ISSN: 2230-9926

Available online at http://www.journalijdr.com

IJDR

International Journal of Development Research
Vol. 08, Issue, 07, pp.21583-21589, July, 2018

ORIGINAL RESEARCH ARTICLE OPEN ACCESS

DETERMINANTS OF FERTILITY RATE DECLINE IN THE SOUTH ASIAN COUNTRIES: A PANEL DATA APPROACH

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ARTICLE INFO

Article History:
Received 17th April, 2018
Received in revised form
21st May, 2018
Accepted 20th June, 2018
Published online 30th July, 2018

Key Words:
Fertility Rate, South Asian Countries,
Fixed effect model,
Cross-sectional dependence,
Panel Corrected Standard Error (PCSE)

ABSTRACT

Over the last three decades fertility rate declines substantially all over the world. The aim of this study is to investigate the macroeconomic determinants of fertility rate decline in the South Asian countries. Data are taken from seven south Asian countries named Bangladesh, India, Sri-Lanka, Nepal, Pakistan, Bhutan and Maldives over the period of 1990-2015. Breusch-Pagan, Honda, King-Wu, Standardized Honda and Standardized King-Wu Lagrange Multiplier test confirm there exists cross-section effects. Hausman test confirms that fixed effect model is appropriate for empirical analysis for this study. But Breusch-Pagan LM test, Pesaran scaled LM test and Baltagi, Feng, and Kao bias-corrected scaled LM test confirm that there exist cross-sectional dependence in residuals. Therefore, Panel Corrected Standard Error (PCSE) model has been employed to get the unbiased estimators. Empirical results of PCSEmodel confirm that per capita GNI, Female labor force participation rate, Education, Infant mortality rate, and urbanization have statistically significant impact on fertility rate in the south Asian countries. Empirical results reveal that increase of per capita GNI, female labor force participation rate, education, and urbanization will cause to decline fertility rate, while decline of infant mortality rate will cause to decline it, which is in accordance with our theoretical expectation. Therefore, we expect that to control the population growth rate policy makers should take these factors under their consideration.

Citation: Istihak Rayhan, 2018. "Determinants of fertility rate decline in the south asian countries: A panel data approach", *International Journal of Development Research*, 8, (07), 21583-21589.

INTRODUCTION

Over the last four decades it's a tremendous achievement for the developing countries that they can substantially bring population growth rate under their control. The highest population growth rate was 1.80 percent per year during 1955-1975 and between 1965 to1970 it was the peak time when population had been grown at a rate of 2.06 percent ('World population' 2017). But in 2010 to 2015 it becomes 1.18 percent. Perhaps, population in the south Asian countries is a matter of concern because three among top ten populous countries around the world are in South Asia; India 2nd, Pakistan 5th and Bangladesh 7th('World population' 2017). Almost 22.43% of world population live in this three south Asian countries. If we consider countries ranking both total population (more than 20 million people) and population density (more than 250 people per square kilometer) then the top three countries of the world are India, Pakistan and Bangladesh, respectively, and Sri-Lanka is in 10th position. It means that south Asian countries are overly populated. Average fertility rate in the south Asian countries were always higher than the word average. In 1961 the average fertility rate at the world level was 5.01, while in the south Asian countries it was 6.05, and in 2015 fertility rate at the world level becomes 2.45, while in the south Asian countries it was 2.492 percent. In the south Asian region, India and Sri-Lanka are considered as growing country respect to population, but Bangladesh and Pakistan are considered rapidly growing countries respect to population. The population size and fertility rate of south Asian countries are shown in Figure-1 and Figure-2 respectively by area plot. Day by day, population size in the south Asain countries is increasing. Such a huge population live in those countries may create a severe pressure on its agricultural lands, forests and other natural resources. As a result, its a great challenge to allocate and distribute the basic

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needs such as food, shelter, education, medical facilities etc. to its entire populatuon. In this context, it is obvious to control the population growth rate of those countries and establish a suitable policyto utilize existing population.

