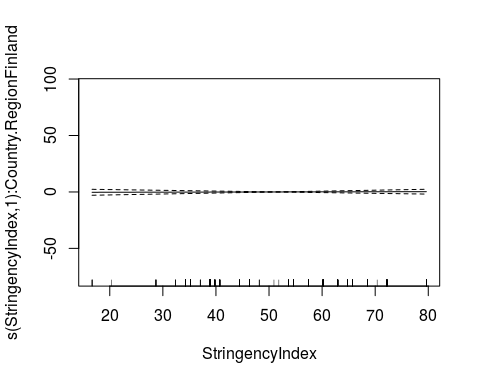
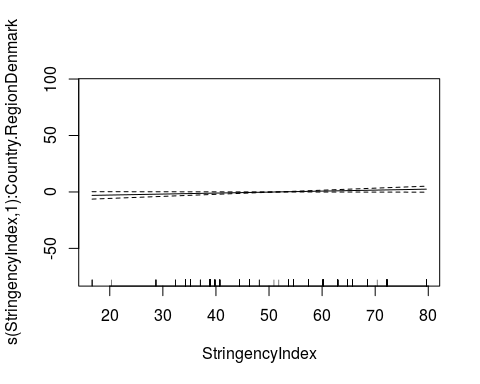
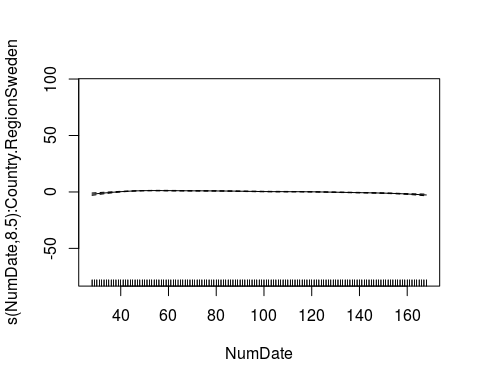
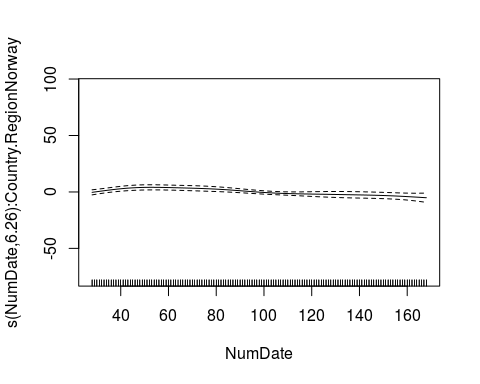
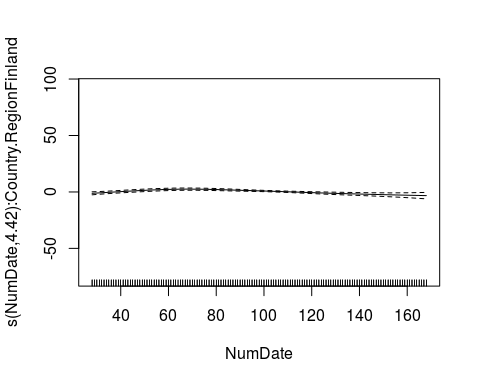
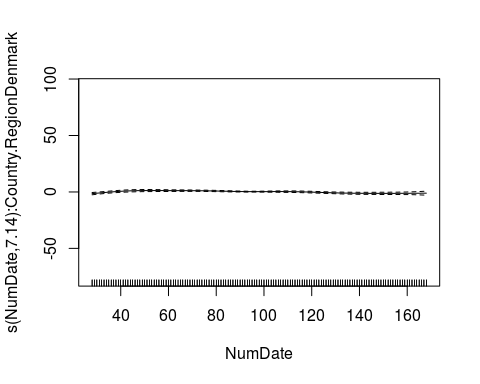
## [1] 632.8655

gam.check(fitwithout)

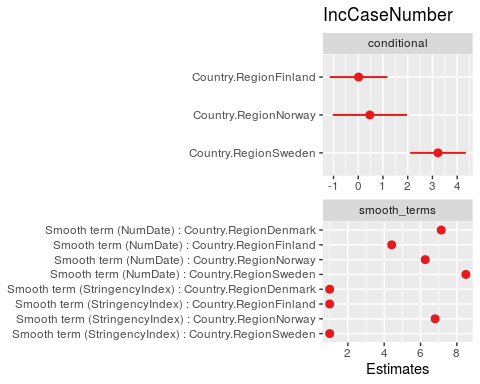


##   
## Method: GCV Optimizer: outer newton  
## full convergence after 11 iterations.  
## Gradient range [-1.690159e-07,2.158844e-08]  
## (score 0.2218963 & scale 0.2351639).  
## Hessian positive definite, eigenvalue range [1.33749e-09,0.001024622].  
## Model rank = 76 / 76   
##   
## Basis dimension (k) checking results. Low p-value (k-index<1) may  
## indicate that k is too low, especially if edf is close to k'.  
##   
## k' edf k-index p-value  
## s(NumDate):Country.RegionDenmark 9.00 7.14 0.94 0.14  
## s(NumDate):Country.RegionFinland 9.00 4.42 0.94 0.18  
## s(NumDate):Country.RegionNorway 9.00 6.26 0.94 0.21  
## s(NumDate):Country.RegionSweden 9.00 8.50 0.94 0.21  
## s(StringencyIndex):Country.RegionDenmark 9.00 1.00 1.05 0.98  
## s(StringencyIndex):Country.RegionFinland 9.00 1.00 1.05 0.99  
## s(StringencyIndex):Country.RegionNorway 9.00 6.80 1.05 0.97  
## s(StringencyIndex):Country.RegionSweden 9.00 1.00 1.05 0.95

plot(fitwithout)



plot\_model(fitwithout)



tab\_model(fitwithout)

IncCaseNumber

Predictors

Estimates

CI

p

(Intercept)

-2.09

-3.16 – -1.01

<0.001

Country.RegionFinland

0.02

-1.15 – 1.19

0.980

Country.RegionNorway

0.47

-1.03 – 1.97

0.540

Country.RegionSweden

3.23

2.10 – 4.35

<0.001

Smooth term (NumDate) :Country.RegionDenmark

7.14

<0.001

Smooth term (NumDate) :Country.RegionFinland

4.42

<0.001

Smooth term (NumDate) :Country.RegionNorway

6.26

<0.001

Smooth term (NumDate) :Country.RegionSweden

8.50

<0.001

Smooth term(StringencyIndex) :Country.RegionDenmark

1.00

0.064

Smooth term(StringencyIndex) :Country.RegionFinland

1.00

0.822

Smooth term(StringencyIndex) :Country.RegionNorway

6.80

0.007

Smooth term(StringencyIndex) :Country.RegionSweden

1.00

0.340

Observations

561

R2

0.950

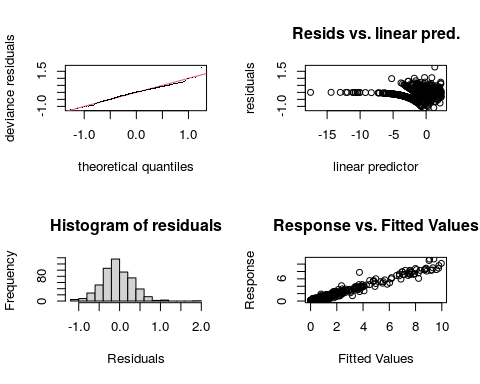
fit <- gam(IncCaseNumber~s(NumDate, by=Country.Region) + s(StringencyIndex, by=Country.Region) +s(retail\_and\_recreation\_percent\_change\_from\_baseline, by=Country.Region)  
 + s(grocery\_and\_pharmacy\_percent\_change\_from\_baseline, by=Country.Region)  
 + s(transit\_stations\_percent\_change\_from\_baseline, by=Country.Region)   
 + s(workplaces\_percent\_change\_from\_baseline, by=Country.Region)  
 + s(residential\_percent\_change\_from\_baseline, by=Country.Region)  
 + Country.Region, data=datam, family=Tweedie(p=1.011))  
summary(fit)

