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Strengthening Institutions to Improve Public Expenditure Accountability:

Policy Simulation of Measles Immunization Programs for Children in Borno State, Nigeria

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ABBREVATIONS AND ACRONYMS

ABS	Annual Abstract of Statistics
AIDS	Acquire Immune Deficiency Syndrome
CDC	Centre for Disease Control
CER	Cost Effectiveness Ratio
CI	Concentration Index
CSEA	Centre for the Studies of the Economies of Africa
CSOs	Civil Society Organisations
DREF	Disaster Relief and Emergency Relief Fund
FMH	Federal Ministry of Health
FMI	Free Measles Immunization
HIV	Human Immunodeficiency Virus
HNLSS	Harmonised National Living Standards Survey
IFRC	International Federation for Red Cross
LGA	Local Government Area
MDG's	Millennium Development Goals
MoHSW	Ministry of Health and Social Works
NBS	National Bureau of Statistics
NIC	National Immunization Coverage
NPC	National Population Commission
NPI	National Programme on Immunization
NRC	National and Regional measles Campaign
RVP	Routine Vaccination Program
SIA	Supplementary Immunization Activity
UNESCO	United Nations Educational Scientific and Cultural Organization
UNICEF	United Nations Children Educational Fund
USAID	United States Agency for International Development
VPD	Vaccine Preventable Disease
WHO	World Health Organisation

ABSTRACT

Despite the efforts made by the Nigerian government, policy makers and other stakeholder to increase children vaccination against infections, measles vaccination coverage remains very low. While this problem is more profound in the northern part of Nigeria, its present form in Borno State even requires urgent attention. This study is an attempt to expose the issue. It conducts a policy simulation exercise on two measles immunization programs for children of age 9-23 months – free immunization against measles with media awareness campaign (Policy A) and free immunization against measles with house to house campaign (Policy B) to boost children measles immunization coverage. The study estimates the relative cost and the effectiveness measure such as the health benefits – morbidity avoided and mortality averted. In what follows, it compares the cost per child covered and the cost-effectiveness ratios of the policy alternatives. The cost per child indicates that policy A has a lower cost and lower level of coverage, while policy B has a higher cost and a higher level of immunization coverage. In terms of cost of treating measles and the value of statistical life (VSL), the results of the cost-effectiveness analysis show that both policies are efficient. However, policy A has a lower cost-effectiveness ratio than policy B.

In terms of paying for the policy alternatives, two funding scenarios as well as the equity distribution were analysed. The equity aspect of the exercise is to ensure that the policies are pro-poor. The findings of sensitivity analysis performed to determine the stability of the results show that the results are not sensitive to changes in the values of the parameters. Overall, since both programs can be implemented (as shown by their cost-effectiveness ratios), the recommendation is that policy B be introduced in the rural areas characterized with high level of illiteracy, uneven distribution of government hospitals, and poor electronic and print media coverage which often discourage or keep parent out of touch of the next vaccination date. However, policy A can be deployed in urban areas where there is reasonable distribution and accessibility of government hospitals, organized electronic and print media coverage and high level of literacy. Lastly, in semi urban areas with moderate literacy, and electronic and media coverage, the best option will be for the government to implement both policies as complements, depending on resource availability.

1. INTRODUCTION AND BACKGROUND

One of the leading causes of infant morbidity and mortality in most developing countries, and indeed, in Nigeria is measles (Dubrey and Choudhurey, 2009). Measles is a highly contagious Vaccine Preventable Disease (VPD) which several countries have tried to eradicate albeit with modest success. In many Sub Saharan African countries, it remains the fifth leading cause of death amongst children less than five years of age (Strebel *et al.* 2003). Measles accounts for 44% of the total deaths of children less than 15 years and also created more lifelong disabilities such as blindness, deafness and permanent brain damage among this age group (Okonko *et al*. 2009). Similarly as Adu (2008) pointed out, the highest mortality from this disease occurred in poor communities with low routine vaccination coverage and the poor quality of the mass immunization campaign.

In Nigeria, the occurrence of persistent measles outbreak is alarming. A recent statistic shows that there were 30, 194 and 256 measles outbreak for 2006, 2007 and 2008 respectively (Adeoye *et al*., 2010). Measles account for a great number of childhood morbidity and mortality in Nigeria, recording about 212,283 and 168,107 cases for 2000 and 2001 respectively (WHO, 2010). The incessant measles outbreak and cases are a reflection of the low measles vaccination coverage as well as poor immunization campaign. The coverage rate of measles vaccine in Nigeria has fluctuated over time, from 55% in 1981 to 59% in 1988 and later falling to 35% in 2003, (SWC, 2005 cited in Agumadu, 2005). As at 1999, children ages 12-23 months immunized against measles in Nigeria stood at 64% this later increased marginally to 71% for 2010 (World Bank 2010 and UNICEF 2012). While this slight uptick may modestly look encouraging, there are still threats to measles eradication in Nigeria due to the following reasons: firstly, there is a large geographical disparity in immunization coverage. Measles coverage is biased against the northern states of Nigeria. For example, the most recent National Immunization Coverage; NICS, 2010 shows that Borno state recorded abysmal 37.5% immunization coverage rate against measles. This finding is further buttressed by the reports from previous studies. Dubray *et al*. (2005), shows that Adamawa state (a neighboring state to Borno) recorded 3,974 cases and 238 measles death in 2005. Secondly, the UNESCO threshold of greater than 95 percent coverage for herd immunization in Nigeria is yet to be achieved[1]. Thus, there is a need to accelerate measles' coverage in Nigeria.

The fact that some countries (developed and developing) have succeeded in reducing measles transmission is an indication that measles eradication in Nigeria, more importantly, in pandemic states is realistic if the appropriate vaccines and intervention strategies are employed. Immunization is one of the most effective public health interventions, and a cost effective strategy to reduce both the morbidity and mortality associated with infectious diseases. Over two million deaths are avoided through immunization each year in the world (Odusanya *et al.*, 2008). In Nigeria, several polices aimed at addressing VPD have been attempted in the past, but most of these problems could not be resolved due primarily to inappropriate policies. Cutts and Markowitz (1994) reported that for more than 20 years since Nigeria joined other nations in combating measles; adopting programmes such as the National Programme on Immunisation (NPI), the level of success recorded especially in northern Nigeria remains insignificant. Measles continues to cause high morbidity and mortality among children in northern Nigeria. This is a

[1] A condition created when immunization levels are so high that even the small minority not immune are still protected from the disease.

sharp contrast from the situation in the developed countries, where the effectiveness of immunisation is core to the success story of measles control achieved. Following the devastating effects of measles outbreaks in recent years coupled with the limited success of previous programmes, the Nigerian government has shown renewed efforts to achieve improved immunization coverage and prevent avoidable deaths. These events have made it imperative to conduct a policy simulation that can achieve lower child morbidity and mortality rates through immunization[2]. This study, therefore, seeks to carry out a simulation exercise on two policy alternatives that the government can adopt in order to increase measles immunization coverage amongst children of age 9-23 months. More specifically, this study will attempt to provide answers to the following questions:

- What specific policy alternatives have government considered (or can consider)?
- What is the relative effectiveness of each policy?
- What are the cost implications of each alternative to the government?
- What is the cost-effectiveness ratio of each policy?
- What proportions of the incremental benefits of these policies are directed to the poor and how can government achieve equity?
- How will the cost of each of the alternatives be covered (funding scenarios)?

Given the enormity of conducting a broad policy simulation exercise in terms of time, resource and data requirement, it will be challenging to extend the simulation exercise to several parts of the country. With this issue in mind, the focus of the study is limited to Borno State. The choice of Borno state is informed by the present geographical disparities in immunization

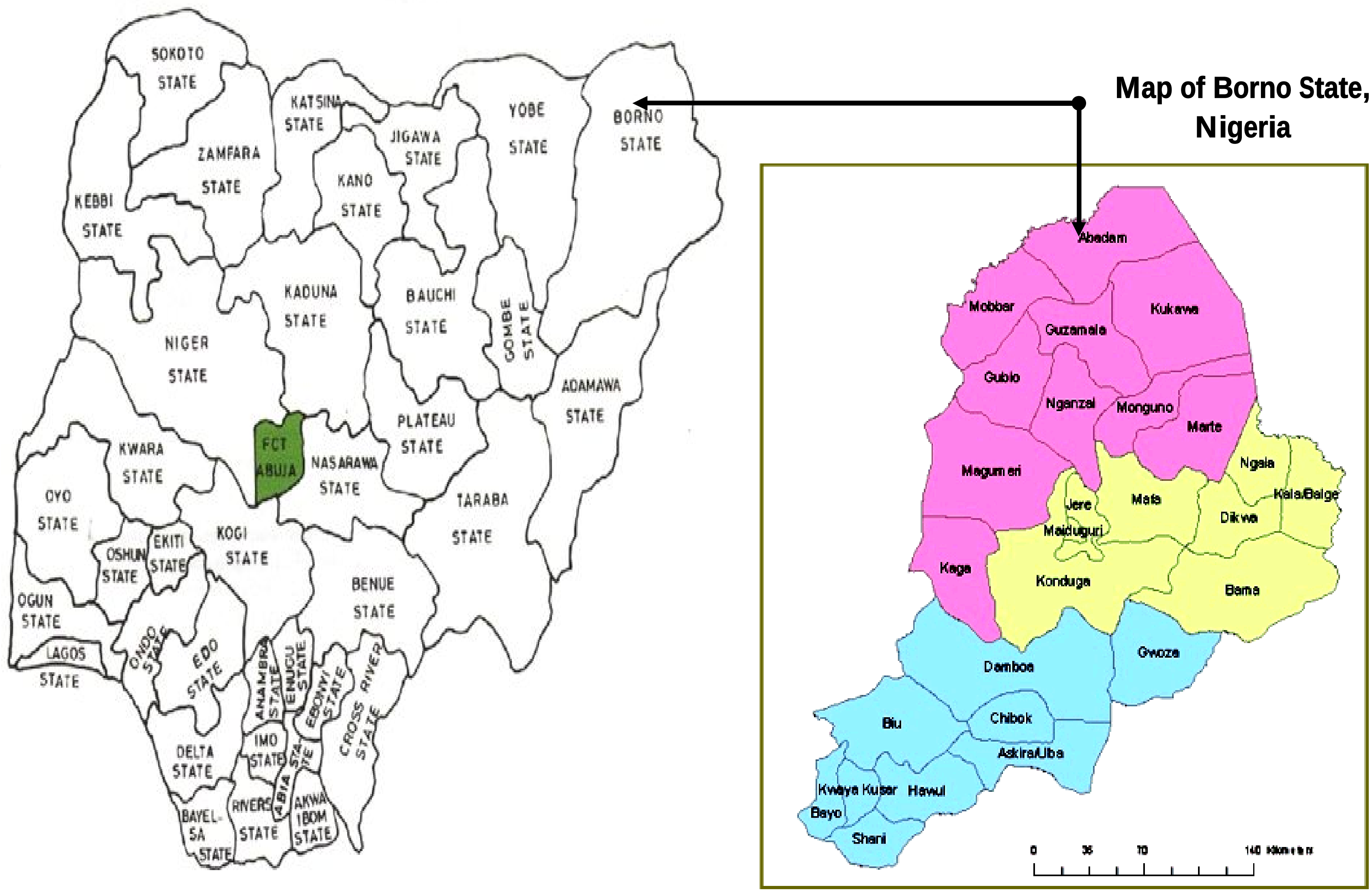
[2] Policy simulation creates a better understanding of how better policy design and proper implementation can help solve most of these problems.

coverage, which is relatively low in the state. The remainder of the report proceeds as follows: Section 2 presents a brief overview of Borno state with measles immunization trend. Section 3 reviews the key studies in the health policy simulation literature. Section 4 focuses on policy goals and alternatives. Section 5 presents the sources of the data and the methodology, including description of the identified cost and benefits of policy alternatives. Section 6 discusses the findings of the policy simulation analysis. Section 7 concludes while Sections 8 and 9 present the policy recommendations and challenges, respectively. Finally, section 10 presents plans for dissemination of the findings.

