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Population Growth and Agricultural Policy

A theoretical and empirical approach to fertilizer subsidies and their effects on population growth in Nigeria

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“The most decisive mark of the prosperity of any country is the increase in the number of its inhabitants”

- Adam Smith, 1776

Abstract

The growing world population creates increasing pressure on the economic growth and the environment. Since the times of Malthus and Smith there has been studies linking population growth and agriculture. We have looked further into the subject; we studied the relationship between agricultural subsidy policies and population growth in an agricultural dependent society. The theoretical model predicted an increased fertility rate and a decreased mortality rate as an effect of an increase in agricultural subsidies e.g. subsidized fertilizers. To examine the significance of our theories we performed an econometric study of Nigeria's different regions during the years 2001-2005. Nigeria has a history of subsidizing fertilizer use and had during the time period a subsidy of 25 percent of landed cost. We found that agricultural policies likely decrease mortality rates in the regions studied. We did not find any significance on an increased fertility. The main objective with the agricultural policy was to increase agricultural production, but as a secondary effect it obtained population growth by decreasing mortality rates. A decreasing mortality is often an indication of the increased wealth of the population. Subsidizing fertilizers in a country such as Nigeria is from this point of view positive for the well-being of its population. [*]

Keywords: Population growth, Agricultural policy, Fertilizer subsidy, Economic growth, Nigeria

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Abbreviations

BLUE – Best Linear Unbiased Estimation
DW – Durbin Watson Test
FAO – Food and Agricultural Organization
GDP – Gross Domestic Product
LS – Least Squares
NBS – The National Bureau of Statistics in Nigeria
NLS - National Longitudinal Surveys of Labor Market Experience
NSDS - The National Strategy for Development Statistics
PLS – Panel Least Squares
UN – United Nations

1. Introduction

On the 30th of October 2011 Danica Camicho was born and elected by the UN to symbolize the seventh billionth baby (Coleman, 2011). The world population has increased by a few millions since and will likely continue to increase for several years to come. The UN believes the world population will peak around 2070 at 9,4 billions (United Nations Economic and Social Council. Commission on Population and Development, 2011). The ever growing population will create increasing pressure on economical, socio-political and environmental issues. It is thus important to study the causes of population growth to understand and create policies to retain sustainable development. The world population growth consists of two variables, total fertility and total mortality. The increased population growth occurring over a period of time, which has been noticed in the developed world and increasingly is occurring in the developing world, is denoted as the demographic transition. It may be summarized as an initial decrease in mortality will result in a decreased fertility after a time delay. During periods of high fertility and low mortality the population growth is high (among others that have studied the phenomenon we can mention (Reher, 1999) (Hirschman, 1994) (Becker, 1993) (Galor & Weil, 1996) (Galor & Weil, 2000) (Strulik & Weisdorf, 2008)). It can be concluded that both fertility and mortality are vectors affected by several variables.

We will in this thesis study the effects of agricultural policies on population growth. Specifically we want to study the effects of agricultural policies trying to promote agricultural production in an agricultural dependent society. Agricultural policies are widely recognized as vital for decreasing the extreme poverty in Sub-Saharan Africa. As large shares of the population are dependent on the agricultural sector it is likely that the policies affecting the sector will give rise to externalities affecting the population in alternative ways than the primary goal of the policy. The formalization and implementation of agricultural policies are important to affect the agricultural production (among others studying the effects of agricultural policies and fertilizer subsidization we can mention (Crawford, et al., 2006) (Dorward, et al., 2004) (Eboh, et al., 2006) (Minde, et al., 2008) (Xu, et al., 2009)). The objective of this thesis is to study the relationship between an artificially improved production in agriculture in an agricultural dependent society and its effect on the determinants of population growth. We may formalize the objective as follows: do agricultural policies affect population growth in terms of fertility and mortality in an agricultural dependent society? In assessing an answer to our objective we will need to answer a few associated questions such as: What affects population growth? Does food availability affect population growth? Are the desired effects of the policy met?

Our econometric research is conducted by studying the variation in crude birth rates and crude death rates and their relationship to fertilizer subsidies in 35 regions of Nigeria between the years of 2001 to 2005.[†] The reason to study Nigeria as an example of our theories is that Nigeria has traditionally been an agricultural society and still a large share of the population are dependent on the sector. The agricultural sector has decreased as a share of the economy during the last 40 years, whilst the employment rate in the sector continues to be substantial. This phenomenon has been observed world wide and is denoted Engel's law, which states that the agricultural sector will decrease as a share of the economy when the economy grows (Yasuda, 2008). Nigeria's agricultural sector is characterized by widespread diversity in both regions and crops and it is unfortunately filled with data problems (National Bereau of Statistics, 2010). The time period is chosen as it is the only time period with available data. Being aware of the data problems we still believe that it is of importance to study if any significance of a relationship exists.

Our thesis is presented as follows: in section two we present theoretical backgrounds upon economic growth and population growth as well as the determinants of fertility and our theories on fertility and mortality. In section three we present the background of Nigeria, their agricultural policies and agricultural production in general. Section four is where we explain the regression model. In this section we go through some of the key concepts of the empirical model, such as the use of panel data and define areas and variables that we will investigate as well as discuss the econometric issues that may occur in such a model. In the fifth section we present our specification, what adjustments that have been done and the result of them. In the sixth section we analyze our results, model and theory. In the final section we summarize and conclude the thesis.

[†] Crude birth rate minus crude death rate equals the rate of natural increase in the population.

2. Theoretical Framework

The theoretical framework aims at making the reader understand what is affecting fertility and mortality. We start of with the determinants of the population. Further we give a brief presentation upon population growth and its relationship to economic growth per capita. Then we present earlier theories of fertility and proceed to our own theory of the relationship between agricultural policies and fertility. Lastly we present the theory of agricultural policy and mortality.

Determinants of the Population

The population in a country grows as a function of mortality, fertility and net migration. The population in period *t* could be written as function such as:

$$L_t = L_{t-1} + F - M + N$$

Equation I: Population in period t

Where L_{t-1} is the population in the period before t, F is fertility, M is mortality and N is the net flow of migration. Formalizing the partial derivatives we find that $\frac{dL_t}{dF} > 0$, $\frac{dL_t}{dM} < 0$ and $\frac{dL_t}{dN} = [\pm 0]$. This implies that the higher mortality between period t-1 and t the smaller value $L_t$will obtain in relation to L_{t-1}. The greater fertility between the periods the larger will L_t be. The derivative of net migration is unknown as it depends on if we have a net inflow or outflow of migrants.

Population Growth and Economic Growth

Population growth is one of the main variables of economic growth. Malthus declared, as early as in 1798, in his paper *"An essay on the principle of population"* that the only way for the population to increase its wealth and well-being were through preventive living. Malthus' theory implied a fixed amount of one factor of production, land, which had decreasing returns to scale to all other factors. According to Malthus the levels of living would be high if the population was small relative to the prevalence of land. Such a standard of living would imply that the fertility rates would increase due to the attraction between the sexes and hence increase the population size. When the population was large, and land was scarce, the living standards would be low which would lower the population either due to "the preventive check" which meant by controlling fertility, or by "the positive check" which implied malnutrition, starvation etc. (Malthus, 1798 (1993 printing)). Adam Smith was of a similar opinion as he stated "The most decisive mark of the prosperity of any country is the increase in the number of its inhabitants" (Smith, 1776). Malthus' model did describe the situation of most countries prior to 1800 well, with living standards roughly stable over the long run. Proofs of Malthus' theory are for example that the growth of GDP per capita in between the years 500 and 1500 in Europe was approximately zero (Maddison, 1982) and that the GDP of England in 1800 remained roughly equal compared to that of England in 1300 (Galor & Weil, 2000). Ironically the stagnation Malthus described in 1798 humanity had just begun emerging from (Maddison, 1982).

Malthus' theory has now been replaced by modern economic growth theories with seemingly endless economic growth per capita, at least in the developed world, and a negative correlation between population growth and GDP growth. The highest population growth rates are found primarily in poor countries and the wealthiest countries have population growth rates close to zero. The modern economic growth theories began with Solow's "A Contribution to the Theory of Economic Growth" from 1956. In the modern growth regime there is steady income and technological growth. The transition between a Malthusian stagnant economy and a modern growing economy has primarily happened through technological growth, human capital accumulation, fertility choices and the decrease of land use in production (Romer, 1990) (Hansen & Prescott, 2002) (Kremer, 1993) (Galor & Weil, 2000).

The effects on economic growth per capita[‡] of mortality and fertility are different. High fertility rates suggest high dependency burdens for the economy; this can also be the case for mortality such that there could be a great number of non-working elderly. While low mortality rates increase the return of education and ensure a productive stable economy, high fertility rates are not positive for economic growth as it requires larger investments in education and capital to remain at a stable economic level. Azomahou et al. finds that the relationship between longevity and economic growth is convex concave in its relationship. At low ages an increase in life expectancy shows a convex relationship to economic growth, while at very

[‡] Further simply referred to as economic growth instead of economic growth per capita.

high ages the economic growth relationship is concave (Azomahou, et al., 2009). In resemblance Chakraborty constructs a model where poor health levels, hence high mortality rates, raise the impatience of individuals and decrease the returns of human capital and thus societies may remain in poverty. An implication is that societies need not necessarily grow even when available technology is not the bottleneck (Chakraborty, 2004). The effect of low mortality seems to be positive for the economic growth.

Given the reasoning above it is likely that a decreased mortality is positive for the economy as it increases longevity and a decrease in fertility would also increase the economic growth. Likewise an increase in mortality or fertility would be negative for economic growth.

Fertility Theory

Traditional theories believed that fertility rates would be maximized at all times. Thus they suggested that the population would produce as many off-springs as the economy could nourish. An example of the failure of these theories is that the fertility rates in Florence and in its surroundings kept a lower birth rate than what would be maximal as early as 1427 (Becker, 1993). The motives for the fertility rates are not as trivial as the early theories once stated.

Modern fertility theories focus on the decision making of parents. It may be as a result of the substitution between quantity and quality of children or as an effect of parents' altruistic preferences towards their children (Becker, 1993). As there are no good substitutes for children there can only be a substitution between the quantity and quality of children Becker denotes. He further assumes that every child has the same quality level within every family.[§] Hence families receive utility from the quality their children have, the quantity of children they have and the amount of commodity goods they consume. He finds that the substitution effects between quantity and quality changes by a greater magnitude than a change in between normal commodity goods would, as the budget constraint for quantity is a function of quality and vice versa. This indicates that when there is large quantity it is cheaper to have yet another child than to increase the quality of all the others, and likewise for quality. The implication is a further cementation of the differences between societies with large quantity and low quality and the ones with low quantity and high quality of children. The advancement

[§] The general idea of the quality standard is to incorporate variables that require large time spent on each child such as education, economic support, and health levels among others.

in income during later centuries and downfall in fertility rates indicates that the income elasticity of quality is higher than that of quantity (Becker, 1993).

There has historically been a fertility rate difference between urban societies and rural societies when farming has been self-sustaining (see among others (Galloway, et al., 1998)). When the rural sector has been consisting of self-supporting farmers the costs of children may be referred to as a hidden cost. This since the children are not considered an expense in monetary terms, but a cost of the agricultural goods in which production they will likely assist. This implies that rural children also tend to be more productive in production, given that the children work, than children in urban areas. This as the human capital required to work is lower in the rural sector, at least traditionally, than in the urban sector. The demand for quality in a rural society is due likely to be less than in an urban society, hence the higher demand for quantity. This suggests that the potential earnings of children in rural sectors initiate at a young age, which further implies that the cost of raising a child until it starts producing return is lower (Becker, 1993). When agricultural production becomes technologically abundant the return of having extra labor diminishes and therefore also the incentives to have a greater quantity of children decrease. In developed societies the costs of having children in the rural sector has, in some cases, bypassed the urban sector as the agricultural production has become mechanized. This means that the children's quality has to be increased and with the cost of transportation, time and low efficient schools the costs for rural children has become higher than for urban children (Becker, 1993). In fact the urban-rural fertility ratio has narrowed greatly and in some societies the rural sector families have lower fertility rates than urban ones (Gardner, 1973) (Becker, 1993).