##   
## Family: Tweedie(1.011)   
## Link function: log   
##   
## Formula:  
## IncCaseNumber ~ s(NumDate, by = Country.Region) + s(StringencyIndex,   
## by = Country.Region) + s(retail\_and\_recreation\_percent\_change\_from\_baseline,   
## by = Country.Region) + s(grocery\_and\_pharmacy\_percent\_change\_from\_baseline,   
## by = Country.Region) + s(transit\_stations\_percent\_change\_from\_baseline,   
## by = Country.Region) + s(workplaces\_percent\_change\_from\_baseline,   
## by = Country.Region) + s(residential\_percent\_change\_from\_baseline,   
## by = Country.Region) + Country.Region  
##   
## Parametric coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) -1.9549 0.5353 -3.652 0.00029 \*\*\*  
## Country.RegionFinland -2.4406 2.8995 -0.842 0.40037   
## Country.RegionNorway -0.3245 1.0341 -0.314 0.75380   
## Country.RegionSweden 3.0919 0.5577 5.544 4.92e-08 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Approximate significance of smooth terms:  
## edf  
## s(NumDate):Country.RegionDenmark 7.014  
## s(NumDate):Country.RegionFinland 6.016  
## s(NumDate):Country.RegionNorway 8.266  
## s(NumDate):Country.RegionSweden 8.565  
## s(StringencyIndex):Country.RegionDenmark 1.000  
## s(StringencyIndex):Country.RegionFinland 4.980  
## s(StringencyIndex):Country.RegionNorway 6.847  
## s(StringencyIndex):Country.RegionSweden 1.000  
## s(retail\_and\_recreation\_percent\_change\_from\_baseline):Country.RegionDenmark 2.132  
## s(retail\_and\_recreation\_percent\_change\_from\_baseline):Country.RegionFinland 1.000  
## s(retail\_and\_recreation\_percent\_change\_from\_baseline):Country.RegionNorway 1.000  
## s(retail\_and\_recreation\_percent\_change\_from\_baseline):Country.RegionSweden 1.000  
## s(grocery\_and\_pharmacy\_percent\_change\_from\_baseline):Country.RegionDenmark 2.631  
## s(grocery\_and\_pharmacy\_percent\_change\_from\_baseline):Country.RegionFinland 4.349  
## s(grocery\_and\_pharmacy\_percent\_change\_from\_baseline):Country.RegionNorway 4.063  
## s(grocery\_and\_pharmacy\_percent\_change\_from\_baseline):Country.RegionSweden 1.000  
## s(transit\_stations\_percent\_change\_from\_baseline):Country.RegionDenmark 2.091  
## s(transit\_stations\_percent\_change\_from\_baseline):Country.RegionFinland 5.864  
## s(transit\_stations\_percent\_change\_from\_baseline):Country.RegionNorway 1.000  
## s(transit\_stations\_percent\_change\_from\_baseline):Country.RegionSweden 1.000  
## s(workplaces\_percent\_change\_from\_baseline):Country.RegionDenmark 1.000  
## s(workplaces\_percent\_change\_from\_baseline):Country.RegionFinland 1.000  
## s(workplaces\_percent\_change\_from\_baseline):Country.RegionNorway 2.509  
## s(workplaces\_percent\_change\_from\_baseline):Country.RegionSweden 1.000  
## s(residential\_percent\_change\_from\_baseline):Country.RegionDenmark 1.000  
## s(residential\_percent\_change\_from\_baseline):Country.RegionFinland 1.000  
## s(residential\_percent\_change\_from\_baseline):Country.RegionNorway 6.172  
## s(residential\_percent\_change\_from\_baseline):Country.RegionSweden 1.000  
## Ref.df  
## s(NumDate):Country.RegionDenmark 7.977  
## s(NumDate):Country.RegionFinland 7.145  
## s(NumDate):Country.RegionNorway 8.817  
## s(NumDate):Country.RegionSweden 8.942  
## s(StringencyIndex):Country.RegionDenmark 1.000  
## s(StringencyIndex):Country.RegionFinland 5.227  
## s(StringencyIndex):Country.RegionNorway 6.979  
## s(StringencyIndex):Country.RegionSweden 1.000  
## s(retail\_and\_recreation\_percent\_change\_from\_baseline):Country.RegionDenmark 2.724  
## s(retail\_and\_recreation\_percent\_change\_from\_baseline):Country.RegionFinland 1.000  
## s(retail\_and\_recreation\_percent\_change\_from\_baseline):Country.RegionNorway 1.001  
## s(retail\_and\_recreation\_percent\_change\_from\_baseline):Country.RegionSweden 1.000  
## s(grocery\_and\_pharmacy\_percent\_change\_from\_baseline):Country.RegionDenmark 3.246  
## s(grocery\_and\_pharmacy\_percent\_change\_from\_baseline):Country.RegionFinland 5.145  
## s(grocery\_and\_pharmacy\_percent\_change\_from\_baseline):Country.RegionNorway 4.954  
## s(grocery\_and\_pharmacy\_percent\_change\_from\_baseline):Country.RegionSweden 1.000  
## s(transit\_stations\_percent\_change\_from\_baseline):Country.RegionDenmark 2.696  
## s(transit\_stations\_percent\_change\_from\_baseline):Country.RegionFinland 6.234  
## s(transit\_stations\_percent\_change\_from\_baseline):Country.RegionNorway 1.000  
## s(transit\_stations\_percent\_change\_from\_baseline):Country.RegionSweden 1.000  
## s(workplaces\_percent\_change\_from\_baseline):Country.RegionDenmark 1.000  
## s(workplaces\_percent\_change\_from\_baseline):Country.RegionFinland 1.000  
## s(workplaces\_percent\_change\_from\_baseline):Country.RegionNorway 3.086  
## s(workplaces\_percent\_change\_from\_baseline):Country.RegionSweden 1.000  
## s(residential\_percent\_change\_from\_baseline):Country.RegionDenmark 1.000  
## s(residential\_percent\_change\_from\_baseline):Country.RegionFinland 1.000  
## s(residential\_percent\_change\_from\_baseline):Country.RegionNorway 6.680  
## s(residential\_percent\_change\_from\_baseline):Country.RegionSweden 1.000  
## F  
## s(NumDate):Country.RegionDenmark 8.838  
## s(NumDate):Country.RegionFinland 10.189  
## s(NumDate):Country.RegionNorway 4.260  
## s(NumDate):Country.RegionSweden 27.581  
## s(StringencyIndex):Country.RegionDenmark 3.781  
## s(StringencyIndex):Country.RegionFinland 1.047  
## s(StringencyIndex):Country.RegionNorway 3.666  
## s(StringencyIndex):Country.RegionSweden 1.117  
## s(retail\_and\_recreation\_percent\_change\_from\_baseline):Country.RegionDenmark 6.366  
## s(retail\_and\_recreation\_percent\_change\_from\_baseline):Country.RegionFinland 2.363  
## s(retail\_and\_recreation\_percent\_change\_from\_baseline):Country.RegionNorway 0.182  
## s(retail\_and\_recreation\_percent\_change\_from\_baseline):Country.RegionSweden 0.367  
## s(grocery\_and\_pharmacy\_percent\_change\_from\_baseline):Country.RegionDenmark 2.906  
## s(grocery\_and\_pharmacy\_percent\_change\_from\_baseline):Country.RegionFinland 3.113  
## s(grocery\_and\_pharmacy\_percent\_change\_from\_baseline):Country.RegionNorway 2.038  
## s(grocery\_and\_pharmacy\_percent\_change\_from\_baseline):Country.RegionSweden 0.150  
## s(transit\_stations\_percent\_change\_from\_baseline):Country.RegionDenmark 1.077  
## s(transit\_stations\_percent\_change\_from\_baseline):Country.RegionFinland 6.304  
## s(transit\_stations\_percent\_change\_from\_baseline):Country.RegionNorway 0.586  
## s(transit\_stations\_percent\_change\_from\_baseline):Country.RegionSweden 0.328  
## s(workplaces\_percent\_change\_from\_baseline):Country.RegionDenmark 0.374  
## s(workplaces\_percent\_change\_from\_baseline):Country.RegionFinland 1.118  
## s(workplaces\_percent\_change\_from\_baseline):Country.RegionNorway 1.268  
## s(workplaces\_percent\_change\_from\_baseline):Country.RegionSweden 0.226  
## s(residential\_percent\_change\_from\_baseline):Country.RegionDenmark 0.045  
## s(residential\_percent\_change\_from\_baseline):Country.RegionFinland 0.111  
## s(residential\_percent\_change\_from\_baseline):Country.RegionNorway 1.081  
## s(residential\_percent\_change\_from\_baseline):Country.RegionSweden 0.006  
## p-value  
## s(NumDate):Country.RegionDenmark 3.25e-11  
## s(NumDate):Country.RegionFinland 4.35e-12  
## s(NumDate):Country.RegionNorway 2.55e-05  
## s(NumDate):Country.RegionSweden < 2e-16  
## s(StringencyIndex):Country.RegionDenmark 0.05241  
## s(StringencyIndex):Country.RegionFinland 0.35198  
## s(StringencyIndex):Country.RegionNorway 0.00135  
## s(StringencyIndex):Country.RegionSweden 0.29118  
## s(retail\_and\_recreation\_percent\_change\_from\_baseline):Country.RegionDenmark 0.00282  
## s(retail\_and\_recreation\_percent\_change\_from\_baseline):Country.RegionFinland 0.12487  
## s(retail\_and\_recreation\_percent\_change\_from\_baseline):Country.RegionNorway 0.67032  
## s(retail\_and\_recreation\_percent\_change\_from\_baseline):Country.RegionSweden 0.54490  
## s(grocery\_and\_pharmacy\_percent\_change\_from\_baseline):Country.RegionDenmark 0.03750  
## s(grocery\_and\_pharmacy\_percent\_change\_from\_baseline):Country.RegionFinland 0.00835  
## s(grocery\_and\_pharmacy\_percent\_change\_from\_baseline):Country.RegionNorway 0.07693  
## s(grocery\_and\_pharmacy\_percent\_change\_from\_baseline):Country.RegionSweden 0.69862  
## s(transit\_stations\_percent\_change\_from\_baseline):Country.RegionDenmark 0.34167  
## s(transit\_stations\_percent\_change\_from\_baseline):Country.RegionFinland 7.40e-06  
## s(transit\_stations\_percent\_change\_from\_baseline):Country.RegionNorway 0.44435  
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## s(workplaces\_percent\_change\_from\_baseline):Country.RegionDenmark 0.54097  
## s(workplaces\_percent\_change\_from\_baseline):Country.RegionFinland 0.29098  
## s(workplaces\_percent\_change\_from\_baseline):Country.RegionNorway 0.26127  
## s(workplaces\_percent\_change\_from\_baseline):Country.RegionSweden 0.63508  
## s(residential\_percent\_change\_from\_baseline):Country.RegionDenmark 0.83293  
## s(residential\_percent\_change\_from\_baseline):Country.RegionFinland 0.73907  
## s(residential\_percent\_change\_from\_baseline):Country.RegionNorway 0.37509  
## s(residential\_percent\_change\_from\_baseline):Country.RegionSweden 0.93679  
##   
## s(NumDate):Country.RegionDenmark \*\*\*  
## s(NumDate):Country.RegionFinland \*\*\*  
## s(NumDate):Country.RegionNorway \*\*\*  
## s(NumDate):Country.RegionSweden \*\*\*  
## s(StringencyIndex):Country.RegionDenmark .   
## s(StringencyIndex):Country.RegionFinland   
## s(StringencyIndex):Country.RegionNorway \*\*   
## s(StringencyIndex):Country.RegionSweden   
## s(retail\_and\_recreation\_percent\_change\_from\_baseline):Country.RegionDenmark \*\*   
## s(retail\_and\_recreation\_percent\_change\_from\_baseline):Country.RegionFinland   
## s(retail\_and\_recreation\_percent\_change\_from\_baseline):Country.RegionNorway   
## s(retail\_and\_recreation\_percent\_change\_from\_baseline):Country.RegionSweden   
## s(grocery\_and\_pharmacy\_percent\_change\_from\_baseline):Country.RegionDenmark \*   
## s(grocery\_and\_pharmacy\_percent\_change\_from\_baseline):Country.RegionFinland \*\*   
## s(grocery\_and\_pharmacy\_percent\_change\_from\_baseline):Country.RegionNorway .   
## s(grocery\_and\_pharmacy\_percent\_change\_from\_baseline):Country.RegionSweden   
## s(transit\_stations\_percent\_change\_from\_baseline):Country.RegionDenmark   
## s(transit\_stations\_percent\_change\_from\_baseline):Country.RegionFinland \*\*\*  
## s(transit\_stations\_percent\_change\_from\_baseline):Country.RegionNorway   
## s(transit\_stations\_percent\_change\_from\_baseline):Country.RegionSweden   
## s(workplaces\_percent\_change\_from\_baseline):Country.RegionDenmark   
## s(workplaces\_percent\_change\_from\_baseline):Country.RegionFinland   
## s(workplaces\_percent\_change\_from\_baseline):Country.RegionNorway   
## s(workplaces\_percent\_change\_from\_baseline):Country.RegionSweden   
## s(residential\_percent\_change\_from\_baseline):Country.RegionDenmark   
## s(residential\_percent\_change\_from\_baseline):Country.RegionFinland   
## s(residential\_percent\_change\_from\_baseline):Country.RegionNorway   
## s(residential\_percent\_change\_from\_baseline):Country.RegionSweden   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## R-sq.(adj) = 0.96 Deviance explained = 94.8%  
## GCV = 0.20111 Scale est. = 0.17759 n = 561

AIC(fit)

