Macro-Economic Determinants of Fertility Rate: A case study of Pakistan

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Abstract
The aim of this study is to find out the macro-economic determinants of fertility rate in Pakistan. This study used time series data for assessing the model over the period of 1971 to 2014. The VECM model is used for short run and ARDL technique is utilized to find out long run association between dependent and independent variables. The empirical results of this study argue that for achieving low level of fertility rate, government should increase secondary school enrollment and try to increase life expectancy by introducing new medical reforms and provide advance medical facilities. Fertility rate in Pakistan can also be control by controlling inflation and urbanization rate. The results of the short run also show the convergence in the long run. The statistics shows that inflation rate and urbanization rate is positively related to fertility rate while secondary school enrollment rate and life expectancy at birth rate has negative impact on fertility rate in short run as well as in long run.

Keywords: Fertility rate, Secondary School Enrollment, Life Expectancy
JEL Codes: J13, E24, J17

I. Introduction

At the beginning of this century, about all developed countries in the world show very low fertility rate. Even in some developed countries, fertility rate is now below replacement rate. This trend of decrease in fertility rate is also observed in developing countries. The rate of decline in fertility is although slow but this pace of declining rate increases continuously time to time. So the macro comparison of fertility rate between countries has now become a very debatable topic for researchers and scholars. The growth in population also affects the development of an economy. Increase in population lead to increase unemployment and other macroeconomic problems like inflation, low per capita income etc (Ali et al , 2013). A lot of socio-economic changes occur in developing countries like other third world countries. A decline in fertility rate is one of the most important phenomena in Pakistan. It is a complex matter to find out the reasons behind the decline in fertility rate. Demographers, sociologist and many other researchers gave many theories in the case of decline fertility rate. The socio-economic theories of fertility evidencing that there are social as well as economic factors which pull down the graph of fertility rate. Fertility decisions by individuals affected by education, life expectancy of children, social status, level of income etc (Galloway et.al., 1994). On the other side, number of demographers and researcher have a point of view that new technology and new thinking about childbearing play vital role in fertility decline. While many of the scholars believe that with new technology and new thoughts, socio economic changes also play significant role in fertility transition (Adhiriki, 2010; Audi and Ali, 2016).

Pakistan has 6th rank in world in the list of most populace countries. The current statistics show that Pakistan has more than 195.4 million populations (Economic survey of Pakistan, 2015-16). The population growth is 1.89 which is higher as compared to neighboring countries. But Pakistan still achieve the goals of fertility transition from 1970-2010. During the period from 1970 to 1975 fertility rate has decreased from 7 percent to 4 percent in 2005 to 2010. The fertility rate began to decline in the late 1980s in Pakistan after a long time period of sustained high fertility decrease by 40% in the past two decades. This decrease continues and the fertility rate decrease 6.3 to 4.8 percent during 1991 to 2000. The statistics also depicts that from 2000 to 2010, we find very slow decrease in fertility trend as from 4.8 to 4 children per women during the childbearing age (Pakistan Economic Survey 2009-10). The costs and benefits of having a large family is depended upon the socio economic changes and economic development. Such changes affect the mind set of parents to have a large family or a small family. Like most of the countries, demand for contraceptives and abortion among families is also increased in Pakistan which reduces family size and lowers the fertility rate in Pakistan. Now a day, family planning programs also play an important role in reduces fertility rate. Apart from this, in the case of development indicators, Pakistan has improved and stabilizes its position in economic development as compare to past few decades. GDP per capita (at constant US$ 2010) which was only and only 453.76 dollars in 1972 increases now the highest level of 1142.75 dollars in 2015. Average age or life expectancy increases from 55 years to 66.8 years from the period 1972 to 2015. Secondary school enrollment has been increased from 16.6 percent in 1972 to 41.6 percent in 2015 (World Bank, 2015).