Becker and Barro (1988) construct a model where parents are altruistic towards their children such that their utility is a function of their own consumption as well as their descendants'. They find that high altruistic preferences as well as high interest rates will lead to a higher fertility. A tax on children in a period would lower the fertility during that period as the tax would imply a higher cost of rearing. They find that a permanent decrease in mortality would temporarily increase population growth. A permanent expansion of social security initially lowers fertility, but would not have a permanent effect on fertility if interest rates are unchanged. High technological growth would imply an increase in consumption and a decrease in fertility (Becker & Barro, 1988).

Becker et al. (1990) construct a model where high societal level creates high return on human capital, the implication is increasing returns to human capital. They find that societies with high levels of human capital will choose few children and invest human capital in them. This will create economic growth while, in societies with low levels of human capital they will instead have a quantity focus investing little human capital in each child. This implies a negative correlation between income per capita and fertility rates. They find that due to increasing return to human capital, societies with low human capital will have relatively large returns to children whereas the opposite is in effect in societies with high levels of human capital. The result of their model is two steady states with one stagnant Malthusian economy and one economically growing economy (Becker, et al., 1990).

The Fertility Decision Model

We will construct a rather straightforward simplistic model to explain the relationship between fertilizers subsidies and fertility. In our model we assume that the subsidies are effective. The trade-off between quantity and quality we assume to be constant, or given exogenous such that individuals take the quality requirements as given, as households are assumed to be poor and dependent on the agricultural sector. Therefore we need a utility function that assumes that the quality of children in the short run is homogenous (Strulik & Weisdorf, 2008).

We assume that parents maximize utility as a function of the amount of offspring they have and the amount of commodity goods which they consume, hence we abstract from the term of quality. The parents have a hierarchy of needs, where having children is a first priority activity and consuming other goods is a second priority activity, meaning that Z is no perfect substitute to n as individuals will desire children no matter what income bracket. We assume a quasi-linear utility function in the same way as (Strulik & Weisdorf, 2008).

$$U = \gamma \ln(n) + Z$$

Equation II : Utility function

Where n is the amount of children, Z is the aggregated commodity goods and γ is the weight added per child. The utility function provides the strongest case of hierarchy of needs as it has no income elasticity, which indicate that the birth rates do not change as an effect of business cycles.

In resemblance with Strulik and Weisdorf (2008) we assume that an individual consumes a fixed amount of food (i.e. calories) measured by a. We will assume that they will carry them with them for the rest of their life. This suggests that the cost of consuming food equals the cost of a child's consumption.[**] We set $a \equiv 1$ such that the amount of calories consumed does not change as an effect off an income change and every child consumes one unit of food. Our budget constraint then is:

$$I = P_n n + P_z Z$$

Equation III: Budget constraint

Where P_n is the cost of children, n is the amount of offspring, I is the total monetary income, P_z is the price of aggregated commodity goods and Z is the amount of aggregated commodity goods. Marshall's demand is the optimal bundle of consumption given a certain utility function and budget constraint. Hence by solving for the optim ization problem we acquire the Marshall demand for children such that:

$$n^* = \frac{\gamma P_z}{P_n}$$

Equation IV: Marshall demand

This implies that the greater weight added per child and the higher price on commodity goods the greater demand there will be for children. Higher cost for children will decrease the demand for children.

Historically the costs of having children have been the cost of food and the mother's time (Strulik & Weisdorf, 2008). We will assume that $P_n = P_A$ where P_A is the cost of food or agricultural goods. This is quite straightforward in several developing countries where large shares of the households are self-sufficient farmers and women work at home.

There is indirect income elasticity in the demand for children; if the cost of agricultural goods decreases as an effect of productivity growth or an intervention, the demand for children increases. The growth of the costs hence affects the demand for children over time. In our utility function, equation II, we assume that the preferences are not a function of the change in income.

[**] "It will not affect the qualitative nature of the results, if instead, the individuals food demand where to be divided over two periods" and hence neither in our. (Strulik & Weisdorf, 2008)

In accordance to Malthus' stagnant society and Becker et al. (1990), the leading growth of rural societies will take place in rural technology and hence lower the price of agricultural goods, while with sustained growth the growth of aggregated goods and hence the decrease of P_z will dominate. This is presented nicely in Strulik and Weisdorf's paper from 2008. (Strulik & Weisdorf, 2008) It is in the long run also likely to see a decrease in the term of γ as for e.g. women change their preferences for career rather than child-raising. (Roy, et al., 2008) This could be interpreted as a change in quality preferences.

The agricultural market

The cost of agricultural goods and in our model also the cost of children is determined in the agricultural market which we assume to be a normal market with perfect competition and rational consumers. The general market equilibrium condition states that supply should equal demand.

$$S_A = D_A = Q_A$$

Equation V: Supply equals Demand

Where S_A is the supply of agricultural goods, D_A is the demand for agricultural goods and Q_A denotes the optimal quantity bundle given the supply and demand. Supply is a function of the production function which it faces such that $S_A = f(TC)$, where TC is the total costs of producing agricultural goods. The price of agricultural goods is thus derived by the interaction of supply and demand. The derivative of supply with concern of p_A is positive which suggests that a higher price increases supply and the opposite is in effect for demand.

$$\frac{dS_A}{dp_A} > 0$$

$$\frac{dD_A}{dp_A} < 0$$

On the market they function and intersect at the optimal price of p_A^*.

The insertion of a subsidy

We now conduct the insertion of an agricultural subsidy (c), which can be seen as a fertilizer subsidy, to the suppliers making them adjust to a new production function $S_A^c = f(TC, c)$, hence it is derived from the cost function and the subsidy. As the subsidy decreases the cost of producing the same volume as before the producers of agricultural goods now increases their supply, this since we assume that $\frac{dS_A}{dc} > 0$.

The result is an increased supply which lowers the price which consumers face and increases the quantity consumed of agricultural products. This means that $Q_A^C > Q_A$, where Q_A^C is the new quantity given the subsidy, and thus the price has changed such that $p_A > P_A^c$, where P_A^c is the price of agricultural goods given the subsidy.

Inserting p_A^c into the Marshall demand for children we get:

$$n^1 = \frac{\gamma P_z}{P_A^c} > n^* = \frac{\gamma P_z}{p_A}$$

Equation VI: Marshall demand and Agriculture price

We can note that demand for children has increased as an effect of the subsidy. This effect should imply an increase in fertility which would positively affect the growth of the population. [††]

Our theory's conclusion is largely dependent of that it is formed as a static one period model. Performing a two period model would likely find that the effect of the subsidy is temporary and hence increase fertility over a time period before it starts decreasing due to the normal development of the prices.

[††] We have not taken into regard the effect of wealth and the increased productivity from the subsidy.

Mortality Theory

Mortality is affected by several variables such as the possibilities of receiving or being able to consume food, medication, education and several other variables. The more food available the less likely is the population to decease as it effects several variables such as starvation and child mortality. On the contrary too much food may also lead to an increase in mortality when taking into account factors such as obesity and cardiovascular diseases. These diseases are primarily observed in the developed world where the problem of food consumption is of another variant than in agricultural dependent societies.

The partial derivative of an agricultural production subsidy or consumption subsidy is likely to decrease the mortality in a low income country whereas in a high income country the effect is ambiguous. This as in our agricultural market above the subsidy is effective and hence increases the supply of agricultural goods. The reasons for the decrease in low income countries are quite straight forward: an increase in the supply of food will prevent people from starving and decrease the malnutrition related diseases.

$$\frac{dM_t}{dc} = f\left(\frac{df(A)}{dc}\right) < 0$$

Equation VII: Derivative of a fertilizer subsidy on Mortality

Where *M* is the Mortality rate, *c* the subsidy and *A is* the agricultural market. As such we find that the mortality rate is a function of the agricultural sector. The more food produced, stimulated by the subsidy, will decrease the amount of malnutrition related deceases.

3. Empirical Background

In the empirical background we start of with presenting Nigeria and some brief facts about the country such that the reader will get a basic understanding of the country and its situation. We continue by presenting some basic facts about agriculture and why fertilizer use is of importance for its productivity. We then present the history of fertilizer use in sub-Saharan Africa and Nigeria. Being aware of the empirics and enclosed variables is of importance to understand the econometric investigations performed later on.

Regarding Nigeria

Nigeria is the largest country in Africa in terms of population, although the statistical data are not exact. One reason for population data being biased is that the federal government distributes tax revenues towards the different regions according to their population size. This implementation provides regional governments incentives to manipulate their population data (Holmén, 2011).

The importance of the agricultural sector's dominance in respect to the population in Nigeria has traditionally been unchallenged. During the 1970s the oil industry became the main income source. Oil is the main export product 2011, yet agriculture still plays an important role for most of Nigerians even if they are no longer self-supporting in the sector. In between 2001 and 2005 an average of 44,6 percent of the employed workforce worked in the agricultural sector, yet Nigeria is a net-importer of agricultural goods. This is likely as Nigeria's agricultural sector is dominated by traditional small farmers, which operate with primitive technology and has great areas in fallow (Holmén, 2011).

Short facts of Nigeria

Average 2001-2005	
Agriculture, value added (% of GDP)	39,56
Employment in agriculture (% of total employment)	44,6
GINI income index	42,93
Birth rate, crude (per 1,000 people)	41,36
Death rate, crude (per 1,000 people)	16,62
Life expectancy at birth, total (years)	47,91
Survival to age 65, female (% of cohort)	40,82
Survival to age 65, male (% of cohort)	37,79
Population growth (annual %)	2,45
Progression to secondary school (%)	47,69
Population, total	133 165 409
Rural population (% of total population)	55,28
Urban population (% of total)	44,72

