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Estimating Production Losses from COVID-19 Pandemic Disruptions Based on Stock Returns

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Abstract

Economic or local disruptions that affect organizations' production activities often result in unexpected losses. An excellent example is the recent COVID-19 pandemic disruption which affected many economies globally. This study presents a deterministic model and uses simple regression analysis to estimate the average condition for production losses. Its corresponding components' input resources impact the overall estimates for selected organizations in Nigeria. It is anticipated that variability in economic activities is always accompanied by unconventional stock returns whose behavior indicates prevailing economic trends. Here we have looked at two organizations in the manufacturing sector as a case study Nigerian Breweries (NB) and Nestle Nigeria, whose stock prices [X] upon analysis reveal that at [X] ≤ N30 and [X] ≤ N821 are estimated conditions for zero net profit for both organizations respectively. Therefore, for NB, during the four quarters of the 2020 fiscal year, the following were assessed production losses, 3.47 billion Naira (Q_1), 4.17 billion Naira (Q_2), 3.72 billion Naira (Q_3) and 0.68 billion Naira (Q_4) with a total of 12.04 billion Naira annual estimated losses; with Costs of Goods Sold (COGS), Operating Expenses (OpEx) and Selling and Advertising Expenses (SAEX) having 39.6%, 44.5% and 15.9% impact on the estimates. Nestle Nigeria records estimated production losses of 5.8 billion Naira (Q_1), 6.4 billion Naira (Q_2), 4.2 billion Naira (Q_3), and -0.8 billion Naira (Q_4) (gain), resulting in a total 15.6 billion Naira annual estimated loss; and COGS, OpEx, and SAEX having 45.9%, 48.2% and 5.9% impact on the estimates respectively. This implies, SAEX had the most negligible percentage impact on overall estimated production losses for both organizations compared to COGS and OpEx. This study, therefore, reiterates the position of other economic reports describing the adverse effects of the pandemic in Nigeria; while also serving as an investment analysis guide to potential investors.

Keywords: Production losses, Estimation, Stock returns, Deterministic model, COVID-19 pandemic, Fiscal year.

1 | Introduction

Stock markets represent "systematic economic news", and their behavior is based on the outcomes of these news findings [6]. This news can be quantified in terms of a few driving variables like industrial production, risk premiums, inflation, and changes in inflation levels to analyze the behavior of stock prices [6]. The cost of a stock is the present value of cash flow that accrues to its owner [25]. Stock returns are used to measure the performance of a company stock [25]. Hence, stock returns are often viewed as economic health and performance indicators. For this reason, a company's financial performance for a given period can also be determined by examining stock returns occasioned by intense business disruptions, as in the case of the global COVID-19 pandemic disruption, which this research work is based on.

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Many studies have attempted to examine the relationship between the financial ratios of companies and the performance of stock certificates. Upon review of relevant literature, studies based on profitability ratios can be grouped into two groups which are stock prices and stock return studies [25]. Although a wide range of studies examines the relationship between stock returns and a firm's profitability ratios, studies about the relationship between share prices and profitability rates are in more limited numbers [25]. These studies comprise the different research areas regarding methods and profitability ratios used, sectors, number of firms, and periods. An example is Cengiz and Püskül [27], who tried to identify profitability ratios related to stock returns. In one such research, earnings per share and book value per share were taken as independent variables and share prices as dependent variables. At the end of the regression data analysis, it was concluded that stocks prices movements are directly proportional to the profitability ratio. In other words, accounting information obtained from the company's balance sheet and income statements have a role in explaining stock price movement. They also examined and revealed the relationship between profitability and stock returns by identifying that an increase in equity and gross sales margin leads to a rise in stock returns.

In contrast, the increased operating profit margin results in decreased stock prices. In another study conducted in the Kuwaiti financial market between the years (2005-2014), the prediction power of 12 financial ratios was analyzed based on data set of 15 firms which took place in three different sectors; results show that the most effective ratios are Returns on Assets (ROA), Returns on Equity (ROE) and net profit ratio in the industry sector, while for service and investment sector they are ROA, ROE, Price-to-earnings ratio and earnings per share [25]. Although there is no perfect equation (relationship) that can predict exactly how the prices of stocks will move, there are market forces or factors that move a stock up or down. Still, ultimately, the price at any given moment is due to the supply and demand at that point in the market which is also subject to economic influence. However, these factors are grouped into fundamental, technical, and market sentiments. Fundamental factors drive stock prices based on the company's earnings and profitability from producing and selling goods and services. Technical factors related to a stock's price history in the market about chart patterns, momentum, and behavioral factors of traders and investors.

