THE PROPOSED PETROCHEMICAL INDUSTRY IN NIGERIA: ITS NET SOCIAL PROFITABILITY AND DOMESTIC RESOURCE COST

By

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I. – INTRODUCTION

The importance of the petrochemical industry to the Nigerian economy cannot be over dramatized. In terms of its impact on the interlocking sectoral relationship and its multiplier effects the petrochemical industry is in every respect comparable to both the iron and steel complex and agriculture. Therefore, the decision to set up a petrochemical complex in a country where the resource base is abundant must, on a *priori* grounds, be assessed as most expedient.

The petrochemical project in Nigeria is to be executed in three phases. Details of products which are contemplated for each of the three phases are provided in Appendix I. In Phase I, only base materials such as Polypropylene, Carbon Black, Linear Alkyl-Benzene will be produced as feedstock to downstream industries which would in turn manufacture end-use products such as carpets, containers, detergents and printing inks among others. This Phase is due for completion in December, 1983. Major plastic base materials such as Low and High Density Polyethylene, Vinyl Chloride Monomer, and Polyvinyl Chloride will be produced in Phase II. This second Phase of the project is due for completion in 1987. The more advanced petrochemicals which are based on simple Aromatics of the Xylene types are expected to be produced in Phase III; these Petrochemicals will be used for the production of a wide range of fibres and more sophisticated plastics.

Data on plant capacity and demand potentials of the domestic market are presented in Table 1. The total picture emerging from Table 1 and data presented in Appendices I and V is that the petrochemical industry is intended not to earn but to save foreign exchange. The success of this industry must therefore be assessed against this background and should be presumed to be in line with the traditional import substitution strategy for industrial development.

Besides saving foreign exchange, the import substitution strategy is expected to, among other things, effect a diversification of the economy, thus providing a wider economic base which would allow for fuller exploitation of the human and material resources through forward and backward linkages. However, the foreign exchange savings argument for import substitution is the most popular because foreign exchange is a very scarce resource in most developing countries. This scarcity is reflected in the chronic balance of payments difficulties of most developing countries. In so

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Table 1: Plant capacity and estimated demand potentials (1984) for petrochemical products

Phase	Product	Plant Capacity (Metric Tons/Year)	Estimated Total Demand Potentials	Deficit – Surplus +
I	Polypropylene	35,000	35,445	– 445
	Carbon Black	25,000	10,010	+ 14,990
	Linear Alkyl-Benzene	30,000	27,830	+ 2,170
II	Low Density Polyethylene	110,000	157,800	– 47,800
	High Density Polyethylene	70,000	100,000	– 30,000
	Polyvinyl Chloride (PVC)	140,000	125,800	+ 14,200

Source: *Adapted from figures provided by the Petrochemicals Division, NNPC, Lagos.*

high an esteem is this argument held that ex ante resource allocation decisions are very often made by ranking industrial projects on the basis of their potentials for saving foreign exchange. Unfortunately, this ranking is very often done by simply comparing the import bills of industrial products thus ignoring any rigorous empirical analysis and other considerations. This in our view is one of the major reasons why there is now a growing disillusionment with the import substitution strategy. This method of selecting import substitution industries has been so inadequate that the resulting foreign exchange savings has been rather small with consequent marginal effect on the balance of payments. The importation of raw materials, the repatriation of profit, the payment of royalties and maintenance costs combine to erode the foreign exchange savings which had been hoped for. Also the linkage effects have been minimal since most inputs including labour, technology and raw materials have had to be imported. Even the employment generation of these industrial projects has been disappointing as the production process is largely capital intensive.

This paper is intended to empirically assess the potentials of the proposed petrochemical industry for:

(a) increasing social welfare benefits and
(b) saving foreign exchange.

The change in social welfare resulting from investment in the petrochemical industry is more appropriately described as the Net Social Profitability (NSP). NSP is the net gain (or loss) from an economic activity after the resulting output, factors of production and all external effects have been evaluated at their respective social opportunity costs. On the other hand the Naira cost of saving one unit of foreign exchange is a measure of the Domestic Resource Cost (DRC) [or social opportunity cost of domestic factors] of saving a unit of foreign exchange. The DRC provides an insight into the impact of an economic activity on the balance of payments position.