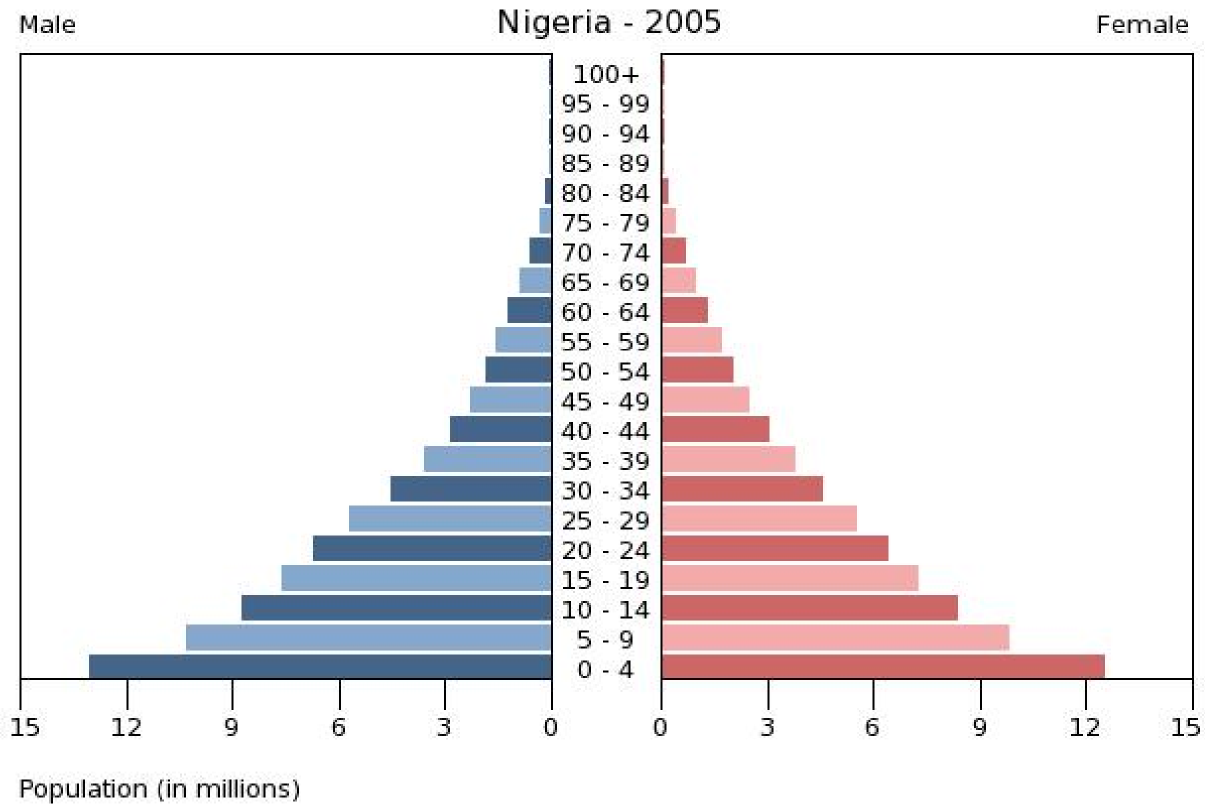
Source: (The World Bank, 2011) ‡‡

Table I Short facts of Nigeria

The above table is an average of statistics in Nigeria over the years that our empirical study analyses. Worth noting from this is among others the low progression rate to secondary school. School attendance is officially mandatory, yet less than half of the population progress to secondary school. The life expectancy is still considerably low which indicates that the expected years of work are low which might also decrease the incentives to spend time and money on education. Nigeria have experienced urbanization the last decades and between 2001-2005 they had an average urbanization rate of 44,72 percent. Since the 1960s the urbanization has increased from 17 percent in 1965 to 51 percent in 2011. As earlier mentioned although the economic importance of agriculture has decreased it still employs 44,6 percent of the population as of 2004 which can be compared to 46,9 percent in 1986.

‡‡ GINI index and Employment in Agriculture are not averages since the only existent data is from 2004.

A population pyramid over Nigeria in 2005:



(U.S Census Bereau International Programs, 2011)

Graph I Population Pyramid

Nigeria's population pyramid has a typical developing nation form, with a large population in the young ages and few elderly. This indicates that Nigeria has high fertility rates and high mortality rates.

Agriculture

Agricultural production is largely dependent of the use of fertilizers. Fertilizers consist of various essentials for plant growth denoted as nutrients. There are six macronutrients and seven micronutrients. The three macronutrients which are most extensively used in fertilizers are nitrogen (N), phosphorous (P) and potassium (K) as these are the most heavily used for plant growth. The other three macronutrients are calcium (Ca), magnesium (Mg), and sulfur (S) are normally found in the soil, yet may be needed to add through fertilizers. (Nationalencyklopedin, 2012) The seven micronutrients are essentials for plant growth, but in micro quantities. These are: boron (B), copper (Cu), iron (Fe), Manganese (Mn), molybdenum (Mo) and zinc (Zn) (Nationalencyklopedin, 2012).

Soil pH measures the acidity in the soil. Macronutrients tend to be less available in soils with low pH and micronutrients tend to be less available in soils with high pH. Lime is typically used to raise pH in acidic areas and hence increases the effects of the macronutrients. It also improves the water penetration and provides a source of calcium and magnesium for plants. Small changes in nitrogen may have a great impact on cereal yield (Granström & Hubendick, 2012). These changes will be considered in the sensitivity analysis performed. The fertilization can be done before the sowing or during the growth. Soil quality as well as fertilizer quality does affect the possibility for the plants to absorb the nutrients added by the fertilizer. UREA is a rather brute fertilizer and may in fact be toxic for some plants (Granström, 2012).

Agriculture in Sub-Saharan Africa

Between the years of 1965-1998 the agricultural growth has been less than the population growth in sub-Saharan Africa and has grown slower than the agricultural labor force in-between 1980-1998. The area of irrigated land has only demonstrated a small rise. Sub-Saharan Africa differs from the world average as they have increased the amount of area under cereals, whereas in other regions areas under cereal has either declined or increased slightly. The Sub-Saharan Africa increase in areas under cereal has resulted in a slight decrease in overall fertilizer use. As a result, when in other areas of the world the cereal production have achieved increases of 80 % from yield increases, in Sub-Saharan Africa more than 70 % of increased cereal production appears to be from area increases (Dorward, et al., 2004). Hence one may suspect that the production technology has not improved.

Fertilizer use in Sub-Saharan Africa

Fertilizer use in Sub-Saharan Africa was 10 kg per hectare in 2007, at that time, the by far lowest in any region of the world (Xu, et al., 2009). By the knowledge of these authors there is no reason to believe differently 2011. There is a widespread consensus that increased fertilizer use in Sub-Saharan Africa is necessary to achieve productivity growth and reduce poverty. Governments have tried different approaches to achieve increased fertilizer usage, e.g. state-subsidized distribution programs, free starter packs, voucher-programs and interlinked input credit/crop marketing arrangements. The literature reveals mixed evidence and much debate about the government's role in the fertilizer market (Dorward, et al., 2004) (Crawford, et al., 2006). (Minde, et al., 2008) (Xu, et al., 2009). Input subsidies may have various objectives such as; increasing agricultural productivity, securing food supply and providing income security for poor farmers (Minde, et al., 2008). The effect of subsidies should try to "crowd in" the private sector and increase the amount of fertilizers demanded, rather than "crowd out" the private sector and decrease the supply. Xu et al. finds that the results of Zambian fertilizer subsidies are dependent on the area in which they act. In areas where fertilizer use is low they find that an additional kg of fertilizer distributed through the subsidy program raised total usage by 0,92 kg. In areas where the private sector had been active another ton of fertilizer distributed under government programs resulted in a decrease of 0,12 ton of total fertilizer use (Xu, et al., 2009). The design and conduction of the subsidy is of great importance for the end results. If constructed in a smart way a subsidy can increase the amount of fertilizers used in the area and hence increase cereal yield.

Fertilizer subsidies in Nigeria

"In concept, fertiliser subsidy programmes in Nigeria aim at making fertilizer prices affordable to poor smallholder farmers in order to ensure increased agricultural outputs, productivity and incomes as well as maintaining food supply to teeming populations (food security)" (Eboh, et al., 2006, p. 4). The subsidy policies of Nigeria have historically been shortsighted with many policy changes after just a few years of implementation. The political situation of Nigeria throughout the last century has been filled with different non elected leaders substituting each other with merely a few gaps of democratic progress in between. The more democratic periods in the Nigerian history has taken place between 1960-1966, 1979-1983 and 1999 and onwards (Holmén, 2011). The frequent changes of governance have often resulted in a change in policy implementation which is shown below in Table II.

Year	Rule	Procurement	Distribution	Subsidy level
1976-1979	Non elected rule	Federal	Federal	75-85 %
1980-1983	Elected rule	Region	Federal	75%
1984-1987	Non elected rule	Federal	Federal	28-38 %
1988-1996	Non elected rule	Region	Federal	70-80 %
1997-1998	Non elected rule	No subsidy policy implemented		
1999-onwards	Elected rule	Federal	Federal	25%

Source: (Eboh, et al., 2006)

Table II Subsidy policies in Nigeria

In 1976 the fertilizer subsidies were controlled by the federal government which centralized both the procurement and the distribution of subsidy levels, meaning the share of landed cost of fertilizers which is paid by the government. The subsidy level was between 75 to 85 percent in 1976 (Eboh, et al., 2006). Table II further explains how the different subsidy programs were formed since 1976 until present day. There was an interruption in the year 2000 in the current subsidy policy but it was in 2001 continued as intended in 1999. This subsidy is managed by the federal government but there are also some state governments that implement additional subsidies (Eboh, et al., 2006). Our empirical research will only take into account the federal subsidy.

The theoretical goals of the agricultural policy in Nigeria are the protection of the agricultural sector, decreased poverty with an increased productivity and to achieve economies of scale in the sector (Nagy & Edun, 2002). This has so far not been reached. “The growth in yield since 1990 has been either very low or negative” explains (Nagy & Edun, 2002, p. 6). The implication of this is that the increase in production does not come from improvements in technology but rather from increasing the use of land in agricultural production. They further explain how science-based agriculture has not yet been embraced and that the use of fertilizers is limited (Nagy & Edun, 2002). In 2006 the national average use of fertilizers in Nigeria was 9,4kg/ha whilst the global average was more than ten times higher, 100kg/ha, and even the African average reached the double with 21kg/ha. Eboh et al. states that the reason for the lack of reaching the goals set out is the inconsistency in the subsidies, the roles of the domestic political forces and the perceived low effectiveness of fertilizer subsidies among others (Eboh, et al., 2006).

One of the strengths with investigating the policy effect in Nigeria´s different regions compared to conducting an investigation over several countries is that the policy is the same. The aims and goals are the same all over the country although the amounts of fertilizer distributed differ in between regions. [§§]

[§§] The Nigerian government subsidize 8 different forms of fertilizers: NPK 12-12-17+2mg, Urea 46 % N, NPK 15-15-15, NPK 20-10-10, NPK 16-16-16, SSP 18 %, AML and BSP, according to CountrySTAT Nigera. (FAO, u.d.) The NPK fertilizers are bound with nitrogen, phosphorus, and potassium. AML is an Agric Lime. SSP (single super phosphate) 18 % is a phosphate, which contains some sulphur.

4. Regression Model

In this section we present essentials for understanding the econometric research and how we will perform it. We start of with presenting the special case of data set which we use and the most likely needed corrections of it. We then present our specification and how we have found and calculated our variables. We continue by analyzing the data itself. Lastly we present some econometrical issues that may occur in an econometric research and how one may test for them. If we have found any econometrical issues they are presented here as well as the adjustments made.

Regarding Panel Data

Our data form is panel data which is a combination of specific units over a specific time period, in our case the different regions of Nigeria in the years 2001-2005. Forming panel data can be very expensive since it entails examining specific units over a time period, which perhaps helps explaining the lack of data in several developing countries. The data collected have a short time span and a wide collection of regions. This is, as Peter Kennedy puts it, a typical example of panel data. “A large number of cross-sectional units observed over a small number of time periods” (Kennedy, 2009, p. 281). The lack of obtainable and correct data in many developing countries is a severe problem when securing the relevance in any empirical study.

Using panel data helps with some of the problems that might occur when performing a statistical analysis. Panel data has the advantage that the combination of variation over time and variations of specific units reduces the problems of multicollinearity. Thus our data likely corrects for different time invariant and cross sectional differences such as soil quality and time variances e.g. short business cycles (Kennedy, 2009). Panel data is often used to examine an occurrence that cannot be studied using only time series data or cross-sectional on its own, an example of this is employment. National Longitudinal Surveys of Labor Market Experience (NLS) is a data set collected in the United States where by combining cross-sectional data, in this case individuals, with time series data enabling it to compare long term unemployment with short term unemployment. This data set is the best to use as we need to compensate for soil qualities and several regional abundant factors and to find differences in variation over time.

Fixed and random effects

When making estimations with panel data it is common to see that even if the specific cross-sectional units have the same tendency over time, their intercepts are different. It is generally argued that cross-sectional heterogeneity is normal (Kennedy, 2009). None the less it does complicate estimations. Using least squares estimation (LS) without correction for heterogeneity would result in a biased model unless the variables that affect the intercept are uncorrelated with the explanatory variables that the model consists of. This means that it is needed to include a dummy variable to correct for the influence of omitted variables that do affect the explanatory variables included in the model. The methods of improving an LS estimation containing this problem are called the fixed effects estimator-LS and the random effects estimator-LS (Kennedy, 2009).

