Bulletin of Business and Economics
ISSN - 2409 - 9368
http://rfh.org.pk/jur/magazine-category/bbe

A Causality and Co-integration Analysis of Some Selected Socio-Economic Determinants of Fertility: Empirics from Tunisia

Marc Audi
Centre d'Economie de la Sorbonne Universite Paris 1;
AZM University Business Faculty

Amjad Ali
Department of Economics, University of the Punjab, Lahore.
E-mail: chanamjadali@yahoo.com

Abstract
This study investigates the impact of some selected socio-economic factors on fertility rate in Tunisia over the period of 1971 to 2014. Philips Perron (PP) unit root test is used for testing the stationarity of the variables. For examining the co-integration among the variables of the model, Autoregressive Distributed Lag (ARDL) approach to co-integration is used. Causality among the variables of the model is examined with the help of Variance Decomposition and Impulse Response Function. The estimated results show that selected variables of the model has mix order of integration. Long run results of the study show that female education, urbanization have a significant negative relationship with the fertility rate in Tunisia. The results reveal that life expectancy and per capita income have positive and significant relationship with fertility in Tunisia. The value of ECT reveals that short needs more than 5 years to converge in the long run equilibrium. The results of Variance Decomposition and Impulse Response Function reveal that all independent variables have causal relationship with the dependent variable. The study suggests that socio-economic improvement is a key in reducing fertility rate in Tunisia.
Keywords: Fertility, urbanization, per capita income
JEL Codes: J13, O18, D31

I. Introduction

The 20th century has seen an unprecedented growth of the human population on this planet. While at the beginning of the century the Earth had an estimated 1.6 billion inhabitants, this number grew to 6.1 billion by the end of the century, and further significant growth is a near certainty (Lutz and Qiang, 2002). Following the empirics of developed and developing countries, the reduction in mortality rate causes to raise population but still fertility rate is one of the main driving forces of developing countries' population growth. Generally, targeted fertility can help in reducing population growth because the trends of population growth are changing. Historically mortality and fertility were very high and kept total population growth very slow over thousands of years. But population growth got a dramatic rise when life expectancy started to increase with the advancement of industrialization and highly effective health facilities.

Nevertheless, in some countries fertility has followed mortality in its decline. Births and deaths appear to be in an equilibrium, resulting in slow to no growth in population. These are the countries that are close to zero population growth. Elsewhere, fertility has not fallen to match mortality. Indeed, the essence of rapid world population growth today lies in this incongruence between fertility and mortality rates where fertility tend to surpass mortality. In a country the where gap between fertility and mortality is greater population growth is witnessed most rapid, where fertility is at a peak or has just begun to fall. Growth rates are slower where the decline in fertility has been under way for a longer time or has been more rapid. Where growth rates are nearly zero, the transition to a low-fertility regime is nearly complete.

International Conference on Population and Development Program of Action (1994) promotes the slogan to reduce fertility and takes it to replacement rate since the mid of 21st century. For this purpose they mention the importance of family and individual well-being, optimum health facilities, timing and space of child birth and preventions from high-risk and unwanted childbirth. Although at the beginning of New Millennium, all the developed nations are showing their fertility rate below the replacement rate. But still fertility rate is one of the main causes of increase in population. The main focus of recent population policies about fertility is to help women to avoid unintended birth for improving child and maternal health.

Fertility decline is also one of the important and complex socio-economic phenomena in developing countries. In existing literature different theories and hypothesis are presented by demographers and researchers to explain this complex phenomenon. Millennium Development Goals of United Nations also highlights some socio-economic factors for reducing fertility in developing countries. Empirically, urbanization, women education and economic status of a family are some important socio-economic factors affecting fertility rate (Ellis, 1988). According to socioeconomic and demand theories of fertility, there are socio-economic factors behind the incentives for fertility decline. Individual decisions are affected by the level of income, life expectancy of children, education and social status (Galloway, Hammel, and Lee (1994) Potter, Schmertmann, and Cavenaghi (2002).

According to the classical demographic transition theory of Notestein (1953), fertility is high to compensate high mortality in traditional agricultural societies as an insurance of population survival. Development in a society and changes in socioeconomic structure (rising education, urbanization, industrialization, public health care investment and child's costs and benefits) decide the level of fertility. The rise in child survival together with the rising cost and declining economic value of children is considered to be the fundamental driving force of the fertility transition. The desire for smaller families leads in turn to a demand for birth control and hence to lower actual fertility. The empirical evidences from developed as well as developing countries show that women education is strongly associated with low fertility rates (Schultz, 1973; Ainsworth et al., 1996; Vavrus and Larsen, 2003; Sackey, 2005). With the increase of women's education the share of women in labor market increased. This leads to the increase of the economic value of women time in the society. Empirically, it had been proved that the higher the women's education the lower is the number of children per woman. (Schultz, 1973; Singh, 1994). This study is going to investigate the impact of some selected socio-economic factors on fertility in case of Tunisia over the period of 1971 to 2014. This type of exercise is hardly done in case of Tunisia. It will be a health contribution in the respective literature.

II. Literature Review

In previous literature, there are two ways to discuss the relationship between socio-economic factors and fertility rate. First, measurement issues and methods of fertility and second the level of development and fertility rate variations. Statistical data publishing agencies have no direct concern to measure the socio-economic changes which explain fertility decline. These agencies do not measure the strategies of mobility, opportunity cost of child rearing and bearing, family mechanisms and other risks with child birth. These are the social scientists which develop, construct and suggest real base good proxies for these types of variables. For example, Prussian dataset arranged, developed and assembled by Galloway et al., (1994). Generally, some researchers make general statement for developmental indicators such as non-agricultural development and gross domestic product etc. Changes in development indicators are sometimes a poor guide to changes in the incentives to limit fertility. Neoclassical economists suggest that more human capital formation increase women participation in labor market and change the fertility rates and in this way few children is more desirable by women (Singh, 1994). it is approved that women education is linked with smaller desired family sizes across the world.

Coale (1967) mentions that modern societies have evolved controls for fertility. Apart from widespread literacy among adults, modern societies are characterized by their pervasive communication networks as well as high attendance rates in primary education. Besides the employment sectors are rather industrial than agricultural. The decrease in death rates raise the survival chances of children, and thus decrease the amount of births necessary in order to acquire the desired number of youngsters per family. The economic value of children in an urban context diminishes compared to a rural setting. This is more intensified due to the restriction of child labor by law as well as the introduction of mandatory education. The role of women in society is more pronounced on account of increasing educational attainment, by which the incentive of employment beyond the household is elevated. Enhancing opportunities for self-realization strongly contrast with the maintenance of uncontrolled fertility. Moreover, rural populations relatively uneducated their fertility conduct seems to be driven by customs and traditions while in an urban context tradition vanishes and rationality dominates.

Empirical tests of socio-economic theories allow us to check the possibility of identical scores of development but having different limitations of family size due to their institutions and policy objectives. Starting from a country which has a generous welfare state that insulates parents from the costs of childrearing, while another country with equivalent development scores does not. To complicate matters further, international development data are notoriously unreliable (Srinivasan 1994; Lloyd et al. 2000).

First glance of the data from United Nations Population Division for estimating fertility in countries such as Angola or Cambodia demonstrates that fertility estimates also the need to be treated with care (United Nations Population Division 2004). Noise in the data further obscures the relationship between fertility and socioeconomic change. Development indicators are, in sum, highly imperfect proxies for the underlying social phenomena that socioeconomic theories of fertility consider important. Socioeconomic theories therefore predict that there will be an association between development indicators and fertility, but one with numerous exceptions. Hence conclusions about the validity of socioeconomic theories based on the strength of the cross-country relationship between fertility and development can never be definitive. Other sources of evidence will always be needed to understand the relationship, including qualitative and micro-level studies. One of the most productive ways to incorporate other sources of evidence is to look at outliers. If a country has higher or lower fertility than it would be expected from its scores on development indicators, then socioeconomic theories would predict that something unusual about the country's history or social structure disrupts the normal relationship between development indicators and incentives to limit fertility. This prediction can be tested using external evidence.

