ST565: Time Series HW2

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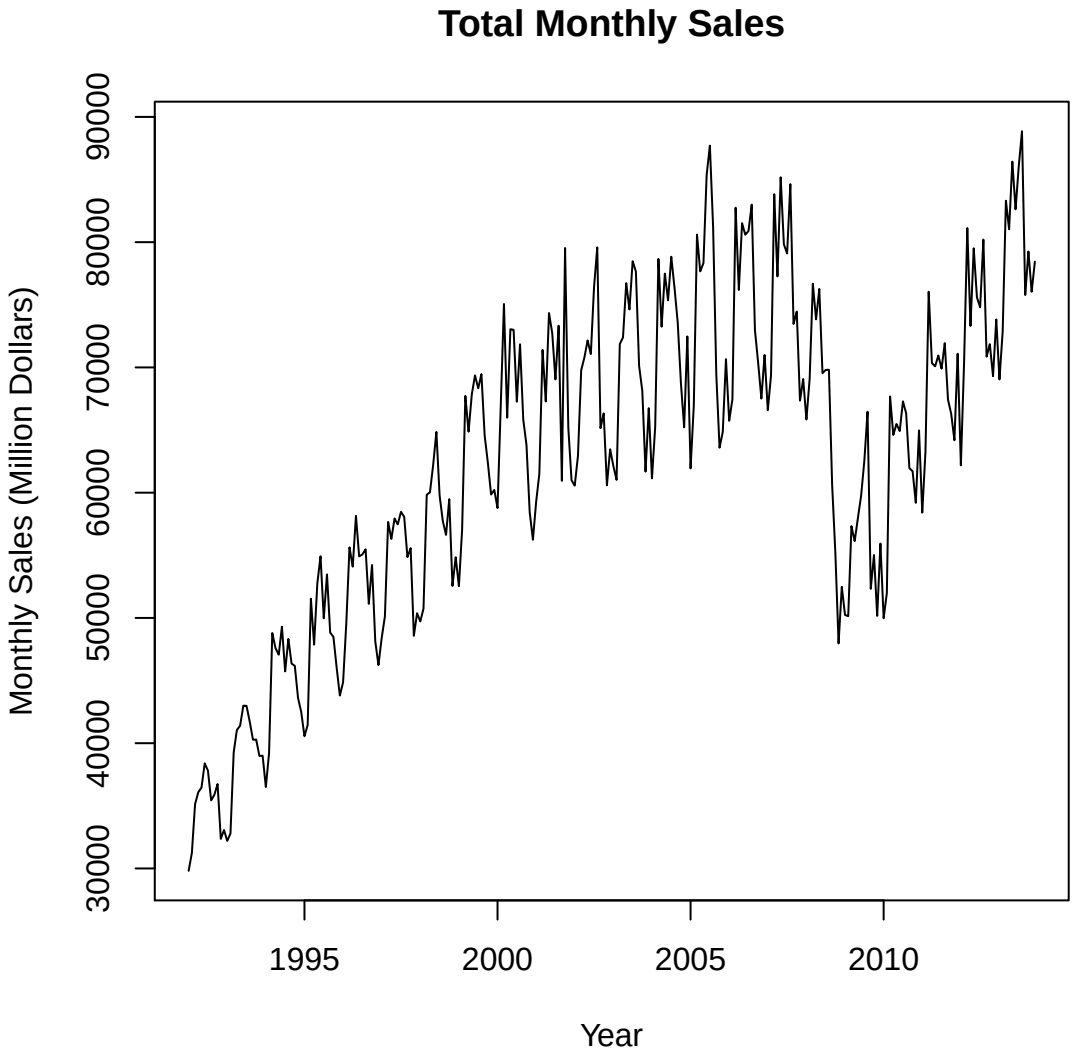
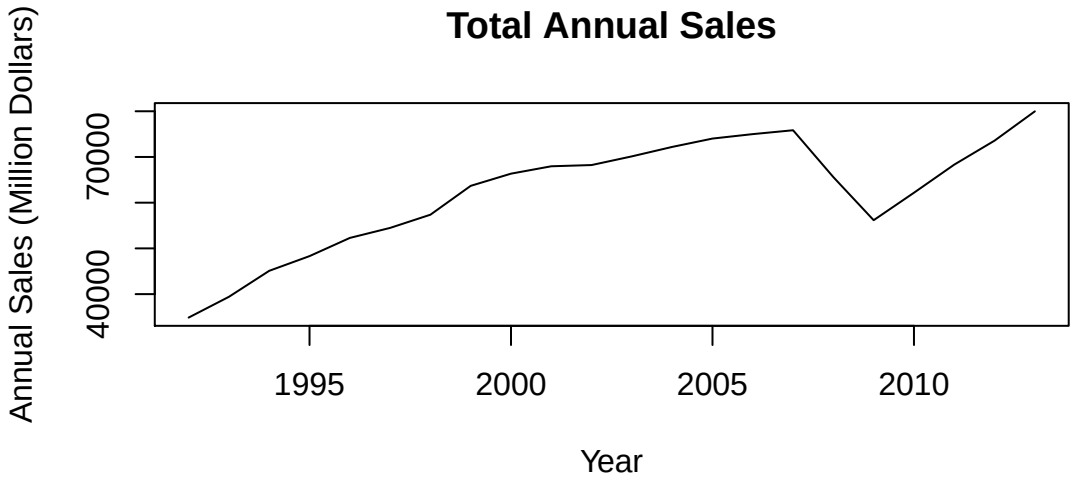
Introduction

