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Investigating Sectoral Drivers of Economic Growth in Sudan using the Autoregressive Distributed Lag Model

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I. ABSTRACT

This paper investigates the crucial role of sectoral transformations to achieve inclusive growth in Sudan over the period (1960-2020), using the Autoregressive Distributed Lag Model. Subsequently, the paper is two-fold: Firstly, it attempts to test the impact of several factors on sectoral growth in the short run, such as age dependency ratio, capital formation, terms of trade, and capital flows. Then, it defines the speed of adjustment of sectoral shifts to the long-run equilibrium. Secondly, the paper examines the sectoral shocks to economic growth, reflecting the responsiveness of economic growth to the variability of real value-added of productive sectors, Agriculture, Industry, and Services. Notably, the paper reached out to a spectrum of findings consistent with theory and empirics. For instance, the analysis finds that the industry sector in Sudan (incl. the manufacturing sector) could be more responsive to economic growth than the agriculture sector if rational macroeconomic policies support it. It is also evidenced that the effect of sectoral drivers on economic growth does not exist in the short run and is likely to occur over the medium and long term. Finally, in this context, the paper provides policy recommendations to policymakers in Sudan, such as the need for benign institutional reforms across sectors.

Keywords: economic growth, structural transformations, sectoral drivers
JEL: L16, C31

II. Introduction

As growth momentum matters, sectoral drivers of growth matter much more. Therefore, most countries worldwide are enormously keen to emphasize the role of sectoral transformations in achieving economic growth. Some of these countries are known as fast-growing economies, such as some Asian countries (e.g., Bangladesh, India, and Lao PDR), in addition to some countries in Sub-Saharan Africa (e.g., Ivory Coast and Rwanda) *(IMF 2020).* In contrast, many others have struggled to catch up with this momentum.

The fast-growing economies, particularly in Sub-Saharan Africa, have witnessed a considerable share of the service sector, and decline in the agricultural sector’s share pattern. In contrast, the manufacturing sector's share of output has remained unchanged. Correspondingly, in East Asia, the growth is underpinned by dynamism in the manufacturing sector. *Dabla-Norris et al. July (2013).*

According to World Bank’s data, the sectoral composition of the Sudanese economy tends to be less diverse over the past 60 years, with a large contribution for the agricultural and services sectors until 2020 despite the availability of the core factors of production (Land, human and natural resources). Over the period, the manufacturing sector has been the least contributed sector in terms of the value-added, while the agricultural sector has been acting as a premier sector for most of the years competing with the services sector.

It is worth mentioning that the current agricultural map of Sudan has evolved over decades, making it the most contributed sector-led growth, yet to remain classical with no developments and innovations. In the pre-independence period, England benefited from Sudan as one of the colonized empires regarding crops and products, especially Cotton, which used to be processed by British manufacturers. However, in the post-independence period, the agricultural sector witnessed a sort of deterioration in value-added, which declined from 51 per cent of GDP to nearly 33 per cent in the late 1970s, reaching a trough of 21 per cent in 2018. Before 1990, the government expanded one of the most significant projects launched by British (The Gezira Scheme) by setting up small pump irrigation schemes alongside the White Nile funded by government and private sectors, whilst a series of irrigated sugar schemes were developed along with both the Blue and White Niles. (A.W. Mohamed, 2011).

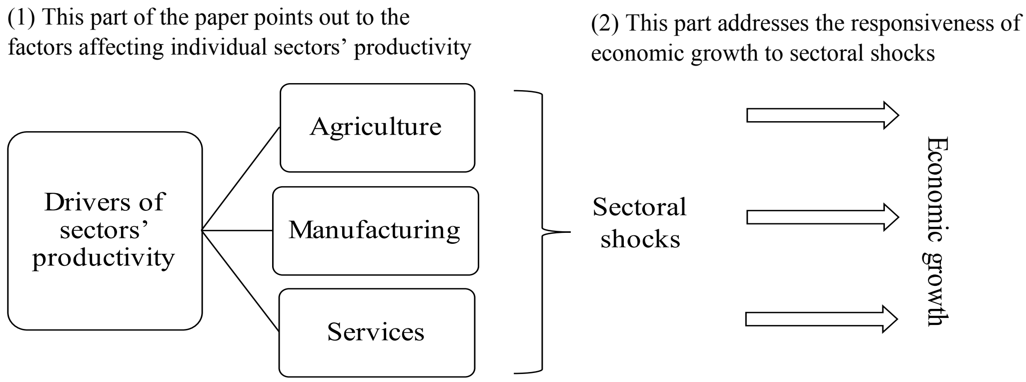
Empirically, oil importers are progressing well to enhance growth momentum, boosted by ongoing reforming programs to remedy economic imbalances. These reforming programs have contributed significantly, in some countries, to macroeconomic stability, supporting growth, reducing unemployment rates, and leading to higher investment and exports level.

On the other hand, in oil exporters, growth momentum is driven by the accelerating activities in non-oil sectors. This acceleration is supported by implementing future visions and strategies to enhance further economic diversification, boost capital spending, and reform. The oil sector in this group of countries is subject to price volatility. Nevertheless, construction operations are likely to benefit from some projects to maximize production and productivity. Another growth momentum in oil exporters is the supportive monetary and fiscal policies for economic growth considering the U.S. monetary conditions. These policies sustain economic growth by stimulating private sector activities and enhancing capital spending levels. (AMF 2020).

To this end, we aim to emphasize the pressing need for sectoral transformation in Sudan and figure out its impact on economic growth. Accordingly, our models have been designed to investigate favourable factors affecting sectoral productivity, hence, economic growth. In this sense, the paper attempts to identify the sectoral determinants of each sector, which allows us to look much closer at the exogenous factors on a sectoral level. On the other hand, the growth momentum has been examined separately by showing the sectoral shocks to economic growth.

Figure (1) roughly displays the paper's overall structure, as the sectoral drivers affect the sectors' productivity, while sectoral shocks refer to the aggregated value-added of sectors.

Figure (1) Sectors' productivity and growth momentum



Source: The Author (2022)

III. Literature reviews

In general, the term "sectoral transformation" is adopted to designate the growth model that Kaldor (1956) and Robinson, (1956,1962) initially coined and later developed by Dutt (1984), Rowthorn (1982) as well as by Bhaduri and Marglin (1990). Some scholars examine the issue of sectoral transformations-growth nexus. For instance, Jha and Afrin (2021) model the economic sectors (agriculture, manufacturing, and services) against economic growth in four South Asian countries (1974-2018) to understand their sectoral transformation pattern.

Overall, the General Equilibrium Dynamics of Multi-Sector Growth Models focusing on the demand side of the economy or preference factors, considering the income effects, e.g., Herrendorf et al., (2013) develop a multi-sector growth model that encompasses the main existing theories of sectoral transformations. While the second set of models addresses the sectoral reallocation of resources over the long run, considering the price effects and supply-side factors. S. Jensen and E. Larsen (2004)). On the other hand, Ketels (2017) views sectoral composition as a largely endogenous part of development, while the sectoral transformation literature frames it as a fundamental driver of growth. In the same context, Salazar st al (2014) points out that changes in production structure led to growth acceleration. (Peneder 2009) finds that multifactor productivity growth appears to be the central driver of sectoral performance.

In this vein, scholars adopt several methodologies to investigate sectoral shifts that led to growth. For instance, Buera and Kaboski (2012a,b) explain industry and services growth patterns through swelling human capital or skill intensity in the services sector and scale technologies as a complementary mechanism. Matsuyama, (2009) and Uy et al., (2012) show trade openness productivity growth rates across sectors to determine the implications for sectoral transformations. On the other hand, Jones et al., (2013) points to several influential factors, including political stability, stakeholder, demand for certain types of knowledge, and communication and sharing. Similarly, Herrendorf, Rogerson and

Valentinyi, (2014) develop a multi-sector extension of the one-sector growth model that encompasses the main existing theories of sectoral transformation.

On the other hand, McMillan et al. (2016) address that the experience with structural transformation worldwide has been extremely diverse and uneven. They find that sectoral changes played only an insignificant role in the recent growth performance of middle-income countries while others contributed significantly. Another paper Lopes et al. (2017) addresses the core drivers of structural transformations, pointing to technology as an indispensable driver, plus capital accumulation, institutional setting, and urbanizations. These drivers are centered in three main dimensions: capital development, institutions settings, and demographic transitions.

Moreover, Kaldor (1956) points to four main empirical facts affecting growth-based models, per capita output grows at a constant rate, the capital-output ratio, the real rate of return to capital, labor productivity. While Kongsamut et al. (2001) and Page (2018) points out that Policies should not concentrate obsessively on manufacturing nor ignore it. Therefore, the key to economic growth will be policies that promote and maximize the sector's productivity and exports in agri-business, tradable services, and the manufacturing sector.