UN (1985) investigates the relationship between fertility rate and women labor force participation for a panel of countries. The results show that if sociological aspects take in account women labor force participation reduces the women role as homemaker and mother. So there is a negative relationship between women employment and fertility of women. But on the other hand when economic value of women force is taken into account then it is noticed that women prefer fewer children to remain the active part of the labor force.Thus it is difficult for women to combine maternity and employment, hence there exist a negative relationship between fertility and work of women.

Ellis (1988) mentions that infant nutrition process needs much energy and time from women, so more children would disturb the women socio-economic activities. In places where Whereas more education, urbanization and modernization are high the opportunity cost of non-working women is higher than in places that do not meet those criteria.The results of the study conclude that women education and urbanization impact inversely on fertility rate.

Bettio and Villa (1998) explore the relationship of unemployment and fertility rate in case of Italy. The results of the study reveal that there is a negative association between unemployment and fertility in Italy. The results of the study mention that women labor force participation will generate more income for household which covers the negative shocks of other partner employment. The study concludes that the remaining part of labor market women leave the childbearing years, hence fertility rate decreases.

Mammen and Paxson (2000) augmented and extended the theoretical work of Goldin (1995). This study will explore the U-shaped association between income per capita of women and women labor force participation rate. The results of the study reveal that poor agriculture economies have high employment rate for women in agricultural activities but they have high family rates as the whole family contribute towards child caring. But in low urbanized and middle income countries where manufactured sector is dominated, combined family and employment duties cannot be handling by women. In this way fertility rates are high in middle income countries but in those countries where urbanization is high the women participation in labor market is high. The results of the study conclude that urbanization and women education affects the fertility rates.

Kravdal (2002) studies the relationship of fertility rates and community education in case of some developed and developing countries. The results of the study confirm the strong negative relationship between fertility rates and community education. The results support the neoclassical theory which emphasis investment in human capital formation increase the women participation in the labor market and in the long run it can change the fertility behavior of households and women prefer few children.

Kreider et al. (2009) examine the reasons of fertility decline in 47 countries of Sub-Saharan Africa, Caribbean, Asia, Latin America and North Africa with the help of DHS data. The main objective of this study is to check the interaction between the velocity of socio-economic progress and the respective stage of fertility transition. Multivariate analysis is used for testing the relationship among the variables of the model. The results of the study reveal that woman's educational attainment, infant and child mortality and growth in per capita income has a strong theoretical and empirical relationship. This study concludes that fertility reductions were smaller in magnitude over time if GDP growth is more rapid.

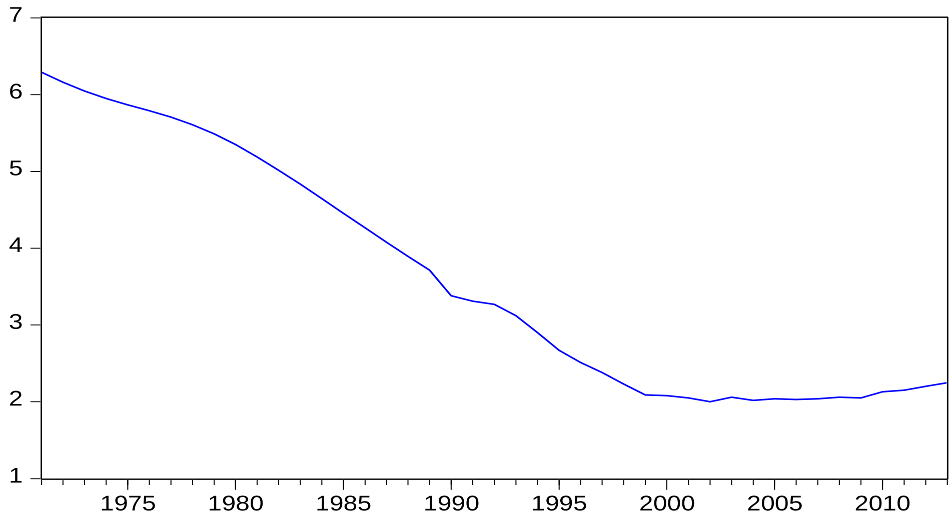
Adhikari (2010) examines 8644 married women of reproductive age in order to detect the demographic, socio-economic, and cultural factors which contribute to fertility differentials in Nepal, where since 1981 birth rates decreased. With DHS data from 2006 for Nepal he applies a bivariate analysis (one-way ANOVA) as well as multiple linear regressions for the purpose to report the effect of each independent variable on the dependent variable after controlling the impact of other predictors. Among literate women, on average, the number of children ever born is half the size of those for illiterate women. In case of Muslim women who were never exposed to mass media, the likelihood to have more children than Hindu women likewise without mass media experience increases by 0.066. The study concludes that socio-economic factors play an important role in determining fertility in case of Nepal.

Abdullah et al., (2013) study the relationship among human development indicators and fertility decline in Pakistan over the period of 1971 to 2010. Bound Testing approach (ARDL) and VECM are applied for empirical analysis of selected variables of the model. The results show that long run co-integration and short run dynamics exist between total fertility rate and Human Development Indicators. Secondary school enrollment and life expectancy at birth prove the negative and significant impact on fertility, while GDP per capita indicated the positive but insignificant impact on fertility. The findings of study suggest that more resources should be invested in human capital formation through the provision of better education and health facilities to keep the fertility on declining.

III. Fertility Trends in Tunisia

The fertility trends in Tunisia are explained in figure-1. Vigorous government programs encouraging social change have contributed to rapid fertility decline in Tunisia despite relatively modest economic development. Reliable fertility statistics first became available in Tunis in 1964; beginning in 1966, civil registration, census, and survey data became the basis of population estimates. Estimates of the general fertility rate by different workers indicated an almost complete lack of voluntary fertility control in Tunisia as recently as 20 years ago. The crude birthrate declined from 43.8 to 35/1000 from 1966-78, while the general fertility rate declined from 193 to 150. The legitimate fertility rate dropped about 25% between 1966-80, from 306 to 229. The rate of decline was greater from 1966-75 than in the 5 succeeding years. Between 1966-75, fertility declined by 53% in the 15-19 cohort, 25% among those 20-24, 12% for those 25-29, 10% for those 30-34, 17% for those 35-39, 15% for those 40-44, and 10% for those 45-49. The fertility decline in the 1st 2 cohorts is almost entirely explained by the advancing age at marriage. Fertility differentials by socioeconomic status and residence were noted; the upper socioeconomic group had a fertility rate of 155/1000 compared to 229/1000 among the poorest. 42% of educated women by 27% of the uneducated used family planning. The fertility decline will continue till 2001 after that is remain stable till 2005 and there is an increasing trend in fertility after 2006.