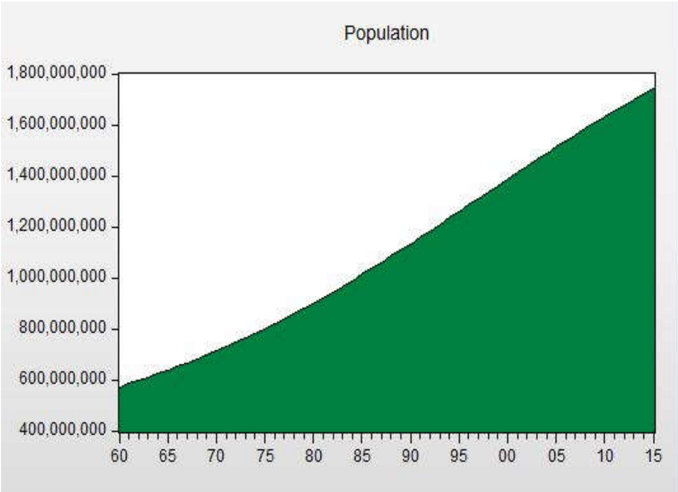

Figure 1. Population in South Asia

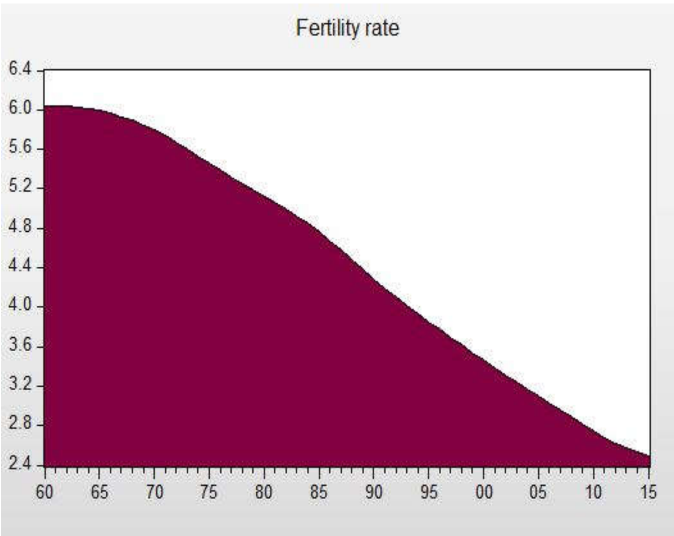

Figure 2. Total Fertility rate in South Asia

The total fertility rate (TFR) is not only an indicator to indicate the future population size of a country but also it has a big impact on the socioeconomic condition of a country. For example, by understanding the level, pattern and the nature of fertility, the decision makers can take appropriate steps to prepare a suitable policy for a country. Low fertility rate can play a good role to accelerate economic growth in a populous country. That's why, in this study we try to identify core macroeconomic factors that can play crucial role in controlling fertility rate. Some very important macroeconomic factors such as per capita GNI, proper education, infant mortality rate, female workers participation in the total labor force, and Urbanization can play a good role in controlling fertility rate, besides biological factors like use of modern contraceptive method. Theoretically female education can play a good role in controlling fertility rate. Generally the opportunity cost of an educated female is higher than an uneducated female so that educated female try to engage themselves into various economic activities which influence them to take less child. At the same time son preference of an educated female is much smaller than an uneducated female. For this reason educated female feels happy with her small family whether she has male or female children. Moreover there exists a trade-off between number of children and the time available for a children. An educated mother try to give more time to their children and it becomes easier for her if family size remains small. Educated women may be more receptive to modern social norms and family planning campaigns and they are aware about planned family size. They are also aware about their health and the risk associated with taking more child. For these type of reason, theoretically it is believed that female education has significant impact on fertility control. It's also an important consideration which won't touch by most of the past empirical works that besides female education male education also has a great importance on fertility rate decline. Whether a girl is sent to school or not, whether a girl can get access to higher education or not, whether a wife take participate in the labor force or not, whether a women take more than two child or not, these type of decisions are greatly controlled by the male in a house in the south Asian region. And an educated father or husband should be more liberal than an uneducated father or husband. That's why, not only female education but also male education are important factor in controlling fertility rate. In this context we use both male and female education that means overall education and try to identify its impact in the south Asian countries in determining fertility rate.