Moreover, there are several empirical studies carried out in different countries. For instance, Atiyas, Galal and Hoda (2015) find that some meditation countries have reached a level of transformation. It could move structurally from relying on agriculture to depend on the industrial sector, yet the transformation tends to be insufficient.

IV. Variables and assumptions

The paper relies on different variables representing the drivers of sectoral growth in Sudan, considering the broad definition of this nexus, such as the value-added (% of GDP) of agriculture, industry, and services sectors acting as dependent variables, in addition to a set of explanatory variables, age dependency ratio, capital formation, GDP per capita, FDI, terms of trade, employment rate in agriculture, industry, and services sectors. The bulk of data was gathered from the World Development Indicators Database (World Bank).

More importantly, there has been a limitation to including a quantitative variable as a proxy for technological advance as a crucial sectoral driver; instead, we add a dummy variable representing technology, taking the value "1" when Sudan began to adopt technology, roughly from the year of 2000 forward, and the value "zero" otherwise.

To further have a closer look into the sectoral transformation over the period (1960-2020), the paper split this period into two sub-periods. The first period is from 1960 to 1990, while the second period is from 1990 until 2020.

Table (1) Definition of variables

The variable	Definition
$agri_i$	value added of agriculture (% of GDP)
$indu_i$	value added of industrial sector (% of GDP)
$serv_i$	value added of services sector (% of GDP)
cf_i	capital formations (% of GDP)
adr_i	age dependency ratio (% of working-age population)
$percap_i$	GDP per capita (current US$), GDP per capita is gross domestic product divided by mid_year population
top_i	Degree of openness or terms of trade, which is the sum of exports and imports of goods and services measured as a share of gross domestic product

Variables mentioned on the table used as given by the data publishers. The author adjusted them in accordance with the research purposes. e.g., adjustment to logarithmic form, or to differences.

The paper set the following assumptions for investigating the plausibility of sectoral drivers and their impact on sectors productivity.

- The paper assumes that sectoral factors are less likely to impact sectors' growth unless they have been underpinned by robust institutional settings, and legal reforms, especially in the short run. The Wald test can evidence this after fulfilling the entire pre-requestees (correlation, cointegration...etc.)
  - $H_0: \beta_{j(j=1,2,\ldots p)} = 0$: the null hypothesis, the short-run relationship does not exist.
  - $H_1: \beta_{j(j=1,2,\ldots p)} \neq 0$: the alternative, the short-run relationship does exist.
- Over the long run, we assume the impact of sectoral drivers appears in the long run. The Error Correction Term (ECT) evidence this after fulfilling the required pre-conditions (correlation, cointegration, … etc.)
  - $H_0: \beta_{j(j=1,2,\ldots p)} = 0$: the null hypothesis, the long-run relationship does not. exist
  - $H_1: \beta_{j(j=1,2,\ldots p)} \neq 0$: he alternative, the long-run relationship does exist.

V. Methodology and modelling

Several studies employ different econometrics approaches to test the impact of sectoral productivity on sectors' value-added. For instance, Switching Regimes Model was first introduced by Quandt (1958) and later developed by Goldfeld and Quandt (1973), surveying different techniques to deal with switching regressions and paying more attention to the sectoral transformations. Alternatively, other scholars employ quantile regression to interpret sectoral changes across different quantiles, such as Koenker and F. Hallock (2001).

This paper uses the Autoregressive Distributed Lag Model (ARDL)[1] to check for the short-run and long-run relationship between a set of variables and the value-added of the core sectors (agriculture, industry, and services). As a result, our respective variables, age dependency ratio, capital formation, GDP per capita, FDI, employment in sectors, labor force participation rate, and terms of trade, tend to be purely stationary at the level *I(0)*, and at the first different *I(1)* but none of them is stationary at the second difference *I(2)*.

$$Y_t = \beta_0 + \beta_1 Y_{t-1} + \beta_2 Y_{t-2} + \cdots + \beta_p Y_{t-p} + \delta_1 X_{t-1} + \delta_2 X_{t-2} + \cdots + \delta_q X_{t-q} + u_i \quad (1)$$

$$E(u_i \backslash Y_{t-1}, Y_{t-2}, \dots \dots .., X_{t-1}, X_{t-2}, \dots .) = 0 \quad (2)$$

Equation (1) is a typical form of the *ARDL (p, q)*, where *p* as a linear function refers to the lagged values of a time series Y_t, whereas q points to the number of lags of time series X_t (This is called *p* lags of Y_t and q lags of X_t). Initially, the paper adopts the following *ARDL* model:

$$ARDL(p,n): \begin{bmatrix} agri_t \\ indu_t \\ serv_t \end{bmatrix} = \beta_0 + \sum_{i=1}^{p} \beta_i \begin{bmatrix} \Delta agri_{t-i} \\ \Delta indu_{t-i} \\ \Delta serv_{t-i} \end{bmatrix} + \sum_{i=0}^{n} \delta_i \, \Delta v_{t-i} + \varphi_1 \begin{bmatrix} agri_{t-i} \\ indu_{t-i} \\ serv_{t-i} \end{bmatrix} + \varphi_2 v_{\ t-i} + \varepsilon_i \quad (2)$$

To determine the sectoral drivers in the short-run and long-run, the paper estimates the above model represented by equation (2). This equation is an aggregated form of the three core equations under examinations that represent the sectoral transformations in the short run and the long run. Where v_{t-i} refers to explanatory variables with their respective number of lags, namely, age dependency ratio, gross capital formation, degree of openness, GDP per capita, employment rate in a sector, and FDI flows. β_0 is the intercept, while β_i and δ_i refer to the short-run coefficients, φ_1 and φ_2 represents the long-run coefficients. The model contains the following short-run term of sectors' value added with their respective lags

$$ARDL(p,n): \sum_{i=1}^{p} \beta_i \begin{bmatrix} \Delta agriculture_{\ t-i} \\ \Delta industry_{\ t-i} \\ \Delta services_{\ t-i} \end{bmatrix} + \sum_{i=0}^{n} \delta_i \, \Delta v_{t-i},$$

and contains the following long-run term:

$$\varphi_1 \begin{bmatrix} agriclture_{\ t-1} \\ industry_{\ t-1} \\ services_{\ t-1} \end{bmatrix} + \varphi_1 v_{\ t-1}$$

where *p* is the number of lags of the dependent variables, while *q* is the number of lags of the explanatory variables.

[1] ARDL stands for Autoregressive Distributed Lag, and OLS stands for ordinary least square

1- Test for stationarity and cointegration

To estimate an ARDL model, it is necessary to ensure that all variables under concern are stationary at the level *I(0)* or at the first difference *I(1)*, and none of these variables is stationary at the second difference *I(2)*. To do so, the paper relies on the augmented *Dicky-Fuller (ADF)* test to check for stationarity at the 5 per cent significance level.

Consequently, there is a need to set a hypothesis testing for stationarity. The null hypothesis indicates that a time series has a unit root (non-stationary), while the alternative hypothesis points out that a time series has no unit root, meaning that it is stationary. The analysis in this regard, shows that the P-value associated with most of the variables at the first difference is less than the 0.05 significance level; accordingly, we cannot reject the null hypothesis of non-stationary at the first difference I(1).

Alternatively, to decide whether to perform the ARDL model or to turn out to another method such as VECM, one can test for the cointegration among the entire variables instead of testing the unit root of individual variables. To do so, the paper checked for the cointegration between variables using the bound test for cointegration. The null hypothesis H_0 indicates that there is no cointegration; hence, it is recommended to perform the ARDL model, while the alternative hypothesis H_0 points to the existence of the cointegration, and in this case, we need to perform VECM.

As it can be seen in the table (4), the analysis evidenced that there is no cointegration for the three sectoral equations represented by the sectors valued added. The decision has been made based on the F-statistic value and F-statistic value stated in the table (4). It is strongly recommended that these values must lie between I(0) and I(1). More obviously, they have to be greater than *I(0)* and lower than I(1).

2- The optimal number of lags

Given the above results, it would be efficient to perform an ARDL model that is appropriate for investigating the sectoral drivers of sectors' value-added. However, there is a need to identify the optimal number of lags beforehand. According to Wooldridge (2009), the optimal number of lags depending on the data frequency tends to be smaller between 1 to 2 lags of low-frequency data (annual) and increase as the data frequency gets higher (e.g., 1 to 8 lags for quarterly, and 6, 12, or 24 lags for monthly data).