Figure-1
FIRRATE



IV. Methodological Framework and Data Sources

Thompson (1947) started the debate of fertility transition in his famous book "Population Problems". Thompson mentions "if the very rapid growth of population during the last century has helped to create interest in population, the even more abrupt decline in the birth rate" after that still population growth and fertility remains a question because the consequences of these changes in rate of growth are likely to affect seriously both the internal economy of nations and the international relations arising from differential rates of national expansion". The existing literature on fertility determinants is mixed; it is unquestionable that fertility is a profoundly personal decision that cannot be fully explained by any set of variables, but rather better understood in a societal context. The literature is primarily about examining the choices available to women. The main aim of the study to see which socioeconomic factors may stand out as significantly correlated with fertility – these factors can then be influenced by public policy decisions to help reduce fertility in Tunisia. Following the previous literature review and keeping work of Ainsworth et al., (1996), Bloom et al. (2007) and Abdullah et al., (2013) in view this study propose the functional form of the model:

$$\text{FRIR} = f(\text{FSS,LIF,URB,GDPP,INF}) \qquad (1)$$

Where
FRIR=Fertility Rate
FSS=Women Secondary School Enrollment Rate
LIF=Life Expectancy
URB=Urbanization
GDPP=Per Capita Income
INF=Inflation Rate
Taking the Log of the both side

$$\text{LFRIR}_t = + \beta_0 + \beta_1 \text{LFSS}_t + \beta_2 \text{LLIF}_t + \beta_3 \text{LURB}_t + \beta_2 \text{LGDPP}_t + \beta_2 \text{LINF}_t + \mu_t \qquad (2)$$

Here
t=Time Period
u=Error Term

V. Econometric Methodology

Nelson and Ploser (1982) highlight the fact that time series data have unit root problem that makes regression results unfavorable for policy implications. On the other hand for examining the cointegration among the variables, stationarity of the time series data is necessary and sufficient condition. In this study the fertility rate is the dependent variable and the women secondary school enrollment rate, life expectancy at birth, urbanization, per capita income and inflation rate are the independent variables. There are number of unit root tests available for removing non-stationarity problem in time series data. The well know are Dickey-Fuller (DF) (1979), Augmented Dickey-Fuller (ADF) (1981), Perron (1989), Zivot and Andrews (ZA) (1992) and Phillips Perron (PP) (1988). This study is using the Philips Perron (1988) unit root test for examining the stationarity of the variables. The Phillips-Perron (PP) unit root tests differ from other unit root tests mainly in how they deal with serial correlation and heteroskedasticity in the errors. In particular, where the ADF tests use a parametric auto-regression to approximate the ARMA structure of the errors in the test regression, the PP tests ignore any serial correlation in the test regression. The test regression for the PP tests is

$$\Delta y_t = \beta_0 D_t + \pi y_{t-1} + u_t \quad (3)$$

Where

ut is I(0) and may be heteroskedastic. The PP tests correct for any serial correlation and heteroskedasticity in the errors ut of the test regression by directly modifying the test statistics tπ=0 and T ˆπ. Under the null hypothesis that π = 0, the PP statistics have the same asymptotic distributions as the ADF t-statistic and normalized bias statistics. One advantage of the PP tests over the ADF tests is that the PP tests are robust to general forms of heteroskedasticity in the error term ut. Another advantage is that the user does not have to specify a lag length for the test regression.

VI. Auto-Regressive Distributed Lag (ARDL)

After confirming the stationarity and lag order of fertility rate, women secondary school enrollment rate, life expectancy at birth, urbanization, per capita income and inflation rate cointegration among the variables of the model can be examined. In applied econometric literature, there are number of cointeration tests are available such as Engle-Granger (1987), Johansen (1991/1992), Johansen-Juselious (1990), Perron (1989, 1997) and Leybourne and Newbold (2003). But as for the empirical analysis, this study will use Autoregressive Distributive Lag (ARDL) bound testing approach developed by Pesaran et al., (2001). Since it the most advanced cointegration method, ARDL has number of advantages over traditional co-integration techniques. It can be applied on mix order of integration and it gives better results for small sample size data. Autoregressive distributed lag model follows this procedure:

$$\begin{aligned} LFRIR_t &= \alpha_1 + \alpha_2 t + \alpha_3 LFRIR_{t-1} + \alpha_4 LFSS_{t-1} + \alpha_5 LLIF_{t-1} + \alpha_6 LURB_{t-1} \\ &+ \alpha_7 LGDPP_{t-1} + \alpha_8 LINF_{t-1} + \sum_{h=1}^{p} \beta_h \Delta LFRIR_{t-h} + \sum_{j=0}^{p} \gamma_j \Delta LFSS_{t-j} \\ &+ \sum_{k=0}^{p} \phi_k \Delta LLIF_{t-k} + \sum_{m=0}^{p} \phi_m \Delta LURB_{t-m} + \sum_{n=0}^{p} \phi_n \Delta LGDPP_{t-n} \sum_{f=0}^{p} \phi_f \Delta LINF_{t-f} + u_{it} \end{aligned} \quad (4)$$

$H_0: \alpha_3 = \alpha_4 = \alpha_5 = \alpha_6 = \alpha_7 = \alpha_8 = 0$ (no co-integration among the variables)

$H_A: \alpha_3 \neq \alpha_4 \neq \alpha_5 \neq \alpha_6 \neq \alpha_7 \neq \alpha_8 \neq 0$ (co-integration among variables)

We will compare the estimated F-Statistic with upper bound value of Pesaran and Pesaran (1997) or Pesaran, Shin and Smith (2001). If calculated, the F-test statistic is greater than the upper bound value, the null hypothesis of no co-integration is rejected. We conclude, there is cointegration among the variables of the model.

As a long run there is a cointegrational relationship among life expectancy, income inequality, globalization, carbon emissions, health infrastructure, availability of food and economic misery. Then a Vector Error Correction Model (VECM) will be used for short dynamic among the variables. VECM procedure is as under:

$$\Delta LFRIR_{it} = \alpha_1 + \alpha_2 t + \sum_{h=1}^{p} \beta_h \Delta LFRIR_{t-h} + \sum_{j=0}^{p} \gamma_j \Delta LFSS_{t-j} + \sum_{k=0}^{p} \phi_k \Delta LLIF_{t-k}$$
$$+ \sum_{m=0}^{p} \phi_m \Delta LURB_{t-m} + \sum_{n=0}^{p} \phi_n \Delta LGDPP_{t-n} \sum_{f=0}^{p} \phi_f \Delta LINF_{t-f} + \omega ECT_{t-1} + u_t \qquad (5)$$

ECT_{t-1} represents one time period lagged error correction term. ECM explains the speed of adjustment from short run to long run. For investigating the optimal lag length Schwarz Information Criteria (SIC) or Akaike's Final Prediction Error (FPE) are used.

VII. Innovative Accounting Technique

The Granger causality test does not determine the relative strength of the causality beyond the selected time span (Shan, 2005); nor does it show the extent of feedback from one variable to the other. To avoid this shortcoming, we employ the innovative accounting approach (IAA) to examine causality between each pair of financial development, economic growth, energy consumption, exports and CO_2emissions. The IAA decomposes forecast error variance and uses impulse response function (IRF). The decomposition is based on the proportion of variation in a series due to its own shocks and those stemming in others (Enders, 1995); and whether the series is strongly impacted. A system of equation is used to examine the impact of one standard deviation shock to the variable on others and also on the future values of the series sustaining the shock (Shan, 2005). For instance, if a shock to financial development affects CO_2emissions significantly but a shock on the latter affects the former minimally, then, we have unidirectional causality from financial development to CO_2emissions. If CO_2emissions explain more of forecast error variance of financial development, then we conclude that CO_2emissions Granger causes financial development. The bidirectional causality exists if shocks in one affect the other and vice versa. If shock to a series has no impact on the other, there is no causality between them.

Impulse response function helps us to trace out the time path of the impacts of shock on variables in the VAR. One can determine how much financial development responds from its own shock and shock in say, CO_2emissions. Financial development causes CO_2emissions if the impulse response function indicates significant response of CO_2emissions to shocks in financial development compared to other variables. A strong and significant reaction of financial development to shocks in CO_2emissions implies that CO_2emissions Granger cause financial development. A VAR system takes the following form:

$$V_t = \sum_{i=1}^{k} \delta_i V_{t-1} + \eta_t$$

where, $V_t = (E_t, F_t, \mathrm{Y}_t, A_t, M_t)$

$$\eta_t = (\eta_C, \eta_F, \eta_{\mathrm{Y}}, \eta_E, \eta_{EX})$$

$\delta_1 - \delta_k$ are four by four matrices of coefficients, and η is a vector of error terms.

