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Impact of Economic Development on Fertility: A Cross-Country Analysis

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Abstract

In this paper, we investigated whether the relationship between TFR and GDP per capita follow a convex pattern in the SAARC 8 countries over the period of 2001-2014. We empirically test the relationship applying panel data analysis assuming non-linearity between examined variables. Using a country-by-year fixed effects model, we find evidence for an inverse J-shaped relationship between fertility and per capita GDP. In addition, the inclusion of regional fixed effects controls for much of the estimated convexity. The connection between fertility and economic growth is assessed empirically. Application of pooled OLS and fixed effects estimation models acknowledge the theoretical predictions. Estimated coefficients of the total fertility rate turn out to influence the GDP growth rate in the significantly negative way. Data applied in our study exclusively derived from World Development Indicator 2017. Our empirical results support the presumption about convex pattern relationship between total fertility and GDP per capita in analyzed countries over 2001-2014. Estimating above we also determined the threshold level of GDP per capita when the fertility rebound takes place.

Keywords: Economic Development, GDP (Gross Domestic Product), TFR (Total Fertility Rate), Cross Country Analysis, Econometric Regression Model.

1. Introduction

Numerous research work has been published about the relation of fertility and economic growth. These two variables are very important world development indicator according to the World Bank. The relationship between TFR and GDP has a great debate. The main essence of this debate is to seek a statistically significant linkage between total fertility rate and GDP per capita. The more concentration is on fundamental question whether or not there exist "fertility-J curve" in which fertility declines would rebind after a certain level.

In an article published in the "Nature" Journal (Myrskyla *et.al.*2009) showed a relationship between fertility and Human Development Index (HDI). They claimed that the countries highly developed development-fertility relationship become J-shaped which means that the advancement in development after reaching threshold point will show a reverse of declining trend in fertility rate.However, after few days (Furuoka,

2009) published another article investigating the same topic. He said that "his study does not support the proposition that advances in development are able to reverse declining fertility rate."

More few researchers focus on the impact of economic outcomes on fertility where economic outcomes are mainly measured by GDP per capita. They proved that a convex impact of GDP per capita on fertility rate does exist. (Luci &The venem 2010) found an inverse J-shaped pattern with some conditions. (Becker, 1960) pointed out that childbearing decisions were based on the function of costs and utilities of having children, given family income. Becker hypothesized that income should have a positive impact on fertility rate, but found a negative relationship in an empirical test.

Later Becker introduced the concept of the trade-off between quality and quantity in fertility decision. (Becker & Lewis 1973) found that under the condition of a rising income, parents would care more about the quality of the children so that the cost of raising children becomes more expensive, thus they prefer to have fewer children. When controlling for the quality, the relationship between income and number of children should be positive.

Based on the idea of the cost of childbearing, (O'Malley Borg, 1989) examined the effect of the net price of a child-the opportunity cost of the wife. The result shows that when variables that control for the net price of a child, for example, relative preference for children, family's potential income, are included in the model, a positive relationship between income and fertility exists. (Hotz *et.al*. 1996) also, confirm that the increasing cost of having children is the key driver of the falling TFRs since the early 1970s.

However, if income reaches a certain level, households are able to afford the cost of bringing up an additional child. Given high income, raising one more child will not lower the household's living standard. The relationship between income and fertility turns positive at a certain level of income. After the "turning-point" economic growth is associated with a rebound of fertility (Luci & Thevenon, 2010). They conclude that economic development is the driving factor for fertility in the majority of the OECD countries, they further indicate that the pattern of income inequality and fertility also play an important role on this topic.

Most of the European countries have gone through a financial crisis in recent years when many countries had just seen a modest increase in their period fertility rate (Goldstein, *et.al.* 2009). They seek to provide macro-level evidence on the role of the crisis in fertility. The unemployment rate is used as the measurement of economic condition. The result shows a negative impact of the unemployment rate on fertility rates. In Northern European countries where states provide strong family support, unemployment does not appear to have a substantial effect on fertility. It can be seen as evidence that the government's effort to influence fertility actual works.

(Tomas, *et.al.*2010) later also examined the relationship between economic recession and fertility. They found that periods of economics recession were frequently followed by one or two years by a slight decline in the period fertility rates. But they also point out that the relationship between economics situation and fertility is contingent upon social arrangements. In the Nordic countries, the government policies can be effective in softening or even reversing the depressing effects of the recession on fertility.