Table (5) reveals that one lag is the optimal number of lags for the agriculture sector, services sector, capital formations, and terms of trade. While age dependency ratio, employment in service, and labour force participation tend to have two lags, industrial sector value-added and employment rate in agriculture have four lags, whereas employment in the industrial sector has five lags. Therefore, our *ARDL (p, q)* would consist of agriculture, industry, and services sectors as dependent variables and their lagged values, and a set of conditioning variables including age dependency ratio, gross capital formation, degree of openness, GDP per capita, the employment rate in a sector, as follows:

$$\mathbf{ARDL(1,1,1,3,2,4)}: \boldsymbol{Agriculture_t} = \beta_0 + \sum_{i=1}^{1} \beta_i \Delta AGRI_{t-i} + \sum_{i=0}^{1} \delta_i \, \Delta CF_{\,t-i} + \sum_{i=0}^{3} \delta_i \Delta ToP_{\,t-i} + \sum_{i=0}^{1} \delta_i \Delta PERCAP_{\,t-i} + \sum_{i=0}^{1} \delta_i \Delta EMP_{agri_{t-i}} + \sum_{i=0}^{1} \delta_i \Delta ADR_{t-i} + \varphi_1 agri_{t-i} + \varphi_2 adr_{t-i} + \varphi_3 cf_{t-i} + \varphi_4 top_{t-i} + \varphi_5 percap_{\,t-i} + \varphi_6 fdi_{\,t-i} + \varepsilon_i$$

$$\mathbf{ARDL(4,1,1,3,2,5)}: \boldsymbol{Industry_{\,t}} = \beta_0 + \sum_{i=1}^{4} \beta_i \Delta INDU_{t-i} + \sum_{i=0}^{1} \delta_i \, \Delta CF_{\,t-i} + \sum_{i=0}^{1} \delta_i \Delta ToP_{\,t-i} + \sum_{i=0}^{3} \delta_i \Delta PERCAP_{\,t-i} + \sum_{i=0}^{2} \delta_i \Delta EMP_{industry_{t-i}} + \sum_{i=0}^{5} \delta_i \Delta ADR_{t-i} + \varphi_1 indu_{t-i} + \varphi_2 adr_{t-i} + \varphi_3 cf_{t-i} + \varphi_4 top_{t-i} + \varphi_5 percap_{\,t-i} + \varphi_6 fdi_{\,t-i} + \varepsilon_i$$

$$\mathbf{AARDL(1,1,1,3,2,2)}: \boldsymbol{Services_t} = \beta_0 + \sum_{i=1}^{1} \beta_i \Delta INDU_{t-i} + \sum_{i=0}^{1} \delta_i \, \Delta CF_{\,t-i} + \sum_{i=0}^{1} \delta_i \Delta ToP_{\,t-i} + \sum_{i=0}^{3} \delta_i \Delta PERCAP_{\,t-i} + \sum_{i=0}^{2} \delta_i \Delta EMP_{services_{t-i}} + \sum_{i=0}^{2} \delta_i \Delta ADR_{t-i} + \varphi_1 indu_{t-i} + \varphi_2 adr_{t-i} + \varphi_3 cf_{t-i} + \varphi_4 top_{t-i} + \varphi_5 percap_{\,t-i} + \varphi_6 fdi_{\,t-i} + \varepsilon_i$$

The above Models consists of short-run and long-run coefficients with their respective number of lags as indicated in Table (3).

3- Residual diagnostic tests

The paper examines the residual diagnostic of sectoral drivers by checking several tests, such as serial correlation, normality test, heteroskedasticity, and model stability. More clearly, there is a need to check that there are neither serial correlations nor heteroskedasticity as they lead to biased outcomes. Nevertheless, it is also crucial to ensure that our sectoral models are normally distributed and largely stable.

$$Lagged\ residuals: z_{t-1} = \begin{bmatrix} agriculture_{t-1} \\ industry_{t-1} \\ services_{t-1} \end{bmatrix} - b_0 - b_1 va_{t-1} \qquad (5)$$

Where z_t is the residual term, $sectors_{\,t-1}$ and va_{t-1} refers to the residual value of the dependent variables and regressors, b_0 and b_1 are the coefficients of the residual term.

Table (6) shows results obtained from the residual diagnostics, confirming that there is neither serial correlation nor heteroskedasticity. The analysis demonstrates that the p-values associated with Chi-Square for the industrial sector during (1960-2020) equal 0.0004, lower than the 0.05 significance level. As a result, we cannot reject the null hypothesis, meaning that there is no evidence of serial correlation. During this period, the remaining sectors demonstrate a problem of serial correlation and heteroskedasticity. Similarly, the period (1960-1990) indicates that only service sector has no serial correlation, while agriculture and industrial sectors tend to have the problem of serial correlation and heteroskedasticity.

The paper also tests the linearity between the conditioning variables and the value-added of sectors. According to the value of *Jarque Bera*, which is more than 0.05, the relationship between sectors' value-added and economic growth is not linearly correlated. Therefore, the paper tests the correlation between the concerned variables and economic sectors. We accepted the null hypothesis at 0.01 and 0.05 significance levels and rejected it at a 0.1 significant level. In other words, there is no serial correlation according to the Harvey method.

Furthermore, the normality test is evidenced by Figure (2), which demonstrates the P-value of the *Jarque Bera test.* The analysis finds that the value-added of manufacturing, agriculture, and services sectors are normally distributed because the P-value equals 0.015, less than the 0.05 significance level. Given this result, we cannot reject the null hypothesis, meaning that the variables are normally distributed.

Figure (4,5, and 6) show that our $\mathrm{ADL(p,q)}$ models are largely stable in the sense that the blue line lies within $5^{\pm}$ Boundary.

4- The benchmark model

The benchmark model has been estimated using the OLS method to capture the direction of the link between sectoral drivers and the value-added of economic sectors, *See Table (8)*. Though, the model indicates that some variables are yet to be captured in the sectoral models as adjusted R squared across the three sectoral models are relatively low. For example, in the agriculture sector model, R-squared is 0.34, around 0.61 in the industrial sector and 0.47 in the services sector.

Consistent with the findings of Dabla-Norris et al.(2013), this paper finds the following: -

Over the entire period (1960-2020), the Age Dependency Ratio (ADR) is positively and significantly associated with the value-added of agriculture, industry, and services sectors; the coefficient is high in agriculture, as ADR raises by 1 per cent keeping other variables constant, the value-added increase by 0.44 per cent, 0.9 per cent, and 0.34 per cent in agriculture, industry, and services sectors respectively.

Moreover, we incorporate the degree of openness (terms of trade) as a proxy for external demand. The analysis reveals that the degree of openness is negatively and significantly associated with the agriculture and services sectors in Sudan, while positively and significantly associated with the industrial sector. More precisely, as the terms of trade increases by 1 per cent, holding others constant, the value-added of agriculture and services decreases by 0.08 per cent, and 0.55 per cent, respectively, while industry value-added increases by 0.08 per cent.

More importantly, the analysis shows that net FDI flows is positively and significantly associated with sectoral shares of the three sectors Dabla-Norris, et al. (2013). If FDI flows increase by 1 per cent, the value-added of agriculture, industry, and services sectors is likely to increase by 0.9 per cent, 1.8 per cent, and 0.3 per cent, respectively. This result sounds consistent with other studies and empirics.

Moreover, the analysis finds that GDP per capita is negatively and significantly associated with the value-added of the agriculture sector and positively and significantly associated with the value-added of the industry and services sectors.

5- ARDL (p,q) bound test

In this part, the paper relies on the *F-statistic* value of the Wald test to check the short-run causality among variables. The null hypothesis points to no short-run relationship between variables, while the alternative indicates short-run causality. Generally, there is evidence that the short-run relationship does not exist among variables across sectors over the entire period and sub-periods, except for the industry sector.

Accordingly, the analysis finds no evidence for the short-run causality between sectoral drivers and the value-added of economic sectors. The P-value evidence this result in Table (9) which is lower than the 5 per cent significance level. Instead of reading the P-value of *F-statistics*, it could be possible to read the value of *F-statistics* itself and compare it with the *Pisaran* critical value.

In this regard, the structural transformation by its broad definition is less likely to occur in the short run due to its forked nature. However, on the ground, sectoral drivers such as capital formation and adoption of new technology are supposed to leave their impacts on sector productivity instantly depending on sector-specific factors.

