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Fertility Rate & Infant Mortality Rate

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Abstract

Enclosed in this research report is the analysis of the effect of a nation's infant mortality rate (per 1,000 live births) on fertility rate. The objective of this paper to evaluate the topic by conducting a cross country analysis. The paper evaluates the effects of infant mortality rate on fertility rate across 80 countries between 1990 and 2015, in five-year time intervals. The additional control variables examined are female labor force as a percentage of total labor force, GNI growth as an annual percentage and secondary education enrollment female percentage. The empirical method conducted found that a nation's infant mortality, female labor force and secondary education enrollment are significant at a one percent level, while GNI growth is not significant at any level.

Table of Content

I. Introduction

Changes in fertility have long been recognized as important correlates of economic growth. The term total fertility rate is used to describe the total number of children the average women in a population is likely to have based on current birth rates throughout her life. The number ranges from more than seven children per woman in developing countries to around one child in more developed nations (*OECD, 2017*). Associated with total fertility rate, is the concept of replacement rate. The replacement rate is the number of children each woman needs to have to maintain current population levels or what is known as zero population growth for her and her partner. Nonetheless, it is hypothesized by many that as a nations fertility rate grows, so will the nation's economic performance.

A complex relationship between population and development has generated intense debates among economists and policy makers. For example, in recent decades, the debate over possible limited food supplies and scarce resources due to the over-population or high fertility rates have surfaced. Worries have been expressed about the ability of the world economy to sustain the ever expanding world population or high fertility rates in the developing countries. In contrast, some claim that advances in economic development could also reserve fertility declines as many women will enter more time consuming careers and possibly desire a family less and less as years progress.

It is easy to see that the fertility rate is a dynamic measure. In this paper I will discuss certain factors that may impact a nation's fertility rate. Prior research suggests that fertility rates are closely tied to growth rates for countries and can be an excellent indicator of future

population growth or decline for a country and economic growth or performance metric. I intend to examine the relationship between a nation's infant mortality rate and the nation's fertility rate while adding and examining other variables and their integral effects; such as, female labor force, gross national income and female secondary education enrollment.

II. Literary Review

A. *Are Fertility Decisions in Turkey Affected by Infant Mortality and Income: (Yilmas and Saytas)*

Discussed by Yilmaz and Saytas is the relation between infant mortality rates, fertility rates, and income in an emerging economy, specifically in Turkey. They use infant mortality, fertility rates, and per capita gross domestic product as variables for an analysis. The fertility and infant mortality rates were found to be related in the literature. The authors explain that their results provide enough evidence in favor of a negative link between per capita real income and fertility rates, however, higher income levels seem to be improving the forecasts of infant mortality rates.

B. *What Are the Determinants of Total Fertility Rates? A Threshold Regression Approach: (Furuoka, Kato, Ho and Munir)*

This paper aims to examine empirical determinants of total fertility rate by employing and exploring a threshold regression analysis. The econometric model used incorporates three main determinants of total fertility rate; human development level, income level, and infant mortality. The regression suggests that there is a complex relationship between the variables, in the countries with relatively low human development, higher human

development index values tend to associate with lower fertility. However, among countries with high human development, there is a significant positive relationship association between infant mortality ratio and total fertility rates.

C. *Infant Mortality Rate as a Measure of a Country's Health: A Robust Method to Improve Reliability and Comparability:(Gonzalez and Gilleskie)*

It is described by Gonzalez and Gilleskie that researchers and policymakers often rely on the infant mortality rate as an indicator of a country's health. Using important socioeconomic indicators, they developed a method that adjusts country-specific reported infant mortality figures. After analyzing the results, the authors conclude that an augmented measure of mortality (including both infant and late fetal deaths) should be considered when assessing levels of social welfare in a country.

D. *Female labor force participation, fertility and infant mortality in Australia: (Narayan and Smyth)*

This study applies the use of Granger Causality tests within a multivariate error correction framework to examine the relationship between female labor force participation rates, infant mortality rates and fertility rates in Australia. Data is annual from 1960 to 2000. The main findings are: first, in the short run there is unidirectional Granger causality running from the fertility rate to female labor force participation and from the infant mortality rate to female labor force participation. Second, in the long run both the fertility rate and infant mortality rate Granger cause female labor participation.