2. BACKGROUND OF BORNO STATE

This section provides a brief discussion on Borno state and some background of measles immunization trend. Borno state is located in the north east of Nigeria (see Figure 1). It shares boundaries with Adamawa state to the South, Gombe state to the West and Yobe State to the North-West. Borno state has a population of 4,588,668 people, with 349,699 children of vaccination age; 9-23 months (NPC, 2006). This population is projected to reach 435,923 by 2013. Borno state is made up of 27 Local Government Areas (LGAs) and 311 council wards. Immunisation against all infant VPD's is mostly coordinated by the State Ministry of Health, similar to other states in the North East region; Borno state has a poor uptake of vaccinations (NICS, 2010). Bassi *et al*. (2008) stated that based on the WHO standard EPI survey questionnaires, the immunization coverage rate against measles for children aged 12-23 months in Maiduguri (Borno state capital) was roughly 20%. Similarly, the most recent National Immunization Cluster Survey, NICS 2010 recorded just 37.5% for measles immunization coverage in Borno state.

Figure 1: Location of Borno State, Nigeria.



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The reasons often advanced for low immunization coverage are; lack of information by health staff on next vaccination dates, long distance from immunization centre; lack of awareness of the need to complete immunization schedule to afford protection for their children (Bassi *et al*., 2008) Following this scenario, this study attempts to provide policy interventions that can help to address these issues.

3. LITERATURE REVIEW

There has been a growing literature on simulation of government programs and policies. These analyses have been carried out on series of health care programs with several goals including reducing maternal mortality, increasing malaria control, prevention of HIV/AIDS and eradication of polio. However, in recent times studies have focused on the programs aimed at increasing measles immunization coverage. For example, Paunio *et al*. (1991) analysed the impact of the 1982 measles vaccination campaign strategy adopted in Finland to boost measles immunization coverage. The campaign strategy was made up of several interventions, including improved compliance, a mass media campaign and notification of nonvaccinated children to local health professionals and parents. During this exercise, the computerized recording of the vaccinated children was considered necessary and was integrated with the population registry to identify the hard-to-reach families. The study revealed that the campaign increased vaccination coverage significantly. In particular, vaccination coverage of over 96% was achieved, which helped prevent measles, mumps and rubella transmission.

Kuroiwa *et al*. (2003) evaluated the impact of the 2000 mass measles vaccination campaign in Laos, comparing the prevalence of measles antibodies before and after the campaign among children aged 9 months to 4 years in the pilot states. The study revealed a significant increase in the number of children covered by the mass measles vaccination campaign. It further confirmed that there is difficulty of maintaining one's increased immunity after the campaign. Therefore, it suggested that more efforts should be put on reconstructing routine immunization service weakened by aggressive eradication programme, and introducing two doses of vaccination at the age of 9-23months and school entrance age in urban areas, as well as comprehensive primary health care approach in remote areas. Recently, Peng *et al.* (2012) analysed the impact of the mass vaccination campaign on measles coverage in the province of Guangdong in China. The campaign employed variety of modalities as well as different communication, print and electronic media. Based on the rapid coverage surveys employed, the study found that significant increase in measles vaccination coverage and reduction in measles cases were achieved within a short period of the campaign. Further analysis revealed that flyers, information from public health doctors, and the use of television programs were particularly the best methods to inform parents about the campaign. The study concluded that comprehensive mobilization, communication with the mass media, support from the government departments were essential to the success of mass immunization campaign.

Unlike the developed countries, only a few studies have analysed the impact of programs aimed at increasing the measles immunization coverage in Africa. For example, Vijayaraghavan *et al*. (2007) examined the relative effectiveness of a Routine Vaccination Program (RVP) and the Supplemental Immunization Activity (SIA) launched in Kenya in 2002, to boost measles vaccine coverage at the national and provincial levels. Apart from determining the relative percentage of previously unvaccinated children (zero-dose children) reached by each program, the study used the equity of measles vaccine coverage among children aged 9-23 months as effectiveness measure. Based on the measles coverage survey data for the national and provincial level derived and the concentration index (CI) estimated to measure equity of measles vaccination coverage, the study found that SIA improved measles coverage and equity, achieving significantly higher coverage in all provinces than RVP. The study, therefore, concludes that SIAs provide an ideal platform for delivering other life-saving child health interventions.

MoHSW (2006) analysed the success of the national and regional campaign program for the eradication of measles in children in Swaziland. The campaign was jointly initiated and financed by UNICEF and WHO, while technical support came from the CDC. This nation-wide campaign involved both the print and electronic media; there were distributions of printed materials (pamphlets) as part of the campaign and children aged 9-59 months were the targeted population. Social mobilization was another critical aspect of the campaign; having breakfast meetings with key players so as to sensitize and inform them of their role in the campaign exercise. Out of the targeted population of 153,504, about 140,149 children (91.3% of the target coverage) were successfully vaccinated against measles. This increased the pre-campaign total coverage rate from 60% in 2005 to 91.3% by the end of 2006.

Similarly, IFRC (2011) reported the success of the 2011 Disaster Relief Emergency Fund (DREF) measles eradication campaign in Kenya. The DREF program was a response to measles outbreak reported in some provinces of Kenya. It involved community education and mobilization on measles as well as vaccination of children through a door-to-door campaign by the International Federation of Red Cross and Red Crescent (IFRC). Children aged 6-14 years were targeted for the measles immunization, the cost of the program was estimated at CHF299, 869 (US $313, 365.65) and the campaign lasted for 27 days (approximately 1 month). Within this period, they had successfully vaccinated 996,524 children exceeding the initial target of 888,796 (i.e. a success rate of 113%).

4. POLICY GOALS AND ALTERNATIVES

The goal of this study is to proffer policy alternatives that can facilitate and increase the immunization coverage rate, particularly against measles in Borno state. Such policies will guarantee the achievement of the government`s improved measles immunization coverage objective. In carrying out this policy simulation exercise, our target is to achieve at least 98% measles immunization coverage of children aged 9-23 months (that is immunize at least 95% of uncovered children) by the end of 2020 in Borno state. This is a massive improvement from the current coverage rate of 37.5% and it is in line with goal 4 of the Millennium Development Goals, which seeks to reduce high child mortality rate.

On several occasions, the federal and state governments have adopted the policy of free measles immunization (FMI) for all children, especially in the rural areas. The free immunization program ensures parents bring their children for vaccination free of charge at various government owned health centres and hospitals. Despite the FMI program, there is low level of measles immunization coverage rate and several factors are responsible for this. For example Adeoye *et al*. (2010) pointed out some of the major reasons for poor measles immunisation coverage in Nigeria as: lack of time to take the children for vaccination; forgetfulness on the part of the parents on when the next vaccination day is due; the impression that it may be unimportant; lack of vaccines and the suspicion of possible side effects. With the above insight, this study proposes two policy alternatives which can complement the existing FMI to enhance the achievements of improved measles immunisation coverage in Borno State. The specific alternative policies are:

- **Free immunisation against measles combined with promotion/awareness campaign (hereafter policy A)**
- **Free immunisation against measles combined with house to house visitations (hereafter policy B)**

The proposed alternatives seek to address the factors hampering the success of immunization against measles in Nigeria. In addition to the cost of vaccines, personnel and logistic cost previously covered, Policy A will involve the use of print and electronic media for creating awareness and sensitization of parents. Specifically, it will entail the use of prepared educational materials such as posters, leaflets and television and radio announcement slots in different local languages. In contrast, policy B will entail outreach teams that will go from house to house sensitizing the parents on the importance of vaccination against measles and still retain the cost of vaccines and logistics previously covered. Nevertheless, both programs will entail a serious commitment of the personnel involved as well as the communities, and it is assumed that government will get the required support from them. For both programs, the personnel will be adequately trained to communicate, persuade and administer the vaccines at minimum supervision, while ensuring proper record keeping of the covered children. The choice of these two policy alternatives is predicated on their previous effectiveness in some countries (see the literature review section for details). The study considers these programme alternatives as effective tools for achieving the stated policy objectives and it is expected that both programmes are to be coordinated by qualified or trained personnel – including nurses that will provide medical support. Both programs create adequate awareness and sensitization of parents about the importance of measles vaccination and reduce the burden of direct cost of measles immunization. This will further encourage parents to make their children available for measles vaccination. Nevertheless, there are other good policy alternatives that this policy simulation exercise has not considered such as distribution of sweets or candies to the children during the vaccination exercise amongst others. Although there are neither existing literatures nor findings suggesting these policies alternatives have been ineffective in achieving desired goals, but it is our conviction that the chosen policies are adequate to address the present problem in the system. Nevertheless they can be examined for future studies.

5. METHODOLOGY

This section presents the step by step plan on how the policy simulation exercise will be conducted. It deals with issues such as source and methods of data collection, the underlying simulation assumptions, measurement of relative effectiveness, and costs of the alternatives, measurement of equity in the alternatives, paying for the alternatives as well as sensitivity analysis.

5.1 Data sources

The major source of data for this analysis is the National Bureau of Statistics. Other sources include: Federal Ministry of Health, National Programme on Immunization, National Population Commission, World Health Organization, World Bank as well as other relevant sources. The NBS data are from the Annual Abstract of Statistics (2009) and Social statistics (2009). In few cases, some data-including average income and growth/changes were derived through several computations.

5.2 Assumptions

There are several important assumptions made in this study:

- Zero inflation rate
- Average cost of transporting personnel on house to house visitations remain constant
- Constant average wages for vaccination personnel, administrative and M&E staff.
- Constant population (age 9-23months) growth rate of 3.2%
- Existing facilities – cold chain storage and ice refrigerator are not at full capacity, thus can take care of preservation of additional vaccine with the interventions.
- Average cost of producing handbills and posters, electronic broadcast remain constant.
- Average cost of vehicular (motorcycle) for monitoring is constant with a zero percent salvage value at the expiration of the programme.
- The standard of existing policy will be maintained or improved upon.
- Constant Gross Domestic Product (GDP) growth
- Sustained increase in immunization coverage in the upper quintiles

5.3 Analysis Approach

As stated earlier, the analysis follows a step by step approach. Firstly, the relative effectiveness of the policy alternatives is derived, followed by the cost. The detailed relative cost of program is estimated by considering all the necessary cost components. Relying on the cost and effectiveness estimates, a cost-effectiveness ratio (CERs) is calculated for both policies to determine which policy is more efficient and sustainable. In addition, a sensitivity analysis is conducted to highlight the impact of changes in the relative effectiveness measure or cost components on the results. Equity consideration in the distribution of coverage are then scrutinized by grouping the recipients into minimum of five quintiles, and ensuring that the low income earners are adequately taken care of, with little or no tradeoff from the rich. This ensures that the analysis is pro-poor. This will be followed by the conduct of a sensitivity analysis; varying either the cost ingredients or the effectiveness, or both based on the underlying effectiveness measures and cost measures. Lastly, the study analyses how the policy alternative can be paid for. At least two scenarios of additional cost with reallocation – reallocate with additional 10% and reallocate with additional 40% are considered for both policies. The detailed sections on the step by step plan are presented below.

5.3.1 Relative Effectiveness

To determine the relative effectiveness of each policy, the exercise will compare the past outcomes of both policy alternatives in previous studies. This will entail the evaluation of effective coverage rates before the introduction of each policy, to the coverage rates after the implementation of the policies. The difference in rates will then form the relative effectiveness of each policy. As earlier pointed out, policies A and B are programs intended to enhance the immunization coverage rate. Both policies have been implemented in some developing countries in the past, for instance, the *National and Regional Campaign (NRC) Program for the Eradication of Measles in Swaziland* and *Disaster Relief Emergency Funds (DREF) Measles Eradication Campaign in Kenya*. There are evidences of positive effectiveness of both programs through the results of the impact evaluation reported in the literature. For example, MoHSW (2006) reported that NRC program for the eradication of measles in Swaziland was a huge success, raising the rate of vaccination coverage against measles from 60% to 91.3% in one year. Policy A is a replica of NRC program that involves the use of the print and electronic media for campaign. In addition to the vaccines, it will entail the use of prepared sensitization materials to be broadcast via the electronic media; specifically, radio, given its versatility, outreach and potential for translation into local dialects for maximum communication and dissemination impact. Therefore, for Policy A, the present simulation will rely on the estimates of the effectiveness measure from MoHSW. It is reasonable to assume that policy A will achieve at least 90% of the stated target (i.e. additional 28.6%) coverage by 2020 (8 years). We expect that if Swaziland can improve the coverage rate from 60% to 91.3% in one year, replicating similar programme, we can improve the coverage rate in Borno state to 95% in 8 years.