In contrast, the market sentiment is simply noise in the market. The investments made by traders based on sentiments, also known as "noise traders," is often compensated by the investment made due to mistaken judgments, thereby suggesting that the market is not affected by sudden noise but by informed investment decisions [22]. There for stock prices and returns can be evaluated using reliable estimation models to determine a company's financial performance. The financial performance of an organization and stock returns are somewhat related to each other [25]. However, the relationship between revenue growth and stock returns has been a puzzle in the corporate and academic environment. Revenue has consistently exhibited direct and significant effects on stock returns [3]. Many studies suggest a strong correlation between stock prices and the production output of organizations and industries. Fama [10] used regression models to justify this relationship between stock prices and real variables like production, cash flows, and Gross National Product (GDP) and growth rates of these variables.

Historically, the Nigerian stock market was established in 1960 but commenced active trading on June 5, 1961, first as the Lagos Stock Exchange; but later (in 1977) renamed the Nigerian Stock Exchange (NSE) [20]. Although trading commenced with few stocks like Nigerian Tobacco Company and Investment Company Limited, by December 2012, more than a hundred and ninety-six (196) equities were traded [20].

It is believed that business disruptions in any economic system greatly threaten organizations' success since incurred operational losses can be enormous. According to Pathak [1], disruption is a state of unbalance or disturbance that affects a system, economy, or nation, which can be an event or series of events causing damage to the normal functioning of these systems. It is a diversion from the state of the usual or expected. The disruptions have increased exponentially [8]-[12]. The average cost of natural disruptions has increased from $50 billion in the 1980s to $200 billion in recent years, and approximate

losses worth $1.5 trillion were incurred between 2003 and 2013 [2]. In Nigeria's economic system report, recent data from the Nigeria Bureau of Statistics (NBS) indicates a decline in the performance of the industrial sector in the first quarter of 2020 on account of the impact of the COVID-19 pandemic, which led to a contraction in manufacturing activities and fall in both crude oil production and electricity generation. The estimated index of industrial production declined by 1.6 percent and 9.6 percent below the level in the preceding and corresponding quarter of 2019, respectively [5]. This decrease is attributed to a contraction in economic activities in all the subsectors during the review period [4]. Also, following the ease of previously imposed lockdown policy measures in some states of the federation to curtail the spread of the pandemic, depending on the firm and consumers' reactions, recovery was, therefore, slower or faster. Real GDP grew by 0.11 percent in 2020 Q4 compared with a contraction of 3.62 percent recorded in 2020 Q_3 and a growth of 2.55 percent in the corresponding quarter of 2019. Therefore, the annual GDP for 2020 contracted by 1.92 percent, compared with the growth of 2.27 percent recorded in 2019 [5]. This confirms the negative impact of the pandemic on the economy. Research has shown that economies often take time to return to business as usual. This, therefore, emphasizes the need to estimate production losses for the period under investigation accurately.

Undoubtedly, knowledge about how the global COVID-19 pandemic disruption affected production activities in Nigeria is imperative. This is necessary for loss estimation purposes and determining the contributions or impacts of various input resources on such estimates, which is a major challenge for organizations, governments, and stakeholders in every business environment. This study, therefore, aims to solve this problem for organizations to facilitate effective production planning and loss management during global or localized operational disruptions.

2 | Research Methodology

Research data for the following organizations were obtained from APT Securities and Funds Limited (member of the Nigeria Stock Exchange) at www.aptsecurities.com/nse-daily-price.php# and https://m.investing.com/equities/historical-data (Real-time NSE financial news provider) for analysis to estimate production losses of these organizations due to the global COVID-19 pandemic disruption using a deterministic model. Therefore, this model analyses the impact of the pandemic using stock price returns, which is believed to be a good representation of underlying economic and production activities in organizations during the affected period.

According to Pathak [1], a deterministic model is considered and used for effective analysis to predict the loss in production solely on the historical output data and input stock prices. This model was also used to estimate production losses from disruptions based on stock market returns as applicable to the 9/11 attacks, the Deepwater Horizon oil spill, and Hurricane Sandy. Many other studies like that of Fama [10], which made use of regression models to justify the relation between stock prices and real variables like production, cash flows, GDP, and the growth rates of these variables, also suggest a strong correlation of the stock prices with the production outputs of any industry. Therefore, consider a given organization (i) in an economy among (n) industrial organizations in a given sector and let the production output (net profit) for the organization (i) for the period (t) be denoted by (X_{it}). The production output (net profit) X_{it} is a linear function of the stock market index prices representing activities in (j) departments within an organization where (P_{jt}) is the stock market index price at time (t) for the organization (i) comprising of (j) departments or sections where J = 1, 2..., m. The linear coefficients relating the stock market index prices of the organization (i) to its production output (net profit) in any given economy is (a_{ij}), and (b_i) is the intercept. The production output (net profit) in the organization (i) at the period (t) is

$$X_{it} = \sum_{j=1}^{m} \left(a_{ij} P_{jt}\right) + b_i. \quad (1)$$

The regression coefficients (a_{ij}) and b_i will be calculated based on the average quarterly historical index stock prices and quarterly production output (net profit) for a given organization in the manufacturing

sector under consideration for a given period. It is assumed that activities in these organizations reflect the larger economy.