II. Literature Review

Audi and Ali (2016) examine a causal and co-integration relationship to find out the socio economic factors which affects the fertility rate in Tunisia. A time series data has been taken over the period of 1971-2014. ARDL approach is used to check the co-integration among variables. Fertility rate is taken as dependent variable while female school enrollment, urbanization, GDP per capita and life expectancy are treated as independent variables. The findings of the study reveal that in long run, female education and urbanization is negatively related to fertility rate while per capita income and life expectancy has a significant positive relation with fertility rate in Tunisia.

Abdullah et al. (2013) depicts the co-integration relationship among fertility and human development indicators for Pakistan. A time series annual data from 1971 to 2010 has been utilized to check the relationship among variables. The stationary of variables is check by applying Ng-perron unit root test and all the variables are stationary. ARDL results shows that there is long run as well as short run relation exist between fertility rate and human development indicators. Moreover, the results describe that fertility is negatively and significantly related to secondary school enrollment and life expectancy. While GDP per capita is insignificantly but positively linked with fertility rate.

Abo-Zaid (2013) investigates the impacts of macroeconomic aggregates on fertility for case of U.S. Annual data from 1980 to 2010 is used to develop and find the relation between fertility rate and other macroeconomic variables. The simple regression is used for statistical analysis and all variables are stationary and significant. The estimated results reveal that Government expenditure GDP per ratio, debt GDP ratio and deficit rate have negative impact on

fertility rate in short run, while tax revenue GDP ratio has positively linked with fertility rate. Furthermore, the study shows that Urbanization also have a negative impact on fertility rate.

Goga et al. (2015) check the impact of population growth on economic development and economic growth between 1990 to 2014 in Albania. This study used secondary data. Author check the impact of demographic variables an economic growth and development by using regression technique. The results show that Population growth has significant negative effects on the economic growth in the Albania.

Klasen and Launov (2006) try to identify the forces which have impact in fertility decline during transition period in the Czech Republic. The data source for their study is Family and fertility survey of 1998 from the United Nation Economic Commission of Europe (2003). They use cross sectional data by under taken the female age from 15 year to 45 year. For estimation, they use Heckman and Walker process. The results of their findings depicts that education and female employment intensity both have a significant and negative relationship with fertility rate. Impact of same variables on child bearing period is also significant and positive. The study also concluded that insufficient childcare facilities and increase use of contraception has oppositely affect the fertility rate in Czecch Republic.

Ndahindwa et al. (2014) uses data of Rwanda of 2010 from demographic and health survey and estimate the determinants of fertility rate in Rwanda. Data of 13,671 women have been consider for this study over the age of 15 to 49 years. Poison OLS is used for empirical analysis. The outcomes of the study explore that education and wealth or working status is significantly and negatively associated with the fertility rate. On the other hand, desires to have more children from men or women have also deeply and significantly affect the fertility rate in Rwanda.

Ali et al. (2013) investigate the impact of population growth on economic development in Pakistan. A time series data from 1975 to 2008 has been taken for this study. ARDL method incorporate to explores the population's impact on Pakistan's development. The statistics show that population growth has a positive and significant relation with economic development as it provides more labor force. But economic development hurt due to increasing unemployment rate and lower human resource development.

El-Ghannam (2005) uses secondary data of 106 countries to find out the relationship among fertility rate and some other variables. The data sample consist of 53 LCD's and 53 MDC's. To check the fertility rate differential among low income countries and high income countries, descriptive analysis, correlation coefficients and multiple regression is used. The results suggest that in low income countries, fertility rate have positive and significant association with high child mortality rate, more life expectancy and more participation in labor force. While in MDC's the fertility rate decrease with an increase in female life expectancy and more participation of women in labor force.