The United States Census Bureau collects and provides data on US retail sales through the Monthly Retail Trade Surveys. For this homework we analyse the estimates of the total monthly sales for motor vehicle and parts dealers in the USA from 1992 to 2014.

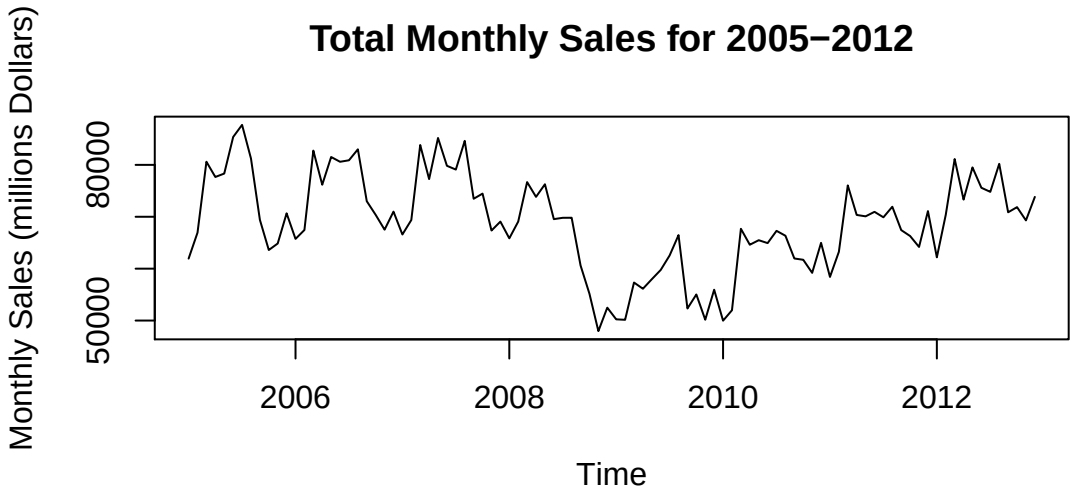
The following plot shows the monthly total sales for motor vehicles and parts dealers in the USA from 1992 to the end of 2013. We can see an upward trend from 1992 to 2007, followed by a sharp decrease in 2008, which picks back up again in 2009. The plot also shows a seasonality which seems to be yearly.