Organization (i's) production may decline due to a disruptive event. We, therefore, assume that the average yearly production output (net profit) at the time step immediately before the disruptive event, t = 0, represents the average production output (net profit), and the production output (net profit) at any given time (t) afterward for the organization (i) as $X_{it.}$ L_{it} is the difference in production output at any given time, t, and reference pre-disruption time 0, which in this case represents the loss in actual production activities. This is based on the assumption that production would have been stable to a reasonable extent all through the year if not for the COVID-19 Pandemic, and changes in index stock prices accurately capture any fluctuation:

$$L_{it} = X_{io} - X_{it}. \quad (2)$$

Therefore, this formulation enables us to estimate production losses for organization (i) in terms of net profit losses for a given period (t). It is believed that for each period ranging from the first quarter of the year 2020, when the COVID-19 pandemic disruption impact was first noticed economically and later became intense, for Q_1, Q_2, Q_3, and Q_4, $X_{it} < X_{io,}$ which indicates actual production losses expressed in net profit.

2.1 | Definition of Terms: COGS, OpEx, and Selling and Administration Expenses

Cost of Goods Sold (COGS)

Represent the direct cost related to the manufacturing of goods/services that are sold to customers. It does not include selling, interest, general, and administrative expenses [26].

Operating Expenses (OpEx)

These are expenses a business incurs through its normal business operations, such as rents, equipment, inventory costs, payroll, maintenance, and Research and Development (R&D) costs [26].

Selling and Advertising Expenses (SAEX)

Expenses related to the running of a business that is not directly included in the production of goods or delivery of services. Examples are utilities, insurance payments, marketing, advertising, and promotion expenses [26].

For a given business entity:

$$NP = \sum R - \sum E, \quad (3)$$

where NP = Net Profit, R = Revenue, E = Expenses.

$$\% \text{ Expense Impact on Estimated Losses} = \frac{RE}{FT} X100, \quad (4)$$

where R_E = Range of quarterly expenses, F_T = Total loss impact factor.

3 | Results and Discussion

Table 1. Showing quarterly stock prices of NB and Nestle Nigeria (2019).

Quarterly average stock prices in Naira (2019)	Q1	Q2	Q3	Q4
NB	73	62	51	53
Nestle Nigeria	1497	1453	1303	1347

Table 2. Showing quarterly net profits for NB and Nestle Nigeria (2019).

Quarterly net profit in billions of Naira (2019)	Q1	Q2	Q3	Q4
NB	8.02	5.3	4.36	3.83
Nestle nigeria	12.8	13.4	10.6	8.8

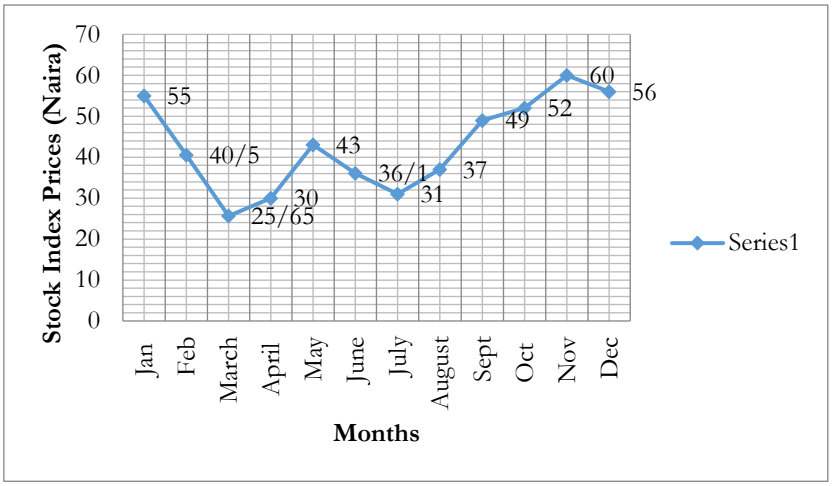

Fig. 1. NB stock prices pattern (2020).

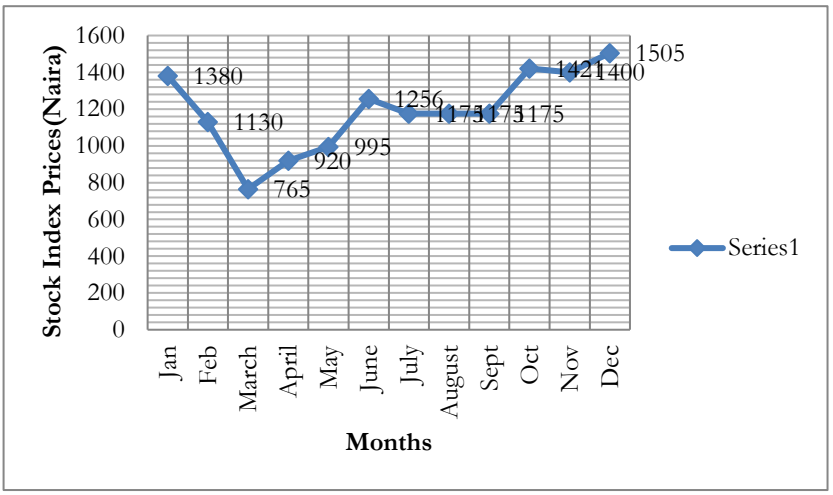

Fig. 2. Nestle Nigeria stock prices pattern (2020).