VIII. Empirical Findings and Discussions

This study is examining the impact of socio-economic factors on fertility rate in case of Tunisia over the period of 1971 to 2014. Fertility rate is taken as dependent variables whereas women secondary school enrollment rate, life expectancy at birth, urbanization, per capita income and inflation rate are taken as independent variables. The Table 1 presents the descriptive statistics of the model. The results of the Table 1 reveal that women secondary school reenrollment rate, life expectancy and urbanization are negatively skewed. Fertility rate, per capita income and inflation rate are positively skewed. The results show that all variables of the model have positive Kurtosis. The values of Skewness and Kurtosis reveal that all the variables are statistically insignificant which means the model is normally distributed. The estimated values of Jarque-Bera indicate that all the variables have zero mean and finite covariance, this confirms that variables are normally distributed.

Table 1
Descriptive Statistics

	LFIR	LFSSE	LLIFE	LURB	LGDPP	LINF
Mean	1.194813	3.697530	4.209178	4.048760	7.993074	1.657178
Median	1.184790	3.726329	4.259204	4.087018	7.951005	1.602265
Maximum	1.839279	4.553068	4.312173	4.196540	8.549281	3.194367
Minimum	0.693147	2.557670	3.956949	3.791098	7.365562	0.635737
Std. Dev.	0.428748	0.715461	0.104165	0.127676	0.324620	0.588489
Skewness	0.168727	-0.291729	-0.973710	-0.505734	0.192531	0.521824
Kurtosis	1.397105	1.630753	2.731963	1.874219	2.028919	2.794490
Jarque-Bera	4.807304	3.969007	6.923522	4.103724	1.955193	2.027157
Probability	0.090387	0.137449	0.031374	0.128495	0.376214	0.362918
Sum	51.37698	158.9938	180.9946	174.0967	343.7022	71.25866
Sum Sq. Dev.	7.720633	21.49912	0.455714	0.684650	4.425873	14.54542
Observations	43	43	43	43	43	43

This study is based on time series data and normally time series data is non-stationarity. Non-stationary data makes the regression results spurious and policy implications on such type of data are not reliable. Philips Perron (1988) (PP) unit root test is used for removing the non-stationary problem in this study. The results of the unit root are presented in the Table 2. The results show that life expectancy and per capita income are stationary at level whereas fertility rate, women secondary school enrollment rate and inflation are not stationary level. But at first difference all variables of the model becomes stationary. The estimated results of PP unit root test show that all variables of the model have mixed order of integration which is suitable condition for applying ARDL co-integration approach.

Table 2
PP Unit Root Test

	At level		At First Difference	
Variable	t-Stat	Prob.	t-Stat	Prob.
LFIR	-1.320969	0.6110	-1.732988	0.0787
LFSSE	-1.441787	0.5528	-3.390163	0.0171
LLIFE	-9.641981	0.0000	-2.088421	0.0367
LGDPP	-5.212136	0.0001	-2.285735	0.0232
LINF	-1.027650	0.7347	-9.096377	0.0000

Table 3
VAR Lag Order Selection Criteria
Endogenous variables: LFIR LFSSE LLIFE LURB LGDPP LINF

Lag	LogL	LR	FPE	AIC	SC	HQ
0	267.8451	NA	8.30e-14	-13.09226	-12.83892	-13.00066
1	654.7960	638.4689	2.03e-21	-30.63980	-28.86648*	-29.99862
2	703.2010	65.34667*	1.24e-21*	-31.26005*	-27.96673	-30.06929*
3	732.4349	30.69562	2.47e-21	-30.92174	-26.10844	-29.18140

* 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

Considering the number of variables and number of observations in mind and maximum lags required for co-integration approach, 2 maximum lags are allowed for Vector Auto-Regressive process. The results of lag selection criteria are presented in Table 3. Following LR, FPE, AIC and HQ optimal lag length 2 is selected for ARDL bound testing approach.

Autoregressive bound (ARDL) testing approach results are presented in table 4, here fertility rate is dependent variable and women secondary school enrollment rate, life expectancy at birth, urbanization, per capita income and inflation rate are independent variables. F-statistic and W-statistic are used for testing the null hypothesis of no co-integration among the variables of the model. The calculated F-statistic (12.2442) is greater than the upper bound (4.3020) value of Pesaran et al., (2001) at 5 percent and the calculated W-statistic (73.8121) is greater than the upper bound (25.8121) value of Pesaran et al., (2001) at 5 percent. So null hypothesis of no co-integration is rejected and alternative hypothesis is accepted which supports co-integration among the variables of the model. This confirms that fertility rate, women secondary school enrollment rate, life expectancy at birth, urbanization, per capita income and inflation rate have long run relationship in case of Tunisia.

Table 4

ARDL Bounds Testing Approach

Dependent Variable LFIR
ARDL(1,0,1,1,0,1)

Critical Value	**F-Statistics** 12.2442		**W-statistic** 73.4650	
	Lower Bound	**Upper Bound**	**Lower Bound**	**Upper Bound**
95%	2.9591	4.3020	17.7547	25.8121
90%	2.4575	3.6766	14.7448	22.0598

Table 5

Estimated Long Run Coefficients using the ARDL Approach

ARDL(1,0,1,1,0,1)
Dependent variable is LFIR
Time Period 1972-2013

Regressor	**Co-efficients**	**Standard-Error**	**T-Ratio (Prob)**
LFSSE	-.61284	.18689	-3.2792[.003]
LLIFE	1.7932	.86163	2.0811[.046]
LURB	-4.5532	1.3701	-3.3232[.002]
LGDPP	1.5222	.36055	4.2218[.000]
LFIN	-.042604	.039629	-1.0751[.290]
C	2.0059	3.4802	.57637[.568]

The results of Table 4 confirm the existence of co-integration among the variables of the model. Now the long run relationship among the variables of the model can be examined. The long run results of the study are presented in the Table 5. The estimated results reveal that women secondary school enrollment has negative and significant impact on fertility rate in Tunisia. The estimates show that 1 percent increase in secondary school enrollment rate in Tunisia decreases fertility rate by (-0.61284) percent and this relationship is significant at 1 percent. The estimated results reveal that life expectancy has positive and significant relationship with fertility rate. The results show 1 percent increase in life expectancy in Tunisia increases fertility rate by (1.7932) percent. These estimated results support the demographic transition first stage when life expectancy increases fertility rate. The results show that urbanization has a negative and significant relationship with fertility rate in Tunisia. The estimates show that 1 percent increase in urbanization decreases fertility rate by (-4.5532) percent in Tunisia and this relationship is significant at 1 percent. The results show that urbanization is attached with increased time value and better health facilities, so fertility rate tends to be downwards. The results show that per capita income has positive and significant relationship with fertility rate in Tunisia. The estimates show that 1 percent increase in per capita income increases fertility rate by (1.5222) percent in Tunisia and this relationship is significant at 1 percent. The results show that inflation rate has negative but insignificant relationship with fertility rate in Tunisia. The results show that women secondary school enrollment rate and urbanization are playing an important role in decreasing fertility rate in case of Tunisia over the selected time period.

