THE MOTHERHOOD WAGE PENALTY

Problem Statement:

Does having children can make women earn less? It is a well-known empirical phenomena that women who do not have children are paid more on average than women who have children as Mothers in the workforce experience additional disadvantage compared to women who are not mothers, including a per-child wage penalty. We will be using the data to investigate the wage penalty size that a mother faces in the USA, we will investigate whether the differences observed represent the casual effect of motherhood and will try to consider the degree to which these differences have changed over time.

Null Hypothesis: there is no significance difference in the mean wages of women with or without children.

Alternative Hypothesis: there is a significance difference in the mean wages of women with or without children.

Data Source:

The data is taken to estimate the effects of having children on the young women wages. It is taken from the national longitudinal survey of youth. The data has been downloaded from the PUBL0055 webpage.

Each observation in the data (N= 2479) represents women (all age between 19 and 30) and the names and description of the variables is included in the data table

Name of the variable	Description of the variable
PUBID	ID of women
Wage	Hourly wage, In dollars
numChilren	Number of children the women has
Age	Age, in years
Educ	Level of education 1. Less than HS 2. High school 3. Some college 4. College
Experience	Relevant experience in months
Tenure	Current job tenure, in years
Marstat	Marital status 1. Cohabitting 2. Married 3. No romantic union
Fulltime	Employment status 1. Full time = TRUE 2. Part- time = FALSE
Y2009	Year of observation 1. 2009 = 1 2. 2004 = 0

Data Preparation for visualisation:

Our first step after importing the data was to look for missing values in our data. We came across a fact that experience column had largest number of missing values. It was not suitable to remove such a large number of observations. So we tried to fill them using mean experience. However after imputing tye missing values for experience we still had some missing values which we thought would be best to remove instead of imputing as the are almost negligible proportion. After cleaning our data we went for preliminary analysis; that includes looking into our data and checking what the variables are and what would be the best modelling technique;

Basically the steps could be counted as EDA or exploratory data analysis.

```r
# libraries
library(knitr)
library(dplyr)
library(ggplot2)

# Importing the data
motherhood <- read.csv("CSVData.csv")

# Taking care of missing data
motherhood %>%  summarise_all((funs(sum(is.na(.)))))

# here it can be seen that experience have largest number of missing values.
# It is not suitable to remove such a large number of observations. So lets try to fill them
motherhood$experience = ifelse(is.na(motherhood$experience),
                               ave(motherhood$experience,
                                   FUN = function(x) mean(x, na.rm = TRUE)),
                               motherhood$experience)

#after filling the column we have less missing values; lets just ignore them;
motherhood = motherhood[complete.cases(motherhood),]
sum(is.na(motherhood))
```

```r
## Working and understanding our dataset
kable(prop.table(table( motherhood$numChildren)),
      caption = "Proportion of women with different number of children",
      col.names = c("No. of children","Proportion of women"))
# """We can see that in this dataset around 57% of women have no children,
# 22% women have one child, 14% have 2 children and only 6% women have more than 2 children.


##Now lets creating a new variable which will define if the women is a mother or not,
#irrespective of the no. of children.
motherhood$isMother <- ifelse(motherhood$numChildren>0,1,0)
kable(prop.table(table( motherhood$isMother)),
      caption = "Proportion of women having atleast one child",
      col.names = c("Child(Yes-1/No-0)","Proportion of women"))
# """As it can be clearly seen in the table that 57% women have no children,
# while 43% women have atleast one child"""


# Now lets look at the proportion of women with or without children working full time.
kable(prop.table(table( motherhood$isMother,motherhood$fullTime)),
      caption = "Proportion of women with/wiithout children working full time",
      col.names = c("Women not working full time","Women working full time"))
# Here, we can see that 37% of women without children work full time however only
# 28% of women work full time when they are mothers.
```

```r
# Scatterplots
a <- ggplot(motherhood,aes(experience,wage))+geom_point()+
  labs( x = "Experience", y = "Wages",title ="Experience and wage plot")
a
#In the plot above it can be seen that as the level of experience increases the wages increases.

boxplot(wage ~ isMother, data = motherhood, xlab = "Is woman a mother?",
        ylab = "Wages", main = "Boxplot showing wages of women with or without children",
        col = c("green","red"),   names = c("No","Yes"))
#Here, it can be easily interpreted from this boxplot that mean wages are almost same
#even if the woman is a mother,
#However the maximum wages of women without children are much higher than those with a child
```

Graphs and tables:

Table: Proportion of women with different number of children

No. of children	Proportion of women
0	0.5754213
1	0.2227702
2	0.1381011
3	0.0497328
4	0.0115084
5	0.0016441
6	0.0004110
7	0.0004110

We can see that in this dataset around 57% of the women have exactly no child, 22% women in our data have only one child while 14% have 2 children and only 6% women have more than 2 children.