6- The Error correction model

The detection of long-run causality is a must for the dynamic of economic sectors towards achieving inclusive and sustainable growth in the long run. The paper in this part focuses on the long-run coefficients φ_1 and φ_2 in equation (3) and more precisely, on coefficients φ_1 to φ_4 in equation (4) Were $ECT_{\ t-1}$ stands for the error correction terms with lag 1.

$$The\ long\_run\!:\ = \varphi_1 gdp_{t-1} + \varphi_2 agriculture_{t-1} + \varphi_3 manufacturing_{t-1} + \varphi_4 services_{\ t-1} + \varphi_4 ECT_{\ t-1} + \varepsilon_i \qquad (6)$$

$$\text{ECT: } \Delta GDP_t = \beta_0 + \sum_{i=1}^{1} \beta_i \Delta GDP_{t-i} + \sum_{i=0}^{1} \delta_i\, \Delta agriculture_{\ t-i} + \sum_{i=0}^{3} \delta_i \Delta manufacture_{\ t-i} + \sum_{i=0}^{1} \delta_i \Delta services_{\ t-i} + \emptyset Z_{t-1} + \varepsilon_i \qquad (7)$$

$$Z_{t-1} = \varphi_1 gdp_{t-1} + \varphi_2 agriculture_{t-1} + \varphi_3 manufacturing_{t-1} + \varphi_4 services_{\ t-1} + \varphi_4 ECT_{\ t-1} \qquad (8)$$

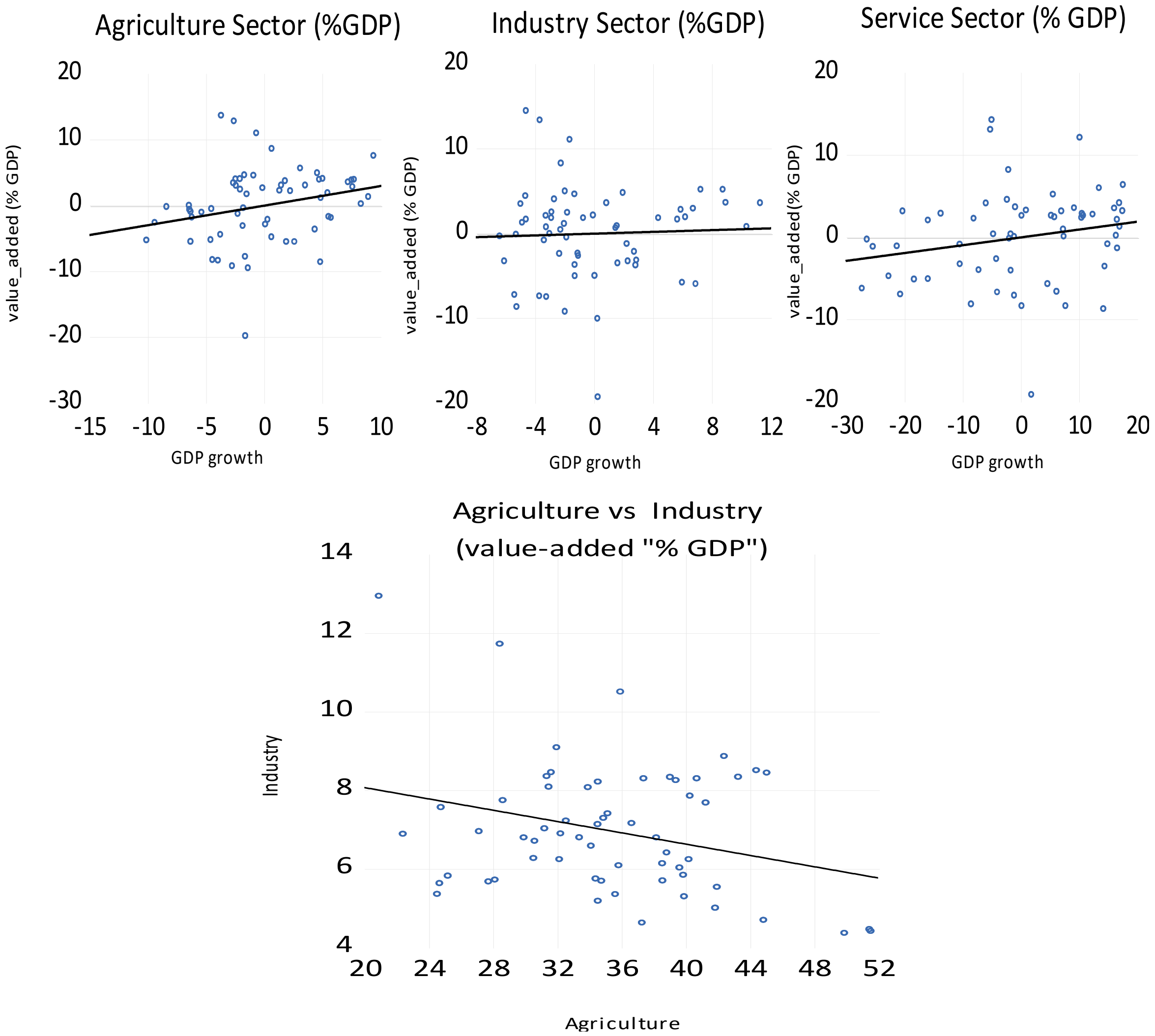
There is a need to add the error term with its time lag as an explanatory variable. There would be existence for the long-run relationship only if the error correction term has a negative sign coefficient and statistically significant at all levels.

As shown in Tables (13, 14, and 15), the coefficient of the Error Correction Term is negatively and significantly associated with the services sector, meaning that there is speed of adjustment toward long-run equilibrium in this sector. However, the analysis does not reveal that agriculture and industry might have a potential speed of adjustment in the long run unless the country urgently adopts for the strong institutional settings followed by robust macroeconomic policies.

VI. Leveraging the sectors value-added to GDP

Figure (2) demonstrates the relationship between GDP growth and the value-added of economic sectors (Agriculture, Industry, and Services). Although, as it can be seen, the leveraging plots show a positive correlation across individual sectors, the slop's elasticity yet to be uneven in these sectors.

Figure (2) Leverage plots between sectors' value-added to GDP growth



For instance, the slop tends to be steeper in the agriculture and services sectors than in the industrial sector. In other words, the industrial sector is likely to be more responsive to economic growth than agriculture and services; this indicates that as the value-added of the industry increase slightly, the GDP is expected to grow proportionally.

More precisely, Figure (2) reveals a positive relationship between economic growth and the value-added of agriculture and manufacturing, noticing a more robust response for the industry than the agricultural sector. In addition, the steep upward sloping curve between the agricultural and service sectors' value-added and economic growth can be observed. It indicates that the agriculture sector's contribution to economic growth is more robust than the manufacturing sector.

On the other hand, the model indicates that the services sector in Sudan shows a positive relationship to the economic growth across the three sectors. This result aligns with empirical literature Krishna and Young (2006), confirming that the service sector's relative growth has a deleterious effect on economic growth. However, the association between the service sector and growth could have both effects depending on how the service sector's role is measured and the size of the informal sector.

Another study Loungani et al. (2017), finds that changes in service value-added are correlated to country-level GDP growth outcomes. The relation of service growth with overall economic growth has become more substantial over time.

VII. Sectoral shocks to economic growth

After testing the short-run and long-run relationship between sectoral shifts and economic growth, it is crucial to determine how would economic growth responds to sectoral shocks. To do so, we run multivariate VAR model of order 1, denoted as VAR (1), to figure out the growth response to sectoral shocks during the period (1960 to 2019). we regress the GDP growth as dependent variable to the value-added of the three productive sectors in Sudan *(Agriculture, Industrial, and Services)*; the data was obtained from the world development indicators database.

$$gdp_t = \alpha_0 + \phi_1 gdp_{t-i} + \phi_2 agri_{t-i} + \phi_3 indu_{t-i} + \phi_4 serv_{t-i} + w_i$$

In Table 16, we run a VAR model to figure out the growth response to sectoral shocks during the period (1960 to 2019). The model tests for structural breaks unit root to capture the sudden variation in the Model's coefficients over time. It is then figured out how sectoral shocks may hurt economic growth; the analysis employs the impulse response function in this vein.

Figure (3) Sectoral shocks to economic growth

The horizontal axis represents the unit variation of the impact variable, and the vertical axis represents the unit variation of the impacted variable.

It is noted that the response of economic growth to sectoral shocks varies across sectors due to the inter-sectoral linkages pass on the standard sectoral shocks through the spillover effect of the common factors. For instance, supply-induced shocks cause a deterioration in one of the strategic sectors' contributions to the value-added. The agricultural sector is more sensitive to shocks than other sectors (manufacturing and services) because its output is considered the core inputs for manufacturing and services, and also due to the climate related risks, and other environmental factors. For instance, the seasonality of rainfall shortage causes a reduction in agricultural productivity and non-agricultural productivity via sectoral interlinkages. This indicates a strong tendency for the short-run impact of supply sectoral shocks compared to the long-run impacts.

Besides, the global oil prices surge affects firms' balance sheets and raises these firms' variable costs, providing that oil is a crucial input for the production process. As a result, firms are likely to raise prices to keep the marginal profit protected. Therefore, supply-induced shocks lead to lower productivity and higher commodity prices. In addition to the supply shocks mentioned above, the sector might encounter a natural disturbance such as drought or flood, leading to stagnation or fall in the world trade. This, in turn, causes a sudden capital flight. On the other hand, demand shocks affect the aggregate demand for the economy's output. For instance, a slowdown in consumption due to a cut in wages or tax rate hike induces producers to reduce prices, which lowers output.

Another example is the slowdown in investment because of government policies towards interest rate hikes or because the country is politically unstable. Exogenous shocks can also be classified as a demand sectoral shock; this results in interest rates or price differential between the domestic economy and trading partners. (e.g., the emergence of the new Corona virus causes some disturbance to the global economy, mainly affecting the trade in services (tourism, travel, and remittances).

