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The Nexus Between Macroeconomics and Demographics: Implications for Sustainable Development*

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Abstract: This paper explores the interlinkage effects of macroeconomic variables on the demographic dynamics of Nigeria. This topic is important because available evidence still suggests that Nigeria has a very young population and that the country is not likely to experience demographic transition in the near future. Using the Ordinary Least Square (OLS) estimation technique, a regression model is developed. The model is used to explore the links between demographic variables and macroeconomic variables such as real gross domestic product, age dependency ratio and agricultural land. The findings indicate that the link between macroeconomic variables and demographic variables is somewhat ambiguous which requires explanations at the micro level. To gain more insights for practical solutions on the post-2015 sustainable development agenda, a comparative analysis of the macroeconomic and demographic indicators as well as policies on population growth for selected countries is conducted.

I INTRODUCTION

Nowadays, progress on the sustainable development agenda is measured by macroeconomic and demographic outcomes. Demographic pressure or population dynamics is of major interest to policymakers, both national governments and the international community. Demographic pressure involves the study of human populations, including their size, growth, density, and distribution and how they affect or "pressure" (in either a positive or negative way) their environment. For example, "demographic pressures" on land are creating a negative effect on the environment as many trees are cut down, land reclaimed to build houses in order to accommodate the increasing

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population. The evolving demographic and population changes are receiving attention in the strategies to accelerate the post-2015 development agenda.

Explaining the relationship between income and population is one of the oldest challenge in economics. Malthus was the first social scientist to develop a model that links population and sustainable development. In his essay on the principles of population, he argued that population is growing faster than the means of subsistence (basically food) due to diminishing returns or pressure on agricultural land. Through various economic activities man exploits environmental resources for the production of basic necessities like food, shelter and clothing. Therefore, an increase in population, ceteris paribus, would increase aggregate consumption and thereby make the exploitation of the environment more intense and a challenge to the planet earth. For this reason, environmental scientists have proposed the idea of having planetary boundaries. The concept of planetary boundaries is a framework designed to define a "safe operating space for humanity". The areas that are in great need of planetary boundaries include climate change, air pollution, biodiversity loss, global consumption of fresh water and change in land use.

This paper explains how important the demographic variables are for assessing progress in economic growth as measured by gross domestic product. It also presents a comparative analysis of selected countries demographic indicators and policies with the aim of gaining more insight for innovative policies to accelerate progress on sustainable development agenda.

II THEORETICAL UNDERPINNINGS AND LITERATURE

2.1 *Classical and Neoclassical Theories*

The foundation for discussion on the link between population and economic growth and development was led by Thomas Malthus. Malthus' view was that the pressure of population will provoke changes in the means of agricultural production which will entail a recourse to intensive farming technique. Although Malthus was criticised by some of his contemporaries, he enjoyed the support of many, including David Ricardo. In his support for Malthus' view, Ricardo linked his law of diminishing returns to the theory of optimum population, emphasising the idea that the earth has maximum or limited carrying capacity of population. He supported the argument that population growth would result in a steady decline of per capita income which would in turn lead to a stationary state where economic growth would cease. The earlier models of endogenous population growth emphasised a demographic trap. The demographic transition can hardly occur in the demographic trap model unless there is a big push to move the economy out of

poverty or a stringent population control like China's one-child policy or India's compulsory sterilisation as a pre-condition for employment.

Generally, Ricardo and other classical economists who are Malthus faithful assume that parents' demand for children is a normal increasing function of real wages. But empirical evidence has shown that fertility does not really increase with income; see, for example, Shultz (1973). This contradiction in the classical viewpoint has inspired many social scientists to seek for an explanation at the micro level.

2.2 *Population Dynamics and Economic Growth*

It is widely argued by economists that population dynamics influence economic growth, quality of life and the management of assets. These assets include physical, natural and human capital. Kelley and Schmidt (1996) indicated that during the 1980s population growth, on average, acted as a brake on economic growth as measured by the growth rate of per capita *gross domestic product*, or GDP. The result of their extensive analysis suggests that the relationship between population growth and depressed economic performance is strongest among the poorest nations of the developing world. The growth of gross domestic product can be constrained by high dependency ratios, which result when rapid population growth produces large proportions of children and youth relative to the labour force. Governments and families spend far more on the children than the children can quickly repay in terms of economic production. In particular, modern schooling and health care consumption for children are quite high, and they are expected to retard household savings, increase government expenditure and ultimately depress the growth of GDP.