The fixed effects estimator-LS is formed by adding a dummy for each individual and/or time period, except for the intercept, to enable for each unit to have a different intercept. This is complicated as the data contains a great number of units and therefore there is an easier way that reaches the same end result. By subtracting the average value of the sum of each unit over the time studied from each observation we will get the desired slope estimate.

The second way of managing the problem is to use the random effects estimator-LS. The random effect estimation does include explanatory variables that are time-invariant which the fixed effect estimation does not. The difference from fixed effects is that random effects interpret the intercepts as random and are treated as a part of the error term, forming a composite error term. Making part of the error term constant over the time period whilst another part of it changes for each time period. The drawback of the random effect estimator is that we need to know that the composite error is not correlated with the explanatory variables. A way to conclude this is by performing a Hausmann random test.

The problem with the fixed effects estimator is that we will be left with only one degree of freedom, by not putting a dummy for the intercept we keep one degree, this is especially complicated when we have a large number of observations. Also the use of fixed effects will result in a dismissal of all of the explanatory variables that do not vary within a unit or a time period. All the explanatory variables that do not change over the entire time period studied will therefore be ignored and will not be estimated (Kennedy, 2009).

Our specification

To complete the empirical research we use a multiple model which we apply to investigate the relationship between population growth and the governmental fertilizer subsidies provided to Nigeria's different regions. We split the population growth in the two determinants, crude birth rate, representing fertility, and crude death rate, representing mortality. We investigate the effects from fertilizer subsidies on the two determinants as separate specifications. Apart from fertilizer subsidies we include fishing production to adjust for coastal areas where the agriculture may not be the main food supplier. This may be relevant as the largest part of agricultural production is located in the northern regions of Nigeria with approximately 70 percent of total fertilizer consumption and merely 30 percent in the southern regions (Eboh, et al., 2006). Using the fish production variable could correct for the coastal contra inland differences, but if most of the fish production is sold abroad or to inland areas the effect is likely insignificant.

Our multivariate regression will be constructed with the panel least square method. By using the least square method with either fixed or random effects, we will know that the regression is the optimal one if, and only if, the assumptions of Panel Least Squares (PLS) hold. These assumptions regard the presence of linearity, autocorrelation, homoscedasticity and normality in residuals. For further specification see (Woolridge, 2006). The assumption of normality is not required to be able to assume BLUE parameters using fixed effect estimation.

The Areas analyzed

We have included almost all the regions in Nigeria to conclude this research; we have excluded Lagos since the lack of data from the region was too severe. This leaves us with 35 regions consisting of: Abia, Adamawa, A´lbom, Anambra, Bauchi, Benue, Borno, Cross River, Delta, Ebonyi, Edo, Ekiti, Enugu, Gombe, Imo, Jigawa, Kaduna, Kano, Katsina, Kebbi, Kogi, Kwara, Nasarawa, Niger, Ogun, Ondo, Osun, Oyo, Plateau, Rivers, Sokoto, Taraba, Yobe, Zamfara and F.C.T. This is a combination of coastal areas, urban and agricultural inland areas.

Sensitivity Analysis

To study the sensitivity of our results we perform an adjustment of the data by calculating the nitrogen level subsidized. As nitrogen is the macronutrient which has the largest impact on cereal yield on short term (at a one year period), we adjust for the subsidized amount of nitrogen. Thus we abstract from the Agric Lime, BSP and SSP 18 % fertilizers as the effect of these are likely to be seen over a longer time period than one year. The calculus is rather simple; multiply the subsidized fertilizer in tons with its N number in percentage to receive the nitrogen level of the NPK fertilizer. The UREA level is calculated as its volume times 0,46, which perhaps may be giving UREA a too big weight as it is perhaps not effective enough for constituting 46 percent nitrogen as it is a rather low quality fertilizer, yet we believe it to be the most efficient way of calculating it. We then sum the amount of nitrogen subsidized fertilizers per year and region to receive our nitrogen corrected subsidy variable.

There is no information upon countrySTAT about the calcium nitrate level or ammonium nitrate level within the different fertilizers available and we cannot try and correct for any differences within the fertilizers. The strength of using panel data shows itself here as panel data most likely will correct for these statistical differences over soil quality and its possibility to absorb the nitrogen as well as time differences.

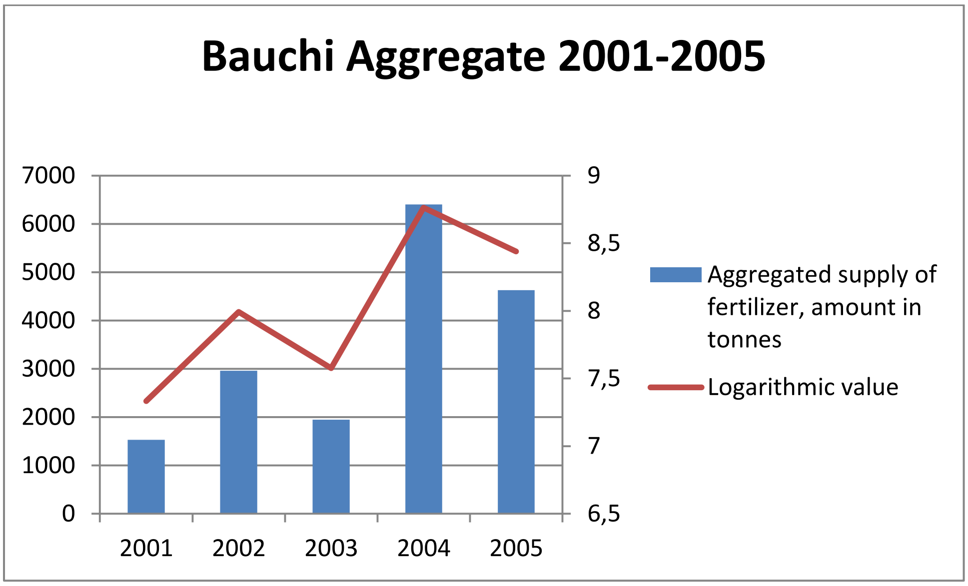
We conduct the calculus to test for the durability of our results as the region and time with the most subsidized nitrogen ceteris paribus would show the highest yield. An example of the nitrogen adjustments calculus can be found in appendix 9.5.4.

The Variables

The variable that we wish to study is fertilizers subsidies and its relationship to the crude birth and death rate. Crude death rate indicates the number of deaths occurring during the year, per 1,000 persons estimated at midyear. Crude birth rate indicates the number of births similarly to crude death rate. The negative effects of using the crude birth and crude death rate is that it does not correct for differences between the sexes, while the positive effect is that it is available for most countries and in our case regions.

We calculate the subsidized fertilizer data as the sum of fertilizers which the federal government supplies given in tons per region and year. Thus it is the sum in tons of all different NPK:s, UREA, BSP, SSP and Agric Lime. (Appendix 9.5.4) The fish-production data is given in ton per region and year.

We use the logarithmic values of our explanatory variables in our specification to study the change in relative value over time instead of the fixed amounts given in the original dataset provided by the Nigerian statistical bureau. In the following specifications *birth* will constitute the logarithmic value of crude birth rate, *death* will constitute the logarithmic value of crude death rate, *fish* will constitute the logarithmic value of fish production and *fertilizer* will constitute the logarithmic value of fertilizer subsidies provided. By performing this we will study the relative change of our parameters rather than the absolute change of them.



Graph II Bauchi Aggregate

As the example of Bauchi, which is one of the regions studied, in graph II shows we have aggregated the amounts of fertilizers per region and then calculated the logarithmic value by year to adapt them to our empirical model. The approach of the logarithmic values is conducted upon all our variables (see Appendix 9.5.1).

CountrySTAT Nigeria

We have obtained the dataset used in our empirical regression from CountrySTAT which is a national statistical information system for food and agriculture, which is managed and part of the FAO statistics division of the United Nations. It is a web-based system for national and subnational statistic levels. FAO forms partnerships with statistical offices and the ministries of agriculture, fisheries and forestry among others to introduce a system and improve national capacity of statistics (CountrySTAT, 2011). CountrySTAT has mandate for official data publication from The National Bureau of Statistics in Nigeria (NBS) which is the apex statistical body in Nigeria. NBS's main responsibility is coordinating all the orderly implementation of statistical activities under the National Statistical System. (CountrySTAT Nigeria, 2012)

Yet, through the national strategy for development statistics (NSDS), ministry departments and agencies are empowered to generate data specific to their own sub sector and contribute to a central database which is managed by the NBS. The ownership of the data is to be assured, according to countrySTAT. The sub-national data which we use is consistent to national core as national core is an aggregation of sub-national data.

The Nigerian agricultural sector contains crops, trees, forestry, fisheries and livestocks. Nigerian agricultural data is characterized by considerable regional and crop diversity. The sector is fraught with serious data problems (National Bureau of Statistics (NBS), 2011). Our data from countrySTAT Nigeria consist of "Federal Government Supply to adminitative level 1, commodity and year", with which we assume they mean administrative level 1, "Quantity of fish capture by administrative level 1, indicator and year", "Crude birth by state and year" and "Crude death rate by state and year" (FAO, 2011). There is no further specification but the names of the variables upon CountrySTAT and that the variables for fish and fertilizer are given in tons.

The fertilizers are of different kind in the data, the federal government provides different types of fertilizers and in different amounts. Since they all aim at increasing the cereal yield we add them up together to create one variable.

Econometrical Issues

In this section we present econometric issues that may occur in our specification, how one can test for them and how it may be possible to adjust for the failure of them.

Panel data, as discussed in the panel data section, creates more variability through combining variation across the regions or firms over time; this in turn alleviates the problems of multicollinearity and helps in performing a more efficient estimation. If we would have had multicollinearity the correlation between our explaining variables would be close to one (Kennedy, 2009). As our explanatory variables are not highly correlated (they have an approximate $corr(X_1, X_2) = -0{,}093$ (Appendix 9.5.3) we can conclude that it is unlikely that they have multicollinearity.

When the assumption of homoskedasticity is violated our regression is no longer the best linear unbiased equation (BLUE). The t-statistics may be misleading as well, which would imply that inference could become problematic. To test for heteroskedasticity we will use White's test. If heteroskedasticity is present one may adjust for it in different ways e.g. generalized least squares or robustness estimation (for further information of correcting against heteroskedasticity see (Kennedy, 2009)). Only one of our specifications had heteroskedasticity namely mortality with non adjustments for nitrogen level. We corrected for it by making the specification robust using PSCE-cross section robustness weighting.

If we have autocorrelation in our residuals the impact upon our parameters are similar to the effect of heteroskedasticity. Autocorrelation is normal in time series as the observation is a chronological function of the previous ones. Testing for autocorrelation within our residuals is constructed by a Durbin Watson test (DW) (Woolridge, 2006). The DW-statistic is constructed by calculating $DW = 2(1 - \rho)$where ρ is the correlation between the residuals. If our residuals are not auto correlated we will obtain $\rho = 0$ which in turn would indicate that our DW=2 which gives us an implication that we do not have autocorrelation in our residuals. Adjusting for autocorrelation in the residuals can be done by making the regression robust or by using generalized least squares or feasible generalized least squares (Westerlund, 2005).

A low DW-statistic is also in combination with a high R^2 and high t-statistic values an indicator of unit roots. For corrections of unit roots see (Kennedy, 2009). None of our specifications had very low DW-statistics and we have treated them as if they were non auto-correlated and without unit roots. Testing them against a critical value DW-table indicated that we could reject the hypothesis of autocorrelation.