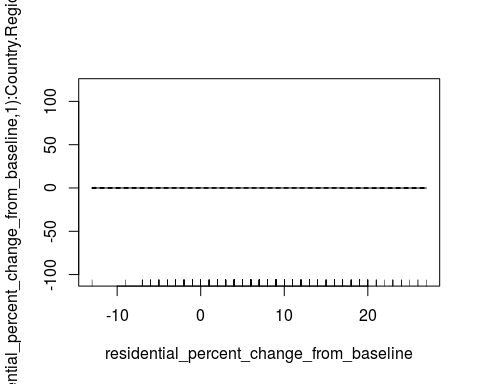
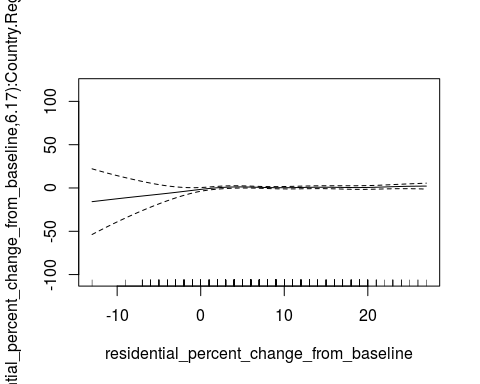
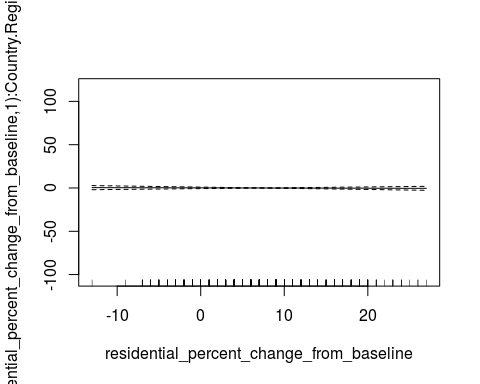
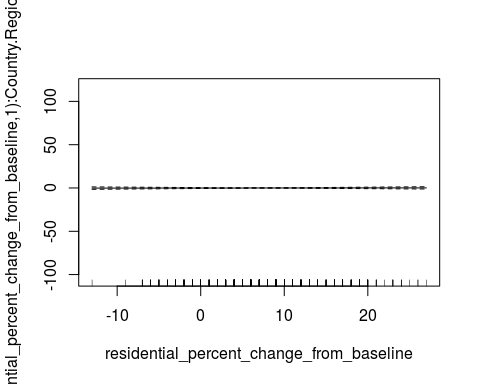
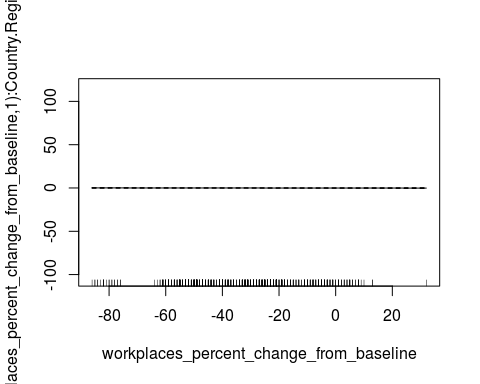
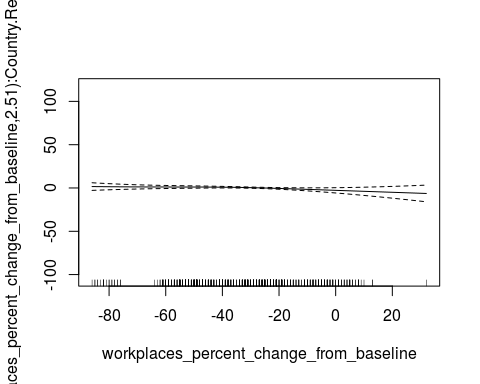
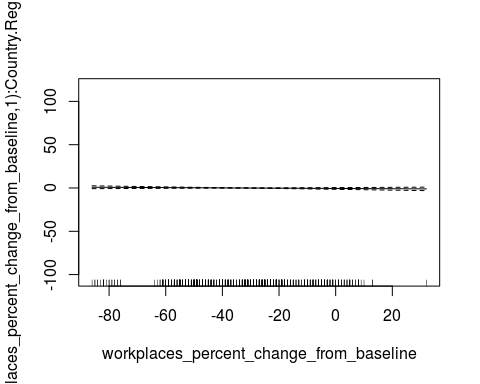
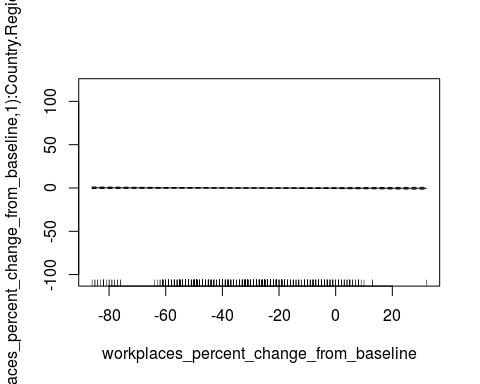
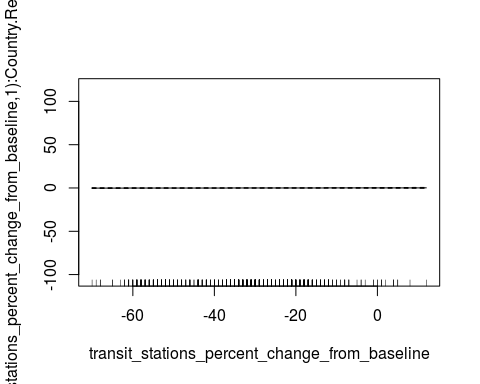
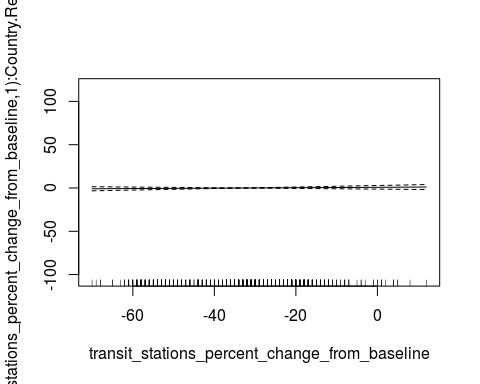
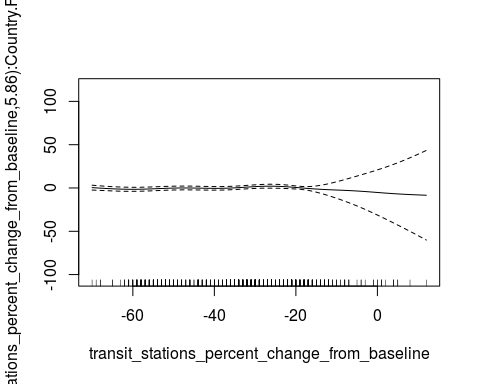
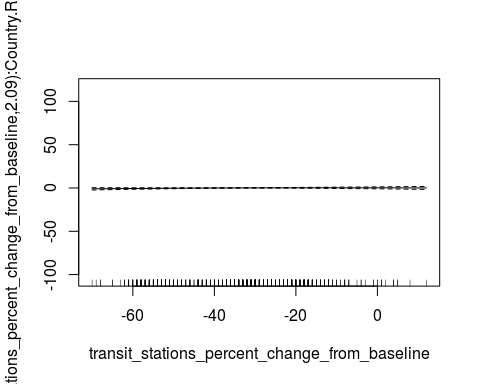
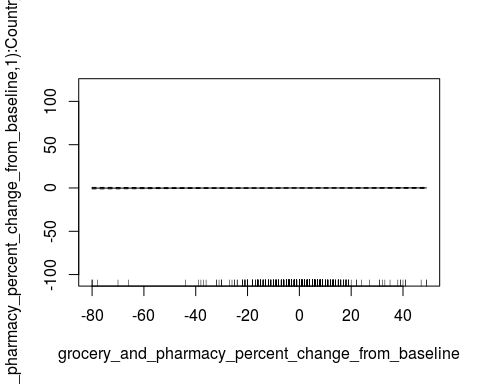
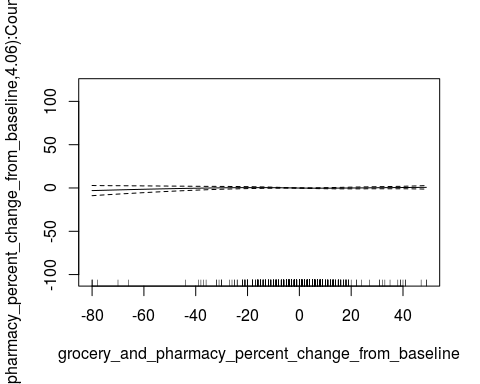
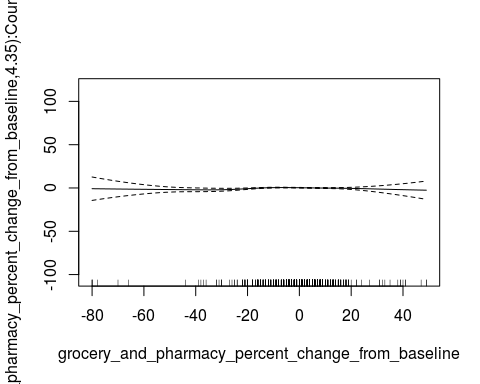
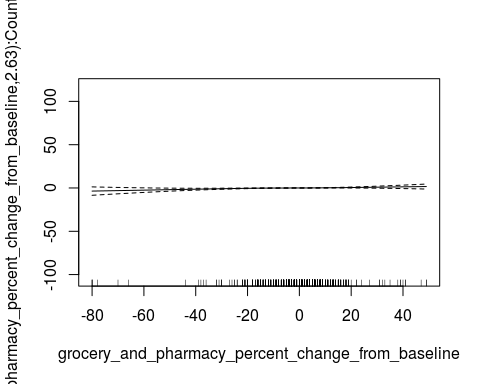
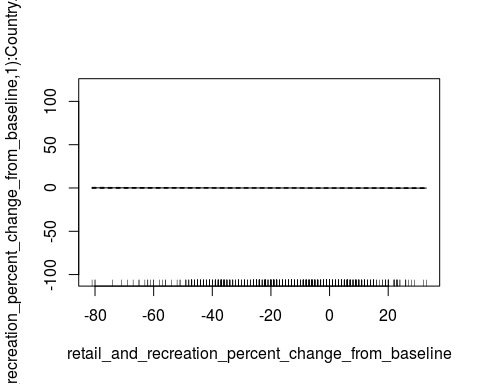
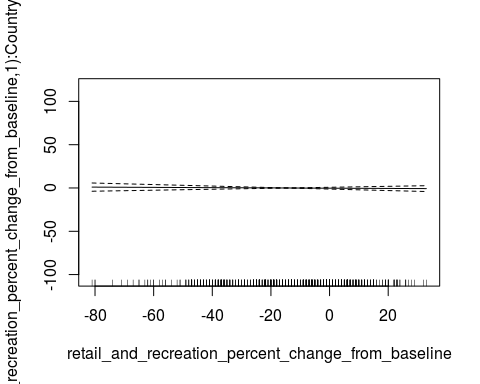
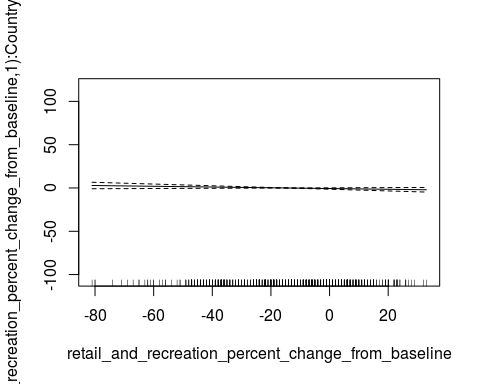
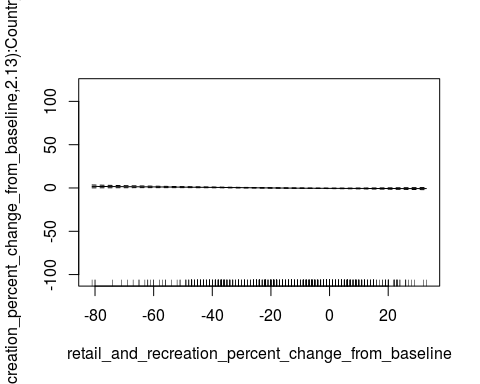
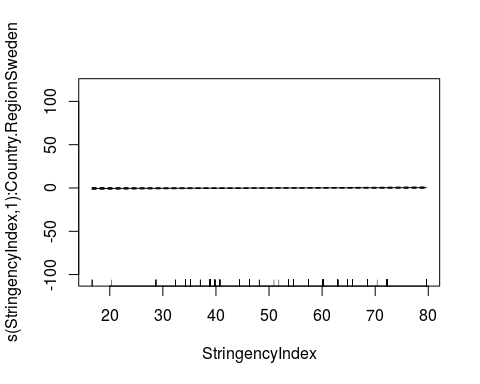
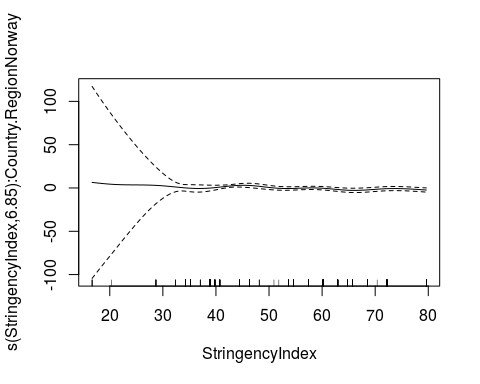
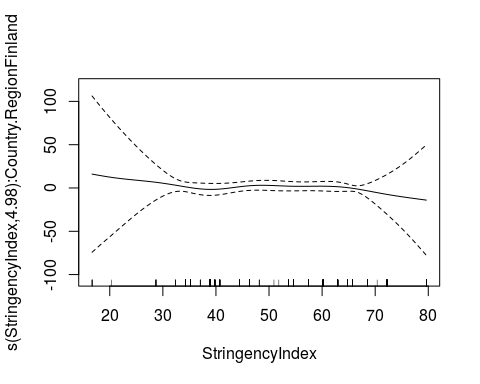
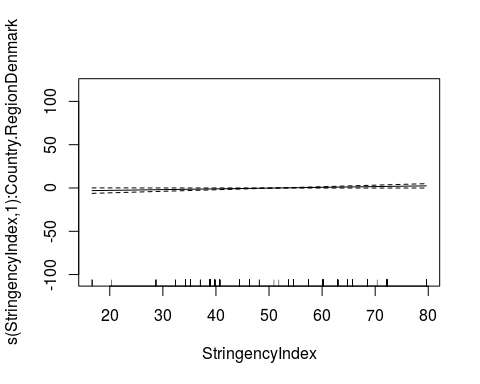
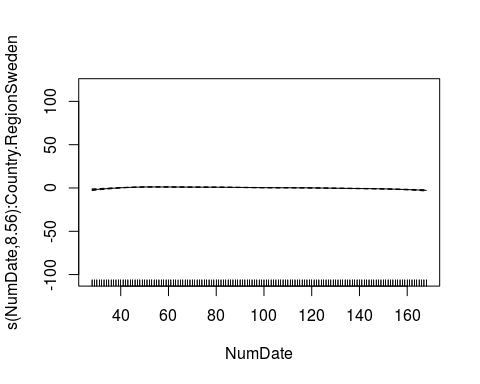
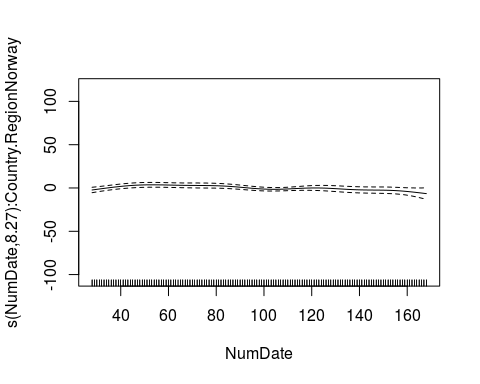
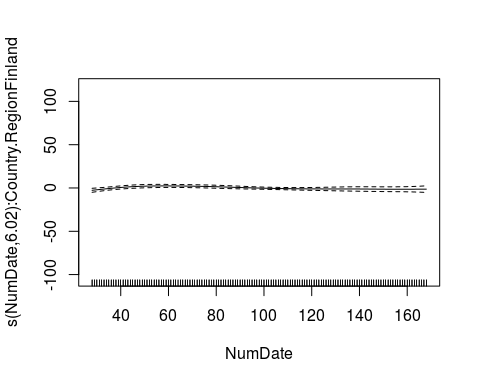
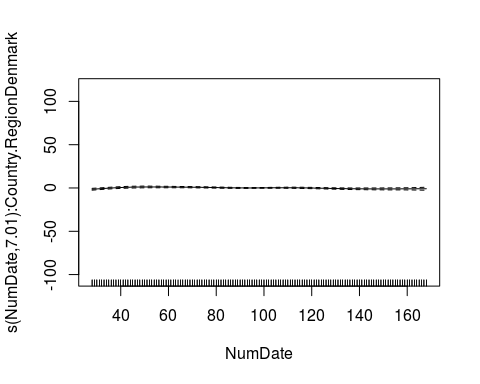
## [1] 1193.837