From the growth theoretical perspective, Boucekkine *et al.* (2002) studied the economic growth consequences of age structured population growth variations by employing an overlapping generations model (OLG) in endogenous economic growth setting. The authors found that growth of working age population and investment in them, have various short-term, intermediate-term, and long-term consequences on economic growth. Moreover, the "… transition from a stagnant economy to a modern-growth economy", could be made solely on the basis of "demographic shifts". In another study, Malmberg and Lindh (2007) emphasised that population growth, specifically the changes in the demographic components (viz, age structure, life expectancy rate, fertility and mortality rates, etc.), exert substantial influence on economic growth and development. Therefore, demographic factors, especially the age-structure distribution, would play a critical role in the current and future economic policy decision making.

Fernández-Villaverde (2001) suggests that standard neoclassical theory can quantitatively account for the dynamics of economic growth and population change. Following the work of Coale and Hoover (1958), Higgins (1998) addresses the relationship between age distributions, national savings and current account balance. He investigated a number of developed and developing countries including Nigeria for the period 1960-64 to 1985-89. In the case of Nigeria, a 0.015 per cent fall in savings as a share of GDP is induced by demographic pressure. The results show a significant and substantial effect of demography on savings rate. Higgins noted that an increase in young and old dependency ratios is associated with lower savings rates. This will have implications on investment and economic growth. Similarly, the empirical findings of Nwakeze and Omoju (2011) show that income and rapid population growth have a positive and negative significant impact respectively on savings in Nigeria. Other related literature includes that of Barlow (1994) among others.

In sum, theoretical models and empirical studies yield ambiguous predictions concerning the link between population and economic growth. The optimists are of the view that population growth could lead to creativity and scientific innovations by geniuses (super intelligent individuals) thereby circumventing any limit on the earth resources (carrying capacity). For the persimists there is reason to worry because the greater the number of people, the more pressure there is on resources. Also, there are some scholars who do not align themselves completely to either of the two extreme views but rather choose to be cautious either way. By and large, the realities of the world today, namely; extreme poverty and hunger, emerging diseases, conflicts, terrorists attack, wars, climate change and natural disaster call for policy concern on population and sustainable development. For more information and conviencing arguements see Sachs (2009); Mason *et al*. (2010); Nwakeze (2013) and Lee and Mason (2013) among others.

III DATA AND METHODS

The data for this study are obtained from secondary sources. The secondary data comprise annual time series spanning 1980 through 2010. The variables of interest are: national output measured by real Gross Domestic Product (GDP), population, age dependency ratio and agricultural land. These data were obtained from the World Bank and United Nations publications. The empirical aspects of the link between population and economic growth have been explored in several studies. The theoretical basis for this paper is derived from the classical theories championed by Malthus and the methodology employed by Higgins (1998).

There is compelling evidence that many demographic and macroeconomic time series data sets are non-stationary, and, as a result, the Ordinary Least Square (OLS) applied to this data set may produce spurious result. Therefore, the analysis employs the error correction modeling (ECM) techniques to estimate the effect of population growth on gross domestic product. Thus, the estimation technique used in this study is based on a test of stationarity using Augmented Dickey Fuller (ADF) test and Johansen's co-integration test for testing the existence of a long-run relationship between the dependent and independent variables.

The function for the empirical analysis is specified as follows:

$$RGDP = F\ (POP, AGEDEP, AGLAND)$$

The econometric model can be statistically written as:

$$LOGRGDP = \beta_0 + \beta_1 LOGPOP + \beta_2 LOGAGEDEP + \beta_3 LOGAGLAND + ECM(-1) + \mu_t$$

Where:

β= Parameters
LOGRGDP = Log of Real Gross Domestic Product
LOGPOP = Log of Population
LOGAGEDEP = Log of Age dependency ratio
LOGAGLAND = Log of Agricultural land
ECM = Error Correction Mechanism
μ_t = Error term

