RELATIONSHIP BETWEEN FERTILITY AND SOME ENDOGENOUS VARIABLES ON BIRTHS VARIATION IN NORTH WEST NIGERIA

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Abstract- The paper tends to investigate the casual relationship between fertility and some selected endogenous variables that tend to affect births, such as Temperature and Rainfall. The study covers monthly data on these variables for the period for 1989-2012. The Unit root and Stationarity properties of the time series data were examined using the Dickey Fuller, Augmented Dickey Fuller and KPSS tests. Johansen Cointegration rank test, Error Correction Model are employed to find out the degree, direction and effect of the relationship, the long-run relationship between these variables. The findings from the Unit root and stationarity tests indicate that all the variables are integrated of order one I(1). Cointegration test provides evidence of the existence of long-run equilibrium between temperature and rainfall Temperature tends to exert positive impact in all cases. In some cases Inverse relationship was noticed in these variables. Thus, some percentages rise in temperature tend to have corresponding percentage increase in fertility.

Keywords: Fertility, Endogenous Variables, Cointegration, Lon-run relationship

I. INTRODUCTION

In most populations with reliable data, birth rates vary with season of the year. The seasonality of birth is not identical in all populations. Climate plays an important role in every area of human activity. Surely, climatic conditions over an area, is determined by the temperature, rainfall, wind, humidity, atmospheric pressure. of etc, prevailing in such area. It is believed that some or all of these conditions affect fertility and births. Among the various climatic parameters, the temperature and rainfall assume special significance as they affect human health. Similarly, in the case of rainfall, it is affected by the change in atmospheric temperature. [10] and temperature depends on global precipitation [14].Changes in temperature and rainfall patterns increase the frequency, duration and intensity of other extreme events, such as floods, droughts, heart waves etc. Weather has a strong effect on human health and wellbeing as well. It has been associated in it changes in birth rates and sperm counts[11].In the recent years, scientific research based on reliable world climate data reveal that the climate is affected by the greenhouse effect, as a result temperature and precipitation are changing globally.

The study covers the North-West part of Nigeria, comprising Sokoto, Kebbi, Zamfara, Jigawa, Kano, Kaduna and Katsina States. Data on Monthly number of births recorded in the hospitals were collected from hospital records at the gynecology unit. The data used span 1989 to 2012 (24years) and were sourced from the major hospitals in the state capitals and the National population commission report supported by UNICEF which gave data on the rural areas and some urban areas. The aim of this paper is to investigate the role of climate/weather conditions in the determination of conception and the long-run relationship between them with a view to determining whether a given aspect of human reproduction is contingent of environmental variable for reasons independent of any seasonal pattern in the variable.

II. CLIMATE AND BIRTH

Childbirth usually begins spontaneously, after about 280 days (40weeks) after conception, but it may be started by artificial means if the pregnancy continues past 42 weeks. The average length of labour is about 14 hours for first pregnancy and about 8 hours in subsequent pregnancies. However, many women experience a much longer or short labour. It is well known that climate and weather have immense effects on human comfort and wellbeing. All human populations exhibit seasonal variation seen in births[4]. [5] have revealed from their study that climatic effects on human well-being affects sperm count and birth rates in agreement. Studies in regions with seasonal climatic variations have revealed a correlation between human natural conception and birth rates[20]. The correlation between weather and fertility has been established from data collected in England [13]. It estimated the effects of temperature on births seven -element months later.

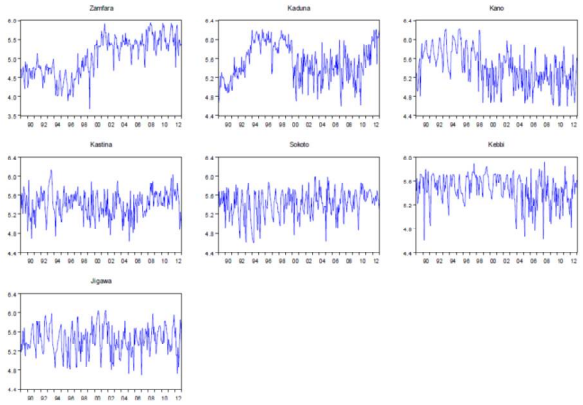
In the South-Western Nigeria, two studies were carried out. First by [2], a total of 12,708 live births registered between 1965 and 1975 in Igbo Ora a rural area in south-western Nigeria, were examined for seasonal variation.[19], also studied of the differences in the seasonality of birth between the rural and urban dwellers in the south-western Nigeria, [16] Studied the seasonality of births in South Eastern Nigeria and concluded that Weather is a major contributor to conception. [1] had his own study in Kaura Namoda & Gusau areas, the method of monthly indices was employed for the analysis of data. The result shows

that conception is very low during the hottest months (March-May) with lowest frequency in May and very high during the coolest months of November to January. He attributed this to temperature. According to [9] on the effects of seasonal variation of temperature in Zaria and Katsina, climatic element has been shown to influence human births seasonality in most parts of the world. The cool and dry season is found to favor conceptions while the conceptions which took place in the hot and dry months of March and April are found to promote the occurrence of preterm births in 9 months later.

