**Onur TEKINER**

**SP23: STAT ANALYSIS FOR EFF DEC MAKING**

**FINAL POLICY MEMO**

## Introduction

According to the World Health Organization, fertility rates are highest in sub-Saharan Africa and South Asia. However, rates in the Middle Eastern and North African regions are also of concern, with some countries reporting rates as high as 80 births per 1,000 women aged 15-19 (World Health Organization, 2022). This policy memo investigates the relationships between fertility rates and economic and social variables in the Middle Eastern and North African regions. Fertility patterns may vary between countries and larger geographic regions for various reasons, including cultural norms, levels of economic development, education systems, and government policies that encourage or discourage family planning (The Future of World Religions, Pg 2, 2015). While many factors are related to fertility rates, the World Bank data shows that the Middle Eastern and North African regions have witnessed plummeting birth rates, from 6.2 in 1980 to 2.7 in 2020 (Sara-Al Mura November 2022). Dr. Golnar Mehrah found that girls' primary school completion rates have increased significantly in the Middle East and North Africa (MENA) since 1985 (Dr. Mehrah,1995), though the reason for this change has yet to be determined.

Many sources say educated women refuse to give birth to children before they are ready. Abbasi-Shavazi and Torabi (2012) claimed that a decline in fertility rates in Middle Eastern and North African countries had been directly linked to women obtaining education. The principal objective of this project is to learn and understand the relationship between these variables.

## Background

Previous research about this subject shows a negative association between female education and fertility rate. According to the National Center for Biotechnology website, the average number of births in Egypt decreases with educational achievement. The NCB report also shows that, on average, women with no education have 3.51 births in their lifetime. In comparison, women with primary education have 3.21 births, women with secondary education have 2.84 births, and women with higher education have 2.67 births in their lifetime. According to this statistic, lower fertility rates occur with higher education levels. Although the average number of births is nearly three per woman, they often have anywhere from 0 to 11 births each (SSM Popul Health. Dec 9, 2019).

There are also other concerns, including child marriage and health issues. Early marriages often lead to limited schooling, increased fertility rate, and poverty (Rand Lateef, 2021); in pre-war Syria, 15% of women between the ages of 20 and 25 were wed before they were 18 years old. Also under investigation is how fertility rates vary in countries depending on their proximity to Europe. For example, Malta is one of the non-Islamic

countries in the North Africa region. According to the Macrotrends data, Malta's fertility rate is 1.4 in 2020. In the meantime, the fertility rate in Libya, which closely neighbors Malta, is 2.3. Both countries are in the same region but have different fertility rates. These variations due to location are of special interest and, therefore, will be more heavily researched in the continuation of this project.

## Research Questions

I collected the data from World Bank, and I want to learn about:

1. What kind of relationship exists between women's education versus female fertility rate?
2. Can a country's female employment level reduce the female fertility rate?
3. Has the marriage indicator score improved over the years, and is there any relationship with the fertility rate?
4. When women have more rights in marriage, the workplace, and society, is it related to the fertility rate?
5. Do non-Muslim countries from the MENA show a significantly different fertility rate pattern than Muslim countries?
6. What are the coefficients of all significant independent variables for the predicted fertility rate in the regression model?

## Data Description

This data is from https://www.worldbank.org/en/home. The World Bank is an international financial institution that provides loans and grants to the governments of low- and middle-income countries to pursue capital projects. In this dataset, I will research how education, workplace environment and marriage life's relationship with women's fertility rates.

This data represents the time between 2003 to 2020. There are 230 observations and a total of 14 variables. There are 20 different countries in the Middle East and North Africa. My variables are:

- **Years:** Between 2003-2020
- **Country:** 20 different countries in the Middle East and North Africa
- **School enrollment, secondary, female (% gross)**
- **A woman can get a job in the same way as a man** (0: No, 1: Yes)
- **Employment to population ratio, 15+, female** (%)
- **The law mandates equal remuneration for females and males for work of equal value** (0: No, 1: Yes)
- **A woman can be head of household in the same way as a man** (0: No, 1: Yes)
- **A woman can obtain a judgment of divorce in the same way as a man** (0: No, 1: Yes)
- **A woman has the same rights to remarry as a man** (0: No, 1: Yes)

- **The law is free of legal provisions that require a married woman to obey her husband** (0: No, 1: Yes)
- **Marriage indicator score: which assesses legal constraints related to marriage, obedience, divorce, and domestic violence. A higher score means higher freedom for women in their social and economic life.** (0-100)
- **Fertility rate, total** (births per woman)
- **There is legislation on sexual harassment in employment** (0: No, 1: Yes)
- **Islamic countries** (0: No, 1: Yes): re-coded from countries in most people are Muslim. I will use this variable in my hypothesis test.

