Nigerian Society of Chemical Engineers Proceedings, 29, 105-116

HEALTH EFFECTS OF OIL POLLUTION IN NIGERIA: AN ECONOMETRIC EXAMINATION

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ABSTRACT

The future of Nigeria has been inextricably linked to the exploitation and exploration of crude petroleum. This development has led to massive pollution of the oil producing areas. The implication of such development on the health of the people in the oil producing areas in Nigeria is far reaching. However, most commentators on the issue have essentially limited their analysis most of the time to economic losses. Admittedly, economic losses exist, but a more dangerous hazard in the area has to do with the health of the citizenry. This paper developed and utilized an econometric model to assess health effect of oil pollution in Nigeria from 1970-1997. The empirical results indicated that the health effect of oil pollution in the oil producing areas was exacerbated by the economic reforms of the 1980s. The paper concluded that for sustainable development to occur in Nigeria, the health impact assessment of the oil producing areas is a necessary condition that must be fulfilled.

INTRODUCTION

In the quest for industrialization and greater economic achievement, many developing countries, including Nigeria have interfered with the environment to the extent that it resulted in environmental degradation and destruction, which have attendant health effects. In Nigeria, the exploration and exploitation of crude petroleum in the oil producing areas have had several adverse impact on the health status of the oil producing communities.

Human welfare is reduced by ill health and premature mortality caused by degradation of air and water quality as well as other environmental risks. Pollutants can cause health problems through direct exposure or indirectly through changes in the physical

* Expressed views are those of the author and do not necessarily reflect the official position of the Central Bank of Nigeria

environment, the effect of which ranges from increased solar radiation to lower nutrition. The links between pollutants and health have been identified through epidemiological studies undertaken primarily in high income countries. The effects are expected to be more severe in lower income countries where people are less healthy and less well nourished.

Impaired health may lower human productivity and environmental degradation reduces the productivity of many resources used directly by people. Water pollution damages fisheries and water logging and salinization of the soil lowers crop yields.

Radical and simultaneous economic reforms were a common feature of many low income countries in Africa, Asia and Latin America for most of the 1980s and early 1990s. The reforms were a response to sharply deteriorating economic conditions in those countries following a period of oil crisis and heavy external indebtedness in the 1970s. The reforms themselves had a common feature, they were market oriented or market friendly in that they relied on the price mechanism as the principal instrument for reviving economic. Further, due to the influence of the brettonwood institutions, the reforms were referred to and continue to be commonly known as structural adjustment programmes because they aimed at first stabilizing a crisis ridden economic and the changing or adjusting its structure of incentives and production in a manner that would reorient it toward a sustainable growth path (Williamson 1990,1994).

The structural change requirement - aimed at efficiency enhancements - was achieved by privatization of public enterprises, by the restructuring of government expenditure and by liberalization of service and commodity markets. Although the oil operations in Nigeria pre-dates the structural adjustment programme, it is also true that the policy of liberalization and private sector participation in core economic sector have influenced the level and rate of oil exploration and operations without any clear cut policy to ameliorate oil pollution in Nigeria from the health effect of such massive operations. The present paper assesses the health effects during the period 1970 - 1997. In particular, it examines health effects of market liberalization of the oil sector within a broader range of health reforms requirements. The assessment is informed by a model of health effects of economic policies recently suggested by Anad and Ohen (1996).

IMPACT OF OIL OPERATION ON THE ENVIRONMENT

Oil operations virtually affect all aspect of the environment. Inextricable from petroleum various forms are such characteristic as instability, reactivity and toxicity. According to the United Nations Industrial Development Organisation (UNIDO), "hazardous wastes may be defined as any waste or combination of wastes which pose a substantial hazard or potential hazard to the health of human or other living organism because the wastes are lethal non-degradable, persistent in nature, can be biologically magnified or otherwise cause detrimental cumulative effects".

From exploration to marketing stage, land is acquired and used for flow stations, oil location, pipeline way, terminal, borrow pits etc. In the process, land is dissurfaced, its

shape changes and most times, the natural waterways are blocked leading to flooding of farmlands. In the exploration of petroleum, some explosives are used to obtain the nature of the sub surface rocks through the reflection and refraction of seismic waves. These shorts destroy aquatic lives in sea and rivers while on land destroy vegetation and farmlands. Also noise pollution is an integral part of the seismic activities. This is followed by the drilling operations. In conventional drilling, drilling muds which consist of various chemical components are purposely added to a given site, pumped and recirculated through the borehole for several operational purposes. Pollution that may possibly arise from drilling operations are: -

Noise
Penetration of drilling mud into the sub surface fresh water;
Spillage during drilling;
Disposal of drilling mud, cuttings waste water and other chemicals in an unlined barrow pit.