III. Empirical Methodology

The models that will be considered in this study will be based on the functional equation:

$$\textit{Fertility\_rate} = f(\textit{infant\_mort}, \textit{LBRFRC\_Fem}, \textit{GNI\_GRWTH}, \textit{SEC\_EDUC})$$

Where the Fertility_rate is the total fertility rate of a nation, infant_mort is the infant mortality rate per 1,000 live births, LBRFRC_Fem represents the female labor force as a percentage of the total labor force, GNI_GRWTH is the gross national income annual percentage, and SEC_EDUC represents secondary education enrollment female percentage. I had hypothesized infant mortality rate, female labor force and gross national income will be positive coefficients, while secondary education will have a negative correlation. I had predicted that all variables will be significant.

IV. Data Description

The data obtained for this paper spans across eighty countries from 1990 to 2015, in five-year time intervals collected from The World Bank Data Bank sources. The World Data Bank coordinates statistical data work and maintains a number of macro, financial and sector databases. As stated prior the variables looked at are a nation's total fertility rate, infant mortality rate per 1,000 live births, the female labor force as a percentage of the total labor force, gross national income growth as an annual percentage and the female percentage of secondary education enrollment. Descriptive statistics for the variables can be found in figure 1.

1. *Dependent variable: Fertility Rate*

The total fertility rate in a specific year for a nation is defined as the total number of children that would be born to each woman if she were to live to the end of her child-bearing years and give birth to children within the prevailing age-specific fertility rates. It is calculated by totaling the age-specific fertility rates as defined over five-year intervals. Assuming no net migration and unchanged mortality, a total fertility rate of 2.1 children per woman ensures a broadly stable population (*World Data Bank, 2017*).

2. *Independent variable one: Infant Mortality Rate (per 1000 live births)*

Researchers and policymakers often rely on the infant mortality rate as an indicator of a country's health. Infant mortality is the death of an infant before his or her first birthday, for every 1,000 live births. In addition to giving key information about maternal and infant health, the infant mortality rate is an important marker of the overall health of a society as it represents the sophistication or development of a nation's medical and health care systems. I hypothesized that infant mortality rate will be significant and have a positive coefficient. I believe that there will be a positive coefficient for this variable because as the fertility rate increases so does the number of births which elevates the chances of infant mortality.

3. *Independent variable two: Female Labor Force (% of total labor force)*

The female labor force variable represents the female percentage of a nations total labor force. In almost every country in the world, men are more likely to participate in labor markets than women. However, these gender differences in participation rates have been narrowing substantially in recent decades. I predicted that the female labor force will have a negative

coefficient and will be a significant variable, this is so because as a woman has more kids it becomes harder for her to participate in the work force.

4. *Independent variable three: Gross National Income Growth (annual %)*

Gross national income (GNI) is defined as the sum of value added by all producers who are residents in a nation, plus any product taxes (minus subsidies) not included in output, plus income received from abroad such as employee compensation and property income (INVESTOPEDIA). I selected this variable because I wanted to see if there was a relationship between a nation's level of wealth and it's fertility rate. I hypothesized that like the other two independent variables this will be a significant variable with a positive coefficient.

5. *Independent variable four: Secondary Education Enrollment Female (%)*

The fourth and finale independent variable addresses the percentage of females in a nation's secondary education enrollment rate. Secondary education is defined as a level of education that follows a nation's mandatory primary level, in many developing countries females do not attend secondary education as it is not culturally prominent. I believed that as the fertility rate increases this variable will decrease as kids will take away from a woman's time for schooling. Like the other variables I predicted that this variable will be significant.

V. Results

The structure of my data was panel with both the cross-section and period being fixed; figure 2, in the appendix reports the effect of each variable. In my empirical analysis, the Durbin

Watson revealed that there was serial correlation across all models that needed to be corrected. To counteract the correlation one would set the coefficient covariance method to White Period. However, when I switched to White Period I received an error message stating that the estimated coefficient covariance matrix is of reduced rank. With this being said, the results discussed below are being stated with serial correlation.