## Analysis and Results

### Descriptive Statistic

In 2003, the mean was 3.19 and the median was 2.90 in the fertility rate variable. The highest frequency of fertility rate is between 2 and 3 childbirths. However, some countries, such as West Bank Gaza and Yemen, are between 5 and 6 total childbirths. The standard deviation of the fertility rate is 1.14. The lowest fertility rate is 1.48, belongs to Malta, and the highest fertility rate is 5.81 belongs to Yemen Republic.

The mean secondary school enrollment for females was 78%, the mean of fertility rate was 3.19 children and 15 and older female employment ratio to the population was 22%.

Another variable is the marriage indicator score (0-100), which assesses legal constraints related to marriage, obedience, divorce, and domestic violence. A higher score means higher freedom for women in their social and economic life. The mean of marriage indicator score is 14.12.

The mean of categorical variables is (0=No, 1=Yes);

- A woman can get a job in the same way as a man variable is 0.47,
- The law mandates equal remuneration for females and males for work of equal value is 0.17
- A woman can be head of household in the same way as a man is 0.29
- A woman can obtain a judgment of divorce in the same way as a man is 0.05
- A woman has the same rights to remarry as a man is 0
- The law is free of legal provisions that require a married woman to obey her husband is 0.29
- There is legislation on sexual harassment in employment is 0.17

However, in 2020, the mean fertility rate decreased by 33% to 2.39. The median is 2.5, and the standard deviation is 0.75. The frequency of fertility rate is mostly between 2.5 and 3 childbirths. The maximum fertility rate in West Bank Gaza was around 3.5 children, and the minimum fertility rate did not change. It is still Malta but decreased to 1.13 from 1.48 total fertility rate.

School enrollment increased to 91.97%. The marriage indicator score also has a similar pattern. Our score increased from 14.11 to 42 from 2003 to 2020. Fifteen years and older female employment ratio to population increased to 27% from 5%.

The mean of my other categorical variables is (0=No, 1=Yes);

- A woman can get a job in the same way as a man variable increased from 0.47 to 0.7,
- The law mandates equal remuneration for females and males for work of equal value increased from 0.17 to 0.70,
- A woman can be head of household in the same way as a man increased from 0.29 to 0.6,
- A woman can obtain a judgment of divorce in the same way as a man increased from 0.05 to 0.1
- A woman has the same rights to remarry as a man increased from 0 to 0.1
- The law is free of legal provisions that require a married woman to obey her husband increased from 0.29 to 0.6
- There is legislation on sexual harassment in employment increased from 0.17 to 0.7

Every single variable in our dataset in the MENA region shows that women's economic, educational, and social freedom improved between 2003 and 2020. The mean fertility rate also decreased from 3.19 children to 2.39 children.

**Correlation Test**

I conducted a correlation test of fertility rate with independent variables in all years between 2003 and 2020. All of the independent variables are significant and have a negative relationship with the fertility rate. The strongest negative relationships are school enrollment and employment. Both of them have **-0.47** negative correlation coefficient with the fertility rate. It means that when school enrollment increased, fertility rates decreased. There is a same relationship between employment and fertility rate as well. The Other variables of the correlation test results;

- Marriage indicates score; **-0.41**
- A woman can get a job in the same way as a man; **-0.25**
- The law mandates equal remuneration for females and males for work of equal value; **-0.27**
- A woman can be head of household in the same way as a man; **-0.13**
- A woman can obtain a judgment of divorce in the same way as a man; **-0.36**
- A woman has the same rights to remarry as a man; **-0.34**
- The law is free of legal provisions that require a married woman to obey her husband; **-0.36**
- There is legislation on sexual harassment in employment; **-0.31**
- A woman can get a job in the same way as a man: **-0.25**
- There is legislation on sexual harassment in employment: **-0.32**