IV RESULTS AND DISCUSSIONS

4.1 *Regression Results*

The unit root test shows that all the variables are stationary. The Johansen co-integration test shows that there exists a long-run relationship between the variables, which enables the independent variables to be used to efficiently predict the dependent variable. Due to the presence of co-integration, error correction mechanism (ECM) was generated to correct the effect. Two different results were generated. The first regression result shows that all variables are significant at 5 per cent except for the age dependency ratio. A second result was generated with the log transformed data and based on the akaike info criterion, the regression result two was adopted as the best. See Appendix. The regression result two shows a significant positive relationship between population and real gross domestic

product. This implies that an increase in population, ceteris paribus, will lead to an increase in real gross domestic product. For instance, population increase will lead to an increase in the real gross domestic product, if and only if, it is accompanied by real investment in the human capital.

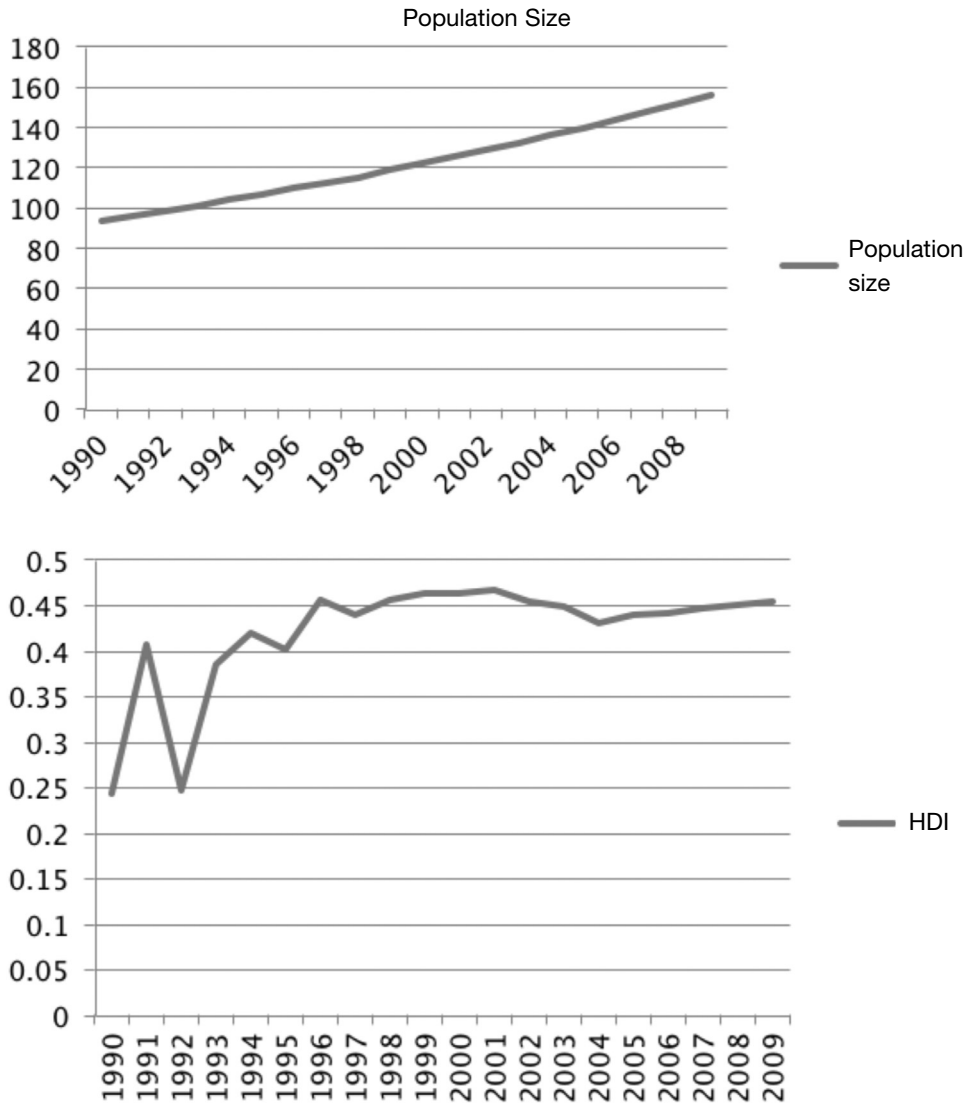
Population size has a significant positive relationship with real gross domestic product. This result shows that increases in population increases the real gross domestic product in Nigeria. This result is consistent with the neo-classical growth model which includes the endogenous population growth models (neo-Malthusian) but contradicts our a priori expectation that an increase in population would lead to a decline in the GDP. In the Malthusian sense, an increase in the rate of population growth leads to a decrease in per capita income both in the short run and long run. A possible explanation for the Nigerian scenario could be the fact that more than 80 per cent of the country's earnings accrue from oil revenue. To gain more insight for an informed policy decision, the trend in Human Development Index (HDI) of Nigeria is compared with the trend in population. See Figure 1.