Fig. 1 and *2* above shows the monthly stock price movement patterns for both organizations during the 2020 COVID-19 pandemic disruption from January to December.

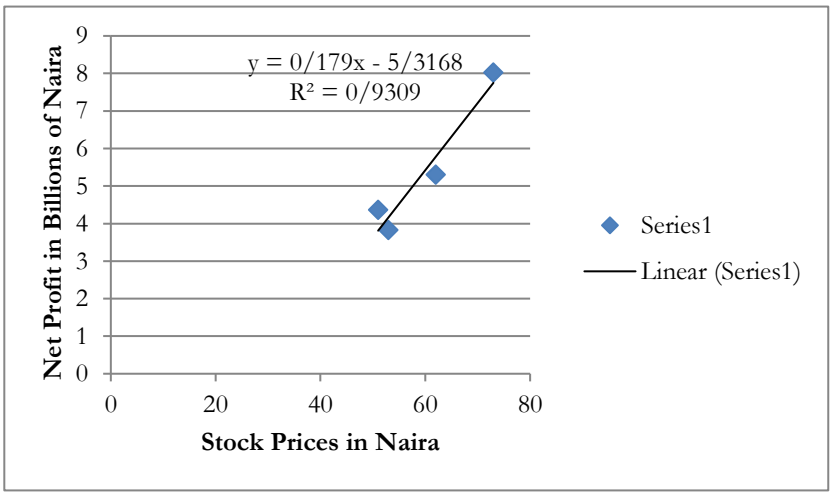

Fig. 3. Graph showing relationship between stock prices and Net Profit (NB) (2019).

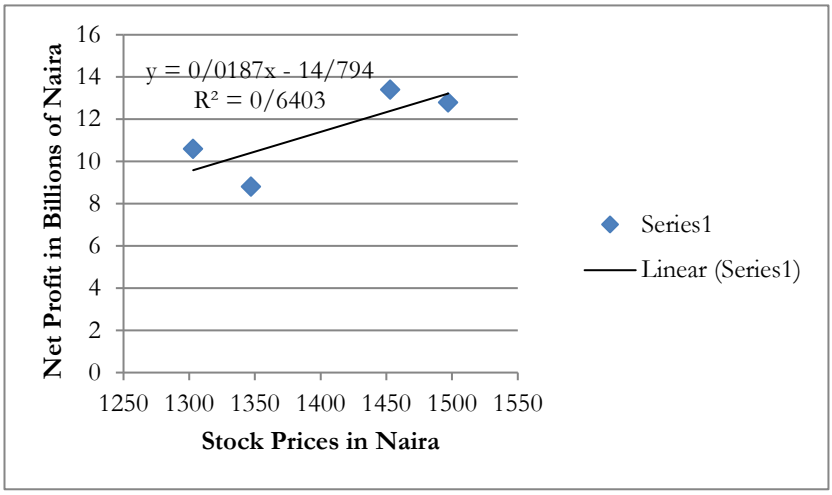

Fig. 4. Graph showing relationship between stock prices and net profit (Nestle Nigeria) (2019).

Figs. 3 and *4* Show the mathematical relationship between stock prices and net profits in the form of simple regression equations. For Nigerian Breweries (NB), we have $Y = 0.179X - 5.316$. Where Y is the dependent variable called net profit in billions of Naira, and X is the independent variable representing stock index prices. A correlation coefficient of $R^2 = 0.9$ indicates a significant relationship between the dependent and independent variables. Therefore, at $X \leq N30$, the average estimated condition for zero net profit on production activities for the business year becomes a basis for estimating production losses for the year 2020. Similarly, for Nestle Nigeria, we have $Y = 0.018X - 14.79$, with $R^2 = 0.64$, which is also significant. Therefore, $X \leq 821$ is the average estimated condition for zero net profit on production activities for the same business year. These equations were used to estimate net profits for all quarters of 2020. These figures were compared to the average yearly net profit figures of the previous year (2019), which is assumed to be a disruption-free period to get the difference, thereby estimating their respective quarterly production losses as shown in *Tables 3* and *5* below. *Tables 4* and *6* below show the summary of estimated net profit losses and COGS, OpEx, and SAEX.

