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Economic Impact of Sectoral Transactions in Nigeria

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Abstract

Most applications of input-output (I-O) analysis to date have been to highlight inter-industry flows and to estimate the main aggregate national accounts, such as GDP, gross output and final demand categories. However, multiplier coefficients relating to output and income multipliers have hardly been explored especially in the Nigerian context. Sectors like agriculture, fishing, food & beverages as well as mining/quarrying have particularly significant roles and their economic impacts can be quantified using Nigeria's I-O table. The study adopted a longitudinal design and utilized the 2015 I-O table comprising of twenty-six (26) sectors obtained from Eurostat database. This table was used to compile an inter-industry transaction table and Leontief matrix, which was then used to derive industry-wise Type I and Type II multipliers for the aforementioned sectors. Type I multiplier takes into account the direct and indirect effects while the Type II multiplier captured the induced effects in addition to the direct and indirect effects. Mining/quarrying as a single sector had a Type I multiplier of 1.80 and 2.17 for both output and income respectively and a Type II multiplier of 2.41 and 3.12 for both output and income respectively. Similarly, the fishing sectors were identified to have the highest contributions (2.11 and 2.89 as well as 2.22 and 3.19) in both Types I and II multipliers for both output and income respectively when compared with other sectors.

Keywords

Input-Output Analysis, Sectoral Transactions, Eurostat Database, Type I and II Multipliers, Nigeria

1. Introduction

Nigeria is one of Africa's largest economy known for its increased fishing, min-

ing and agricultural activities. Owing to the increased population in the country, demand for products from these sectors has been increased over the years and has contributed immensely to nation's Gross Domestic Product [1].

The agricultural sector has been known to contribute about 20.85 percent to the nation's GDP (National Bureau of Statistics, 2018) [2]. The amount of value added measured in nominal terms was 5,288,339.21 million naira in the third quarter of 2018. Average annual growth rate of the mining industry had a GDP of about 8.71 percent increase at the end of 2018. The fishing sectors has also been known as a major contributor to Nigeria's GDP in last five (5) years following the protectionist trade measure in fish production (import quota) introduced since the first quarter of 2014 has stimulated the country's self-sufficiency through a 25 percent annual fish import cut [3].

Input-output analysis has been proven to be one of the most useful techniques to measure economic impacts, relating to both indirect and induced impacts, like the effect of given levels of final demand, for example, personal consumption expenditure, government expenditure, capital formation and exports. It is also possible to forecast the elements of the economy under different assumptions regarding the level of one or more of these indicators. This quantitative analysis first introduced by [4] is a top-down approach used to describe the general flow of goods and services in an economy, classified into various sectors. The total output multiplier for a sector measures the sum of the direct and indirect input requirements from all sectors needed to fulfill the final demand requirements of that sector. Multiplier effects which are associated with Keynes are defined as the change in equilibrium GDP divided by the change in investment [5]. The multiplier effect has been used as an argument for the efficacy of government expenditures to stimulate aggregate demand. One of the best-known results of input-output analysis is its ability to derive multipliers using supply and use sides of the national accounts [6].

This paper is aimed at estimating the economic impacts resulting from sectors like, mining/quarrying, fishing, food & beverages and agriculture on the Nigerian economy using the input-output multiplier analysis. This also helps to predict the consequences of any planned and potential changes in the demand for the country's output. The study derived a Type I and Type II multipliers for the aforementioned sectors. The Type I multiplier measures the change in output in both sectors due to the change in final demand. It is the ratio between the change in gross output and the change in final demand. For example, as presented in **Table 1**, if $ 1 additional demand for agricultural inputs generates $ 2 additional gross industrial output then the Type I multiplier relating to the agricultural sector is equal to 2. In other words, if the Type I agricultural multiplier is 2, then for each $ 1 additional demand for agricultural inputs would generate $ 2 worth of additional gross output within the economy.

Specifically, this paper sets to describe the use of Type I and Type II multipliers to measure direct, indirect and induced effects from the fishing, min-

ing/quarrying, food/beverage and agricultural sectors in Nigeria. The paper also highlights the important steps involved in deriving Type I and Type II multipliers from the I-O table to include the calculation of inter-industry transaction table and the Leontief matrix. The most recent I-O table was obtained for 2015 at aggregated level with 26 industries [7]. The reference year of 2015 means the multiplier coefficients need to be updated when more recent I-O tables are available.

2. Review of Related/Empirical Literature

Input-output analysis has been known as a veritable tool that addresses the following: multiplier effects of an investment program; environmental restrictions impact on prices; national accounting as well as its efficiency and dynamic performance [8]. However, application of input-output analysis to measure economic impacts for fishing, mining/quarrying, food/beverage and agricultural sectors has been limited. According to [9], output, employment and income multipliers have been known to be used to describe different economic impacts thus:

1) Output Multipliers

Output multiplier for an industry is defined as the ratio of output changes to a unit increase in final demand. This is, Changes in output

Final demand

2) Employment Multipliers

The employment multiplier expresses an estimate of the total employment attributable to the stimulus per man-year of employment.

3) Income Multipliers

This measures the change in income (wages, salaries, and profits, etc.) which occurs throughout the economy as a result of a change in final demand.