The importance of determining the role of weather has a profound effect on human health and well-being it has been demonstrated to be associated with changes in birth rates and sperm counts.[12]. [13] used time series data to examine the effects of weather on seasonal and non-seasonal variation in monthly births for USA and selected states, and selected European countries (Canada, Indian, Israel) with an extension of the analysis of [18]. The results showed that weather had an important influence on seasonal and non-seasonal variation in the USA.

III. METHODOLOGY

Graphical representation



Visual Rpresentation of Fertility at Log Levels.

3.1 The Johansen Co-integration Test

The co-integration analysis involve unit roots test performed on both level and first difference to determine whether the individual input series are stationary and exhibit similar statistical properties. The Johansen's Approach was adopted so as to take care of the draw backs of the Eagle-Granger approach. Here, the Johansen's method is based on the Vector Autoregessive Model (VAR) estimation, where the data is transformed to a dynamic form called the Vector Error correction Model (VECM).

$Y_t = \rho\, Y_{t-1} + U_\rho \qquad 1 \leq \rho, where\ U\ is\ the\ white\ noise\ error$ k.

…(3.1)

IF Y_t is regressed on its lagged value of Y_{t-1} and estimated,ρ is statistically equal to 1then Y_t is non-stationary, that is, it exhibit unit root 1(1). On the other hand, if the estimated value of ρ is not statistically equal to 1, then Y_t is stationary that is it has no unit root. Augmented Dickey Fuller (ADF) test was used to test for the stationary of the data the test consists of the following regression

$$\Delta Y_t = \beta_1 + \beta_{2t} + \beta_{3t} + \delta Y_{t-1} \alpha \sum_1^n \Delta Y_t + \varepsilon_t \qquad \text{….(3.2)}$$

Where $\varepsilon_t = \Delta_{t-1}$

The Johansen procedure was used to test for the number of cointegration vectors in the model. The Johansen technique was used not only because it is a vector auto regressive based but because it performs better in multivariate model.[15] IfX_t *and* $Y_t$are then co-integrated their shorten dynamics can be described by Error correction model (ECM). The theory states that if two variables X *and* Y are co-integrated then the relationship between them can be expressed as ECM. The co-integrated model is given as

$$LY_t = \beta_0 + \beta_1 LX_{1t} + \beta_2 LX_{2t} + \mu_{t0} \qquad \text{…(3.3)}$$

Where Y_t = Fertility, X_1 = temperature (^{0}c), X_2 = Rainfall (mm)

The Unit toot test tests whether a time series variable is non-stationary using autoregressive model. For instance, If $Y_t = \alpha + \beta Y_{t-1} + \mu_t$

…(3.4)

The **Jarque–Bera test** is a goodness-of-fit test of whether sample data have the skewness and kurtosis matching a normal distribution. The Dickey-Fuller (DF) DF tests whether a unit root is present in an autoregressive model. The Augmented Dickey-Fuller (ADF) is a test for a unit root in a time series sample. It is an augmented version of the Dickey-fuller test for a larger and more complicated set of time series model. ADF takes care of serial correlation with lag of which Dickey-Fuller does not. The ADF statistic, used in the test, is a negative number. The more negative it is, the stronger the rejection of the hypothesis that there is a unit roots at some level of confidence. The test regression in the Phillips–Perron test is

$$\Delta Y_t = \emptyset Y_{t-1} + \alpha + \beta_t + \mu_t \qquad \text{….(3.5)}$$

Where $\mu_t$is a stationary process, (which also may be heteroscedastic) the PP tests correct for any signal correlation and heteroscedasticity in the errors μ_t of the test regression by directly modifying the test statistic. The Kwiatkowski, Phillips, Schmidt and Shin, and called henceforth the KPSS test has a null of stationarity for the series around either mean or a linear trend; and the alternative assumes that a series is non-stationary due to presence of a unit root.

3.2 Vector Autoregression Model

The interdependency of climatic variables suggests for multivariate stochastic analysis. Vector

Autoregressive (VAR) is one of the multivariate stochastic too, is a natural extension from the conventional univariate time series. [17] and [21]. This VAR model includes two particularly important variables for climatic condition analysis: temperature and rainfall as earlier mentioned in the introductory part of this research..In order to keep the model simple and tractable, only temperature and rainfall are selected. There may be a sense that a bias exists in projected temperature and rainfall in many climate models [2], [22]. The VAR model seems appropriate to examine climatic data because it is expected uncover dynamic interactions among variables of interest; because intuitively it is known that the rainfall is affected by temperature.

