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# Do Agricultural Sub-Sectors Predict Industrial Capacity Utilisation in Nigeria? Evidence From a Dolado-Luetkepohl Augmented Var, 1990-2024

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## *Abstract*

*This article examines whether agricultural sub-sector outputs predict industrial capacity utilisation in Nigeria over the period 1990-2024. The study is motivated by the persistent policy concern that agricultural expansion in Nigeria has not been fully converted into agro-processing, value addition and manufacturing capacity use. Industrial sector development is proxied by industrial capacity utilisation, while agricultural output is disaggregated into crop, livestock, forestry and fishery production. Because the Augmented Dickey-Fuller results show a mixture of I(1) and I(2) variables, the article adopts the Dolado-Luetkepohl augmented VAR framework rather than ARDL, FMOLS or DOLS. The empirical results show that none of the four agricultural sub-sector outputs individually Granger-causes industrial capacity utilisation at the 5 per cent level, and the joint Wald test is also insignificant. The findings imply that Nigeria's agriculture-industry problem is less an output-volume problem than a weak-linkage problem involving agro-processing, storage, transport, cold-chain systems, finance, power supply and value-chain coordination. The study contributes by combining disaggregated agricultural output, a method suitable for mixed integration orders, and updated policy evidence on agricultural value-chain reforms in Nigeria. Policy should therefore prioritise agro-industrial processing zones, livestock value-chain transformation, sustainable forestry, fishery cold chains and financing mechanisms that convert primary agricultural output into industrial inputs and finished products.*

***Keywords:*** *Agricultural output; industrial capacity utilisation; agro-industrialisation; Dolado-Luetkepohl augmented VAR; Nigeria.*

## 1. Introduction

Agriculture-industry linkage remains central to structural transformation because agriculture supplies food, labour, raw materials, foreign exchange and markets for domestic manufacturing [1, 21]. Nigeria provides an important case because agriculture remains a major livelihood sector while industrial capacity utilisation and manufacturing competitiveness continue to lag behind the levels required for broad-based transformation [13, 24].

Recent macroeconomic evidence shows that Nigeria's growth pattern is still heavily service-led, while agriculture and industry grow more slowly and remain exposed to weak productivity, import dependence, infrastructure constraints and high input costs [13, 17, 24]. The 2019-based GDP rebasing improved the measurement of the economy, but the updated figures did not remove the structural problem that agriculture and manufacturing remain insufficiently connected through processing, logistics and domestic input supply [14, 18].

The policy relevance of this problem has increased because recent development programmes now emphasise value chains rather than primary production alone [26, 2]. The AGROW project [26] targets smallholder productivity, competitive agricultural value chains, digital farmer registries and improved extension services, while the Special Agro-Industrial Processing Zones [2] aim to place processing infrastructure closer to farm output [26, 19].

The empirical question is whether growth in crop, livestock, forestry and fishery output has been transmitted into industrial capacity utilisation in Nigeria [1, 4, 15]. This question matters because positive agricultural output trends may still fail to stimulate industry if post-harvest losses, low processing intensity, cold-chain weaknesses, limited finance and power shortages prevent the conversion of farm output into industrial inputs and finished products [10, 19, 26].

This article contributes to the literature in three ways. First, it disaggregates agricultural output into crop, livestock, forestry and fishery production instead of using only aggregate agricultural output [4, 15]. Second, it uses the Dolado-Luetkepohl augmented VAR approach because the study variables contain I(1) and I(2) series, making standard ARDL bounds testing unsuitable in this case [6, 16]. Third, it links the empirical results to recent Nigerian policy reforms on agricultural value chains, livestock transformation, sustainable forestry and agro-industrial processing zones [9, 22, 26].

## 2. Recent Literature and Hypothesis Development

### 2.1 Agriculture-industry linkage and structural transformation

Recent development literature continues to treat industrialisation as a key route to productivity growth, job creation and higher value addition, while warning that countries that remain dependent on low-productivity primary production may struggle to move into more complex activities [21, 23]. In this framework, agriculture supports industry when raw materials, rural demand and agro-processing linkages are strong enough to stimulate manufacturing capacity utilisation [1, 21].

Evidence from [1] shows that agro-industrialisation in Nigeria is linked to financial intermediation, implying that agricultural output requires finance and institutional support to become industrial value added. The implication is that higher agricultural output is not automatically industrialising unless processing, finance and market linkages are present [1, 26].