Related studies have been carried out by researchers using input-output analysis and multipliers to investigate economic impacts but dearth is evident in Nigeria. [10] used input-output tables to analyze the use of energy for transport purposes in Germany. He calculated energy necessities of transport-related final demand by means that of the Leontief-inverse connected to the energy information. He found that the energy necessities of transport-related final demand have truly big quicker than the energy consumption by transport as associate business.

On the other hand, [11] in his study suggested input-output multiplier analysis as one of the recommended techniques for assessing economic impacts of transportation projects. Their output multiplier coefficients (Type I) for transport services were 2.4 and 1.8 for larger and smaller state respectively [12].

3. Methodology

3.1. Data Sources

The latest available Nigeria's I-O table was the symmetric for year 2015 and was obtained from Eurostat database who considered all the "classical" drawbacks of

the I-O approach (static, linear production function, no substitution or scale economy effects, infinite elasticity of supply) in its estimation and interpretation. It consisted of forty-six (46) sectors aggregated into twenty-six (26) sectors of economic activity, compiled following the industry-technology assumption, product-by-product, with total flows and valued at basic values at current prices.

3.2. Model Specification

1) The Theoretical Model

The income expenditure equality is given by:

$$E = C + I + G + X - M \tag{1}$$

where,

E = expenditure measure of Gross Domestic Product (GDP);

C = consumption; I = Investment;

G = Government expenditure;

X = Exports;

M = Imports.

$C + I + G + X - M$ = components of final demand;

C = Household consumption expenditure (HCE);

I = Fixed Capital Formation;

G, X, & M are as already defined.

Re-writing Equation (1), we have:

$$E = GDP = C + I + G + X - M \tag{2}$$

In terms of production, GDP value is given as:

$$GO - IC = GDP = C + I + G + X - M \tag{3}$$

where,

GO = Gross Output;

IC = intermediate consumption

Multiplying GO-IC by *Gross output* and simplifying we have:

$$GO\left(1 - \frac{GO}{IC}\right) = GDP \tag{4}$$

But, $a = \frac{GO}{IC}$, by substitution we have:

$$GO(1 - a) = GDP \tag{5}$$

In terms of GO, we have,

$$GO = (1 - a)^{-1} VA$$

where,

$$VA = GDP \tag{6}$$

$(1 - a)^{-1}$ = Leontief Inverse proportion of

$\frac{GO}{IC}$ = Proportion of intermediate consumption in the gross output which is

also referred to as the technical coefficient matrix in the Input-output analysis.

By inversion, the symmetric matrix, $(1-a)$ is transformed to get the asymmetric input-output table using the supply and use table.

Equation (6) forms the basis for the multiplier analysis. The column sum of the Leontief Inverse which is also known as the total requirement matrix, shows the input requirements for a unit increase in the final demand for a given industry, called the multiplier coefficient. These input requirements commonly referred to as "backward linkages" measure the impact on the supplier industries of a unit increase in final demand [13].

However, the following steps are involved in the transformation of the asymmetric matrices (supply and use tables) to an input-output table viz:

2) The Empirical Model

Use and supply tables

Suppose an economy with "t" number of products and "I" number of industries. The relationship between the use of products by industries and end users are presented in Table 1.

where,

$j=1,2,\cdots,n$, organized in rows.

Industries are denoted by Ind(k)

where,

$k=1,2,\cdots,n$, organized in columns.

The columns represent the value of the intermediate consumption for the corresponding industry, which uses various products by a particular industry. Similarly, the rows represent the value-added components of each industry. The gross output of each industry is given by the sum of the total intermediate consumption.

On the other hand, Table 2 presents the supply of products to various industries.

Table 1. (a) Use of products by industries and end users (use table); (b) data used for analysis.

(a)

		Industry use				End users					Products gross output
		Ind (1)	Ind (2)	..	Ind (n)	HC	GP	INV	Exp	Imp	
Product	Com (1)	i1, 1	i1, 2	..	i1, n	hc_1	gp_1	inv_1	exp_1	imp_1	go $(com)_1$
	Com (2)	i2, 1	i2, 2	..	i1, n	hc_2	gp_2	inv_2	exp_2	imp_2	go $(com)_2$
	..	..	..	..	..	..	..	..	..	..	..
	Com (m)	im, 1	im, 2	..	im,n	hc_m	gp_m	inv_m	exp_m	imp_m	go $(com)_m$
GDP	Compensation of employees	iw_1	w_2	..	w n						
	Operating surplus	ops_1	ops_2	..	ops_n						
	Taxes on products	$taxp_1$	$taxp_2$	..	$taxp_n$						
Industry Gross Output		go $(ind)_1$	go $(ind)_2$	..	go $(ind)_n$						

Source: Authors conceptualization. NB: Products are denoted by Com (j).

