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Fertility and Mortality Rates, and the Nigerian Population: An Empirical Investigation

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ABSTRACT

In spite series of programme of actions embark upon by the United Nation in 1990s globally to address the population issues in the broader contexts of reproductive health and development, the decline in population growth still persists in developing countries (Nigeria inclusive). Given the above, this study is out to investigate the interrelationship between fertility rate, mortality rate, and the growth of Nigerian population which have not been considered simultaneously in the existing literature. The study used annual time series data spanning between 1980 and 2017. A five-variable of interest were analyzed using Structural Vector Autoregressive (SVAR) model, comprising two of its conventional analysis-impulse response functions(IRFs) and forecast error variance decomposition (FEVD). Quite insightful findings emanated from the study. Result from SVAR impulse response functions revealed that shocks to mortality and fertility rates exhibited mixed influence on population growth rate in Nigeria. Notably, the variables in question had both negative and positive effect on population growth in the country. While Variance Decomposition analysis result showed that in the long run, mortality and fertility rates exerts a greater influence as more shocks occur on the growth rate of population in Nigeria. Findings from the study showed that the more declines in mortality rate, the higher the growth rate of population while fertility rate exerts a greater influence on Nigerian population. This will further increase labourers leading to potential long term economic growth and development. The study therefore recommends synergy between the Nigerian government and policymakers to design a framework that will further improve the reproductive health services and healthy of Nigerian in the midst of enhanced rapid population growth in the country. Policymakers should also take cognizance of these variables in question while formulating health policy in the country.

KEYWORDS: Fertility Rate, Mortality Rate, Population Growth Rate, (SVAR) model, Nigeria

I. INTRODUCTION

In spite series of programme of actions embark upon by the United Nation in 1990s globally to address the population issues in the broader contexts of reproductive health and development, the decline in population growth still persists in developing countries most especially in Nigeria. Thus, this have been a major concern to both stakeholders, policymakers and the Nigerian academician. Given the above, the pattern of population distribution could have a major implications for the country's development and on the nation's post independence history, using relevant macroeconomic and health variables such as, fertility rate, infant mortality, under-five-mortality, population growth rate among others. For instance, infant (and child) mortality are connected with fertility in different ways, including but not limited to the reductions in infants and child mortalities used to be regarded as a key trigger for the fertility transition thereby reduces the demand for children by improving the chances of survival to adulthood, which hitherto shown an inverse relationship on population growth in the country. Although, there are other analyses that strongly suggest that continuing high rates of infant and child mortality are significant barriers to fertility decline in Sub-Saharan Africa (Bongaarts, 2008). Theories like demographic transition have shown that prior to modernization, societies are characterized by high mortality and fertility levels. Thus, with improvements in health and living conditions, mortality rates declines and thereafter as the development continues, fertility levels follow (Kibirige, 1997). Much of this rise may have resulted from a sharp decline in mortality among infants younger than one year and children ages one to five. Evidently in Figures 1, 2 and 3 of this study, infant mortality was estimated to have declined 124.5% from 152 per 1,000 live births in 1993 to 64.6% in 2017, while child mortality declined by 100% from 209.7 to 108.7 per 1,000 live births in 1994 and 2015 respectively. These levels are likely to continue to fall, thereby exerting continuing upward pressure on the population growth rate from 2.5% in 2000 to 2.8% for the year 2012 and beyond (Eli, Mohammed & Amade, 2015).

Fig. 1: Contribution of Infant Mortality to Population Growth Rate

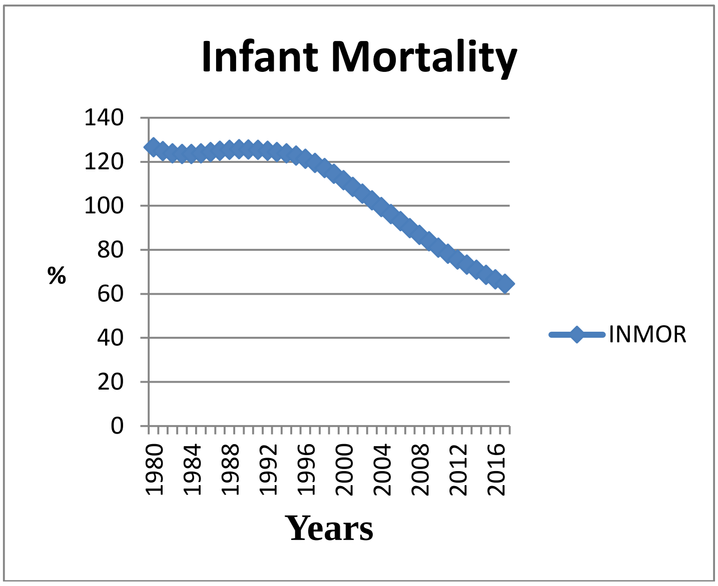
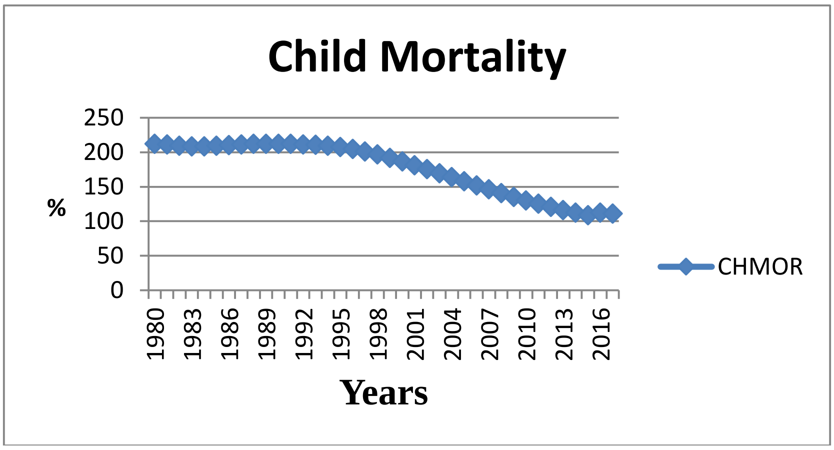
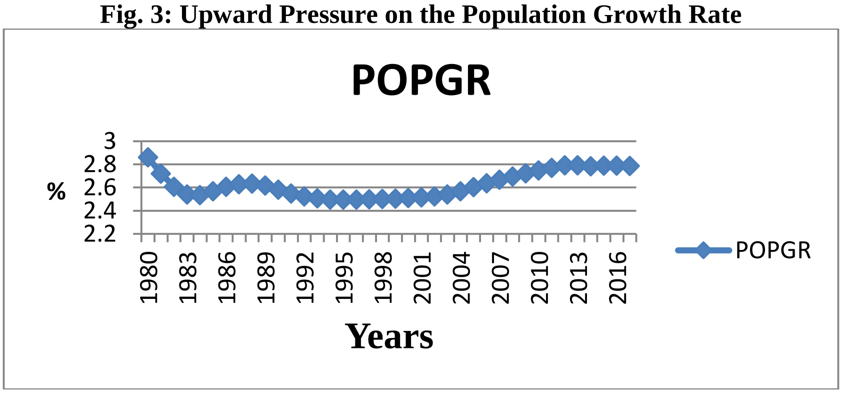