Shakya and Gubhaju (2016) find out the factors that decline the fertility rate in Nepal. They use data of national fertility survey from 1976 to 2011 for this study. Decomposition analysis technique is used to determine the impact of different variables on fertility rate. The study covers the periods as 1991 to 1996, 1996 t0 2001. 2001 to 2006 and 2006 to 2011 for analysis. The findings of the study show that increasing age of marriage, increase in male migration for employment are cause to decline fertility rate. Moreover, increase in use of contraception and increasing trend of abortions are also the main factors of fertility decline in Nepal.

Adhikari (2010) give an analysis on the socio economic factors that affect fertility behavior in Nepal. The study is conducted by using data from Nepal demographic and health survey 2006. The study argued that age at first marriage, wealth status, literacy status, child mortality, mass media exposure has strong and significant effect on fertility rate. The author investigate that child mortality rate have very strong and positive effect on fertility rate in the case of Nepal. The study concluded that more knowledge about contraception, family planning methods, give knowledge by mass media can reduce the fertility rate in Nepal.

III. Methodological Framework

A debate has started about population in 1798 when Thomas Malthus wrote an essay on population and describes those resources of the world increases in arithmetic way while population of the universe increases in geometric way. After this essay discussion about population reduction has been started. Many demographers, researchers and scholars gave many theories about population. Nobody still found the exact factors which cause population increase.

Many theorists explain different factors and variables which effect fertility rate. Few studies found that GDP per capita and life expectancy at birth as well as secondary school enrollment are the only factors which affect fertility rate in Pakistan (Abdullah et al. (2013). The current study added more key factors that affect fertility rate in the case of Pakistan. This study follows the same framework as Abdullah et al. (2013) and Audi and Ali (2016). The study purposes the model as

F = f(URB, SSE, INF, LIFEE)

The econometric model of the fertility rate in the log form is as:

$$LF_t = \beta_0 + \beta_1 LURB_t + \beta_2 LSSE_t + \beta_3 LINF_t + \beta_4 LLIFEE_t + \in_t$$

Where LF is symbolized fertility rate, LURB is the urbanization rate, LSSE is the secondary school enrollment rate, LINF is the inflate rate and LIFEE is life expectancy at birth. Here L represented the logarithmic form of all variables. β_0 Is intercept while $\beta_1, \beta_2, \beta_3, \beta_4$ are coefficients of variables. $\in$ reveal as the error term.

This study is used time series data over the period 1971 to 2014. Data for all variables is collected from world development indicators (WDI) online database, World Bank (2015). In this study, total fertility rate is dependent variable while urbanization rate, inflation rate, life expectancy at birth, and secondary school enrollment rate treated as independent variables.

IV. Econometric Methodology

Nelson and Ploser (1982) points out that time series data mostly have a problem of unit root. If the series of data is non stationary, then all the results of the classical regression are become spurious and have no meaning. We have a number of test available to remove the problem of non-stationarity like Dickey Fuller (1979), Perron (1989), Augmented Dickey Fuller (1981), Philips Perron (1988) and Zivot and Andrews (1992). Most commonly used test is Augmented Dickey fuller (ADF) (1981). The general notation of ADF is as:

$$\Delta T_{t-1} = \gamma T_{t-1} + \sum_{l-1}^{g} \theta_l \Delta T_{t-l} + \mu_{1t}$$

$$\Delta T_{t-1} = \alpha + \gamma T_{t-1} + \sum_{l-1}^{g} \theta_l \Delta T_{t-l} + \mu_{2t}$$

$$\Delta T_{t-1} = \alpha + \beta t + \gamma T_{t-1} + \sum_{l-1}^{g} \theta_l \Delta T_{t-l} + \mu_{3t}$$

H_0: $\gamma = 0$ non-stationary time series
H_1: $\gamma < 0$ stationary time series