**Hypothesis Test**

One of the research questions is whether non-Islamic countries in the MENA have a different pattern from the Muslim countries in the region. I created a variable indicating whether the majority of the country is Muslim. Out of 20 different countries, I have only two countries that are not Islamic which are Israel and Malta. I gathered data for these countries for every year between 2003-2000. The rest of the countries in another cluster include all years between 2003 and 2020. The first hypothesis is; is the fertility rate in non-Muslim countries significantly lower than Muslim countries' fertility rates (95% confidence level)?

- Welch Two Sample t-test shows the p-value is 4.946e-06, which is the null hypothesis rejected. There is strong evidence that non-Muslim countries have significantly lower fertility rates than Muslim countries. The mean of non-Muslim countries' fertility rate is 2.19, and that of the Muslim countries is 2.99. We are 95% confident that true fertility differences mean differences of two groups is less than or equal to –0.53 with a t value of –5.13.
- Another question is; since fertility rates are highly correlated with the school enrollment variable, let's check whether the school enrollment variable is significantly higher in non-Muslim countries than in Muslim countries. I applied for the same Welch Two Sample test (95% confidence level), but this time I am looking for greater value instead of lower. The P-value is 2.2e-16. So, there is strong evidence that the school enrollment variable in non-Muslim countries is significantly higher than the Muslim countries. Again, the null hypothesis is rejected.
- The result of the female employment variable and marriage indicator score in non-Muslim countries was also significantly higher than in Muslim countries with p-score 2.2e-16 and 2.2e-17.

**Multiple Linear Regression**

I used multi-variate linear regression in all countries in every year between 2003-2020. The dependent variable is the fertility rate, and independent variables are school enrollment, job opportunities for females, female employment rate, equal work conditions, being head of household rights, divorce equality, remarrying equality, legal rights for not obeying husband, marriage indicator score, and law for protecting sexual harassment.

The intercept of the dependent variable is 4.63. When every independent variable is zero, the predicted fertility rate is 4.63

The regression output shows that only school enrollment, total employment, equal work condition, divorce equality, and marriage indicates scores are below 0.05. I only consider these variables as significant independent variables.

The F statistic is 19.64 with a p-value is 2.2e-16, which indicates that our model is statistically significant. The multiple R-squared is 0.47, which indicates that the model explains 42% of the variance in the dependent variable with these independent variables. The residual standard error is 0.69.

Our equation is;

**Y=4.63 - 0.01*(X1) - 0.01*(X2) - 1.01*(X3) - 1.57*(X4) + 0.02*(X5)**

- **Y= Fertility rate, total** (births per woman)
- **X1= School enrollment, secondary, female** (% gross)
- **X2= Employment to population ratio, 15+, female** (%)
- **X3= The law mandates equal remuneration for females and males for work of equal value** (0: No, 1: Yes)
- **X4= A woman can obtain a judgment of divorce in the same way as a man** (0: No, 1: Yes)
- **X5= Marriage indicator score** (0-100)

Our intercept is 4.63, and while holding other variables constant;

- Each percentage-point increase in school enrollment decreases the predicted fertility rate by 0.01
- Each percentage-point increase in employment variable decreases the predicted fertility rate by 0.01
- When "the law mandates equal remuneration for females and males for work of equal value" is 1 or "Yes"; the prediction of fertility decrease by 1.01
- When "A woman can obtain a judgment of divorce in the same way as a man value" is 1 or "Yes"; the prediction of fertility decrease by 1.57
- Each increase in marriage indicates score, also increases the predicted fertility rate by 0.02

## Conclusion

The first question's answer in our dataset is that there is a negative relationship between women's education and fertility rate. It means that the predicted fertility rates are decreased when women are educated. We have also seen a similar pattern with education versus the fertility rate for the second question. When women work more, there is less fertility rate. In the correlation test, women's workplace and marriage environments had a negative relationship with the fertility rate. However, only divorce rights and equal work condition variables were significant in the regression model. Also, non-Muslim countries' fertility rates and Muslim countries in the MENA region are undoubtedly significant differences. Besides the variables I used, other variables would be strongly related to fertility rates, such as the healthcare system, economic size, female birth-control habits, etc. I did not include those variables in the dataset.