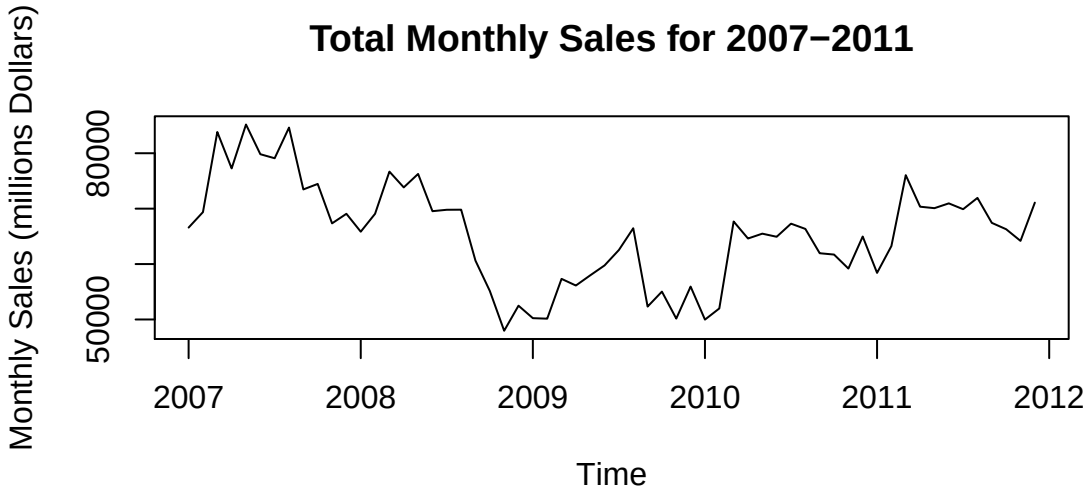
The following plot shows total annual sales, aggregated for years 1992-2014. The sharp decrease around 2008 is easier to see in this aggregated plot.



If we zoom in, to explore the period leading up to and including 2008, as in the following plots, we see how the year 2008 experienced the sharp fall of motor vehicle and parts in the US.



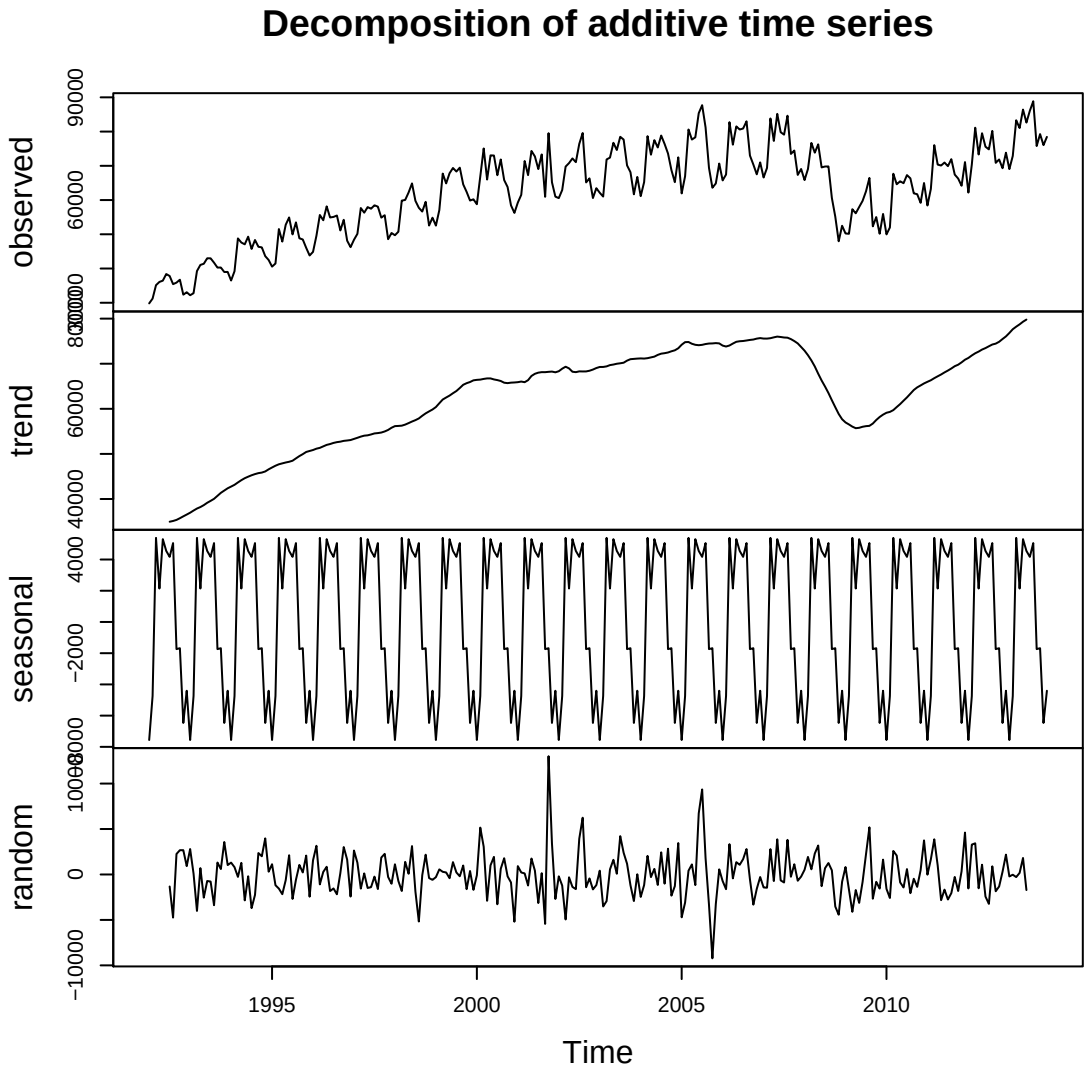
Zooming further in:



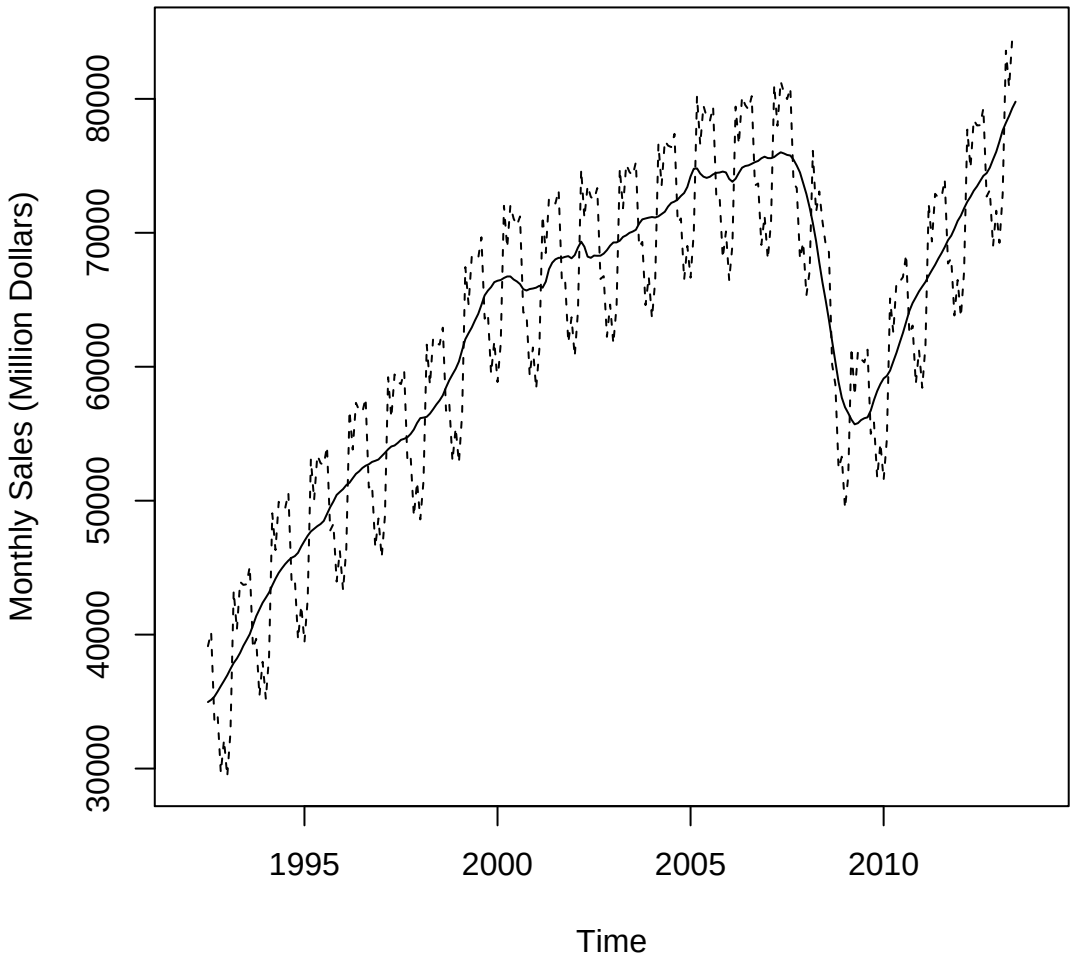
Looking at the actual values might help. We can compare the figures from 2006, which seems to be a typical year leading to the crash of 2008.