As the assumption of normality dictates we need a normal distribution Normal$(0, \sigma_u^2)$ when estimating a regression using fixed effects. If the assumption of normality is violated, the regression might still be BLUE but then it requires a large N, in our case a large number of regions, and a small T, number of time periods (Woolridge, 2006). If the residuals in the population are far from normal distributed we may need a very large sample to be able to assume that our parameters are following normal distribution. To test for normality we will use the Jarque-Bera test. To correct for normality it may be needed to construct dummy variables, which will erect the outliers.

We have not had normality within any of our presented specifications' residuals. Since we study 35 regions over five years with annual data one may suspect that it is a large enough N and a small enough T for normality not to be needed. Although not necessary we have also presented the regressions with dummys which erased the extreme values. These extreme values are especially significant in the mortality functions. The full results of correcting for non-normal distribution are available in the appendix (Appendix 9.1.7, 9.2.7, 9.3.7, 9.4.7).

A way of testing the linearity and correct specification assumption is through the RESET-test (for further reading upon RESET-test see (Woolridge, 2006)). When we conducted this test upon our specifications we find that our fertility specifications are wrongly specified, while our mortality specifications seem to be correct (Appendix 9.1.9, 9.2.9, 9.3.9, 9.4.9).

Trustworthiness of data

An additional source of error is of course the data in itself. There have been claims that the data in Nigeria, especially the data collected regarding population, are not entirely correct. Among others a reason is that tax revenue and political power is granted on the basis of population size of that region (Holmén, 2011).

5. The Results

This section presents the results which we have obtained after performing our research. We start of with presenting the results we found in our fertility specifications and afterwards present our mortality results. We present four regressions for both fertility and mortality.

We will perform this study using the program Eviews 7th edition. Our specifications will look like the one beneath:

$$y_{it} = \alpha + u_i + e_t + \beta_i x_{1it} + \beta_i x_{2it} + \epsilon_{it}, \qquad t = 2001, \dots, 2005$$

Where *i* is the cross sectional unit ranging between 1-35 depending on region, *t* is the time period index, *y* is the dependent variable, either mortality or fertility, α is the intercept, u_i is the fixed effect correcting for differences between regions and e_t is the fixed time period effect. Further we have the independent variables f*ertilizer* and f*ish*. Also we have performed a sensitivity analysis using the most active substance in the short term of the fertilizers, nitrogen, this to further conclude if our results do show significance or not. This is determined as *fertilizer nitrogen adj.* and is based on the nitrogen percentage in each of the aggregated fertilizers studied.

Fertility

Below we present a table of the regressions made using crude birth rate as the dependent variable. The results have been adjusted according to the test results found in appendix and discussed in the previous chapter regarding econometrical issues. On the left hand side we do not have normal distribution within our residuals, while on the right hand side we have inserted a dummy to correct for normal distribution. The upper specification consists of the sum of all the subsidized fertilizers written as *Fertilizer*. The lower specification we have adjusted for the nitrogen level within the subsidized fertilizers, as nitrogen is the macronutrient which has the largest impact on plant growth, written as *Fertilizer Nitrogen Adj*.

Dependent Variable	**Birth rate**		**Birth rate, normality adjusted**	
	Coefficient	P-Value	Coefficient	P-Value
Alpha	2,1521	0,0000	2,0566	0,0000
Fish	0,0317	0,5767	0,0374	0,4533
Fertilizer	-0,0225	0,3907	-0,0167	0,4674
Normality dummy Fertility	-	-	1,04908	0,0000
	Model R^2	0,887202	Model R^2	0,913883
	Model F-statistic	0,0000	Model F-statistic	0,0000

Dependent Variable	**Birth rate**		**Birth rate and normality adjusted**	
	Coefficient	P-Value	Coefficient	P-Value
Alpha	2,0464	0,0000	1,9937	0,0000
Fish	0,0348	0,5408	0,0405	0,4163
Fertilizer Nitrogen Adj	-0,0154	0,5171	-0,0153	0,4649
Normality dummy Fertility	-	-	1,0471	0,0000
	Model R^2	0,886361	Model R^2	0,913427
	Model F-statistic	0,0000	Model F-statistic	0,0000

* Significance on a 10 % level ** Significance on a 5 % level

Table III Fertility Results

We can in our fertility model note that none of the variables sought show any significance. The results are similar throughout all the specifications although minor differences are noticed. The high R^2 values found in the models are due to the low variance in our dependent variable as well as due to the fixed effects applied to the models. The fertilizer parameter has taken the opposite indication than the expected. The parameter is though highly insignificant with a p-value circulating around 0,44 in all the specifications and hence it is likely that the parameter has no effect upon fertility. The fish parameter indicates a positive value, yet does not demonstrate significance. As the RESET-test indicated the model is not specified correctly (Appendix 9.2.9 and 9.4.9).

Mortality

The results of the specifications using mortality as a dependent variable are presented in the same order as the fertility.

Dependent Variable	**Death rate**		**Death rate normality adjusted**	
	Coefficient	P-Value	Coefficient	P-Value
Alpha	1,7263	0,234	0,7201	0,4302
Fish	-0,0529	0,7556	-0,0236	0,822
Fertilizer	-0,158	0,0453 **	-0,0508	0,3762
Normality dummy mortality 1	-	-	-3,1461	0,0000
Normality dummy mortality 2	-	-	-2,9044	0,0000
Normality dummy mortality 3	-	-	-2,3899	0,0000
	Model R^2	0,718982	Model R^2	0,855558
	Model F-statistic	0,0000	Model F-statistic	0,0000

Dependent Variable	**Death rate**		**Death rate normality adjusted**	
	Coefficient	P-Value	Coefficient	P-Value
Alpha	1,2599	0,3659	0,6015	0,5516
Fish	-0,0426	0,8035	-0,0178	0,8859
Fertilizer Nitrogen Adj.	-0,1338	0,0642 *	-0,0516	0,3289
Normality dummy mortality 1	-	-	-3,1608	0
Normality dummy mortality 2	-	-	-2,9017	0
Normality dummy mortality 3	-	-	-2,3814	0
	Model R^2	0,71616	Model R^2	0,85508
	Model F-statistic	0,0000	Model F-statistic	0,0000

* Significance on a 10 % level ** Significance on a 5 % level

Table IV Mortality results

The specifications without normal distribution within the residuals indicate some significance. The significance differs however in between the two parameters, where the upper one is significant at a 5% level and the lower one is significant at a 10 % level. Both *Fertilizer* and *Fertilizer Nitrogen Adj*. show a negative indication upon mortality, which we expected as it would likely increase the food supply. The correction for normal distribution does however decreases the significance previously encountered. The specifications do, after normal distribution correction, still show a negative correlation with crude death rate, even if the P-value is not indicating any significance. The fish parameter is indicating a negative correlation in mortality yet it does not show any significance. The results are similar when performed both with the PCSE weights as well as without which does indicate a stronger indication for our model and the results of it. (See appendix 9.1-9.4 specification A)

6. Analysis

With basis of the results obtained in the previous chapter we analyze our theory as well as the empirical study performed. We try to evaluate why we received the results we obtained. Our analysis begins by examining the data and later continues with a theoretical analysis.

In developing countries the presence of statistics are often of concern. This has been the case in this thesis. It is likely that the results we found in our empirical regression are not as significant as they could be due to the fact that our statistical sample is small and uncertain in quality. Our sample's small T may be of concern as greater policy changes would likely have given effect over a larger time span. Noticing the differences of the different subsidy policies during the 1970s and 1980s would probably have differentiated the results. The result of our small T is a small variance in our fertility and mortality variables which is mostly described by our intercept. A greater variance, due to a larger T, would decrease the effect of our fixed effects and hence likely increase the strength of the regression. The effects over time would probably be more accurate as a change in behavior might take more than five years to become noticeable.

The poor quality of the data created by biased tax revenues reporting may be grave and would be disruptive for the explanatory differences between the regions. The data used is presented by a subdivision of the UN, FAO. However as it is the NBS in Nigeria whom provides the data which in turn is collected by several agencies, ministry departments and NSDS within the country the problem of bias does occur. If the same body issues the subsidies and collects the statistics of distribution, there exists an incentive to provide data that are satisfying for the organization. As the approach of tax revenue distribution is national one may suspect that the biased statistics are equally distributed over the regions. An effect of this would be that the significance found is true, even with the biased statistics.

The lack of available data restricted our empirical analysis to the two explanatory variables presented in the empirical research. We would much prefer to use several variables concerning among others: education, gender equality, GDP development. This to improve the significance of our empirical research.

The results of our nitrogen corrected specifications enhances the results we obtained by our earlier specifications. There seems to be a negative correlation between the agricultural policy and the mortality rates, and there does not seem to be any significant relationship between fertility rates and the agricultural policies. The decreased significance may be interpreted as a result of other macronutrients also being essential for agricultural production. UREA might be given too much importance as it is as rather brute fertilizer. Even though UREA contains 46 percent nitrogen, the soil cannot absorb the nitrogen as effective as the more advanced NPK:s. This is a question for a more chemically advanced interpretation. Thus the significance differences between our mortality regressions may be due to an over approximation of UREA or an effect of the complementary abilities of the BSP, SPP 18 % and Agric Lime.

The theoretical reasoning of our fertility variable is: fertilizers will increase the production in the agricultural sector, which will decrease the cost of raising children, and therefore enhance the demand for children, leading to the implication that fertility would increase. The causes for this reasoning to fail may be various.

The effect of the subsidies may be unclear. Xu et al. finds that the formalization of the subsidy policy, heavily affects the increase of fertilizer use and hence also improves agricultural productivity. The design of the fertilizer subsidy program may not be optimal. As an example the aims of Nigeria's fertilizer policies are not fulfilled. The sought economics of scale in agriculture has not been reached. Further it is possible that the earlier disruptive changes in the subsidy policies may still disturb the incentives for the private market to increase its engagements in the market. Thus the lack of consistency in the policy making can become a problem. The objective is to stimulate an improvement in production. If there are frequent changes in the subsidy policies the incentives to improve productions methods might decrease. This is the case of the agricultural subsidies in Nigeria. They have repeatedly changed during the last decades and therefore the incentives to change production methods have been disturbed. Even the present policy was interrupted only one year after its initial implementation in 1999. Thus the increased productivity as a result of increased fertilizer use has not been satisfactory used. The incentives to change production methods are lower when policies are non-stable. None the less, if the subsidy would be completely non effective then the effect of the subsidization would not be an increased production in agricultural goods. The effect of no productivity and consumption change would most likely disintegrate any significance on both the fertility and mortality specifications. This may very well be in effect, yet we do find some significance with our mortality specifications which contradict that there would not be an agricultural increase due to the agricultural policy. This is further enhanced by our testing of the subsidized nitrogen level which still proclaims the decrease of mortality due to increased cereal yield. Due to our specification results upon mortality we find it unlikely that the agricultural policy would not have had any effect.

One possible assumption that may be incorrect is that the price of agricultural goods would decrease, as Nigeria today is a net importer of agricultural goods. Given such reasoning the effect of the subsidy would be a decrease in import and hence not increase the total amount of agricultural goods. Such an effect is dependent on the assumption that the agricultural goods are managed through the international market and that producers are not self supporting. This is plausible yet perhaps not likely as a large share of the households in Nigeria is self-supporting. This as for the self-supporting households the subsidy effect primarily increases their budget constraint. A subsidy is in traditional trade theory becoming a tax on the export sector and decreases the wealth of the nation as it leads to a decreased specialization. This is not the case in a self supporting society as large shares of the population are not producing what would be considered maximal production. Factors of production are unused and the subsidy is rather a correction of a market imperfection than a decrease in total production.