Table: Proportion of women having atleast one child

Child(Yes-1/No-0)	Proportion of women
0	0.5754213
1	0.4245787

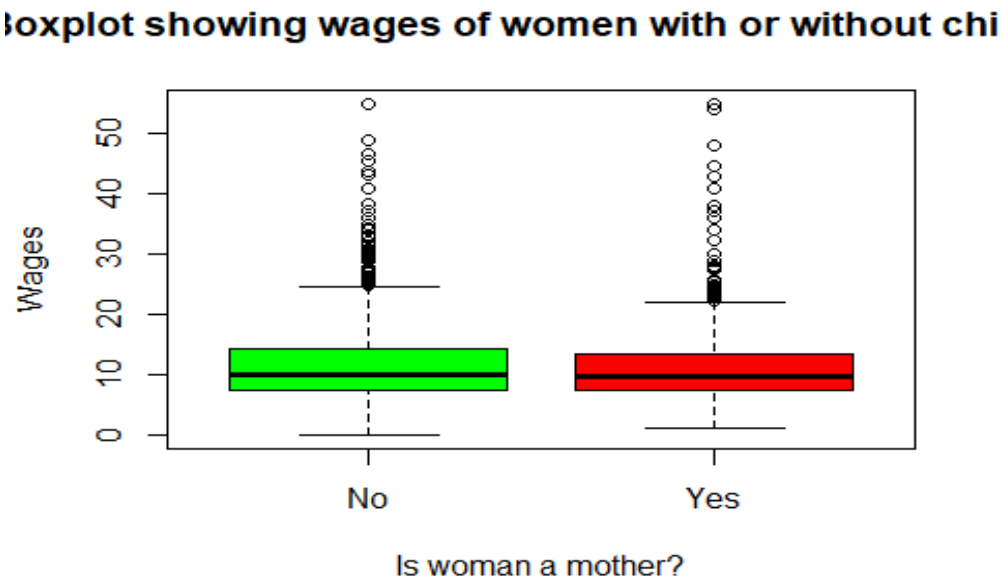
As it can be clearly seen in the table that 57% women have exactly no children, while 43% of the women in our data have at least one child.

Table: Proportion of women with/wiithout children working full time

	Women not working full time	Women working full time
0	0.2083847	0.3670366
1	0.1430333	0.2815454

Here, we can see that 37% of the women who do not have any children work full time whereas only 28% are seen working full time when they are mothers.

In the plot above it can be seen that as the level of experience increases the wages increases.



Here, it can be easily interpreted from this boxplot that mean wages are almost same even if the woman is a mother, However the maximum wages of women without children are much higher than those with a child.

Analysis:

After our preliminary analysis we came to the t-test to see if our null hypothesis is to be accepted or rejected. And after checking for the effect of motherhood on wages and getting that if it is clearly a case or not the case whether a woman who have children completely determines her wage level after that we will investigate the other relationships i.e. to see if the motherhood wage penalty has changed overtime?

```
70  ## Calculating the difference in mean wages between women with and without children.
71  t.test( motherhood$wage~motherhood$isMother , var.equal = TRUE)
81  #the data we are using includes information from two surveys
82  # one is 2004 an another is in 2009.
83  # lets see 5he degree to which motherhood wage penalty has changed overtime.
84  model1 <- lm(wage ~ isMother+y2009+experience, data = motherhood)
85  summary(model1)
86
87  model2 <- lm(wage ~ isMother+y2009+(isMother*y2009)+experience, data = motherhood)
88  summary(model2)
89
```

```
        Two Sample t-test

data:  motherhood$wage by motherhood$isMother
t = 1.9578, df = 2431, p-value = 0.05037
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -0.0008256733  1.0227236128
sample estimates:
mean in group 0 mean in group 1
       11.81057        11.29962
```