After estimating the long run relationship among the model variables, we can examine the short run dynamic among them through the Vector Error-Correction Model (VECM). The results of short run dynamic are presented in Table 6. The results reveal that secondary school reenrollment rate has a negative and significant relationship with fertility rate. The coefficient of life expectancy reveals that there is a negative and significant relationship between life expectancy and fertility rate in Tunisia. The results indicate that 1 percent increase in life expectancy in Tunisia decreases fertility rate by (-1.4575) percent in short run and this relationship is significant at 5 percent. This shows that life expectancy decreases fertility rate in short run which is opposite to long run. Urbanization and per Capita income have positive and significant relationships with fertility rate in Tunisia. The estimated results show that inflation rate has positive but insignificant relationship with fertility rate in Tunisia. The overall short run dynamic shows that women secondary school enrollment rate and life expectancy decreases fertility rate in short run. ECM has significant and negative value (-.18761) which is theoretically correct. The significant negative value of ECM shows the speed of adjustment from short run to long run equilibrium. The estimates of ECM reveal that short run needs 5 years and three month to converge in the long run equilibrium. This shows that for achieving the lowest level of fertility rate the government of Tunisia should need sound planning because most of socio-economic factors need a long run changes.

Table 6

Vector Error-Correction Model (VECM)

ARDL(1,0,1,1,0,1)
Dependent variable is dLFIR
Time Period 1972-2013

Regressor	**Co-efficients**	**Standard-Error**	**T-Ratio (Prob)**
dLFSSE	-.11498	.041364	-2.7796[.009]
dLLIFE	-1.4575	.54052	-2.6964[.011]
dLURB	3.2887	1.3531	2.4306[.020]
dLGDPP	.28558	.036170	7.8955[.000]
dLINF	.0035595	.0048560	.73301[.468]
ecm(-1)	-.18761	.050831	-3.6909[.001]

R-Squared	.83096	R-Bar-Squared	.78341
S.E. of Regression	.013947	F-Stat. F(6,35)	26.2166[.000]
Mean of Dependent Variable	-.024484	S.D. of Dependent Variable	.029968
Residual Sum of Squares	.0062246	Equation Log-likelihood	125.5599
Akaike Info. Criterion	115.5599	Schwarz Bayesian Criterion	106.8716
DW-statistic	2.0496		

Diagnostic tests are conducted to overview the problem of serial correlation, functional form, normality and Heteroscedasticity among the variables of the model. The estimated results are presented in Table 7. The results of Lagrange multiplier test of residual serial correlation show that there is no serial correlation among the variables of the model. Ramsey's RESET test, using the square of the fitted values, reveal that the model has a correct functional form. Normality based on Skewness and Kurtosis explains that the time series data of all variables is normally distributed. The results show that there is no heteroscedasticity in data.

Table 7

Diagnostic Tests

Test Statistics	**LM-Version**	**F-Version**
A-Serial Correlation CHSQ(1)	.049825[.823]*F(1,31)	.036819[.849]
B-Functional Form CHSQ(1)	.70090[.402]*F(1,31)	.52611[.474]
C-Normality CHSQ(2)	.50183[.778]	Not-applicable
D-Heteroscedasticity CHSQ(1)	3.6980[.054]*F(1,40)	3.8619[.056]

A: Lagrange multiplier test of residual serial correlation
B: Ramsey's RESET test using the square of the fitted values
C: Based on a test of skewness and kurtosis of residuals
D: Based on the regression of squared residuals on squared fitted values

Figure 1

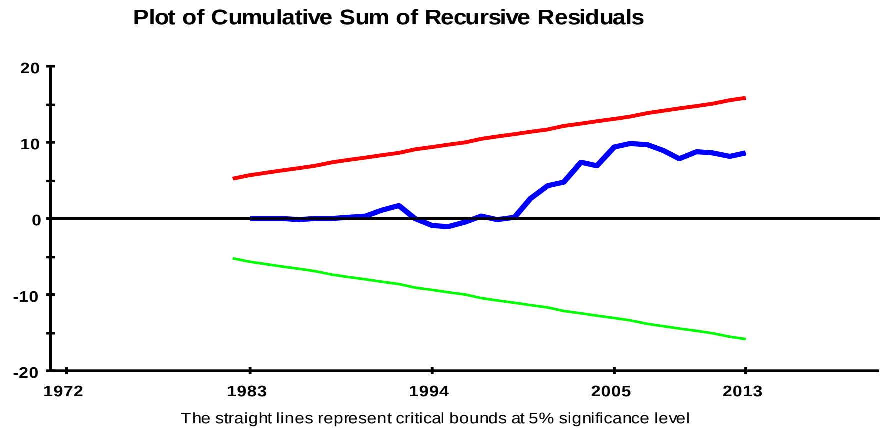
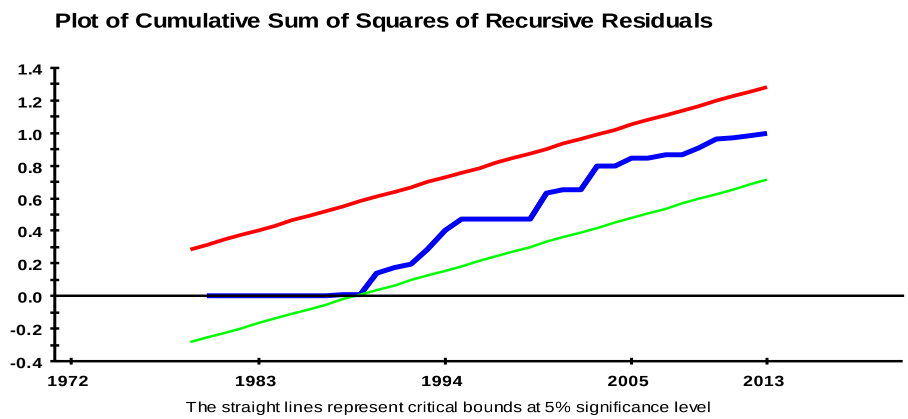


Figure 2



Hansen (1996) mentioned that the misspecification of the model may provide biased results that influence the explanation of the results. The CUSUM and CUSUMsq tests are employed to test the parameters constancy. Further, Brown et al., (1975) pointed out that these test provide help in testing the gradual changes in parameters. The expected value of recursive residual which is zero leads to accept that the null hypothesis of parameter constancy is correct, otherwise not. The plots of both CUSUM and CUSUMsq are shown by Figure-1 and 2 at 5 per cent level of significance. Results indicate that plots of both tests are within critical bounds at 5 per cent level of significance.

There are number of causality approaches available in existing applied econometric literature and the most widely used is the vector error correction method (VECM) Granger causality. The main demerit with the VECM Granger causality is that it only captures the relative strength of causality within a sample period and cannot explain anything out of the selected time period. Further, the VECM Granger approach is unable to identify the exact magnitude of feedback from one variable to another variable (Shan, 2005). To solve this issue, Shan (2005) introduced the new term of Innovative Accounting Approach (IAA) i.e. variance decomposition approach and impulse response function. Under the umbrella of IAA, variance decomposition method (VDM) points out the exact amount of feedback in one variable due to innovative shocks occurring in another variable over the various time horizons. The variance decomposition is considered a substitute of the impulse response function (IRF).The variance decomposition approach indicates the magnitude of the predicted error variance for a series accounted for by innovations from each of the independent variable over different time-horizons beyond the selected time period. It is pointed by Pesaran and Shin (1998) that the generalized forecast error variance decomposition method shows proportional contribution in one variable due to innovative stemming in other variables. The main advantage of this approach is that like orthogonalized forecast error variance the decomposition approach; is insensitive with ordering of the variables because ordering of the variables is uniquely determined by VAR system. Further, the generalized forecast error variance decomposition approach estimates the simultaneous shock affects. Engle and Granger (1987) and Ibrahim (2005) argued that with VAR framework, variance decomposition approach produces better results as compared to other traditional approaches.