gam.check(fit)

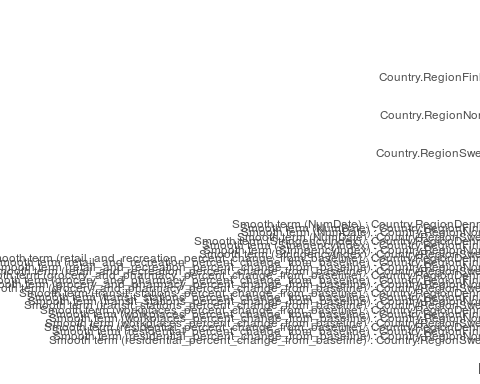


##   
## Method: GCV Optimizer: outer newton  
## full convergence after 22 iterations.  
## Gradient range [-5.655339e-08,1.065778e-08]  
## (score 0.2011125 & scale 0.1775935).  
## Hessian positive definite, eigenvalue range [4.317938e-10,0.0008462312].  
## Model rank = 256 / 256   
##   
## Basis dimension (k) checking results. Low p-value (k-index<1) may  
## indicate that k is too low, especially if edf is close to k'.  
##   
## k'  
## s(NumDate):Country.RegionDenmark 9.00  
## s(NumDate):Country.RegionFinland 9.00  
## s(NumDate):Country.RegionNorway 9.00  
## s(NumDate):Country.RegionSweden 9.00  
## s(StringencyIndex):Country.RegionDenmark 9.00  
## s(StringencyIndex):Country.RegionFinland 9.00  
## s(StringencyIndex):Country.RegionNorway 9.00  
## s(StringencyIndex):Country.RegionSweden 9.00  
## s(retail\_and\_recreation\_percent\_change\_from\_baseline):Country.RegionDenmark 9.00  
## s(retail\_and\_recreation\_percent\_change\_from\_baseline):Country.RegionFinland 9.00  
## s(retail\_and\_recreation\_percent\_change\_from\_baseline):Country.RegionNorway 9.00  
## s(retail\_and\_recreation\_percent\_change\_from\_baseline):Country.RegionSweden 9.00  
## s(grocery\_and\_pharmacy\_percent\_change\_from\_baseline):Country.RegionDenmark 9.00  
## s(grocery\_and\_pharmacy\_percent\_change\_from\_baseline):Country.RegionFinland 9.00  
## s(grocery\_and\_pharmacy\_percent\_change\_from\_baseline):Country.RegionNorway 9.00  
## s(grocery\_and\_pharmacy\_percent\_change\_from\_baseline):Country.RegionSweden 9.00  
## s(transit\_stations\_percent\_change\_from\_baseline):Country.RegionDenmark 9.00  
## s(transit\_stations\_percent\_change\_from\_baseline):Country.RegionFinland 9.00  
## s(transit\_stations\_percent\_change\_from\_baseline):Country.RegionNorway 9.00  
## s(transit\_stations\_percent\_change\_from\_baseline):Country.RegionSweden 9.00  
## s(workplaces\_percent\_change\_from\_baseline):Country.RegionDenmark 9.00  
## s(workplaces\_percent\_change\_from\_baseline):Country.RegionFinland 9.00  
## s(workplaces\_percent\_change\_from\_baseline):Country.RegionNorway 9.00  
## s(workplaces\_percent\_change\_from\_baseline):Country.RegionSweden 9.00  
## s(residential\_percent\_change\_from\_baseline):Country.RegionDenmark 9.00  
## s(residential\_percent\_change\_from\_baseline):Country.RegionFinland 9.00  
## s(residential\_percent\_change\_from\_baseline):Country.RegionNorway 9.00  
## s(residential\_percent\_change\_from\_baseline):Country.RegionSweden 9.00  
## edf  
## s(NumDate):Country.RegionDenmark 7.01  
## s(NumDate):Country.RegionFinland 6.02  
## s(NumDate):Country.RegionNorway 8.27  
## s(NumDate):Country.RegionSweden 8.56  
## s(StringencyIndex):Country.RegionDenmark 1.00  
## s(StringencyIndex):Country.RegionFinland 4.98  
## s(StringencyIndex):Country.RegionNorway 6.85  
## s(StringencyIndex):Country.RegionSweden 1.00  
## s(retail\_and\_recreation\_percent\_change\_from\_baseline):Country.RegionDenmark 2.13  
## s(retail\_and\_recreation\_percent\_change\_from\_baseline):Country.RegionFinland 1.00  
## s(retail\_and\_recreation\_percent\_change\_from\_baseline):Country.RegionNorway 1.00  
## s(retail\_and\_recreation\_percent\_change\_from\_baseline):Country.RegionSweden 1.00  
## s(grocery\_and\_pharmacy\_percent\_change\_from\_baseline):Country.RegionDenmark 2.63  
## s(grocery\_and\_pharmacy\_percent\_change\_from\_baseline):Country.RegionFinland 4.35  
## s(grocery\_and\_pharmacy\_percent\_change\_from\_baseline):Country.RegionNorway 4.06  
## s(grocery\_and\_pharmacy\_percent\_change\_from\_baseline):Country.RegionSweden 1.00  
## s(transit\_stations\_percent\_change\_from\_baseline):Country.RegionDenmark 2.09  
## s(transit\_stations\_percent\_change\_from\_baseline):Country.RegionFinland 5.86  
## s(transit\_stations\_percent\_change\_from\_baseline):Country.RegionNorway 1.00  
## s(transit\_stations\_percent\_change\_from\_baseline):Country.RegionSweden 1.00  
## s(workplaces\_percent\_change\_from\_baseline):Country.RegionDenmark 1.00  
## s(workplaces\_percent\_change\_from\_baseline):Country.RegionFinland 1.00  
## s(workplaces\_percent\_change\_from\_baseline):Country.RegionNorway 2.51  
## s(workplaces\_percent\_change\_from\_baseline):Country.RegionSweden 1.00  
## s(residential\_percent\_change\_from\_baseline):Country.RegionDenmark 1.00  
## s(residential\_percent\_change\_from\_baseline):Country.RegionFinland 1.00  
## s(residential\_percent\_change\_from\_baseline):Country.RegionNorway 6.17  
## s(residential\_percent\_change\_from\_baseline):Country.RegionSweden 1.00  
## k-index  
## s(NumDate):Country.RegionDenmark 0.93  
## s(NumDate):Country.RegionFinland 0.93  
## s(NumDate):Country.RegionNorway 0.93  
## s(NumDate):Country.RegionSweden 0.93  
## s(StringencyIndex):Country.RegionDenmark 1.11  
## s(StringencyIndex):Country.RegionFinland 1.11  
## s(StringencyIndex):Country.RegionNorway 1.11  
## s(StringencyIndex):Country.RegionSweden 1.11  
## s(retail\_and\_recreation\_percent\_change\_from\_baseline):Country.RegionDenmark 1.03  
## s(retail\_and\_recreation\_percent\_change\_from\_baseline):Country.RegionFinland 1.03  
## s(retail\_and\_recreation\_percent\_change\_from\_baseline):Country.RegionNorway 1.03  
## s(retail\_and\_recreation\_percent\_change\_from\_baseline):Country.RegionSweden 1.03  
## s(grocery\_and\_pharmacy\_percent\_change\_from\_baseline):Country.RegionDenmark 1.04  
## s(grocery\_and\_pharmacy\_percent\_change\_from\_baseline):Country.RegionFinland 1.04  
## s(grocery\_and\_pharmacy\_percent\_change\_from\_baseline):Country.RegionNorway 1.04  
## s(grocery\_and\_pharmacy\_percent\_change\_from\_baseline):Country.RegionSweden 1.04  
## s(transit\_stations\_percent\_change\_from\_baseline):Country.RegionDenmark 0.99  
## s(transit\_stations\_percent\_change\_from\_baseline):Country.RegionFinland 0.99  
## s(transit\_stations\_percent\_change\_from\_baseline):Country.RegionNorway 0.99  
## s(transit\_stations\_percent\_change\_from\_baseline):Country.RegionSweden 0.99  
## s(workplaces\_percent\_change\_from\_baseline):Country.RegionDenmark 0.99  
## s(workplaces\_percent\_change\_from\_baseline):Country.RegionFinland 0.99  
## s(workplaces\_percent\_change\_from\_baseline):Country.RegionNorway 0.99  
## s(workplaces\_percent\_change\_from\_baseline):Country.RegionSweden 0.99  
## s(residential\_percent\_change\_from\_baseline):Country.RegionDenmark 1.02  
## s(residential\_percent\_change\_from\_baseline):Country.RegionFinland 1.02  
## s(residential\_percent\_change\_from\_baseline):Country.RegionNorway 1.02  
## s(residential\_percent\_change\_from\_baseline):Country.RegionSweden 1.02  
## p-value  
## s(NumDate):Country.RegionDenmark 0.10  
## s(NumDate):Country.RegionFinland 0.14  
## s(NumDate):Country.RegionNorway 0.10  
## s(NumDate):Country.RegionSweden 0.13  
## s(StringencyIndex):Country.RegionDenmark 1.00  
## s(StringencyIndex):Country.RegionFinland 1.00  
## s(StringencyIndex):Country.RegionNorway 1.00  
## s(StringencyIndex):Country.RegionSweden 1.00  
## s(retail\_and\_recreation\_percent\_change\_from\_baseline):Country.RegionDenmark 0.89  
## s(retail\_and\_recreation\_percent\_change\_from\_baseline):Country.RegionFinland 0.89  
## s(retail\_and\_recreation\_percent\_change\_from\_baseline):Country.RegionNorway 0.92  
## s(retail\_and\_recreation\_percent\_change\_from\_baseline):Country.RegionSweden 0.94  
## s(grocery\_and\_pharmacy\_percent\_change\_from\_baseline):Country.RegionDenmark 0.94  
## s(grocery\_and\_pharmacy\_percent\_change\_from\_baseline):Country.RegionFinland 0.96  
## s(grocery\_and\_pharmacy\_percent\_change\_from\_baseline):Country.RegionNorway 0.97  
## s(grocery\_and\_pharmacy\_percent\_change\_from\_baseline):Country.RegionSweden 0.98  
## s(transit\_stations\_percent\_change\_from\_baseline):Country.RegionDenmark 0.61  
## s(transit\_stations\_percent\_change\_from\_baseline):Country.RegionFinland 0.69  
## s(transit\_stations\_percent\_change\_from\_baseline):Country.RegionNorway 0.71  
## s(transit\_stations\_percent\_change\_from\_baseline):Country.RegionSweden 0.64  
## s(workplaces\_percent\_change\_from\_baseline):Country.RegionDenmark 0.64  
## s(workplaces\_percent\_change\_from\_baseline):Country.RegionFinland 0.65  
## s(workplaces\_percent\_change\_from\_baseline):Country.RegionNorway 0.66  
## s(workplaces\_percent\_change\_from\_baseline):Country.RegionSweden 0.63  
## s(residential\_percent\_change\_from\_baseline):Country.RegionDenmark 0.86  
## s(residential\_percent\_change\_from\_baseline):Country.RegionFinland 0.85  
## s(residential\_percent\_change\_from\_baseline):Country.RegionNorway 0.93  
## s(residential\_percent\_change\_from\_baseline):Country.RegionSweden 0.88

plot(fit)



plot\_model(fit)



tab\_model(fit)