The exploitation state of oil operation cause land, air and water pollution. Prominent sources of pollution at this stage are - oil spillage and gas flaring. Oil spillage, which is the spilling of crude oil on the environment, can either be caused by rupture or corrosion of flow line/pipe lines or sabotage. Oil spillage usually causes great damage to the soil and vegetation. On seas and rivers, oil spillage destroys marine lives and other aquatic organisms. This, more often than not, places the lives of the people in the affected areas who may be predominantly farmers and fishermen in great danger and severe hardship. The economic costs in terms of lost incomes and reduction in the standard of living can therefore be expected to be staggering.

Gas flaring pollutes mainly the air. The gas flared release oxides of carbon, nitrogen and sulphur to the atmosphere and exposes the inhabitants in the gas faring zone to the direct heat of ultra-violent rays from the sun, which has been diagnosed to cause cancer. Other effects of gas flaring is production of heat, destruction of vegetation around the head area, retardation of growth and flowering of plants, etc. Also, carbon monoxide, smoke and the unburnt hydrocarbon particles resulting from gas flare are injurious to health. In the refinery operations, water pollution resulting from effluents that contain a wide range of organic and inorganic substances such as phenol, hydrogen sulphite, ammonia, oil and grease, phosphate and toxic material do occur. According to Onwioduokit (1998); high rate of disposal of fluid from the petroleum industry into the rivers is responsible for the high flood experienced in the Niger delta. This is because such disposal increase the viscosity of the river water hence reducing the velocity of flow but flow rate remains constant. To contain the flow rate, the water spread and over flows its banks causing high flood. Since the whole essence of industrialization or natural resource extraction is to contribute to economic development which in itself has human being as its centre piece. It is reasonable to attempt a brief analysis of the health effects of both water and air pollution in order to ascertain in clear terms the magnitude of the danger its potents.

WATER POLLUTION

The use of polluted waters for drinking and bathing is one of the principal pathways for infection by diseases that kill millions and sicken more than a billion people each year. Diseases such as typhoid and cholera are carried in infected drinking water; others are spread when people wash themselves in contaminated water. Because of their effect on human welfare and economic growth, water pollution pose the most serious environmental problems to the oil producing areas.

The direct impact of water borne diseases is huge, especially for children and the poor (who are most at risk). Unsafe water is implicated in many cases of diarrhea diseases, which, as a group, kill more that 3 million people, mostly children, and cause about 900 million episodes of illness each year (World bank, 1992). At any one time more than 900 million people are afflicted with roundworm and 200 million with schistosomiasis. Many of these conditions have large indirect health effects - frequent diarrhea, for instance, can leave a child vulnerable to illness and death from other causes.

The costs of water pollution includes the damage it does to fisheries, which provide the main source of protein in many countries, and to the livelihoods of many rural people. For instance, pollution of coastal waters in northern China is implicated, along with over fishing in a sharp drop in prawn and shellfish harvests. Heavy silt loads aggravated by land development and logging are reducing coastal canal and the fish population that feed and breed in it, as in bacuit bay in Palawan, the Philippines. Fish are often contaminated by sewage and toxic substances that make them unfit for human consumption. Contamination of sea food is thought responsible for a serious outbreak of hepatitis A in Shanghai and for the spread of cholera in Peru (World Bank, 1992).

AIR POLLUTION

Although consistent monitoring of ambient air pollution in the world's cities has been going on for only slightly more that a decade, it has already shown that several pollutants frequently exceed the levels considered safe for health. However, even though such records are lacking in most developing countries including Nigeria, the most serious health risks arise from exposure to suspended particulate matter (SPM), and lead. Large numbers of people are also exposed to somewhat less health threatening effects of sulphur dioxide

The chemical composition of the gas determines the nature of physiological response on exposure. Physiological response ranges from virtually instantaneous death resulting from an accidental acute hydrogen oxide exposure to little or no effect from exposure to appreciably higher concentrations of methane which is classified as 'simple asphyxiant' or 'inert' gas. Carbon monoxide is the commonest toxic gas encountered in and outside industrial environment and accounts for most of the death resulting from acute exposures. This gas is so universally encountered that it is worth while going into a more detailed discussion of its effects and mode of action. It is formed in varying quantities during incomplete combustion of fuel.