In a seminal study of (Myrskyla *et al.* 2009), they apply panel data for 37 high developed countries over the period 1975 to 2005, to examine the relation between the Human Development Index (HDI) and the total fertility rates. They suggest that HDI-TFR relationship tends to reveres from negative to positive, as countries pass the critical level of HDI. Their findings show that, at the low and medium level of human development index (HDI), a decrease in fertility rate coincides with continuously progressing economic growth. The situation changes diametrically at higher HDI levels. Further development, upon reaching a particular threshold, may lead to a reversal in fertility declining trend. The level of HDI, which turns the correlation between human development and fertility from negative to positive, is at about 0.9. Following the above, they predict that, in a long-run perspective, advanced in human development shall impact positively fertility rates, however, changes in fertility are not exclusively attributed to economic effect solely. Changing relationship – from negative to positive – between two covariates like total fertility rates and economic development can be graphically approximated by the U-shaped pattern. When analyzing trends in fertility in short time perspective, there might arise, some difficulties with clear distinguish between fertility changes and fertility timing [postponement of the birth].

Only in few studies, we observe a trial to tackle the problem just mentioned. Formal analysis trying to combine short and long run perspective in detecting relationships between economic development and fertility, are found. Empirical evidence linking fertility changes with GDP per capita is even rarer than the previous.

The main concentration of our study also on the relationship between fertility and economic development. We examine the hypothetical statement that the relationship between TFR and GDP per capita follow a convex pattern curve for SARRC 8 countries over the period 2001 to 2014.Our empirical analysis, presented in following sections of the paper, predominantly concentrates on detecting long-term relationships between changing total fertility rates and GDP per capita.

2. Data Description

The data we used in our research is macroeconomic panel datasets contain observations from 8 SAARC countries over the year 2001 to 2014. In this study, the selected variables are GDP per capita (the current US), Total Fertility Rate (birth per women).

3. Empirical Strategy

The objective of this section is to provide an overview of estimation methods and illustrate econometric regression models. The main aim of our study is to figure out the relationship between total fertility and GDP per capita in SAARC countries. In order to explore the relation firstly we estimate a linear model by using total fertility rate (TFR) as the dependent variable and the natural logarithm of GDP per capita (lnGDP) as an explanatory variable. Again we continue this with 2-degree polynomial [quadratic equation] then after a 3-degree polynomial [cubic equation]. The regressions are based on the Pooled Least Square estimation.

The objective of taking the natural logarithm of GDP per capita is to interpret the coefficients as percentage changes instead of absolute changes. Many macroeconomic works related to GDP followed this approach.

Here we introduce the quadratic regression because of examining the convexity of relationship and find out the minimum point. To confirm a convex impact of economic development on fertility, and also with a minimum point, a significant β_2 must be found, as β_2 is an indicator of convex pattern of a trend curve. With a negative β_1 and a positive β_2, we can decide that an increase in lnGDP will lead to a decreased fertility. When GDP reached a certain level (the minimum point), an increase of lnGDP will result in an increase fertility rate.

To formalize above, we specify :

$$TFR_{it} = \beta_0 + \beta_1 * \ln GDP + \varepsilon_{it} \quad [1]$$
$$TFR_{it} = \beta_0 + \beta_1 * \ln GDP + \beta_2 * [\ln GDP]^2 + \varepsilon_{it} \quad [2]$$
$$TFR_{it} = \beta_0 + \beta_1 * \ln GDP + \beta_2 * [\ln GDP]^2 + \beta_3 * [\ln GDP]^3 + \varepsilon_{it} \quad [3]$$

Where i denotes country, t period [year] and ε_{it} an error term.

In the next step, we consider quadratic longitudinal models. We take yearly data and test that the cross-country relationship of TFR and lnGDP and its square term explained by convex shape curve. We define country fixed effect regression that can be capture time-invariant countries' effects.

$$TFR_{it} = \alpha_i + \delta_1 * \ln GDP + \delta_2 * [\ln GDP]^2 + \varepsilon_{it} \quad [4]$$

Which can be written as [country dummies included]

$$TFR_{it} = \alpha_i + \delta_1 * \ln GDP + \delta_2 * [\ln GDP]^2 + \gamma_2 * C_2 + \text{--------} + \gamma_n * C_n + \varepsilon_{it} \quad [5]$$

In [4] and [5], α_i denotes unobserved, time invariant fixed effect, γ_2 is coefficient for binary-country regressor C is country-dummy, n is the number of country in the sample. In this two model to satisfy exogeneity assumption we assume that $E[\varepsilon_i \mid X_i] = 0$ where X_i means $\ln GDP_{it}$.

Again to check time fixed effects we estimate

$$TFR_{it} = \alpha_i + \delta_1 * \ln GDP + \delta_2 * [\ln GDP]^2 + \gamma_2 * C_2 + \text{----} + \gamma_n * C_n + \lambda_2 * Y_2 + \text{----} + \lambda_t * Y_t + \varepsilon_{it} \quad [6]$$

where Y is year dummy and λ indicates the coefficient of year dummy. This model estimated for n-1 countries and t-1 years to avoid falling into the dummy variable trap (i.e. the situation of perfect collinearity). Thus we control unobserved factors that are potentially related to the both GDP and Fertility rate.