### 2.2 Recent evidence on crop, livestock, forestry and fishery value chains

Crop production is Nigeria's dominant agricultural sub-sector, but recent policy documents place increasing emphasis on rice, maize, cassava and soybeans because these crops can support food security, input markets, smallholder income and processing industries [26]. The persistence of post-harvest losses and storage problems weakens crop-to-industry transmission, and a recent agricultural-loss survey in Nigeria [10] shows why output growth must be combined with loss-reduction and processing investments.

Livestock output can supply meat, milk, hides, skins, feed and pharmaceutical-related materials, but Nigeria's livestock sector continues to face productivity, infrastructure and farmer-herder conflict constraints [22]. The creation of a Federal Ministry of Livestock Development and the continuation of livestock transformation initiatives show that current policy recognises livestock as a value-chain and industrial-input issue rather than a purely pastoral activity [22].

Forestry output can support furniture, paper, construction and wood-processing industries, but the sustainability of this linkage depends on legal timber supply, plantation forestry and value addition [9, 7]. Recent forest-sector evidence stresses innovation and sustainability, while the Nigeria EUDR assessment notes that weak timber processing has historically limited domestic value addition in Nigerian wood exports [7, 9].

Fishery production can support food processing, packaging, cold storage, feed industries and export logistics, but the Nigerian fisheries sector still faces a demand-supply gap, post-harvest losses, aquaculture constraints and weak policy enforcement [3, 11]. Recent fisheries research argues that Nigeria must improve aquaculture, processing and post-harvest management if fish output is to contribute more effectively to food security, employment and value addition [3, 27].

### 2.3 Recent empirical studies and research gap

Recent Nigerian studies generally find that agricultural sub-sectors influence economic growth, but they also show that the size, sign and significance of the effects differ across crop, livestock, forestry and fishery outputs [4, 15]. For example, one recent study [4] used a structural VAR model for 1981-2023 and found positive significant effects of crop, forestry and fishery output on economic growth, while livestock was negative and insignificant. Another recent study [15] used an ARDL framework for 1981-2024 and found that crop production and fisheries were relatively more important for long-run growth than livestock and forestry.

Although recent studies are useful, most of them focus on GDP rather than industrial capacity utilisation, and GDP-based findings do not directly answer whether agricultural output strengthens industrial operations [4, 15]. This study, therefore, shifts the outcome variable from aggregate GDP to industrial capacity utilisation, which more directly captures whether factories are able to use productive capacity in response to agricultural sub-sector dynamics [5, 12].

The methodological gap is also important because mixed integration orders can make standard cointegration approaches inappropriate when I(2) variables are present [16]. The Dolado-Luetkepohl augmented VAR approach addresses this problem by estimating an augmented level VAR and testing only the theoretically selected lag coefficients, while additional lags correct the distribution of Wald statistics [6, 20].

*Table 2.1. Recent literature and sources used to reposition the manuscript*

| Theme | Recent evidence used in this article | Role in the manuscript |
|---|---|---|
| Agro-industrialisation | [1]; [26] | Frames agriculture-industry linkages and financial/value-chain conditions. |
| Crop/value-chain constraints | [10]; [26]; [19] | Supports the argument that output must be connected to storage and processing. |
| Livestock transformation | [22]; [8] | Supports the livestock value-chain and industrial-input discussion. |
| Forestry sustainability | [9]; [7] | Supports the sustainable forestry and wood-processing discussion. |
| Fishery and aquaculture | [3]; [11]; [27] | Supports the fishery cold-chain, aquaculture and processing discussion. |
| Econometric method | [6]; [20]; [12] | Justifies augmented VAR causality testing under mixed integration orders. |

***Source:*** *Author's compilation from recent literature and official sources.*

### 2.4 Hypotheses

$H0_1$: Crop production output does not Granger-cause industrial capacity utilisation in Nigeria.

$H0_2$: Livestock production output does not Granger-cause industrial capacity utilisation in Nigeria.

$H0_3$: Forestry production output does not Granger-cause industrial capacity utilisation in Nigeria.

$H0_4$: Fishery production output does not Granger-cause industrial capacity utilisation in Nigeria.

$H0_5$: Crop, livestock, forestry and fishery outputs jointly do not Granger-cause industrial capacity utilisation in Nigeria.

## 3. Methodology

The article adopts an ex-post facto time-series design because the data are historical annual observations that cannot be manipulated by the researcher [12]. The sample covers 1990-2024 and uses industrial capacity utilisation as the dependent industrial-development variable, while crop, livestock, forestry and fishery outputs are the agricultural sub-sector variables [5, 25].