II. – THE THEORETICAL FRAMEWORK

The Net Social Profitability of the proposed petrochemical industry is expressed in the following mathematical form (5):

$$NSP = [u - (M + r)]\, v_1 - \sum_{s=2}^{m} (f_s v_s) + E \quad \ldots\ldots\ldots\ldots (1)$$

where u = value of petrochemical output [in foreign currency]
m = value of all imported materials [in foreign currency], for petrochemical production.
r = repatriated earnings of foreign owned factors in the petrochemical industry.
v_1 = shadow price of foreign exchange – (the ratio of domestic currency to foreign currency).
$(f_s v_s)$ = quantity of the respective domestic factors «f_s» multiplied by its shadow price «v_s».
E = the external effects on the domestic economy.

The external effects (E in equation 1) on the domestic economy refer not only to the forward and backward linkages of the petrochemical industry but also to other benefits or costs such as savings resulting from non-payment of import duties on raw materials and intermediate goods, port development charges and the cost of obtaining forein exchange.

The external effects of the petrochemical industry on the domestic economy is very extensive and complex requiring very detailed information system and rigorous social valuation. In view of this difficulty, the external effects of the petrochemical industry on the domestic economy will be difficult if not impossible to estimate. The NSP will be underestimated and the DRC inflated if as is generally believed, the external effects of the petrochemical industry on the domestic economy is very extensive.

The Domestic Resource Cost (DRC) is expressed in the following mathematical form (2).

$$DRC = \frac{\sum_{s=2}^{m} (f_s v_s) - E}{u - (M + r)} \quad \ldots\ldots\ldots\ldots (2)$$

It should be noted that DRC and NSP are directly related; the former is in fact derivable from the latter. The relationship between the two concepts can be shown by rewriting equation (2) and substituting into equation (1) as follows:

$$DRC\ [u - (M + r)] = \sum_{s=2}^{m} (f_s v_s) - E \quad \ldots\ldots\ldots\ldots\ldots\ldots (3)$$

$$NSP = [u - (M + r)]\, v_1 - DRC\,(u - M + r) \quad \ldots\ldots\ldots (4)$$

$$\text{therefore } NSP \begin{cases} > \\ = \\ < \end{cases} 0 \quad \text{as } DRC \begin{cases} < \\ = \\ > \end{cases} v_1$$

Investment in the petrochemical industry will be desirable if the NSP is positive i.e. if the DRC is less than the shadow price of foreign exchange. Since the petrochemical industry in Nigeria is to be executed in phases, the potential of each of these phases for net social profitability and for saving foreign exchange should be evaluated consequent to which the phases could be ranked not only on the basis of their potentials for increasing social welfare benefits but also for their potentials for saving foreign exchange.

III. – DATA: SOURCES AND LIMITATIONS

The data employed in the application of the models to the proposed petrochemical industry in Nigeria were obtained from the Petrochemicals Division of the Nigerian National Petroleum Corporation. The NSP and DRC were calculated for each of the three phases of the petrochemical project. The unavailability of data for calculating the external effects of the petrochemical industry on the domestic economy and the limitations which this imposes on the calculation of NSP and DRC have been discussed in the preceding section. In effect the NSP which is calculated in this paper is equivalent to the economic rent.

In this paper the reference years are 1984, 1987 and 1990 for Phases I, II and III respectively. However, the unit price range for output and the shadow price of foreign exchange (v_1) used are for 1982. «v_1» is defined as the black market exchange rate ratio of the Naira to the U.S. Dollar; this ratio was presumed to be 1:1. The fixed cost and other lump sum payments were armortized over the repayment period of the foreign loan since the project is being executed with export credit facilities. Under normal circumstances the period over which the fixed costs are allocated would have been much longer thus these costs as allocated are somewhat higher than they otherwise would have been. They therefore reinforce the underestimation of the NSP and further inflate the DRC. Details of the data employed are provided in Appendices II, III and IV.

IV. – RESULTS AND INFERENCES

Using the data provided in Appendices II, III and IV the following results were obtained:

Table 2: The NSP and DRC obtained for Phases I, II and III of the proposed petrochemical industry.

Phase	NSP (in Millions of ₦)	DRC
I	36.890	0.46
II	310.157	0.25
III	199.791	0.17

Table 2 shows that the NSP is positive in all the cases. It is lowest for Phase I and highest for Phase II. The social welfare implications, given the limitations imposed by data availability, are that the incremental contributions to social welfare will be highest for Phase II.

The DRCs are respectively less than the shadow price of the foreign exchange (which is taken as 1). This means that the cost of saving one unit of foreign exchange (one U.S. Dollar), is 46k for Phase I, 25k for Phase II and 17k for Phase III. Therefore the foreign exchange savings which the proposed petrochemical industry will make is very impressive and attractive. This is bound to have a very favourable effect on Nigeria's balance of payments.