Table 8							
Variance Decomposition of LFIR							
Period	S.E.	LFIR	LFSSE	LLIFE	LURB	LGDPP	LINF
1	0.016201	100.0000	0.000000	0.000000	0.000000	0.000000	0.000000
2	0.024200	81.25298	9.105806	5.391841	0.144840	0.569908	3.534625
3	0.032790	70.51080	9.770946	13.14486	0.081121	1.595764	4.896503
4	0.039175	65.57716	8.827608	19.47157	0.283761	1.989237	3.850672
5	0.043869	61.62926	8.282303	23.19437	1.062754	2.734125	3.097188
6	0.047559	58.50956	7.905090	24.65112	2.598413	3.698300	2.637525
7	0.050630	56.12951	7.862934	24.37083	4.425023	4.867861	2.343842
8	0.053465	54.25402	8.428467	22.87225	6.104255	6.170232	2.170777
9	0.056393	52.72773	9.744207	20.75689	7.280436	7.448410	2.042335
10	0.059615	51.52860	11.69620	18.57812	7.753560	8.548335	1.895183
Variance Decomposition of LFSSE							
Period	S.E.	LFIR	LFSSE	LLIFE	LURB	LGDPP	LINF
1	0.029195	6.695877	93.30412	0.000000	0.000000	0.000000	0.000000
2	0.044301	14.64613	80.55856	4.170893	0.029874	0.137217	0.457326
3	0.052489	20.35425	72.36810	5.586112	0.121857	0.772898	0.796782
4	0.057224	25.57540	66.09028	5.189484	0.132120	0.818907	2.193806
5	0.060591	29.79111	61.19226	4.628783	0.330369	0.731440	3.326032
6	0.062995	32.68956	57.93934	4.330083	0.495055	0.757037	3.788931
7	0.064590	34.54473	55.89619	4.155712	0.488252	0.932174	3.982948
8	0.065633	35.61090	54.55068	4.046825	0.525668	1.232001	4.033925
9	0.066452	36.07173	53.50057	3.987919	0.803360	1.647272	3.989152
10	0.067307	36.08974	52.50174	3.999564	1.349100	2.166979	3.892873
Variance Decomposition of LLIFE							
Period	S.E.	LFIR	LFSSE	LLIFE	LURB	LGDPP	LINF
1	0.004288	11.21130	2.963032	85.82566	0.000000	0.000000	0.000000
2	0.006294	6.570926	3.351529	87.00486	0.817433	1.731222	0.524026
3	0.007631	7.116836	5.015394	82.30839	0.895986	2.827571	1.835822
4	0.008443	8.096227	6.150765	79.83104	0.977634	3.176629	1.767709
5	0.009047	8.511646	7.108386	78.36002	0.956131	3.425523	1.638298
6	0.009536	8.672492	7.583922	77.63527	0.887376	3.610123	1.610820
7	0.009961	8.665591	7.746370	77.41790	0.827095	3.758737	1.584311
8	0.010355	8.547504	7.837951	77.41529	0.778590	3.888924	1.531738
9	0.010722	8.391292	7.944079	77.45855	0.739640	3.994434	1.472001
10	0.011063	8.238329	8.060712	77.50597	0.710808	4.066992	1.417187
Variance Decomposition of LURB							
Period	S.E.	LFIR	LFSSE	LLIFE	LURB	LGDPP	LINF
1	0.000997	2.058666	0.010520	2.781480	95.14933	0.000000	0.000000
2	0.001800	4.289291	0.066933	2.565495	92.87904	0.114387	0.084850
3	0.002427	3.067794	2.024205	1.415036	92.67258	0.761804	0.058578
4	0.003026	2.132886	9.887517	1.699935	84.30383	1.662142	0.313692
5	0.003727	3.751912	21.80169	3.233193	68.42677	2.408587	0.377846
6	0.004548	8.116777	31.83673	5.414028	51.56033	2.813460	0.258677
7	0.005466	13.69812	37.56554	7.927145	37.55523	3.021767	0.232186
8	0.006440	18.98670	39.54459	10.51334	27.42272	3.174739	0.357911
9	0.007414	23.23620	39.15916	12.97851	20.70126	3.347335	0.577528
10	0.008331	26.30503	37.59430	15.27799	16.43122	3.572623	0.818847
Variance Decomposition of LGDPP							

Period	S.E.	LFIR	LFSSE	LLIFE	LURB	LGDPP	LINF
1	0.021158	19.60826	11.33670	3.292261	0.392411	65.37037	0.000000
2	0.026014	29.46539	8.453134	8.290301	3.391561	49.30345	1.096161
3	0.029562	27.99844	8.148275	9.033464	3.736317	45.24032	5.843185
4	0.031753	29.04335	8.517489	7.940280	4.816097	44.17973	5.503051
5	0.033720	30.63998	8.799160	7.270948	4.608598	43.43630	5.245014
6	0.035911	31.92635	9.603619	7.721753	4.063730	41.77868	4.905861
7	0.038286	32.85923	10.53684	8.906972	3.723310	39.52892	4.444720
8	0.040580	33.55412	11.00522	10.46245	3.761278	37.23764	3.979289
9	0.042655	33.84188	10.91017	12.23129	4.180975	35.23387	3.601813
10	0.044438	33.65237	10.45713	14.08598	4.861760	33.62012	3.322644
Variance Decomposition of LINF							
Period	S.E.	LFIR	LFSSE	LLIFE	LURB	LGDPP	LINF
1	0.476042	0.187701	0.021427	0.249838	0.314272	0.158270	99.06849
2	0.500012	1.245584	3.867298	0.258202	4.317780	0.412955	89.89818
3	0.518624	1.786776	3.710416	0.266744	4.697469	0.384681	89.15391
4	0.524760	3.290372	3.652599	0.429731	4.882057	0.375758	87.36948
5	0.533900	4.575996	4.510262	0.538304	5.417927	0.501244	84.45627
6	0.541177	5.878035	5.335373	0.548239	5.454377	0.556326	82.22765
7	0.545300	6.816396	5.407696	0.702566	5.426696	0.572834	81.07381
8	0.547384	7.313728	5.366679	0.796429	5.407921	0.602932	80.51231
9	0.548445	7.532009	5.360936	0.834934	5.389266	0.668378	80.21448
10	0.549103	7.610222	5.366086	0.858665	5.384902	0.757808	80.02232
Cholesky Ordering: LFIR LFSSE LLIFE LURB LGDPP LINF							