Conversely, policy B entails a door-to-door visitation approach to sensitize parents on the vaccination exercise. This is a replica of the DREF eradication campaign carried out successfully by the IFRC in Kenya in 2011. IFRC (2011) reported that the programme was able to cover 999,524 children against measles, exceeding the initial target of 888,796 (i.e. a success rate of 113%) in one month. For Policy B which is compatible with DREF eradication campaign in Kenya, the present simulation will rely on the estimates of effectiveness measure from IFRC (2011). Thus, it is reasonable to assume that policy B will achieve the stated target of 95% (additional 31.8%) children coverage by 2020 (8 years). Following this insight, it suffices that policy A is almost as effective as policy B (at least capable of achieving close to 90% of what policy B can achieve). More importantly, in choosing an eight year policy plan to eradicate Measles in Nigeria, we have considered the deep structural problems associated with project and program implementation in the country. However, to ensure that these measures are well suited for the present situation, specific assumptions and adjustments will be made where necessary, and adequate sensitivity analysis conducted in order to determine the robustness of the estimates.

5.3.2 Relative Benefits

This study focus on two expected health related benefits; reduction in morbidity and mortality arising from improved immunization coverage and the benefits will be estimated based on the underlying relative effectiveness (that is increased coverage) for each policy intervention. Reduction in morbidity from the improved coverage is computed by subtracting the number of projected incidence of measles of the age group (9-23 months) with intervention from the projected incidence of measles without the programs (at status quo). Similarly, reduction in mortality is computed by subtracting the likely death or mortality due to measles with the programme from likely death due to measles without the program (at status quo). Equations 1 and 2 present the details. However, these estimations are based on certain assumptions presented in section 5.2.

$$RMD_{t,i} = \left(UP_{prepolicy} \times AMD\%\right)_{t,i} - \left(UP_{postpolicy} \times AMD\%\right)_{t,i} \dots\dots\dots\dots\dots (1)$$

$$RMT_{t,i} = \left(MD_{prepolicy} \times AMT\%\right)_{t,i} - \left(MD_{postpolicy} \times AMT\%\right)_{t,i} \dots\dots\dots\dots\dots (2)$$

Where $RMD_{t,i}$ is the reduction in morbidity in year t, and i represents the policy alternatives. UP is the uncovered population and $AMD\%$ is the average morbidity as percentage of UP. $RMT_{t,i}$ is the reduction in mortality in year t, MD is the estimated morbidity and $AMT\%$ is the average mortality as percentage of MD.

5.3.3 Relative Costs

The total cost of policy A will be determined by estimating the total value of the recurrent and capital cost components. For the recurrent costs, it will include; cost of vaccine, cost of the print and electronic media of communication, personnel cost and logistics. While the capital costs includes the vehicular monitoring cost. Similarly, the cost for policy B will involve an estimation of the total value of the recurrent and capital cost components, some of the recurrent cost includes the cost of the vaccines, logistics, personnel cost, and cost of additional health workers who will carry out the house to house visitation for sensitization towards the program. The capital cost components for policy B are the same as policy A. However, the estimates will rely on certain assumptions in section 5.2 and some of the cost components of both programs will vary with the number of covered children over the duration of the policies, while others might be constant. More specifically, the analysis will rely on the information presented in Table A1 of the appendix.

5.3.4 Cost-Effectiveness Analysis

This subsection explains the techniques for the cost-effectiveness analysis. The estimated cost and effectiveness are projected over 8 years (the life span of the intervention) for both policy alternatives. Following these projections, the cost-effectiveness ratios (CERs) are estimated for the entire period to reflect the successive improvement of the programs. Thereafter, the values are discounted to present values using a discount rate of 3% in order to evaluate the relative usefulness (attractiveness) of the policies. Two different CERs will be computed based on the health benefits; CERs-morbidity (i.e. cost per measles related morbidity averted) and CERs-Mortality (i.e. cost per measles related death averted) using equations 3 and 4, respectively.

$$CERs_i\ (Morbidity) = \sum_{t=1}^{7} \frac{Cost_{t,i}}{(1+r)^t} \Bigg/ \sum_{t=0}^{7} RMD_{t,i} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots .. (3)$$

$$CERs_i\ (Mortality) = \sum_{t=1}^{7} \frac{Cost_{t,i}}{(1+r)^t} \Bigg/ \sum_{t=0}^{7} RMT_{t,i} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

Where $Cost_{t,i}$ is the total cost of policy alternative in year $t, T = 7$ and r is the discount rate. $CERs_i(Morbidity)$ is the cost effectiveness ratio as per reduced morbidity and $CERs_i(Morbidity)$ are the cost effectiveness ratios as per reduced mortality. All other variables are as earlier defined.

5.3.5 Sensitivity Analysis

In order to explore the robustness of our findings as well as to ensure that the assumptions guiding the analysis are sound and valid, the study will conduct a one way and multi way sensitivity analysis on a number of assumptions included in the base model. More specifically, sensitivity analysis will be conducted on the parameters of the effectiveness, some cost components and prospective benefits. For instance, a sensitivity analysis will be carried out to see how effective the less preferred policy will have to be in order to improve immunization coverage rate against measles in Borno state and become more preferable to the preferred policy.

5.3.6 Measurement of equity

The 2012 Harmonised National Living Standards Survey (HNLSS) conducted by the NBS indicated that at least over 60% of Nigerians are poor. It suffices that only few people can afford to pay for health services. Therefore, any health policy can only be significant if it targets the poor (i.e. pro poor). Thus, this simulation exercise will address equity in the distribution of health subsidy to ensure that children from poor households benefit more from government spending. This will be achieved by grouping the children population (9-23 months) into quintiles (at most five), ranging from the poorest to the richest. Subsequently, resources are re-allocated in such a way that more beneficiaries and increased measles immunization coverage come from the poorest income households in Borno state. The study will rely on the demographic health survey (2010) and the Nigeria poverty profile (2010) to derive children measles immunization coverage for various quintiles in Borno State, Nigeria.

5.3.7 Paying for the Alternatives

In conclusion, with respect to paying for the selected alternatives this study will consider at least two possible scenarios for each policy alternative.

Scenario 1: Reallocate and slightly raise the existing health budget by 5% as stipulated in the National Strategic Health Development Plan 2010 to 2015, to fund activities targeted at providing free immunization against measles. Also, it will be made pro-poor by reducing the eligibility of the rich.

Scenario 2: Reallocate and raise the existing budget by 22% (Adequate growth for all quintiles). It is worth noting that the choice of these two payment scenarios is greatly determined by the number of targeted beneficiaries/coverage and the cost of policy alternatives. Additionally, the percentage increment in children immunization coverage will be paid for on a sequential basis. In both scenarios, data on existing budget allocation to primary health care, total government spending and Borno State's GDP are utilized.

6 RESULTS AND DISCUSSION

This section presents and discusses the cost of the policy alternatives, estimated probable impact (benefits), cost effectiveness ratios, equity distribution (distribution of the benefits across the different income groups) and finally the results of the proposed payment scenarios. The results of the simulation show that policy A will achieve 86% additional vaccination coverage of the children (9-23 months) not immunized against measles. In addition, it will lead to gross immunization coverage of about 95% by 2020 (8 years). Similarly, policy B will achieve about 95% additional vaccination coverage of the children not immunized against measles and gross immunization coverage of 98% by the end of 2020. Therefore, the difference of 3% in gross immunization coverage is a reflection of relative effectiveness of the policy alternative (see Tables 1 & 2 for details). Nonetheless, this does not necessarily imply that policy A is better than policy B. in this case, it is imperative to consider associated probable impact and cost.

Cost Estimate – pre policy

As stated earlier, the existing free measles immunization program requires parents to bring their children to government hospitals for free vaccination as at when due. In most cases, government hospitals are not very close to the people, especially in the rural areas, parents travel long distances to vaccinate their children. Similarly, sensitization and publicity on the measles vaccination is almost none existent implying that parents are bound to remember the dates for vaccinations. Nonetheless, there are limited data on the cost per child vaccinated. With this in mind, the study finds it important to estimate the cost of vaccination per child as it creates the opportunity to determine the incremental costs with the introduction of policy A and B, respectively.

Table 1: Effectiveness (Additional Measles Immunization Coverage) of Policy A

	2013	2014	2015	2016	2017	2018	2019	2020
A. Projection of children age 9 - 23 months in Borno State	435,928	449,878	464,274	479,131	494,463	510,286	526,615	543,466
B. Projection of children 9 -23 months immunised in Borno State	201,399	220,890	241,423	263,049	285,800	309,744	334,927	361,405
Gross coverage ratio (GCR)	46.2%	49.1%	52%	54.9%	57.8%	60.7%	63.6%	66.5%
Projected children age 9-23 months not immunised in Borno State	234,529	228,988	222,852	216,088	208,663	200,542	191,688	182,061
Policy objective (covers 95% of children not immunized in the next 8 years)	20%	40%	55%	70%	80%	85%	90%	95%
Policy Alternatives (Effectiveness)								
I. Free Immunisation against measles + awareness campaign	18%	36%	50%	63%	72%	77%	81%	86%
projected increment in number of children covered (Policy A)	42,215	82,436	110,312	136,135	150,238	153,415	155,267	155,662
Total children covered in Borno State based on policy A	243,614	303,326	351,734	399,178	436,037	463,158	490,194	517,068
Gross coverage ratio (GCR) after program	56%	67%	76%	83%	88%	91%	93%	95%
Needs in Health (Trainers) & Non Health staff – M&E, Admin, Vaccinator								
Number of M&E staff (one per Local Govt.)	27	27	27	27	27	27	27	27
Number of Admin (one per Local Govt.)	27	27	27	27	27	27	27	27
Proposed Vaccinators- Ad hoc staff/ Children ratio per day	1:20	1:20	1:20	1:20	1:20	1:20	1:20	1:20
Number of ad hoc - vaccinator	70	137	184	227	250	256	259	259
Number of Trainers - Nurses (one per 20 trainees)	4	7	9	11	13	13	13	13

Source: Computed by Authors

Table 2: Effectiveness (Additional Measles Immunisation Coverage) of Policy B

	2013	2014	2015	2016	2017	2018	2019	2020
A. Projection of children age 9 - 23 months in Borno State	435,928	449,878	464,274	479,131	494,463	510,286	526,615	543,466
B. Projection children 9 -23 months immunised in Borno State	201,399	220,890	241,422	263,043	285,800	309,744	334,927	361,405
Gross coverage ratio (GCR)	46.2%	49.1%	52%	54.9%	57.8%	60.7%	63.6%	66.5%
Projected children 9-23 months not immunised in Borno State	234,529	228,988	222,852	216,088	208,663	200,542	191,688	182,061
Policy objective (covers 95% of children not immunised in the next 8 years)	20%	40.0%	55.0%	70.0%	80%	85.0%	90.0%	95.0%
Policy Alternatives (Effectiveness)								
II. Free Immunisation against measles + house-to house visitations	20%	40%	55%	70%	80%	85%	90%	95%
projected increment in number of children covered (Policy A)	46,906	91,595	122,568	151,262	166,931	170,461	172,519	172,958
Total children covered in Borno State based on policy B	248,305	312,485	363,991	414,304	452,730	480,204	507,446	534,364
Gross coverage ratio (GCR) after program	57%	69%	78%	86%	92%	94%	96%	98%
Needs in Health (Trainers) & Non Health staff- M&E, Admin, Vaccinator								
Number of M&E staff (one per Local Govt.)	27	27	27	27	27	27	27	27
Number of Admin (one per Local Govt.)	27	27	27	27	27	27	27	27
Proposed Ad hoc -vaccinator staff/Children ratio per day	1:20	1:20	1:20	1:20	1:20	1:20	1:20	1:20
Number of Ad hoc-vaccinator	78	153	204	252	278	284	288	288
Number of Ad hoc-house to house campaign staff (one per ward)	311	311	311	311	311	311	311	311
Numbers of Trainer – Nurses (one per 20 trainees)	4	8	10	13	14	14	14	14