Figure 1 clearly shows that while there was a steady increase in population between 1990 and 2009, the human development index fluctuates (around 0.25 and 0.4) between 1990 and 1995. Thereafter (1996-2009), it remained stagnant at around 0.45 which falls under the low human development category.

Also, from the regression result two, the age dependency ratio has a significant negative relationship with the real gross domestic product. This indicates that an increase in age dependency ratio will lead to a decrease in the real gross domestic product. Therefore, as the number of the dependent population in Nigeria increases, economic growth decreases. This will operate through the savings mechanism. The higher the dependency burden, the lower the savings, and this situation may be worse for Nigeria because of rising youth unemployment. Ironically, the majority of the young adults who are supposed to be working and earning income are still dependent on their family for livelihood. This is a vicious cycle that affects savings, investment and economic growth. This view is supported by the findings of Nwakeze and Omoju (2011) which suggest that rapid population growth has negative significant impact on savings in Nigeria.

The findings also show that agricultural land has a significant negative relationship with the real gross domestic product. This demonstrates that an increase in agricultural land will lead to a decrease in the real gross domestic product of Nigeria. This is not consistent with a priori expectations that agricultural land will decrease as the population increases since land is relatively fixed. The first result, however, showed the expected positive relationship but is not significant. By this result, it may be argued that the

Figure 1: *Trend in Population Size and HDI for Nigeria (1990-2009)*



predictive power of agricultural land on the gross domestic product of Nigeria is inconclusive. Two reasons may be adduced for this: one is the fact that oil extraction has been an important economic activity and a major source of fiscal revenue for several decades. No doubt, the discovery of oil wealth has brought about neglect in agriculture. The situation is worsened by rural-to-urban migration especially among the youth and thereby limits the supply of

agricultural labour to the older and febrile adults whose productivity is very low. A second reason is the fact that agriculture is mostly on subsistence level in that most of what is produced is consumed and is excluded in the computation of GDP. Presently, an attempt is underway to rebase Nigeria's GDP by including non-marketable economic activities, especially those of the private sectors which were hitherto excluded.

By and large, the coefficient of determination R^2 of 0.80 indicates that about 80 per cent of the total variations in the real gross domestic product is explained by the independent variables. This shows the explanatory power of the independent variables and as well shows a good measure of fit. The F-statistics, which shows the overall significance of the model, is significant at 5 per cent level. Therefore, the null hypothesis that the model is not significant in explaining the variations in real gross domestic product is rejected. The Durbin Watson test which is 2.31 shows the absence of serial autocorrelation. See result 2 in Appendix 1.

4.2 *Macroeconomic and Demographic Indicators of Selected Countries*

This section presents a comparative analysis of selected countries from the diverse regions of the world. It highlights the major demographic concerns and policies of the selected countries with a view to providing solutions for more sustainable development in the post-2015 agenda. To achieve this, countries were selected from each regions of the world on the basis of population size – the largest and the smallest respectively. See Tables 1 and 2.

The current world population of 7.2 billion is projected to increase to 9.6 billion by 2050. Much of the increase is expected to take place in high fertility countries, mostly in Africa. Table 1 shows Nigeria has the highest population growth rate at 2.7 per cent and paradoxically the lowest Human Development Index (HDI) of 0.471. Relative to other countries, Nigeria has the highest support ratio and highest adult dependency ratio. For old-age dependency ratio, Australia has the highest while Nigeria has the lowest. For those countries with small population size shown in Table 2, Belize has the highest growth rate of 2.53 with HDI of 0.702. It also has the highest dependency ratio of 64.9, which is well above the world average of 52.2. Dependency ratios vary substantially across countries, reflecting changes in the age structure of the population. For instance, as fertility declines, the child dependency ratio (the number of children under age 15 per 100 working-age adults between ages 15-64) also declines creating an opportunity for economic growth. This opportunity for growth ("demographic opportunity") ceases as the population ages. Comparing Tables 1 and 2, the assumption that countries with small populations tend to grow faster than those with large populations can not be easily confirmed. The next section examines the views and policies of governments of selected countries.