3.1 | Loss Estimation for 2020 COVID-19 Pandemic Disrupted Business Year

Table 3. Showing estimated quarterly production losses (NB).

Year/Quarter	Average Share Price (n), (2020)	Average Net Profit in Billions of Naira (2019)	Estimated Net Profit in Billions of Naira (2020)	Estimated Net Profit Losses in Billions of Naira
2020-Q1	40.38	5.38	1.39	3.47
2020-Q2	36.46	5.38	1.21	4.17
2020-Q3	39	5.38	1.66	3.72
2020-Q4	56	5.38	4.70	0.68

Note: We assume that COGS, OpEx, SAEX, and other negligible miscellaneous expenses make up the total production expenses for the business year. Generally, total expenses include labor, services, supplies, employee's salary, materials, inventory, depreciation, rents, insurance coverage, advertising, income tax, etc.

Table 4. Showing net profit losses (billions), cogs, OpEx, and saex (NB).

Year/Quarter	Net Profit Losses	COGS	OpEx	SAEX
2020-Q1	3.47	48.3	72.2	24.1
2020-Q2	4.17	44.4	64.5	20.3
2020-Q3	3.72	51.4	74.8	23.6
2020-Q4	0.68	74.3	95.9	21.9

Loss estimation for 2020 COVID-19 pandemic disrupted business year (Nestle Nigeria).

Table 5. Showing estimated quarterly losses (NB).

Year/Quarter	Average Share Price (n), (2020)	Average Net Profit in Billions of Naira (2019)	Estimated Net Profit in Billions of Naira (2020)	Estimated Net Profit Losses in Billions of Naira
2020-Q1	1092	11.4	5.6	5.8
2020-Q2	1057	11.4	5.0	6.4
2020-Q3	1175	11.4	7.2	4.2
2020-Q4	1442	11.4	12.2	-0.8

Note: negative sign (-) indicates no loss and a potential excess net profit gain based on estimates.

Table 6. Showing net profit losses (Billions), COGS, OpEx, and SAEX (Nestle Nigeria).

Year/Quarter	Net Profit Losses	COGS	OpEx	SAEX
2020-Q1	5.8	38.7	52.8	14.1
2020-Q2	6.4	41.5	53.9	12.4
2020-Q3	4.2	42.5	55.8	13.3
2020-Q4	-0.8	45.2	60.1	15

3.2 | Relationships between Cogs, OpEx, SAEX, and Net Profit Losses

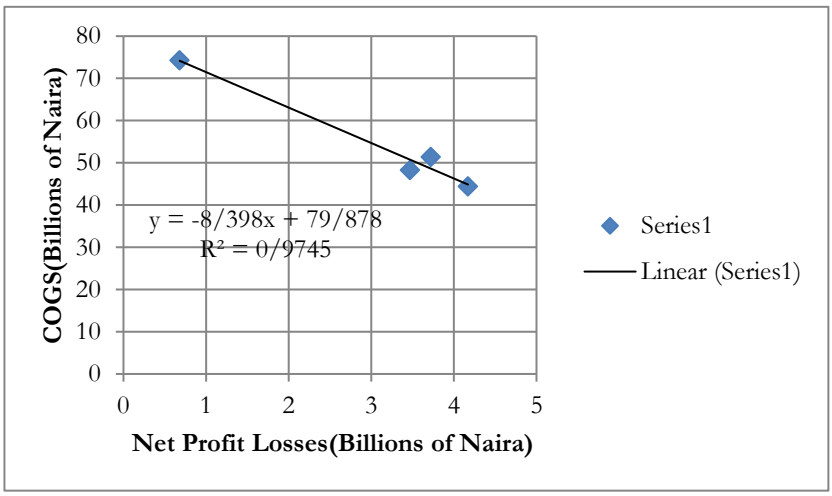

Fig. 5. Graph showing relationship between cogs and net profit losses (NB).

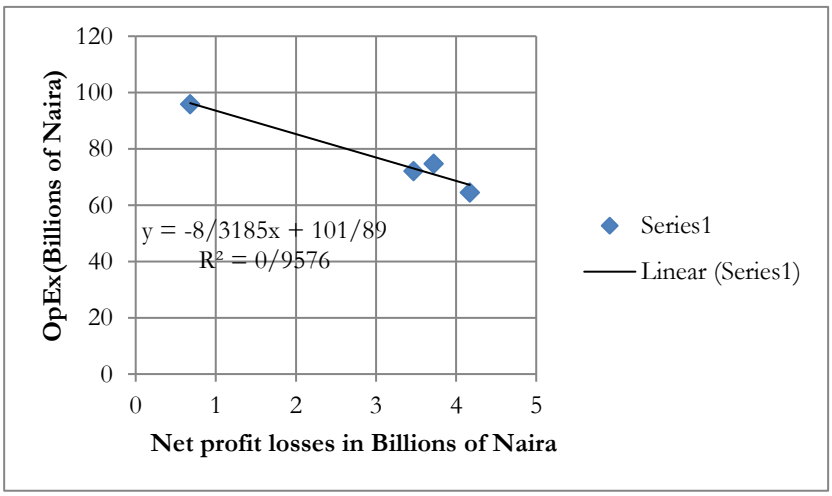

Fig. 6. Graph showing relationship between OpEx and net profit losses (NB).