VIII. Conclusion and policy implications

As per the previous analysis, the paper reached to a set of outcomes necessary for the policymaking process, providing an appropriate policy mix for Sudan and some policy recommendations in this vein.

- The paper finds no evidence of a short-run relationship between sectoral productivity and economic growth. However, the analysis reveals that the long-run relationship exists. This result is consistent with empirical and theoretical literature, which point that the growth momentum of sectoral transformations appears in the medium and long term.
- The analysis reveals a positive relationship between economic growth and the value-added of agriculture, industry, and services sectors, noticing a more robust response for the industry than the agricultural and services. This result provides evidence that the industrial sector (incl. manufacturing sector) is more elastic than agriculture and services.
- On the other hand, it is found that the manufacturing sector's value-added demonstrates an upward sloping trend over the period (1960-2020), yet flatter than the agriculture sector's slope. Similarly, the agriculture and services sector, shows

an upwards sloping trend towards economic growth, reflecting the informal activities in the Republic of Sudan.

- After testing for the sectors' elasticity in Sudan (sectoral linkages or cross-sector spillover), the analysis finds that the value-added of agriculture is negatively associated with the manufacturing value-added.

The intuition behind the results as mentioned above is because the following:

- Countries with higher household consumption and lower saving rates are likely to have capital goods slower than countries with lower household consumption and higher savings rates through fund accumulation.
- Countries lacking access to the global market may suffer more in dealing with their assets replacement or maintenance, leading to a higher depreciation rate.

To this end, much has yet to be done in Sudan to further reallocate the Total Factors Productivity (TFP) across economic sectors, given the country's favorable specific factors.

- There is a need to promote economic transformations to advance productive sectors; this allows the republic of Sudan to enhance their efforts in other less focused sectors. Subsequently, the Sudanese government could emphasize diversifying production patterns, trade, and strategies.

- The Sudanese government could maximize the manufacturing output through maximizing the agriculture output. This requires the government to provide capital and raw materials for the manufacturing sector. Fortunately, the Republic Sudan could use in-state raw materials in the mining and agriculture sectors.

- The Sudanese government needs to formalize informal activities specially in the services sector. It is also recommended to recognize household service providers and the barriers to outsourcing.

- There is an urgent need for the Sudanese government to set strategies and future visions for Sudan covering the entire sectors. These strategies could be aligned with SDGs directions and the international and regional bests practices.

Table (2) Descriptive statistics

	GDP growth	Agriculture Sector	Manufacturing Sector	Services Sector
Mean	2.770	35.429	6.966	33.262
Median	3.468	34.858	6.802	38.739
Maximum	16.665	51.503	12.942	54.697
Minimum	-17.005	20.901	4.368	-7.856
Std. Dev.	5.785	6.743	1.670	15.818
Skewness	-0.350	0.169	1.051	-1.164
Kurtosis	4.330	2.932	4.955	3.312

Table (3) Stationary test

		1% level	5% level	10% level	ADF test (t-statistics)	P-value
Agriculture sector (value added)	I(1)**	-3.5460	-2.9120	-2.5940	-6.5150	0.0000
Industry sector (value added)	I(1)**	-3.5460	-2.9120	-2.5940	-8.3110	0.0000
services sector (value added)	I(1)**	-3.5460	-2.9120	-2.5940	-6.5380	0.0000
GDP per capita	I(1)**	-3.5482	-2.9126	-2.5940	-3.1003	0.0300
terms of trade	I(1)**	-3.5461	-2.9117	-2.5936	-7.2538	0.0000
capital formation	I(1)**	-3.5812	-2.9266	-2.6014	-6.6370	0.0000
Foreign Direct investment	I(1)**	-3.5441	-2.9109	-2.5931	-8.4351	0.0000

*the variable is stationary at the level I(0). ** the variable is stationary at the first difference. *** the data is available from 1990 – 2020. Null Hypothesis: AGRI has a unit root. Lag Length: 0 (Automatic - based on SIC, maxlag=10).

Table (4) Bound test performance for cointegration test

	sign.	F-statistic value = 3.313305		T-statistic value=-3.585344	
		I(0)	I(1)	I(0)	I(1)
Agriculture Value added	10%	2.26	3.35	-2.57	-3.86
	5%	2.62	3.79	-2.86	-4.19
	2.50%	2.96	4.18	-3.13	-4.46
	1%	3.41	4.68	-3.43	-4.79
	sign.	**F-statistic value = 3.224341**		**T-statistic value =-2.951625**	
		I(0)	**I(1)**	**I(0)**	**I(1)**
Industry value added	10%	2.26	3.35	-2.57	-3.86
	5%	2.62	3.79	-2.86	-4.19
	2.50%	2.96	4.18	-3.13	-4.46
	1%	3.41	4.68	-3.43	-4.79
	sign.	**F-statistic value = 5.033370**		**T-statistic value= -3.262060**	
		I(0)	**I(1)**	**I(0)**	**I(1)**
Service value added	10%	2.26	3.35	-2.57	-3.86
	5%	2.62	3.79	-2.86	-4.19
	2.50%	2.96	4.18	-3.13	-4.46
	1%	3.41	4.68	-3.43	-4.79

* Denotes rejection of the hypothesis at the 0.05 level, unrestricted cointegration rank test

Table (5) Optimal number of lags

	no Lag	Lag (1)	Lag (2)	Lag (3)	Lag (4)	Lag (5)
Industrial value added	6.259536	4.714943	4.724372	4.766009	4.594588*	4.636194
Agriculture value added	6.347122	5.199991*	5.212423	5.23916	5.274302	5.30394
Services value added	7.805702	5.460463*	5.493855	5.501458	5.53665	5.507859
Age dependency ratio	6.692794	6.692794	6.692794*	6.692794	6.692794	6.692794
Gross capital formation	6.559036	5.502245*	5.539132	5.583071	5.586444	5.635925
GDP per capita	15.04699	12.92229	12.86991	12.76049*	12.79611	12.82377
Terms of trade	7.756636	6.171802*	6.199765	6.232604	6.224264	6.230618
Employment in agriculture [(1)]	6.030083	1.020042	0.739294	0.79808	0.559477*	0.585431
Employment in Industrial [(1)]	4.678033	0.738304	0.514628	0.591283	0.639058	0.350927*
Employment in Services [(1)]	4.650542	-0.5235	-0.578652*	-0.530901	-0.45452	-0.432448
Labor Force Participation	2.78367	-0.984935	-2.054404*	-1.977756	-1.902366	-1.831386

*Indicates the optimal number of lags. These number of lags have been determined based on AIC: Akaike information criterion. [(1)] The number of lags of these variables are for the period (1990-2020).

Table (6) Residual Diagnostic: testing for serial correlation and heteroskedasticity

	1960-2020		1960-1990		1990-2020	
	Ser. Corr.	Heteroskedasticity	Ser. Corr.	Heteroskedasticity	Ser. Corr.	Heteroskedasticity
Agriculture						
F-statistics	0.7929	0.3087	0.8926	0.2321	0.8615	0.4773
Chi-squared	0.3739	0.2605	0.7816	0.2142	0.6311	0.4043
Industrial						
F-statistics	0.0003	0.5556	0.3891	0.0886	0.8806	0.3583
Chi-squared	0.0004	0.4987	0.088	0.1218	0.2143	0.315
Services						
F-statistics	0.8443	0.2485	0.0037	0.2152	0.7339	0.5585
Chi-squared	0.7751	0.2351	0.0019	0.2056	0.3666	0.469

Table (7) Normality test

	1960-2020		1960-1990		1990-2020	
	Jarque-Bera	Probability	Jarque-Bera	Probability	Jarque-Bera	Probability
Agriculture	0.770171	0.680392	0.720279	0.697579	3.266894	0.195255
Industrial	3.740121	0.154114	2.873836	0.237659	0.512057	0.77412
Services	1.941022	0.378889	15.5231	0.000426	2.090381	0.351625

