Difference in Difference_Rating

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```
rm(list = ls()) # Clear the workspace
x <- paste("C:/Users/User/Desktop/UW-Madison/Courses/BUS 740 - Experiments and Causal Methods for Busine
           "Assignment/Homework 5_Difference in Difference", sep="")
setwd(x)
```

Import the dataset and name it as data.rating

```
data.rating <- read.csv("RatingData.csv")
summary(data.rating)
```

```
##        id              month           rating          treat
##  Min.   :    75   Min.   : 1.00   Min.   :1.000   Min.   :0.0000
##  1st Qu.:  4224   1st Qu.: 7.00   1st Qu.:3.000   1st Qu.:0.0000
##  Median : 16821   Median :14.00   Median :4.000   Median :0.0000
##  Mean   : 29071   Mean   :13.39   Mean   :3.742   Mean   :0.2341
##  3rd Qu.: 47383   3rd Qu.:20.00   3rd Qu.:5.000   3rd Qu.:0.0000
##  Max.   :104668   Max.   :24.00   Max.   :5.000   Max.   :1.0000
```

From the summary statistics, we can see that month ranges from 1 through 24. The size of the treatment (Trip Advisor) group in which restaurants were scored on multi-attribute rating is around 23%.

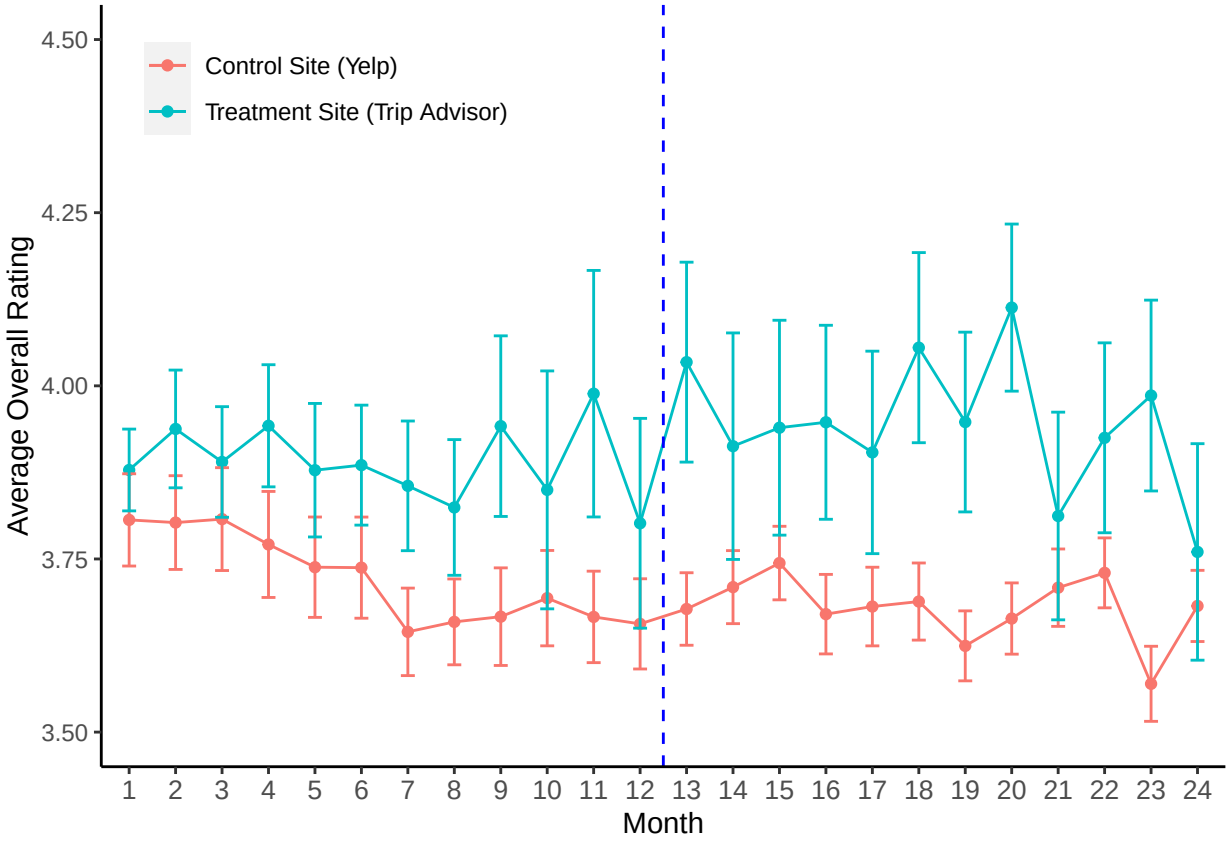
Plot the Average Overall Rating with CIs for All Months

We start by creating a graph of the average overall rating in each restaurant by month (averaged across the restaurants in Trip Advisor and Yelp).

