Factors Affecting Fertility Rates

Background

Based on the World bank data, it can be seen that generally developed nations are seeing reduced fertility rate. Over the last 5 decades the global fertility rate has halved. Global average fertility rate is currently is ~2.3 children per woman.

The fertility rate may be affected due to various parameters including educational background, participation of the women in labor force, availability of contraception, socio-economic parameters, etc. In this study, we focus on the following factors and study if there is any association and possible causality could be explained as far as "Fertility rate" is concerned:

- Female Labor Participation
- Mean Years of Schooling
- Child Mortality Rate
- Unmet Contraception Need

Hypothesis

Null Hypothesis
Neither of Female Labor Participation, Mean Years of Schooling, Child Mortality Rate, Unmet Contraception Need have an impact on Fertility Rate

Alternate Hypothesis
Either of Female Labor Participation, Mean Years of Schooling, Child Mortality Rate, Unmet Contraception Need have an impact on Fertility Rate

Dataset

Data obtained from the observational studies conducted by the United Nations across all the countries from the years ranging from 1973 to 2022.

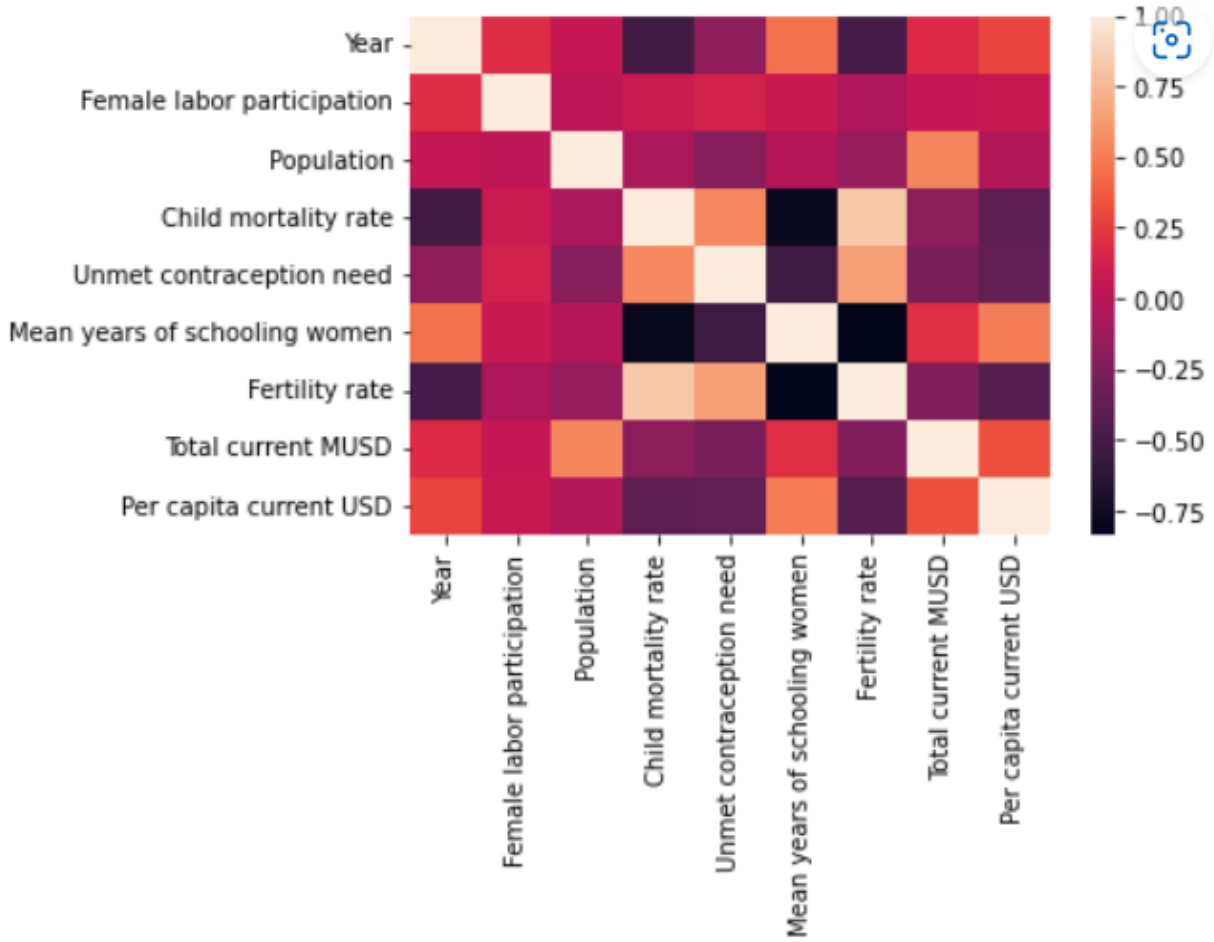
Source of data: https://population.un.org/wpp/Download/