Fig. 2: Contribution of Child Mortality to Population Growth Rate



Source: Constructed by the Author based on data from WDI, 2017

Fig. 3: Upward Pressure on the Population Growth Rate



Source: Constructed by the author based on data from WDI, 2017

To this end, empirical findings had shown the mixed evidence on the relationship between fertility rate, mortality rate and their major determinants in relation to population dynamics. For instance, Eli *et al.*, (2015) identified that, population booms were positive indications of the potential for long term economic growth. Hence, high fertility rates during these times allowed for increased labourers and also helped overcome the correspondingly exorbitant death rates. Tsui and Li Liu (2016) revealed and concludes that SSA countries may accelerate the catch-up process in reducing fertility by investing more in family planning program, which in turn will leads to a more favourable dependency ratio and consequently facilitate a demographic dividend opportunity in SSA. Adeyele and Ofoegbu (2013) reveals positive linear association between infant and child mortality and each of the variables serving as indicators for women's status, while higher level of educational attainment exhibited negative impact on infant and child mortality in the country. While, Hillard, Hooper, Stieglitz, McAllister and Gurven (2012) shown tangible trade-offs between fertility and infant mortality in a population transition of Bolivia.

In addition, Oloo's study (2005) also gesticulates on child mortality as a function of fertility rates, HIV prevalence, female literacy rates, GDP per capita, health expenditure per capita, immunization rates, proportion of doctors and nurses to the population, and access to safe drinking water. However, the study also shown mixed relationships. That is positive and negative between child mortality and both fertility rates and HIV prevalence and as well between child mortality and both female literacy and access to safe drinking water respectively, which definitely will have dual influence on population growth in the country. The most concerns effect is the decline in the population growth rate, that remains deleterious in some sub-Saharan Africa countries particularly Nigeria despite series of programme of actions instituted by UN in several decades globally to address the population issues in the broader contexts of reproductive health and development. However, the major reasons may not far reached as a result of the balance between the demand for smaller families and the supply of birth control technology in the country's healthcare centres. Other important factors were likely to include the availability of health care, birth control information and equipment in both rural and urban areas, the rate of expansion of education and as well the general pace of economic development. If the pattern of change in Africa were to follow, just like in other parts of the world; per capita income, urbanization, improved health care economic development, education (literacy rate), increased availability of birth control, and declining infants mortality would eventually lead to a marked decline in fertility rates. Which according empirical findings, a number another factors might have led to this; ranging from the use of contraception, fertility preferences, educational levels of women, women's status, and age structure of the society are the most important determinants (Angeles, 2004).

Several studies conducted in Nigeria have either examined the impact of population dynamics on economic growth or its determinants in Nigeria with no intense emphasis on the interrelationship between fertility rate, mortality rate and the growth of Nigerian population. Moreover, most of these studies had not critically analyzed the theme simultaneously applying Structural Vector Auto-regressive (SVAR) technique using its two conventional analysis-impulse response functions (IRFs) and forecast error variance decomposition (FEVD). Hence, findings from these studies have been inconclusive and as well lack of consistent in the literature which lends justification to the analysis that we pursue in this study. On this premises, this study sought to analyze the interrelationship between fertility rate, mortality rate and the population growth in Nigeria. The rest of the study via objective is organised as follows. Section two reviews the extant literature. Methodology and data sources are outlined in Section three. Section four reports and interprets the empirical results. Section five concludes the study along side with policy recommendations arising from the findings.

II. LITERATURE REVIEW

Conceptual Literature: Population growth represents the increase in the number of individual in a population. On the other hand, it represents the number of persons added to (or subtracted from) a population in a year due to natural increase and net migration expressed as a percentage of the population at the beginning of the time period (Beaie & Acol, 2009). It is an indication of an increase in a country's population during a period of time usually a year, expressed as a percentage of the population at the start of the period. It reflects the number of births and deaths during the period and the number of people migrating to and from a country. In a nutshell, population growth is primarily the result of a rapid transition from a long historical era characterized by high birth rate especially in the developing countries (Todaro & Smith, 2011). Population dynamics comprises trends and changes in population growth, migration, urbanization, population density, age structures (Royal Society, 2012). Population growth occurs mainly in developing countries and this tends to have negative influence on poverty alleviation and the already fragile economic growth through putting undue pressure on investment in health, education and other basic services. With a high birth rates and a high level of people in their reproductive ages, populations of the least developed countries are projected to increase from 830 million in 2010 to 1.7 billion by 2050 and to almost triple to 2.5 billion by 2085 (UNDP, 2011).

Fertility: the total fertility rate (TFR) sometimes also called the fertility rate, absolute or potential nasality, period total fertility rate (PTFR), or total period fertility rate (TPFR) of a population is the average number of children that would be born to a woman over her lifetime if she were to experience the exact current age-specific fertility rates (ASFRs) through her lifetime, and she were to survive from birth to the end of her reproductive life. Hence, it is obtained by summing the single-year age-specific rates at a given time (WPP-UN, 2015). Therefore, fertility becomes an important predictor of maternal mortality, with high fertility levels associated with high maternal mortality (Shen & Williamson, 1999). By addressing fertility issues in line with the theoretical models and research evidence on determinants of fertility, the Programme of Action provides a solid basis in influencing a major component of population dynamics such as fertility, which in turn should have an impact in reducing maternal deaths. The human female is generally fertile from early teens to about mid-forties. The human male generally remains fertile throughout adulthood, though sperm count and quality diminish from middle-age onward. In the absence of a conscious effort to control the size of families, the larger the fraction of the population who are in the fertile age range the more rapid will be the population growth, and this will influence the average age of the population structure towards the younger end of the spectrum.

Mortality rate: measure the number of deaths (in general, or due to a specific cause) in a particular population, scaled to the size of that population, per unit of time. Mortality rate is typically expressed in units of deaths per 1,000 individuals per year; thus, a mortality rate of 9.5 (out of 1,000) in a population of 1,000 would mean 9.5 deaths per year in that entire population, or 0.95% out of the total. However, the effect of mortality on population structures is to reduce the component of the population in which the mortality occurs. Historically, the most dangerous ages were infancy and old age (variously reckoned according to circumstances). In addition, some epidemics of infectious diseases such as Spanish 'flu; had their highest mortality among young adults, whose immune systems were presumably insufficiently primed. It is expected that the forecast bird 'flu epidemic will behave similarly. War differentially reduces the proportion of younger men. The majority of infectious diseases of early childhood have been reduced by immunization, and improved nutrition and hygiene have rendered childhood safer. Antibiotics, welfare state, and improvements in medical, surgical, and palliative care have resulted in great increases in life expectancy in the developed world, where life expectancy is now in the middle to upper 70s or lower 80s, and rising every year. The effect of this is to raise the population in the upper age groups substantially. Women have higher life expectancy than men wherever they live. The tendency of people to retire to particular resorts means that in some parts of the South Coast of England the average (arithmetic mean) age of the population is only just below retirement age. The down side of this is that the extended lives are often lived in bad health, as the treatments people receive may keep them alive but do little to ameliorate the underlying pain or disability brought on by the diseases, and virtually nothing for the various forms of senile dementia that are increasingly encountered.