In applied econometrics, there are number of tests to check co-integration among variables. Most commonly used techniques are Johansen Juselious (1990), Eangle Granger (1987), Perron (1989), Johansen (1991) and (1992), Leybourne and Newbold (2003) and ARDL by Pesaran et al. (2001). This study used most advanced Auto regressive distribution lag (ARDL) technique to check co-integration between variables. Eangle-Granger (1987) and Johansen test of co-integration (1991) and (1992) are specifically used if all the variables have same order of integration. ARDL is used generally for mix order of integration. It also gives better results for small sample size data. The functional form of the model is as follow

$$LF_t = \beta_0 + \beta_1 LURB_{t-1} + \beta_2 LSSE_{t-1} + \beta_3 LINF_{t-1} + \beta_4 LLIFEE_{t-1} + \sum_{f=1}^{k} \alpha_f \Delta LURB_{t-f} + \sum_{g=1}^{k} \alpha_g \Delta LSSE_{t-g} + \sum_{h=1}^{k} \alpha_h \Delta LINF_{t-h} + \sum_{j=1}^{k} \alpha_j \Delta LLIFEE_{t-j} + \mu_t \quad (7)$$

$H_0: \beta_1 = \beta_2 = \beta_3 = \beta_4 = 0$ (No co integration between variables)
$H_1: \beta_1 \neq \beta_2 \neq \beta_3 \neq \beta_4 \neq 0$ (co integration between variables)

Bound testing approach is utilized to check that either there is some long run relationship exists between variables or not. If value of F statistic is greater than upper bond value then we reject null hypothesis of no co-integration between variables and conclude that there exist long run association between variables.
To find out the short run association between fertility rate and urbanization rate, inflation rate, secondary school enrollment rate and inflation rate vector error correction model (VECM) is used. The value of ECT reveals the speed of adjustments from short period of time to long run. The functional form of the VECM model is as follow

$$\Delta LF_t = \alpha_0 + \sum_{f=1}^{k} \alpha_f \, \Delta LURB_{t-f} + \sum_{g=1}^{k} \alpha_g \, \Delta LSSE_{t-g} + \sum_{h=1}^{k} \alpha_h \, \Delta LINF_{t-h} + \sum_{j=1}^{k} \alpha_j \, \Delta LLIFEE_{t-j} + \omega ECT_{t-1} + \mu_t$$

IV. Empirical results and Discussion

This study is uses time series data from 1971 to 2014 for Pakistan. First, we analyze the properties of data by descriptive statistics. The dynamics of descriptive statistics has summarized in table 1. The values of skewness and kurtosis show that variables are normally distributed as the values lie between 0 to 3. Fertility rate (LF), life expectancy (LIFEE) and urbanization rate (LURB) is negatively skewed while secondary school enrollment rate (LSSE) and inflation rate (LINF) are positively skewed. The results also depict kurtosis of the variables and results confirm that all variables are platykurtic (fat or short tailed). The assumption of normality can be checked by Jarque-Beratest. The statistics of JarqueBera P-values for all variables explain that all variables are normally distributed as p-value of Jarque-Bera is higher than 0.05 for all variables. These dynamics confirm that variables are normally distributed and does not have random walk problem. So we can now easily check the relationship among variables.

Table 1 Descriptive Statistics

	LF	LLIFEE	LSSE	LINF	LURB
Mean	1.663414	4.116436	3.147813	2.102256	3.438687
Median	1.738812	4.117137	3.263199	2.090903	3.440506
Maximum	1.888886	4.207003	3.729019	3.283278	3.645528
Minimum	1.285645	4.001838	2.772419	1.069573	3.222230
Std. Dev.	0.219727	0.062838	0.293456	0.522853	0.118686
Skewness	-0.416112	-0.149323	0.275815	0.085530	-0.063735
Kurtosis	1.538272	1.773339	1.807072	2.765980	2.009552
Jarque-Bera	5.186949	2.922126	3.166851	0.154050	1.828267
Probability	0.074760	0.231990	0.205271	0.925867	0.400864
Sum	73.19023	181.1232	138.5038	92.49927	151.3022
Sum. Sq. Dev	2.076047	0.169793	3.703001	11.75512	0.605716
Observations	44	44	44	44	44