The red blood cells prefer carbon monoxide 300 times more than oxygen when it is present in breathed air. Rather than accept oxygen which would be transported back to the tissues where it is needed, the cells transport carbon monoxide which is acceptable. As the exposure progresses, the red blood cells become increasingly saturated with carbon monoxide while getting more and more depleted in oxygen. Initial symptoms of excessive exposure are headache and nausea, sometimes followed by loss of consciousness and death. Thus, even though the air being breathed has adequate oxygen content for survival, this oxygen never gets to the system because red blood cells' unfortunate preference for carbon monoxide. Exposure to fractions of 1% carbon monoxide in the air can be fatal in a matter of minutes.

Even though LNG and LPG does not contain carbon monoxide, the latter can still occur in varying amounts if the full air mixture is not right. If not properly vented, the products of combustion containing this gas may be sufficient to cause a similar condition to exist even though the vent or chimney operates properly under ordinary conditions.

THEORETICAL ISSUES

Evaluation of the extent to which the fundamental objective of increasing the stock of human health from the additional resources gained from the exploration and exploitation of the petroleum is not an easy task. In a recent contribution, Anan and Ohen (1996) proposed a robust theoretical model for assessing health impacts of social and economic policies. The model identifies the critical factors that govern short-run health effects of economic reforms as measured for example, by changes in mortality rate might be large or negligible, and shows how the evolution of health status of the population over time might be influenced by public policy.

The model is based on the concept of individual - specific health production function as in Grossman(1972). In the model an individual's evolution of health stock over time, from its initial level, is determined by a flow of health and non health inputs, conditional on individual behaviour and environmental conditions. The health inputs include the amount of nutrients taken, and the quality of health services used by an individual over a specified time period, whereas the inputs outside the health sector include for instance the quantities of housing, water and sanitation services consumed over the same period. It is pertinent to note here, that oil pollution affects all these variables negatively.

Consistent with the theory of the household, an individual enhances his or her health capital over a given time period using market and non-market inputs. The market inputs include medical services, food, housing, and clothing, a fraction of each of these inputs can be obtained outside the market. The non-market or non-tradable inputs include an individuals genetic endowment and environmental capital , such as unpolluted air, which is supposedly commonly available (but which is heavily polluted in the oil producing areas). However, in contrast to market inputs, the non-market inputs are all non-tradables. Given the non-tradable input set, and subject to a full income constraint as in Becker (1991), an individual purchases quantities of market inputs that minimize the cost of increasing health

capital stock to a certain level over a specified time period. Both the purchased inputs and the efficiency at which an individual uses them determine health status at any given period.

Thus, an individual's health capital stock at any period t, is assumed to be self produced according to the following production function.

$$H_{it} = F(X_{it}, Z_{it}, V_{it}, S_{it}, Q_{it}, H_{it-1}) \quad \ldots. (1)$$

where H_{it} is unobservable stock of health capital for individual I at time t, X_{it} is vector of nutrients or types of food consumed by I at time t; Z_{it} is a vector of health services used by I at time t; V_{it} is vector of environmental conditions faced by I at time t; S_{it} is a vector of I's special characteristics at time t; Q_{it} is a vector of indicators of macroeconomic situation faced by I at time t; for example unemployment rate, inflation rate, and social infrastructure; and H_{it-1} is individual health stock in the previous period.

Equation (1) is a meta production function because its arguments include infra structural and environmental inputs. From equation (1), it can be seen that the magnitude of the change in health stock from H_{t-1} to H_t, depends on the extent of the changes in its determinants. Denoting changes in variables in equation (1) in lower case letters, and suppressing the I subscript, the health capital production function at period t can be expressed as:-

$$Ht = g(x_t, z_t, v_t, s_t, q_t) \quad \ldots. (2)$$

where $h_t = H_t - H_{t-1}$, is the change in previous period health stock, so that wherever $H_t > h_{t-1}$, $h_{it} > 0$, indicating that health stock has appreciated conversely, if $h_t < 0$, an individual's health status has depreciated.