III. THEORETICAL LITERATURE

The theoretical relationship between fertility rate, mortality rate and population dynamics changes overtime as a result of macroeconomic and health related variables fluctuations. Evidence revealed that, there is no clear theoretical conclusion on the effect of fertility and mortality rates on population boom. A number of studies have critically analyzed a bi-directional relationship between fertility and juvenile mortality risks using life history theory derived from evolutionary biology as rightly put forth by Blurton-Jones (1986); and also used by Hillard *et al.,* (2012). This theory posits that, organisms face a trade-off between quantity and quality of offspring. Increasing fertility reduces available time and energy to invest in each individual offspring, increasing their likelihood of dying. At the same time, for organisms that engage in post-natal investment in offspring (including all birds and mammals), the death of an existing offspring releases time and energy for the mother to invest in new replacement offspring. The theory proposes that natural selection results in organisms possessing characteristics that will tend to maximize biological fitness, often measured by the number of surviving offspring they produce. Furthermore from this theory is that, the effect of an exogenous reduction in mortality risks to offspring will depend on how it affects the trade-off between quantity and quality of offspring. By increasing the number of existing offspring demands on the mother, reductions in mortality will tend to reduce fertility, but if the cause of reduced mortality is due to an increase in available resources, organisms may respond by increasing fertility, if that will increase their fitness. Hence, for most organisms, populations will eventually return to equilibrium due to resource constraints. The second justification theories for this study is the one developed by Coale and Watkins (1987) called ‘‘Demographic Transition Theory (DTT). Notably, demographic transition model represents the process by which fertility rates eventually decline to replacement levels and as well summarizes change in population growth over time. This theory also posits that mortality rates for infants and children drive fertility rates, mediated through cultural, social and psychological processes. Those social processes have the effect of keeping population size stable. Under conditions of high mortality, high fertility rates are required to keep populations from shrinking. When there is a transition from high to low mortality rates, cultural processes, albeit with some lags, will result in reduced fertility rates. After a period of rapid growth, the population returns to stable equilibrium.

Empirical Evidences : The relationship between fertility rate, mortality rate and the population growth is quite a well researched topic, with special and primary focus on the recent studies that relate to Nigeria and other countries in sub-Sahara Africa that share similar characteristics together. Adeyele and Ofoegbu (2013) examined the influence factors of infant and child mortalities in Nigeria using Survey data from the National Health Demographic Survey. The simple regression estimation technique was employed to investigate the effects of some selected socio-economic variables on infant and child mortality. The selected variables include; the educational attainment of mothers, place of delivery, women's status respecting decision making in the house-final Say on Mother's Health Care, final Say on Making Large Household Purchases, final Say on Making Household Purchases for Daily Needs, final Say on Visits to Family or Relatives, final Say on Deciding What to do With Money Husbands Earns. The study reveals that there exist positive linear association between infant and child mortality and each of the variables serving as indicators for women's status. The study concludes that higher level of educational attainment exhibited negative impact on infant and child mortality in the country.
Odusina (2009) analyzed the implications of a rapidly Growing Nigerian Population: a review of literature with a specific reference to its history and growth by reviewing the available literature and documents. The study shown the analysis of efforts made by different governments as regard population policies to influence demographic variables, increase welfare and standard of living of people and why some of these policies failed or ineffective. The study concludes and recommends that Nigeria needs to design an intervention programmes that will help in reducing population growth rate, stimulate socio-economic development and achievement of Sustainable Development Goals. While government should create an enabling environment that will facilitate savings, investment, innovation, entrepreneurship and technical know-how.

Aidi, Emecheta and Ngwudiobu (2017) examined the relationship between population growth and economic growth in Nigeria using annual time series data covering the period of 1970 to 2013. Granger-Causality was used as estimation technique to capture the objective of the study. Empirical result of the study showed that neither economic growth (GDPGR) Granger caused population growth (POPGR) nor population growth (POPGR) Granger caused economic growth (GDPGR) within the study period with no causal link between among the variables. The study thus recommended that the Nigerian government should invests more in education/human capital development which will further spurs the quantity and quality of the labour force towards positive impact on economic growth in the long-run.

Adediran (2012) examines the effect of population on economic development in Nigeria using trend analysis with the scope spanning between 1981 and 2007. The study adopted ordinary least square method using the Phillips-Perron (PP) non-parametric unit root test for time series variables. The study showed that real gross domestic product, population growth and per capita income are non-stationary at levels, but the null hypothesis of non stationary is rejected at first difference for the models with intercept and trend. The study concludes that population growth has positive and significant impact on economic sustainability proxied as real gross domestic product (RGDP) and per capita income.

Bekele (2011) examined the determinants of high fertility status among married women in Kersa district, Ethiopia: a case control study using simple random sampling method. The study used Backward logistic regression techniques to analyze the data. The result revealed that, the mean number of children per women in the high fertile group was 7.25 and while it was 2.83 in the low fertile group. Under-five mortality affected number of children ever born alive significantly (Adjusted OR= 634, 95% CI: (3.43,11.73). Age at first birth, Number of children desired before marriage and desire more additional children currently were the other variables that showed significant associations with the level of fertility. Measures taken to decrease under-five mortality are believed to decrease fertility status besides promoting child survival with expanding interventions to reduce the high under-five mortality rate through child health services, is recommended.

Tartiyus, Daud, and Peter (2015) evaluates the impact of population growth on economic growth in Nigeria using secondary data spanning between 1980-2010. The data were analysed using descriptive statistics as well as regression analysis. The result revealed that there is a positive relationship between economic growth (proxied by GDP growth) and population, fertility and export growth; while negative relationships were found between economic growth (proxied by GDP growth) and life expectancy, and crude death rate. The study

recommends among others that the average population growth rate of Nigeria should be maintained since it is found to impact positively on economic growth in Nigeria within the period of study and that measures should be adopted to check the crude death rate of Nigeria as it affects economic growth negatively. Tsui and Li Liu (2016) examine the impact of mortality and fertility on demographic dividend in low and middle-income countries of Asia, Latin America and the Caribbean (LAC), Northern Africa, and sub-Sahara Africa (SSA): an analysis of 201 countries from 1960 to 2015. Result showed that the child dependency ratio (0-14 years), per 100 working age population (15-64 years), would be 54 higher than the observed level in 2015 both in Asia and LAC, had their fertility not declined. This implies that every 100 working age population would need to support an additional 54 children. The result further showed that child dependency ratio would only be 16 higher if there were no fertility decline in SSA as a result of less substantial fertility decline. Global GDP (constant 2011 international $) would be $19,016 billion less than the actual level in 2015 had the fertility decline during 1960-2015 not occurred, while the respective regional decreases are $12,390 billion in Asia, $1,985 billion in LAC, $484 billion in Northern Africa, and $321 billion in SSA.
The study concludes that, SSA countries may accelerate the catch-up process in reducing fertility by investing more in family planning programs. This will lead to a more favourable dependency ratio and consequently facilitate a demographic dividend opportunity in SSA, however, if properly utilized, will spur economic development for the coming decades.