IncCaseNumber

Predictors

Estimates

CI

p

(Intercept)

-1.95

-3.01 – -0.90

<0.001

Country.RegionFinland

-2.44

-8.14 – 3.26

0.400

Country.RegionNorway

-0.32

-2.36 – 1.71

0.754

Country.RegionSweden

3.09

2.00 – 4.19

<0.001

Smooth term (NumDate) :Country.RegionDenmark

7.01

<0.001

Smooth term (NumDate) :Country.RegionFinland

6.02

<0.001

Smooth term (NumDate) :Country.RegionNorway

8.27

<0.001

Smooth term (NumDate) :Country.RegionSweden

8.56

<0.001

Smooth term(StringencyIndex) :Country.RegionDenmark

1.00

0.052

Smooth term(StringencyIndex) :Country.RegionFinland

4.98

0.352

Smooth term(StringencyIndex) :Country.RegionNorway

6.85

0.001

Smooth term(StringencyIndex) :Country.RegionSweden

1.00

0.291

Smooth term(retail\_and\_recreation\_percent\_change\_from\_baseline): Country.RegionDenmark

2.13

0.003

Smooth term(retail\_and\_recreation\_percent\_change\_from\_baseline): Country.RegionFinland

1.00

0.125

Smooth term(retail\_and\_recreation\_percent\_change\_from\_baseline): Country.RegionNorway

1.00

0.670

Smooth term(retail\_and\_recreation\_percent\_change\_from\_baseline): Country.RegionSweden

1.00

0.545

Smooth term(grocery\_and\_pharmacy\_percent\_change\_from\_baseline): Country.RegionDenmark

2.63

0.037

Smooth term(grocery\_and\_pharmacy\_percent\_change\_from\_baseline): Country.RegionFinland

4.35

0.008

Smooth term(grocery\_and\_pharmacy\_percent\_change\_from\_baseline): Country.RegionNorway

4.06

0.077

Smooth term(grocery\_and\_pharmacy\_percent\_change\_from\_baseline): Country.RegionSweden

1.00

0.699

Smooth term(transit\_stations\_percent\_change\_from\_baseline): Country.RegionDenmark

2.09

0.342

Smooth term(transit\_stations\_percent\_change\_from\_baseline): Country.RegionFinland

5.86

<0.001

Smooth term(transit\_stations\_percent\_change\_from\_baseline): Country.RegionNorway

1.00

0.444

Smooth term(transit\_stations\_percent\_change\_from\_baseline): Country.RegionSweden

1.00

0.567

Smooth term(workplaces\_percent\_change\_from\_baseline): Country.RegionDenmark

1.00

0.541

Smooth term(workplaces\_percent\_change\_from\_baseline): Country.RegionFinland

1.00

0.291

Smooth term(workplaces\_percent\_change\_from\_baseline): Country.RegionNorway

2.51

0.261

Smooth term(workplaces\_percent\_change\_from\_baseline): Country.RegionSweden

1.00

0.635

Smooth term(residential\_percent\_change\_from\_baseline): Country.RegionDenmark

1.00

0.833

Smooth term(residential\_percent\_change\_from\_baseline): Country.RegionFinland

1.00

0.739

Smooth term(residential\_percent\_change\_from\_baseline): Country.RegionNorway

6.17

0.375

Smooth term(residential\_percent\_change\_from\_baseline): Country.RegionSweden

1.00

0.937

Observations

561

R2

0.960

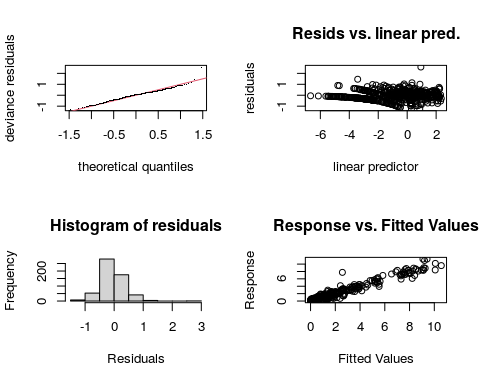
fitcb<-gam(IncCaseNumber~s(NumDate, by=Country.Region) + cb1 + cb2 + cb4 + cb5 + cb6 + cb7 + Country.Region, data = datat, select=TRUE, family=Tweedie(p=1.011))  
summary(fitcb)

##   
## Family: Tweedie(1.011)   
## Link function: log   
##   
## Formula:  
## IncCaseNumber ~ s(NumDate, by = Country.Region) + cb1 + cb2 +   
## cb4 + cb5 + cb6 + cb7 + Country.Region  
##   
## Parametric coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) 8.05318 27.50005 0.293 0.7698   
## cb1v1.l1 -1.30591 2.59921 -0.502 0.6156   
## cb1v1.l2 2.85496 4.65313 0.614 0.5398   
## cb1v1.l3 -0.56056 3.40475 -0.165 0.8693   
## cb1v1.l4 0.48205 2.07818 0.232 0.8167   
## cb1v1.l5 -0.61686 1.83559 -0.336 0.7370   
## cb1v2.l1 -0.37922 1.87308 -0.202 0.8396   
## cb1v2.l2 1.84564 1.72817 1.068 0.2861   
## cb1v2.l3 1.10309 1.62660 0.678 0.4980   
## cb1v2.l4 -0.05519 1.63239 -0.034 0.9730   
## cb1v2.l5 1.16550 1.27677 0.913 0.3618   
## cb1v3.l1 -0.38250 2.28006 -0.168 0.8668   
## cb1v3.l2 1.58064 3.31864 0.476 0.6341   
## cb1v3.l3 -1.07597 2.36788 -0.454 0.6498   
## cb1v3.l4 0.05005 1.44819 0.035 0.9724   
## cb1v3.l5 -0.92820 1.32879 -0.699 0.4852   
## cb2v1.l1 0.54021 2.94249 0.184 0.8544   
## cb2v1.l2 -1.88302 2.84706 -0.661 0.5087   
## cb2v1.l3 1.53167 2.31681 0.661 0.5089   
## cb2v1.l4 1.93879 2.08913 0.928 0.3539   
## cb2v1.l5 -1.13119 1.55959 -0.725 0.4686   
## cb2v2.l1 -0.08033 1.18763 -0.068 0.9461   
## cb2v2.l2 -0.10948 1.42581 -0.077 0.9388   
## cb2v2.l3 -0.68043 1.32144 -0.515 0.6069   
## cb2v2.l4 -0.78017 0.83783 -0.931 0.3522   
## cb2v2.l5 0.03741 0.82717 0.045 0.9639   
## cb2v3.l1 0.35919 2.47206 0.145 0.8845   
## cb2v3.l2 -2.04113 2.46886 -0.827 0.4088   
## cb2v3.l3 0.67519 1.88310 0.359 0.7201   
## cb2v3.l4 0.64020 1.58940 0.403 0.6873   
## cb2v3.l5 -0.75236 1.37597 -0.547 0.5848   
## cb4v1.l1 -2.96108 2.00508 -1.477 0.1404   
## cb4v1.l2 0.91248 2.22538 0.410 0.6820   
## cb4v1.l3 -1.03858 1.42046 -0.731 0.4650   
## cb4v1.l4 -0.77342 1.32729 -0.583 0.5604   
## cb4v1.l5 0.57638 1.09059 0.529 0.5974   
## cb4v2.l1 0.38868 1.03766 0.375 0.7081   
## cb4v2.l2 -1.85245 1.34650 -1.376 0.1696   
## cb4v2.l3 0.60072 0.97246 0.618 0.5370   
## cb4v2.l4 1.14557 0.84944 1.349 0.1781   
## cb4v2.l5 -0.45727 0.62576 -0.731 0.4653   
## cb4v3.l1 -2.90433 2.01283 -1.443 0.1497   
## cb4v3.l2 0.88707 2.33411 0.380 0.7041   
## cb4v3.l3 -0.57040 1.50704 -0.378 0.7052   
## cb4v3.l4 0.89613 1.18486 0.756 0.4498   
## cb4v3.l5 -0.03797 0.99905 -0.038 0.9697   
## cb5v1.l1 -0.17573 1.13786 -0.154 0.8773   
## cb5v1.l2 0.45476 1.69105 0.269 0.7881   
## cb5v1.l3 -1.15095 1.62091 -0.710 0.4780   
## cb5v1.l4 0.30526 1.32095 0.231 0.8173   
## cb5v1.l5 -0.77891 0.90455 -0.861 0.3896   
## cb5v2.l1 1.34220 1.19302 1.125 0.2611   
## cb5v2.l2 -0.97138 1.40564 -0.691 0.4899   
## cb5v2.l3 0.61239 1.31128 0.467 0.6407   
## cb5v2.l4 1.11480 0.80526 1.384 0.1669   
## cb5v2.l5 0.35568 0.83064 0.428 0.6687   
## cb5v3.l1 -1.53072 1.28584 -1.190 0.2345   
## cb5v3.l2 1.66570 1.84662 0.902 0.3675   
## cb5v3.l3 -2.70818 1.83818 -1.473 0.1413   
## cb5v3.l4 -0.10580 1.23025 -0.086 0.9315   
## cb5v3.l5 -1.51457 1.13173 -1.338 0.1815   
## cb6v1.l1 -7.77860 3.93990 -1.974 0.0489 \*  
## cb6v1.l2 7.47078 4.49358 1.663 0.0971 .  
## cb6v1.l3 -4.46189 4.25865 -1.048 0.2953   
## cb6v1.l4 -2.42551 3.25645 -0.745 0.4567   
## cb6v1.l5 -1.41913 2.78601 -0.509 0.6107   
## cb6v2.l1 -2.57890 1.84961 -1.394 0.1639   
## cb6v2.l2 1.56998 2.28145 0.688 0.4917   
## cb6v2.l3 -2.27140 2.02237 -1.123 0.2620   
## cb6v2.l4 0.90905 1.40097 0.649 0.5167   
## cb6v2.l5 -1.31250 1.52928 -0.858 0.3912   
## cb6v3.l1 -6.28814 3.22950 -1.947 0.0521 .  
## cb6v3.l2 3.54822 3.62629 0.978 0.3283   
## cb6v3.l3 -3.15131 3.08752 -1.021 0.3079   
## cb6v3.l4 -0.29447 2.49247 -0.118 0.9060   
## cb6v3.l5 -1.10240 2.04508 -0.539 0.5901   
## cb7v1.l1 3.39543 2.32685 1.459 0.1452   
## cb7v1.l2 1.14865 0.91269 1.259 0.2088   
## cb7v1.l3 1.30844 1.10493 1.184 0.2369   
## cb7v1.l4 -4.36446 2.90864 -1.501 0.1342   
## cb7v1.l5 3.01479 1.97787 1.524 0.1281   
## cb7v2.l1 1.50447 1.18750 1.267 0.2058   
## cb7v2.l2 1.26163 0.88336 1.428 0.1539   
## cb7v2.l3 0.04555 0.77487 0.059 0.9532   
## cb7v2.l4 -3.15306 1.57084 -2.007 0.0453 \*  
## cb7v2.l5 1.44206 1.14910 1.255 0.2101   
## cb7v3.l1 1.94008 1.47603 1.314 0.1894   
## cb7v3.l2 1.52875 0.92091 1.660 0.0976 .  
## cb7v3.l3 0.67277 0.83815 0.803 0.4226   
## cb7v3.l4 -3.19558 1.95445 -1.635 0.1027   
## cb7v3.l5 1.79043 1.37654 1.301 0.1940   
## Country.RegionFinland -1.84650 1.27561 -1.448 0.1484   
## Country.RegionNorway -0.11712 1.47810 -0.079 0.9369   
## Country.RegionSweden 3.39072 1.45489 2.331 0.0202 \*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Approximate significance of smooth terms:  
## edf Ref.df F p-value  
## s(NumDate):Country.RegionDenmark 1.035e-04 9 0 0.538  
## s(NumDate):Country.RegionFinland 1.187e-05 9 0 0.552  
## s(NumDate):Country.RegionNorway 1.229e-04 9 0 0.389  
## s(NumDate):Country.RegionSweden 9.182e-05 9 0 0.794  
##   
## R-sq.(adj) = 0.946 Deviance explained = 93.2%  
## GCV = 0.26636 Scale est. = 0.23812 n = 561