This study is comprised on time series data. The problem of unit root exists in time series data. Non-stationary data make the results of regression fake and spurious and this is why policy formation on the basis of such data is unreliable. The Augumented Dickey Fuller (ADF) test is used to remove the non-stationarity problem in this model. The table 2 depicts the results of ADF. The estimated results reveal that total fertility rate (LF), life expectancy (LIFEE) and inflation rate (LINF) are stationary at level with 1% significance level and have integration level I(0). While secondary school enrollment (LSSE) and urbanization rate (LURB) are not stationary at level but stationary at 1st difference with 1% significance level and have integration level of I(1). The estimated results of ADF test show that the model consists on mix order of integration.

Table 2 Augumented Dickey Fuller (ADF) unit root test

	At Level		At 1st difference	
Variables	t statistics	P Value	t statistics	P Value
LF	3.38	0.0016	-1.33	0.6103
LIFEE	-2.74	0.0092	-5.68	0.0000
LINF	-3.104	0.0034	-6.53	0.0000
LSSE	0.915	0.3656	-5.17	0.0000
LURB	-1.63	0.1109	-2.118	0.0408

The optimal selection is important as it depicts the true results of the model. To find out optimal lag of VAR model the LR, AIC, FPE, Sc and HQ lag selection criteria is utilized. For this purpose, this study chooses 2 lags according to AIC and SC which is suitable for ARDL approach. The results of optimal lag length criteria are summarized in table 3.

Table 3 VAR Lag Order Selection Criteria

Variables: LF LLIFEE LSSE LURB LINF						
Lag	LogL	LR	FPE	AIC	SC	HQ
0	267.5997	NA	2.55e-12	-12.50475	-12.29788	-12.42892
1	668.6823	687.5702	4.30e-20	-30.41344	-29.17225	-29.95850
2	784.1930	170.5159*	6.09e-22*	-34.72348*	-32.44796*	-33.88941*

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

Auto regressive distribution lag (ARDL) approach is used to find out long run as well as short run relationship between fertility rate with inflation rate, life expectancy rate, secondary school enrollment rate and urbanization rate. The findings of ARDL bound testing approach is represented in table 4. The value of F-statistics is higher than upper bond value at significance level of 5% which reject the null hypothesis of no long run relationship exist among variables and support the existence of co-integration between variables.

Table 4 ARDL Bounds Testing Approach

Dependent variable LF ARDL (1,0,0,1,1)		
F Statistic= 13.3075*		
Level of Significance	Lower Bound Value	Upper Bound Value
5%	2.86	4.01
10%	2.45	3.52

*denote the significant at 5 percent level.

After the co-integration among variables, we can now move forward to find short run association among variables by using Vector Error Correction Model (VECM). Results for short run relationships have explained in table 5. The estimated results describe that inflation rate has positive and significant relation with fertility rate as in the long run. Urbanization rate is also positively related to fertility rate and the result is significant at 0.03 percent in Pakistan. While the coefficient of life expectancy and secondary school enrollment describe that there is negative but significant association prevail in life expectancy and secondary school enrollment with fertility rate. Results reveal that 1 percent increase in life expectancy will decrease fertility rate by 0.49 percent. While 1 percent increase in secondary school enrollment will decrease fertility rate by 0.02 percent. The value of ECM is negative and significant (2.55) which shows the speed of adjustments from short run to long run. The overall results explore that fertility rate is declined by increasing life expectancy and secondary school enrollment rate. On the other side by controlling on inflation rate and urbanization, the graph of fertility can be decline.