Craig (2011) analyzed replacement level fertility and the future population growth in United Kingdom. Result showed that replacement level fertility leads to zero population growth as a result of constant mortality rates, which further implies that migration has no effect. In addition, the momentum of past and current demographic trends takes several generations to work itself out. A change to replacement level fertility therefore leads to zero population growth only in the long run. The size of the population at which population growth levels off will usually differ from the current population size. The study concludes that in a countries with high infant and child mortality rates, however, the average number of births need to be much higher. Fehr, Jokisch, and Kotlikoff (2004) analyzed the effects of changes in fertility and mortality on the developed world's demographic transition in three regions- the U.S., Japan, and the EU-15 using dynamic general equilibrium model. The model incorporates age and time-specific fertility and mortality rates, detailed fiscal institutions, and international capital mobility, subject to adjustment costs. The result of the simulations confirmed the offsetting fiscal and economic consequences of both higher fertility and lower mortality rates. The simulations indicates very minor effects on the developed world's rather bleak baseline transition path from either major increases in fertility rates or major reductions in mortality rates.

Hillard, Hooper, Stieglitz, McAllister, and Gurven (2012) examines the causal relationship between fertility and infant mortality: Prospective analyses of a population in transition among the Tsimane of low-land Bolivia using prospective data collected between 2002 and 2010. Result showed that the loss of an infant leads to an earlier progression to the next birth, as do prospective measures of maternal health and energy balance. The total fertility rate is about 9.0, but greater integration with the Bolivian market and educational system is associated with lower fertility rates. The data indicate tangible trade-offs between fertility and infant mortality. Infants of first-time mothers who delay reproduction show significantly improved survival rates. For parous mothers, short inter-birth intervals increase the mortality risks of subsequent infants. Infant mortality significantly predicted indicators of mother's nutritional and health status.

Akeju (2015) examined the impact of population momentum on economic development in Nigeria using both macro and micro study analysis involving primary and time series data from 1980 to 2013 while the micro analysis using primary data are sourced from respondents across population samples from the six geopolitical zones. Result from macro level showed that fertility rate, high population growth rate and dependency ratio exhibited negative effects on the growth of per capita income in the country. While micro level result showed an inverse influence of large family size on income and human development index in Nigeria. The study recommends the adoption of fertility rate reduction policies which should revolve around the cultural norms, values and religions of each region. Massive awareness campaign must be carried out to sensitize the people on the need for child spacing in the country.

IV. METHODOLOGY

Theoretical Framework : The theoretical framework adopted for this study is based on the neoclassical growth theory as evidence from Solow-Swan growth model (Grabowski & Shields, 1996; Barro & Sala-i-Martin, 2004). According to this theory, the growth in per capita income can be achieved either by increased savings or reducing rates of population growth. Therefore, if the population grows more slowly, less savings and investment will be required for capital widening, which in turn may caused increase in infant mortality and fertility rates and as well leads to capital deepening. In furtherance allusion to this framework, neoclassical model demonstrates the influences of population growth, capital accumulation and technical progress on the growth rate of national income and per capita real income over time. In addition, this model assumes constant returns to scale and diminishing marginal returns to factors of production, the output per individual in the country, population growth and capital depreciate rates.

Model Specification : The model for this study take its root from Hillard *et al.*, (2012) in concordance with Solow-Swan growth of Ak^{π} model (Barro & Sala-i-Martin, 2004). In the model, there is an assumption of exponentially growing production of an individual function as re-modify from Ak^{π} framework out of the growth population as given in equation (1)

$$POPgr = f(AK^{\pi}) \qquad (1)$$

Where $POPgr$ is the population growth rate, while A represents the total productivity, π the output elasticity of capital, and k the capital stock per individual in the country. Thus, the average growth rate of output per individual in the country is proportional to the difference between the output per individual at the steady state and that of the initial period. On this premises, we estimate a model with changes in output growth with respect to macroeconomic variables. Given the dynamic nature of the Nigerian population, the model of this study is builds on recursive formation (Cholesky decomposition) Structural Vector Auto-regression (SVAR) approach developed by Amisano and Giannini (1997), implying that the policy shocks are orthogonal to all other contemporaneous variables in the VAR system. The SVAR estimation considered all variables as endogenous and consequently no variable is imposed on the model exogenously except the intercept term. In ordering the variables, the basic identification is based on the assumption that variables do not respond contemporaneously to output shocks or affected by the external sector variables. Specifically, two blocks of variables are used in this study so as to capture the stated objective.

Equation (2) summarizes the identification variables approach, and hence implies the relationship between the reduced-form disturbances and the structural disturbances using matrix A as a lower triangular matrix with ones on the main diagonal, and the matrix K as identity matrix given as:

$$K\varepsilon_t = \begin{bmatrix} \varepsilon_t - POPgr \\ \varepsilon_t - MOR \\ \varepsilon_t - FER \\ \varepsilon_t - LITR \\ \varepsilon_t - PCI \end{bmatrix} = A\varepsilon_t \begin{bmatrix} 1 & 0 & 0 & 0 & 0 \\ a_{21} & 1 & 0 & 0 & 0 \\ a_{31} & a_{32} & 1 & 0 & 0 \\ a_{41} & a_{42} & a_{43} & 1 & 0 \\ a_{51} & a_{52} & a_{53} & a_{54} & 1 \end{bmatrix} \begin{bmatrix} v_t - POPgr \\ v_t - MOR \\ v_t - FER \\ v_t - LITR \\ v_t - PCI \end{bmatrix} \qquad (2)$$

Where $\varepsilon_t - POPgr, \varepsilon_t - MOR, \varepsilon_t - FER, \varepsilon_t - LITR, and\ \varepsilon_t - PCI$ are the structural disturbances from five endogenous variables, while $v_t - POPgr, v_t - MOR, v_t - FER, v_t - LITR, and\ v_t - PCI$ are the residual-form residuals. The restrictions on the structural parameters in the matrix are imposed following earlier studies; such as Sims (1999), Lee and Ni (2002) and Muhammad et al (2011). Identification of the variables in equation 2 follows their response to shocks.