AIC(fitcb)

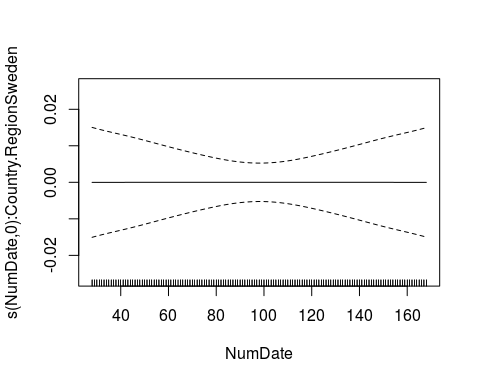
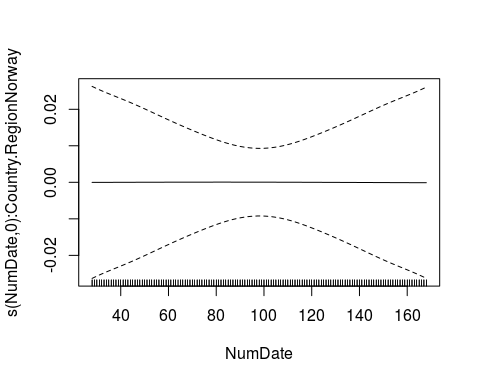
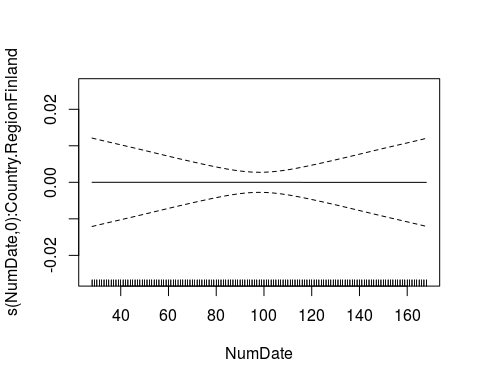
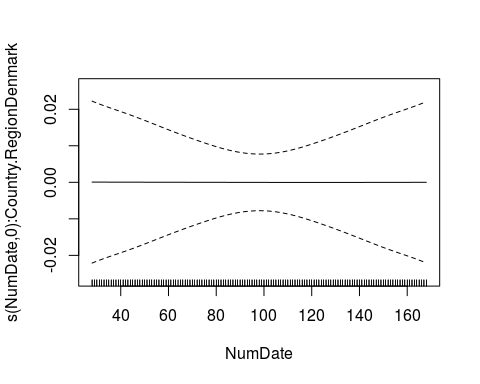
## [1] 642.3532

gam.check(fitcb)



##   
## Method: GCV Optimizer: outer newton  
## full convergence after 7 iterations.  
## Gradient range [-7.045237e-08,-1.316899e-09]  
## (score 0.2663578 & scale 0.2381195).  
## Hessian positive definite, eigenvalue range [1.316904e-09,7.044551e-08].  
## Model rank = 130 / 130   
##   
## Basis dimension (k) checking results. Low p-value (k-index<1) may  
## indicate that k is too low, especially if edf is close to k'.  
##   
## k' edf k-index p-value  
## s(NumDate):Country.RegionDenmark 9.00e+00 1.03e-04 1 0.77  
## s(NumDate):Country.RegionFinland 9.00e+00 1.19e-05 1 0.70  
## s(NumDate):Country.RegionNorway 9.00e+00 1.23e-04 1 0.73  
## s(NumDate):Country.RegionSweden 9.00e+00 9.18e-05 1 0.72

plot(fitcb)



plot\_model(fitcb)

## Warning in mapply(function(.d, .l) {: longer argument not a multiple of length  
## of shorter

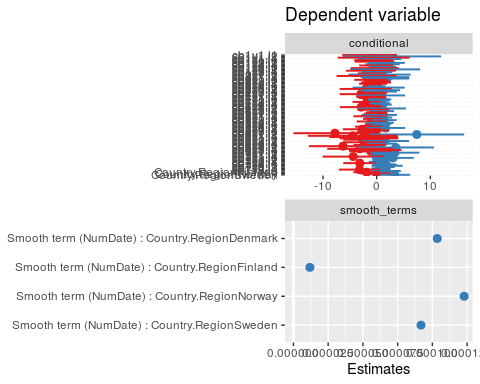
## Warning: Some model terms could not be found in model data. You probably need to  
## load the data into the environment.

## Warning in mapply(function(.d, .l) {: longer argument not a multiple of length  
## of shorter

## Warning: Some model terms could not be found in model data. You probably need to  
## load the data into the environment.

## Warning in mapply(function(.d, .l) {: longer argument not a multiple of length  
## of shorter

## Warning: Some model terms could not be found in model data. You probably need to  
## load the data into the environment.



tab\_model(fitcb)

## Warning in mapply(function(.d, .l) {: longer argument not a multiple of length  
## of shorter  
  
## Warning in mapply(function(.d, .l) {: Some model terms could not be found in  
## model data. You probably need to load the data into the environment.

## Warning in mapply(function(.d, .l) {: longer argument not a multiple of length  
## of shorter

## Warning: Some model terms could not be found in model data. You probably need to  
## load the data into the environment.

## Warning in mapply(function(.d, .l) {: longer argument not a multiple of length  
## of shorter

## Warning: Some model terms could not be found in model data. You probably need to  
## load the data into the environment.

Dependent variable

Predictors

Estimates

CI

p

(Intercept)