Table 5 Vector Error Correction Model (VECM

ARDL (1,0,0,1,1) Dependent variable LF, Time period 1971 2014				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LINF)	0.004613	0.001966	2.346376	0.0247
D(LIFEE)	-0.493491	0.161254	-3.060345	0.0042
D(LSSE)	-0.021896	0.023013	-0.951494	0.3479
D(LURB)	2.031776	0.916539	2.216792	0.0332
CointEq(-1)	-0.060212	0.023582	-2.553308	0.0152

R^2= 0.7932
Adjusted R^2= 0.7519
F- Statistic= 19.188
Prob (F- Statistic)= 0.0000
Durbin-Watson= 0.4657

After analyzing the short run relationship between fertility rate and all other variables, we can move forward to check the long run relationship among variables. The estimated results of ARDL long run co-integration is summarized in table 6.

The findings reveal that inflation rate is positively affecting the fertility rate in the case of Pakistan. Results confirm that 1 percent change in inflation rate brings 0.07 percent change in fertility rate and p-value depicts that relationship is significant. As Pakistan is a developing country and the literature shows that less developing countries face high fertility rate (Yoon et al., 2014) and high inflation rate (Killick, 1981). Our results support that in developing countries fertility rate increases with increase in inflation and results are significant at 5%.

On the other side, life expectancy at birth has a negative but significant relationship with fertility rate. The above results describe that 1% increase in life expectancy causes 8.19 percent decrease in fertility rate. Fortunately, expected age in Pakistan is increasing day by day as it increases 63 to 66 year from 2004 to 2014. The urbanization rate has positive and highly significant long run relationship with fertility rate. The results show that 1% increase in urbanization rate increases fertility rate 4.14 percent and result is significant at 1% level.

Following results also tells that secondary school enrollment rate has negative and significant association with fertility rate. The statistics show that fertility rate is decreased by 1% due to 0.99 percent increase in secondary school enrollment rate. Abdullah et al. (2013) also find negative relationship between fertility rate and secondary school enrollment. Actually with education, female get knowledge and become able for decision making with their husbands about family size and the result is that family size reduces. The statistics explore that literacy rate among male as well as among female is increasing time to time and this increase in education rate tends to decrease in family size in this Islamic republic country.

Table 6 Long Run Coefficients using ARDL

ARDL (1,0,0,1,1) Dependent variable LF, Time Period 1971 2014				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
LINF	0.076606	0.036312	2.109677	0.0421
LIFEE	-8.195836	2.481055	-3.303367	0.0022
LSSE	-0.998301	0.366044	-2.727270	0.0099
LURB	4.145180	1.637679	2.531131	0.0160
C	23.608099	5.525606	4.272491	0.0001

V. Conclusion and Policy Recommendation

This study finds out the factor which effects fertility rate in Pakistan. Time series data from 1971 to 2014 is being utilized for this purpose. In this study, fertility rate is treated as dependent variable while inflation rate, urbanization rate, secondary school enrollment rate and life expectancy at birth are consider as exogenous variables. Augmented Dickey Fuller (ADF) test is applied to swipe out the problem of non-stationarity. Results of ADF test explain that

our data has mix order of co-integration. ARDL bound testing approach is utilized to analyze long run dynamics between variables. The results of ARDL show that long run co-integration exist between dependent and independent variables. Results of long run coefficients describe that inflation rate and urbanization rate have a positive and significant effect on fertility rate in Pakistan. Secondary school enrollment and life expectancy at birth appear to have negative and significant influence on fertility rate in long run for the case of Pakistan. The results of VECM depict the same relationship between variables in short run. Like long period of time, inflation rate and urbanization rate have positive impact on fertility rate and results are significant at 5 percent. While secondary school enrollment rate and life expectancy have a significant but negative relation with fertility rate in Islamic republic of Pakistan. The coefficient of ECT is significant and theoretical correct sign which is the further proof of the short run convergence towards the long run equilibrium. So the Government of Pakistan should give advance medical facilities to people so that life expectancy increase and also focus on literacy rate specially in tribal areas. Despite all of it, if Government of Pakistan wants to decline fertility rate then it has to make control on inflation rate and urbanization rate. Government of Pakistan should take some serious steps to reduce fertility rate in Pakistan.

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