These favourable results were achieved despite the bias introduced by the unavailability of data for calculating the external effects of the petrochemical industry and the armortization of certain costs over shorter periods than is 'justified'.

It can be seen why the NSP and the DRC serve as useful guides for ranking investment proposals according to their potentials for saving foreign exchange. The higher the NSP and/or the smaller the DRC, the more attractive an investment opportunity becomes. The fact that each of the indices indicates very positive social and economic returns is good enough reason to commend investment in the petrochemical industry.

V. – CONCLUSION

The objective of this paper were to assess the potentials of the proposed petrochemical industry for increasing social welfare and for saving foreign exchange. Models which were popularized by BRUNO (2, 3, 4), and which had been in use in Israel since the 1950's as aid to ex ante resource allocation decision-making were applied to the Nigerian situation with particular reference to the petrochemical industry.

These models were applied to each of the three phases of the proposed petrochemical industry. Certain calculations, especially those relating to the external effects of the petrochemical industry were difficult to make because the scope and complexity of these effects require very detailed data and presumptuous social valuation. This limitation introduced a negative bias into the NSP's and a positive bias into the DRC's. These biases were reinforced by the failure to armortize the fixed costs and other lump sum payments over appropriately longer life cycles.

In spite of these limitations the NSP's for all of the three phases of the proposed petrochemical industry were found to be positive and the DRCs were respectively found to be less than the shadow price of foreign exchange. Hence from an empirical point of view the petrochemical industry is expected to increase social welfare in the domestic economy while effecting substantial foreign exchange savings.

APPENDIX I: Details of the proposed petrochemical production

Phase	Product	Plant capacity (metric tons per year)	Main End-Use	Completion Date
I	Polypropylene (PP)	35,000	1. Woven sacks 2. Crates for bottles 3. Injection moulded goods 4. Automotive Components and Appliances 5. Floor carpets and tiles.	1983
	Carbon Black(CB)	25,000	1. Tyres, hoses, belts & foot wares, electrodes, printing inks.	
	Linear Alkyl-Benzene (LAB)	30,000	1. Active material for biodegradable Synthetic detergents 2. Liquid detergents.	
	Heavy Alkylate	2,700	1. Lube oil additives 2. Thermal fluids 3. Transformer oil 4. Greases.	
II	Low Density Polyethyline (LDPE)	110,000	Synthetic fibres, insecticides, food preservative chemicals and chlorinated solvents.	1986/87
	High Density Polyethyline (HDPE)	70,000		
	Polypropylene (PP)	60,000		
	Vinyl Chloride Monomer (VCM)	145,000		
	Polyvinyl Chloride (PVC)	140,000		
	Ethylene Oxide) Ethylene) EC/EG Glycol)	35,000		
	Plasticizer Units	30,000		
	Chlorine/Caustic	90,000		
	Soda Units	102,000		
III	Terephthalic Acid (TPA)	70,000	A wide range of fibres and more sophisticated plastics.	
	Phthalic anhydride (PA)	20,000		
	Diotylphthalate	30,000		

APPENDIX I: Details of the proposed petrochemical production

Phase	Product	Plant capacity (metric tons per year)	Main End-Use	Completion Date
	Styrene-Butadiene Rubber (SBR)	25,000	A wide range of fibres and more sophisticated plastics.	
	Polystyrene (PS)	30,000		
	Paraxylene (P–X)	50,000		
	Ortho Xylene (C–X)	20,000		
	Benzene	100,000		
	Polyol	30,000		
	Formaldehyde	40,000		
	2–ethyl-hexanol	21,000		
	Methanol	50,000		

Source: *The Petrochemicals Division, NNPC, Lagos.*

APPENDIX 2: Details of data employed in the calculation of NSP and DRC for Phase I of the petrochemical project

Variable	Variable Items	Total Product Value (Amount in '000 US $)
u	Carbon Black	19,930
	Polypropylene	42,770
	Linear Alkyl – Benzene	60,000
	Total	**122,700**
(m +r)	Royalties	6,020
	Reimbursement of foreign currency (Loan Repayment)	24,700
	Interest on foreign currency	11,500
	Expatriate Remittances	10,000
	Maintenance Cost (foreign exchange component)	2,000
	Total	**54,220**
(fv)	Manpower	2,750
	Maintenance	9,550
	Insurance	2,250
	Overhead Expenses	6,500
	Chemical and Catalysts	4,000
	Utilities	5,500
	Packaging	950
	Total	**31,500**