Table 3: RESULTS (Financial Implications) of Policy A

COST FROM SIMULATION – POLICY A	NGN'000	NGN'000	NGN'000	NGN'000	NGN'000	NGN'000	NGN'000	NGN'000
Total Recurrent Cost	15,889.9	22,488.8	27,011.2	31,200.7	33,488.6	34,004.0	34,304.5	34,368.6
Salary/Wages:	**3,162.2**	**4,502.9**	**5,432.1**	**6,292.8**	**6,762.9**	**6,868.8**	**6,930.6**	**6,943.7**
Ad hoc-vaccinators (Minimum SSCE holder@NGN20,000; one off payment)	1,407.2	2,747.9	3,677.1	4,537.8	5,007.9	5,113.8	5,175.6	5,188.7
Admin staff (Minimum of OND holder @NGN30,000; one off payment)	810.0	810.0	810.0	810.0	810.0	810.0	810.0	810.0
M&E staff (minimum of B.Sc holder @NGN35,000; one off payment)	945.0	945.0	945.0	945.0	945.0	945.0	945.0	945.0
Cost of A day training of Ad hoc – vaccinators:	**1,154.8**	**1,446.5**	**1,597.5**	**1,737.4**	**1,813.8**	**1,831.0**	**1,841.0**	**1,843.2**
Stipend for vaccinators@ NGN2,000 per vaccinator	140.7	412.2	551.6	680.7	751.2	767.1	776.3	778.3
Stipend for trainers@NGN4,000 per trainer	14.1	34.3	46.0	56.7	62.6	63.9	64.7	64.9
Average cost of training materials	1,000.0	1,000.0	1,000.0	1,000.0	1,000.0	1,000.0	1,000.0	1,000.0
Cost of Ingredients:	**5,212.9**	**10,179.4**	**13,621.6**	**16,810.5**	**18,551.8**	**18,944.2**	**19,172.9**	**19,221.7**
Cost of Vaccine	5,038.4	9,838.7	13,165.7	16,247.8	17,930.9	18,310.1	18,531.1	18,578.3
Cost of syringes with needles @ 0.01$ per pack	65.4	127.8	171.0	211.0	232.9	237.8	240.7	241.3
Cold bags for vaccines @ $10 each.	109.1	213.0	285.0	351.7	388.1	396.3	401.1	402.1
Promotion/Awareness Campaign Cost	**6,360.0**	**6,360.0**	**6,360.0**	**6,360.0**	**6,360.0**	**6,360.0**	**6,360.0**	**6,360.0**
Electronic campaign + translation (3 slots per day X 31days) @NGN40,000/slot	1,860.0	1,860.0	1,860.0	1,860.0	1,860.0	1,860.0	1,860.0	1,860.0
Print campaign – flyers (@ NGN30 per flyer X 150,000 quantity)	4,500.0	4,500.0	4,500.0	4,500.0	4,500.0	4,500.0	4,500.0	4,500.0
Total Capital Cost	**286.9**	**286.9**	**286.9**	**286.9**	**286.9**	**286.9**	**286.9**	**286.9**
Vehicular for monitor (one motorcycle/LGA) @ N100,000 (dep.@ 15% salvage value)	286.9	286.9	286.9	286.9	286.9	286.9	286.9	286.9
Total (Capital and Recurrent) Cost	**16,176.7**	**22,775.7**	**27,298.1**	**31,487.6**	**33,775.4**	**34,290.9**	**34,591.4**	**34,655.5**
Transport cost (5% of total cost)	808.8	1,138.8	1,364.9	1,574.4	1,688.8	1,714.5	1,729.6	1,732.8
Annual Incremental Grand Total Cost (Recurrent + Capital + Transport)	**16,985.6**	**23,914.5**	**28,663.0**	**33,062.0**	**35,464.2**	**36,005.4**	**36,321.0**	**36,388.3**
Total Cost of Immunization without Programs	**51,809.9**	**54,237.1**	**56,793.9**	**59,486.2**	**62,320.1**	**65,301.7**	**68,437.8**	**71,735.0**
Total cost of Immunization with Program A	**68,795.5**	**78,151.5**	**85,456.9**	**92,548.2**	**97,784.3**	**101,307.2**	**104,758.7**	**108,123.3**
Unit Cost of Vaccination without program (NGN)	**257**	**246**	**235**	**226**	**218**	**211**	**204**	**198**
Unit Cost of Measles Immunisation with Program A (NGN)	**282**	**258**	**243**	**232**	**224**	**219**	**214**	**209**
Incremental Cost of Program A (NGN) as per additional coverage	**402**	**290**	**260**	**243**	**236**	**235**	**234**	**234**

NB:
exchange rate : 1US$= NGN155
Cost of vaccines per dose is US$0.77
Cost of syringes with needles and other accessories is US$0.01 per pack

Source: Computed by Authors

Table 4: RESULTS (Financial Implications) of Policy B

COST FROM SIMULATION – POLICY B	NGN'000	NGN'000	NGN'000	NGN'000	NGN'000	NGN'000	NGN'000	NGN'000
Total Recurrent Cost	**21,002.6**	**28,174.5**	**33,145.2**	**37,750.0**	**40,264.6**	**40,831.1**	**41,161.4**	**41,231.9**
Salary/Wages	**9,538.5**	**11,028.2**	**12,060.6**	**13,017.1**	**13,539.4**	**13,657.0**	**13,725.6**	**13,740.3**
Ad hoc-vaccinators (Minimum SSCE holder@NGN20,000; one off payment)	1,563.5	3,053.2	4,085.6	5,042.1	5,564.4	5,682.0	5,750.6	5,765.3
Ad hoc house-to-house campaigner@NGN20,000 per staff(one off payment)	6,220.0	6,220.0	6,220.0	6,222.0	6,220.0	6,220.0	6,220.0	6,222.0
Admin staff (Minimum of OND holder @ NGN30,000; one off payment)	810.0	810.0	810.0	810.0	810.0	810.0	810.0	810.0
M&E staff (minimum of B.Sc holder @ NGN35,000; one off payment)	945.0	945.0	945.0	945.0	945.0	945.0	945.0	945.0
Cost of A day training of Ad hoc - vaccinators	**1,172.0**	**1,335.8**	**1,449.4**	**1,554.6**	**1,612.1**	**1,625.0**	**1,632.6**	**1,634.2**
Stipend for vaccinators@NGN2,000 per vaccinator	156.4	305.3	408.6	504.2	556.4	568.2	575.1	576.5
Stipend for trainers@NGN4,000 per trainer	15.6	30.5	40.9	50.4	55.6	56.8	57.5	57.7
Average cost of training materials	1,000.0	1,000.0	1,000.0	1,000.0	1,000.0	1,000.0	1,000.0	1,000.0
Cost of other ingredients	**5,792.1**	**11,310.5**	**15,135.1**	**18,678.3**	**20,613.2**	**21,049.1**	**21,303.2**	**21,357.5**
Cost of Vaccine	5,598.2	10,931.9	14,628.5	18,053.1	19,923.2	20,344.5	20,590.2	20,642.6
Cost of syringes with needles @ 0.01$ per pack	72.7	142.0	190.0	234.5	258.7	264.2	267.4	268.1
Cold bags for vaccines @ $10 each.	121.2	236.6	316.6	390.8	431.2	440.4	445.7	446.8
House-to house campaign cost	**4,500.0**	**4,500.0**	**4,500.0**	**4,500.0**	**4,500.0**	**4,500.0**	**4,500.0**	**4,500.0**
Print campaign – flyers (@ NGN30 per flyer X 150,000 quantity)	4,500.0	4,500.0	4,500.0	4,500.0	4,500.0	4,500.0	4,500.0	4,500.0
Total Capital (Fixed) Cost	**286.9**	**286.9**	**286.9**	**286.9**	**286.9**	**286.9**	**286.9**	**286.9**
Vehicular for monitor (one motorcycle/LGA) @ N100,000 (dep.@ 15% salvage value)	286.9	286.9	286.9	286.9	286.9	286.9	286.9	286.9
Total (Capital and Recurrent) Cost	**21,289.5**	**28,461.4**	**33,432.1**	**38,036.9**	**40,551.5**	**41,118.0**	**41,448.3**	**41,518.8**
Transport Cost (3% of total cost)	638.7	853.8	1,003.0	1,141.1	1,216.5	1,233.5	1,243.5	1,245.6
Annual Incremental Grand Total Cost (Recurrent + Capital + Transport)	**21,928.2**	**29,315.2**	**34,435.0**	**39,178.0**	**41,768.0**	**42,351.6**	**42,691.8**	**42,764.4**
Total Cost of Immunization without Programs (NGN)	**51,809.9**	**54,237.1**	**56,793.9**	**59,486.2**	**62,320.1**	**65,301.7**	**68,437.8**	**71,735.0**
Total cost of Immunization with Program B (NGN)	**73,738.1**	**83,552.3**	**91,229.0**	**98,664.2**	**104,088.1**	**107,653.3**	**111,129.6**	**114,499.4**
Unit Cost of Vaccination without program (NGN)	**257**	**246**	**235**	**226**	**218**	**211**	**204**	**198**
Unit Cost of Measles Immunisation with Program B (NGN)	**297**	**267**	**251**	**238**	**230**	**224**	**219**	**214**
Incremental Cost of Program B (NGN) as per additional coverage	**467**	**320**	**281**	**259**	**250**	**248**	**247**	**247**
NB: Exchange rate : 1$= N155 Cost of Vaccines per dose is US$0.77 Cost of syringes with needles and other accessories is US0.01 per pack								

Source: Computed by Authors

With the existing free vaccination program, the major cost to the government is likely to be limited to cost of vaccines, cost of syringes with needles, cold chain storage, iced refrigerators, administrative and transport cost. The estimated cost per child vaccinated with existing program is NGN257 and this cost is expected to decline to NGN198 by 2020. (See details in Table A3 of appendix).

Cost Estimate - post policy

With the introduction of either policy, vaccinators are required to move from house-to-house to vaccinate children against measles, preceding this visit; there will be a campaign and sensitization of parents to make their children available for vaccination. Policy A will adopt a house to house campaign strategy, while policy B will adopt the electronic and print media campaign. Therefore, for either policy A or B, Ad-hoc staff will be required for the exercise. To ensure that the program is successful, vaccinators with minimum qualification of SSCE, administrative staff with a minimum qualification of OND, M&E staff with a minimum qualification of B.Sc as well as the trainers (nurses) will be employed. For flexibility, average vaccinator to children ratio of 1:20 per day will be maintained for 30 days. Therefore, with policy A, 70 vaccinators will be needed in 2013 and this number will increase to 259 by 2020. Similarly, based on estimated average of one additional administrative and M&E staff per LGA, about 27 administrative and M&E staff will be needed over the intervention period. For the vaccinator trainers (nurses), based on average of one trainer per vaccinator, 4 trainers will be needed by 2013 and this number will increase to 13 by 2020 (see Table 1 for details). In contrast, only 288 Ad-hoc vaccinators will be employed by the end of 2020 for policy B. Like policy A, policy B will require the same number of additional administrative and M&E staff by the end of 2020. Similarly, only 4 trainers will be needed by 2013 and this number will increase to 14 by 2020. Furthermore, policy B requires additional Ad-hoc staff for campaign and with an average of one person per ward about 311 campaigners will be needed over the intervention period (see Table 2 for details).