Estimation Technique : This study uses a five-variable Structural Vector Autoregressive (SVAR) model. However, this model is similar to that used by Amisano and Giannini (1997), Kim and Roubini (2000) to capture the interaction between fertility rate, mortality rate and the Nigerian population. Thus, all variables are considered as endogenous and as well none of the variables are imposed on the model exogenously except the intercept term. The SVAR model assumes that the Nigerian population is represented by a structural-form equation using five endogenous variables in the k-dimensional vector $POPgr$ as follows:

$$POPgr = \sum_{i=0}^{k} Ai\ POP_{t-i} + V_t \qquad (3)$$

where $POPgr$ is defined by Population growth $= f(MOR, FER, LITR, PCI)$ and A_i is the n×n matrix of coefficients. The optimal number of included lags k can be determined by some information criteria such as the Akaike or Schwarz criterion. The vector of reduced form residuals v_t is n-dimensional with the variance-covariance matrix $\sum_\varepsilon$ where $E(e_t e_t') = 0$. To transform the reduced form model into a structural model, an AB- Model is usually employed. The AB – model as developed by Amisano and Gannini (1997) simply describes the relationship between the reduced form residuals v_t and the structural form residuals e_t, such that v_t gives:

$$V_t = A_t^{-1} K_0\ \varepsilon_t \qquad (4)$$

Hence, the structural VAR model with A_t variables could be written thus:

$$AoPOP_t A_i POP_{t-1} + Ke_t \quad (5)$$

Moreover, because the shocks in the reduced form are likely to be correlated, they cannot be considered as true structural shocks, so that correctly identifying the structural shocks necessitates the imposition of ten restrictions. Given that q is the number of endogenous variables, the approach utilising recursive identification requires that there is a minimum number of m(m+1)/2 restrictions. Therefore, five restrictions are obtained by normalising the original matrix, while the six remaining long run identifying restrictions, for instance population growth shocks do not have permanent effect on mortality rate, fertility rate, literacy rate and per capita income.

Sources of Data : This study uses secondary data collected from the publications of various organizations and agencies. Majorly, all the data used in this study such as morality rate, fertility rate, literacy rate and per capita income were obtained from World Bank's World Development Indicator (WDI) including the Nigeria's population annual growth rate measured a change in population as a fraction of the initial population over a unit time period. Meanwhile, morality rate is measured as the number of deaths of children per 1000 live births, literacy rate gives the percentage of the population age 15 and above who can read and understanding. Per capita income measures the average income earned per person in a certain country (GDP per capita, constant USD); and also it is a measure of a country's standard of living. While fertility rate is obtained by summing the single-year age-specific rates at a given time.

V. ANALYSIS AND DISCUSSION OF RESULTS

The result of the unit root test is presented in Table 1. Critical values of the t-statistics are reported to determine whether the null hypothesis that variables have unit root would be rejected or not. The t-values show that mortality rate (MOR) and per capita income (PCI) are stationary at levels, while other variables including fertility rate (FER), literacy rate (LITR) and population growth rate (POPgr) were stationary at first difference. The results obtained suggest that SVAR can be applied to estimate the model, with the use of its conventional methods such as impulse response functions (IRFs) and structural variance decomposition analysis.

Table 1: Augmented Dickey-Fuller Test

S/No	Variables	ADF @ Levels	C.V@ 1%	ADF @ 1st Diff.	C.V@ 1%	Order of Intergr.
1	POPgr	-1.493897	-3.65373	-5.08416	-3.62678	I(1)
2	MOR	-1.458332	-3.62678	-4.36752	-3.69987	I(1)
3	FER	-1.030956	-3.62678	-3.58543	-3.62678	I(1)
4	LITR	-6.147877	-3.62102	-10.1659	-3.62678	I(0)
5	PCI	-4.482829	-3.62102	-9.67334	-3.62678	I(0)

Note: C.V= Critical Value
Source: Extracted from Regression Output

Johansen Co-integration Test : Following the properties exhibited by the time series variables above, a co-integration test was carried out to examine the long-run relationship among the variables. The framework established by Johansen and Juselius (1990) was employed to carry out the test. That is, using two likelihood ratio test statistic-the trace and maximum eigen-value statistics. There is growing evidence in favour of the robustness of the trace statistic (Hasan, 2010). However, we accept the trace test result as presented in Table 2.

Table 2: Johansen Unrestricted Co-integration Test

No. of CE(s)	Eigen Value	Trace Stat.	0.05 Critical Value	Prob.**
None *	0.802314	130.1401	69.81889	0.0000
At most 1 *	0.630056	73.40241	47.85613	0.0000
At most 2 *	0.512044	38.59833	29.79707	0.0038
At most 3	0.314655	13.48481	15.49471	0.0982
At most 4	0.007419	0.260643	3.841466	0.6097

Decision: Trace test indicates 3 co-integrating eqn(s) at 0.05 levels
*denotes rejection of the hypothesis at the 0.05 level
**Mackinnon-Haug-Michelis (1999) P-values.

Source: Extracted from Regression Output : The result of the trace test statistic from Table 2 indicates that there is at least three co-integrating equations among the variables and the rejection of the null hypothesis of no co-integration at 5% level. Both the maximal eigen value and trace statistics indicates that the hypothesis of no co-integration among the variables is rejected at the 5% significance level, as there is at least one co-integrating vector among the variables of interest. It therefore concludes that a long run relationship exist among the variables.

Table 3: VAR Optimal Lag Length Selection Test

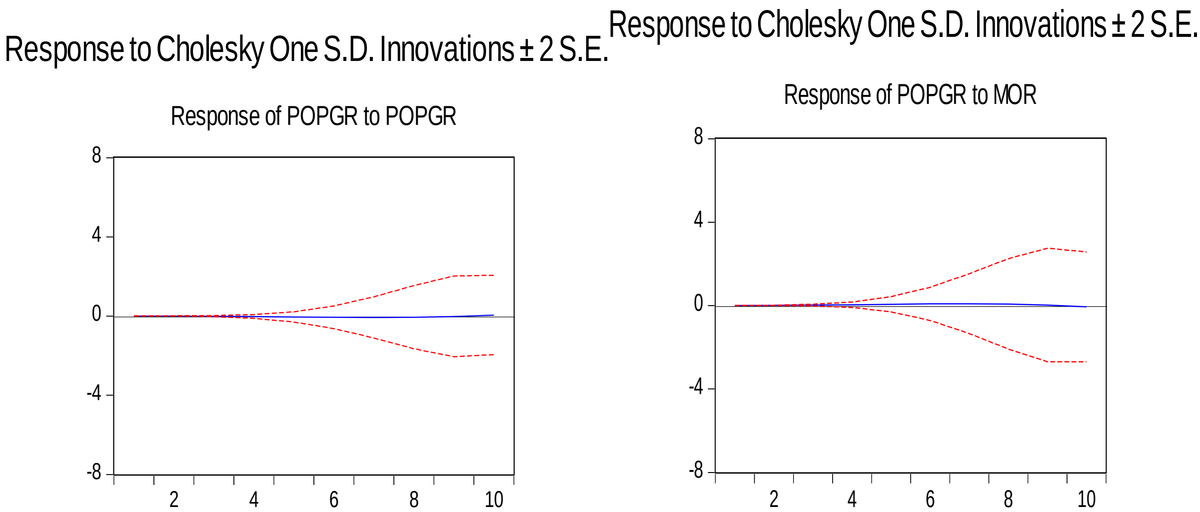
Lag	LogL	LR	FPE	AIC	SIC	HQ
0	-398.209	NA	3681.82	22.4004	22.6204	22.4772
1	-173.447	374.602	0.056638	11.30262	12.6222	11.76320
2	-33.9246	193.781*	0.00011*	4.94026*	7.35952*	5.78465*