Economic reforms in the health sector or in any other sector of the economy, generate equation (2) by changing one or more of the determinants of the heath status. For example, imposition of cost showing in health sector is assumed to change the quantity of health services used by the population via its effects on service prices and quantity in equation (2), the change in health services resulting from cost sharing in the health sector is X_t(that is $X_t - X_{t-1}$). The sign of this change, would be negative in the case of the oil producing areas because the oil operations affects negatively almost all known means of livelihood of the population in these areas. Similarly, Z_t is the change in nutrient intake or food consumption resulting from liberalization of food markets. Again, aprori, this is expected to be negative in the oil producing areas since the activities of the oil companies combined with gas flaring have considerably eroded the vegetation of the areas, hence, the nutrient content of their food intake is dismally low. Macroeconomic reforms such as devaluation of the national currency, trade liberalization and privatization may generate Vt and Qt, and these changes might also affect health status. Note that a given set of reform measures generate specific values for the flow variables in equation (2). Thus, the change in health status in equation (2) can be related directly to the environmental and reform activities. That is, reform activities can be used as proxies for the flow variables in equation (2); nonetheless as is shown below, a different formulation is needed because many of the flows are unobservable. Equation (2) further emphasis the need to control for effects of

policies outside the health sector when assessing impacts of the environment and reform within the sector.

Equations (1) and (2) describe health capital formation of an individual. To obtain the health status of the whole population, aggregation of health stocks across individuals is required. Despite the great difficulties involved in measuring health status, a variety of aggregation approaches exist (World Bank, 1993).

Theoretical and empirical problems arise using equation (2) to assess health effects of pollution and economic reforms such as the institution of user charges or of health insurance - reforms that alter health services utilization levels and patterns. The theoretical issue relates to the complexity of the process that generate changes in health stocks. Health effects of a decrease in X_t ($X_t < 0$) for example, might be off set by counter raising effects of an increase in Z_t or of the changes in other variable in equation (2). Thus, negative health effects of a decrease in health service utilization due to cost sharing may never be observed because of compensating effects, deceptively suggesting that cost sharing has no effect on health status. Similarly, positive health effects of an increase in health care use might not be observed. The empirical issue, as noted earlier, concerns difficulties in the measurement of health stock. Health stock is typically measured using mortality rates or life expectancy. A decrease in X_t (due to cost sharing) might not lead a rise in mortality rate if the decrease is not sustained, or if the health status of the population is not close to a minimum level that is critical for survival. Similarly, health improvements of an increase in X_t may never be observed if the increase is not sustained or if at the time it occurs the health stock of the population is already close to the survived minimum. In that case, even with a sustained increase in X_t, and a moderately large increase in health stock a decrease in mortality rate may never be observed. A distributional issue also arises in using equation (2) to measure health effects of user charges. If the health stock of a small segment of the population is close to the survival threshold, a large and sustained decrease in X_t (due to cost sharing) may have no effect on aggregate mortality, whereas the same change in X_t would likely have a substantial increase in mortality rate if it were to occur when health stock of the bulk of the population is close to survival minima. However, a dramatic decline in aggregate mortality can be observed following a small sustained increase in X_t when health stocks of the majority of the population are sufficiently above survival levels.

In an attempt to use equation (1) and (2) to examine the above issues, difficult data problem arises: data on variables specified in health production functions are not easy to obtain. In particular, data on nutrient intake, health care consumption and environmental exposure of the population are currently not available from non-survey sources. To get around this problem, we work with demand side counterparts of equation (1) and (2). The underpinning assumption equation (1) and (2) is that people minimize the cost of producing a given level of health stock using market and non-market inputs. This assumption simply implies that in their health maintenance activities, people do not waste the health care resources they can afford, because, if saved, these resources can be used to meet other necessities of life. In this sense, cost minimization is a very reasonable assumption about human behaviour. The demand side counter part of this assumption is that people benefit from better health, that is, from an improvement in health status, and thus they seek better health in the same way that they seek other goods and services. People benefit from better health because as an asset, it raises their productivity or because, as an intrinsic goods, are

obtained at a price, it is a fair assumption that people use their limited resources on these goods in a way that confers them as much benefit is possible. This is the benefit maximization assumption in demand theory, which is adopted in this analysis.

Given this assumption people's resources are limited, the reduced form aggregate demand function for health capital at time t (that is H_t), can be written as

$$h_t = F(p_t, q_t, A_t, W_t, Y_t) \quad \ldots. (3)$$

where suppressing the t subscript, h is demand for health capital stock (a flow variable); P is the price per unit of health stock; P is the price per unit of health stock; q is per capita income, A is a vector of aggregate social variables such as literacy rates, W is a vector of structure activities such as privatization or price liberalization in the social and other sectors; Y is a vector of environmental and infrastructural factors and inflow of external resources like foreign aid. It should be noted that equation (3) can also be derived from the cost functions underlying equations (1) and (2) (see Varian, 1984).