Theoretically it is believed that there exists a negative relationship between economic growth and fertility rate. When per capita income is very low then people cannot invest more on their children to enhance human capital or they cannot afford that. Rather they want more children, especially boys, because they believe that these boys will remove their suffering in the future by increasing family income. But as per capita income increases, people convert their focus on human capital, which gradually reduce the tendency of more child. As a result, with higher economic growth cause to decline fertility rate. Theoretically infant mortality rate is a very important determinant of fertility rate. When infant mortality rate was high, the uncertainty associated with a child becomes high too. To minimize this uncertainty people have a tendency to take more child which increase fertility rate. But when infant mortality rate was low or negligible then this uncertainty also tends towards zero and people feel happy with less child and for this reason fertility rate decline. Moreover theoretically it is believed that four possible mechanisms such as biological, replacement, insurance and societal response play influential role by which infant mortality can influence fertility rate. It is believed that the process of urbanization can directly influence the fertility rate, because empirical studies suggest that urban fertility rate is lower than the rural fertility rate. The reason behind this is that urban women get some extra facilities like access to higher education, access to health care service, access to labor force etc. Moreover, Urban area free from many superstition and urban women can overcome some back dated social norms which remains at a strong position in the rural mind. For this reason expansion of urbanization process is helpful to control fertility rate.

Literature Review

This section para-phase some relevant literature related to fertility rate decline. Caldwell (1980) proposed mechanisms through which mass education produces declines in fertility.

Table 1. Variables, their definitions and expected sign

Variable name	Definition	Expected Sign
Fertility rate (FR)	Fertility rate, total (births per woman)	
Per capita GNI (PGNI)	GNI per capita (current US dollar)	(-)
Education (EDU)	Enrollment in secondary school, general	(-)
Infant mortality rate (IMR)	Mortality rate, infant (per 1,000 live births)	(+)
Urbanization (UR)	Urban population percentage of total population	(-)
Female Labor Force Participation (FLF)	female labor participation percentage of total female labor force	(-)

He argued that the primary determinant of the timing of the onset of the fertility transition is the effect of mass education on the family economy. Dreze and Murthi (1995) demonstrated the interaction among Fertility, Education and Development by analyzing the data of India. They examined the determinants of fertility levels and fertility decline using panel data. They found that women`s education is the most important factor explaining fertility differences. Low levels of child mortality and son preference also contribute to lower fertility. They also find that general indicators of modernization and development such as urbanization, poverty reduction and literacy bear no significant association with fertility. Martin (1995) by analyzing data from the Demographic and Health Surveys for 26 countries found that higher education is consistently associated with lower fertility rate. Galored and Zang (1997) showed that the combined effect of fertility and income distribution is substantial in explaining per worker (per-capita) output and growth performance accross countries. Ahn and Mira (2001) by analyzing a panel of OECD aggregate fertility and labor market data between 1970-1995 found significant negative correlation between fertility rate and female labor force participation rate during 1970's and up to early 1980's, but found significant positive correlation by the late 1980's. Syamala (2001) analyzed the relationship between infant and child mortality and fertility. They demonstrated the influence of child mortality on fertility behavior of women. They found that the net effect of child mortality could be substantial. Women with personal experience of child loss and having pessimistic opinion about the level of mortality produced on an average about two children more than similar women who never experience a child loss and were optimistic about the level. The tendency to replace a dead child was found to cut across the level of literacy and religious background of women.