Attributes available from the data:

Attribute	Definition	Variable type
Entity	Country	Predictor
Year	1973-2022, year of observation	Predictor
Births per thousand	Number of children born per 1000 population	Predictor
Female labor participation	% of women participating in labor, above 15 years	Predictor
Population	Historical estimates	Predictor
Child mortality rate	Mortality for children < 4 years of age, per 1000 births	Predictor
Unmet contraception need	For married women between 15-49 years of age, %	Predictor
Mean years of schooling women	For women between 15-49 years of age	Predictor
Fertility Rate	Average number of children per woman	Outcome

Observations

Based on the preliminary analysis of the data, the following correlations could be observed



High correlation between (Child mortality rate, Fertility rate), (Unmet contraception need, Fertility rate)

Methodology

We formulate the below to study the causality
Fertility_Rate ~ Female_Labor_Participation + Mean_Years_of_Schooling + Child_Mortality_Rate + Unmet_Contraception_Need

Data subset

To study the same effectively, the data was reduced to two groups, as per the World bank classification of the countries.

- Developing countries – India, Bangladesh, Pakistan – (Control)
- Developed countries – USA, UK, France – (Treatment)

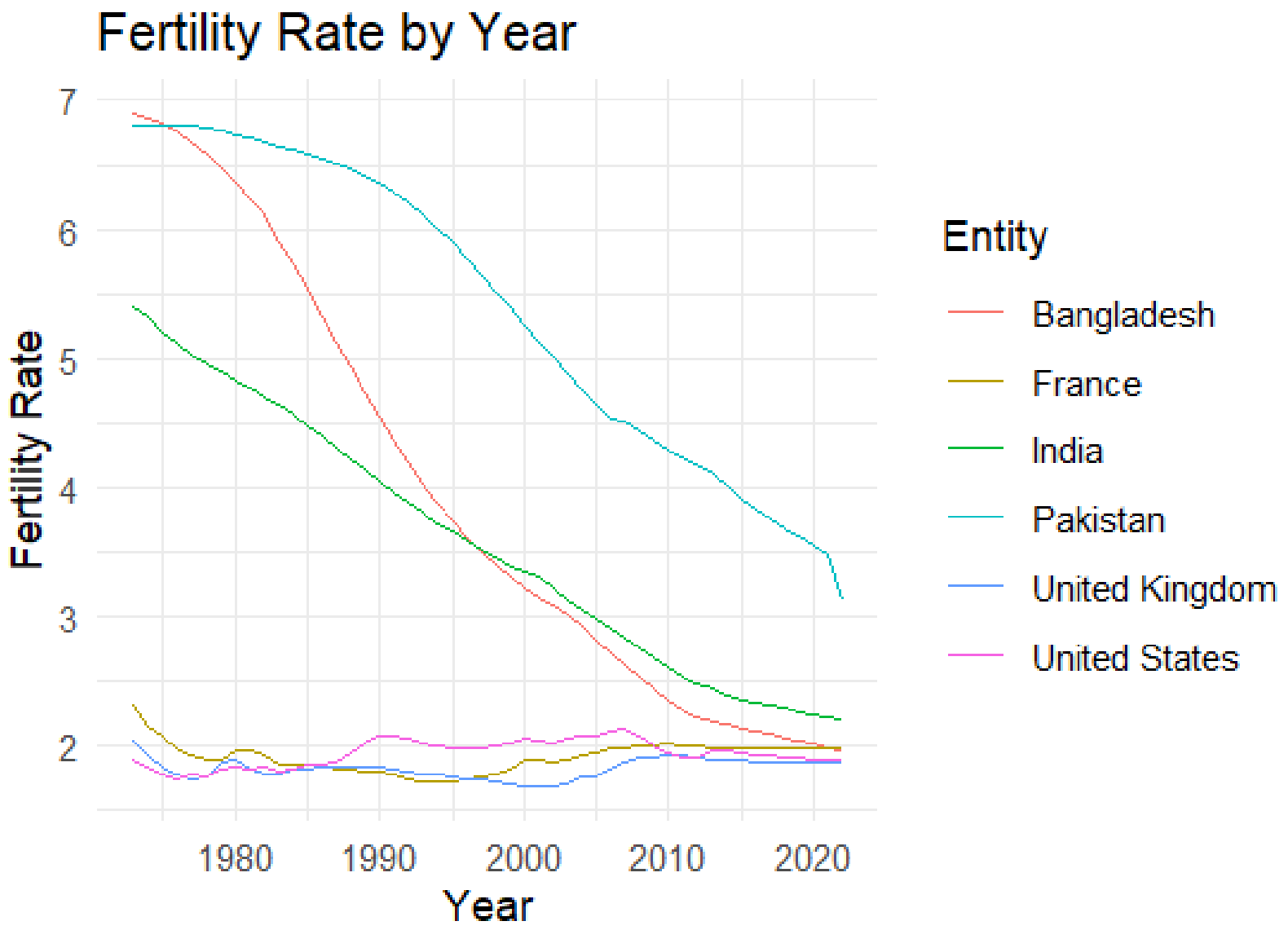
To study the causality as per the proposed hypothesis, we adopted the below methods:

Fixed effects

Fixed effects refer to a modeling technique used to account for individual-specific or entity-specific characteristics that remain constant over time or across observations