With an average of NGN20, 000 one off payment per vaccinator, the vaccinators required for policy A creates additional cost of NGN1.407million by 2013 and this value increase to NGN5.189million by 2020. Policy A will further result in additional administrative cost of NGN8.10miilion per annum (based on NGN30, 000 one off payment), M&E will cost NGN9.45million per annum (based on NGN35, 000 one off payment). Similarly, with an average of NGN4, 000 one off payment per trainer for one day training, it creates additional cost of NGN0.649million by the end of 2020. Other recurrent cost of policy A including cost of vaccination, cold bag of vaccines, syringes with needles and stipend for vaccinators during training further increase the cost of the program. However, the major cost component of policy A is the electronic and print media campaign cost. This will cover the cost of television and radio campaign and cost of printing flyers, and it is estimated at NGN14million per annum. Capital cost – vehicles for monitoring and other transport cost of the program are estimated at NGN0.287million and NGN0.809million by 2013 respectively and these cost increases to NGN0.287million and NGN1.73million by the end of 2020. In total, the incremental cost of policy A will be NGN16.18million by 2013, and later increase to NGN36.39milion by 2020 (see table 3 for details). For policy B, the administrative, M&E staff and capital (vehicular for monitor) cost will be the same as in policy A, while the cost of Ad-hoc vaccinators will be NGN1.56million by 2013, and a further increase to NGN5.77million by 2020. The house to house campaigner cost is estimated at NGN6.22million (based on average of NGN20, 000 one off payment) per annum. Other cost included in policy B - cost of other ingredient; vaccines, syringes with needles and cost of one day training created additional cost to the program. Therefore, the incremental cost of policy B will be NGN21.93million by 2013, increasing to NGN42.76million by 2020. Therefore, excluding the existing free vaccination program of NGN257 per child, the additional unit cost to be incurred by 2013 as a result of the new policy alternatives will amount to NGN402 per child and NGN467 per child for policy A and B, respectively. This cost will decrease to NGN234 per child and NGN247 per child for policy A and policy B, respectively by 2020. This is as the children vaccination coverage increases in Borno state. Overall, policy A has the least cost, though with lower coverage.

Relative Benefits

As stated earlier two important health benefits – reduction in morbidity and mortality are considered. By the end of 2020, it is projected that additional coverage of 155,662 for policy A or 172,298 for policy B will be achieved. With the prevailing average percentage of incidence (morbidity) to uncovered population as well as percentage of measles mortality to incidence of 1.61% and 1.03% respectively (see Table A2 of appendix for details), it is estimated that 680 morbidity (with policy A) or 755 morbidity (with policy B) will be avoided by 2013 and later increases to 2,506 and 2,785 respectively by 2020. Based on this, measles mortality of 7 (with policy A) and 8 (with policy B) will be averted and these will later increase to 26 and 29 respectively. Clearly, it shows that policy B which has higher children coverage has more benefits (Details in Tables 5, 6 and 7).

) Analysis of Policy A and Policy B

	2013	2014	2015	2016	2017	2018	2019	2020
en (age 9-23 months) in Borno State (X)	435,928	449,878	464,274	479,131	494,463	510,286	526,615	543,467
@ average of 2.9% change in coverage rate (Y)	201,399	220,890	241,423	263,043	285,800	309,743	334,927	361,405
en (X-Y)	234,529	228,988	222,852	216,088	208,663	200,542	191,688	182,061
orbidity)@average of 1.61% of the uncovered children (Z)	3,776	3,687	3,588	3,479	3,359	3,229	3,086	2,931
lortality) @ average of 1.03% of the incidence (Z*)	39	38	37	36	35	33	32	30
stimated Benefits from Policy A								
ed children with Policy A; based of effectiveness (A*)	**42,215**	**82,436**	**110,312**	**136,135**	**150,238**	**153,415**	**155,267**	**155,662**
y A ((X-Y)-A*)	192,314	146,552	112,540	79,953	58,426	47,127	36,421	26,399
er Policy A @ average of 1.61% of the uncovered children (z)	3,096	2,359	1,812	1,287	941	759	586	425
ter Policy A @average of 1.03% of the incidence (z*)	32	24	19	13	10	8	6	4
	680	**1,327**	**1,776**	**2,192**	**2,419**	**2,470**	**2,500**	**2,506**
	7	**14**	**18**	**23**	**25**	**25**	**26**	**26**
stimated Benefits from Policy B								
ed children with Policy B; based on effectiveness (B*)	**46,906**	**91,595**	**122,568**	**151,262**	**166,931**	**170,461**	**172,519**	**172,958**
y B ((X-Y)-B*)	187,624	137,393	100,283	64,826	41,733	30,081	19,169	9,103
er Policy A@ average of 1.60% of the uncovered children (V)	3,021	2,212	1,615	1,044	672	484	309	147
ter Policy A @average of 1.03% of the incidence (V*)	31	23	17	11	7	5	3	2
	755	**1,475**	**1,973**	**2,435**	**2,688**	**2,744**	**2,778**	**2,785**
	8	**15**	**20**	**25**	**28**	**28**	**29**	**29**

Authors

Cost-Effectiveness ratio (CER)

The CERs show that policy A is more economical and beneficial than policy B. Tables 6 and 7 present the total benefits (decrease in morbidity and mortality), the cost of each policy alternative and the CERs for policy A and B, respectively. The associated incremental costs of the policy alternatives are discounted at 3%.

Table 6: Cost-Effectiveness Ratio (CER) of Policy A

Year	Estimated Incremental cost of Policy A (NGN)	Discount Factors @ 3%	Discounted Incremental cost of Policy A (NGN)	Decrease in Morbidity	Decrease in Mortality
2013	16,985,562	1	16,985,562	680	7
2014	23,914,467	0.971	23,217,929	1,327	14
2015	28,662,984	0.943	27,017,611	1,776	18
2016	33,061,960	0.915	30,256,377	2,192	23
2017	35,464,199	0.888	31,509,482	2,419	25
2018	36,005,426	0.863	31,058,597	2,470	25
2019	36,320,952	0.837	30,418,226	2,500	26
2020	36,388,286	0.813	29,587,006	2,506	26
Total	**246,803,837**		**220,050,791**	**15,869**	**163**
			CER (Morbidity)		**13,866**
			CER (Mortality)		**1,346,244**

The results presented in Table 6 shows that by the end of 2020 the incremental benefits (decrease in morbidity and decrease in mortality) as a result of the policy intervention will amount to 15,869 and 163, respectively. That is, with policy A, about 15,869 cases of measles would have been avoided with 163 deaths averted. However, for these achievements to be sustainable, about NGN220.05million will be required by the end of 2020. Combining both cost and effectiveness shows that, policy A has a CER of NGN13, 866 in terms of morbidity and about NGN1.3million for mortality. This implies that, by the end of 2020, it will cost Borno state government NGN13, 866 for a unit of morbidity avoided and NGN1.3Million for the death averted with the introduction of policy A.

Table 7: Cost-Effectiveness Ratio (CER) of Policy B

Year	Estimated Incremental cost of Policy A (NGN)	Discount Factors @ 3%	Discounted Incremental cost of Policy A (NGN)	Decrease in Morbidity	Decrease in Mortality
2013	21,928,197	1	21,928,197	755	8
2014	29,315,237	0.971	28,461,395	1,475	15
2015	34,435,039	0.943	32,458,327	1,973	20
2016	39,177,972	0.915	35,853,394	2,435	25
2017	41,768,042	0.888	37,110,364	2,688	28
2018	42,351,587	0.863	36,532,851	2,744	28
2019	42,691,784	0.837	35,753,697	2,778	29
2020	42,764,383	0.813	34,771,356	2,785	29
Total	**294,432,241**		**262,869,582**	**17,633**	**182**
			CER (Morbidity)		**14,908**
			CER (Mortality)		**1,447,384**

The result presented in Table 7 shows that the total health benefits (decrease in morbidity and decrease in mortality) of the additional children immunization coverage are 17,633 and 182, respectively. On the other hand, the total present cost of the associated intervention (policy B) is NGN294.43million. Discounting this value at 3%, we get NGN262.87million. Combining both cost and effectiveness shows that, policy B has a CER of NGN14, 908 in terms of morbidity and NGN1.4million for mortality. This implies that, by the end of 2020, it will cost Borno state government about NGN14, 908 for a unit of morbidity avoided and about NGN1.4million for the death averted with the introduction of policy B. Considering the cost of treating measles (CTM) as well as the value of statistical life (VSL), policy A and B are both beneficial, with moderate CERs[3]. However, it is worth nothing that policy B costs more than policy A because it guarantees more measles vaccination coverage than policy A. That said, when we combine both costs and effectiveness, we find that policy A has lower CER and is preferred to policy B.

[3] Several studies have estimated cost of treating measles as well as VSL. On the average, cost of treating measles is estimated at $276 = NGN41,400 and the average value of statistical life is estimated at NGN6.154million. For example see Carbin *et al.* (2002) and ICF International (2009).

Sensitivity Analysis

This subsection presents the results of the sensitivity analysis. The analysis focuses on the adjustment of the cost and the probable effectiveness (coverage) and it indicates how effective or cheap policy B would have to be to encourage more children vaccination coverage and become preferable to policy A. This exercise entails re-estimating the CERs of both policies by either increasing or reducing the values of the parameters. The results are presented in Table 8. The analysis is conducted for the following variations:

1. Sensitivity of policy A to a decrease in the probable effectiveness (coverage) value and/or sensitivity of policy B to an increase in the probable effectiveness (coverage) value
2. Sensitivity of policy A to an increase in total cost and/or sensitivity of policy B to decrease in total cost
3. Sensitivity of Policy A to a decrease in the probable effectiveness (coverage) value and an increase in total cost and/or sensitivity of policy B to an increase in probable effectiveness (coverage) value and a decrease in total cost.

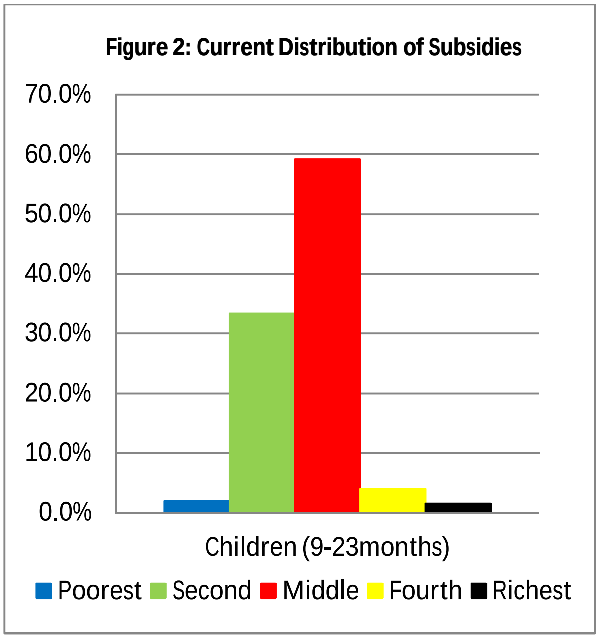
The findings of the sensitivity analysis remained robust despite substantially varying individual parameters and assumptions. What this means is that policy A has to become much worse for policy B to be preferred. In terms of changes in the probable effectiveness, the results favour the implementation of policy A, 10% increase in effectiveness value of policy B (I.e. to achieve over 100% of what policy A is able to achieve in terms of coverage) will give a CER either in terms of morbidity or mortality that is close to what policy A achieved. However, taking changes in cost and effectiveness together slightly favours the implementation of policy B. This implies that with a 10% increase in effectiveness of policy B and 10% decrease in total cost, policy B is preferred to policy A.