The results of variance decomposition approach that are reported in Table-8 reveal that a 51.52 percent portion of fertility rate is explained by its own innovative shocks while innovative shocks of women secondary school enrollment rate contribute to fertility rate by 11.69 percent. The results show that innovative shocks of life expectancy contribute to fertility rate by 18.57 percent. The role of urbanization, per capita income and inflation rate is minimal. These variables by their shocks contribute to fertility rate by 7.75 percent, 8.54 percent and 1.89 percent respectively. Fertility rate contribute to women secondary school enrollment rate by 36.08 percent and 52.50 percent innovative shocks are explained by women secondary school enrollment rate by itself. But life expectancy, urbanization, per capita income and inflation rate has very minimal role in explaining the secondary school enrollment in Tunisia. These variables by their shocks contribute to secondary school enrollment by 3.99, 1.34, 2.16 and 3.89 percent respectively. Fertility rate and women secondary school enrollment rate contribute to life expectancy by 8.23 percent and 8.06 percent, whereas 77.50 percent innovative shocks in life expectancy are explained by life expectancy by itself. But urbanization, per capita income and inflation rate has very minimal role in explaining the life expectancy in Tunisia. These variables by their shocks contribute to life expectancy by 0.71, 4.06 and 1.41 percent respectively. Fertility rate, women secondary school enrollment and life expectancy contribute to urbanization by 26.30, 37.59 and 15.27 percent respectively. The innovative shocks of urbanization 16.43 percent are explained by urbanization itself. But as for per capita income and inflation rate, they have very minimal role in explaining urbanization in Tunisia. These variables by their shocks contribute to urbanization by 3.57 and 0.81 percent respectively. Fertility rate, women secondary school enrollment and life expectancy contribute to per capita income by 33650, 10.45 and 14.08 percent respectively. The innovative shocks of per capita income 33.62 percent are explained by per capita income itself. But urbanization and inflation rate have very minimal role in explaining per capita income in Tunisia. These variables by their shocks contribute to per capita income by 4.86 and 3.32 percent respectively. Fertility rate, women secondary school enrollment and urbanization contribute to inflation rate by 7.61, 5.36 and 5.38 percent respectively. The innovative shocks of inflation rate 80.02 percent are explained by inflation rate itself. But per capita income and life expectancy have very minimal role in explaining inflation rate in Tunisia. These variables by their shocks contribute to urbanization by 0.75 and 0.85 percent respectively. Overall, results find the feedback effect between fertility rate and women secondary school enrollment rate, and between fertility rate and urbanization. The results show that there is bidirectional causality running between fertility rate and women secondary school enrollment rate, and between fertility rate and urbanization in case of Tunisia. There is an unidirectional causality running from per capita income to fertility rate. The results show there is unidirectional causality running from life expectancy to fertility rate in case of Tunisia.

Normally, the impulse response function is considered an alternative to the variance decomposition method. Nevertheless, it gives us detailed information on how long and to what extent the dependent variable reacts to a shock stemming in the independent variables. The results indicate that the response in fertility rate due to forecast error stemming in women secondary school enrollment rate initially decreases but after a 2^{nd} time horizon, it goes upward and remains stable till the 7^{th} time horizon. After the 8^{th} time horizon, it is showing a stable decreasing trend. Due to forecast error stemming in life expectancy, the results show that the response in fertility rate initially rises to reach the peak and after 5^{th} time horizon it declines. Due to forecast error stemming in urbanization, the results show that the response in fertility rate has a continuous decreasing trend. Due to forecast error stemming in per capita income, the results show that the response in fertility rate has increasing relationship with per capita income. The estimated results show that no significant changes have occurred in fertility rate due to forecast error stemming in inflation rate. When women secondary school enrollment rate is the dependent variable, the results show that response in women secondary school enrollment rate is minimal and this is due to forecast error stemming in fertility rate.

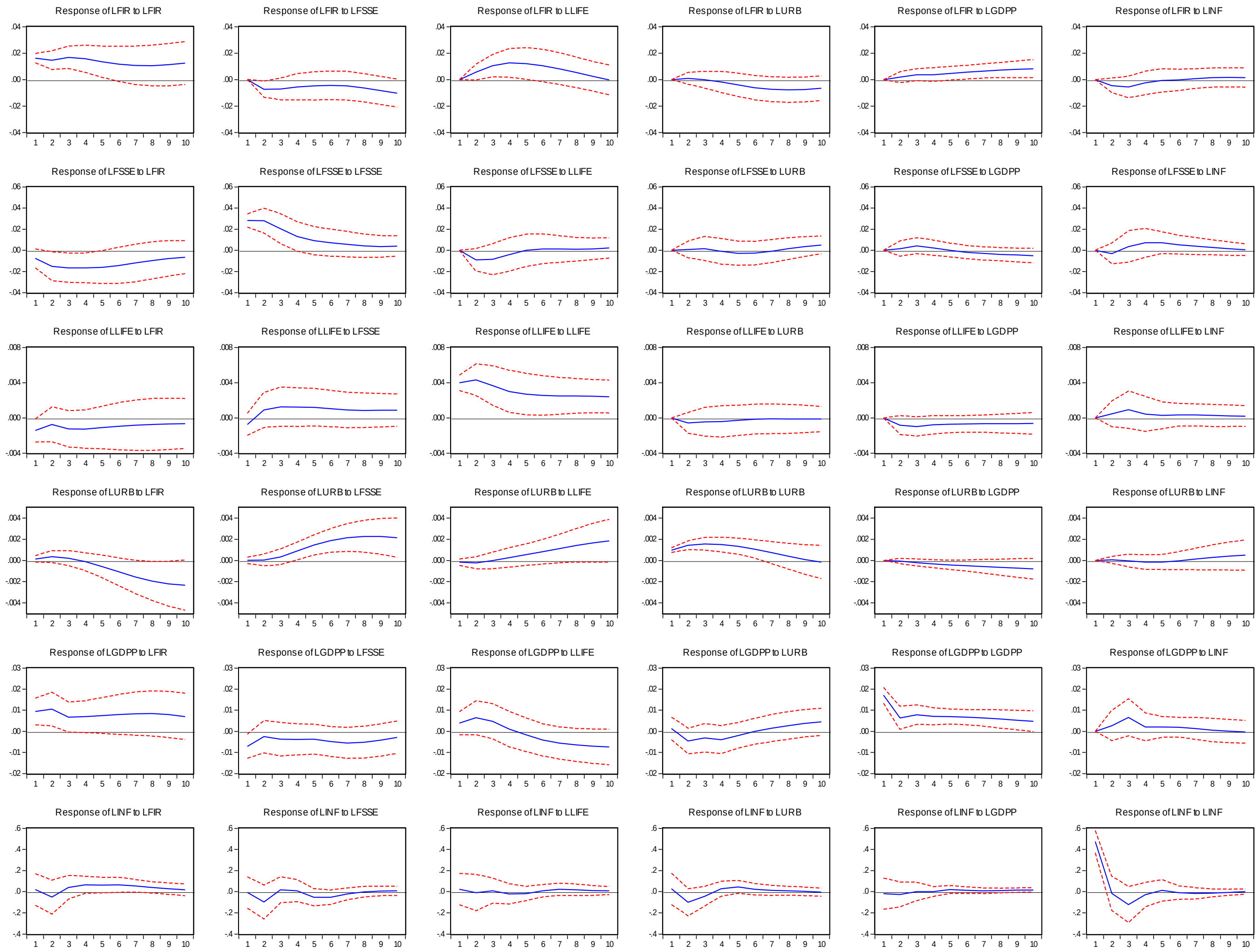
The results show that the response in secondary school enrollment rate from forecast error stemming in life expectancy, urbanization, per capita income and inflation rate is minimal. The results show that life expectancy response to fertility rate, women secondary school enrollment, urbanization, per capita income and inflation rate is very minimal. The results also show that when urbanization, per capita income and inflation rate are the dependent variables, they get little fluctuations in response. Following our main model, the overall results show that all independent variables appear to have causality with fertility rate in Tunisia over the selected time period. This means that all independent variables positively contribute to forecast fertility rate in Tunisia.

IX. Conclusions and Policy Recommendations

This study has investigated the impact of socio-economic factors on fertility in Tunisia over the period of 1971 to 2014. Fertility rate is taken as dependent variables whereas women secondary school enrollment rate, life expectancy at birth, urbanization, per capita income and inflation rate are taken as socio-economic independent variables. PP unit root test is applied for examining the unit root problem of the data. This study has applied ARDL bound testing approach for co-integration among the variables of the model. Innovative Accounting Approach (IAA) is used for exploring the causal relationship between the model variables. The results of the PP unit root test approve the mix order of integration among the selected variables. The estimated results of ARDL bound testing approach show that there is a co-integration among the model variables. Women secondary school enrollment and urbanization appear to have a negative and significant impact on fertility rate in Tunisia. Whereas per capita income and life expectancy have positive and significant relationship with fertility rate. This shows that Tunisia is still at the first stage of its demographic transition. The short dynamic results show that the same type of relationship existed among independent and dependent variables. The ECM estimates reveal that short run needs around 5 years and three month to converge in the long run equilibrium. The variance decomposition and impulse response function results reveal that there is a causal relationship between all explanatory variables and the dependent variables. So if the Government of Tunisia wants to reduce fertility rate it has to improve women secondary school enrollment and urbanization and those steps should be taken in the coming years in order to affect the Tunisian demographic transition.