McNown (2003) investigated a cointegration model of age – specific fertility and female labor supply. They also included women's wages, unemployment rates and education attainment and male relative income. Their estimated long run relationships and short run dynamics are consistent with economic models of fertility and female labor market behavior. Engelhardt *et al.* (2004) analyzed the relationship between fertility and women`s employment status by taking macro-level the time series data of France, West Germany, Ttaly, Aweden, the UK, and the USA over the period of 1960 - 2000. They find a negative and significant correlation between them until about the mid 1980`s and an insignificant or weaker negative correlation afterwards. Kimura and Yasui (2007) developed an overlapping generations model that incorporates occupational (educational) choices and fertility decisions and explained the fertility decline as the result of the popularization of higher education with capital accumulation. Li and Zhang (2007) found negative impact of fertility rate on economic growth using a panel dat set of 28 provinces in China over twenty years. Hasan *et al*. (2009) examined the determinants of fertility decline by analyzing the Asian countries over the period 1975-2008. They explore the association of socioeconomic factors with fertility outcome in Asia. They found that family planning use in a community and female education are associated with a lower likelihood of giving birth. Family planning in a community is the main contributor in explaining fertility decline particularly in Bangladesh. Hondroyiannis (2009) examined the relationship between fertility determinants and economic uncertainty based on panel data for 27 European countries. They used two measures of economic uncertainty associated with labor market decisions; one is production volatility and another is unemployment rate. Their results reveal that both measures of economic uncertainty have a significant negative impact on fertility rate. Ashraf *et al*. (2013) examined the interaction between the effects of Fertility reduction on economic growth. They assessed quantitatively the effect of exogenous reduction in fertility on output per capita. They examined the effect of a change in fertility from the UN medium –variant to the UN low – variant projection in Nigeria. They found that such a change would raise output per capita. Cygan-Rehm and Maeder (2013) investigated the effect of education on fertility under inflexible labor market conditions. They exploited exogenous variation from a German compulsory schooling reform to deal with the endogeneity of education. By using the data from two complementary datasets they examine different fertility outcomes over the life cycle. They found that increased education causally reduces completed fertility.

MATERIALS AND METHODS

In this study we try to investigate the relationship among fertility rate, per capita GNI, female labor force participation rate, education, infant mortality rate, and urbanization. We treated fertility rate as dependent variable and rest of them as independent variables. The data are collected from the World Development Indicator 2017. A balanced panel data set of seven south Asian countries named Bangladesh, India, Sri-Lanka, Nepal, Pakistan, Bhutan and Maldives over the period of 1990-2015 are used for empirical works. Variables, their definitions and expected sign are presented in Table-1.

Logarithemic transformation of the variables have been used to get the elasticities. The estimable model of this study is:

$$LnFR = \alpha + \beta_1 LnPGNI_{it} + \beta_2 LnFLF_{it} + \beta_3 LnEDU_{it} + \beta_4 LnIMR_{it} + \beta_5 LNUR_{it} + \varepsilon_{it} \ldots\ldots(1)$$

Where i = 1, 2, 3,…, N
t = 1, 2, 3,…, T

And ε_{it} = the error or the disturbance term.

Table 2. Descriptive Statistics

Variables		Mean	Std. Dev.	Min	Max	Observations
Id	Overall	4	1.419684	1	7	N= 182
	Between		1.581139	1	7	n= 7
	Within		0	4	4	T= 26
Year	Overall	2002.5	7.529014	1990	2015	N=182
	Between		0	2002.5	2002.5	n =7
	Within		7.529014	1990	2015	T=26
lnfr	Overall	1.157251	.297836	.7241612	1.795752	N=182
	Between		.2502592	.8127498	1.497429	n =7
	Within		.1954843	.6693976	1.574334	T=26
lnpgni	Overall	6.410511	.6733581	5.247024	8.229511	N=182
	Between		.481176	5.757361	7.084599	n=7
	Within		.5164794	5.478644	7.555423	T=26
lnflf	Overall	3.651891	.5177217	2.526049	4.415848	N=182
	Between		.5574119	2.878975	4.389036	n=7
	Within		.1324482	3.298965	3.963927	T=26
	Overall	15.73807	1.469392	12.98963	18.66754	N=182
lnedu	Between		1.578859	14.15189	18.21403	n =7
	Within		.386544	14.57581	16.55001	T=26
	Overall	3.818435	.7122418	2.116256	4.665324	N=182
lnimr	Between		.7233409	2.564172	4.433438	n =7
	Within		.2923458	3.182051	4.420067	T= 26
	Overall	3.130929	.3545957	2.180869	3.657337	N=182
lnur	Between		.3657723	2.614852	3.529699	n =7
	Within		.1337047	2.696946	3.440045	T=26