If the p-value is inferior or equal to the significance level 0.05, we can reject the null hypothesis and accept the alternative hypothesis. In other words, we can conclude that the mean values of group A and B are significantly different. So, here we came to the conclusion that it is clearly a case where a women with children earn less than a women who does not have children. Thus we reject our null hypothesis.

```
> summary(model1)

Call:
lm(formula = wage ~ isMother + y2009 + experience, data = motherhood)

Residuals:
    Min      1Q  Median      3Q     Max
-14.993  -3.185  -0.840   1.824  39.566

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  6.81566    0.29597  23.029  < 2e-16 ***
isMother    -1.40906    0.23597  -5.971  2.7e-09 ***
y2009        2.97147    0.30299   9.807  < 2e-16 ***
experience   0.35924    0.03018  11.905  < 2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 5.651 on 2429 degrees of freedom
Multiple R-squared:  0.2133,    Adjusted R-squared:  0.2123
F-statistic: 219.5 on 3 and 2429 DF,  p-value: < 2.2e-16
```

```
> summary(model2)

Call:
lm(formula = wage ~ isMother + y2009 + (isMother * y2009) + experience,
    data = motherhood)

Residuals:
    Min      1Q  Median      3Q     Max
-14.643  -2.975  -0.796   1.877  39.736

Coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept)    6.43855    0.30471  21.130  < 2e-16 ***
isMother      -0.21525    0.34036  -0.632    0.527
y2009          3.94868    0.36279  10.884  < 2e-16 ***
experience     0.35646    0.03004  11.865  < 2e-16 ***
isMother:y2009 -2.27870    0.47016  -4.847 1.34e-06 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 5.625 on 2428 degrees of freedom
Multiple R-squared:  0.2208,    Adjusted R-squared:  0.2195
F-statistic:   172 on 4 and 2428 DF,  p-value: < 2.2e-16
```

Models have negative effect of motherhood on wages, i.e. if the woman becomes a mother than her wages decreases, However model 2 have more negative effect than model 1 but the variable is not significant for model2 but is significant for model1.

Coefficients Shows the regression beta coefficients and their statistical significance. Predictor variables, that are significantly associated to the outcome variable, are marked by stars.

Based on model 2 the model is:

wage = 6.43855 + (-0.21525)*(isMother) + (3.94868)*(y2009)+ (0.35646)*(experience) + (-2.27870)*(isMother:y2009),

Here are a few real time questions which we may want to look at:

1. Interviewed in 2004, A woman without children, with 10 months of relevant job experience.

```
wage1 = 6.43855 + (-0.21525)*0 + (3.94868)*0 + 0.35646*10 + (-2.27870)*(0)
wage1
```

```
## [1] 10.00315
```

Wage of woman interviewed in 2004 without children, with 10 months of relevant job experience is 10.00315

2. Interviewed in 2004, A woman with children, with 10 months of relevant job experience

```
wage2 = 6.43855 + (-0.21525)*1 + (3.94868)*0 + 0.35646*10 + (-2.27870)*(1*0)
wage2
```

```
## [1] 9.7879
```

Wage of a woman interviewed in 2004 with children and 10 months of relevant job experience is 9.7879

3. Interviewed in 2009, A woman without children, with 10 months of relevant job experience

```
wage3 = 6.43855 + (-0.21525)*0 + (3.94868)*1 + 0.35646*10 + (-2.27870)*(1*0)
wage3
```

```
## [1] 13.95183
```

Wage of a woman interviewed in 2009 without children and with a 10 months of relevant job experience is 13.95183.

4. Interviewed in 2009, A woman with children, with 10 months of relevant job experience

```
wage4 = 6.43855 + (-0.21525)*1 + (3.94868)*1 + 0.35646*10 + (-2.27870)*(1*1)
wage4
```

```
## [1] 11.45788
```

Wages of a woman interviewed in 2009 with children and a relevant 10 months job experience is 11.45788.

Consideration and evaluation of results:

Mothers have to suffer a penalty with respect to women who are not mothers. Women without children have more wages than women with children. Also it has been noticed that the size of motherhood penalty have changed overtime, wages have increased overtime irrespective of motherhood.

Conclusion

We came with the below conclusions in our analysis.

- We reject our null hypothesis and conclude that there is a significant difference in mean wage of mothers and non- mothers.
- The wages have increased overtime for all the women but the increase in wages of non-mothers is more than increase in wages of mothers.