Decomposition: Trend, Seasonality

The following plot shows the original time series, the trend, the seasonality, and the residual noise.

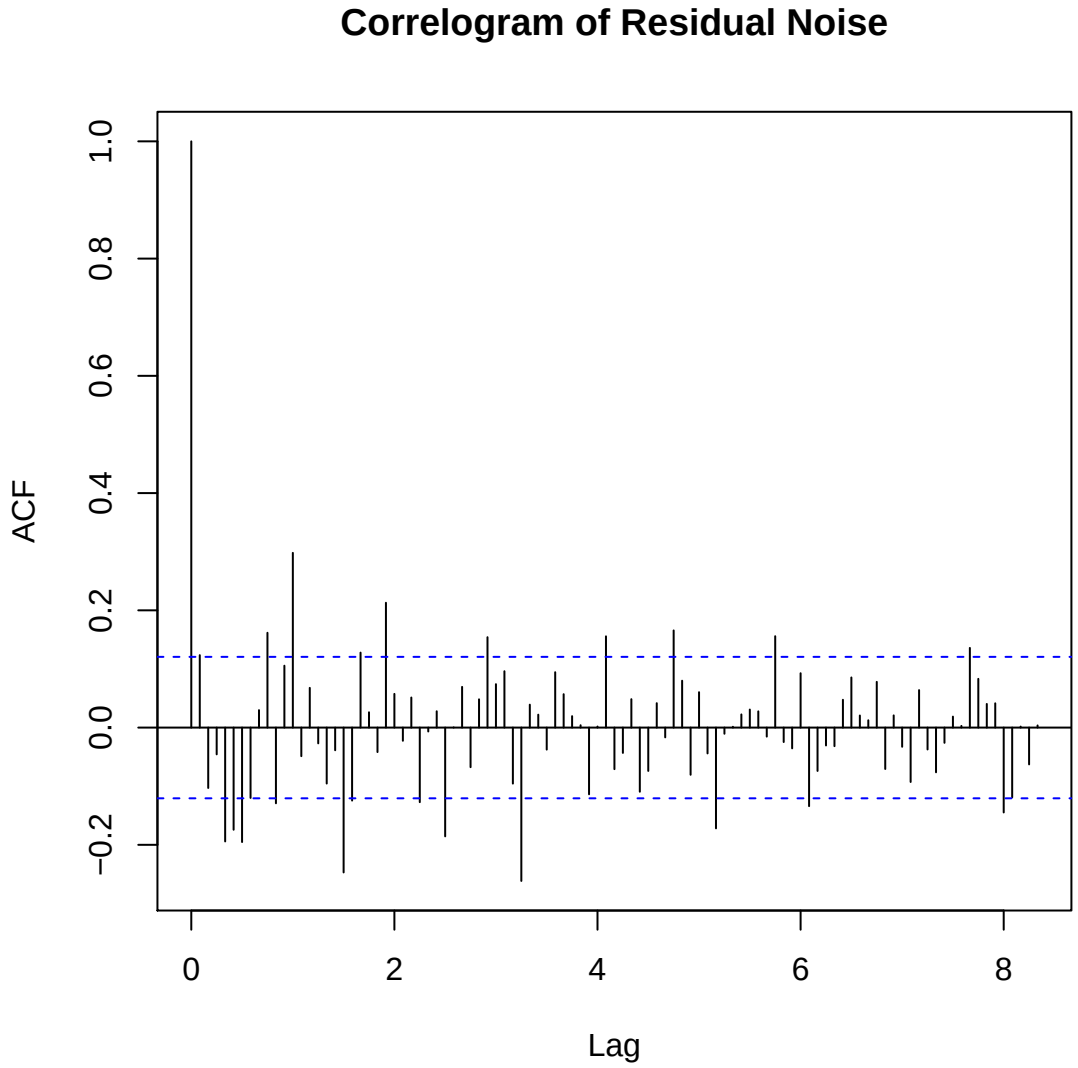


The superimposed Trend + Seasonality plot shows how trend and seasonality look with the noise removed.