**Works Cited**


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**Multi-Regression**

```
Call:
lm(formula = fertility ~ enrollment + job_opportunity + employment +
    equal_work + household + divorce + remarry + obey + score +
    sexual_harass, data = newdata)

Residuals:
    Min      1Q  Median      3Q     Max
-1.3920 -0.4257  0.0307  0.4278  1.9347

Coefficients:
                Estimate Std. Error t value Pr(>|t|)
(Intercept)      4.636116   0.218341  21.233  < 2e-16 ***
enrollment      -0.016872   0.002933  -5.753 2.94e-08 ***
job_opportunity  0.406678   0.209841   1.938  0.05391 .
employment      -0.018109   0.004140  -4.374 1.88e-05 ***
equal_work      -1.019604   0.192549  -5.295 2.88e-07 ***
household        0.146450   0.173101   0.846  0.39845
divorce         -1.579332   0.376923  -4.190 4.05e-05 ***
remarry         -0.411683   0.446956  -0.921  0.35802
obey            -0.373520   0.282623  -1.322  0.18767
score            0.022565   0.007164   3.150  0.00186 **
sexual_harass   -0.280153   0.213773  -1.311  0.19139
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.6915 on 219 degrees of freedom
Multiple R-squared:  0.4728,    Adjusted R-squared:  0.4487
F-statistic: 19.64 on 10 and 219 DF,  p-value: < 2.2e-16
```

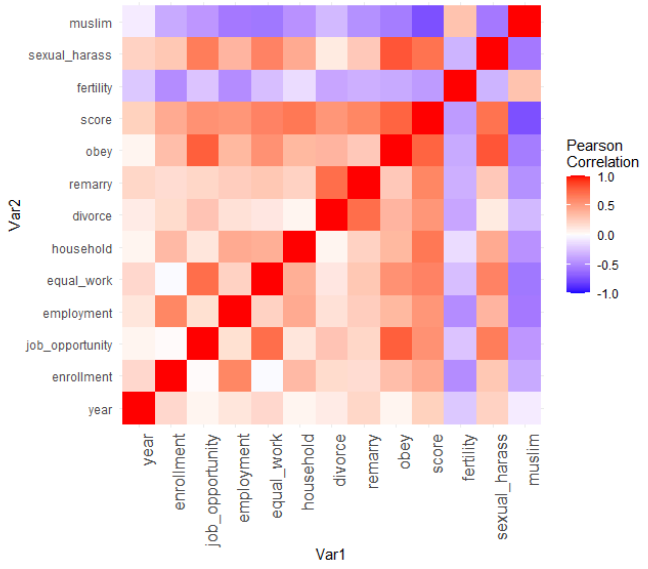
## T-test

```
> t.test(nonmuslim$employment, muslim$employment,  conf.level=0.95, alternative = "greater", var.equal = F)

        Welch Two Sample t-test

data:  nonmuslim$employment and muslim$employment
t = 12.098, df = 53.484, p-value < 2.2e-16
alternative hypothesis: true difference in means is greater than 0
95 percent confidence interval:
 20.92689      Inf
sample estimates:
mean of x mean of y
 44.87491  20.58785

> t.test(nonmuslim$score, muslim$score,  conf.level=0.95, alternative = "greater", var.equal = F)

        Welch Two Sample t-test

data:  nonmuslim$score and muslim$score
t = 15.071, df = 42.551, p-value < 2.2e-16
alternative hypothesis: true difference in means is greater than 0
95 percent confidence interval:
 46.8882     Inf
sample estimates:
mean of x mean of y
 68.57143  15.79487
```

```
        Welch Two Sample t-test

data:  nonmuslim$fertility and muslim$fertility
t = -5.1311, df = 48.918, p-value = 2.473e-06
alternative hypothesis: true difference in means is less than 0
95 percent confidence interval:
       -Inf -0.5384276
sample estimates:
mean of x mean of y
 2.192571  2.992323

> t.test(nonmuslim$enrollment, muslim$enrollment,  conf.level=0.95, alternative = "greater", var.equal = F)

        Welch Two Sample t-test

data:  nonmuslim$enrollment and muslim$enrollment
t = 12.578, df = 225.37, p-value < 2.2e-16
alternative hypothesis: true difference in means is greater than 0
95 percent confidence interval:
 19.62891      Inf
sample estimates:
mean of x mean of y
102.36407  79.76796

>
```