(b)

Sectors	Agriculture	Fishing	Mining and quarrying	Food & beverages	Textiles and wearing apparel	Wood and paper	Petroleum, chemical and non-metallic mineral products	Metal products	Electrical and machinery	Transport equipment	Other manufacturing	Recycling	Electricity, gas and water
Agriculture	11,629,000,000	1,309,938	407,265.1	70,354,510	1,837,713	50,027,600	195,806,700	14,332,600	14,110,910	1,268,929	1,734,205	6177.78	26,676,410
Fishing	618,736.1	22,593,000	14877.83	1,591,911	590,093.80	2,348,743	9,615,271	1,768,041	2,487,598	748,855.6	1189587	73.1535	250,090.7
Mining and Quarrying	75,202,100	100,760.6	29,784	1,799,882	22,576,050	173,567,400	773,602,400	862,459,700	541,229,600	79,407,780	76,650,390	4,942,408	524,863,300
Food & Beverages	2,145,869,000	1.11E+08	327,062.6	7,790,100	3,783,949	336,693,000	244,183,000	251,398,600	35,446,150	3,280,219	11,119,340	193,176	66,297,420
Textiles and Wearing Apparel	35,052,290	12,138.56	16,085.43	1,151,831	2,463,000	27,092,520	112,082,000	13,748,550	8,346,351	142,785.8	4637676	9748.98	10,166,720
Wood and Paper	90,803,360	343.4175	44,128.87	282,344.9	507,065	7,261,500	56,957,200	11,270,350	13,379,860	113,561.9	1,764,079	73,309.3	15,154,250
Petroleum, Chemical and Non-Metallic Mineral Products	10,349,840	40,834.75	13,175,930	2,102,135	1,865,472	45,466,550	22,442,000	76,836,100	54,990,450	3850193	3,347,802	492,725	74,928,690
Metal Products	476,354.5	12,522.01	449,256.5	7139.935	111,030.2	6,527,237	21,166,520	11,249,000	43,403,830	561,883.3	887,995	406,099	21,247,580
Electrical and Machinery	903,772	3741.543	40,795.87	31,150.49	1,883,078	28,013,520	132,834,000	278,155,500	22,352,000	18,769,460	6,099,971	28,656.5	27,894,860
Transport Equipment	236,826.1	1322.147	92,746.37	15,914.1	3,421,974	19,029,460	127,028,000	238,985,200	639,539,600	9,934,700	30,019,510	970.238	13,942,770
Other Manufacturing	2,355,584	1,623,950	7810.565	318,798.3	2,056,351	87,960,860	45,527,640	78,860,400	41,852,000	3,398,030	359,380	13,241.8	4,850,122
Recycling	4,934,861	10,2784.4	15,602,350	2,634,551	1,423,141	30,734,020	259,435,400	297,725,800	1,389,810	444,238.8	2,213,881	106,540	8,916,552
Electricity, Gas and Water	751,960.2	1886.21	16,759,440	76,169.63	316,120.1	6,535,187	40,786,740	6,007,663	19,855,220	209,079.9	1,236,334	373,756	7,409,400
Construction	52,182,120	1167.267	3,634,445	30,378.27	2,679,812	198,036,200	458,758,800	437,497,700	240,255,000	13,930,010	28,916,850	25,494.7	14,535,580
Maintenance and Repair	1,537,388	334,449.4	1408.238	731,386.3	249,950.6	8,689,313	3,356,054	3,185,001	5,539,357	973,792.9	732,265	1044.29	2,485,158
Wholesale Trade	5,018,556	1480.698	48,373.84	2,611,951	3,218,699	80,647,570	39,541,670	26,226,140	51,054,220	3,826,693	9,495,582	1009.25	13,961,950
Retail Trade	134,263,000	1.07E+08	14,274.74	5,569,2190	15,371,890	695,837,500	191324900	230664400	375580300	120434600	67335870	25,806.4	185308000
Hotels and Restaurants	553,797,100	1.27E+08	264,033.2	417,198,100	8,067,266	258,550,300	156,775,100	133,954,400	64,601,250	3,309,921	37,789,090	83,094.9	185,623,500
Transport	2,594,074	30,220.26	1,750,062	308,332.4	1,669,572	46,612,370	302,262,900	56,736,460	44,321,000	22,573,270	5,160,954	107,941	25,520,060
Post and Telecommunications	263,492.7	1683.696	25,325.15	62,166.42	415,158	52,724,740	21,985,520	7,893,271	34,432,500	1,174,748	2,795,281	32,079.2	7,175,681
Financial Intermediation and Business Activities	47,997,160	1,476,761	1,119,647	13,752,930	4,097,882	244,546,300	128,174,100	72,657,370	150,090,500	27,950,840	34,130,700	296,718	73,047,380
Public Administration	18,315,040	160,092.6	1,380,022	16,133,390	3,760,085	174,507,900	215,619,700	44,006,180	214,805,600	61,407,650	10,404,370	2098.05	47,960,740
Education, Health and Other Services	21,549,080	2,081,798	702,599.9	33,627,350	7,864,157	102,812,400	295,255,500	16,697,210	95,200,840	2,129,999	18,873,470	286,918	83,835,470
Private Households	95,286.3	26,976.89	1215.035	552,831.2	64,848.63	5,307,919	3,321,611	1,597,218	2,401,361	325,658	291,631.6	159.822	622,561.8
Others	266,349.9	6383.872	610.053	16,110.44	151,706.8	19,652,000	12,407,850	11,870,120	4,934,165	144,845.6	449,209.6	67.742	2,001,532
Re-export & Re-import	97,104.49	262,877.8	34,609.97	11,853.96	27,835.4	64,119.05	23,907.34	84,652.8	43,677.41	14,198.25	19,842.4	11,876.4	28,425.64