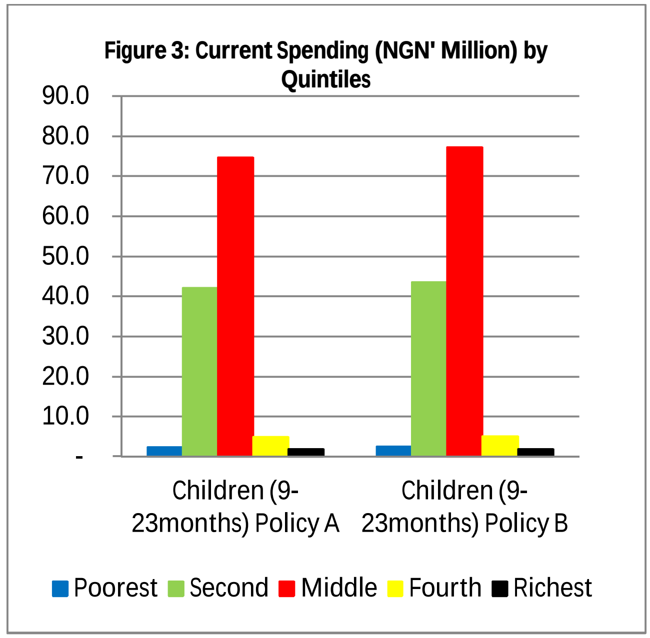
Table 8*: One-way and Multi-way Sensitivity Analysis: 1, 2 & 3*

SENSITIVITY ANALYSIS						
	Policy A			**Policy B**		
	Sensitivity on effectiveness					
	Decrease in effectiveness			**Increase in effectiveness**		
	Base case	5%	10%	Base case	5%	10%
Additional children Vaccination coverage	985,680	930,920	876,160	1,095,200	1,149,960	1,204,720
Decrease in morbidity	15,869	14,988	14,106	17,633	18,514	19396
Decrease in mortality	163	154	145	182	191	200
Cost of program (NGN)	220,050,791	211,791,143	203,531,496	262,869,582	270,888,686	278,907,790
CERs (morbidity)	13,866	14,131	14,429	14,908	14,631	14,380
CERs (mortality)	1,346,244	1,371,931	1,400,829	1,447,384	1,420,512	1,396,084
	Sensitivity on the cost of programs					
	Increase in cost of program			**Decrease in cost of program**		
	Base case	5%	10%	Base case	5%	10%
Additional children vaccination coverage	985,680	985,680	985,680	1,095,200	1,095,200	1,095,200
Decrease in morbidity	15,869	15,869	15,869	17,633	17,633	17,633
Decrease in mortality	163	163	163	182	182	182
Cost of program (NGN)	220,050,791	231,053,331	242,055,870	262,869,582	249,726,103	236,582,624
CERs (morbidity)	13,866	14,560	15,253	14,908	14,162	13,417
CERs (mortality)	1,346,244	1,417,505	1,485,005	1,447,384	1,372,121	1,299,905
	Sensitivity on effectiveness and cost of programs					
	Decrease in effectiveness and increase in cost of program			**Increase in effectiveness and decrease in cost of program**		
	Base case	5% & 5%	10% & 10%	Base case	5% & 5%	10% & 10%
Additional children vaccination coverage	985,680	930,920	876,160	1,095,200	1,149,960	1,204,720
Decrease in morbidity	15,869	14,988	14,106	17,633	18,514	19396
Decrease in mortality	163	154	145	182	191	200
Cost of program (NGN)	220,050,791	222,380,700	223,884,646	262,869,582	257,344,252	251,017,011
CERs(morbidity)	13,866	14,837.25	15,871.59	14,908	13,899.98	12,941.69
CERs (mortality)	1,346,244	1,444,031	1,544,032	1,447,384	1,347,352	1,255,085

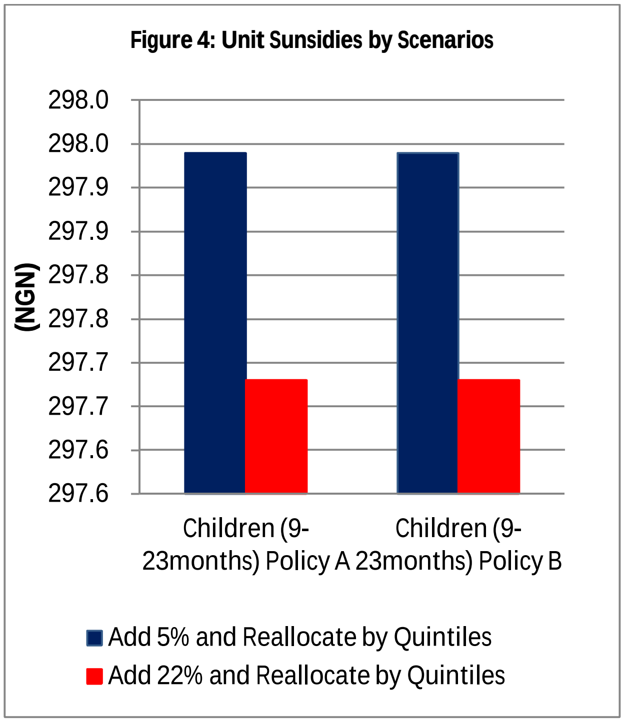
Equity – Distribution

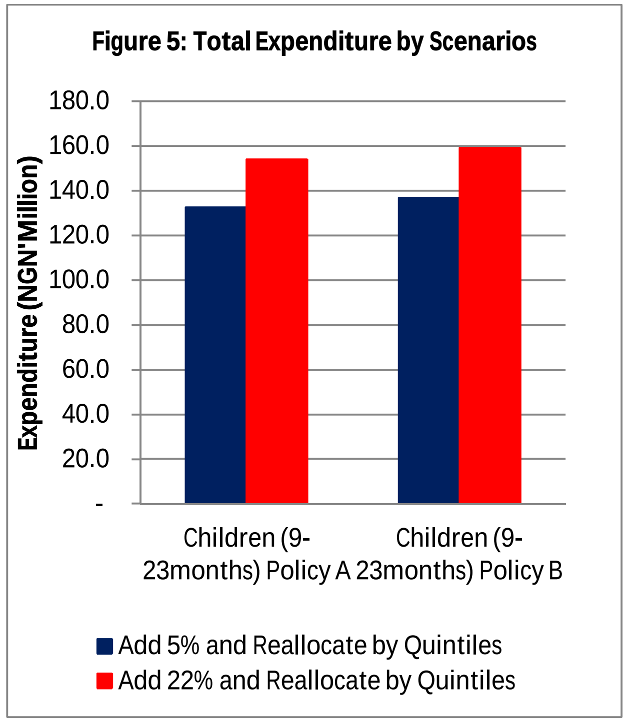
This study follows the DHS (2010) and Nigeria poverty profile (2010) to categorize measles immunization coverage of children age 9-23months in Borno State on five (5) income quintiles – from the poorest to the richest. The arrangement shows that 1.9% of the children vaccination coverage is from the poorest households while 1.49% is from the richest households. The middle income group has the highest children vaccination coverage of about 59.22%, while the second richest and poorest households have 3.96% and 33.40%, respectively. This distribution is a reflection of income profile and the allocation of the existing aggregate subsidy of each quintile in Borno state. Additional details are presented in Table A4 in the appendix. However, with the existing policy (free measles immunization) unit subsidy to the beneficiaries is an average of NGN244.00

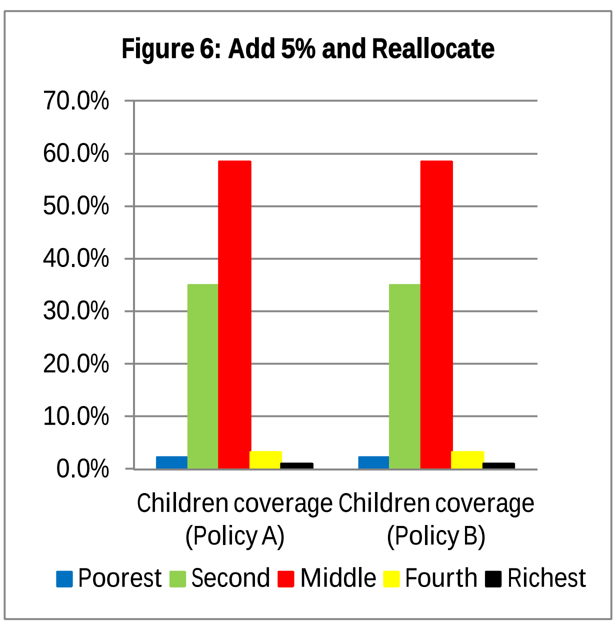


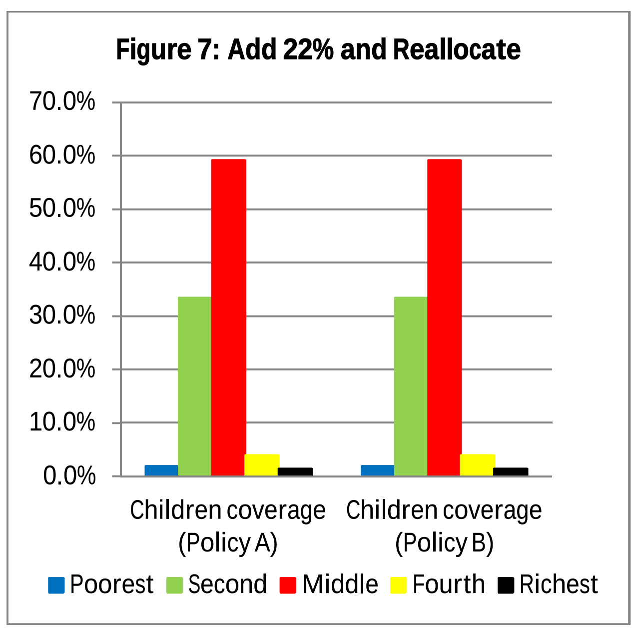


Figures 2 and 3, and Table A5 in the appendix, presents the current percentage and spending distribution of the five income quintiles of the measles immunization coverage. In this case, of the 517,068 and 534,364 total immunization coverage to be achieved in Borno State by 2020 with policy A and B, respectively, 9,944 (due to policy A) and 10,277 (due to policy B) will come from the poorest households, while the middle income quintiles has the highest coverage of 306,215 and 316,457 with policy A and B respectively (see Table A6 in the appendix for details). Turning to the funding scenarios, this study earlier proposed two additional funding scenarios- to add 5% or 22% to the existing funds and redistribute the unit subsidy for the beneficiaries such that it is more pro-poor and encourage more children measles immunization coverage from the poorest households. For the first scenario, to add 5% with reallocation, this study ensures that the poorest households get 100% subsidy, the second poorest get 90%, while the richest get 60%. Unit subsidy for policy A and B now stand at NGN297.94, while the new percentage distributions of benefits stand at 2.2% (poorest), 35.0% (second poorest), 58.5% (middle income), 3.2% (second richest) and 1.0% (richest) see figures 4 and 6.

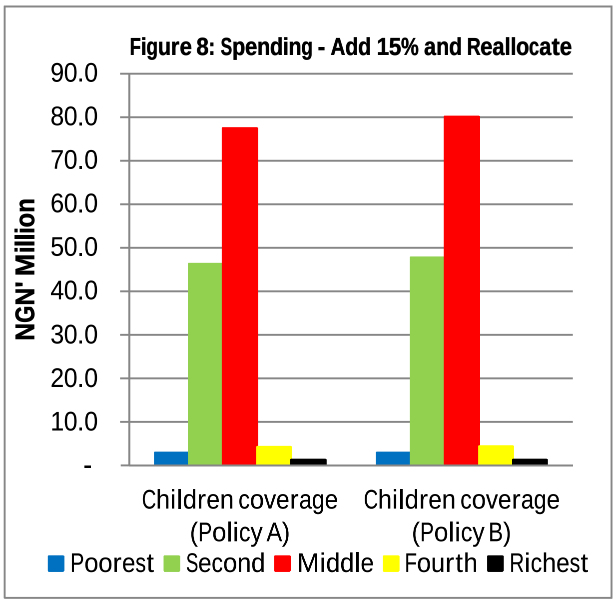


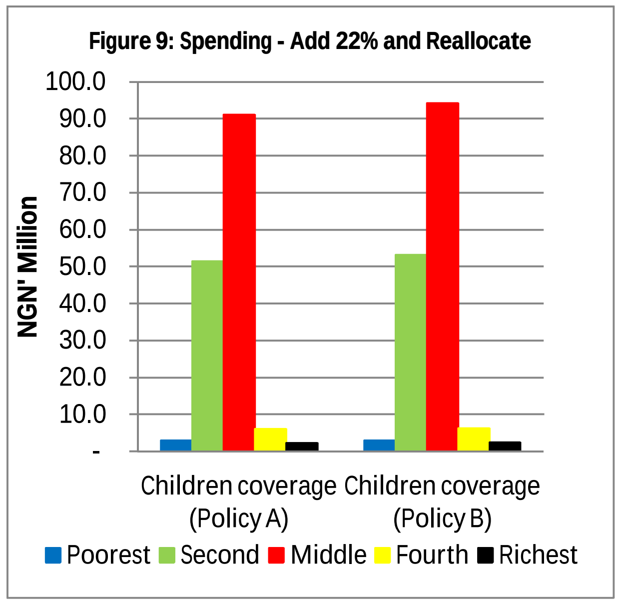






In the second scenario which is to add 22% with the reallocation, the study ensures that no group is made worse off in the distribution of the total subsidy. Every group had a full subsidy benefits i.e. the poorest, second poorest up to the richest will receive 100% subsidy benefits (see details in Table 1F in the Appendix). This then leaves the new unit subsidy for policies A and B at NGN297.68, with the new percentage distribution of benefits amounting to 1.9% (poorest), 33.4% (second poorest) and 1.5% for the richest. These results are given in figures 3 and 7.