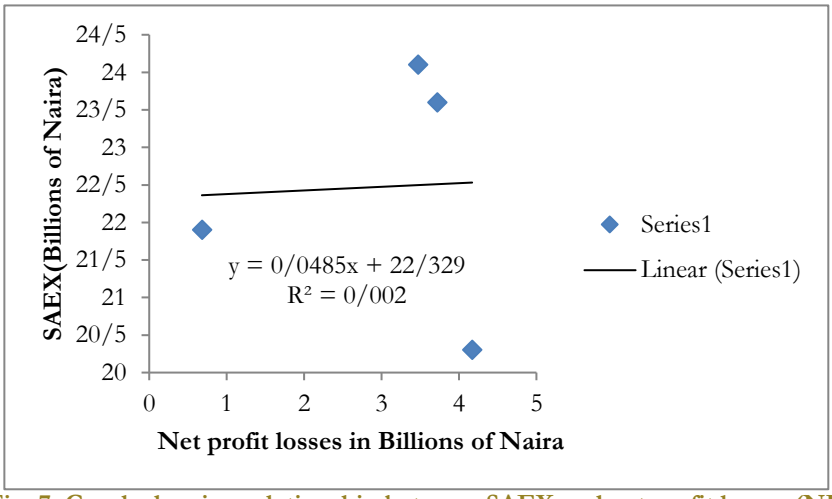

Fig. 7. Graph showing relationship between SAEX and net profit losses (NB).

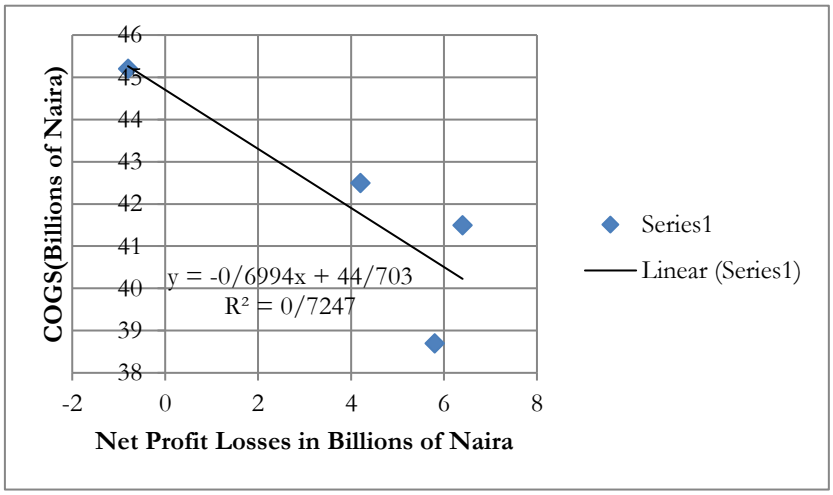

Fig. 8. Graph showing relationship between cogs and net profit losses (nestle).

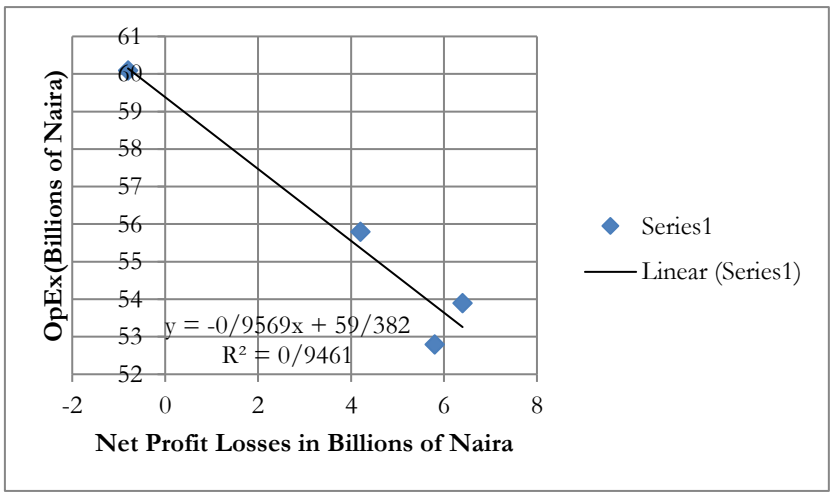

Fig. 9. Graph showing relationship between OpEx and net profit losses (nestle).