Figure (4) Model stability for agriculture sector

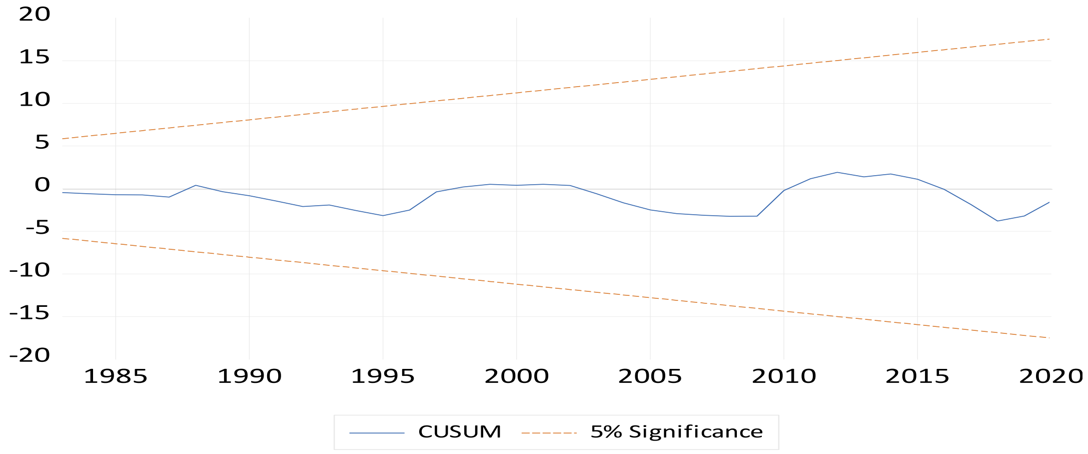


Figure (5) Model stability for industry sector

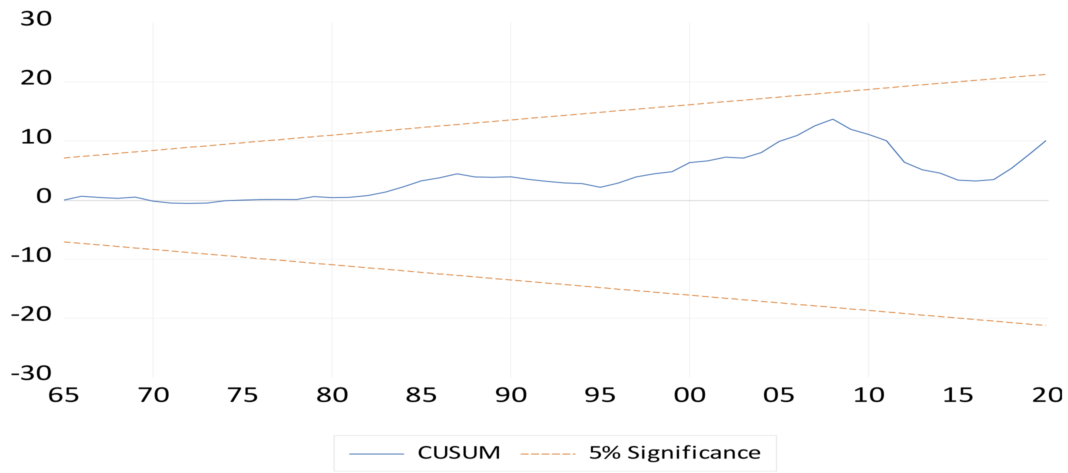


Figure (6) Model stability for services sector

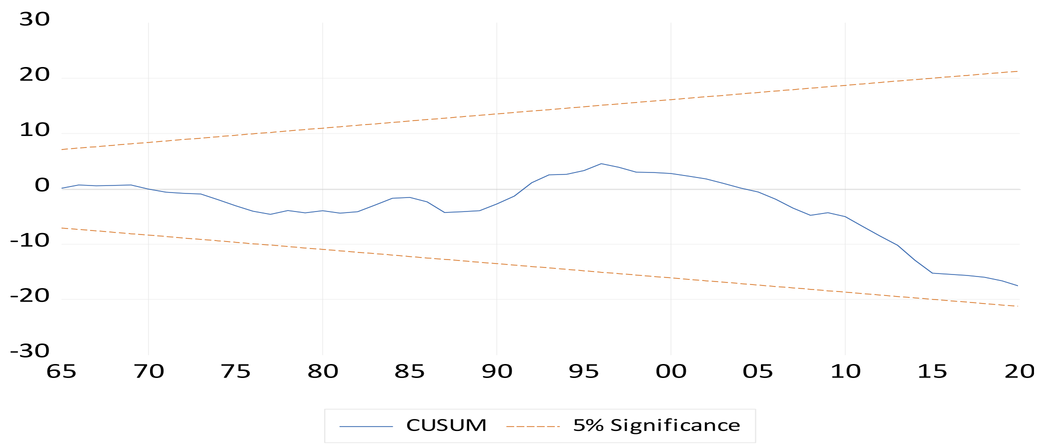


Table (8) OLS model for sectoral drivers of sectors' productivity

	Agriculture		Industrial		Services	
	Coefficient	Prob.	Coefficient	Prob.	Coefficient	Prob.
The Intercept	55.343*	0.010	48.194*	0.000	-101.973**	0.025
Age Dependency Ratio	-0.164	0.474	-0.431	0.001	1.456*	0.004
Capital formation	0.005	0.948	0.035	0.390	0.379**	0.021
Foreign Direct investment	-0.501	0.490	0.584	0.137	2.934	0.063
GDP per capita	-0.010*	0.000	0.002**	0.036	0.018*	0.000
Degree of openness	0.054	0.524	0.200079	0.0000	-0.79395*	0.0001
R-squared	0.4181		0.7095		0.5136	
Adjusted R-squared	0.3652		0.6831		0.4693	
S.E. of regression	5.3727		2.8822		11.5231	
Sum squared resid	1587.6390		456.8898		7302.9530	
Log likelihood	-185.9590		-147.9690		-232.5030	
F-statistic	7.9027		26.8680		11.6134	
Prob(F-statistic)	0.0000		0.0000		0.0000	
Mean dependent var	35.4292		16.0775		33.2617	
S.D. dependent var	6.7432		5.1200		15.8183	
Akaike info criterion	6.2937		5.0482		7.8198	
Schwarz criterion	6.5014		5.2558		8.0274	
Hannan-Quinn criter.	6.3751		5.1295		7.9011	
Durbin-Watson stat	0.4774		0.7461		0.4121	

*, **, ***The estimated coefficient is statistically significant at 0.01, 0.05, 0.10 level of significance respectively

Table (9): The short-run causality

	1960-2020		1960-1990		1990-2020	
	value	Probably	value	probability	value	probability
Agriculture						
F-statistics	8.542451	0.000100	8.344554	0.000200	13.243110	0.000000
Chi-squared	34.169800	0.000000	33.378210	0.000000	52.972440	0.000000
Industrial						
F-statistics	1.527892	0.222200	1.911520	0.138500	20.309170	0.000000
Chi-squared	6.111567	0.191000	7.646082	0.105400	81.236670	0.000000
Services						
F-statistics	27.109390	0.000000	29.489380	0.000000	2.780023	0.048800
Chi-squared	108.437600	0.000000	117.957500	0.000000	11.120090	0.025200

Table (10) Agriculture sector: short run models

		1960 - 2020	1960 - 1990	1990 - 2020
$\Delta AGRI_{t-1}$				
	Coefficient	0.60*	0.25	0.89**
	Prob.	0.01	0.42	0.05
ΔADR_{t-1}				
	Coefficient	3.68	2.86	5.65
	Prob.	0.22	0.43	0.37
ΔADR_{t-2}				
	Coefficient	-2.27	0.69	-1.63
	Prob.	0.45	0.86	0.81
ΔCF_{t-1}				
	Coefficient	0.06***	0.03	0.45
	Prob.	0.37	0.60	0.37
ΔTOP_{t-1}				
	Coefficient	0.28***	0.11	0.21
	Prob.	0.06	0.67	0.39
$\Delta PERCAP_{t-1}$		0.00	0.00	0.00
	Coefficient	0.40*	0.75*	0.59*
	Prob.	0.00	0.00	0.00
$\Delta PERCAP_{t-2}$				
	Coefficient	0.76*	0.28**	0.63*
	Prob.	0.00	0.02	0.00
$\Delta PERCAP_{t-3}$				
	Coefficient	-0.01**	0.00	-0.01
	Prob.	0.03	0.85	0.15
ΔFDI_{t-1}				
	Coefficient	0.65	-7.12	0.89
	Prob.	0.45	0.61	0.49
Interaction Term (Tech*agriculture)				
	Coefficient	-0.11**	0.26	-0.14
	Prob.	0.03	0.13	0.20
Intercept				
	Coefficient	36.64*	34.79*	38.75*
	Prob.	0.00	0.00	0.00
R-squared		0.370	0.269	0.487
Adjusted R-squared		0.233	-0.187	0.167
Prob(F-statistic)		0.011	0.800	0.219
Durbin-Watson stat		0.815	1.049	1.011

*, **, ***The estimated coefficient is statistically significant at 0.01, 0.05, 0.10 level of significance respectively