Table 3. Results of Lagrange Multiplier Tests for Random Effects

Lagrange Multiplier Tests for Random Effects Null hypothesis: No effects Alternative hypothesis: Two-sided (Breusch-Pagan) and one-sided (all others) alternatives			
Test Hypothesis			
Test	Cross-section	Time	Both
Breusch-Pagan	95.8930 (0.0000)	0.62088 (0.4307)	96.5139 (0.0000)
Honda	9.79250 (0.0000)	0.78796(0.2154)	7.48151 (0.0000)
King-Wu	9.79250 (0.0000)	0.78796 (0.2154)	9.14058 (0.0000)
Standardized Honda	16.4788 (0.0000)	0.91902 (0.1790)	5.05698 (0.0000)
Standardized King-Wu	16.4788 (0.0000)	0.91902 (0.1790)	9.26331 (0.0000)

Fixed effect model: To analyze the impact of the variables those are time invariant fixed effect model is used. A fixed effect model allows the intercept in the regression model to vary across cross sections but does not allow the intercept to vary across time. The relationship between independent and dependent variables is explored by this model within an entity (here country). Independent variables may or may not be influenced by the individual characteristics of each entity. The functional form of fixed model is:

$$LnFR = (\alpha + \mu_i) + \beta_1 LnPGNI_{it} + \beta_2 LnFLF_{it} + \beta_3 LnEDU_{it} + \beta_4 LnIMR_{it} + \beta_5 LNUR_{it} + v_{it} \quad \text{................(2)}$$

Where i =1, 2, 3… N

Random effect model: Random effect model is used to examine the differences in error variance components across time period or individual. In this model the variation across individuals (countries) is supposed to be random and uncorrelated with the explanatory variables included in the model. The functional form of random effect model is:

$$LnFR = \alpha + \beta_1 LnPGNI_{it} + \beta_2 LnFLF_{it} + \beta_3 LnEDU_{it} + \beta_4 LnIMR_{it} + \beta_5 LNUR_{it} + (\mu_i + v_{it}) \quad \text{..........(3)}$$

Where i =1, 2, 3… N

It has been assumed in a random effect model that there is no correlation between individual effect (heterogeneity) and any predictor variable. Based on this assumption the model estimates error variance specific to groups (or times). The intercept and slopes of predictor variables are finite across entity. The difference among entities (or time periods) is not reflected in their intercepts, rather it is reflected in their individual specific errors. Random effect model is often termed as error component model as is treated as a part of the composite error term.

Lagrange Multiplier Tests for Random Effects: To select the best model between simple pooled OLS and random effect model Lagrange Multiplier tests are used. In this study Breusch-Pagan, Honda, King-Wu, Standardized Honda and Standardized King-Wu LM test have been employed.

Hausman Test: Hausman (1978) suggests a test that can be applied to the hypothesis testing problems with two different estimators. This test is called Hausman test. To select between fixed effect and random effect Model Hausman test is applied in this study.