Industrial capacity utilisation is used because it captures the extent to which installed industrial capacity is being used, which is closer to industrial performance than aggregate GDP in an agriculture-industry linkage study [5, 21].

The agricultural sub-sector outputs are retained in disaggregated form because recent evidence shows that crop, livestock, forestry and fishery outputs may have different economic and industrial effects [4, 15].

The baseline relationship is expressed as $IND_t = f(CROP_t, LIVSTK_t, FORE_t, FISH_t)$, where IND is industrial capacity utilisation, CROP is crop production output, LIVSTK is livestock production output, FORE is forestry output and FISH is fishery output. This specification follows the logic that agricultural sub-sectors may contain predictive information for industrial capacity use through raw-material supply, agro-processing and value-chain linkages [1, 12].

The ADF results show that IND, CROP and LIVSTK are I(1), while FORE and FISH are I(2), which means that a standard ARDL bounds approach is not retained because ARDL bounds testing is designed for I(0) and I(1) variables rather than I(2) series [16]. The study therefore uses the Dolado-Luetkepohl augmented VAR framework, which is appropriate for Wald causality testing when variables are integrated, and the analyst wants to avoid pre-test bias from incorrectly imposed cointegration restrictions [6, 20].

The Dolado-Luetkepohl model estimates a VAR in levels with k + dmax lags, where k is the selected VAR lag length, and dmax is the maximum integration order among the variables [6, 12]. In this study, the Schwarz criterion selects k = 1, and the maximum integration order is dmax = 2, so the estimated augmented VAR is VAR(3), while Wald restrictions are imposed only on the first lag coefficients in the IND equation [6, 20].

Augmented VAR system: $Y_t = A_0 + A_1Y_{\{t-1\}} + ... + A_kY_{\{t-k\}} + A_{\{k+1\}}Y_{\{t-k-1\}} + ... + A_{\{k+dmax\}}Y_{\{t-k-dmax\}} + e_t$, where $Y_t = [IND_t, CROP_t, LIVSTK_t, FORE_t, FISH_t]$.

At the 5 per cent level, a p-value below 0.05 leads to rejection of the null hypothesis of no predictive causality, while a p-value above 0.05 implies that the null hypothesis cannot be rejected [6, 12].

## 4. Results

*Table 4.1. Descriptive statistics of study variables*

| Variable | Obs. | Mean | Std. Dev. | Minimum | Maximum | Skewness | Kurtosis |
|---|---|---|---|---|---|---|---|
| IND | 35 | 46.3523 | 8.6122 | 30.4000 | 62.0400 | -0.3109 | -0.6835 |
| CROP | 35 | 9698.0437 | 5373.9992 | 2828.5896 | 17865.5901 | 0.0551 | -1.5497 |
| LIVSTK | 35 | 826.0369 | 296.3694 | 454.8232 | 1247.7194 | 0.1036 | -1.6652 |
| FORE | 35 | 126.6028 | 45.5978 | 72.6136 | 204.6788 | 0.3967 | -1.4534 |
| FISH | 35 | 227.0172 | 115.6283 | 66.4869 | 386.2438 | 0.1387 | -1.5870 |

***Source:*** *Author's computation from the uploaded annual dataset, 1990-2024.*

Table 4.1 shows that industrial capacity utilisation averaged 46.35 per cent, confirming that Nigeria's industrial sector operated below full capacity over much of the sample period [5, 21]. Crop output recorded the largest mean among the agricultural sub-sectors, which is consistent with recent evidence that crop production remains the dominant agricultural component in Nigeria [4, 15].

*Table 4.2. Correlation matrix*

| Variable | IND | CROP | LIVSTK | FORE | FISH |
|---|---|---|---|---|---|
| IND | 1.0000 | 0.7035 | 0.6669 | 0.6230 | 0.6541 |
| CROP | 0.7035 | 1.0000 | 0.9825 | 0.9808 | 0.9871 |
| LIVSTK | 0.6669 | 0.9825 | 1.0000 | 0.9743 | 0.9882 |
| FORE | 0.6230 | 0.9808 | 0.9743 | 1.0000 | 0.9838 |
| FISH | 0.6541 | 0.9871 | 0.9882 | 0.9838 | 1.0000 |

***Source:*** *Author's computation from the uploaded annual dataset, 1990-2024.*

Table 4.2 shows positive correlations between industrial capacity utilisation and all agricultural sub-sector outputs, but the very high correlations among the agricultural sub-sectors indicate that the outputs move together over time and that simple correlation is insufficient for causal interpretation [12]. This justifies the use of a dynamic multivariate framework that controls for the lagged behaviour of all variables in the system [6, 20].