Figure 3

Response to Cholesky One S.D. Innovations ± 2 S.E.



References

Abdullah, M., Chani, M. I., Ali, A., and Shoukat, A. (2013). Co-Integration Between Fertility and Human Development Indicators: Evidence from Pakistan. *Middle-East Journal of Scientific Research*, *15*(4), 586-591.

Adhikari, R. (2010). Demographic, socio-economic, and cultural factors affecting fertility differentials in Nepal. *BMC pregnancy and childbirth*, *10*(1), 1.

Ainsworth, M., Beegle, K., and Nyamete, A. (1996). The impact of women's schooling on fertility and contraceptive use: A study of fourteen sub-Saharan African countries. *The World Bank Economic Review*, *10*(1), 85-122.

Bettio, F., and Villa, P. (1998). A Mediterranean perspective on the breakdown of the relationship between participation and fertility. *Cambridge Journal of Economics*, *22*(2), 137-171.

Bloom, D. E., Canning, D., Fink, G., and Finlay, J. E. (2009). Fertility, female labor force participation, and the demographic dividend. *Journal of Economic Growth*, *14*(2), 79-101.

Brown, R. L., Durbin, J., and Evans, J. M. (1975). Techniques for testing the constancy of regression relationships over time. *Journal of the Royal Statistical Society. Series B (Methodological)*, 149-192.

Coale, A. J. (1967). The voluntary control of human fertility. *Proceedings of the American Philosophical Society*, *111*(3), 164-169.

Dickey, D. A., and Fuller, W. A. (1979). Distribution of the estimators for autoregressive time series with a unit root. *Journal of the American statistical association*, *74*(366a), 427-431.

Dickey, D. A., and Fuller, W. A. (1981). Likelihood ratio statistics for autoregressive time series with a unit root. *Econometrica: Journal of the Econometric Society*, 49, 1057-1072.

Enders, W. (1995). Applied economic time series. *Iowa State University*.

Engle, Robert F. and C. W. J. Granger (1987). Co-integration and error correction: Representation, estimation, and testing. *Econometrica*, Volume 55(2), 251-276.

Ellis, F. (1988). *Peasant Economics: Farm Households and Agrarian Development*. Sydney, Australia: Cambridge University Press.

Galloway, P. R., Hammel, E. A., and Lee, R. D. (1994). Fertility decline in Prussia, 1875–1910: A pooled cross-section time series analysis. *Population Studies*, *48*(1), 135-158.

Goldin, C. (1994). *The U-shaped female labor force function in economic development and economic history* (No. w4707). National Bureau of Economic Research.

Hansen, P., and King, A. (1996). The determinants of health care expenditure: a cointegration approach. *Journal of health economics*, *15*(1), 127-137.

Ibrahim, M. H. (2005). Sectoral effects of monetary policy: evidence from Malaysia. *Asian Economic Journal*, *19*(1), 83-102.

International Conference on Population and Development Programme of Action (1994). United Nations, Report of the conference on Population and development Cairo, Egypt.

Johansen, S. (1991). Estimation and hypothesis testing of cointegration vectors in Gaussian vector autoregressive models. *Econometrica*, Volume 59(6), 1551-1580.

Johansen, S. and K. Juselius (1990). Maximum likelihood estimation and inference on cointegration—With application of demand for money. *Oxford Bulletin of Economics and Statistics,* 52(2), 169-210.

Johansen, S. (1992). Cointegration in partial systems and the efficiency of single-equation analysis. *Journal of Econometrics,* 52(3), 389-402.

Kreider, A., Shapiro, D., Varner, C., and Sinha, M. (2009, December). Socioeconomic progress and fertility transition in the developing world: evidence from the Demographic and Health Surveys. In *International Union for the Scientific Study of Population International Population Conference, Marrakesh, Morocco, September27-October* (Vol. 2, p. 2009).

Kravdal, Ø. (2002). Education and fertility in sub-Saharan Africa: Individual and community effects. *Demography*, *39*(2), 233-250.

Leybourne, S. J., and Newbold, P. (2003). Spurious rejections by cointegration tests induced by structural breaks. *Applied Economics*, *35*(9), 1117-1121.

Lloyd, C. B., Kaufman, C. E., and Hewett, P. (2000). The Spread of Primary Schooling in Sub-Saharan Africa: Implications for Fertility Change. *Population and Development Review*, *26*(3), 483-515.

Mammen, K., and Paxson, C. (2000). Women's work and economic development. *The Journal of Economic Perspectives*, *14*(4), 141-164.

Nelson, C. R., and Plosser, C. R. (1982). Trends and random walks in macroeconomic time series: some evidence and implications. *Journal of monetary economics*, *10*(2), 139-162.

Notestein, F. W. (1953). *Economic problems of population change* (pp. 13-31). London: Oxford University Press.

Pesaran, M. H., and Shin, Y. (1997). An autoregressive distributed-lag modelling approach to cointegration analysis. *Econometric Society Monographs*, *31*, 371-413.

Pesaran, M. H., Shin, Y. and Smith, R. J. (2001). Bound Testing Approaches to the Analysis of level Relationships. *Journal of Applied Econometric*, 16(3), 289-326.

Perron, P. (1997). Further evidence of breaking trend functions in macroeconomic variables. *Journal of Econometrics*, Volume 80(2), 355-385.

Perron, P. (1989). The great crash, the oil price shock, and the unit root hypothesis. *Econometrica: Journal of the Econometric Society*, 57(6), 1361-1401.

Phillips, P. C. B. and P. Perron (1988). Testing for a unit root in time series regression. *Biometrika*, Volume 75(2), 335-346.

Potter, J. E., Schmertmann, C. P., and Cavenaghi, S. M. (2002). Fertility and development: Evidence from Brazil. *Demography*, *39*(4), 739-761.

Sackey, H. A. (2005). *Female labour force participation in Ghana: The effects of education* (Vol. 150). African Economic Research Consortium.

Schultz, T. P. (1973). Explanation of birth rate changes over space and time: A study of Taiwan. *Journal of Political Economy*, *81*(2), S238-S274.

Shan, J. (2005). Does financial development ‘lead' economic growth? A vector auto-regression appraisal. *Applied Economics*, *37*(12), 1353-1367.

Singh, R. D. (1994). Fertility‐Mortality Variations Across LDCs: Women's Education, Labor Force Participation, and Contraceptive‐Use. *Kyklos*, *47*(2), 209-229.

Srinivasan, T. N. (1994). Data base for development analysis Data base for development analysis: An overview. *Journal of development Economics*,*44*(1), 3-27.

Thompson, W. S. (1942). *Population Problems*. New York: McGraw-Hill Book Company, Inc.

United Nations. Dept. of International Economic. (1985). *Women's employment and fertility: a comparative analysis of world fertility survey results for 38 developing countries* (No. 96). United Nations Pubns.

United Nations (2004).Fertility trends in world. (No. 100).

Vavrus, F., and Larsen, U. (2003). Girls' Education and Fertility Transitions: An Analysis of Recent Trends in Tanzania and Uganda*. *Economic development and cultural change*, *51*(4), 945-975.

Zivot, E., and Andrews, D. W. (1992). Further Evidence on the Great Crash, the Oil-Price Shock, and the Unit-Root. *Journal of Business and Economic Statistics*, *10*(0), 3p.