Methods to Deal with Contemporaneous Correlation in the Model: When cross-sectional dependence or contemporaneous correlation exists in a panel data model, basic fixed effect or random effect model provides biased estimate.Therefore, in the presence of cross-sectional dependence Panel Corrected Standard Error (PCSE) model has been employed to get the unbiased results. Breusch-Pagan (1980) LM test, Pesaran (2004) scaled LM test and Baltagi, Feng, and Kao (2012) bias-corrected scaled LM test are used to check the cross-sectional dependence in this study.

RESULTS AND DISCUSSION

The descriptive statistics of the variables used in this study in terms of their mean, standard deviation, minimum and maximum values are listed in following table. N, n and T represent number of total observation, number of panel ids (countries) and number of time periods respectively. As panel data consists of repeated observations on the same individuals, we can find two sources of variance within the sample. It is due to the fact that each individual is systematically different from other individuals (between- individual variations) and individual's characteristics vary among observations over time (within – individual variation). Table-2 shows the results of descriptive statistics of all the variables under consideration.

Table 4. Results of Hausman test

Hausman Test	Chi-Sq Statistic	Chi-Sq d.f.	Probability
Cross-section random	75.990764	5	0.0000

Table 5. Results of cross-section dependence test

Residual Cross-section Dependence Test
Null hypothesis: No cross-section dependence (correlation) in residuals

Test	Statistic	Degrees of freedom	Probability value
Breusch-Pagan LM	179.1480	21	0.0000
Pesaran scaled LM	24.40277		0.0000
Bias-corrected scaled LM	24.2677		0.0000

Table 6. Results of estimated models

Variables	Pooled Regression	Fixed Effect Model	Random Effect Model	PCSE Model
lnpgni	.0160065***	-.046268**	-.066800***	-.0472177***
	(0.0000)	(0.0334)	(0.0000)	(0.0000)
lnflf	-.122312***	-.117757***	-.244969***	-.100210***
	(0.0000)	(0.0014)	(0.0001)	(0.0000)
lnedu	-.013410***	-.136453***	-.049734***	-.120010***
	(0.0001)	(0.0000)	(0.0000)	(0.0000)
lnimr	.506850***	.225478***	.296354***	.208300***
	(0.0000)	(0.0000)	(0.000)	(0.0000)
lnur	-.369613***	-.342854***	-.282549***	-.433292***
	(0.0000)	(0.0064)	(0.0000)	(0.0000)
constant		4.08***	3.0089***	4.123690***
		(0.0000)	(0.000)	(0.0000)
R^2	0.8412	0.9538	0.900	0.9986
Adj R^2	0.8376	0.9508	0.897	0.9985

***Significant at 1% level
** significant at 5% level
* significant at 10% level

Results of Lagrange Multiplier Tests for Random Effects: To identify whether Pooled OLS model is the best model or there exists random effects we run Breusch-Pagan LM test, Honda LM test, King-Wu LM test, Standardized LM test and Standardized King-Wu LM test. All these tests reject the null hypothesis of no effects. Therefore, Pooled OLS is not suitable for this study.

Results of Hausman Test: Hausman test is run to determine whether fixed effect model or random effect model provides best estimates of the variables. Table-4 shows the results of Hausman test. The probability value of the test statistic for Hausman test is lower than 0.001 in this study. So, we can reject the null hypothesis easily. As we can rejected the null hypothesis of random effect, alternative hypothesis of fixed effect is accepted. So fixed effect model is preferred over Random effect model according to Hausman test.

Results of cross-sectional dependence test: We use Breusch-Pagan (1980) LM test, Pesaran (2004) scaled LM test and Baltagi, Feng, and Kao (2012) bias-corrected scaled LM test are used to check the cross-sectional dependence in this study. The results of the cross-section dependence test are presented in Table-5. The null hypothesis of this three tests is that there is no cross-section dependence (correlation) in residuals. From table-5 we see that the respective p-value of these three test are zero. So we can reject the null hypothesis at 0.001 percent level of significance. As we can reject the null hypothesis, so we can say that there exist cross-sectional dependence (correlation) in residuals.