Source: *Petrochemicals Division, NNPC, Lagos.*

APPENDIX 3: Details of Data employed in the calculation of NSP and DRC for Phase II of the Petrochemical project

Variable	Variable Items	Total Product Value (Amount in '000 US $)
u	Low Density Polyethylene	98,120
	High Density Polyethylene	67,340
	Polypropylene	73.320
	Vinyl Chloride Monomer	90,000
	Polyvinyl Chloride	126,420
	Ethylene Oxide) Ethylene Glycol)	23,975
	Plasticizer	23,400
	Chlorine	29,340
	Caustic Soda	25,500
	Total	**557,895**
(m + r)	Royalties	19,800
	Reimbursement of foreign currency	58,500
	Interest on foreign currency	59,800
	Expatriate remittances	2,118
	Maintenance (foreign element)	6,260
	Total	**146,478**
(fv)	Manpower	8,470
	Maintenance	25,040
	Insurance	9,760
	Overhead Expenses	28,000
	Chemicals and catalysts	6,450
	Utilities	18,020
	Packages	5,520
	Total	**101,260**

Source: *Ibid.*

APPENDIX 4: Details for Data employed in the Calculation of NSP and DRC for Phase III of the petrochemical project

Variable	Variable Items	Total Product Value (Amount in '000 US $)
u	Terephthalic Acid	73,150
	Phthalic Anhydride	18,680
	Dioctylphthalate	28,020
	Styrene-Butadiene Rubber	29,275
	Polystyrene	33,990
	Para Xylene	31,500
	Ortho Xylene	9,780
	Benzene	41,000

APPENDIX 4: Details for Data employed in the Calculation of NSP and DRC for Phase III of the petrochemical project

Variable	Variable Items in '000 US S)	Total Product Value (Amount in '000 US $)
u	Polyol	24,000
	Formaldehyde	7,000
	2–ethyl-hexanol	15,246
	Methanol	11,000
	Total	322,641
(m + r)	Royalties	16,300
	Reimbursement of foreign currency	43,400
	Interest on foreign currency	17,400
	Expatriate remittances	1,330
	Maintenance (foreign element)	3,990
	Total	82,420
(fv)	Manpower	5,320
	Maintenance	9,610
	Insurance	3,820
	Overhead expenses	12,970
	Chemicals and catalysts	4,310
	Utilities	3,910
	Packages	890
	Total	40,430

Source: *Ibid.*

APPENDIX 5: Actual demand/market potentials in Nigeria for some selected petrochemicals (in '000 MT)

Year / Product	1979	1980	1981	1982	1983	1984	1985
Polypropylene	9.674	13.625	17.304	21.976	27.910	35.445	45.015
Carbon black	4.870	5.730	6.715	7.630	8.745	10.010	11.400
Linear alkyl-benzene	17.100	19.000	20.900	23.000	25.300	27.830	30.613
Low density Polyethylene*	41.500	54.100	71.000	92.000	120.900	157.800	–
High density Polyethylene*	30.000	39.000	50.000	65.000	84.500	100.000	–
Polyvinyl chloride*	65.000	70.000	75.000	80.000	–	–	–
Polyols	–	17.200	–	22.700	26.150	–	–

* *refers to market potentials.*

Source: *Petrochemical Division, NNPC, Lagos.*

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RESUME

Compte tenu de son rôle qui consiste à tisser des relations sectorielles et de ses effets multiplicateurs, l'industrie pétrochimique est comparable au complexe sidérurgique et à l'agriculture. La décision de mettre en place l'industrie pétrochimique au Nigéria où les ressources sont abondantes devra donc, à priori, être évaluée comme une décision opportune. Cet article évalue les possibilités du projet d'industrie pétrochimique d'augmenter les bienfaits sociaux et de réaliser des économies de devises, en se servant des modèles vulgarisés par M. Bruno et mis en application en Israel depuis les années 50 pour prendre des décisions ex ante relatives à la répartition des ressources. La rentabilité sociale nette des trois phases du projet pétrochimique s'est avéré positive, et le coût des ressources locales (et l'économie de devises qui en découle) constamment inférieur au cours fictif des devises. Le coût de l'acquisition d'une unité de devise en ressources locales est de 46 k pour la phase I, 25 k et 17 k pour les phases II et III respectivement. Par conséquent l'on s'attend à ce que l'industrie pétrochimique nigériane augmente le bien-être social tout en permettant de réaliser des économies substantielles de devises.