3.3 Long-Run Relationship

The next step is to investigate the existence of a long-term relationship between the variables considered in this study: the temperature and rainfall and fertility. If the temperature rainfall and fertility variables are co-integrated with each other, then this will provide statistical evidence for the existence of a long-run relationship. [8]). The maximum-likelihood test procedure established by Johansen is used as to the test for cointegration [23]). Johansen's method is to test the restrictions imposed by cointegration on the unrestricted VAR involving the series. Consider a VAR of order p:

$$F_t = \gamma_o + \gamma_1 T_{t-1} + \cdots . \gamma_p T_{t-p} + \beta_1 R_{t-1} + \cdots . \beta_p R_{t-p} + \omega_t$$

$$R_t = \gamma_0 + \gamma_1 T_{t-1} + \cdots . \gamma_p T_{t-p} + \beta_1 R_{t-1} + \cdots . \beta_p R_{t-p} + \omega_t$$

$$T_t = \gamma_0 + \gamma_1 T_{t-1} + \cdots . \gamma_p T_{t-p} + \beta_1 R_{t-1} + \cdots . \beta_p R_{t-p} + \omega_t \quad \ldots(3.6)$$

Where the $\gamma_t's$ and the $\beta_t's$ are coefficients and ω_t are white noise error term of innovations.

IV. Analysis of Data

Table 4.1 Descriptive Statistics for the Fertility Variable in all the states

	ZAMFARA	KADUNA	KANO	KATSINA	SOKOTO	KEBBI	JIGAWA
Mean	174.9618	272.3125	242.7330	231.5590	234.8333	241.2083	237.1007
Median	175.0000	249.5000	222.0000	224.5000	235.0000	238.5000	225.5000
Maximum	375.0000	497.0000	500.000	459.0000	401.0000	368.0000	432.000
Minimum	40.0000	100.0000	100.000	103.000	100.0000	100.0000	109.000
Std. Dev.	81.0946	102.7116	93.7236	61.2466	60.5839	54.0782	67.2006
Skewness	0.4165	0.4417	0.7240	0.6052	0.0266	-0.3199	0.4604
Kurtosis	2.2335	2.0751	2.9812	3.5733	2.7048	2.4528	2.7505
Jargue-Bera	15.7272	18.6066	25.1664	21.5249	12.0794	8.5061	10.9231
Probability	0.0003	0.0000	0.0000	0.0000	0.0005	0.0051	0.0042
Sum	50389.00	78426.00	9795.00	34482.80	67632.00	69468.00	68285.00
Sum Sq. Dev.	1887407	3027758	2521041	1076581	1053408	839317.5	1296072
Observation	288	288	288	288	288	288	288

Table 4.2 Descriptive Statistics for the Rainfall Variable in all the states

	ZAMFARA	KADUNA	KANO	KATSINA	SOKOTO	KEBBI	JIGAWA
Mean	199.8837	236.5531	231.7330	119.7319	155.8976	167.4486	171.5076
Median	180.8000	222.2000	198.4000	107.5000	143.3000	161.9000	149.7500
Maximum	625.0000	548.8000	604.1000	413.4000	353.1000	457.1000	488.5000
Minimum	24.0000	49.8000	6.5000	19.9000	14.4000	24.8000	19.9000
Std.Dev.	97.2230	89.4323	137.9984	73.5790	82.1803	71.6810	109.2917
Skewness	1.2941	0.5758	0.7553	1.1964	0.6967	0.8837	0.9501
Kurtosis	5.5495	3.2117	2.8136	4.4510	2.8059	4.4085	3.2208
Jargue-Bera	158.3902	16.4517	27.8011	93.9777	23.7525	61.2921	43.9167
Probability	0.0000	0.0003	0.0000	0.0000	0.0000	0.0000	0.0000
Sum	57566.50	68127.30	66739.10	34482.80	44898.50	48225.20	49394.20
Sum Sq. Dev.	2712813	2295465	5465503	1553782	1938283	1474651	3428121
Observation	288	288	288	288	288	288	288

Table 4.3 Descriptive Statistics for the Temperature Variable in all the states

	ZAMFARA	KADUNA	KANO	KATSINA	SOKOTO	KEBBI	JIGAWA
Mean	10.0402	8.6577	10.4928	10.7462	9.4714	8.9792	9.9514
Median	9.7000	8.9000	10.5000	10.7000	9.7000	9.3000	9.8000
Maximum	17.4000	11.4000	17.4000	14.6000	13.9000	13.8000	17.4000
Minimum	4.3000	4.2000	6.8000	7.2000	0.9000	2.5000	4.2000
Std. Dev.	2.0604	1.3832	1.7037	1.5083	2.4352	2.1735	1.8802
Skewness	0.6276	-0.5299	0.8529	0.4560	-1.4797	-1.1234	0.5035
Kurtosis	4.3097	3.0000	4.9514	2.7183	6.82168	4.3130	4.8943
Jargue-Bera	39.4937	13.4792	80.6166	10.9341	280.3527	81.2630	55.2055
Probability	0.0000	0.0011	0.0000	0.0042	0.0000	0.0000	0.0000
Sum	2891.60	2493.410	3021.860	3094.900	2727.50	2586.00	2866.00
Sum Sq.Dev	1218.35	549.13	833.05	652.96	1702.02	1355.80	1014.60
Observation	288	288	288	288	288	288	288