Table (11) Industry sector: short run models

		1960 - 2020	1960 - 1990	1990 - 2020
$\Delta indu_{t-1}$				
	Coefficient	0.301**	0.383	-0.309
	Prob.	0.033	0.194	0.450
$\Delta indu_{t-2}$				
	Coefficient	0.346*	0.548***	-0.058
	Prob.	0.005	0.066	0.858
$\Delta indu_{t-3}$				
	Coefficient	0.553*	0.502***	0.044
	Prob.	0.000	0.099	0.929
ΔADR_{t-1}				
	Coefficient	-0.326	0.409	2.934
	Prob.	0.758	0.722	0.407
ΔADR_{t-2}				
	Coefficient	0.242	-1.633	3.753
	Prob.	0.816	0.202	0.405
ΔCF_{t-1}				
	Coefficient	-0.007	-0.002	-0.429
	Prob.	0.764	0.922	0.206
ΔTOP_{t-1}				
	Coefficient	-0.042	-0.070	0.234
	Prob.	0.482	0.399	0.316
$\Delta PERCAP_{t-1}$				
	Coefficient	-0.001	-0.003	0.001
	Prob.	0.780	0.418	0.824
$\Delta PERCAP_{t-2}$				
	Coefficient	0.001	-0.001	-0.004
	Prob.	0.492	0.750	0.427
$\Delta PERCAP_{t-3}$				
	Coefficient	0.003	-0.004	-0.009
	Prob.	0.262	0.388	0.250
ΔFDI_{t-1}				
	Coefficient	-0.134	-3.432	-1.381
	Prob.	0.690	0.397	0.238
Interaction term (Tech*industry)				
	Coefficient	0.407*	0.136	0.353*
	Prob.	0.000	0.367	0.013
Intercept				
	Coefficient	12.827	13.272	
	Prob.	0.000	0.000	
R-squared		0.91	0.69	0.91
Adjusted R-squared		0.89	0.43	0.71
Prob(F-statistic)		0.00	0.04	0.03
Durbin-Watson stat		1.18	1.80	1.68

*, **, ***The estimated coefficient is statistically significant at 0.01, 0.05, 0.10 level of significance respectively

Table (12) Services sector: short run models

		1960 - 2020	1960 - 1990	1990 - 2020
$\Delta SERV_{t-1}$				
	Coefficient	-0.107152	-0.375277	-0.181478
	Prob.	0.489	0.24	0.4623
ΔADR_{t-1}				
	Coefficient	1.147054	3.658785	-1.660535
	Prob.	0.5914	0.034	0.6912
ΔADR_{t-2}				
	Coefficient	0.88825	-0.585918	-5.105539
	Prob.	0.685	0.7708	0.26
ΔCF_{t-1}				
	Coefficient	0.018218	-0.002764	0.755079**
	Prob.	0.7038	0.9101	0.0317
ΔTOP_{t-1}				
	Coefficient	-0.002844	0.043558	0.113084
	Prob.	0.9773	0.7187	0.4604
$\Delta PERCAP_{t-1}$				
	Coefficient	0.006896**	-0.008338	0.016616*
	Prob.	0.0677	0.1346	0.0168
$\Delta PERCAP_{t-2}$				
	Coefficient	0.005577	-0.00472	0.003664
	Prob.	0.1352	0.5067	0.5957
$\Delta PERCAP_{t-3}$				
	Coefficient	0.001732	-0.000144	9.43E-05
	Prob.	0.6803	0.9825	0.9903
ΔFDI_{t-3}				
	Coefficient	-0.075015	-3.608416	0.701277
	Prob.	0.9021	0.593	0.4165
*Interaction Terms (Tech*serv)*				
	Coefficient	-0.010606	-0.04578	0.140208
	Prob.	0.6947	0.5105	0.1142
Intercept				
	Coefficient	1.177831	2.560952	
	Prob.	0.0741	0.0021	
R-squared		0.561309	0.613659	0.627327
Adjusted R-squared		0.185288	0.372195	0.307893
Prob(F-statistic)		0.235127	0.046652	0.114372

*, **, ***The estimated coefficient is statistically significant at 0.01, 0.05, 0.10 level of significance respectively

Table (13) Agriculture sector: long run models

	1960 - 2020	1960 - 1990	1990 - 2020
$AGRI_{t-1}$			
Coefficient	0.6875*	0.6190***	0.7213*
Prob.	0.0000	0.0888	0.0001
ADR_{t-1}			
Coefficient	-0.2959**	-0.8881***	-0.6799
Prob.	0.0285	0.0740	0.3210
CF_{t-1}			
Coefficient	0.0039	0.0280	-0.4449**
Prob.	0.9259	0.6664	0.0214
TOP_{t-1}			
Coefficient	0.0316	0.0902	0.2432*
Prob.	0.5119	0.6965	0.0024
$PERCAP_{t-1}$			
Coefficient	-0.0033**	0.0043	-0.0057**
Prob.	0.0227	0.6956	0.0317
FDI_{t-1}			
Coefficient	-0.9082**	3.8266	-0.8587
Prob.	0.0284	0.7137	0.1135
$employment\ in\ agriculture_{t-1}$			
Coefficient			-0.0762
Prob.			0.9072
Error correction Term (t-1)			
Coefficient	0.0711	0.0040	0.0808
Prob.	0.5833	0.9912	0.6688
R-squared	0.8147	0.7958	0.8961
Adjusted R-squared	0.7898	0.7308	0.8545
Prob(F-statistic)	0.0000	0.0000	0.0000
Durbin-Watson stat	1.7412	1.7820	2.4238

*, **, ***The estimated coefficient is statistically significant at 0.01, 0.05, 0.10 level of significance respectively

Table (14) Industry sector: long run models

	1960 - 2020	1960 - 1990	1990 - 2020
$INDU_{t-1}$			
Coefficient	0.74071*	0.51741**	0.71746**
Prob.	0.00000	0.06410	0.01510
ADR_{t-1}			
Coefficient	-0.00139	-0.05801	-0.28866
Prob.	0.98840	0.80160	0.70860
CF_{t-1}			
Coefficient	-0.01365	-0.01728	-0.12407
Prob.	0.62660	0.32870	0.60430
TOP_{t-1}			
Coefficient	-0.01190	-0.03513	0.04858
Prob.	0.75530	0.63840	0.64630
$PERCAP_{t-1}$			
Coefficient	-0.00157**	0.00039	-0.00149
Prob.	0.05650	0.90170	0.57280
FDI_{t-1}			
Coefficient	0.96634***	1.81939	1.05636***
Prob.	0.00100	0.63510	0.08810
$\text{employment in industry}_{t-1}$			
Coefficient			-0.32306
Prob.			0.78740
Error Correction Term (t-1)			
Coefficient	0.04434	-0.08120	0.29674
Prob.	0.58510	0.41050	0.17480
R-squared	0.86734	0.60416	0.83849
Adjusted R-squared	0.84948	0.47821	0.77389
Prob(F-statistic)	0.00000	0.00212	0.00000
Durbin-Watson stat	2.36992	1.71466	2.47750

*, **, ***The estimated coefficient is statistically significant at 0.01, 0.05, 0.10 level of significance respectively

Table (15) Service sector: long run models

		1960-2020	1960-1990	1990-2020
$SERV_{t-1}$				
	Coefficient	0.86283*	0.98246*	0.76307*
	Prob.	0.00000	0.00000	0.00200
ADR_{t-1}				
	Coefficient	0.47891*	0.75221**	0.40248
	Prob.	0.00210	0.02480	0.66900
CF_{t-1}				
	Coefficient	0.03473	0.01406	0.48347**
	Prob.	0.45970	0.63660	0.03080
TOP_{t-1}				
	Coefficient	-0.03763	-0.15176	-0.17751**
	Prob.	0.52090	0.19920	0.05830
$PERCAP_{t-1}$				
	Coefficient	0.00464*	-0.01147	0.00652*
	Prob.	0.00160	0.13120	0.00550
FDI_{t-1}				
	Coefficient	0.55379	0.04051	-0.46019
	Prob.	0.21430	0.99470	0.44160
$\text{employment in industry}_{t-1}$				
	Coefficient			-0.72153
	Prob.			0.58240
Error Correction Term (t-1)				
	Coefficient	-0.07107	0.14704	-0.67049**
	Prob.	0.60010	0.24980	0.03300
R-squared		0.96059	0.99321	0.79837
Adjusted R-squared		0.95529	0.99105	0.71772
Prob(F-statistic)		0.00000	0.00000	0.00002
Durbin-Watson stat		2.25747	2.69686	2.46703

*, **, ***The estimated coefficient is statistically significant at 0.01, 0.05, 0.10 level of significance respectively

Table (16) VAR model for GDP response to sectoral shocks

	GDP growth	Agriculture	Industry	Services
GDP(-1)	0.961712	-0.113064	0.110768	0.333745
	(0.02113)	(0.02852)	(0.03048)	(0.04869)
	[45.5189]	[-3.96397]	[3.63438]	[6.85390]
AGRI (-1)	0.027822	0.987192	0.057665	-0.236956
	(0.01165)	(0.01573)	(0.01681)	(0.02686)
	[2.38763]	[62.7536]	[3.43052]	[-8.82311]
INDU (-1)	-0.052215	-0.122686	1.037602	-0.106022
	(0.00926)	(0.01250)	(0.01336)	(0.02134)
	[-5.64004]	[-9.81610]	[77.6932]	[-4.96883]
SERV (-1)	0.004751	0.048886	0.006939	0.883226
	(0.00360)	(0.00485)	(0.00519)	(0.00829)
	[1.32158]	[10.0723]	[1.33807]	[106.594]
C	-0.244755	0.745702	-3.078816	13.81090
	(0.54063)	(0.72987)	(0.77989)	(1.24603)
	[-0.45272]	[1.02170]	[-3.94775]	[11.0840]
R-squared	0.988397	0.996102	0.993594	0.998528
Adj. R-squared	0.987553	0.995818	0.993128	0.998421
Sum sq. resids	3.416439	6.226653	7.109450	18.14774
S.E. equation	0.249233	0.336470	0.359531	0.574420
F-statistic	1171.286	3513.475	2132.603	9328.062
Log likelihood	0.836057	-17.17114	-21.14872	-49.26235
Akaike AIC	0.138798	0.739038	0.871624	1.808745
Schwarz SC	0.313327	0.913567	1.046153	1.983274
Mean dependent	2.806522	35.17385	16.14011	33.94778
S.D. dependent	2.233959	5.203153	4.337018	14.45604
Determinant resid covariance (dof adj.)		4.07E-05		
Determinant resid covariance		2.87E-05		
Log likelihood		-26.83461		
Akaike information criterion		1.561154		
Schwarz criterion		2.259268		
Number of coefficients		20		

Figure (7): Response to cholesky one S.D. (d.f. adjusted) innovations ± 2 S.E.