Continued

Subsidies on production D.39	Taxes on production D.29	Compensation of employees D.1	Re-export & re-import	Others	Private households	Education, health and other services	Public administration	Financial intermediation and business activities	Post and telecommunications	Transport	Hotels and restaurants	Retail trade	Wholesale trade	Maintenance and repair	Construction
−8,330,602	12,033,320	72,255,140	40.6728	4,726,052	81.126	4,434,005	174,795	461,354,300	7,706,717	52,998,880	442,534.20	3,762,909	111,618,100	1,144,344	7,878,077
−292,756.2	440,335.3	10,557,110	40.1236	599,960.6	82.626	397,126.5	2334.76	6,239,492	911025.2	1,724,511	4606.215	151,044.6	3816474	52,074.86	162,326.9
−708,251.1	40,928,560	177,656,300	1344.95	1.01E+08	1245.8	11,572,860	2,963,315	2,397,601,000	97,888,040	1.17E+09	14,681,620	108,032,000	737,502,300	15,509,810	550,299,100
−12,248,850	33,005,090	226,730,400	72.92	11,208,780	261.81	5,986,657	407,695	915,555,700	27,262,780	144,982,800	4,528,279	2,656,415	396,170,200	3,113,086	14,146,610
−125,211.3	1,459,668	91,491,040	72.6852	2,759,979	233.93	946,156	25,411.70	249,883,900	7,664,183	15,040,570	526,340.3	1,060,302	68,405,990	328,723.4	2,296,437
−435,201.7	2,804,710	168,212,100	69.5468	1,035,469	205.09	1,446,906	56,122.90	253,473,600	14,470,490	19,211,170	826,873.7	284,037.5	58,089,980	207,238	3,994,853
−1,584,180	22,474,490	344,058,800	75.4039	4,282,657	227.7	5,536,962	254,775	1,161,634,000	31,114,170	79,525,370	2,769,267	3,462,171	185,674,300	1,175,694	17,802,750
−385,726.1	3,811,557	188,747,700	73.2044	2,138,033	216.32	1,296,691	42,512.30	310,808,000	12,691,160	18,666,660	728,968.2	249,404.9	56739470	192,081.2	5,506,366
−1,600,968	7,936,136	625,396,700	76.997	5,634,905	300.83	3,972,727	80,732.50	1,445,809,000	92,522,940	39,158,000	1,995,570	2,787,011	256,331,100	1,258,713	9,888,676
−243,161.5	2,725,045	231,574,000	79.5999	1,231,989	352.5	1,553,797	55,462.50	543,241,000	16,761,270	29,443,200	726,433.50	2,569,567	145,206,500	881,801.2	3,974,293
−167,550.3	1,574,040	101,059,200	75.7132	992,337.70	279.02	895,911.70	83,128.30	195,785,900	11,312,880	16,535,830	624,152.50	2,286,640	59,947,470	329,631.2	2,455,602
−1482.256	154,730.9	10,897,200	911.261	2,125,918	660.22	115,110	4318.45	9,587,102	1,276,313	225,465,700	69,955.9	697,590.6	9,410,987	197,191	168,531.6
−8,221,725	31,075,660	200,057,300	73.2077	5,430,287	226.4	6,065,932	20,844.5	636,605,600	44,759,730	117,897,900	6,303,795	542,224.9	39,015,060	210,022.6	66,035,370
−8,548,742	20,376,790	1.25E+09	73.9874	7,692,484	339.92	9,956,258	107,285	1,971,016,000	162,745,900	156,514,300	4,125,583	58,802,710	375,220,900	3,800,739	19,799
−668,832.1	4,272,410	54,623,420	71.1117	1,458,765	239.49	710566.8	15916.3	133,664,600	22,899,020	10,608,620	327439.6	491941.5	10,360,100	41,469	1,051,707
−19,762,340	84,514,910	1.11E+09	72.0824	33,401,690	239.39	9,982,062	111,074	2,080,483,000	315,304,000	170,657,900	5,320,095	5,695,073	56,524,000	726,027.5	10,444,620
−12,396,260	101,348,800	1.24E+09	106.694	49,812,580	276.64	28,102,560	855,472	4,373,844,000	1.03E+09	409360700	14530780	19710000	245426800	2792346	73511330
−3,418,708	37,869,880	744,747,200	72.3788	48,044,000	527.27	69,713,120	1,392,599	2,343,416,000	422,389,500	199,825,000	13,908,000	63,751,580	438,983,600	6,879,088	47,507,420
−4,215,616	18,357,430	751,519,600	74.2498	12,832,180	225.07	14,602,240	433,430	2,168,388,000	360,842,400	38,384,000	5,534,597	15,321,440	70,371,220	960,130.8	26,353,530
−6,325,942	23,171,260	608,376,100	72.0773	4,529,480	231.9	28,732,710	300,350	1,449,358,000	52,176,000	18,748,950	3,800,177	786,039.9	17,614,510	117,379.3	11760180
−100,351,600	145,798,900	2.69E+09	75.4748	38,214,080	908.43	158,426,400	5,218,927	1,250,600,000	314,328,300	101,271,000	56,032,630	23,731,060	118,089,900	2,043,281	184,251,500
−873,834.8	12,721,210	3.00E+09	69.7774	7,086,930	77,911	84,724,130	158.14	1,804,533,000	388,302,000	70,803,150	17,883,780	1,518,647	149,894,300	759,227.5	139,929,300
−21,779,370	50,199,980	4.44E+09	70.6223	10,741,980	52,373	40,326	1,170,549	1,891,390,000	170,036,400	75,856,620	18,681,940	7,978,957	132,415,700	1,416,525	49,960,390
−22,156.26	436,150.1	132,136,500	77.3916	744,023.2	158.14	738,546.9	150,167	51,617,830	7,880,233	719,687.1	154,515	23,659.85	1,675,562	16,109.09	908,977.9
−268,638.4	809,135.7	17,624,020	75.6992	521.8	72.095	1,228,460	1,474,235	121,003,300	25,061,690	3,531,088	80,013.28	76339.4	3,321,597	14,347.91	1,273,097
−154.4392	3932.704	3932.704	521.8	44,953.69	4227.5	11,491.94	3668.36	16,532.97	21,879.19	30,592.83	14,777.11	19,138.19	23,131.68	28,727.32	13,775.01