To justify the results came from [5] and [6], we include instrumental variables which avoids the significant correlation between error term and explanatory variables. Let us provided $y_i = \beta x_i + \varepsilon_i$ but $E[x_i,\varepsilon_i]\neq 0$,although exogeneity assumption requires $E[x_i,\varepsilon_i]=0$. So avoid endogeneity we introduce z_i as instrument satisfying $E[z_i,x_i]\neq 0$ and $E[z_i,\varepsilon_i]=0$. To get unbiased β, we select 2SLS method where $y_i = \beta x_i + \varepsilon_i$ and $x_i = \phi z_i + \mu_i$, if $\phi \neq 0$ [i.e. $E[z_i,\varepsilon_i]=0$]. We consider lagged lnGDP and lnGDP^2 [[lnGDP- 1 year lag], [lnGDP^2 - 1 year lag]] as instrumental variable and these are sufficiently correlated with lnGDP and lnGDP^2 respectively but uncorrelated with ε_{it} which produce unbiased δ_1 and δ_2.

The calculation procedure of minimum point of convex curve we define a parabola as $TFR_{it} = \beta_0 + \beta_1 * \text{lnGDP} + \beta_2 * [\text{lnGDP}]^2$ equation [2]. A general form of 2 degree polynomial is

$$f(x) = ax^2 + bx + c \qquad [7]$$

where, $x \ \varepsilon \ [-\infty, +\infty]$ and at least $a \neq 0$. Thus the minimum point of the [7] is

$$[-\frac{b}{2a}, f(-\frac{b}{2a})] \qquad [8]$$

In another way of finding [8] is taking 1st derivation of [7] and then equating this zero. i.e. $f'(x) = 2ax + b$ and

$$f'(x) = 2ax + b = 0$$

4. Results and discussion

For a preliminary exploration of the relationship pattern of TFR and GDP, we make a visual graph. We plot the panel dataset for 8 SAARC countries and observed the nature of the relationship. We see in the Figure-1 that the relationship between these two variables followed a convex pattern (invers - *J* shaped curve) over the period 2001-2014. Earlier, when the GDP is comparatively low, the TFR is high. However when the GDP increasing gradually, the TFR declining, at last, reached at a turning point (minimum / threshold point) and then after trend became upward.

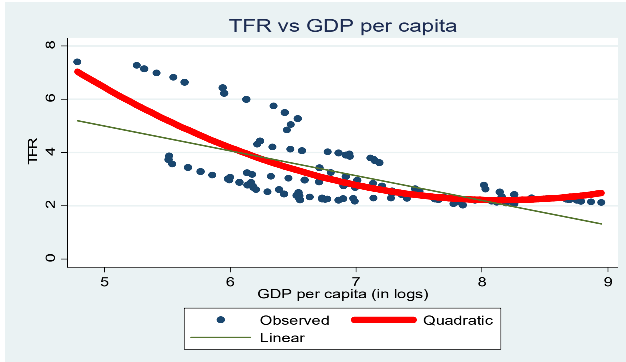

Figure 1. Total Fertility Rate against GDP per capita. 8 SAARC countries. Period 2001-2014

Table 1 displays the summary of the results of linear, quadratic and cubic estimation for TFR_{it} and GDP_{it}. We see that quadratic model is a best-fitted model as $R^2 = 0.51$ and all coefficient are statistically significant. Hence we decided that the quadratic model better than linear or cubic to express the relationship between TFR and GDP.

Table 1. Pooled OLS for TFR versus GDP

	Linear	**Quadratic**	**Cubic**
	Pooled OLS		
	TFR	**TFR**	**TFR**
lnGDP	-0.931*** (7.25)	-6.925*** (5.63)	-26.821** (3.02)
$lnGDP^2$		0.425*** (5.15)	3.316** (2.65)
$lnGDP^3$			-0.138* (2.37)
Constant	9.651*** (10.09)	30.456*** (6.72)	75.445*** (3.65)
#Observations	112	112	112
#country	8	8	8
R-squared	0.41	0.51	0.47

Robust t statistics in parentheses
*p<.05, **p<.01, ***p<.001

Table 2 displays the estimation results over different periods of 8 SARRC countries. Our analysis based on a strongly balanced panel data. So the evidence said us the changing of total fertility rate is due to economic advancement.