However, figures 8 and 9 present the financial implication for both policies A and B. It shows that the additional funding will increase absolute spending on various groups, except for the richest and the second richest groups where spending slightly decreases in the first scenario (add 5% new funds) and this is based on the assumption that with the new unit subsidy, the rich households will still have the financial capacity to immunize their children against measles such that overall children immunization coverage target is achieved by 2020. In the second scenario (add 22% new funds) all the various groups experience increase in absolute spending.

The final aspect of this policy simulation exercise is the analysis of how the cost of each alternative is covered, and the results are clearly presented in Tables 9 and 10. For the first funding scenario (add 5% new funds), the reallocated funds will be NGN132.47million for policy A and NGN136.90million for policy B by 2020. The new funding requirement will be NGN6.31million for policy A and NGN6.52million for policy B. In the case of the second funding scenario (add 22% new funds), the reallocated funds will be NGN153.92million for policy A and NGN159.07million for policy B by 2020. Similarly, the new funding requirement will be NGN27.76million for policy A and NGN28.68 for policy B. In addition, this exercise suggests how government can sequence the payment for the program. The sequencing of payment is meant to reflect the gradual increment in measles vaccination coverage. In case of the first funding scenario, lesser amount (-6%) for policy A or (-7%) for policy B of additional payment is required by 2013 while the 5% (policy A and B) increment will be required by 2020. For the second funding scenario, lesser amount (-2%) for policy A or (-3%) for policy B additional payment is required by 2013 while the 22% (policy A and B) increment will be incurred by 2020. In general, for the first funding scenario, about 197% (policy A) and 207% (policy B) increment of what the government spent on measles vaccination in 2012 would have been spent by 2020, while about 245% (policy A) and 256% (policy B) would have been payed for by 2020 in case of the second scenario (see Table 9 and 10 again for details).

Table 9: Gradual Payment of Funding Scenario (Add 5% New Fund and Redistribute)

5% Increment									
	NGN' Million	NGN' Million	NGN' Million	NGN' Million	NGN' Million	NGN' Million	NGN' Million	NGN' Million	NGN' Million
	2012	2013	2014	2015	2016	2017	2018	2019	2020
Total Expenditure (with existing policy)	44.63	59.44	74.01	85.82	97.40	106.39	113.01	119.61	126.16
Yearly Growth in Expenditures (Existing Policy)		14.81	14.57	11.81	11.58	8.99	6.61	6.60	6.56
Percentage Change in Expenditure		33.2%	24.5%	16.0%	13.5%	9.2%	6.2%	5.8%	5.5%
Total Percentage Change	0.0%	33.2%	65.8%	92.3%	118.2%	138.4%	153.2%	168.0%	182.7%
Expenditures (with Policy A)	44.63	55.61	66.59	77.57	88.55	99.53	110.51	121.49	132.47
Yearly Growth in Expenditure		10.98	10.98	10.98	10.98	10.98	10.98	10.98	10.98
Percentage Change in Expenditure		25%	20%	16%	14%	12%	11%	10%	9%
Total Percentage Change	0%	25%	49%	74%	98%	123%	148%	172%	197%
Percentage change as a result of Policy A	**0%**	**-6%**	**-10%**	**-10%**	**-9%**	**-6%**	**-2%**	**2%**	**5%**
Total Expenditure (with existing policy)	44.63	60.59	76.25	88.81	101.09	110.45	117.17	123.82	130.38
Yearly Growth in Expenditures (Existing Policy)		15.96	15.66	12.57	12.28	9.38	6.70	6.65	6.57
Percentage Change in Expenditure		35.8%	25.8%	16.5%	13.8%	9.3%	6.1%	5.7%	5.3%
Total Percentage Change	0%	36%	71%	99%	127%	148%	163%	177%	192%
Expenditures (with Policy B)	44.63	56.16	67.70	79.23	90.77	102.30	113.84	125.37	136.90
Yearly Growth in Expenditure		11.53	11.53	11.53	11.53	11.53	11.53	11.53	11.53
Percentage Change in Expenditures		26%	21%	17%	15%	13%	11%	10%	9%
Total Percentage Change (wit Policy B_	0%	26%	52%	78%	103%	129%	155%	181%	207%
Actual Percentage with Complementary Policy B	**0%**	**-7%**	**-11%**	**-11%**	**-10%**	**-7%**	**-3%**	**1%**	**5%**
Borno State GDP	367,308.01	395,223.42	425,260.40	457,580.20	492,356.29	529,775.37	570,038.30	613,361.20	659,976.66
GDP Growth Rate	7.6%								
% GDP to Government Expenditure	29.5%								
Government Spending	108,355.86	116,590.91	125,451.82	134,986.16	145,245.10	156,283.73	168,161.30	180,941.56	194,693.11
Increase in Government Spending		8,235.04	8,860.91	9,534.33	10,258.94	11,038.63	11,877.56	12,780.26	13,751.56
Notes									
Health in GDP	2.70%								
Borno State Health Spending	9,917.32								
Borno State GDP 2010	317,050.98								

Source: Computed by Authors

Table 10: Gradual Payment of Funding Scenario (Add 22% New Fund and Redistribute)

22% Increment									
	NGN' Million	NGN' Million	NGN' Million	NGN' Million	NGN' Million	NGN' Million	NGN' Million	NGN' Million	NGN' Million
	2012	2013	2014	2015	2016	2017	2018	2019	2020
Total Expenditure (with existing policy)	44.63	59.44	74.01	85.82	97.40	106.39	113.01	119.61	126.16
Yearly Growth in Expenditures (Existing Policy)		14.81	14.57	11.81	11.58	8.99	6.61	6.60	6.56
Percentage Change in Expenditure		33.2%	24.5%	16.0%	13.5%	9.2%	6.2%	5.8%	5.5%
Total Percentage Change	0.0%	33.2%	65.8%	92.3%	118.2%	138.4%	153.2%	168.0%	182.7%
Expenditures (with Policy A)	44.63	58.29	71.95	85.61	99.27	112.94	126.60	140.26	153.92
Yearly Growth in Expenditure		13.66	13.66	13.66	13.66	13.66	13.66	13.66	13.66
Percentage Change in Expenditure		31%	23%	19%	16%	14%	12%	11%	10%
Total Percentage Change	0%	31%	61%	92%	122%	153%	184%	214%	245%
Percentage change as a result of Policy A	**0%**	**-2%**	**-3%**	**0%**	**2%**	**6%**	**12%**	**17%**	**22%**
Total Expenditure (with existing policy)	44.63	60.59	76.25	88.81	101.09	110.45	117.17	123.82	130.38
Yearly Growth in Expenditures (Existing Policy)		15.96	15.66	12.57	12.28	9.38	6.70	6.65	6.57
Percentage Change in Expenditure		35.8%	25.8%	16.5%	13.8%	9.3%	6.1%	5.7%	5.3%
Total Percentage Change	0%	36%	71%	99%	127%	148%	163%	177%	192%
Expenditures (with Policy B)	44.63	58.93	73.24	87.54	101.85	116.15	130.50	144.76	159.07
Yearly Growth in Expenditure		14.31	14.31	14.31	14.31	14.31	14.31	14.31	14.31
Percentage Change in Expenditures		32%	24%	20%	16%	14%	12%	11%	10%
Total Percentage Change (wit Policy B)	0%	32%	64%	96%	128%	160%	192%	224%	256%
Actual Percentage with Complementary Policy B	**0%**	**-3%**	**-4%**	**-1%**	**1%**	**5%**	**11%**	**17%**	**22%**
Borno State GDP	367,308.01	395,223.42	425,260.40	457,580.20	492,356.29	529,775.37	570,038.30	613,361.20	659,976.66
GDP Growth Rate	7.6%								
% GDP to Government Expenditure	29.5%								
Government Spending	108,355.86	116,590.91	125,451.82	134,986.16	145,245.10	156,283.73	168,161.30	180,941.56	194,693.11
Increase in Government Spending		8,235.04	8,860.91	9,534.33	10,258.94	11,038.63	11,877.56	12,780.26	13,751.56
Notes									
Health in GDP	2.70%								
Borno State Health Spending	9,917.32								
Borno State GDP 2010	317,050.98								

Source: Computed by Authors

7 CONCLUSION

This study conducted a simulation exercise for two (2) measles immunization policy alternatives. The policy goal is to achieve at least 95% measles immunization coverage of children age 9-23month not immunized in Borno State, Nigeria. The results of the cost analysis show that policy A has a lower cost per child and lower immunization coverage, while policy B is more effective in terms of the number of additional coverage and health benefits (morbidity avoided and mortality averted) to the beneficiaries. For both polices, the values of the cost-effectiveness ratios with respect to morbidity avoided and mortality averted are lower than the cost of treating measles and value of statistical life respectively, suggesting that both policies can be implemented. However, policy A is more beneficial and efficient since it has a lower cost-effectiveness ratio.

Subsequently and for each policy, the study analyzed two possible funding scenarios and how each policy can be gradually financed. The study further addressed equity issues in the distribution of benefits across the different income groups. For each payment option considered, subsidies were redistributed in favour of the poorest quintile. Overall, the results suggest that policy A is the best alternative to achieve the proposed policy goal. Conclusively, the findings provide relevant answers to all the research questions stated in the earlier part of this report.

8 POLICY RECOMMENDATION

There are several important policy recommendations emerging from this policy simulation analysis, including:

- If Borno state government and in general, the national government are to achieve the objective of increasing measles immunization coverage of children aged 9-23months not yet covered, it may need to introduce a complementary policy of house-to-house vaccination campaign and sensitization to the existing free measles vaccination. More so, this policy should target the rural areas characterized with high level of illiteracy, uneven distribution of government hospitals, poor electronic and print media coverage which often discourage or keep parents out of touch with the next vaccination date.
- It is reasonable and efficient for government to also consider the need to introduce a complementary policy of regular electronic and print media vaccination campaign and sensitization to the existing free measles vaccination policy in the urban centres characterized with a reasonable distribution and accessibility of government hospitals, organized electronic and print media coverage and high level of literacy. These factors enhance the process of keeping parents updated on the next vaccination date and other government health programs.
- In case of the semi urban areas with moderate literacy and electronic and media coverage, the best option will be for the government to implement both policies as complements. Nonetheless, this will depend on resource availability.
- In addition, since the extra funds required substantially increasing measles vaccination coverage and taking care of all income quintiles is not much, the second funding scenario – which is to add 22% new funds is recommended. This policy is likely to gain adequate support from all stakeholders since no particular group is worse off.

- Finally, there is need to put in place a good monitoring and evaluation system. This way, it will be easy to see whether the policies are being adequately implemented and if there are improvements in the measles vaccination coverage that can be associated with such policies.

9 CHALLENGES TO CONDUCTING THIS WORK

The major challenges faced in conducting this policy simulation analysis are insufficient access to the required data and lack of effectiveness measure. Data on the total cost of existing intervention (free measles immunization) and impact of the program were not available. Nonetheless, this study generates some of the data through several computations, using relevant literature as well as using average market estimates. For example, for the relative effectiveness measure, the values are generated from similar programs discussed in the literature review.

10 PLAN FOR DISSEMINATION

The findings of this policy simulation will be disseminated using various tools, including:

- Media: Press conferences, press releases, policy briefs as well as newspaper publications will be used to reach out to potential stakeholders and policy makers.
- Collaboration and sharing research findings with Civil Society Groups, Community Based organizations, academics, economists and researchers working on similar project.
- Interactive communication: seminars, workshops and conferences will be conducted with various representatives of civil society organizations, non-governmental organizations, policy makers and stakeholders to share result of the findings.

- Website: the final report will be placed on CSEA's website to create awareness and inform different audiences of the findings and policy recommendations.