Continued

Consumption of fixed capital K.1	50,855,150	2,446,571	102,859,000	45,572,020	10,387,320	21,089,710	82,009,970	24,456,930	91,047,120	37,129,070	12,650,460	1,183,830	53,284,680	100,980,800	4,548,065	83,862,020	113,051,300	72,046,420	77,820,700	125,364,000	1,002,136,000	215,714,100	342,401,400	2,608,402	11,281,410	3932.704
Net mixed income B.3n	65,012,030	2,703,238	144,330,600	94,373,290	23,145,350	43,516,240	117,785,500	42,285,580	143,896,400	65,572,010	28,531,300	745,364.9	120,220,800	278,956,300	15,849,510	294,183,300	392,339,800	222,543,100	166,064,400	230,516,300	1.50E+09	984,043,100	1.11E+09	53,565,400	11,773,930	3932.704
Net operating surplus B.2n	6.22E+09	436,125,700	1.42E+10	8.05E+09	1.45E+09	2,924,000,000	9.31E+09	2.32E+09	8.06E+09	3.95E+09	1.65E+09	121,853,400	5.25E+09	9.30E+09	705203200	1.39E+10	1.42E+10	8.48E+09	8.00E+09	1.25E+10	1.20E+11	1.39E+10	3.95E+10	258,434,900	1.49E+09	3932.704

Source: Eurostat Database.

Table 2. Supply of products to industries (supply table).

		Sectors				Products gross output
		Sec (1)	Sec (2)	..	Sec (m)	
Product	Com (1)	s1, 1		..	s1, n	gross $(com)_1$
	Com (2)	s2, 1		..	s2, n	gross (com)2
	..	..	..	..	..	..
	Com (m)	sm, 1		..	sm,n	gross(com)m
Sectors Gross Output		Gross $(sec)_1$	Gross $(sec)_2$	..	Gross$(sec)_n$	

Authors' conceptualization.

Each row shows the value of products supplied to each industry while the columns represent the industry gross output for each sector. The total gross output of products in the use table should be equal to those in the supply table. Also, the industry gross outputs in the use tables should be equal to those in the supply table. This equality characteristic forms the basis in national income/expenditure accounting.

3) The Input-Output Table

As presented in Table 1 and Table 2, the use and supply tables are used to calculate the use and supply proportions, technical coefficients and the inter-industry or inter-product transaction tables. The inter-industry or inter-product transaction tables are important for compiling the input-output tables. A typical input-output table is presented in Table 3. An input-output table consists of an inter-product transaction table (the shaded area), the final demand matrix and the value added or GDP components (measured using production method).

The shaded area represents the inter-industry coefficients where output of an industry can be used as input in other industries while input of an industry can be used to produce a good. For example, industry $A_{1,2}$ implies that, industry 1 supplies input to industry 2 for use its production process while industry 2 is the purchaser or user of the inputs. This table is the matrix required to calculate the Leontief matrix and the Type I & II multipliers are presented as follows:

Table 3. Input-output table.

		Industry/sectors				Final users					Sectors gross output
		Sector (1)	Sector (2)	…	Sector (n)	HC	Govt	Invt.	Exp.	Imp.	
Industry	Sec (1)	$A_{1,1}$	$A_{1,2}$	…	$A_{1,n}$	Hc_1	$Govt_1$	$Invt_1$	Exp_1	imp_1	Gross $(sec)_1$
	Sec (2)	$A_{2,1}$	$A_{2,2}$	…	$A_{2,n}$					imp_2	Gross $(sec)_2$
		…	…	…	…					…	…
	Sec(n)	$A_{n,1}$	$A_{n,2}$	…	$A_{n,n}$					imp_n	Gross $(sec)_3$
Value added	Compensation of employee (wages)	W1	W2	…	W_3						
	Operating surplus	Ops_1	Ops_2	…	Ops_3						
	Taxes on products	$Taxp_1$	$Taxp_2$	…	$Taxp_3$						
Sectors Gross output		Gross $(sec)_1$	Gross $(sec)_2$	…	Gross $(sec)_3$						

NB: HC = household consumption, Govt = government expenditure, Invt = investment, Exp = exports, Imp = imports, Sec = sectors, Taxp = taxes on products, Ops = operating surplus, W = wages.