Table 1: *Economic and Demographic Indicators for Selected Countries (Largest by Population)*

Region	*Country*	*Per Capita GDP ($) 2011*	*HDI 2012*	*Population Size 2013*	*Population Growth Rate*	*Density*	*Support Ratio*	*Dependency Ratio*		
								Total	*Child*	*Old-age*
Asia	China	7,418	0.699	1,384,694,199	0.579	141.7	8.8	36.0	24.7	11.4
Africa	Nigeria	2,221	0.471	173,611,131	2.799	172.9	19.5	87.8	82.7	5.1
Europe	Russia	14,808	0.788	142,572,794	–0.406	8.4	5.5	38.9	20.7	18.2
North America	USA	42,486	0.937	316,862,000	0.867	32.4	5.1	49.0	41.7	10.2
Latin America and Caribbean	Brazil	10,278	0.730	201,032,714	0.912	22.9	9.8	47.9	29.6	19.5
Oceania	Australia	34,548	0.938	23,215,262	1.315	2.9	5.0	47.9	28.0	19.9
World	World	10,103	0.694	7,118,279,573	1.226	50.8	8.6	52.2	40.5	11.7

Sources: Human Development Report 2012 and *United Nation Population Prospects,* 2012 Revision.

Table 2: *Economic and Demographic Indicators for Selected Countries (Smallest by Population*)*

Region	*Country*	*Per Capita GDP ($)*	*HDI*	*Population Size*	*Growth Rate*	*Density*	*Support Ratio*	*Dependency Ratio*		
								Total	*Child*	*Old-age*
Asia	Maldives	7,478	0.688	345,256	1.806	1,092.9	13.0	53.8	46.1	7.7
Africa	Seychelles	22,615	0.806	93,035	0.923	200.5	9.2	42.7	31.8	10.8
Europe	Vatican (Holy See)	–	–	839	0.025	1,815.9	–	–	–	–
North America	Canada	35,369	0.911	35,163,430	1.129	3.4	4.9	44.1	23.7	20.4
Latin America and Caribbean	Belize	5,327	0.702	333,433	2.530	13.4	15.6	64.9	58.5	6.4
Oceania	Fiji	4,087	0.702	883,763	0.905	47.1	13.7	51.2	43.9	7.3
World	World	10,103	0.694	7,118,279,573	1.226	50.8	8.6	52.2	40.5	11.7

Sources: Human Development Report 2012 and *United Nation Population Prospects,* 2012 Revision.
* Refers to the smallest for which information is available.

4.3 *Government Views and Policies on Population Growth*

The major population concern of the world in 2009 was HIV/AIDS as reported by a total of 87 per cent of governments. Other concerns include size of the working age population (62 per cent), population ageing (55 per cent) and pattern of spatial distribution 51 per cent – United Nations (2010). On regional basis, the major population concern for the developed region is population ageing (79 per cent) and for the less developed region it was HIV/AIDS (90 per cent). In terms of policies, governments mostly adopt implicit or explicit policies that will influence the desired change in any of the three important demographic processes namely fertility, mortality and migration. Table 3 presents the views and policies of selected countries on population growth. The government views are considered to be either satisfactory, too high or too low. In 2009, 18 per cent of countries of the world had policy interventions in order to raise the population, 17 per cent had policies to maintain the rate and 34 per cent had policies to lower the rate while 30 per cent had no policy intervention. For the more developed countries, 45 per cent of the countries had policy intervention to raise population while none wanted to lower population growth – United Nations (2010), for example, see Table 3. With the present satisfactory view of the Chinese government concerning population growth, plans are on the way to officially relax the controversial one-child policy.