Difference in difference

Difference-in-differences (DD) is a statistical technique used to estimate the causal effect of a treatment or intervention by comparing changes in outcomes between a treatment group and a control group, before and after the treatment is implemented


Fertility Rate by Year
Fertility Rate
7
6
5
4
3
2
1980
1990
2000
2010
2020
Year
Entity
Bangladesh
France
India
Pakistan
United Kingdom
United States

Fixed Effects

Treated Entity, Year as the parameters from panel data for fixed effects

Developed Countries

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Coefficients:
                                                Estimate  Std. Error t-value  Pr(>|t|)
Female_Labor_Participation                    -0.03428699  0.00681587 -5.0305 1.465e-06 ***
Mean_Years_of_Schooling                       -0.22459111  0.03087767 -7.2736 2.217e-11 ***
Child_Mortality_Rate                          -0.14954307  0.04429672 -3.3759 0.0009507 ***
Unmet_Contraception_Need                      -0.05830787  0.00585209 -9.9636 < 2.2e-16 ***
Female_Labor_Participation:Mean_Years_of_Schooling  0.00510004  0.00056016  9.1047 7.570e-16 ***
Child_Mortality_Rate:Unmet_Contraception_Need  0.07002530  0.00841088  8.3256 6.595e-14 ***
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Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Total Sum of Squares:    1.4452
Residual Sum of Squares: 0.43512
R-Squared:      0.69892
Adj. R-Squared: 0.68184
F-statistic: 54.5523 on 6 and 141 DF, p-value: < 2.22e-16
```

Developing Countries