## Correlation Test

| | year | enrollment | job_opportunity | employment | equal_work | household | divorce | remarry | obey | score | fertility | sexual_harass | muslim |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| year | 1.00000000 | 0.191927047 | 0.043764236 | 0.1207670 | 0.18758191 | 0.05175167 | 0.09613828 | 0.2059000 | 0.04842656 | 0.2378621 | -0.2248381 | 0.2312855 | -0.07077634 |
| enrollment | 0.19192705 | 1.000000000 | 0.008847739 | 0.6061966 | -0.02238366 | 0.35274748 | 0.17803104 | 0.1643285 | 0.33365676 | 0.4352365 | -0.4772320 | 0.2850139 | -0.36287988 |
| job_opportunity | 0.04376424 | 0.008847739 | 1.000000000 | 0.1592831 | 0.71307580 | 0.12857259 | 0.28997907 | 0.2071367 | 0.77856559 | 0.5505326 | -0.2503299 | 0.6550598 | -0.43485925 |
| employment | 0.12076699 | 0.606196593 | 0.159283140 | 1.0000000 | 0.21771405 | 0.43408426 | 0.14529912 | 0.2461231 | 0.36199973 | 0.5220810 | -0.4772670 | 0.3710769 | -0.57507045 |
| equal_work | 0.18758191 | -0.022383658 | 0.713075801 | 0.2177141 | 1.00000000 | 0.40032356 | 0.10770936 | 0.2763285 | 0.54569666 | 0.6222008 | -0.2771686 | 0.6190022 | -0.58011935 |
| household | 0.05175167 | 0.352747481 | 0.128572593 | 0.4340843 | 0.40032356 | 1.00000000 | 0.04384204 | 0.2221231 | 0.36317613 | 0.6746820 | -0.1314645 | 0.4180572 | -0.46632137 |
| divorce | 0.09613828 | 0.178031041 | 0.289979069 | 0.1452991 | 0.10770936 | 0.04384204 | 1.00000000 | 0.7143161 | 0.37245297 | 0.5385829 | -0.3686180 | 0.1019752 | -0.29670607 |
| remarry | 0.20590004 | 0.164328520 | 0.207136727 | 0.2461231 | 0.27632855 | 0.22212310 | 0.71431613 | 1.0000000 | 0.26604917 | 0.6113132 | -0.3420444 | 0.2711122 | -0.47633051 |
| obey | 0.04842656 | 0.333656760 | 0.778565594 | 0.3619997 | 0.54569666 | 0.36317613 | 0.37245297 | 0.2660492 | 1.00000000 | 0.7607940 | -0.3635335 | 0.8116505 | -0.55853900 |
| score | 0.23786207 | 0.435236507 | 0.550532633 | 0.5220810 | 0.62220075 | 0.67468196 | 0.53858289 | 0.6113132 | 0.76079395 | 1.0000000 | -0.4119106 | 0.6953600 | -0.75387079 |
| fertility | -0.22483813 | -0.477231989 | -0.250329943 | -0.4772670 | -0.27716861 | -0.13146454 | -0.36861796 | -0.3420444 | -0.36353355 | -0.4119106 | 1.0000000 | -0.3183501 | 0.30912723 |
| sexual_harass | 0.23128547 | 0.285013914 | 0.655059794 | 0.3710769 | 0.61900220 | 0.41805717 | 0.10197522 | 0.2711122 | 0.81165051 | 0.6953600 | -0.3183501 | 1.0000000 | -0.56916823 |
| muslim | -0.07077634 | -0.362879876 | -0.434859246 | -0.5750705 | -0.58011935 | -0.46632137 | -0.29670607 | -0.4763305 | -0.55853900 | -0.7538708 | 0.3091272 | -0.5691682 | 1.00000000 |