8.05

-45.99 – 62.09

0.770

cb1v1.l1

-1.31

-6.41 – 3.80

0.616

cb1v1.l2

2.85

-6.29 – 12.00

0.540

cb1v1.l3

-0.56

-7.25 – 6.13

0.869

cb1v1.l4

0.48

-3.60 – 4.57

0.817

cb1v1.l5

-0.62

-4.22 – 2.99

0.737

cb1v2.l1

-0.38

-4.06 – 3.30

0.840

cb1v2.l2

1.85

-1.55 – 5.24

0.286

cb1v2.l3

1.10

-2.09 – 4.30

0.498

cb1v2.l4

-0.06

-3.26 – 3.15

0.973

cb1v2.l5

1.17

-1.34 – 3.67

0.362

cb1v3.l1

-0.38

-4.86 – 4.10

0.867

cb1v3.l2

1.58

-4.94 – 8.10

0.634

cb1v3.l3

-1.08

-5.73 – 3.58

0.650

cb1v3.l4

0.05

-2.80 – 2.90

0.972

cb1v3.l5

-0.93

-3.54 – 1.68

0.485

cb2v1.l1

0.54

-5.24 – 6.32

0.854

cb2v1.l2

-1.88

-7.48 – 3.71

0.509

cb2v1.l3

1.53

-3.02 – 6.08

0.509

cb2v1.l4

1.94

-2.17 – 6.04

0.354

cb2v1.l5

-1.13

-4.20 – 1.93

0.469

cb2v2.l1

-0.08

-2.41 – 2.25

0.946

cb2v2.l2

-0.11

-2.91 – 2.69

0.939

cb2v2.l3

-0.68

-3.28 – 1.92

0.607

cb2v2.l4

-0.78

-2.43 – 0.87

0.352

cb2v2.l5

0.04

-1.59 – 1.66

0.964

cb2v3.l1

0.36

-4.50 – 5.22

0.885

cb2v3.l2

-2.04

-6.89 – 2.81

0.409

cb2v3.l3

0.68

-3.03 – 4.38

0.720

cb2v3.l4

0.64

-2.48 – 3.76

0.687

cb2v3.l5

-0.75

-3.46 – 1.95

0.585

cb4v1.l1

-2.96

-6.90 – 0.98

0.140

cb4v1.l2

0.91

-3.46 – 5.29

0.682

cb4v1.l3

-1.04

-3.83 – 1.75

0.465

cb4v1.l4

-0.77

-3.38 – 1.83

0.560

cb4v1.l5

0.58

-1.57 – 2.72

0.597

cb4v2.l1

0.39

-1.65 – 2.43

0.708

cb4v2.l2

-1.85

-4.50 – 0.79

0.170

cb4v2.l3

0.60

-1.31 – 2.51

0.537

cb4v2.l4

1.15

-0.52 – 2.81

0.178

cb4v2.l5

-0.46

-1.69 – 0.77

0.465

cb4v3.l1

-2.90

-6.86 – 1.05

0.150

cb4v3.l2

0.89

-3.70 – 5.47

0.704

cb4v3.l3

-0.57

-3.53 – 2.39

0.705

cb4v3.l4

0.90

-1.43 – 3.22

0.450

cb4v3.l5

-0.04

-2.00 – 1.93

0.970

cb5v1.l1

-0.18

-2.41 – 2.06

0.877

cb5v1.l2

0.45

-2.87 – 3.78

0.788

cb5v1.l3

-1.15

-4.34 – 2.03

0.478

cb5v1.l4

0.31

-2.29 – 2.90

0.817

cb5v1.l5

-0.78

-2.56 – 1.00

0.390

cb5v2.l1

1.34

-1.00 – 3.69

0.261

cb5v2.l2

-0.97

-3.73 – 1.79

0.490

cb5v2.l3

0.61

-1.96 – 3.19

0.641

cb5v2.l4

1.11

-0.47 – 2.70

0.167

cb5v2.l5

0.36

-1.28 – 1.99

0.669

cb5v3.l1

-1.53

-4.06 – 1.00

0.234

cb5v3.l2

1.67

-1.96 – 5.29

0.368

cb5v3.l3

-2.71

-6.32 – 0.90

0.141

cb5v3.l4

-0.11

-2.52 – 2.31

0.932

cb5v3.l5

-1.51

-3.74 – 0.71

0.181

cb6v1.l1

-7.78

-15.52 – -0.04

0.049

cb6v1.l2

7.47

-1.36 – 16.30

0.097

cb6v1.l3

-4.46

-12.83 – 3.91

0.295

cb6v1.l4

-2.43

-8.82 – 3.97

0.457

cb6v1.l5

-1.42

-6.89 – 4.06

0.611

cb6v2.l1

-2.58

-6.21 – 1.06

0.164

cb6v2.l2

1.57

-2.91 – 6.05

0.492

cb6v2.l3

-2.27

-6.25 – 1.70

0.262

cb6v2.l4

0.91

-1.84 – 3.66

0.517

cb6v2.l5

-1.31

-4.32 – 1.69

0.391

cb6v3.l1

-6.29

-12.63 – 0.06

0.052

cb6v3.l2

3.55

-3.58 – 10.67

0.328

cb6v3.l3

-3.15

-9.22 – 2.92

0.308

cb6v3.l4

-0.29

-5.19 – 4.60

0.906

cb6v3.l5

-1.10

-5.12 – 2.92

0.590

cb7v1.l1

3.40

-1.18 – 7.97

0.145

cb7v1.l2

1.15

-0.64 – 2.94

0.209

cb7v1.l3

1.31

-0.86 – 3.48

0.237

cb7v1.l4

-4.36

-10.08 – 1.35

0.134

cb7v1.l5

3.01

-0.87 – 6.90

0.128

cb7v2.l1

1.50

-0.83 – 3.84

0.206

cb7v2.l2

1.26

-0.47 – 3.00

0.154

cb7v2.l3

0.05

-1.48 – 1.57

0.953

cb7v2.l4

-3.15

-6.24 – -0.07

0.045

cb7v2.l5

1.44

-0.82 – 3.70

0.210

cb7v3.l1

1.94

-0.96 – 4.84

0.189

cb7v3.l2

1.53

-0.28 – 3.34

0.098

cb7v3.l3

0.67

-0.97 – 2.32

0.423

cb7v3.l4

-3.20

-7.04 – 0.65

0.103

cb7v3.l5

1.79

-0.91 – 4.50

0.194

Country.RegionFinland

-1.85

-4.35 – 0.66

0.148

Country.RegionNorway

-0.12

-3.02 – 2.79

0.937

Country.RegionSweden

3.39

0.53 – 6.25

0.020

Smooth term (NumDate) :Country.RegionDenmark

0.00

0.538

Smooth term (NumDate) :Country.RegionFinland

0.00

0.552

Smooth term (NumDate) :Country.RegionNorway

0.00

0.389

Smooth term (NumDate) :Country.RegionSweden

0.00

0.794

Observations

561

R2

0.946

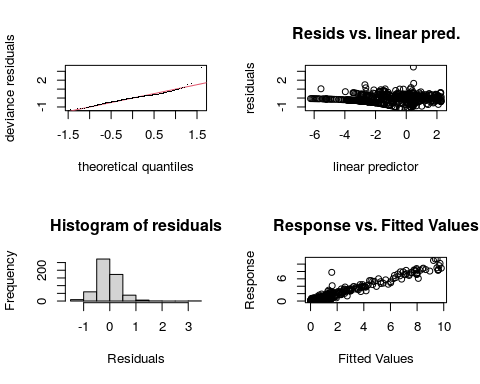
##stringency distributed lag  
fitcbstr<-gam(IncCaseNumber~s(NumDate, by=Country.Region) + cb7 + Country.Region, data = datat, select=TRUE, family=Tweedie(p=1.011))  
summary(fitcbstr)

##   
## Family: Tweedie(1.011)   
## Link function: log   
##   
## Formula:  
## IncCaseNumber ~ s(NumDate, by = Country.Region) + cb7 + Country.Region  
##   
## Parametric coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) -3.2518186 3.4567443 -0.941 0.347281   
## cb7v1.l1 1.3910054 1.6575300 0.839 0.401736   
## cb7v1.l2 -0.0229497 0.5104872 -0.045 0.964159   
## cb7v1.l3 0.3279331 0.7130251 0.460 0.645765   
## cb7v1.l4 -0.0925183 2.0100482 -0.046 0.963305   
## cb7v1.l5 0.8126939 1.3800863 0.589 0.556200   
## cb7v2.l1 0.9349625 0.7430691 1.258 0.208861   
## cb7v2.l2 -0.0005351 0.3549750 -0.002 0.998798   
## cb7v2.l3 0.4988975 0.4273068 1.168 0.243521   
## cb7v2.l4 -1.1383909 1.0102593 -1.127 0.260327   
## cb7v2.l5 0.7162625 0.7764030 0.923 0.356669   
## cb7v3.l1 1.3572165 0.9976003 1.360 0.174259   
## cb7v3.l2 -0.3249160 0.3563350 -0.912 0.362277   
## cb7v3.l3 0.6614440 0.4916829 1.345 0.179118   
## cb7v3.l4 -0.4281769 1.3040191 -0.328 0.742776   
## cb7v3.l5 0.5309457 0.9069206 0.585 0.558504   
## Country.RegionFinland -1.2373211 0.3523923 -3.511 0.000484 \*\*\*  
## Country.RegionNorway -1.3284778 0.3053806 -4.350 1.63e-05 \*\*\*  
## Country.RegionSweden 2.0283613 0.3456458 5.868 7.79e-09 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Approximate significance of smooth terms:  
## edf Ref.df F p-value   
## s(NumDate):Country.RegionDenmark 2.382 9 6.956 5.79e-16 \*\*\*  
## s(NumDate):Country.RegionFinland 4.184 9 9.760 < 2e-16 \*\*\*  
## s(NumDate):Country.RegionNorway 1.000 9 1.825 1.52e-05 \*\*\*  
## s(NumDate):Country.RegionSweden 7.602 9 24.733 < 2e-16 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## R-sq.(adj) = 0.948 Deviance explained = 92.5%  
## GCV = 0.23179 Scale est. = 0.24938 n = 561

AIC(fitcbstr)

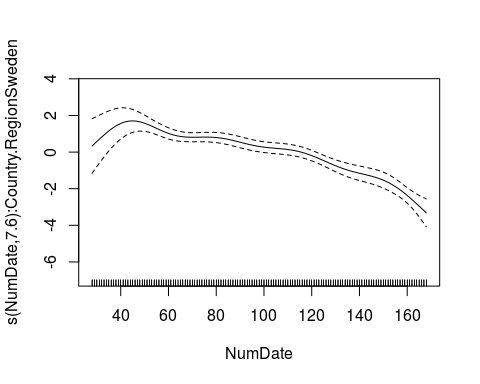
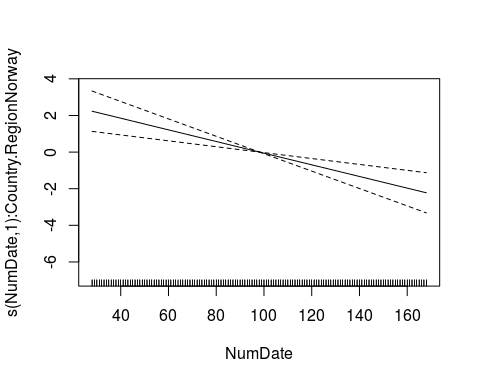
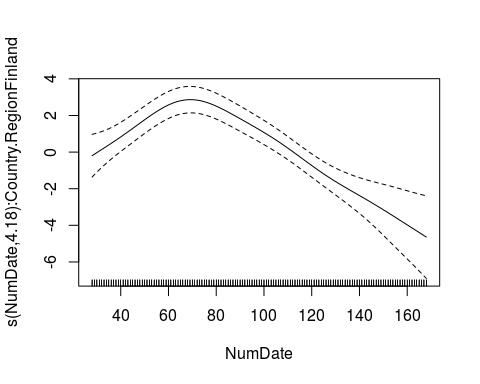
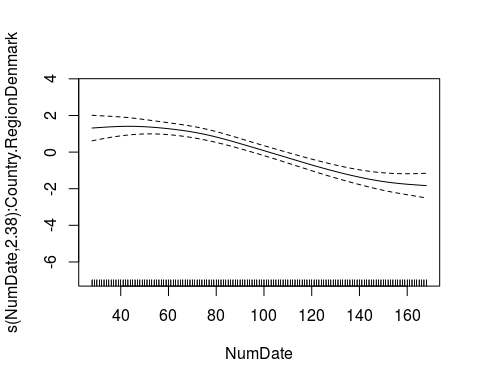
## [1] 939.9851

gam.check(fitcbstr)



##   
## Method: GCV Optimizer: outer newton  
## full convergence after 14 iterations.  
## Gradient range [-3.044887e-08,3.616392e-08]  
## (score 0.2317901 & scale 0.2493848).  
## eigenvalue range [-2.843228e-09,0.0007378199].  
## Model rank = 55 / 55   
##   
## Basis dimension (k) checking results. Low p-value (k-index<1) may  
## indicate that k is too low, especially if edf is close to k'.  
##   
## k' edf k-index p-value  
## s(NumDate):Country.RegionDenmark 9.00 2.38 0.99 0.64  
## s(NumDate):Country.RegionFinland 9.00 4.18 0.99 0.61  
## s(NumDate):Country.RegionNorway 9.00 1.00 0.99 0.59  
## s(NumDate):Country.RegionSweden 9.00 7.60 0.99 0.59

plot(fitcbstr)



plot\_model(fitcbstr)

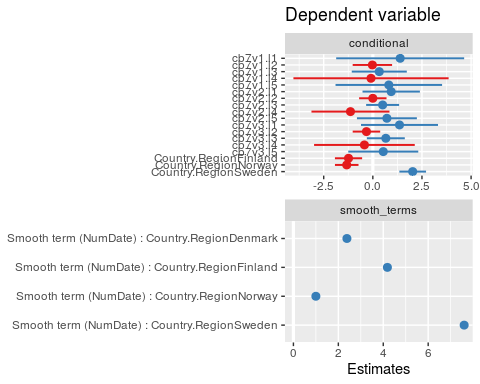
## Warning in mapply(function(.d, .l) {: longer argument not a multiple of length  
## of shorter  
  
## Warning in mapply(function(.d, .l) {: Some model terms could not be found in  
## model data. You probably need to load the data into the environment.

## Warning in mapply(function(.d, .l) {: longer argument not a multiple of length  
## of shorter

## Warning: Some model terms could not be found in model data. You probably need to  
## load the data into the environment.

## Warning in mapply(function(.d, .l) {: longer argument not a multiple of length  
## of shorter

## Warning: Some model terms could not be found in model data. You probably need to  
## load the data into the environment.



tab\_model(fitcbstr)

## Warning in mapply(function(.d, .l) {: longer argument not a multiple of length  
## of shorter  
  
## Warning in mapply(function(.d, .l) {: Some model terms could not be found in  
## model data. You probably need to load the data into the environment.

## Warning in mapply(function(.d, .l) {: longer argument not a multiple of length  
## of shorter

## Warning: Some model terms could not be found in model data. You probably need to  
## load the data into the environment.

## Warning in mapply(function(.d, .l) {: longer argument not a multiple of length  
## of shorter

## Warning: Some model terms could not be found in model data. You probably need to  
## load the data into the environment.

Dependent variable

Predictors

Estimates

CI

p

(Intercept)

-3.25

-10.04 – 3.54

0.347

cb7v1.l1

1.39

-1.87 – 4.65

0.402

cb7v1.l2

-0.02

-1.03 – 0.98

0.964

cb7v1.l3

0.33

-1.07 – 1.73

0.646

cb7v1.l4

-0.09

-4.04 – 3.86

0.963

cb7v1.l5

0.81

-1.90 – 3.52

0.556

cb7v2.l1

0.93

-0.52 – 2.39

0.209

cb7v2.l2

-0.00

-0.70 – 0.70

0.999

cb7v2.l3

0.50

-0.34 – 1.34

0.244

cb7v2.l4

-1.14

-3.12 – 0.85

0.260

cb7v2.l5

0.72

-0.81 – 2.24

0.357

cb7v3.l1

1.36

-0.60 – 3.32

0.174

cb7v3.l2

-0.32

-1.02 – 0.38

0.362

cb7v3.l3

0.66

-0.30 – 1.63

0.179

cb7v3.l4

-0.43

-2.99 – 2.13

0.743

cb7v3.l5

0.53

-1.25 – 2.31

0.559

Country.RegionFinland

-1.24

-1.93 – -0.55

<0.001

Country.RegionNorway

-1.33

-1.93 – -0.73

<0.001

Country.RegionSweden

2.03

1.35 – 2.71

<0.001

Smooth term (NumDate) :Country.RegionDenmark

2.38

<0.001

Smooth term (NumDate) :Country.RegionFinland

4.18

<0.001

Smooth term (NumDate) :Country.RegionNorway

1.00

<0.001

Smooth term (NumDate) :Country.RegionSweden

7.60

<0.001

Observations

561

R2

0.948

AIC(fitplain)

## [1] 961.4624

AIC(fitwithout)

## [1] 632.8655

AIC(fit)

## [1] 1193.837

AIC(fitcb)

## [1] 642.3532

AIC(fitcbstr)

## [1] 939.9851

#preparing data for the validation  
  
datav$cb1 <- crossbasis(datav$grocery\_and\_pharmacy\_percent\_change\_from\_baseline , lag=28, argvar=list(fun="bs"),arglag=list(df=5), group=datav$Country.Region)