A. *Infant Mortality Rate:*

When examining the models, I found that my hypothesis is supported by the data. As seen in all models in figure 2, infant mortality rate has positive coefficients and in all models has a probability less than 0.01 (e-views models 1-4) indicating that the variable is significant at a one percent level. In model one, one can interpret the results as for every increase of one in the fertility rate the infant mortality rate experiences a 0.0196 increase. As the models progress the coefficients increase but still remain at a one percent level significance. Having a one percent significance indicates a strong relationship, illustrating that the fertility rate and infant mortality rate are closely intertwined.

B. *Other Variables*

As for the other variables, female labor force and secondary education enrollment were both found to be significant at a one percent level as well. Gross national income was the only variable to be deemed insignificant. Both female labor force and secondary education enrollment were also found to have negative coefficients; this is reasonable as women having more kids would take away from the time they have to work and pursue education. The results from gross national income suggest that for every increase of one in the fertility rate there is a 0.0031 increase in GNI (model 3,

figure 2), however, in model four when secondary education is added the coefficient decreases to -0.0017 while remaining insignificant.

VI. Conclusion

The models that I ran supported my hypotheses besides one, which was not that altering of my main hypothesis. Infant mortality rate was found to be a significant variable as previous literature reported. Prior literature suggests a supporting link between a nation's fertility rate and a nation's economic performance, with this notion and the findings of my models one can infer that because infant mortality rate effects fertility rate it in turn effects a nation's economic performance. Due to the direct nature of the relationship between fertility rates and infant mortality rates, one can also predict the opposite of my findings, this being that as fertility rates decrease so will infant mortality rates.

Infant mortality rates and fertility rates are integral components of a nation's population statistics and there is a proven complex relationship between population and development. Female labor force and secondary education enrollment also affect a nations fertility rate at a significant level, thus they also effect a nation's level of development. If a nation wanted to improve its level of development I recommend analyzing its fertility rate along with its infant mortality rate and react according to the data.

VII. References

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VIII. Appendix

[Figure 1]

Variable Name	Observations	Mean	Std. Dev.	Max	Min
Fertility_Rate	309	2.513	1.310	7.184	1.076
Infant_Mort	309	22.999	25.415	124.100	2.000
LBRFRC_FEM	309	40.623	7.594	52.538	10.424
GNI_GRWTH	309	4.154	3.309	17.011	-8.299
SEC_EDUC	309	83.311	32.048	177.700	4.738

[Figure 2]

Variables	**Original Models**			
Fertility rate [Y]	Model I	Model II	Model III	Model IV
Infant mortality rate per 1000 births [X1]	0.0196*** (13.388)	0.0209*** (13.829)	0.0258*** (14.575)	0.027*** (11.789)
Female Labor Force (% of total labor force) [X2]		-0.027*** (-3.01)	-0.036*** (-4.06)	-0.041*** (-3.824)
GNI growth (annual %) [X3]			0.0031 (0.918)	-0.0017 (0.297)
Secondary Educ. Enrollment Female % [X4]				-0.0041*** (-2.639)
Obs	480	480	422	309
Adj R^2	0.9618	0.9626	0.9638	0.9629
F-stat (p-value)	143.06 (0.00)	144.41 (0.00)	134.79 (0.00)	98.53 (0.00)
Serial Correlation Test (DW Stat)	0.66	0.69	.874	.889

IX. E-Views

Model 1: *fertility rate = f(infant mortality)*

Equation: UNTITLED Workfile: QUANT DATA ATTEMPT 2::Untitled\

View | Proc | Object | Print | Name | Freeze | Estimate | Forecast | Stats | Resids

Dependent Variable: FERTILITY_RATE
Method: Panel Least Squares
Date: 12/08/17 Time: 16:50
Sample (adjusted): 1990 2015
Periods included: 6
Cross-sections included: 80
Total panel (balanced) observations: 480

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2.320693	0.047680	48.67234	0.0000
INFANT_MORT	0.019651	0.001468	13.38883	0.0000

Effects Specification

Cross-section fixed (dummy variables)
Period fixed (dummy variables)