```
Coefficients:
                                                Estimate  Std. Error t-value  Pr(>|t|)
Female_Labor_Participation                    -1.0033e-02  2.9046e-03 -3.4543  0.000729 ***
Mean_Years_of_Schooling                       -3.4849e-02  3.7107e-02 -0.9392  0.349260
Child_Mortality_Rate                           1.1248e-01  1.3349e-02  8.4257 3.737e-14 ***
Unmet_Contraception_Need                      -9.5011e-04  8.6001e-03 -0.1105  0.912188
Female_Labor_Participation:Mean_Years_of_Schooling -7.8916e-05  9.9831e-04 -0.0790  0.937105
Child_Mortality_Rate:Unmet_Contraception_Need  4.2772e-03  6.9036e-04  6.1956 6.009e-09 ***
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Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Total Sum of Squares:    263.23
Residual Sum of Squares: 2.9605
R-Squared:      0.98875
Adj. R-Squared: 0.98811
F-statistic: 2065.92 on 6 and 141 DF, p-value: < 2.22e-16
```

Findings

- Female labor participation, mean years of schooling, child mortality rate, and unmet contraception need are all significant factors in explaining fertility rates for developed countries while Female labor participation, child mortality rate are significant for the developing countries.
- The findings for developing and developed countries indicate some differences in the factors influencing fertility rates. While female labor participation, mean years of schooling, and child mortality rate are significant for both groups, the impact of unmet contraception need appears to be more significant in the context of developing countries.
- Female Labor Participation: 1% increase in female labor participation is associated with a decrease of 0.034 in fertility rates.
- Mean Years of Schooling: 1-year increase in mean years of schooling is associated with a decrease of 0.22 in fertility rates for developed countries
- Child Mortality Rate: An increase in child mortality rate by 1 is associated with a slight increase of 0.15 decrease in fertility rates. However, in the developing countries the relation is positively associated with coefficient of 0.11.
- Unmet Contraception Need: 1% increase in unmet contraception need is associated with a decrease of 0.05 in fertility rates for the developed countries

Regression with Interactions