## Histogram


## Descriptive Statistic for 2020

```
> summary(subset_2020)
      year         country            enrollment     job_opportunity   employment
 Min.   :2020   Length:10          Min.   : 55.23   Min.   :0.00    Min.   : 9.871
 1st Qu.:2020   Class :character   1st Qu.: 82.46   1st Qu.:0.25    1st Qu.:11.277
 Median :2020   Mode  :character   Median : 99.02   Median :1.00    Median :21.255
 Mean   :2020                      Mean   : 91.97   Mean   :0.70    Mean   :27.485
 3rd Qu.:2020                      3rd Qu.:105.31   3rd Qu.:1.00    3rd Qu.:43.695
 Max.   :2020                      Max.   :110.32   Max.   :1.00    Max.   :57.443
   equal_work      household       divorce         remarry          obey          score
 Min.   :0.00   Min.   :0.0   Min.   :0.0   Min.   :0.0   Min.   :0.0   Min.   :  0
 1st Qu.:0.25   1st Qu.:0.0   1st Qu.:0.0   1st Qu.:0.0   1st Qu.:0.0   1st Qu.: 20
 Median :1.00   Median :1.0   Median :0.0   Median :0.0   Median :1.0   Median : 40
 Mean   :0.70   Mean   :0.6   Mean   :0.1   Mean   :0.1   Mean   :0.6   Mean   : 42
 3rd Qu.:1.00   3rd Qu.:1.0   3rd Qu.:0.0   3rd Qu.:0.0   3rd Qu.:1.0   3rd Qu.: 60
 Max.   :1.00   Max.   :1.0   Max.   :1.0   Max.   :1.0   Max.   :1.0   Max.   :100
   fertility     sexual_harass
 Min.   :1.130   Min.   :0.00
 1st Qu.:1.869   1st Qu.:0.25
 Median :2.576   Median :1.00
 Mean   :2.399   Mean   :0.70
 3rd Qu.:2.867   3rd Qu.:1.00
 Max.   :3.570   Max.   :1.00
>
```

## Descriptive Statistic for 2003

```
      year         country            enrollment     job_opportunity    employment
 Min.   :2003   Length:17          Min.   : 29.07   Min.   :0.0000   Min.   : 8.663
 1st Qu.:2003   Class :character   1st Qu.: 74.90   1st Qu.:0.0000   1st Qu.:13.494
 Median :2003   Mode  :character   Median : 83.78   Median :0.0000   Median :19.840
 Mean   :2003                      Mean   : 78.73   Mean   :0.4706   Mean   :22.562
 3rd Qu.:2003                      3rd Qu.: 97.53   3rd Qu.:1.0000   3rd Qu.:26.733
 Max.   :2003                      Max.   :107.23   Max.   :1.0000   Max.   :46.686
   equal_work       household        divorce          remarry       obey
 Min.   :0.0000   Min.   :0.0000   Min.   :0.00000   Min.   :0   Min.   :0.0000
 1st Qu.:0.0000   1st Qu.:0.0000   1st Qu.:0.00000   1st Qu.:0   1st Qu.:0.0000
 Median :0.0000   Median :0.0000   Median :0.00000   Median :0   Median :0.0000
 Mean   :0.1765   Mean   :0.2941   Mean   :0.05882   Mean   :0   Mean   :0.2941
 3rd Qu.:0.0000   3rd Qu.:1.0000   3rd Qu.:0.00000   3rd Qu.:0   3rd Qu.:1.0000
 Max.   :1.0000   Max.   :1.0000   Max.   :1.00000   Max.   :0   Max.   :1.0000
     score         fertility     sexual_harass
 Min.   : 0.00   Min.   :1.480   Min.   :0.0000
 1st Qu.: 0.00   1st Qu.:2.632   1st Qu.:0.0000
 Median : 0.00   Median :2.906   Median :0.0000
 Mean   :14.12   Mean   :3.196   Mean   :0.1765
 3rd Qu.:20.00   3rd Qu.:3.838   3rd Qu.:0.0000
 Max.   :60.00   Max.   :5.819   Max.   :1.0000
>
```