Appearance of P in equation (3) signals an estimation problem because health capital is a non-tradable good, and so, it cannot be bought or sold in the for human capital, it appears at first sight that there is no market price for additional health stock. A shadow price for health capital or investment can of course be computed via estimation of an output production function in which health capital stock is included as one of the input arguments of the function. But computation of the shadow price would be too tedious for the present work. Nevertheless, a proxy for market price for health stocks is still possible. A look at equation (1) and (2) shows that health capital is self produced with market and non-market inputs. We make the assumption that purchased inputs such as medical care, food, and housing are the dominant inputs in the production process. Thus, the higher the prices of these inputs the greater the cost of producing a unit of health stock. From this, if follows that the price at which a unit of health stock would be traded in the market (were such a market to exist), would strongly move in the same direction with health production costs. For this reason, we adopt the consumer price index as a proxy for the price of aggregate demand for health stock in equation (3). They reflect the relative importance of the health sector in the accumulation of health stocks, the consumer price index can be weighted by the share of health expenditure in gross domestic product. However, since in equation (1) and (2) other sectors in the economy play a significant role in health capital formation, there is no need to weight the consumer price index. This treatment of the consumer price index is consistent with the view that health capital formation is better promoted through inter-sectoral activities rather than through activities in a single sector such as the public health sector (WHO, 1983).

To be able to interpret the empirical sign of the coefficient on P, it is important that equation (3) be identified as a demand rather than a supply equation before estimation. This is a crucial issue because P is the price at which health capital is self supplied and it is the same price at which it is bought from self (where self is the case of the aggregate health capital stock is the whole community). Thus, a change in health stock due to a change in P might be a demand or a supply response. An increase in P signals a higher rent to be received from health capital (as a final good); thus more of it is supplied as P rises. However, an increase in P also makes health stock (as a consumer or an intermediate

good) more expensive relative to other goods, so that other things being equal, less of it is demanded. Thus, there is a need to determine whether the relation to be estimated in (3) is a demand or a supply function. Identification of equation (3) is achieved by variables in vector Y that shift the supply of health capital without affecting the position of the demand function.

METHODOLOGY

DATA AND THEIR SOURCES

The data sources include World Bank Development Report, World Bank Social indicators of development, Human development Report, International Financial Statistics Year Book of the IMF, Survey result of health status of Oil producing areas in Nigeria by the (CBN), Federal Office of Statistics and National Planning. The data for the study spans 1970 - 1997.

ANALYSIS

Double log linear version of equation (3) were estimated using ordinary least squares and robust regression methods. Robust regression was used to take account of the fact that the variance of the error term is not constant as assumed in the ordinary least squares estimation only the robust regression results are reported.

RESULTS

The health effect of prices and incomes (see Table 1) is theory consistent: demand for health capital declines with the consumer price index and increases with per capita income. The magnitudes of the estimated effects show that health capital is inelastic with respect to price and income. The price elasticities however are statistically insignificant. The positive and less than unity demand responses to income indicate that health capital is a necessary good. The inelastic price response indicates that health capital has few substitutes. The inverse and significant relaltionship that exist between oil spillage proxied by a dump and the demand for health further confirmed the critical nature of the health depletion of the oil producing areas in Nigeria.

Table 1
Regression Results. (Infant Mortality as dependent variable).

Explanatory Variables	Values
Constant	6.067 (7.4)
Log of change real consumer price index	0.216 (1.69)
Log of change real pt Capita income	-0.486 (-8.32)
Log of change real Population density	-0.085 (2.33)
Dummy to capture peculiarities of Oil Producing areas	0.479 (4.31)
Economy Wide Reforms	0.203 (1.29)
Adjusted R-Squared	0.73
F-Statistic	2.04
Standard Error of Regression	0.36

Note: Absolute t - ratios in parenthesis.

CONCLUSION

The health effects of oil pollution in Nigeria might not have been adequately captured in this study, but one thing that comes out clearly is that the continuous pollution of the oil producing areas as a result of the oil exploration and exploitation activities have reduced the life expectancy of the inhabitants of these areas. In addition, the rate of infant mortality seems higher in these areas. The reforms variable though not significant has also exacerbated the health status of the oil producing areas due to the increase in the prices of medical services and concomitant reduction in the economic means of existence of the populace. There is need for the oil companies in collaboration with the host governments to focus on the health stock of the people by building hospitals for the host communities. The PTF should also assist in drugs procurement for the inhabitants. There is no easy way out of the problem, the issue of health stock is critical as no country can hope to make any meaningful progress without a high level of healthy human capital.

Finally, the need to fund research studies in the areas of health stock of the oil producing areas to ascertain the level of depletion in order to inform appropriate policy cannot be over-emphasized.

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