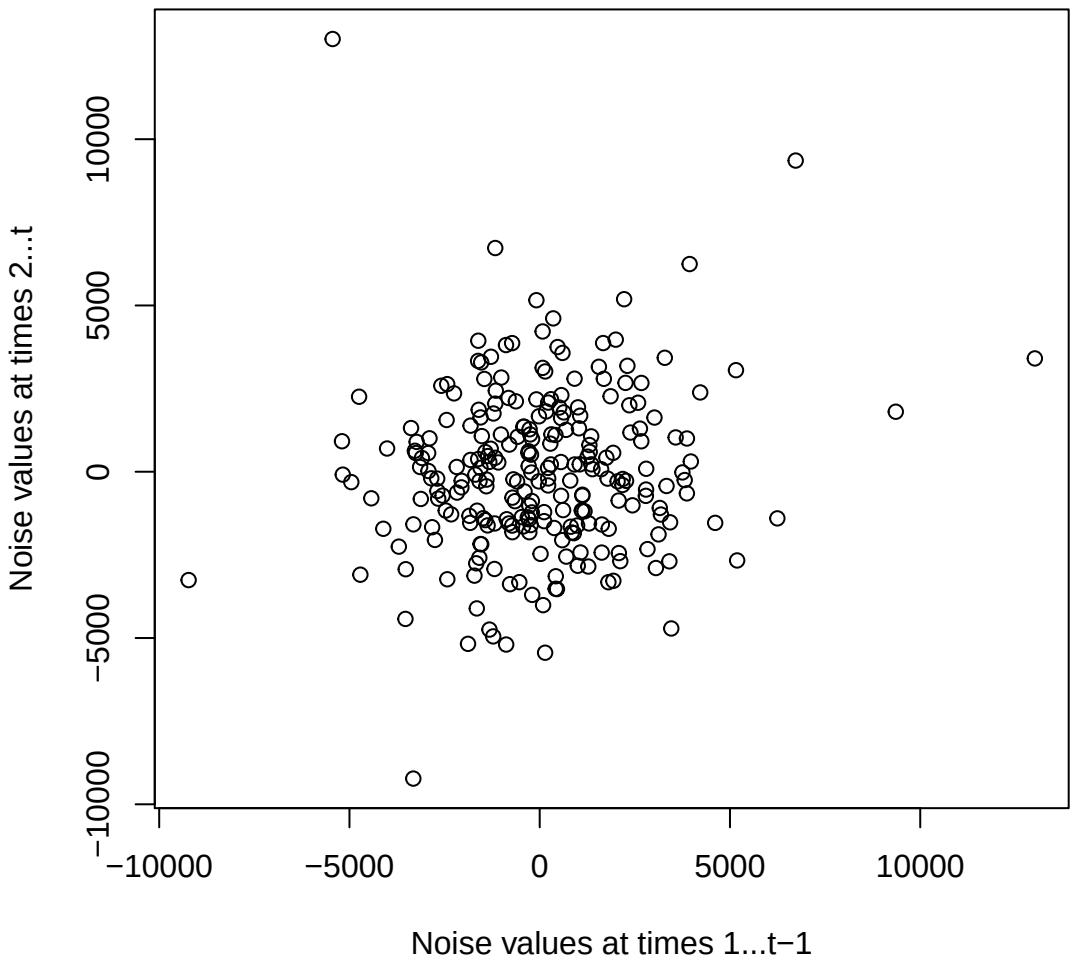


Residual Noise

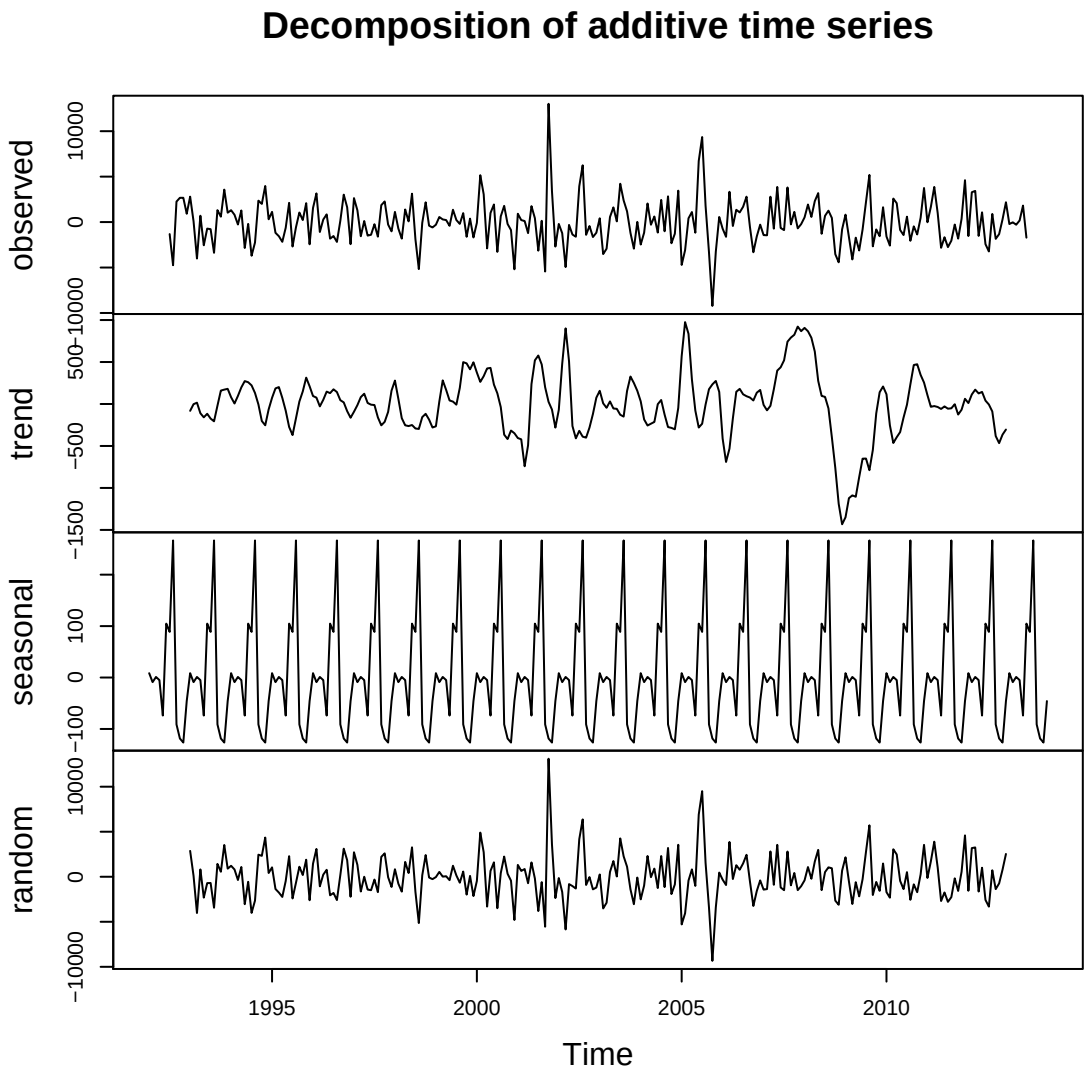
The following plot shows the correlogram of residual noise, which shows a weakly stationary process.



We can also look at the autocorrelation for lag 1 top check for correlations:



Out of curiosity, I decomposed the residual noise, looking for a trend and seasonality, and interestingly, the trend in the noise, follows a similar pattern as the trend in the signal. Even though, with the trend and seasonality removed from the residual noise, the residual noise OF the residual noise, is identical to the residual noise. (:-?)