Table 3: *Government Views and Policies on Population Growth – 2009*

Region	*Country*	*Government Views on Population Growth*	*Government Policies on Population Growth*
Asia	China	Satisfactory	Maintain
Africa	Nigeria	Too high	Lower
Europe	Russia	Too low	Raise
North America	USA	Satisfactory	No intervention
Latin America and Caribbean	Brazil	Satisfactory	No intervention
Oceania	Australia	Satisfactory	No intervention

Sources: United Nation (2010).

In Table 3 it is shown that the USA, Brazil and Australian governments view their population growth as satisfactory and had no policy intervention. The Nigerian government considered population growth to be too high, and its policy intervention was to lower the population. The Russian government's view was that the population growth was too low and the policy was to raise

the population. China's intervention policy was to maintain the population growth. It should be noted that China has the highest population in the world and for more than three decades has had the most stringent anti-natalistic (one-child) population policy.

V SUMMARY AND CONCLUSIONS

This paper has explored the link between macroeconomics and the demographics. The major findings indicate that population size affects gross domestic product positively. The age dependency ratio was also found to have a negative effect which reflects the Nigerian situation as a country with a youthful population and unemployment crisis. A trend analysis of the population size and Human Development Index (HDI) indicates that Nigeria has consistently maintained a low human development. The comparative analysis with selected countries from the diverse regions of the world shows that Nigeria's population is growing at a rapid rate.

On the views and policies of governments concerning population growth it was observed that population is considered a development challenge. The intervention approach depends on whether the government views population growth as a stimulus or as an impediment to development. By and large, governments' population policy intervention is either to raise, reduce or maintain population growth. For most countries from Europe (example Russia) policy intervention was to raise population growth. The Nigerian government intervention is aimed at lowering the population growth.

Conclusively, the paper suggests that in addition to population policy interventions, macroeconomic policies should generally integrate demographic concerns for more sustainable development. For instance, there is need to identify unsustainable consumption and production practices with a view to improving not just the gross national product but also the "gross national happiness". To ensure happiness, macroeconomic policies should address all threats to peace and security that are linked to the demographics. For instance, the youth bulge and the youth unemployment crisis. These suggestions are considered important for the post-2015 development agenda.

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APPENDIX
Regression Output

Result 1

Dependent Variable:	RGDP
Method:	Least Squares
Date: 09/02/13	Time: 14:58
Sample:	1980 2010
Included observations:	31

Variable	*Coefficient*	*Std. Error*	*t-Statistic*	*Probability*
C	–1.57E+08	48648581	–3.235271	0.0032
POPSIZE	221899.2	60830.91	3.647803	0.0011
AGEDEP	456442.6	480931.2	0.949081	0.3510
AGLAND	136.3540	55.43649	2.459643	0.0206
R-squared	0.839957	Mean dependent variable		5971026.
Adjusted R-squared	0.822174	S.D. dependent variable		8695059.
S.E. of regression	3666657.	Akaike info criterion		33.18737
Sum squared residual	3.63E+14	Schwarz criterion		33.37240
Log likelihood	–510.4043	F-statistic		47.23471
Durbin-Watson statistics	0.164901	Probability (F-statistic)		0.000000

Result 2

Dependent Variable:	D(RGDP)
Method:	Least Squares
Date: 09/02/13	Time: 15:00
Sample (adjusted):	1981 2010
Included observations:	30 after adjustments

Variable	*Coefficient*	*Std. Error*	*t-Statistic*	*Probability*
C	–20209451	2416851.	–8.361895	0.0000
D(LOG(POPSIZE))	4529279.	519500.7	8.718524	0.0000
D(AGEDEP)	–1399394.	–426324.1	–3.282464	0.0030
D(AGLAND)	–40.84692	–11.97015	–3.412397	0.0022
ECM(–1)	–0.085287	0.063539	–1.342287	0.1916
R-squared	0.806488	Mean dependent variable		971871.7
Adjusted R-squared	0.775526	S.D. dependent variable		1373821.
S.E. of regression	650898.0	Akaike info criterion		29.76111
Sum squared residual	1.06E+13	Schwarz criterion		29.99464
Log likelihood	–441.4166	F-statistic		26.04776
Durbin-Watson statistics	2.316422	Probability (F-statistic)		0.000000