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APPENDIX

Table A 1: Cost Items of the Two Policy Options

Policy A	Policy B
Recurrent Items:	**Recurrent Items:**
Cost of Vaccines	Cost of Vaccines
Cost of print and electronic media campaign	Cost of Ad-hoc campaigner (house-to-house)
Program M&E personnel cost	Program M&E personnel cost
Program Administrative staff cost	Program Administrative staff cost
Cost of Ad Hoc vaccinator	Cost of Ad-hoc vaccinator
Cost of trainers (Nurses) team	Cost of trainers (Nurses) team
Transport cost	Transport cost
Logistics; syringes with needles, cold bags for vaccines	Logistics; syringes with needles and cold bags for vaccines
Capital Cost:	**Capital Cost:**
Vehicular; motorcycle	Vehicular; motorcycle

Table A 2: Percentage Morbidity and Mortality

Year	Population of children (0-2 years)	coverage as % of population	Uncovered children	Incidence from uncovered	Incidence as % of Uncovered	Death from Incidence	Death as % of Incidence
1990	7,791,601	54%	3,584,136	115,682	3.23%	1,399	1.21%
1991	8,032,578	57%	3,454,009	44,026	1.27%	388	0.88%
1992	8,273,555	43%	4,715,926	85,965	1.82%	1,032	1.20%
1993	8,521,762	40%	5,113,057	54,734	1.07%	373	0.68%
1994	8,777,415	41%	5,178,675	106,084	2.05%	695	0.66%
1995	9,040,737	44%	5,062,813	49,880	0.99%	671	1.35%
1996	9,311,959	38%	5,773,415	102,166	1.77%	2,031	1.99%
1997	9,591,318	38%	5,946,617	73,677	1.24%	147	0.20%
1998	9,879,058	40%	5,927,435	104,069	1.76%	1,804	1.73%
1999	10,175,429	35%	6,614,029	217,159	3.28%	749	0.34%
2000	10,480,692	33%	7,022,064	110,242	1.57%	269	0.24%
2001	10,795,113	32%	7,340,677	169,001	2.30%	2,294	1.36%
2002	11,118,966	30%	7,783,276	87,941	1.13%	811	0.92%
2003	11,452,535	34%	7,558,673	141,633	1.87%	2,929	2.07%
2004	11,796,111	37%	7,431,550	82,227	1.11%	204	0.25%
2005	12,149,995	41%	7,168,497	149,561	2.09%	648	0.43%
2006	12,646,287	44%	7,081,921	18,669	0.26%	225	1.21%
2007	13,025,676	41%	7,685,149	12,925	0.17%	230	1.78%
Average					**1.61%**		**1.03%**

Source: WHO and Adu (2008)

Table A 3: Average cost of Measles immunization in Borno State (2013-2020) pre - program

	2013	2014	2015	2016	2017	2018	2019	2020
A. Projection of children (age 9 – 23 months) in Borno state	**435,928**	**449,878**	**464,274**	**479,131**	**494,46**	**510,286**	**526,615**	**543,467**
B. Projection of children (age 9 - 23 months) immunised	**201,399**	**220,890**	**241,423**	**263,043**	**285,800**	**309,744**	**334,927**	**361,405**
Gross coverage ratio	46.2	49.1	52	54.9	57.8	60.7	63.6	66.5
Need in administrator								
Number of wards	311	311	311	311	311	311	311	311
Admin Staff @ 2 per ward	622	622	622	622	622	622	622	622
COST IMPLICATIONS	**NGN'000**	**NGN'000**	**NGN'000**	**NGN'000**	**NGN'000**	**NGN'000**	**NGN'000**	**NGN'000**
Recurrent Cost	**49,229.1**	**51,585.6**	**54,068.0**	**56,681.9**	**59,433.2**	**62,328.0**	**65,372,689**	**68,573.9**
wages of admin staff (@ 40,000 per staff)	24,880.0	24,880.0	24,880.0	24,880.0	24,880.0	24,880.0	24,880.0	24,880.0
Cost of Vaccine	24,0367.0	26,363.2	28,813.8	31,394.2	34,110.2	36,967.9	39,973.6	43,133.7
Cost of syringes with needles @0.01$ per pack	312.2	342.3	374.2	407.7	443.0	480.1	519.1	560.2
Capital Cost	**1,071.8**	**1,071.8**	**1,071.8**	**1,071.8**	**1,071.8**	**1,071.8**	**1,071.8**	**1,071.8**
One (1) cold chain storage @N6,900,000 (dep. @0% salvage value)	862.5	862.0	862.0	862.0	862.5	862.0	862.0	862.0
27 Ice refrigerators @ $400 per one (dep. at 0% salvage value)	209.2	209.3	209.3	209.3	209.2	209.3	209.3	209.3
Total (Recurrent and Capital) COST	**50,300.9**	**52,657.4**	**55,139.7**	**57,753.6**	**60,504.9**	**63,399.7**	**66,444.4**	**69,645.7**
Transport Cost (@ 3% of total cost)	1,509.0	1,579.7	1,654.2	1,732.6	1,815.1	1,902.0	1,993.3	2,089.4
Grand Total	**51,809.9**	**54,237.1**	**56,793.9**	**59,486.2**	**62,320.1**	**65,301.7**	**68,437.8**	**71,735.0**
Unit Cost of Vaccination without program (NGN)	**257**	**246**	**235**	**226**	**218**	**211**	**204**	**198**

NB:
exchange rate : 1$= N155
Cost of Vaccines per dose is US$0.77
Cost of syringes with needles and other accessories is US0.01 per pack

Source: Computed by Authors

Table A 4: Estimated Children Vaccination (Measles) Coverage by Quintiles (Expenditure)

Estimated Measles Vaccination Coverage by Quintiles (Expenditure)						
Wealth Index	**poorest**	**second**	**middle**	**fourth**	**Richest**	
	1	2	3	4	5	Total
Population (9-23months) Wealth Index (%)	3.90%	41.70%	51.30%	2.40%	0.70%	100%
2010 Population (9-34months)	409,313					
Absolute Population (9-23months) Index	15,963	170,684	209,978	9,824	2,865	409,313
Vaccination Coverage as % of Wealth Index						
(9-23month) Coverage Index	17.30%	28.10%	40.50%	57.90%	74.90%	
Absolute Coverage Index	2,762	47,962	85,041	5,688	2,146	143,598
Distribution of Coverage Index as % Total Coverage						
	Poorest	**Second**	**Middle**	**Fourth**	**Richest**	
	1	2	3	4	5	Total
	1.92%	33.40%	59.22%	3.96%	1.49%	100%
2020						
Estimated (Projected) Measles Vaccination Coverage by Quintiles (Expenditure)						
Total (Projected) coverage policy A	517,068					
Total (Projected) coverage policy B	534,364					
Coverage Wealth Index	**Poorest**	**Second**	**Middle**	**Fourth**	**Richest**	
	1	**2**	**3**	**4**	**5**	**Total**
Children coverage (Policy A)	9,944	172,701	306,215	20,481	7,727	517,068
Children coverage (Policy B)	10,277	178,478	316,457	21,166	7,986	534,364

Source: Computed by Authors

Table A 5: Equity Distribution of Benefits (Scenario 1) across the Quintiles (Expenditure Group)

Current Situation (Free Measles Vaccination)							
Average Unit Cost(Vaccination)	**244.00**						
Projected Children (9-23months) Vaccination Coverage Based on Policy A or Policy B							
	Poorest	**Second**	**Middle**	**Fourth**	**Richest**	**Total**	
Children coverage (Policy A)	9,944	172,701	306,215	20,481	7,727	517,068	
Children coverage (Policy B)	10,277	178,478	316,457	21,166	7,986	534,364	
Total Cost	**Poorest**	**Second**	**Middle**	**Fourth**	**Richest**	**Total**	**Add New Funds (5%)**
	NGN'000	**NGN'000**	**NGN'000**	**NGN'000**	**NGN'000**	**NGN'000**	**NGN'000**
Children coverage (Policy A)	2,426.4	42,139.1	74,716.3	4,997.3	1,885.5	126,164.6	132,472.8
Children coverage (Policy B)	2,507.5	43,548.7	77,215.6	5,164.4	1,948.6	130,384.8	136,904.1
Distribution of Benefits	**Poorest**	**Second**	**Middle**	**Fourth**	**Richest**		
Children coverage (Policy A)	1.9%	33.4%	59.2%	4.0%	1.5%	100.0%	
Children coverage (Policy B)	1.9%	33.4%	59.2%	4.0%	1.5%	100.0%	
Reallocate	**100% subsidy to Q1; 90% subsidy to Q2; 85% subsidy to Q3 and lower subsidies to the two richer quintiles**						
Children Coverage	**Poorest**	**Second**	**Middle**	**Fourth**	**Richest**		
Quintiles	1	2	3	4	5	Total	
Subsidy	1.00	0.90	0.85	0.70	0.60		
Weight of Quintiles (Policy A)	9,944	155,431	260,282	14,336	4,636	444,631	
Weight of Quintiles (Policy B)	10,277	160,630	268,989	14,816	4,792	459,503	
Unit Subsidy (Policy A) **NGN**	**297.94**						
Unit Subsidy (Policy B) **NGN**	**297.94**						
Total Cost	**Poorest**	**Second**	**Middle**	**Fourth**	**Richest**	**Total**	
	NGN'000	**NGN'000**	**NGN'000**	**NGN'000**	**NGN'000**	**NGN'000**	
Children coverage (Policy A)	2,962.7	46,309.0	77,548.3	4,271.4	1,381.4	132,472.8	
Children coverage (Policy B)	3,061.8	47,858.1	80,142.3	4,414.3	1,427.6	136,904.1	
Distribution of Benefits (%)	**Poorest**	**Second**	**Middle**	**Fourth**	**Richest**		
Children coverage (Policy A)	2.2%	35.0%	58.5%	3.2%	1.0%	100.0%	
Children coverage (Policy B)	2.2%	35.0%	58.5%	3.2%	1.0%	100.0%	

Source: Computed by Authors

Table A 6: Equity Distribution of Benefits (Scenario 2) across the Quintiles (Expenditure Group)

Current Situation (Free Measles Vaccination)							
Average Unit Cost(Vaccination)	**244.00**						
Projected Children (9-23months) Vaccination Coverage Based on Policy A or Policy B							
	Poorest	**Second**	**Middle**	**Fourth**	**Richest**	**Total**	
Children coverage (Policy A)	9,944	172,701	306,215	20,481	7,727	517,068	
Children coverage (Policy B)	10,277	178,478	316,457	21,166	7,986	534,364	
Total Cost	**Poorest**	**Second**	**Middle**	**Fourth**	**Richest**	**Total**	**Add New Funds (22%)**
	NGN'000	**NGN'000**	**NGN'000**	**NGN'000**	**NGN'000**	**NGN'000**	**NGN'000**
Children coverage (Policy A)	2,426.4	42,139.1	74,716.3	4,997.3	1,885.5	126,164.6	153,920.8
Children coverage (Policy B)	2,507.5	43,548.7	77,215.6	5,164.4	1,948.6	130,384.8	159,069.5
Distribution of Benefits	**Poorest**	**Second**	**Middle**	**Fourth**	**Richest**		
Children coverage (Policy A)	1.9%	33.4%	59.2%	4.0%	1.5%	100.0%	
Children coverage (Policy B)	1.9%	33.4%	59.2%	4.0%	1.5%	100.0%	
Reallocate	**Poor and Rich Quintile Benefits 100% subsidies**						
Children Coverage	**Poorest**	**Second**	**Middle**	**Fourth**	**Richest**		
Quintiles	1	2	3	4	5	Total	
Subsidy	1.00	1.00	1.00	1.00	1.00		
Weight of Quintiles (Policy A)	9,944	172,701	306,215	20,481	7,727	517,068	
Weight of Quintiles (Policy B)	10,277	178,478	316,457	21,166	7,986	534,364	
Unit Subsidy (Policy A) **NGN**	**297.68**						
Unit Subsidy (Policy B) **NGN**	**297.68**						
Total Cost	**Poorest**	**Second**	**Middle**	**Fourth**	**Richest**	**Total**	
	NGN'000	**NGN'000**	**NGN'000**	**NGN'000**	**NGN'000**	**NGN'000**	
Children coverage (Policy A)	2,962.7	51,409.7	91,153.9	6,096.7	2,300.3	153,920.8	
Children coverage (Policy B)	3,061.8	53,129.4	94,203.1	6,300.6	2,377.2	159,069.5	
Distribution of Benefits (%)	**Poorest**	**Second**	**Middle**	**Fourth**	**Richest**		
Children coverage (Policy A)	1.9%	33.4%	59.2%	4.0%	1.5%	100.0%	
Children coverage (Policy B)	1.9%	33.4%	59.2%	4.0%	1.5%	100.0%	

Source: Computed by Authors