Results of Estimated models: Panel Corrected Standard Error (PCSE) model provides unbiased results in case cross-sectional dependence. It also gives results by correcting auto-correlation and heteroscedasticity.

The estimated results of pooled regression, fixed effect model, random effect model and PCSE model are presented at Table-6. From the estimated results of the PCSEwe find that the impact of per capita GNI is statistically significant and negative and one percent increase in per capita GNI, on average, will cause to decline fertility rate by 0.0472177 percent. This result is consistent with many other empirical findings and also consistent with our theoretical expectantion. Economic growth plays a significant role to decline fertlity rate. It is found that the impact of female labor force participation rate on fertility rate is statistically significant and negative, which is in accordance with theoretical expectations and also consistent with many others empirical works. One percent increase in female labor force participation rate, on average, will cause to decline fertility rate by 0.10 percent. Impact of education on fertility rate is found statistically significant and negative, which is consistent with many other empirical works and in accordance with our theoretical expectations. Empirical results reveal that one percent increase in education, on average, decline fertility rate by 0.12 percent.

Table 7. Results of cross-sectional dependence for PCSE model

Residual Cross-section Dependence Test Null hypothesis: No cross-section dependence (correlation) in residuals			
Test	Statistic	Degrees of freedom	Probability value
Breusch-Pagan LM	10.64013	21	0.9693
Pesaran scaled LM	-1.598563		0.1099
Bias-corrected scaled LM	-1.7353		0.0821

Table 8. Normality test result

Jarque-Bera = 0.2080
Probability = 0.9025

Empirical results also reveal that impact of urbanization on fertility rate is statistically significant and negative too, which is in accordance with our expectations. One percent increase in rate of urbanization process, on average will cause to decline fertility rate by 0.433292 percent. Finally, the impact of infant mortality rate on fertility rate is found statistically significant and positive, which is in accordance with our theoretical expectation and also consistent with many other empirical works. Results reveal that if infant mortality rate can be reduced by one percent then, on average, fertility rate will decline by 0.2083 percent. The R-square of the PCSE model is 0.9986 and the adjusted R-square is 0.9985 which is almost same as R-square. Therefore, after adjusted with degress of freedom almost 99.85 percent of the total variation of the total fertility rate can be explained by per capita GNI, female labor force participation rate, education, infant mortality rate and urbanization process in the south Asian countries. PCSE model gives the unbiased estimators by correcting cross-sectional dependece. We also check the cross-sectional dependence of PCSE model, which are tabulated in table-7. From table-7 we see that all the three tests can not reject the null hypothesis of no cross-sectional dependence (correlation) inresiduals. Therefore, there are no cross-sectional dependence in PCSE model. We also check whether data are normaly distributed or not. The results of normality test are presented in table-8. The null hypothesis of normality test is data are normally distributed and we can not reject the null-hypothesis at 10 percent level of significance. That means our data, which is used in this study, are normally distributed.

Conclusion and Policy Recommendation

In our study we attempt to identify the macroeconomic determinants of female fertility rate decline by analyzing seven South Asian countries using panel data regression analysis over the period of 1990- 2015. From the estimated PCSE results we find that the impact urbanization on fertility rate is higher than rest of the variables. One percent increase in urbanization process will cause to decline fertility rate by 0.433292 percent on average. The second influential variable to control fertility rate is the infant mortality rate. One percent decline of infant mortality, on average, will cause to decline feryility rate by 0.21 percent. The third important factor is education. If total secondary enrollment can be increased by one percent then, on average, fertility rate will decline by 0.12 percent. The fourth important variable is the female labor force participation rate. If female labor force participation can be increased by one percent then, on average, female labor force participation rate will decline by 0.10 percent. Finally the impact of per capita GNI on fertility rate is relatively small. One percent increase in per capita GNI, on average, will cause to decline fertility rtae by 0.047 percent. So policy makers can give special focus on urbanization process, infant mortality rate, education and female labor force participation rate to control fertility rate in the south Asian countries.

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