```
library(dplyr)
summary <- data.rating %>%
  mutate(treat = as.factor(treat)) %>%
  mutate(month = as.factor(month)) %>%
  group_by(treat,month) %>%  # group the data by treat and month
  summarise (n = length(id),
             m.rating= mean(rating),
             error = sd(rating)/sqrt(n),
             lci = m.rating - 1.96*error,
             uci = m.rating + 1.96*error)
#print(summary)

library(ggplot2)
summary %>%
```

```
ggplot(aes(x=month, y = m.rating, group = treat, color = treat)) +
# here we declare what's the horizontal and vertical vars for the plot
# and what variable we want to group by
geom_point()+ # add the dots to the plot
geom_line()+  # connect the dots
geom_vline(xintercept=12.5, linetype="dashed", color = "blue")+
# add a dash line to indicate the change time.
geom_errorbar(aes(ymin = lci, ymax = uci,
                  color=treat), width= 0.3)+
scale_y_continuous(limits = c(3.5,4.5)) + # define the range of y-axis
ylab("Average Overall Rating") +
xlab("Month") +
theme(panel.grid.major = element_blank(), panel.grid.minor = element_blank(),
      panel.background = element_blank(),axis.line = element_line(colour = "black"),
      axis.text.x= element_text(size = 10), legend.position = c(0.2,0.9),
      plot.title=element_text(hjust=.5) ) +
scale_color_discrete(name=NULL, labels = c("Control Site (Yelp)", "Treatment Site (Trip Advisor)"))
```



The "parallel trends" assumption between Trip Advisor ratings and Yelp ratings seems valid in this case. In the graph, the Trip Advisor average rating in the pre-change period was higher than the Yelp average rating in the pre-change period. We know that this was not a randomized assignment to multi-dimensional rating treatment. However, Trip Advisor ratings and Yelp ratings show quite similar pre-treatment trends. They both show a small decline trend from month 1 through month 7, and small bump(s) across month 8 to month 12. Although the trends are not completely equivalent, at least no clear evidence shows that Yelp doesn't give us a reasonable counterfactual for the Trip Advisor patterns. Given that the pre-treatment trends are roughly parallel between Trip Advisor ratings and Yelp ratings, it gives us some level of confidence that the

post-treatment trends would have evolved similarly without the treatment.

In the graph, we can also see that there is no or just minor discernible effect of the treatment at Trip Advisor. After the month 8, Trip Advisor ratings are quite volatile. It doesn't seem that there is an abrupt change after month 12, but it shows that the post-treatment variation of Trip Advisor ratings is larger than the pre-treatment variation.

Regression Analysis

Now we can use regression analysis to quantify the average differences we are seeing in the graph above.

We begin by creating a few variables we need for the regression.

```
#generate a dummy variable named post to indicate
#if this observation is recorded after the change month or not
data.rating$post = ifelse(data.rating$month>12,1,0)

#generate a dummy variable named post_treat to indicate
#if this observation is in the treatment region AND recorded after the change month
#Since the variable treat is a 0/1 indicator, multiplying
#these two variables is also a 0/1 indicator.
data.rating$post_treat = data.rating$post*data.rating$treat
```

Now we run a regression of the ratings on indicators for being in the multivariate rating system (treatment), indicator for observations after the change month, and the indicator for the interaction between the treatment and post-change period.

```
library(jtools)
fit.rating = lm(rating~treat+post+post_treat, data = data.rating)
summ(fit.rating, robust = "HC1", confint = TRUE, digits = 3)
```

```
## MODEL INFO:
## Observations: 38004
## Dependent Variable: rating
## Type: OLS linear regression
##
## MODEL FIT:
## F(3,38000) = 97.734, p = 0.000
## R² = 0.008
## Adj. R² = 0.008
##
## Standard errors: Robust, type = HC1
## ------------------------------------------------------------
##                       Est.     2.5%    97.5%    t val.       p
## ----------------- -------- -------- -------- --------- -------
## (Intercept)          3.714    3.694    3.734   367.218   0.000
## treat                0.173    0.139    0.207     9.977   0.000
## post                -0.036   -0.061   -0.011    -2.832   0.005
## post_treat           0.095    0.039    0.151     3.344   0.001
## ------------------------------------------------------------
```

As the estimated coefficient of 0.095 of the "post_treat" term represents the estimate of the treatment effect from the difference-in-difference approach, I would conclude that switching to the multivariate rating

system increases average overall ratings at Trip Advisor by 0.095, and the interval (0.039, 0.151) has 95% chance of containing the true treatment effect on average overall ratings at Trip Advisor. Thus, the effect of multivariate rating system on average overall ratings is statistically positive significant at the 95% confidence level, although we're unsure whether it really has big business significance.