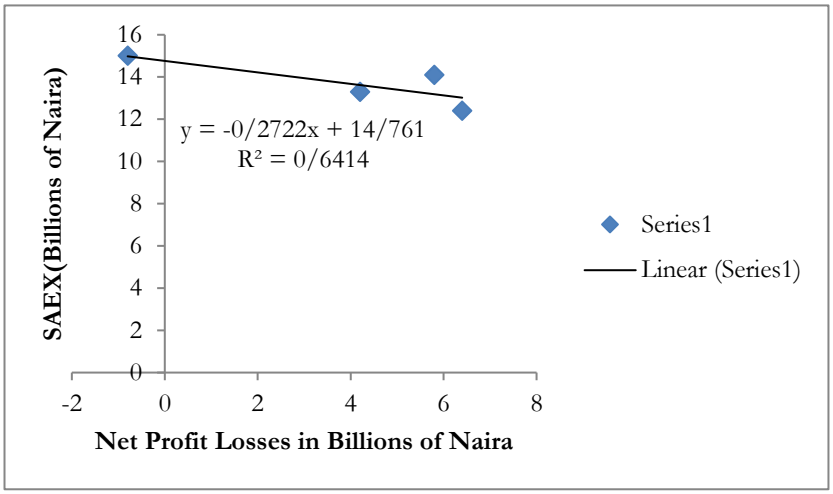

Fig. 10. Graph showing relationship between SAEX and net profit losses (nestle).

The above graph shows the relationship between the various production input resources and estimated net profit losses for both organizations.

3.3 | Percentage Expense Impact Factor on Estimated Productionlosses Determination

Table 6. Showing percentage expense impact on estimated production losses (NB).

Inputs (Billions of Naira)	Q1	Q2	Q3	Q4	Range	Estimated Loss Impact Factor (f)	%Expense Impact on Estimated Losses
COGS	38.7	41.5	42.5	45.2	6.5	6.5	39.6
OpEx	52.8	53.9	55.8	60.1	7.3	7.3	44.5
SAEX	14.1	12.4	13.3	15	2.6	2.6	15.9

Table 7. Showing percentage expense impact on estimated production losses (Nestle Nigeria).

Inputs (Billions of Naira)	Q1	Q2	Q3	Q4	Range	Estimated Loss Impact Factor (f)	%Expense Impact on Estimated Losses
COGS	48.3	44.4	51.4	74.3	29.9	29.9	45.9
OpEx	72.2	64.5	74.8	95.9	31.4	31.4	48.2
SAEX	24.1	20.3	23.6	21.9	3.8	3.8	5.9

From the above graphs (*Figs. 5-10*), COGS and OpEx show a strong negative correlation with net profit losses for both organizations, with correlation coefficients of 0.99 and 0.98 for NB and 0.85 and 0.97 for Nestle Nigeria, respectively. In contrast, SAEX shows no significant correlation with net profit losses for NB (0.04). However, that of Nestle Nigeria is slightly negatively significant at 0.64. Therefore, operational net profit losses during the COVID-19 pandemic for both organizations were caused primarily by unforeseen operational disruptions, which affected raw materials and other OpEx throughout the year. From *Table 6* and *7* above, the outcome of this analysis clearly shows the effect of OpEx on estimated production losses which is comparatively higher than others for both organizations, having a higher estimated loss impact factor (F), followed by COGS and SAEX. Nestle Nigeria, therefore, recorded the following percentage expense impact on estimated production losses: 44.5%, 39.6%, and 15.9% for OpEx, COGS, and SAEX, respectively, while NB has the following percentage expense impact on estimated production losses: 48.2%, 45.9% and 5.8% for OpEx, COGS, and SAEX respectively. Also, NB operational business performance reveals that at the stock price [X] ≤ N30 is the average estimated condition for zero net profit on production activities for the 2019 fiscal year, while that of Nestle Nigeria is at the stock price [X] ≤ 821. These estimates, no doubt, will serve as reliable guides to potential investors. Hence, we conclude that the COVID-19 pandemic's impact on OpEx led to a greater percentage of the estimated production losses in both organizations for the year. This, however, is possibly due to huge losses in operating person-hours occasioned by various lockdown policies to curtail the spread of the pandemic across the federation.