4.1 Results of Cointegration test involving trace and maximum Eigenvalue

Hypothesized		Trace		
No of CE (s)	Eigenvalue	Statistics	C. Value	Prob
None	0.1088	50.8198	24.2760	0.0000
At most 1	0.0634	18.4579	12.3209	0.0742
At most 2	0.0001	0.0395	4.1299	0.8707

Hypothesized		Maximum Eigen value		
No of CE (s)	Eigenvalue	Statistics	C. Value	Prob
None	0.1088	32.3620	17.7993	0.0002
At most 1	0.0634	18.4183	11.2248	0.0742
At most 2	0.0001	0.0395	4.1299	0.8707

All results are presented at 5% level of significance

4.2. Results of Long-Run Relationship Equations

Zamfara:

Vector Error Correction Estimates

$$\beta = \begin{pmatrix} 1.0000 \\ 1.5190 \\ -3.2201 \end{pmatrix} \qquad \alpha = \begin{pmatrix} -0.0003 \\ -.00119 \\ 0.0037 \end{pmatrix}$$

NOTE: This Analysis was made for every state and the results are seen in the log-run equations below.

Zamfara $LogFertility = -1.519LogRainfall + 3.22LogTemperture$

Katsina $LogFertility = 2.1255LogTemperture$ $\qquad LogRainfall = 1.9403LogTemperture$

Sokoto $LogFertility = 0.5160LogRainfall + 1.1385LogTemperture$

Kebbi $LogFertility = 2.2349LogTemperture$ $\qquad LogRainfall = 2.334LogTemperture$

Kano $LogFertility = 2.155LogTemperture$ $\qquad LogRainfall = 2.1554LogTemperture$

Jigawa $LogFertility = 2.1836LogTemperture$ $\qquad LogRainfall = 2.1410LogTemperture$

Kaduna $LogFertility = 2.3254LogTemperture$ $\qquad LogRainfall = 2.5200LogTemperture$

V. RESULTS AND DISCUSSION

Now, looking at individual states in the region: For Zamfara, there is only one co-integration

The log run co-integration relation here shows that temperature exert positive impact on fertility. 1% increase brings about 3.2% increment in fertility. Again body temperature and fertility has been shown in the existing literature to exhibit positive coherence. The negative impact of rainfall on fertility in Zamfara can be interpreted as short-fall of rainfall for the specified period. In fact there is partial coefficient of adjustment of 0.0003 in fertility to disequilibrium. For Katsina, there are two cointegration equations. First, the long-run co-integration relation shows that Temperature exerts impact on fertility. 1% increase brings about 2.1% increase in fertility while in the second relation there exists a long run relationship between Rainfall and temperature with virtually no impact on fertility. This agrees with [13] which tested Sweden, A northern European country and found out that No significant relationship exists between temperature and fertility. Similarly, for Sokoto there is only one cointegration equation. Here temperature and rainfall exerts positive impacts on fertility. 1% increase in temperature brings about 1.1% increase in fertility. Also 1% increase I rainfall brings about 0.5% increase in fertility. For Kebbi state, we have two co-integration equations. Firstly, there exists a long-run relationship between Fertility and temperature and also rainfall and temperature. The result is similar to that of Katsina. Kano, Jigawa and kaduna states also have similar long-run relationships in the variables considered. In some instances, there is a long-run inverse relationship between Temperature and Rainfall. It is similar to [6], who in their study on variation of temperature and rainfall in India found that there is a long-term inverse relationship between these variables.

CONCLUSION

It was revealed that the least number of births was 40 and highest births was 500. The estimated peak period of birth was from May to June.The Unit root tests revealed that all the variables are I(1) and hence candidate for cointegration. Trace and Maximum likelihood tests showed that there were two long relations in the states considered except for Sokoto and Zamfara that showed only each. Temperature tends to exert positive impact on Fertility in all cases.For instance, the results from Sokoto showed that for a 1% rise in Temperature there tend to be 1.13% increase in fertility, etc. An application of cointegration and VECm approach found out that fertility, temperature and rainfall and cointegrated and that long-run relationship exist among the variables. The results of VECM also show some inverse relationship among the variables.

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