The assumption that agricultural policies do not affect quality preferences, in self supporting societies, might not be correct. This since the agricultural policy leads to an increased budget constraint. The effect of a failure of this assumption would be a decrease in the cost of food which may increase the demand for quality on children rather than for quantity. A substitution for quality would be the effect rather than for quantity due to the enhanced budget which the families meet, in accordance with Becker’s theories. This would imply that the income elasticity of quality is higher than the income elasticity of quantity. The effect of the policy would be increased demand for quality and hence the substitution effect would be quality rather than quantity, instead of quantity rather than other goods as presented in our theory.

The assumption that the historical cost of children in traditional societies equals the cost of raising children may not be valid in the case of Nigeria, even though the agricultural sector forms a large share of the Nigerian labor force. The development may have bypassed such a situation. One of the reasons can be the great urbanization that has occurred in Nigeria. This would explain why we cannot see any significance between the fertility rates and the subsidized fertilizers. The theory would in this case be outdated and the part of quality in determining population growth has risen to greater importance in Nigeria.

Although there was no significance in the effect on fertility, we found indications of population growth due to the decreased mortality. The effects of a decreased mortality are likely to increase the economic growth in Nigeria. In accordance to (Azomahou, et al., 2009) we would expect the economic growth to increase with a convex relationship as the mean age in Nigeria is fairly low. Using the model of (Chakraborty, 2004) we would find a similar conclusion as the economy would become more stable and its population would become less impatient and thus increase the returns of human capital. The effect of a decreased mortality could, using the model of (Becker, et al., 1990), give the results, at least with support of investments in human capital, of a great leap and hence fling the economy into sustainable economic growth with increasing human capital and decreasing fertility rates. The end results of the policy seem in this case to be positive. Even if the results are not as strong as they could be, the indication is that the policy is positive for the economy and development of Nigeria, when studying the effects on the population.

7. Conclusion

The purpose of this thesis has been to accomplish a theoretic framework for the potential effects of agricultural policies on population growth. This has been done by investigating agricultural policies in an agricultural dependent society. Primarily the aims of the policies have been to increase the agricultural production. The model we formed investigates if the implications of earlier population growth theories are still valid in societies today. Earlier studies did not consider quality as a variable such as modern population theories do. The theoretical hypothesizes were that the agricultural policies would increase fertility and decrease mortality and thus increase population growth in both its determinants. Testing the hypothesizes on data from Nigeria's different regions during the years 2001-2005 we found indications at the decrease of mortality due to agricultural policies. Our empirical fertility model seems to be incorrectly specified and hence show no significance.

Using a longer time period than the five years studied should be more accurate, although the lack of available data made it impossible. We believe that performing the same study with a larger sample over a longer time period would prove giving, as well as to perform it with a greater number of explanatory variables. We conducted this study on a specific country not to take into consideration differing policy aims. Studying the phenomenon at a cross country basis would be interesting as it would increase the variation in policy performance. It would also be interesting to see for differences between regions which differ in their dependence on the agricultural sector.

Initially we formalized our objective with the question: do agricultural policies affect population growth in an agricultural dependent society? Our answer after performing an econometric research in Nigeria is thus: yes, given the conditions provided in our dataset of Nigeria we find an indication that it does increase population growth by lowering the mortality rates. The decrease of mortality rates are by most standards positive and from the perspective of this thesis the effect of the agricultural policy in Nigeria is positive.

8. Bibliography

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9. Appendix

9.1 Fertility

9.1.1 Initial Specification

Dependant Variable: Birth				
Variable	Coefficient	Standard error	t-Statistic	P-Value
Fish	-0,0574	0,0171	-3,3549	0,0010
Fertilizer	0,0640	0,0366	1,7474	0,0825
Alpha	2,1852	0,3257	6,7083	0,0000
R^2	0,087490	DW-Statistic	0,335248	
Log likelihood	-90,88042	F-Statistic	0,000601	

9.1.2 Hausman Test, random effects

Haussman Test			
	Chi^2 Statisitc	Degress of Freedom	Probability
Cross-Section Random	11,5280	2,0000	0,0031
Period Random	3,8891	2,0000	0,1431

9.1.3 Likelihood Ratio Test, fixed effects

Log Likelihood Test			
	Statistic	Degress of Freedom	Probability
Cross-section F	23,6471	-34,1240	0,0000
Cross-section Chi-square	332,1037	34,0000	0,0000
Period F	15,5085	-4,1240	0,0000
Period Chi-square	66,9317	4,0000	0,0000
Cross-Section/Period F	23,1350	-38,1240	0,0000
Cross-Section/Period Chi-square	344,9489	38,0000	0,0000

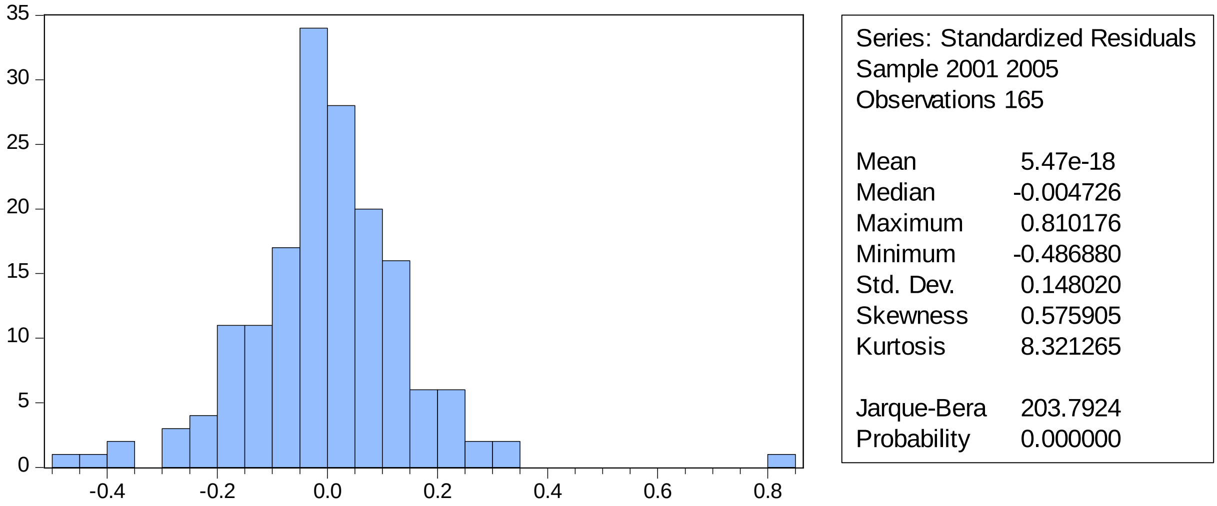
9.1.4 White’s test

Dependant Variable: ε^2 of Birth				
Variable	Coefficient	Standard error	t-Statistic	P-Value
Fish	0,0052	0,0217	0,2396	0,8110
Fertilizer	-0,0153	0,0528	-0,2894	0,7726
Fish^2	0,0000	0,0014	0,0348	0,9722
Fertilizer^2	0,0008	0,0035	0,2158	0,8294
Alpha	0,0498	0,2267	0,2196	0,8265
R^2	0,044050	Prob(F-	0,123124	

9.1.5 Specification A.

Dependant Variable: Birth	Fixed effects time and cross-section			
Variable	Coefficient	Standard error	t-Statistic	P-Value
Fish	0,0317	0,0566	0,5597	0,5767
Fertilizer	-0,0225	0,0261	-0,8613	0,3907
Alpha	2,1521	0,4820	4,4647	0,0000
R^2	0,887202	DW-Statistic	1,73382	
Log likelihood	81,59401	F-Statistic	0,00000	

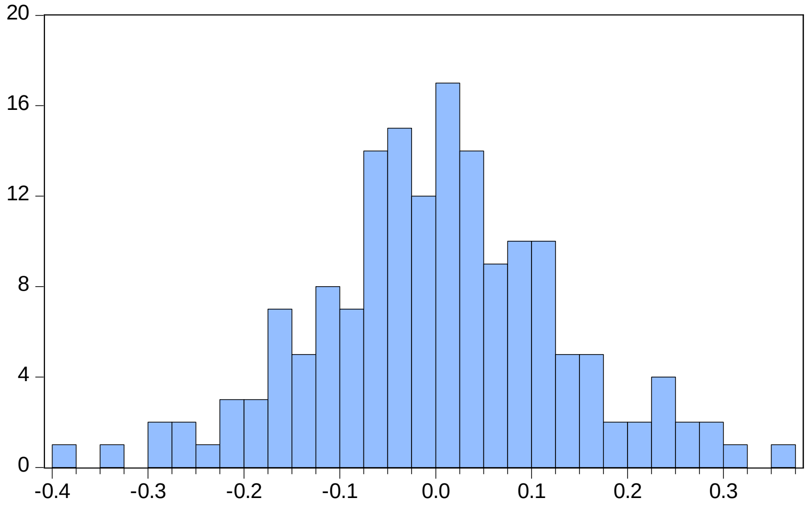
9.1.6 Exogeneity, Normality and Jarque-Bera



9.1.7 Specification B. adjusted for normality.

Dependant Variable: Birth	Fixed effects time and cross-section, Normality			
Variable	Coefficient	Standard error	t-Statistic	P-Value
Fish	0,0374	0,0497	0,7523	0,4533
Fertilizer	-0,0167	0,0229	-0,7290	0,4674
Alpha	2,0566	0,4232	4,8599	0,0000
Dummy1	1,04908	0,169941	6,173207	0
R^2	0,913883	DW-Statistic	2,04964	
Log likelihood	103,86020	F-Statistic	0,00000	

9.1.8 Exogeneity, Normality and Jarque-Bera for normality adjusted Specification B



Series: Standardized Residuals
Sample 2001 2005
Observations 165

Mean	0.000000
Median	0.000711
Maximum	0.357897
Minimum	-0.380172
Std. Dev.	0.129334
Skewness	-0.050349
Kurtosis	3.357185
Jarque-Bera	0.946835
Probability	0.622870

9.1.9 Reset Test

Dependant Variable: Birth				
Variable	Coefficient	Standard error	t-Statistic	P-Value
Fish	0,0023	0,0069	0,3272	0,7439
Fertilizer	-0,0053	0,0143	-0,3720	0,7104
Adjusted birth^2*	0,2243	0,0074	30,4523	0,0000
Alpha	1,0993	0,1306	8,4153	0,0000
R^2	0,865012	F-Statistic	0,000000	

*ln_birth-(ε of birth

9.2 Mortality

9.2.1 Initial Specification

Dependant Variable: Death				
Variable	Coefficient	Standard error	t-Statistic	P-Value
Fish	-0,0820	0,0328	-2,4965	0,0135
Fertilizer	0,1450	0,0703	2,0643	0,0406
Alpha	-0,3831	0,6250	-0,6130	0,5407
R^2	0,066558	DW-Statistic	0,718186	
Log likelihood	-198,40110	F-Statistic	0,003776	

9.2.2 Hausman Test, random effects

Haussman Test			
	Chi^2 Statisitc	Degress of Freedom	Probability
Cross-Section Random	2,0435	2,0000	0,3600
Period Random	0,7958	2,0000	0,6717

9.2.3 Likelihood ratio test

Log Likelihood Test			
	Statistic	Degress of Freedom	Probability
Cross-section F	8,3587	-34,1240	0,0000
Cross-section Chi-square	196,5917	34,0000	0,0000
Period F	3,4384	-4,1240	0,0106
Period Chi-square	17,3554	4,0000	0,0016
Cross-Section/Period F	7,5759	-38,1240	0,0000
Cross-Section/Period Chi-square	198,0759	38,0000	0,0000

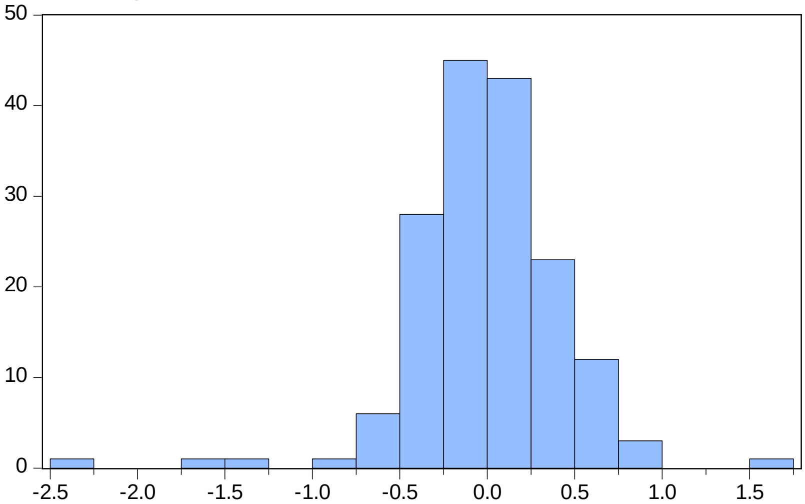
9.2.4 White's test.