R-squared	0.968616	Mean dependent var	2.931504
Adjusted R-squared	0.961845	S.D. dependent var	1.554589
S.E. of regression	0.303662	Akaike info criterion	0.615092
Sum squared resid	36.33088	Schwarz criterion	1.362896
Log likelihood	-61.62216	Hannan-Quinn criter.	0.909038
F-statistic	143.0606	Durbin-Watson stat	0.668833
Prob(F-statistic)	0.000000		

Model 2: *fertility = f(infant mortality, female labor force)*

Dependent Variable: FERTILITY_RATE
Method: Panel Least Squares
Date: 12/08/17 Time: 17:05
Sample (adjusted): 1990 2015
Periods included: 6
Cross-sections included: 80
Total panel (balanced) observations: 480

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	3.397906	0.360117	9.435570	0.0000
INFANT_MORT	0.020932	0.001514	13.82914	0.0000
LBRFRC_FEM_	-0.027526	0.009123	-3.017314	0.0027

Effects Specification

Cross-section fixed (dummy variables)
Period fixed (dummy variables)

R-squared	0.969327	Mean dependent var	2.931504
Adjusted R-squared	0.962614	S.D. dependent var	1.554589
S.E. of regression	0.300586	Akaike info criterion	0.596357
Sum squared resid	35.50830	Schwarz criterion	1.352856
Log likelihood	-56.12577	Hannan-Quinn criter.	0.893721
F-statistic	144.4113	Durbin-Watson stat	0.691090
Prob(F-statistic)	0.000000		

Model 3: *fertility rate = f(infant mortality, female labor force, gni)*

Equation: UNTITLED Workfile: QUANT DATA ATTEMPT 2::Untitled\

View | Proc | Object | Print | Name | Freeze | Estimate | Forecast | Stats | Resids

Dependent Variable: FERTILITY_RATE
Method: Panel Least Squares
Date: 12/08/17 Time: 17:19
Sample (adjusted): 1990 2015
Periods included: 6
Cross-sections included: 77
Total panel (unbalanced) observations: 422

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	3.508282	0.353108	9.935437	0.0000
INFANT_MORT	0.025875	0.001775	14.57589	0.0000
LBRFRC_FEM_	-0.036021	0.008863	-4.064273	0.0001
GNI_GRWTH_	0.003141	0.003418	0.918848	0.3588

Effects Specification

Cross-section fixed (dummy variables)
Period fixed (dummy variables)

R-squared	0.971098	Mean dependent var	2.761441
Adjusted R-squared	0.963894	S.D. dependent var	1.416877
S.E. of regression	0.269230	Akaike info criterion	0.391419
Sum squared resid	24.42736	Schwarz criterion	1.206172
Log likelihood	2.410530	Hannan-Quinn criter.	0.713385
F-statistic	134.7980	Durbin-Watson stat	0.874466
Prob(F-statistic)	0.000000		

Model 4: *fertility rate = f(infant mortality, female labor force, gni, secondary education enrollment)*

Dependent Variable: FERTILITY_RATE
Method: Panel Least Squares
Date: 12/14/17 Time: 22:41
Sample (adjusted): 1990 2015
Periods included: 6
Cross-sections included: 74
Total panel (unbalanced) observations: 309

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	3.879463	0.426839	9.088824	0.0000
INFANT_MORT	0.027044	0.002294	11.78925	0.0000
LBRFRC_FEM_	-0.040616	0.010619	-3.824783	0.0002
GNI_GRWTH_	0.001735	0.005827	0.297815	0.7661
SEC_EDUC	-0.004150	0.001572	-2.639466	0.0089

Effects Specification

Cross-section fixed (dummy variables)
Period fixed (dummy variables)

R-squared	0.972790	Mean dependent var	2.512935
Adjusted R-squared	0.962918	S.D. dependent var	1.310154
S.E. of regression	0.252292	Akaike info criterion	0.307954
Sum squared resid	14.38523	Schwarz criterion	1.310761
Log likelihood	35.42104	Hannan-Quinn criter.	0.708879
F-statistic	98.53545	Durbin-Watson stat	0.889065
Prob(F-statistic)	0.000000		

Scatter Plot