Table 2. Pooled OLS & Fixed Effect for TFR versus GDP

	Pooled OLS		FE [I]		FE [II]		FE [III]	FE [IV]
	1	2	3	4	5	6	7	8
	TFR	TFR	TFR	TFR	TFR	TFR	TFR	TFR
lnGDP	-6.925*** (5.63)	-5.520** (2.95)	-3.795** (4.40)	-3.987** (4.82)	-3.585** (3.81)	-4.042** (3.78)	-4.410*** (9.07)	-4.213*** (8.66)
$lnGDP^2$	0.425*** (5.15)	0.433*** (3.66)	0.218* (3.13)	0.279** (3.92)	0.255** (3.46)	0.285** (3.64)	0.261*** (7.41)	0.287*** (8.68)
lnGDP-3year Lag		-1.572* (1.95)		-0.666* (3.33)		-0.563 (1.80)		
Constant	30.456*** (6.72)	30.834*** (4.61)	18.849*** (7.18)	21.617*** (6.71)	16.062** (5.03)	21.088** (4.64)	20.710*** (12.23)	17.742*** (9.11)
R-squared	0.51	0.58	0.82	0.88	0.86	0.88		
Year-fixed	No	No	No	No	Yes	Yes	No	Yes
Country-fixed	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Instruments	No	No	No	No	No	No	Yes	Yes
#Observations	112	88	112	88	112	88	104	104
#country	8	8	8	8	8	8	8	8

Robust t statistics in parentheses
*p<.05,**p<.01,***p<.001

From the displayed results it is found that a significant negative correlation between lnGDP and TFR through the linear regression. With one percentage increase in GDP per capita, the total fertility decreased by 0.931. The negative relationship is consistent with the empirical finding. By adding the variable of $lnGDP^2$ i.e. the result obtained by the quadratic regression presents a positive coefficient of $lnGDP^2$. The coefficient predicts generally that the relationship between income and total fertility rate is changeable. It will change with the level of income. Now we can say that although negative coefficient of lnGDP indicates a reverse relation of GDP and TFR, the positive coefficient of $lnGDP^2$ indicates a positive relationship when after GDP per capita reaches a certain level. It is clear that the pattern of relationship between GDP per capita TFR has a minimum point. This is the point, the TFR is on the bottom and will go upwards if income increases.

The minimum point is calculated in the following way
Firstly, the least squares estimate yields:

$$TFR=30.834 - 3.794*\ln GDP + .218*\ln GDP^2$$

1st derivation is

$$\frac{dTFR}{d\ln GDP} = -3.794 + 0.436*\ln GDP$$

Then equating zero we get

$$-3.794 + 0.436*\ln GDP = 0$$

Hence lnGDP = 8.70 => GDP = 6002.91(US$)

We can decide from the pooled OLS, when the level of GDP per capita equal to 6002.91(US$), fertility will be increase for increase GDP. Otherwise, the pooled OLS estimates result matches the prediction result shown in figure "x" in the previous section i.e. a convex pattern curve.

The same pattern is found in the fixed effect models. The coefficients δ_1 and δ_2 of model FE[I] explaining arbitrated effects of lnGDP on TFR due cross country differences, and these are statistically significant however in each cases δ_1(negative) is higher than δ_2(positive). It indicates that over 2001-2014 there is a negative relation between the variables. We find a result including lagged GDP that a higher R^2.

Again we suppose that the impact of GDP on TFR can be determined by the time varying factor. We control influence GDP per capita on TFR for time fixed effect. The result of model FE[II] suggest that after controlling the unobserved effect the strength and direction found too similar with FE[I].

For controlling the endogeneity we included an instrumental variable in the model and the estimated results presented in column 7 and 8. Here we performed 2SLS method. The results are similar to the previous steps.

The results of all estimations show a negative coefficient of lnGDP and a positive coefficient of $\ln GDP^2$ which confirm a convex pattern of economic development and fertility rates with a turning point. The implication is that if income level develops to a certain stage, further advancement is expected to exert a positive effect on fertility behavior.

5. Discussion and Conclusion

Our study designed to see the changing relationship between total fertility rate and economic growth in 8 countries of SAARC over the period 2001-2014. We have conduct longitudinal analysis to examine the relationship, which showed us an average change of fertility rate as the change in the economic advancement of countries.

It was hypothesized in our study that a convex shaped (inverse - J shaped) curve express the changes in long run total fertility for changing economic development and our presumption was confirmed. Our empirical estimations tell us to make a general conclusion about TFR and GDP that these two indicators are closely related and it was found that the quantitative relationship is inter-temporal in nature. Hence there has a relatively strong time and country specific effects on the relationship between TFR and GDP. Comparatively the estimation results of pooled OLS model and fixed effected models, the effect of income on fertility becomes stronger when controlled for country specific unobserved factors. I also conclude that fixed effect estimation is better captures the critical value of GDP per capita that leads to an increase in fertility.

Further, we found that if GDP per capita reaches a certain level, then after increasing condition of income level expected to improve movement of fertility. The turning point is found to be around 6000 (US$) in SAARC countries as many of them are lower middle-income country.

Although our findings showing such relationship between TFR and GDP per capita, we do not claim that after achieving threshold GDP per capita TFR automatically shall increase. Additionally, any country may not follow the path of growing fertility because of its' negative performance in economic development.

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