Within difference was calculated as within the countries of the same development status and between difference between countries otherwise

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Coefficients:
                                                Estimate Std. Error t value Pr(>|t|)
(Intercept)                                    2.2601464  0.2516466   8.981  < 2e-16 ***
Treatment                                      1.5767818  0.5221066   3.020  0.00275 **
Female_Labor_Participation                    -0.0297052  0.0029346 -10.122  < 2e-16 ***
Mean_Years_of_Schooling                       -0.2050217  0.0407316  -5.033 8.50e-07 ***
Child_Mortality_Rate                           0.1066879  0.0174227   6.123 2.99e-09 ***
Unmet_Contraception_Need                       0.0667798  0.0103634   6.444 4.89e-10 ***
Female_Labor_Participation:Mean_Years_of_Schooling  0.0041509  0.0009194   4.515 9.24e-06 ***
Child_Mortality_Rate:Unmet_Contraception_Need  0.0020222  0.0008877   2.278  0.02347 *
Treatment:Female_Labor_Participation          -0.0061857  0.0095347  -0.649  0.51701
Treatment:Mean_Years_of_Schooling             -0.0126172  0.0299149  -0.422  0.67351
Treatment:Child_Mortality_Rate                -0.0850685  0.0531335  -1.601  0.11047
Treatment:Unmet_Contraception_Need            -0.0887623  0.0127600  -6.956 2.35e-11 ***
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Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.1947 on 288 degrees of freedom
Multiple R-squared:  0.9863,    Adjusted R-squared:  0.9858
F-statistic:  1886 on 11 and 288 DF,  p-value: < 2.2e-16
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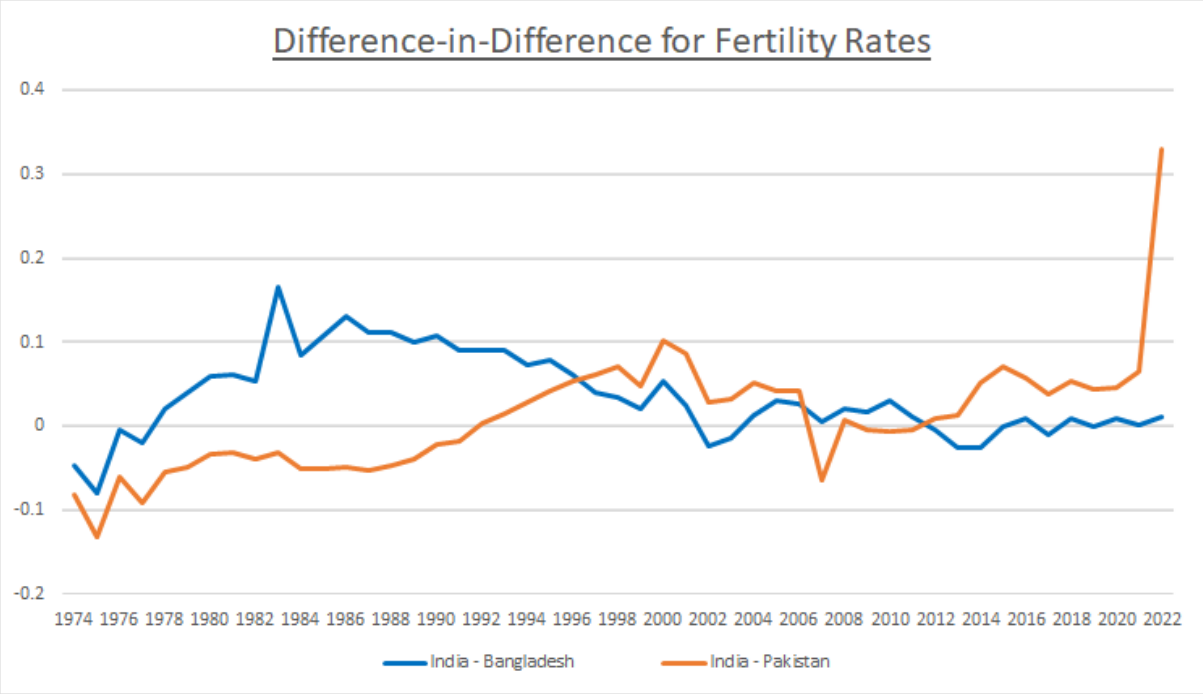
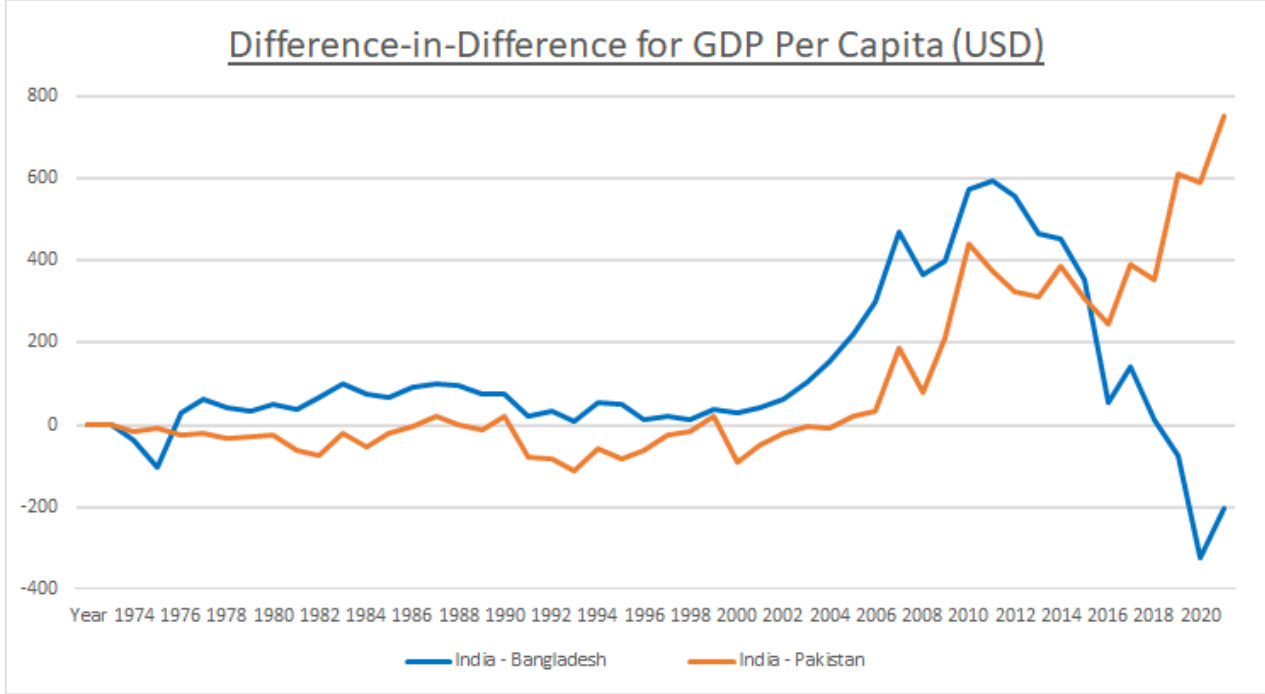
Findings

- Intercept: The estimated intercept is 2.260, indicating the expected value of the outcome variable when all predictors are zero.
- Treatment: The coefficient is 1.577, suggesting that being in the treatment group is associated with an increase in the Fertility
- Female_Labor_Participation: The coefficient of -0.030 indicates that an increase in female labor participation is associated with a decrease in Fertility rate
- Mean_Years_of_Schooling: The coefficient of -0.205 suggests that an increase in mean years of schooling is associated with a decrease in Fertility rate