In summary, it's visible that in 2008, the motor vehicle and parts dealers in the USA experienced a shock to their sales. I assume this can be attributed to the 2008 financial crisis.

Appendix

```
knitr::opts_chunk$set(echo=FALSE, message = FALSE,
  warning = FALSE, results = "hide", fig.height = 3, fig.width = 6)
library(plyr)
library(lubridate)
options(stringsAsFactors = FALSE)

# import data
load(url("http://stat565.cwick.co.nz/data/sales.rda"))
# class(sales)
head(sales)
# tail(sales)
# sales <- sales %>% select(value)
# sales <- sales$value
```

```r
# Convert to a Time Series object
sales.month.ts <- ts(sales$value, start = c(1992, 1), freq = 12)
sales.month.ts
plot(sales.month.ts, ylab = "Monthly Sales (Million Dollars)", xlab = "Year", main = "Total Monthly Sale
# create an annual aggregate object
sales.annual.ts <- aggregate(sales.month.ts)/12
sales.month.aggregated.ts <- aggregate(sales.month.ts)
# head(sales.annual.ts)
# plot(sales.annual.ts)
# layout(1:1)
# plot(sales.month.ts, ylab = "Monthly Sales (Million Dollars)", xlab = "Year", main = "Total Monthly S
plot(sales.annual.ts, ylab = "Annual Sales (Million Dollars)", xlab = "Year", main = "Total Annual Sales
# explore the dip, zoom in to see better resolution
plot(window(sales.month.ts, start=c(2005, 1), end=c(2012, 12)), ylab = "Monthly Sales (millions Dollars)
plot(window(sales.month.ts, start=c(2007, 1), end=c(2011, 12)), ylab = "Monthly Sales (millions Dollars)

# plot(window(sales.month.ts, start=c(2007, 1), end=c(2008, 12)), ylab = "Monthly Sales (millions Dolla
sales.1992to2007 <- window(sales.month.ts, start=c(1992, 1), end=c(2007, 12))
sales.2008 <- window(sales.month.ts, start=c(2008, 1), end=c(2008, 12))
sales.2009to2013 <- window(sales.month.ts, start=c(2009, 1), end=c(2013, 12))

sales.2006 <- window(sales.month.ts, start=c(2006, 1), end=c(2006, 12))
sales.2006
sales.2008

# plot(sales.1992to2007, ylab = "Monthly Sales (millions Dollars)", main = "Total Monthly Sales for 199
# plot(sales.2009to2013, ylab = "Monthly Sales (millions Dollars)", main = "Total Monthly Sales for 200
# layout(1:2)
# plot(sales.2006, ylab = "Monthly Sales (millions Dollars)", main = "Total Monthly Sales for 2006", co
# plot(sales.2008, ylab = "Monthly Sales (millions Dollars)", main = "Total Monthly Sales for 2008", co
# plot(decompose(sales.month.ts))
# plot(decompose(sales.month.ts, type = "add"))
# plot(decompose(sales.month.ts, type = "mult"))
layout(1:1)
sales.month.ts.decomposed <- decompose(sales.month.ts, type = "add")
Trend <- sales.month.ts.decomposed$trend
Seasonal <- sales.month.ts.decomposed$seasonal
Noise <- sales.month.ts.decomposed$random
plot(sales.month.ts.decomposed)
# str(sales.month.ts.decomposed)
ts.plot(cbind(Trend, Trend + Seasonal), lty = 1:2, main = "Superimposed Trend + Seasonality", ylab = "M
# correlogram
acf(Noise, na.action = na.pass, lag.max = 100, main = "Correlogram of Residual Noise")
# acf(Noise, na.action = na.pass)$acf[1:10]
# scatterplot of each autocorrelation for lag 1
# length(Noise)
plot(Noise[1:length(Noise)-1], Noise[2:length(Noise)], xlab = "Noise values at times 1...t-1", ylab = "

# get autocovariances
# acf(Noise,type = c("covariance"), na.action = na.pass)$acf[2]
# let's decompose the noise to see if there's any trends
Noise.decomposed <- decompose(Noise)
plot(Noise.decomposed)
```