*Table 4.3. Augmented Dickey-Fuller unit-root results*

| Variable | Test form | ADF statistic | Probability | Decision | Order |
|---|---|---|---|---|---|
| IND | Level | -2.183517 | 0.2156 | Not stationary | I(1) |
| IND | First difference | -8.157743 | 0.0000 | Stationary | I(1) |
| CROP | Level | 0.463206 | 0.9828 | Not stationary | I(1) |
| CROP | First difference | -5.125647 | 0.0002 | Stationary | I(1) |
| LIVSTK | Level | 0.489063 | 0.8155 | Not stationary | I(1) |
| LIVSTK | First difference | -2.209057 | 0.0282 | Stationary | I(1) |
| FORE | Level | 0.334905 | 0.9767 | Not stationary | I(2) |
| FORE | First difference | -1.818444 | 0.3654 | Not stationary | I(2) |
| FORE | Second difference | -6.628062 | 0.0000 | Stationary | I(2) |
| FISH | Level | -0.693653 | 0.8347 | Not stationary | I(2) |
| FISH | First difference | -2.312432 | 0.1742 | Not stationary | I(2) |
| FISH | Second difference | -6.307803 | 0.0000 | Stationary | I(2) |

***Source:*** *Eviews result output*

The ADF results in Table 4.3 confirm the presence of I(1) and I(2) series in the same system, which is a key methodological reason for not using a conventional ARDL bounds test in this recast manuscript [16]. The Dolado-Luetkepohl augmented VAR approach is therefore retained because it allows Wald-type causality inference in an augmented level VAR without imposing inappropriate differencing or cointegration restrictions [6, 20].

*Table 4.4. VAR lag selection criteria*

| Lag | AIC | SIC/BIC | HQIC | FPE |
|---|---|---|---|---|
| 1 | 27.0162 | 28.3630 | 27.4755 | 5.509e+11 |
| 2 | 26.5017 | 28.9959 | 27.3410 | 3.690e+11 |
| 3 | 26.6297 | 30.2941 | 27.8443 | 6.016e+11 |
| 4 | 24.0838 | 28.9409 | 25.6671 | 1.252e+11 |

***Source:*** *EViews result output*

Table 4.4 shows that the Schwarz/Bayesian information criterion selects one lag, and this criterion is preferred because the annual sample is small and excessive lag length can consume degrees of freedom [12]. Since dmax = 2, the augmented VAR is estimated with three lags, while the causality restrictions are imposed only on the first lag coefficients [6].

*Table 4.5. Wald causality results from the Dolado-Luetkepohl augmented VAR*

| Null hypothesis direction | Chi-square | df | Probability | Decision | Inference |
|---|---|---|---|---|---|
| CROP -> IND | 1.8014 | 1 | 0.1983 | Do not reject H0 | No significant predictive causality |
| LIVSTK -> IND | 1.2419 | 1 | 0.2816 | Do not reject H0 | No significant predictive causality |
| FORE -> IND | 1.5598 | 1 | 0.2297 | Do not reject H0 | No significant predictive causality |
| FISH -> IND | 0.9925 | 1 | 0.3340 | Do not reject H0 | No significant predictive causality |
| Joint agricultural outputs -> IND | 0.9262 | 4 | 0.4732 | Do not reject H0 | Jointly not significant |

***Source:*** *EViews Wald test output*

The Wald test results in Table 4.5 show that crop, livestock, forestry and fishery outputs do not individually Granger-cause industrial capacity utilisation at the 5 per cent level, and the joint test is also statistically insignificant. This finding does not imply that agriculture is unimportant; rather, it indicates that past agricultural sub-sector outputs do not contain statistically strong predictive information for industrial capacity utilisation in the estimated VAR system [6, 12].

*Table 4.6. Diagnostic summary of augmented VAR equations*

| Equation | R-squared | Adj. R-squared | F-statistic | Prob(F) | Durbin-Watson | JB Prob. | Ljung-Box Prob. | White Prob. |
|---|---|---|---|---|---|---|---|---|
| IND | 0.7446 | 0.5052 | 3.1104 | 0.0154 | 1.8646 | 0.9316 | 0.4450 | 0.4167 |
| CROP | 0.9951 | 0.9904 | 215.2619 | 0.0000 | 2.1907 | 0.0000 | 0.6369 | 0.4167 |
| LIVSTK | 0.9951 | 0.9905 | 216.8093 | 0.0000 | 2.2267 | 0.0000 | 0.4330 | 0.4167 |
| FORE | 0.9997 | 0.9994 | 3366.5723 | 0.0000 | 2.2203 | 0.0000 | 0.4526 | 0.4167 |
| FISH | 0.9979 | 0.9959 | 509.0421 | 0.0000 | 2.2717 | 0.0439 | 0.1659 | 0.4167 |

***Source:*** *EViews diagnostic output*

Table 4.6 indicates that the IND equation is reasonably well behaved because the Durbin-Watson statistic is close to two and the reported Ljung-Box probability does not suggest serious residual autocorrelation [12]. The agricultural output equations show residual normality concerns, which is common in macroeconomic time-series analysis under structural shocks and reinforce the need to interpret the findings cautiously [12, 24].