Type I and II multipliers derivation

In line with the UN guidelines [14] [7] there are five (5) steps involved in these derivations thus:

Step 1: Calculate from use and supply tables, the use and supply proportions;

Step 2: Calculate inter-product transaction table;

Step 3: Calculate Leontief matrix;

Step 4: Derivation of the multipliers;

Step 5: Validation of the empirical model.

Step 1: The Use and Supply Proportions

Use proportions:

Industry-by-industry use proportions are obtained by dividing each cell entry in the use table by industry gross output in the final row of the use table. We denote intermediate consumption and the value added parts of the use matrix as $i(j+v,k)$.

where,

v = number of rows in value added part of the use table.

But, $G(1, k)$ = Industry gross output.

Then,

$$B(j+v,k)=\frac{U(j+v,k)}{G(1,k)} \tag{7}$$

Equation (7) represents the use proportions matrix comprising, intermediate consumption and value-added components.

The use proportion matrix with only intermediate consumption is given by:

$$B(j,k)=\frac{U(j,k)}{G(1,k)} \tag{8}$$

Each column in Equation (7) represents the proportion of use by each indus-

try, having a column sum of use proportions to be equal to 1.

Supply proportions:

Industry-by-industry supply proportions are obtained by dividing each cell entry by row sum as given below. Suppose the supply matrix is denoted by $M(j, k)$. Gross output of products is a column vector and given by $Q(j, 1)$.

Then the supply proportions matrix is:

$$D(j,k) = \frac{M(j,k)}{Q(j,1)} \tag{9}$$

Notice that row sum is equal to 1, which means that each cell shows the proportion of supply of each product to a particular industry.

Step 2: Inter-industry transaction table

This is presented in two (2) different symmetric transaction tables viz:

a) Industry-by-industry transaction table;

b) Product-by-product transaction table.

The industry-by-industry transaction table is also known as inter-industry transaction table with an equal number of industries (in both rows and columns). The product-by-product transaction table is with an equal number of products (in both rows and columns). However, for this paper used the industry-by-industry transaction table to analyze the industry demand and the industry output, because of its proximity to the statistical sources and the actual market transactions [7].

The general transaction table is done using the use and supply proportions matrix.

Note: Intermediate consumption in use and supply proportions matrices have m number of rows (products) and n number of columns (industries). Hence, $m \neq n$ represents rectangular matrices. Use and supply proportions matrices are as shown in Equations (8) and (9) and are used to calculate the technical coefficient matrix.

Using the Inter-industry transaction table, we obtained the industry-by-industry technical coefficients matrix as follows.

$$a(m,m) = D'(m,n)B(n,m) \tag{10}$$

where,

$D'(m,n)$ = transpose of $D(n, m)$.

NB: Number of columns in the first matrix, $D'(m,n)$ equals number of rows in the second matrix, $B(n,m)$. The resulting matrix denoted by $a(m, m)$ is called the industry-by-industry technical coefficient matrix. Each cell in this matrix represents the proportion of transaction from one industry to another industry, while the diagonal shows the transaction within one particular industry. We obtain the inter-industry transaction table by multiplying the technical coefficients matrix by a diagonal matrix representing industry gross output denoted by *diag.* $[Q(m, m)]$. The resulting inter-industry transaction table is denoted by $A(m, m)$.

$$A(m,m) = a(m,m)\,diag\left[Q(m,m)\right] \tag{11}$$

where,

A (m, m) = symmetric matrix of size m *by* m. Each cell in this matrix represents the value of transaction in dollars from one industry to another industry.

D'A (k, k) s = transaction within any particular industry.

Step 3: Derivation of the Leontief inverse

In Equation (6), the Leontief inverse matrix is presented as:

$$L(m,m) = \left[I(m,m) - a(m,m)\right]^{-1} \tag{12}$$

where,

I (m, m) is an identity matrix of size m *by* m.

Leontief inverse is obtained by:

Technical coefficients matrix a (k, k) minus identity matrix I (k, k).

By inversion, we have,

L (k, k), which represents the Leontief matrix.

Step 4: Derivation of Type I and II multipliers

For Type I multipliers

Multiplier coefficients which represent the column sum of the Leontief inverse is given by:

$$\alpha(i) = \sum_{i=1}^{n} L(i,k) \tag{13}$$

where,

$\alpha(i)$ = multiplier coefficient for any given industry.

For Type II multipliers

By introducing the household consumption (HC) sector as the $(k+1)^{th}$ column and employee income (compensation of employees) as $(k+1)^{th}$ row of the interindustry transaction table, the product-wise household consumption is transformed into the industry-wise household consumption by:

$$HC(m,1) = D'(m,n)\,HC(n,1) \tag{14}$$

where,

HC (n, 1) = column vector of HC (in terms of demand for products obtained from the use table);

HC (m, 1) = HC column vector (in terms of demand for industries).

But, HC (m, 1) is added as the $(m+1)^{th}$ column of the inter-industry transaction table which is the compensation of employees expressed in terms of industries as the row vector COE (1, m).

The new inter-industry transaction table now becomes $A(m+1,m+1)$.