(*) denotes minimum AIC and SBC
Source: Extracted from Regression Output

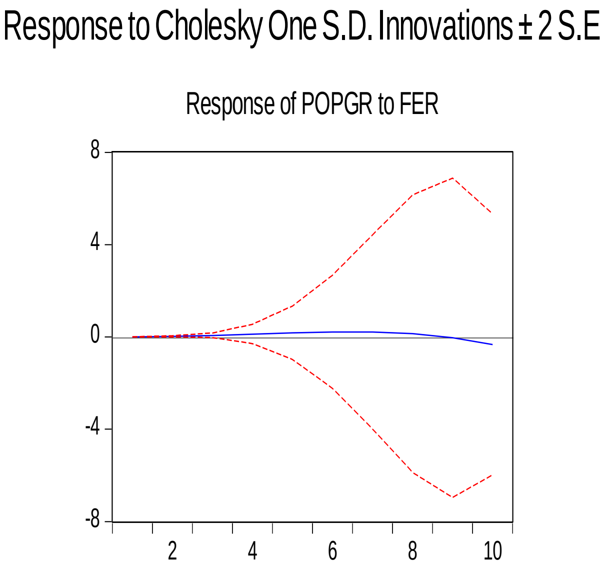
Following the result from the lag order selection criteria in Table 3, optimal lag length 2 is selected, as indicted by the various selection criteria for the estimation of Structural Vector Autoregressive (SVAR) in Fig. 4 and Table 4 of the study.

SVAR Impulse Response Functions

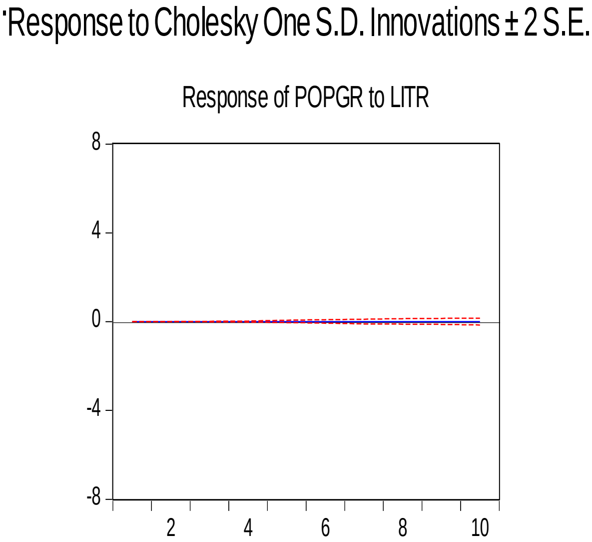
Figure 4: Response of Cholesky one S.D



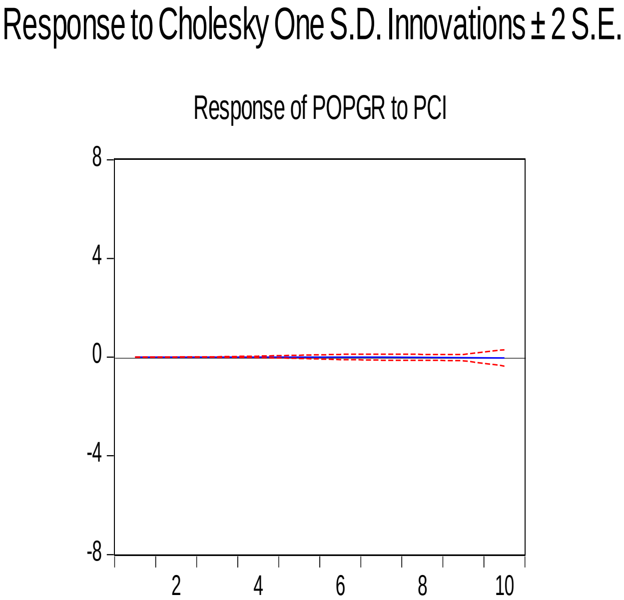
A **B**



C



D



E

The impulse response function of the SVAR is depicted in Figure 3 as evidence from Figures A to E. Our emphasis is on the Impulse response of population growth rate to fertility and mortality rates. A cursory look at the Figure B shows that the response of POPgr to a shock in mortality rate produces a constant and slightly positive response at the initial stage up to 9th periods which later becomes constant again and slightly negative and as well significant throughout the forecast horizon (see the work of Fehr, Jokisch & Kotlikoff, 2004). The response of fertility rate in Figure C was initially and marginally positive up till 8th periods and thereafter becomes negative and significant throughout the time horizon, meaning that it leads to a reduction in population growth contrary to theoretical expectation, which as well consistent with the previous studies of Akeju (2015). However, the response of population growth rate to shocks of both literacy rate and per capita income produces an irresponsive and muted fluctuations throughout the forecast horizon (see Figure D and E).

Table 4: Structural Variance Decomposition of Population growth rate

Period	S.E.	POPgr	MOR	FER	LITR	PCI
1	0.005281	100.0000	0.000000	0.000000	0.000000	0.000000
2	0.022502	7.450357	7.045505	85.37810	0.120841	0.005199
3	0.071249	1.810154	7.549318	90.42834	0.081992	0.130194
4	0.146885	3.174645	8.088310	88.58121	0.051215	0.104624

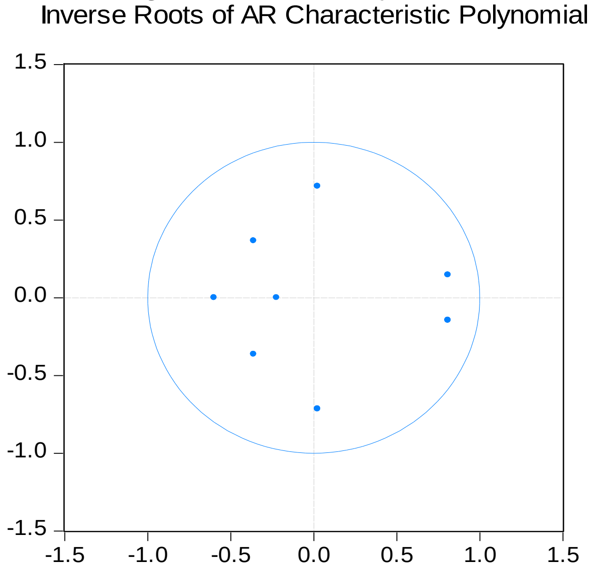
5	0.241646	4.552485	8.817289	86.53833	0.037851	0.054045
6	0.340025	5.657942	9.692512	84.58959	0.032648	0.027311
7	0.417483	6.606982	10.75979	82.56424	0.032546	0.036443
8	0.450105	7.449953	11.96950	80.41857	0.036965	0.125016
9	0.453879	7.537467	12.13817	79.88901	0.041299	0.394048
10	0.569036	5.653351	8.903735	84.83288	0.026375	0.583656