## 5. Discussion

The first main result is that crop production output does not significantly predict industrial capacity utilisation in the augmented VAR. This is consistent with the argument that crop output volume alone cannot generate industrial development unless the produce is processed, stored and linked to domestic manufacturing value chains [10, 19, 26].

The crop finding also speaks to the difference between agricultural growth and agro-industrialisation. Recent studies [4, 15] find that crop output can contribute to aggregate economic growth, but this article shows that such contribution does not necessarily translate into industrial capacity use when the outcome variable is industrial capacity utilisation rather than GDP.

The second result is that livestock production output does not significantly predict industrial capacity utilisation. This is consistent with recent policy evidence showing that livestock transformation in Nigeria requires ranching, feed systems, veterinary services, dairy processing, meat processing and leather value-chain upgrading before output can become a stable industrial input [22].

The third result is that forestry output does not significantly predict industrial capacity utilisation. This aligns with evidence that forestry-based industrialisation depends on sustainable resource management, legal harvesting, wood processing and value addition rather than output extraction alone [7, 9].

The fourth result is that fishery output does not significantly predict industrial capacity utilisation. This is consistent with the view that Nigeria's fishery sector needs aquaculture investment, cold-chain logistics, processing facilities, training and post-harvest loss reduction to convert production into industrial value added [3, 11, 27].

The joint insignificance of all agricultural sub-sectors suggests that the agriculture-industry transmission channel is weak in Nigeria. This result is compatible with recent policy interventions such as AGROW and SAPZ, which focus explicitly on value-chain upgrading, private capital mobilisation, smallholder productivity, processing facilities and market linkages rather than production alone [26, 19].

## 6. Conclusion and Policy Implications

This article examined whether crop, livestock, forestry and fishery outputs predict industrial capacity utilisation in Nigeria from 1990 to 2024 using the Dolado-Luetkepohl augmented VAR approach. The method was selected because the ADF tests revealed I(1) and I(2) variables, which made the augmented VAR framework more appropriate than ARDL bounds testing in the recast manuscript [6, 16].

The main finding is that none of the agricultural sub-sector outputs individually Granger-causes industrial capacity utilisation, and the joint Wald test is also statistically insignificant.

The conclusion is that agricultural output growth has not been sufficiently transmitted into industrial sector development because Nigeria's agro-processing, storage, power, logistics, cold-chain, finance and value-chain systems remain underdeveloped [1, 10, 26].

The first policy implication is that government should deepen agro-processing zones and link them to major crop belts, because processing facilities located near farmers can reduce post-harvest losses and improve the conversion of crops into industrial inputs [2, 19]. The second implication is that livestock policy should move from herd-size expansion to value-chain transformation through ranching, feed production, veterinary systems, dairy processing, leather clusters and cold-chain investment [22].

The third policy implication is that forestry policy should promote plantation forestry, legal timber supply, traceable wood value chains and domestic furniture and paper processing in order to turn forest resources into sustainable industrial inputs [7, 9]. The fourth implication is that fishery policy should prioritise aquaculture finance, local feed production, fish processing, refrigerated transport, packaging and quality standards so that fishery output can support the food-processing and cold-chain industries [3, 27].

Future studies should use sector-level manufacturing data, state-level panel datasets, agro-processing indicators and infrastructure variables to identify the conditions under which agricultural output becomes industrial capacity utilisation. Future work should also compare augmented VAR, structural VAR and local projection methods to test whether agriculture-industry linkages differ across policy regimes and structural shocks [4, 12, 15].

**Declarations**

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Conflict of interest: The author declares no conflict of interest.

Data availability: The study uses annual secondary data and EViews output supplied with the project; readers can replicate the analysis using CBN/WDI annual series and the augmented VAR specification reported in this manuscript.

Methodological caution: The results are interpreted as predictive Granger causality within an augmented VAR and not as structural causal effects in the experimental sense [6, 20].

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