As a follow-up, technical coefficients matrix from the new inter-industry transaction table is given thus:

$$a(m+1,m+1) = \frac{A(m+1,m+1)}{Q(1,m+1)} \tag{15}$$

where,

$A(m+1, m+1)$ = Individual columns;

$Q(1, m+1)$ = row vector of industry gross outputs;

$a(m+1, m+1)$ = technical coefficients matrix with an additional row for compensation of employees and an additional column for *HC*.

Step 5: Validation of the empirical model

This is done to ascertain the validity of the empirical exercise by re-estimating the gross output, intermediate consumption and value added using the model and then comparing them with the actual values. The estimated Leontief inverse is multiplied by the actual values for final demand to obtain the estimated values thus:

From Equation (6),

$$GO = (L)(FD) \tag{16}$$

where,

GO = estimated gross output;

L = estimated Leontief matrix;

FD = actual total final demand.

The results of the model validation exercise are presented in Table 4.

4. Results and Discussions

The components of the final demand comprising, household consumption, non-profit institution serving households, government consumption, gross fixed capital formation and changes in inventories. are classified based on the individual industries. Table 5 summarizes the two (2) sets of industries: 1) Three industries representing only the agricultural sector (agriculture, fishing, food/beverage); and 2) one industry representing only mining sector (mining/quarrying).

The components of the final demand give an indication of the significance of each component in the total final demand of each industry. For example, total final demand of agriculture in 2015 consists of 75 percent Household consumption, 25 percent non-profit institution serving households, 0.12 percent government consumption, 0.49 percent gross fixed capital formation and 0.09

Table 4. Results of the model validation exercise.

		Estimated total ($ million)	Percentage (%)
Industry by industry method	Gross output	106,619,721	52.28
	Intermediate consumption	96,744,498	47.44
	Value added	560,998	0.28

Note: Actual totals are sourced from 2010 Nigeria's supply and use tables; This confirms a high level of accuracy of the empirical model.

percent related to changes in inventories. Household consumption expenditure represents the largest proportion of the final demand. On the other hand, changes in inventories in terms of exports and imports are of particular importance to the agricultural sector.

Table 6 presents components of value added with the contributions of agricultural, fishing, food/beverage and mining industries to total GDP in 2015. It is also observed that approximately 1.13 percent of total compensation of employees is paid to employees in the agricultural sector which is relatively lower compared to the food/beverage industry (having 2.69 percent). The net operating surplus (profit) was highest in the agricultural industry (having about 97.01 percent) compared to other industries. The value-added components of the industries were found to be highest in the mining/quarrying industry having about $14,649,226,208.9 million.

Table 5. Industry-wise final demand and gross output—2015. (Percentages are in parenthesis).

	Industry	Household final consumption	Non-profit institutions serving households	Government final consumption	Gross fixed capital formation	Changes in inventories	Total final demand	Gross output
1	**Agriculture**	3,043,598,000 (74.78)	997,578,500 (24.51)	5,074,180 (0.12)	20,341,830 (0.49)	3,640,730 (0.09)	4,070,233,240 (100)	19,204,942,655.41
2	**Fishing**	131,415,700 (81.98)	25,103,830 (15.66)	2,514,548 (1.57)	8644.47 (0.005)	1,243,550 (0.78)	160,286,272.47 (100)	567,250,260.9
3	**Food and beverages**	14,812,110,000 (68.69)	6,744,033,000 (31.28)	4644.285 (0.000022)	8007.873 (0.000037)	5,934,145 (0.028)	21,562,089,797.158 (100)	322,729,713,512.514
4	**Mining/quarrying**	137,691,400 (85.93)	15,892,030 (9.92)	1,543,437 (0.96)	2,411,855 (1.51)	2,706,671 (1.69)	160,245,393 (100)	587,920,334.78
	Total of all industries	15,111,652,900 (50.90)	7,782,607,360 (26.22)	6,753,165,165 (22.75)	22,770,337.343 (0.077)	13,525,096 (0.046)	29,683,720,858.343 (100)	43,089,826,763.604

Computation from Eurostat database.

Table 6. Components of value added—2015 ($ million) (Percentages are in parenthesis).

	Industry	Compensation of employees	Taxes on production	Subsidies on production	Net operating surplus	Net mixed income	Consumption of fixed capital	Value added	Gross output
1	**Agriculture**	72,255,140 (1.13)	12,033,320 (0.19)	−8,330,602 (−0.13)	6,223,971,000 (97.01)	65,012,030 (1.01)	50,855,150 (0.79)	6,415,796,038 (100)	19,204,942,655.41
2	**Fishing**	10,557,110 (2.34)	440,335.3 (0.09)	−292,756.2 (−0.06)	436,125,700 (96.49)	2,703,238 (0.59)	2,446,571 (0.54)	4,519,801,98.1 (100)	567,250,260.9
3.	**Food/ beverage**	226,730,400 (2.69)	33,005,090 (0.39)	−12,248,850 (−0.15)	8,048,809,000 (95.41)	94,373,290 (1.12)	45,572,020 (0.54)	8,436,240,950 (100)	587,920,334.78
4	**Mining/ quarrying**	177,656,300 (1.21)	40,928,560 (0.28)	−708,251.1 (−0.005)	14,184,160,000 (96.83)	144,330,600 (0.99)	102,859,000 (0.70)	14,649,226,208.9 (100)	322,729,713,512.514
	Total of all industries	262,278,320	86,407,305.3	−21,580,459.3	23,291,491,800	306,419,158	201,732,741	24,126,748,865	43,089,826,763.604

NB: Value added is calculated as the sum of compensation of employees, operating surplus, consumption of fixed capital, other taxes on products, and subsidies.