- Child_Mortality_Rate: The coefficient of 0.107 indicates that an increase in the child mortality rate is associated with an increase in the Fertility rate
- Unmet_Contraception_Need: The coefficient of 0.067 suggests an increase in unmet contraception need is associated with an increase in Fertility rate.
- The coefficients for the interaction terms represent the additional effect on the Fertility rate when two variables interact. E.g., coefficient of Female_Labor_Participation and Mean_Years_of_Schooling is 0.004, indicating that the combined effect of these two variables on Fertility rate is positive.
- High adjusted R-squared value of 0.9863 indicates that the model explains a significant amount of the variation in the outcome variable.

Illustrative DID comparison





Conclusion

- Over the course of the modernization of societies the Fertility Rates have decreased significantly (6 -> 2.5)
- Over the last five decades (1973 – 2022), the fertility rates for the developed countries have remained in the below range:
  - France: 2.2 – 1.7
  - United Kingdom: 2.1 – 1.6
  - United States: 2.2 – 1.7
- On the contrary, for the developing countries, the fertility rates have reduced significantly over the last five decades (1973 – 2022):
  - India : 5.4 – 2.2
  - Bangladesh: 6.9 – 2.0
  - Pakistan: 6.8 – 3.1
- The Female labour participation seems to be causing significant impact to the Fertility rate in both the developing and developed countries.
- When examining the findings separately for developing and developed countries, interesting contrasts emerge. Child mortality rate show stronger statistical significance in influencing fertility rates. In developing countries, it is positively correlated while it is negatively correlated in the developed countries.
- Unmet contraception has significant impact in explaining the fertility rates in developed countries unlike the developing countries.

Next Steps

- Explore additional factors that may influence fertility rates
- Calculate the distance for every entity and year vis-à-vis the Developing and Developed countries chosen as sample for the current analysis
- Analyze the effect of improvement in the GDP as per the timeline on the Fertility rate