Dependant Variable: ε^2 of Death				
Variable	Coefficient	Standard error	t-Statistic	P-Value
Fish	0,0148	0,2056	0,0719	0,9428
Fertilizer	-0,6401	0,5012	-1,2773	0,2034
Fish^2	0,0023	0,0129	0,1797	0,8576
Fertilizer^2	0,0494	0,0335	1,4728	0,1428
Alpha	1,8844	2,1519	0,8757	0,3825
R^2	0,061107	Prob(F-	2,603359	

9.2.5 Specification A

Dependant Variable: Death	Fixed effects time and cross-section			
Variable	Coefficient	Standard error	t-Statistic	P-Value
Fish	-0,0529	0,1694	-0,3119	0,7556
Fertilizer	-0,1580	0,0781	-2,0219	0,0453
Alpha	1,7263	1,4433	1,1961	0,2340
R^2	0,718982	DW-Statistic	2,18359	
Log likelihood	-99,36316	F-Statistic	0,00000	

9.2.6 Exogeneity, Jarque-Bera and Normality



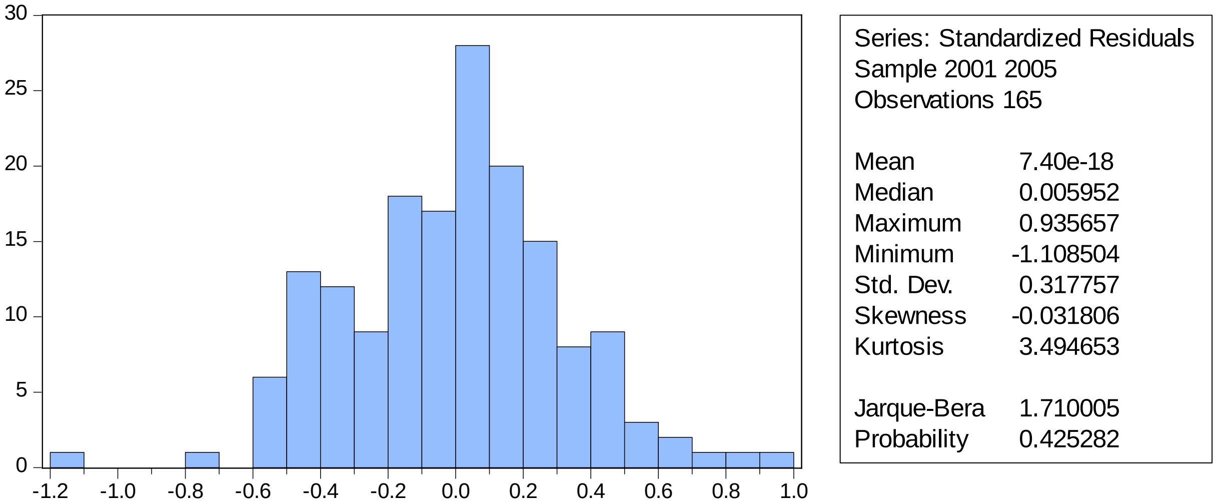
Series: Standardized Residuals
Sample 2001 2005
Observations 165

Mean	-9.08e-18
Median	-0.002711
Maximum	1.667812
Minimum	-2.385416
Std. Dev.	0.443216
Skewness	-0.964685
Kurtosis	9.355801
Jarque-Bera	303.3159
Probability	0.000000

9.2.7 Specification B. adjusted for normality.

Dependant Variable: Death	Fixed effects time and cross-section, Normality			
Variable	Coefficient	Standard error	t-Statistic	P-Value
Fish	-0,0236	0,1047	-0,2255	0,8220
Fertilizer	-0,0508	0,0571	-0,8882	0,3762
Alpha	0,7201	0,9098	0,7916	0,4302
Dummy1	-3,1461	0,3942	-7,9802	0,0000
Dummy2	-2,9044	0,4870	-5,9638	0,0000
Dummy3	-2,3899	0,4822	-4,9565	0,0000
R^2	0,855558	DW-Statistic	2,40139	
Log likelihood	-44,45630	F-Statistic	0,00000	

9.2.8 Normality and Jarque-Bera test upon normality adjusted specification



9.2.9 Reset Test

Dependant Variable: Death				
Variable	Coefficient	Standard error	t-Statistic	P-Value
Fish	-0,0806	0,0332	-2,4325	0,0161
Fertilizer	0,1406	0,0716	1,9638	0,0513
Adjusted death^2*	0,0403	0,1159	0,3479	0,7284
Alpha	-0,3799	0,6268	-0,6061	0,5453
R^2	0,067260	F-Statistic	0,010474	

*ln_death-(ε of death

9.3 Nitrogen Adjusted Fertility

9.3.1 Initial Specification

Dependant Variable: Birth				
Variable	Coefficient	Standard error	t-Statistic	P-Value
Fish	-0,0580	0,0172	-3,3807	0,0009
Fertilizer, Nitrogen adjust	0,0288	0,0351	0,8222	0,4122
Alpha	2,4988	0,2703	9,2442	0,0000
R^2	0,073297	DW-Statistic	0,323370	
Log likelihood	-90,65429	F-Statistic	0,002181	

9.3.2 Hausman Test, random effects

Haussman Test			
	Chi^2 Statisitc	Degress of Freedom	Probability
Cross-Section Random	11,2252	2,0000	0,0037
Period Random	5,5690	2,0000	0,0618

9.3.3 Likelihood ratio test, fixed effects

Log Likelihood Test			
	Statistic	Degress of Freedom	Probability
Cross-section F	23,6651	-34,1230	0,0000
Cross-section Chi-square	331,3506	34,0000	0,0000
Period F	16,1360	-4,1230	0,0000
Period Chi-square	69,1800	4,0000	0,0000
Cross-Section/Period F	23,1590	-38,1230	0,0000
Cross-Section/Period Chi-square	344,1716	38,0000	0,0000

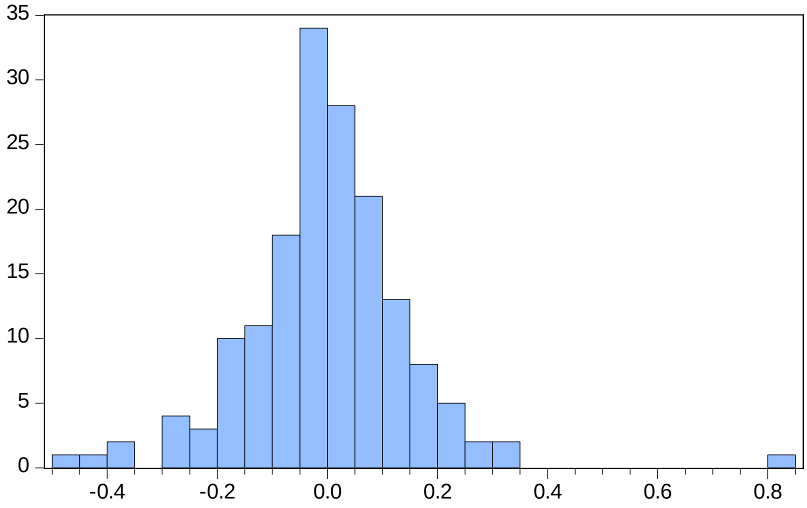
9.3.4 White's test.

Dependant Variable: ε^2 of Birth				
Variable	Coefficient	Standard error	t-Statistic	P-Value
Fish	0,0076	0,0217	0,3495	0,7271
Fertilizer Nitrogen adjust	-0,0031	0,0413	-0,0757	0,9397
Fish^2	-0,0001	0,0014	-0,0718	0,9428
Fertilizer^2 Nitrogen adjust	0,0002	0,0034	0,0506	0,9597
Alpha	-0,0188	0,1606	-0,1173	0,9067
R^2	0,040166	Prob(F-Statistic)	0,161118	

9.3.5 Specification A

Dependant Variable: Birth	Fixed effects time and cross-section			
Variable	Coefficient	Standard error	t-Statistic	P-Value
Fish	0,0348	0,0567	0,6134	0,5408
Fertilizer Nitrogen adjust	-0,0154	0,0238	-0,6498	0,5171
Alpha	2,0464	0,4603	4,4461	0,0000
R^2	0,886361	DW-Statistic	1,74041	
Log likelihood	81,43153	F-Statistic	0,00000	

9.3.6 Exogeneity, Jarque-Bera and Normality



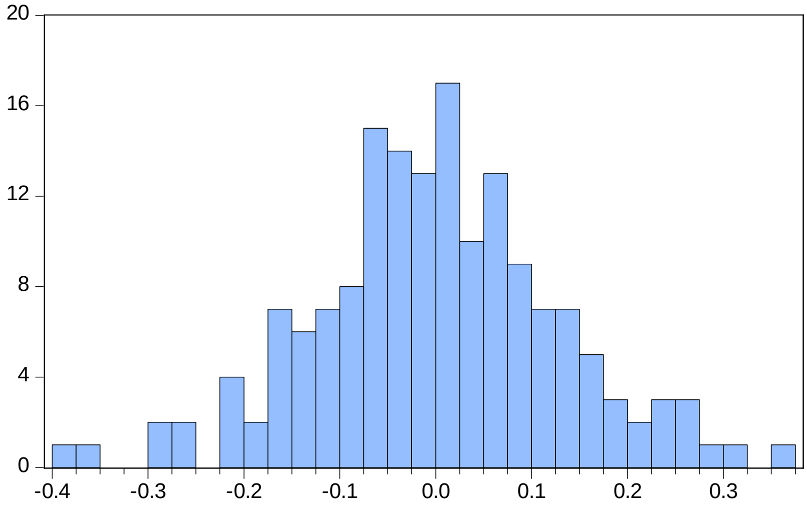
Series: Standardized Residuals
Sample 2001 2005
Observations 164

Mean	1.03e-17
Median	-0.006693
Maximum	0.809086
Minimum	-0.483114
Std. Dev.	0.147723
Skewness	0.567808
Kurtosis	8.431032
Jarque-Bera	210.3691
Probability	0.000000

9.3.7 Specification B. adjusted for normality.

Dependant Variable: Birth	Fixed effects time and cross-section, Normality			
Variable	Coefficient	Standard error	t-Statistic	P-Value
Fish	0,0405	0,0497	0,8156	0,4163
Fertilizer	-0,0153	0,0208	-0,7330	0,4649
Alpha	1,9937	0,4035	4,9413	0,0000
Dummy1	1,0471	0,1695	6,1758	0,0000
R^2	0,913427	DW-Statistic	2,06242	
Log likelihood	103,73820	F-Statistic	0,00000	