Source: Authors' Computation

The results of the Structural Variance Decomposition (SVD) are given in table 4. The prime interest of this discussion is the shocks to mortality rate, fertility rate, literacy rate and per capita income explained by innovation in population growth rate. It can be deduced that 11.9% and 12.1% of the variation in mortality rate are explained by innovations in population growth rate in the eight and ninth periods respectively (as evidence in table 3). This implies that mortality rate decline as more shocks occur on the growth rate of population in the country contrary to the result of Impulse Response Function in Figure B, that remain slightly positive throughout the forecast horizon. Furthermore, 90.4% and 88.6% variation in the fertility rate are explained by population growth rate in the third and fourth periods, respectively. The implication of this result is that, in the long run, fertility rate exerts a greater influence on the growth rate of population in the country contrary to the result of Impulse Response Function in Figure C that exhibited negative influence in the ninth periods. Quite unbelievable, the responses of literacy rate and per capita income are not pronounced throughout by innovations in population growth rate, which hitherto, their variations dies out afterwards. This is obvious in the results of its structural variance decomposition.

VAR Stability Test: At optimal lag length 2, the estimates of SVAR are found to be stable as indicated in the VAR stability check result in Figure 2, as the value of its AR root is less than one and there is no root that lies outside the unit circle.

Figure 2: VAR Stability Check



Source: Authors' Computation

Policy Implications of the Results

The following policy implications are drawn from the result:

(i) Results from SVAR impulse response function revealed that positive shocks to mortality and fertility rates exhibited mixed influence on population growth rate of Nigerian during this period of study credence to empirical studies of Eli, Mohammed & Amade (2015). Quite insightful results, the variables in question had negative and positive effect on their each influences to population growth. However, this may be as a result of modernization of societies and as well improvements in health and living conditions of people leading to declines in mortality rates, while if development continues fertility levels follow. The implication of this is that policymakers should not leave stone on turn during policy formulations to provide a solid basis in influencing a major component of population dynamics majorly on fertility and mortality which in turn will have an impact in reducing maternal and infant deaths.

(ii) The Structural Variance Decomposition analysis result indicates that in the long run fertility and mortality rates exerts a greater influence on the growth rate of population which further improves country's development. Hence, policymakers should take cognizance of these variables during policy formulations and as well to be forward looking for more strategy to be adopted to further increase fertility rate in Nigeria, which in turn will allow for increased labourers leading to potential long term economic growth and as well helped overcome the correspondingly exorbitant death rates in the country, according Eli *et al.*, (2015).

(E) Concluding Remarks and Policy Recommendations

This paper x-rays a five-variable SVAR model to investigate the interrelationship between fertility rate, mortality rate and the growth of Nigerian population which have not been considered simultaneously in the existing literature. The study used annual time series data spanning between 1980 and 2017. The result of the stationarity test of the variables showed that three co-integrating equations were established which further implies that a long run relationship exists among the variables. Obviously, result from the SVAR impulse response revealed that positive shocks to fertility rate exhibited mixed influence on population growth rate of Nigerian. Apparently, the variables in question had negative and positive effect on population growth. This is an indication that despite series of programme of actions embark upon by the United Nation to improve the growth of population in developing countries in the broader contexts of reproductive health and development, the decline in population growth still persists. This has not been translated to a significant improvement on Nigerian population. Further, variance decomposition (VD) analysis showed that mortality rate decline as more shocks occur on the growth rate of population in the country. This indicates that the more declines in mortality rate, the higher the growth rate of population in the country credence to empirical studies of Fehr *et al.*, (2004). While in the long run, fertility rate exerts a greater influence on the growth rate of population which further improves country's development. However, this will further allow increased of labourers leading to potential long term economic growth and as well helped overcome the correspondingly exorbitant death rates which is in concordance with the works of Eli *et al.*, (2015).

As a remedy via the findings of this study, the following policy recommendations are proffer:

(i) Nigerian government should guide against relative low proportion of 6% budget allocation to the health sector like ever before. In view of this, government should provide enough funds for the health sector so as to meet WHO recommended annual budgetary allocation of the 15% to the health sector, which will further improves the health and living conditions of people, as may be evidences in mortality rates decline first and as development continues, fertility levels follow.

(ii) In conjunction with private sector, government needs provide universal access to reproductive health care for all individuals at appropriate ages by 2020 in the context of primary health care. To this end, it will create an environment that will enable individuals to fulfil their fertility preferences and needs while respecting their basic rights.

(iii) Finally, Government should fashion way out for the country to complete her demographic transition via demographic trends. This will serve as a panacea to the country's economic development and poverty alleviation, especially in rural areas; improvement of women's status, ensuring of universal access to quality primary education and primary health care, including reproductive health and family-planning services, which in turn will have a greater influence on Nigerian population growth rate significantly.

Further studies in relation to this theme may include more macroeconomic and health variables such as morbidity, mobility (migration), socio-economic levels, education, ethnic composition, age structure and gender equity directly or indirectly affecting reproductive health of individual in the analysis of population dynamics and economic performance. This study involves time series data analysis. However, future studies could consider more countries and employ a panel data procedure as the case may be. Usually, inference drawn from time series analysis might be different from a panel analysis.