Multipliers

Multipliers are derived based on direct and indirect effects arising from associate exogenous amendment in an industry's final demand. These multipliers which were estimated on the basis of the I-O analysis, are defined as the system of economic transactions that follow a disturbance in an economy. The Type I multipliers considers only the direct and indirect effects while the Type II multipliers consider both direct, indirect, and induced multipliers. The results of the multiplier coefficients are as presented in Table 7.

As presented in Table 7, different industry groups within the agricultural, fishing, food/beverage and mining/quarrying sectors have varying multiplier coefficients. This means their abilities to generate economic effects are different. The results explain that every $1 additional demand for agriculture generates a total of $ 1.76 and $ 1.77 output and income respectively throughout the economy in 2010.

In other words, a 1dollar investment in the fishing industry will lead to a 2.89 and 3.19 increase in output and income (which is the highest when compared to other sectors) in the economy when both intermediate and final demand sectors (Type 11) are considered. Similarly, a 1dollar investment in the fishing industry will lead to a 2.11 and 2.22 increase in output and income in the economy when only the intermediate sectors (Type 1) are considered. Hence, the output and income in the fishing industry make up 27.93 and 29.24 percent of total domestic production. This implies that the fishing industry does not only represents a major socio-economic sector, but also is one of the major contributors to Nigeria's

Table 7. Multiplier coefficients.

Total output multipliers								
Sector	Nigeria's input output							
	INITIAL	FIRST	INDUS	TOTAL	CONS'M	TOTAL	TYPE I	TYPE II
Agric	1.000	0.383	0.376	1.758	0.653	2.411	1.758	2.411
Fishing	1.000	0.613	0.505	2.118	0.772	2.890	2.118	2.890
Food/bev.	1.000	0.399	0.326	1.726	0.910	2.635	1.726	2.635
Mining/Q	1.000	0.440	0.363	1.803	0.609	2.412	1.803	2.412

Total income multipliers								
Sector	Nigeria's input output							
	INITIAL	FIRST	INDUS	TOTAL	CONS'M	TOTAL	TYPE I	TYPE II
Agric	0.141	0.053	0.055	0.249	0.109	0.357	1.769	2.540
Fishing	0.133	0.087	0.074	0.294	0.128	0.423	2.222	3.190
Food/bev.	0.243	0.055	0.049	0.347	0.151	0.498	1.430	2.063
Mining/Q	0.107	0.072	0.053	0.232	0.101	0.334	2.178	3.127

Input-output analysis result from Eurostat database.

GDP in terms of output and income to Nigeria's economy. The economic meaning of this is that salaries & wages received by employees in the fishing industry have gone through more rounds of subsequent purchases than any other industry. In general, induced effects added by employee income are more than the total direct and indirect effects indicated by the Type I multiplier. Hence, the resultant effect from the protectionist trade measures in fish production (import quota) introduced since the first quarter of 2014 has stimulated the country's self-sufficiency through a 25 percent annual fish import cut.

Currently in Nigeria, fish production by artisanal fishers dominates fish production in Nigeria contributing about 85% of fish production, since aquaculture that could compliment the fisheries is not well developed. This sector employs over eight million fishermen, and regarding eighteen million individuals have interactions in fish process, distribution and selling that accounts for over eighteth of the entire annual domestic fish production [15]. Hence, the fishing industry represents the highest Type I and Type II multiplier coefficients when both output and income are considered.

5. Conclusions and Suggestions for Further Studies

An input-output multiplier approach was used to measure the economic impacts of mining/quarrying and agricultural related industries. The Type I and II multipliers were derived as measures of direct, indirect and induced effects emanating from a change in final demand. Mining/quarrying as a single sector had a Type I multiplier of 1.80 and 2.17 for both output and income respectively and a Type II multiplier of 2.41 and 3.12 for both output and income respectively. Similarly, the agricultural related sector (fishing) was identified to have the highest contributions (2.11 and 2.89 as well as 2.22 and 3.19) in both Types I and II multipliers for both output and income respectively. The different industries had varying multiplier coefficients, which means their abilities to generate economic activities also vary.

The findings of our research were limited by the availability of an up-to-date-data and therefore the present study has given more focus on the application of the methodology and opines on the need for further studies to adopt this study using the most recent data available, then make comparison in order to understand the changes in the multiplier effects occurring over time. Further research is also needed to address the product-wise economic impacts in addition to the aspects such as employment multipliers, import leakage and changing patterns of inter-industry dependence over time as the present study focused on industry-wise economic impacts, as well as the income and output multipliers.

Availability of Data and Materials

Data for the study were obtained online from Eurostat database. These datasets used and/or analyzed in the study are available from the corresponding author on reasonable request.

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Authors' Contributions

The corresponding author, MOE handled the research methodology, analysis and interpretation, while the co-author, CUO, conceptualized the research work, literature and validated the results, and NJN proffered suggestions for further studies. All authors read and approved the final manuscript.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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