9.3.8 Normality and Jarque-Bera test upon normality adjusted specification



Series: Standardized Residuals
Sample 2001 2005
Observations 164

Mean	9.31e-18
Median	-0.000170
Maximum	0.352044
Minimum	-0.385095
Std. Dev.	0.128937
Skewness	-0.063869
Kurtosis	3.391844
Jarque-Bera	1.160700
Probability	0.559702

9.3.9 Reset Test

Dependant Variable: Birth				
Variable	Coefficient	Standard error	t-Statistic	P-Value
Fish	0,0025	0,0069	0,3661	0,7147
Fertilizer	-0,0017	0,0135	-0,1257	0,9001
Adjusted death^2*	0,2251	0,0073	30,6535	0,0000
Alpha	1,0635	0,1135	9,3672	0,0000
R^2	0,865162	F-Statistic	0,000000	

*ln_birth-(ε of birth

9.4 Nitrogen Adjusted Mortality

9.4.1 Initial Specification

Dependant Variable: Death				
Variable	Coefficient	Standard error	t-Statistic	P-Value
Fish	-0,0840	0,0332	-2,5317	0,0123
Fertilizer, Nitrogen adjust	0,0734	0,0678	1,0829	0,2805
Alpha	0,2877	0,5228	0,5503	0,5829
R^2	0,048261	DW-Statistic	0,715857	
Log likelihood	-198,83150	F-Statistic	0,018650	

9.4.2 Hausman Test, random effects

Haussman Test			
	Chi^2 Statisitc	Degress of Freedom	Probability
Cross-Section Random	0,4108	2,0000	0,8143
Period Random	1,8093	2,0000	0,4047

9.4.3 Likelihood ratio test, fixed effects

Log Likelihood Test			
	Statistic	Degress of Freedom	Probability
Cross-section F	8,2931	-34,1230	0,0000
Cross-section Chi-square	195,4252	34,0000	0,0000
Period F	3,2936	-4,1230	0,0133
Period Chi-square	16,6874	4,0000	0,0022
Cross-Section/Period F	7,6166	-38,1230	0,0000
Cross-Section/Period Chi-square	198,4203	38,0000	0,0000

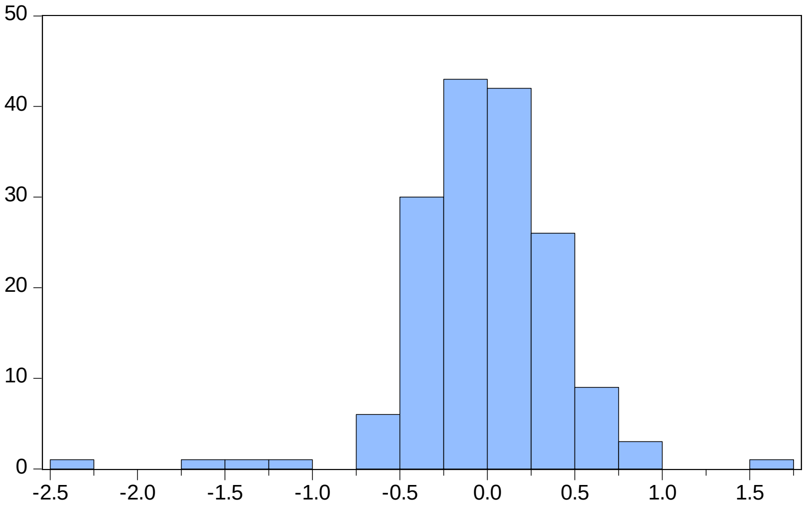
9.4.4 White's test.

Dependant Variable: ε^2 of Death				
Variable	Coefficient	Standard error	t-Statistic	P-Value
Fish	0,0551	0,2116	0,2602	0,7950
Fertilizer Nitrogen adjust	-0,2862	0,4025	-0,7111	0,4780
Fish^2	-0,0003	0,0133	-0,0198	0,9842
Fertilizer^2 Nitrogen adjust	0,0296	0,0329	0,9010	0,3690
Alpha	0,3844	1,5657	0,2455	0,8064
R^2	0,044246	Prob(F-Statistic)	0,123711	

9.4.5 Specification A

Dependant Variable: Death	Fixed effects time and cross-section			
Variable	Coefficient	Standard error	t-Statistic	P-Value
Fish	-0,0426	0,1709	-0,2493	0,8035
Fertilizer Nitrogen adjust	-0,1338	0,0716	-1,8678	0,0642
Alpha	1,2599	1,3883	0,9075	0,3659
R^2	0,716160	DW-Statistic	2,18536	
Log likelihood	-99,62134	F-Statistic	0,00000	

9.4.6 Exogeneity, Jarque-Bera and Normality



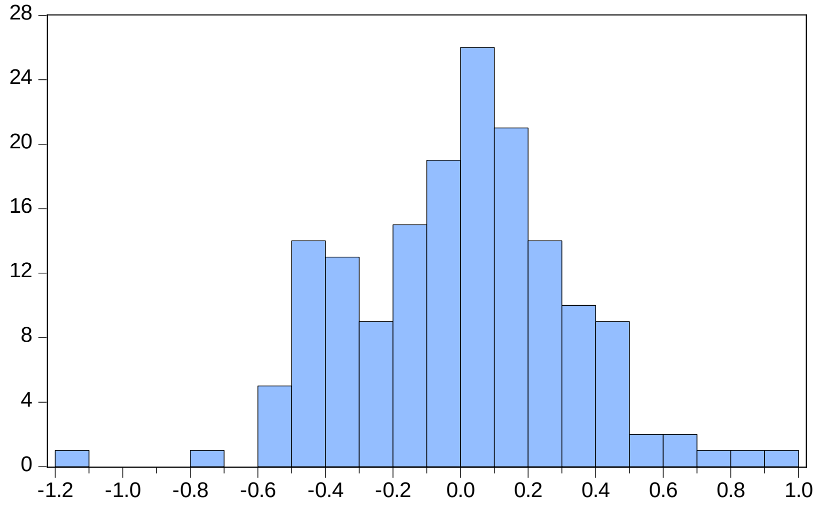
Series: Standardized Residuals
Sample 2001 2005
Observations 164

Mean	3.38e-18
Median	-0.005849
Maximum	1.636459
Minimum	-2.427901
Std. Dev.	0.445556
Skewness	-1.035809
Kurtosis	9.575746
Jarque-Bera	324.8023
Probability	0.000000

9.4.7 Specification B. adjusted for normality.

Dependant Variable: Death	Fixed effects time and cross-section, Normality			
Variable	Coefficient	Standard error	t-Statistic	P-Value
Fish	-0,0178	0,1237	-0,1438	0,8859
Fertilizer	-0,0516	0,0526	-0,9802	0,3289
Alpha	0,6015	1,0075	0,5970	0,5516
Dummy1	-3,1608	0,4243	-7,4494	0,0000
Dummy2	-2,9017	0,4406	-6,5860	0,0000
Dummy3	-2,3814	0,4350	-5,4749	0,0000
R^2	0,855080	DW-Statistic	2,40760	
Log likelihood	-44,49882	F-Statistic	0,00000	

9.4.8 Normality and Jarque-Bera test upon normality adjusted specification



Series: Standardized Residuals
Sample 2001 2005
Observations 164

Mean	-1.22e-17
Median	0.004655
Maximum	0.934018
Minimum	-1.125661
Std. Dev.	0.318368
Skewness	-0.038771
Kurtosis	3.515799
Jarque-Bera	1.859083
Probability	0.394735

9.4.9 Reset Test

Dependant Variable: Death				
Variable	Coefficient	Standard error	t-Statistic	P-Value
Fish	-0,0807	0,0335	-2,4128	0,0170
Fertilizer	0,0683	0,0682	1,0011	0,3183
Adjusted death^2*	0,0942	0,1147	0,8215	0,4126
Alpha	0,2467	0,5257	0,4693	0,6395
Adjusted R^2	0,034489	F-Statistic	0,034880	

*ln_death-(ε of death

9.5 Charts

9.5.1 Aggregate amounts of fertilizer subsidies

Aggregate Amounts of Fertilizer Subsidies

Region/Year	**2001**	**2002**	**2003**	**2004**	**2005**
Abia	1290	1500	870	1700	6640
Adamawa	2740	5850	2840	7081	11720
A/Ibom	0	1290	2000	3710	3290
Anambra	750	1420	180	2545	560
Bauchi	1530	2960	1950	6400	4630
Benue	1980	4140	4440	4070	2130
Borno	1050	4165	3218	7250	3002
C/River	0	1180	1135	1980	600
Delta	660	945	1920	2600	1130
Ebonyi	500	2280	1380	2220	300
Edo	60	1200	1710	1600	840
Ekiti	480	2220	1020	2880	795
Enugu	1050	2187	2235	4398	2400
Gombe	1500	3420	2550	8710	10560
Imo	328	2221	1359	5120	1760
Jigawa	3750	3950	3630	6150	2600
Kaduna	2700	5010	2920	8830	0
Kano	2790	5710	3990	8201	6200
Katsina	2700	4100	4200	7070	500
Kebbi	3300	3220	1810	5900	1450
Kogi	1020	1360	4200	13880	12220
Kwara	0	240	1230	3000	290
Lagos	1380	1440	1560	0	3200
Nasarawa	1530	2250	2010	3580	3570
Niger	1370	4080	3070	12785	11459
Ogun	930	1470	1770	4550	0
Ondo	510	1990	1440	3510	460
Osun			1377	5430	1200
Oyo	330	3390	2100	5450	4795
Plateau	1200	3600	2850	3250	6416
Rivers	900	1650	1020	3900	1050
Sokoto	2670	2770	2100	0	0
Taraba	690	2725	884	5580	5872
Yobe	1200	3780	1410	5850	7769
Zamfara	1050	3630	1770	6000	8628
F.C.T	1170	3450	4470	9470	0

9.5.2 Indicators of Nigeria 2001-2005

Indicator/Year	2001	2002	2003	2004	2005
Agriculture, value added (% of GDP)		48,57	42,71	34,21	32,76
GINI index				42,93	
Employment in agriculture (% of total employment)				44,6	
Birth rate, crude (per 1,000 people)	41,72	41,55	41,37	41,17	40,97
Death rate, crude (per 1,000 people)	17,42	17,01	16,6	16,22	15,86
Life expectancy at birth, total (years)	46,79	47,35	47,92	48,47	49
Survival to age 65, female (% of cohort)	40,38	40,61	40,83	41,03	41,23
Survival to age 65, male (% of cohort)	37,2	37,52	37,81	38,08	38,35
Population growth (annual %)	2,41	2,44	2,46	2,47	2,48
Progression to secondary school (%)		42,72	48,57	50,44	49,04
Population, total	126 704 722	129 832 447	133 067 097	136 399 438	139 823 340
Rural population (% of total population)	56,76	56,02	55,28	54,54	53,8
Urban population (% of total)	43,24	43,98	44,72	45,46	46,2

9.5.3 Correlation

$$\rho = \frac{Cov(X_i X_j)}{Var(X_i) * Var(X_j)} = \frac{E(X_i - \mu_{X_i})(X_j - \mu_{X_j})}{Var(X_i) * Var(X_j)}$$

Correlation	Fish
Fertilizer	-0,09226
Nitrogen Adj.	-0,09132

9.5.4 Example of fertilizer amounts in Bauchi

Bauchi year 2003									
Fertilizer sort	NPK 12-12-17 + 2Mg0	Urea 46% N	NPK 15-15-15	NPK 20-10-10	SSP 18%	AML(Agric lime)	NPK 16-16-16	BSP	Sum
Amount	120	750	590	900	-	-	-	600	2960
Nitrogen adjusted amounts	120*0,12	750*0,46	590*0,15	900*0,20	-	-	-	-	627,9