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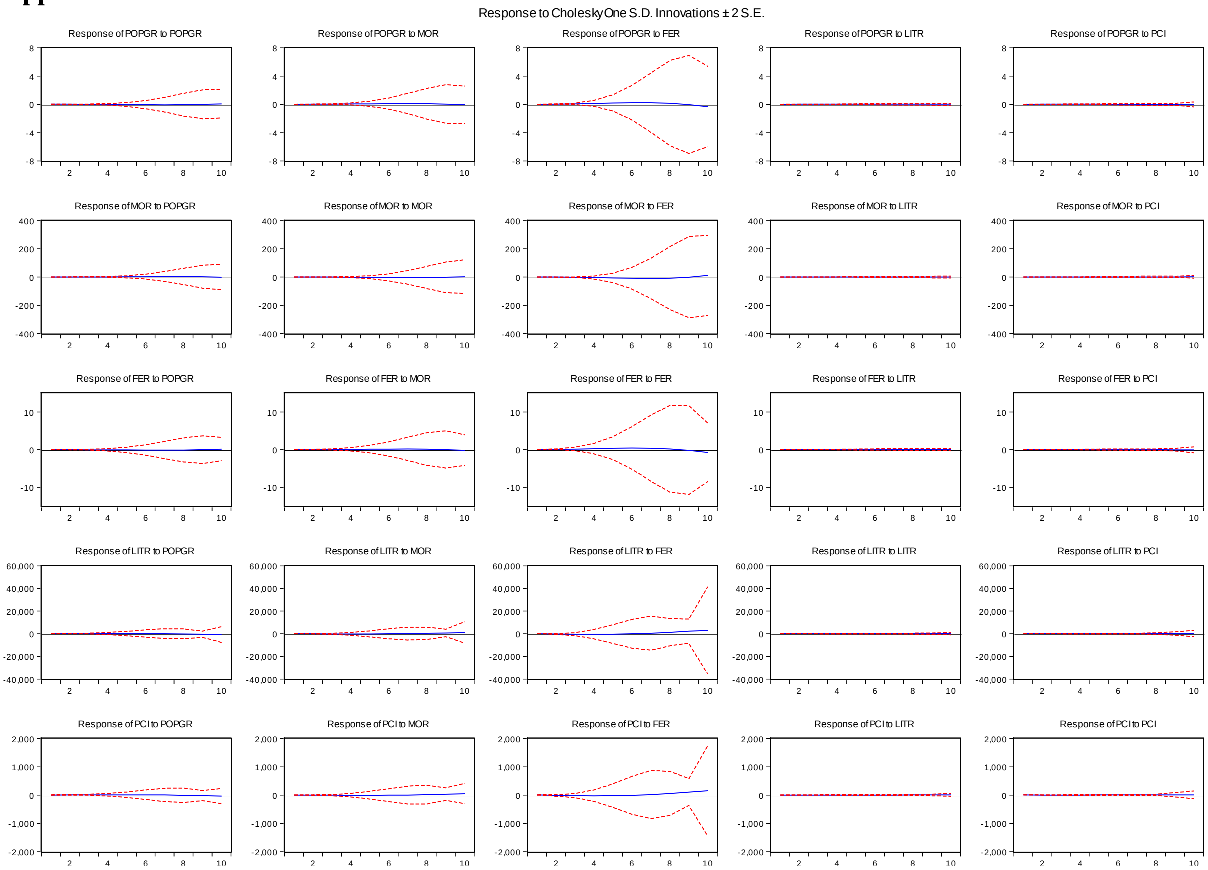
Appendices

Appendix I



Appendix II

Variance Decomposition of POPGR:

Period	S.E.	POPGR	MOR	FER	LITR	PCI
1	0.005281	100.0000	0.000000	0.000000	0.000000	0.000000
2	0.022502	7.450357	7.045505	85.37810	0.120841	0.005199
3	0.071249	1.810154	7.549318	90.42834	0.081992	0.130194
4	0.146885	3.174645	8.088310	88.58121	0.051215	0.104624
5	0.241646	4.552485	8.817289	86.53833	0.037851	0.054045
6	0.340025	5.657942	9.692512	84.58959	0.032648	0.027311

7	0.417483	6.606982	10.75979	82.56424	0.032546	0.036443
8	0.450105	7.449953	11.96950	80.41857	0.036965	0.125016
9	0.453879	7.537467	12.13817	79.88901	0.041299	0.394048
10	0.569036	5.653351	8.903735	84.83288	0.026375	0.583656

Variance Decomposition of MOR: Period	S.E.	POPGR	MOR	FER	LITR	PCI
1	0.092953	0.056482	99.94352	0.000000	0.000000	0.000000
2	0.525382	1.888477	3.391914	94.47668	0.059513	0.183417
3	1.897452	2.936225	2.605324	94.12757	0.006526	0.324354
4	4.462773	3.726481	4.807293	91.22657	0.004393	0.235261
5	8.232959	4.456131	6.515497	88.87474	0.007322	0.146310
6	12.74808	5.177257	7.912913	86.81698	0.011327	0.081523
7	16.97094	5.937414	9.227904	84.77249	0.016190	0.046006
8	19.49137	6.768685	10.59908	82.54561	0.022688	0.063930
9	19.79152	7.333987	11.53458	80.87154	0.030325	0.229565
10	22.64898	5.862863	9.178638	84.40588	0.024452	0.528168

Variance Decomposition of FER: Period	S.E.	POPGR	MOR	FER	LITR	PCI
1	0.022100	2.829772	5.018413	92.15181	0.000000	0.000000
2	0.077856	3.530634	6.322120	90.09059	0.005891	0.050764
3	0.177519	4.193628	7.327642	88.40306	0.007988	0.067681
4	0.322006	4.831413	8.273787	86.83759	0.010819	0.046394
5	0.498268	5.460672	9.226788	85.27491	0.014310	0.023317
6	0.674106	6.117282	10.27150	83.57774	0.018596	0.014875
7	0.801158	6.839890	11.50201	81.58996	0.024478	0.043661
8	0.841344	7.530091	12.78027	79.48119	0.032673	0.175773
9	0.862988	7.175801	12.22905	80.05535	0.036231	0.503574
10	1.177136	5.240899	8.443877	85.70838	0.019482	0.587365

Variance Decomposition of LITR: Period	S.E.	POPGR	MOR	FER	LITR	PCI
1	79.87067	2.789405	1.514262	2.504197	93.19214	0.000000
2	332.1311	3.292014	7.543940	83.61709	5.498268	0.048689
3	588.6481	4.295556	8.162752	85.39885	1.765129	0.377710
4	777.6171	5.491105	9.699101	83.57286	1.020349	0.216585
5	889.4840	6.570944	11.24925	81.13278	0.794709	0.252317
6	905.6124	7.240779	12.29018	79.24805	0.775846	0.445136
7	1018.476	5.890463	9.951189	82.82049	0.614468	0.723388
8	1664.556	4.497517	7.165940	87.59692	0.231096	0.508532
9	2861.059	4.904026	7.560166	87.20027	0.082436	0.253099

10	4307.725	5.665246	8.709956	85.45700	0.042927	0.124867

Variance Decomposition of PCI: Period	S.E.	POPGR	MOR	FER	LITR	PCI
1	7.085588	0.013709	4.218331	4.873307	4.204439	86.69021
2	16.60694	2.562752	7.476618	73.35014	0.825389	15.78510
3	29.90093	3.916130	8.013665	82.51879	0.255437	5.295976
4	41.33623	5.130078	9.442835	82.50930	0.143948	2.773844
5	49.48159	6.220415	10.90851	80.77353	0.115925	1.981611
6	52.00739	7.099522	12.22555	78.62852	0.115873	1.930539
7	53.79401	6.651442	11.46025	79.63582	0.111810	2.140672
8	77.29803	4.743243	7.797316	86.05884	0.054283	1.346323
9	134.1713	4.716373	7.322038	87.37107	0.021072	0.569441
10	211.2558	5.420969	8.320204	85.98625	0.014260	0.258313

Cholesky Ordering: POPGR MOR FER LITR PCI