4 | Conclusion

From the preceding analysis, it is evident that the COVID-19 pandemic disruption led to significant production losses for both manufacturing organizations under consideration, even though the impact varies based on estimates as expected. A closer look at *Tables 1* and *2* in the Appendix shows the selected period's global Purchasing Managers' Index (PMI). This is an indicator of the global economic health of various economies during the COVID-19 pandemic. Between the last quarter of 2019 (Q_4) and the third quarter of 2020 (Q_3), the effect of the pandemic on economic activities was more severe compared to the last quarter of 2020 (Q_4) and beyond. From the tables, we can also see the quarterly GDP of selected countries for the period under review. GDP is a reflection of economic activities, especially in a nation's manufacturing and service sectors. All countries listed show a steady decline in GDP figures beginning from the last quarter of 2019 due to the impact of the pandemic, which also showed a slight improvement towards the end of the second quarter of 2020 (Q_2) for most countries, possibly due to the gradual lifting of COVID-19 restrictions and installation of containment measures to deaden the spread of the pandemic which led to a rise in GDP figures during the last quarter of the year. Accordingly, the average J. P Morgan Global Composite PMI accelerated in the fourth quarter of 2020, compared with the levels in the third quarter of 2020 and the corresponding quarter of 2019 [5]. Therefore, this study confirms the effectiveness of a loss estimation model that has also been used in previous research work with potential to significantly improve decision-making and enable industries and governments to expedite recovery actions by providing rich and informative data. Conclusively, the overall business output remained positive for the United States, United Kingdom, China, Germany, India, United Arab Emirates, and Italy but negative for Japan, South Africa and Nigeria [5]. Therefore, the overall economic impact of the COVID-19 pandemic on the selected organizations and the economy for the period considered remains negative compared to pre and post-pandemic eras.

Although we have successfully estimated the production losses and various inputs resources percentage impacts on estimates, it is important to note that the accuracy of such estimates largely depends on the correlation coefficients between the dependent and independent variables. The closer this value is to unity, the more accurate the results obtained.

Both NB and Nestle Nigerian should look into possible measures to optimize their business operations to enhance operational resilience. This can result in low OpEx, which accounted for the highest percentage contribution to estimated production losses since no business entity is entirely immune to unforeseen operational disruptions like in the case of the global COVID-19 pandemic disruption. By so doing, investment risks and operational losses will be minimal. Also, splitting input resources into specifics instead of grouping them will make possible a more detailed analysis and insights towards knowing the highest specific contributor to estimated production losses so that efforts can be channeled to reduce the negative impact of such individual input resources by being proactive. Also, other stock market indices can be analyzed for possible correlation with industrial production output variables which can also be used for loss estimation purposes with the aid of this model or other loss estimation models.

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Appendix

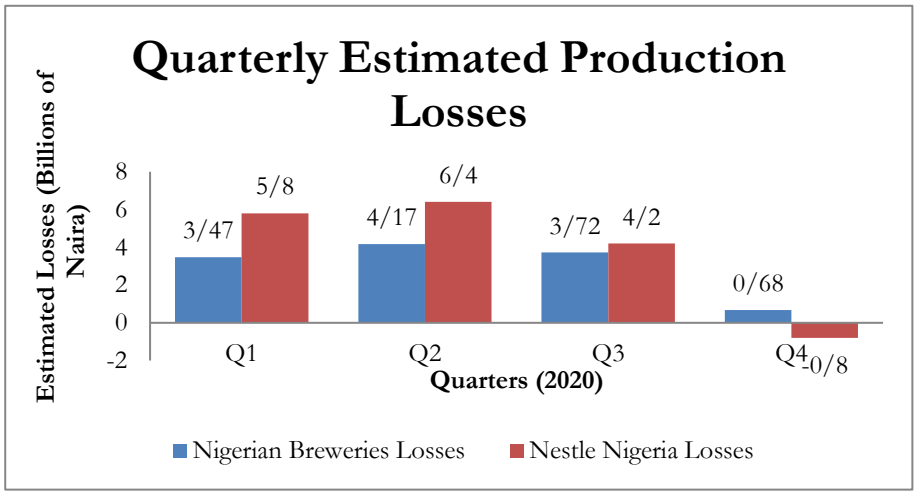

Fig. 1. Quarterly estimated production losses.

Table 1. Global purchasing managers index (PMI).

	2019 Q4	2020 Q3	2020 Q4
Composite	51.27	51.83	52.70
Manufacturing	50.07	51.57	53.53
Servics (business activity)	51.53	51.37	52.20
Employment level	50.93	49.33	51.40

Soursces: JP morgan, CBN staff compilation.

Table 2. Quarterly GDP in selected countries.

	Q4 2019	Q1 2020	Q2 2020	Q3 2020	Q4 2020
US	2.1	0.3	-9.0	-2.9	-2.4
UK	-1.7	-1.7	-21.5	-9.6	-7.8
CHN	6.0	-6.8	3.2	4.9	6.5
IND	4.7	3.1	-23.9	-7.5	0.4
GM	0.4	-2.1	-11.3	-4.0	-3.7
IT	0.1	-5.6	-17.7	-5.0	-6.6
JP	1.7	-1.8	-10.2	-5.0	-1.2
SA	-0.5	-0.1	-17.1	-6.0	Na
NG	2.6	1.9	-6.1	-3.6	0.11

Sources: Trading Economics/Various Country Websites, CBN Staff compilation.
Note: US, UK, CHN, IND, GM, IT, JP, SA and NG represent United States, United Kingdom, China, India, Germany, Italy, Japan, South Africa and Nigeria, respectively.