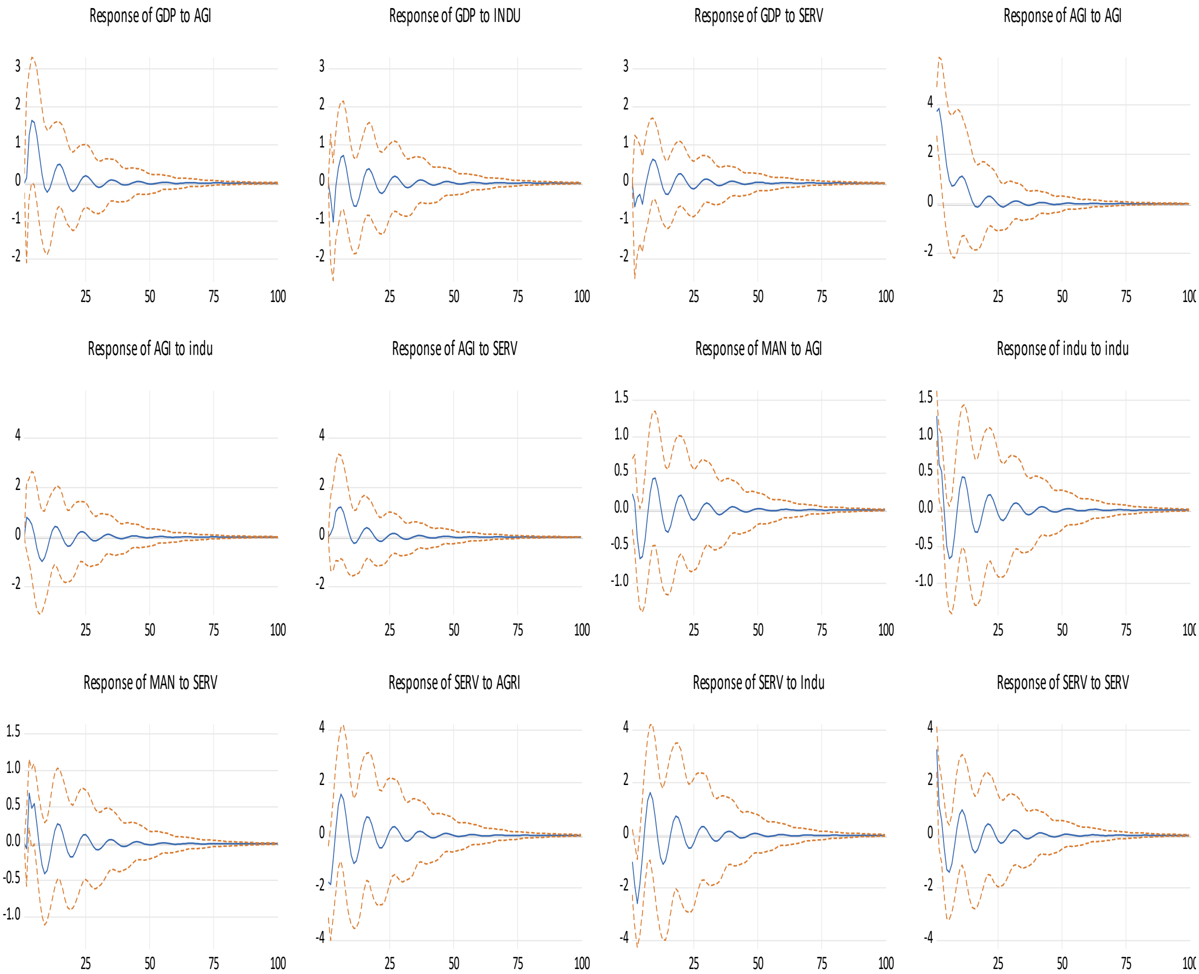
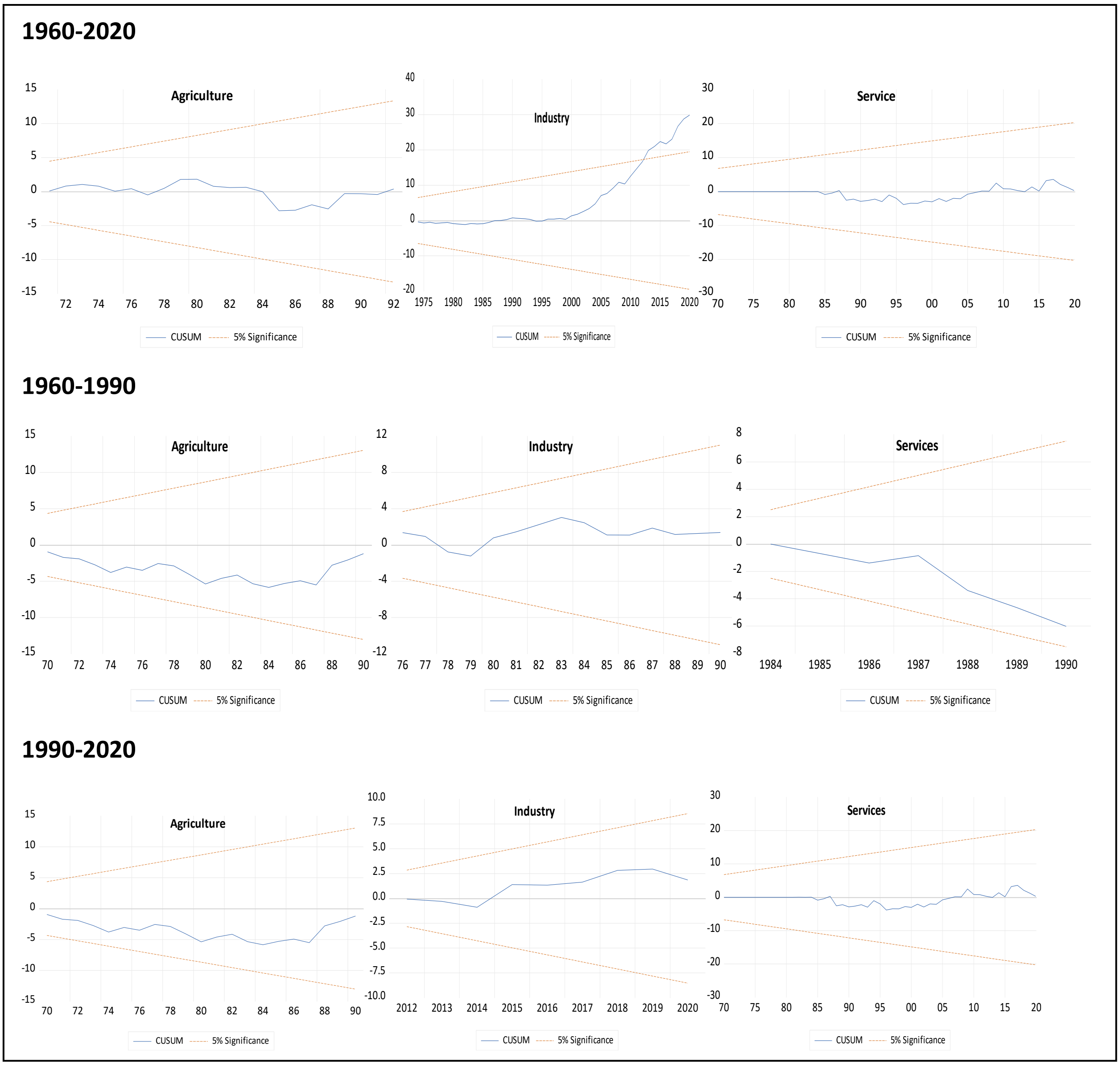


Figure (8) Leveraging GDP growth vs economic sectors



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