## Warning in (function (fun = NULL, df = NULL, knots = NULL, ...) : default knots placement along lags has changed since version 2.0.0.  
## See 'file.show(system.file('Changesince200',package='dlnm'))'.  
## See also help(logknots) for setting the knots  
## consistently with the previous versions

datav$cb2 <- crossbasis(datav$retail\_and\_recreation\_percent\_change\_from\_baseline , lag=28, argvar=list(fun="bs"),arglag=list(df=5), group=datav$Country.Region)

## Warning in (function (fun = NULL, df = NULL, knots = NULL, ...) : default knots placement along lags has changed since version 2.0.0.  
## See 'file.show(system.file('Changesince200',package='dlnm'))'.  
## See also help(logknots) for setting the knots  
## consistently with the previous versions

datav$cb4 <- crossbasis(datav$transit\_stations\_percent\_change\_from\_baseline , lag=28, argvar=list(fun="bs"),arglag=list(df=5), group=datav$Country.Region)

## Warning in (function (fun = NULL, df = NULL, knots = NULL, ...) : default knots placement along lags has changed since version 2.0.0.  
## See 'file.show(system.file('Changesince200',package='dlnm'))'.  
## See also help(logknots) for setting the knots  
## consistently with the previous versions

datav$cb5 <- crossbasis(datav$workplaces\_percent\_change\_from\_baseline , lag=28, argvar=list(fun="bs"),arglag=list(df=5), group=datav$Country.Region)

## Warning in (function (fun = NULL, df = NULL, knots = NULL, ...) : default knots placement along lags has changed since version 2.0.0.  
## See 'file.show(system.file('Changesince200',package='dlnm'))'.  
## See also help(logknots) for setting the knots  
## consistently with the previous versions

datav$cb6 <- crossbasis(datav$residential\_percent\_change\_from\_baseline , lag=28, argvar=list(fun="bs"),arglag=list(df=5), group=datav$Country.Region)

## Warning in (function (fun = NULL, df = NULL, knots = NULL, ...) : default knots placement along lags has changed since version 2.0.0.  
## See 'file.show(system.file('Changesince200',package='dlnm'))'.  
## See also help(logknots) for setting the knots  
## consistently with the previous versions

datav$cb7 <- crossbasis(datav$StringencyIndex , lag=28, argvar=list(fun="bs"),arglag=list(df=5), group=datav$Country.Region)

## Warning in (function (fun = NULL, df = NULL, knots = NULL, ...) : default knots placement along lags has changed since version 2.0.0.  
## See 'file.show(system.file('Changesince200',package='dlnm'))'.  
## See also help(logknots) for setting the knots  
## consistently with the previous versions

dataval<-datav %>%  
 group\_by(Country.Region) %>%  
 slice(-c(1:28))  
  
  
dataval$pred<-predict.gam(fitplain, dataval, type="response")  
dataval$pred1<-predict.gam(fitwithout, dataval, type="response")  
dataval$pred2<-predict.gam(fit, dataval, type="response")  
dataval$predcb<-predict.gam(fitcb, dataval, type="response")  
dataval$predcbstr<-predict.gam(fitcbstr, dataval, type="response")  
  
  
  
dataval<-na.omit(dataval)  
pred1<-predict.gam(fitplain, dataval, type="response")  
pred<-predict(fitplain, dataval, type="response", interval = "response")  
pred1<-predict.gam(fitwithout, dataval, type="response")  
pred2<-predict.gam(fit, dataval, type="response")  
predcb<-predict.gam(fitcb, dataval, type="response")  
predcbstr<-predict.gam(fitcbstr, dataval, type="response")  
  
  
  
  
  
#predcb<-predcb[!is.na(predcb)]  
  
  
RMSE <- function(pred, obs){  
 sqrt(mean((pred - obs)^2))  
}  
  
  
RMSE(dataval$pred, dataval$IncCaseNumber)

## [1] 0.2503114

RMSE(dataval$pred1, dataval$IncCaseNumber)

## [1] 0.2486492

RMSE(dataval$pred2, dataval$IncCaseNumber)

## [1] 0.5219219

RMSE(dataval$predcb, dataval$IncCaseNumber)

## [1] 104.6195

RMSE(dataval$predcbstr, dataval$IncCaseNumber)

## [1] 0.2520634

library(forecast)

## Registered S3 method overwritten by 'quantmod':  
## method from  
## as.zoo.data.frame zoo

##   
## Attaching package: 'forecast'

## The following object is masked from 'package:nlme':  
##   
## getResponse

## The following object is masked from 'package:ggpubr':  
##   
## gghistogram

dm.test(pred-dataval$IncCaseNumber, pred1-dataval$IncCaseNumber)

##   
## Diebold-Mariano Test  
##   
## data: pred - dataval$IncCaseNumberpred1 - dataval$IncCaseNumber  
## DM = 2.535, Forecast horizon = 1, Loss function power = 2, p-value =  
## 0.01248  
## alternative hypothesis: two.sided

dm.test(pred-dataval$IncCaseNumber, pred2-dataval$IncCaseNumber)

##   
## Diebold-Mariano Test  
##   
## data: pred - dataval$IncCaseNumberpred2 - dataval$IncCaseNumber  
## DM = -4.9851, Forecast horizon = 1, Loss function power = 2, p-value =  
## 2.019e-06  
## alternative hypothesis: two.sided

dm.test(pred-dataval$IncCaseNumber, predcb-dataval$IncCaseNumber)

##   
## Diebold-Mariano Test  
##   
## data: pred - dataval$IncCaseNumberpredcb - dataval$IncCaseNumber  
## DM = -2.1245, Forecast horizon = 1, Loss function power = 2, p-value =  
## 0.0356  
## alternative hypothesis: two.sided

dm.test(pred1-dataval$IncCaseNumber, pred2-dataval$IncCaseNumber)

##   
## Diebold-Mariano Test  
##   
## data: pred1 - dataval$IncCaseNumberpred2 - dataval$IncCaseNumber  
## DM = -5.0094, Forecast horizon = 1, Loss function power = 2, p-value =  
## 1.818e-06  
## alternative hypothesis: two.sided

dm.test(pred1-dataval$IncCaseNumber, predcb-dataval$IncCaseNumber)

##   
## Diebold-Mariano Test  
##   
## data: pred1 - dataval$IncCaseNumberpredcb - dataval$IncCaseNumber  
## DM = -2.1245, Forecast horizon = 1, Loss function power = 2, p-value =  
## 0.0356  
## alternative hypothesis: two.sided

dm.test(pred2-dataval$IncCaseNumber, predcb-dataval$IncCaseNumber)

##   
## Diebold-Mariano Test  
##   
## data: pred2 - dataval$IncCaseNumberpredcb - dataval$IncCaseNumber  
## DM = -2.1244, Forecast horizon = 1, Loss function power = 2, p-value =  
## 0.03561  
## alternative hypothesis: two.sided

dm.test(pred2-dataval$IncCaseNumber, predcbstr-dataval$IncCaseNumber)

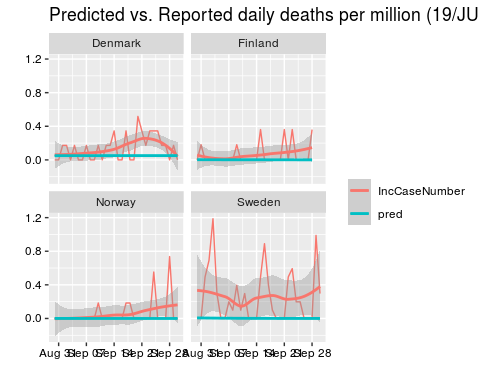
##   
## Diebold-Mariano Test  
##   
## data: pred2 - dataval$IncCaseNumberpredcbstr - dataval$IncCaseNumber  
## DM = 4.9585, Forecast horizon = 1, Loss function power = 2, p-value =  
## 2.264e-06  
## alternative hypothesis: two.sided

library(tidyr)  
datavallong<-gather(dataval, reportedornot, number, c(22,10))

## Warning: attributes are not identical across measure variables;  
## they will be dropped

ggplot(datavallong, aes(date, number, group=reportedornot, colour=reportedornot)) +  
 geom\_line() + geom\_smooth() +  
 ggtitle("Predicted vs. Reported daily deaths per million (19/JUN/2020 to 07/OCT/2020)") +  
 xlab("Date") + ylab("Daily deaths per million") + xlab(" ") + ylab(" ") +   
 theme(legend.title=element\_blank()) + xlab(" ") +   
 theme(axis.text.x=element\_text(colour="black")) +  
 theme(axis.text.y=element\_text(colour="black")) + facet\_wrap(.~Country.Region)

## `geom\_smooth()` using method = 'loess' and formula 'y ~ x'

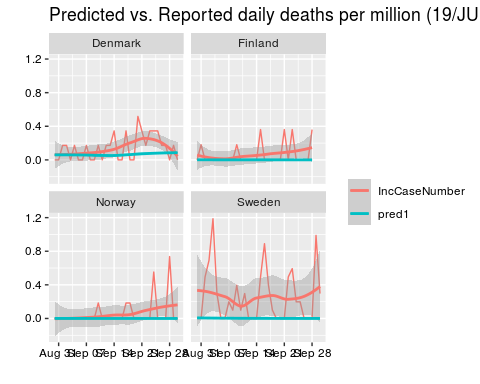


datavallong<-gather(dataval, reportedornot, number, c(23,10))

## Warning: attributes are not identical across measure variables;  
## they will be dropped

ggplot(datavallong, aes(date, number, group=reportedornot, colour=reportedornot)) +  
 geom\_line() + geom\_smooth() +  
 ggtitle("Predicted vs. Reported daily deaths per million (19/JUN/2020 to 07/OCT/2020)") +  
 xlab("Date") + ylab("Daily deaths per million") + xlab(" ") + ylab(" ") +   
 theme(legend.title=element\_blank()) + xlab(" ") +   
 theme(axis.text.x=element\_text(colour="black")) +  
 theme(axis.text.y=element\_text(colour="black")) + facet\_wrap(.~Country.Region)

## `geom\_smooth()` using method = 'loess' and formula 'y ~ x'

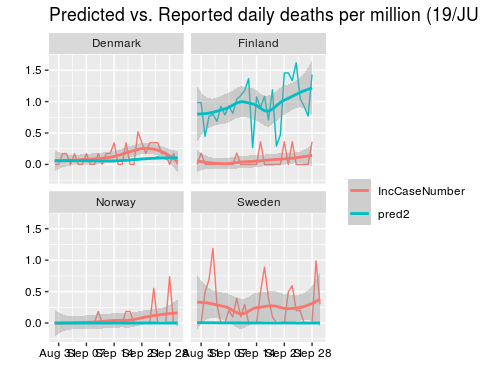


datavallong<-gather(dataval, reportedornot, number, c(24,10))

## Warning: attributes are not identical across measure variables;  
## they will be dropped

ggplot(datavallong, aes(date, number, group=reportedornot, colour=reportedornot)) +  
 geom\_line() + geom\_smooth() +  
 ggtitle("Predicted vs. Reported daily deaths per million (19/JUN/2020 to 07/OCT/2020)") +  
 xlab("Date") + ylab("Daily deaths per million") + xlab(" ") + ylab(" ") +   
 theme(legend.title=element\_blank()) + xlab(" ") +   
 theme(axis.text.x=element\_text(colour="black")) +  
 theme(axis.text.y=element\_text(colour="black")) + facet\_wrap(.~Country.Region)

## `geom\_smooth()` using method = 'loess' and formula 'y ~ x'



datavallong<-gather(dataval, reportedornot, number, c(25,10))

## Warning: attributes are not identical across measure variables;  
## they will be dropped

ggplot(datavallong, aes(date, number, group=reportedornot, colour=reportedornot)) +  
 geom\_line() + geom\_smooth() +  
 ggtitle("Predicted vs. Reported daily deaths per million (19/JUN/2020 to 07/OCT/2020)") +  
 xlab("Date") + ylab("Daily deaths per million") + xlab(" ") + ylab(" ") +   
 theme(legend.title=element\_blank()) + xlab(" ") +   
 theme(axis.text.x=element\_text(colour="black")) +  
 theme(axis.text.y=element\_text(colour="black")) + facet\_wrap(.~Country.Region)

## `geom\_smooth()` using method = 'loess' and formula 'y ~ x'

