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A VAR Model Approach for Analysing Causative Association between Sri Lankan Economy and the Components of Economy

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ABSTRACT

The major perception for every emerging state such as Sri Lanka, is to touch excessive economic growth. This study inspects the causal association among Gross Domestic Product (GDP) which is the monetary measure of a country's economy and its three components, agricultural (primary component), industrial (secondary component) and services sectors (tertiary component) in Sri Lanka, established on the annual time series data for the period of 1960 – 2017 obtained from the Annual Report of World Bank Economic Indicators and Annual Report of Central Bank of Sri Lanka. For this motive, Augmented Dickey Fuller unit root test was involved to test the stationarity of the four variables and they have been found stationary at first differences. The least information criterions were used to estimate the optimum lag length. The presence of the long run association between the GDP and the three components were examined using the Vector Autoregressive (VAR) Cointegration test. Then the Engle-Granger causality/block exogeneity Wald test, Impulse Response and Variance Decomposition analysis were supported out and the significances displayed two-way Granger causality from agricultural sector to economy and service sector, two-way Granger causality from agricultural sector to industrial sector and from industrial sector to both GDP and service sector. This is an predictable concern for every emerging country wherever the agriculture is answerable for a countless proportion of nationwide economic growth. Therefore the suitable commendations were proposed.

KEYWORDS: Agriculture, GDP, Engle-Granger causality, Impulse-Response, Sri Lanka.

I. INTRODUCTION

The primary components of GDP is agriculture, appear to be a significant fraction of work force in the emerging states. Agriculture can be a significant basis of development through sustaining other sectors via transmission of resources, and delivering a marketplace for non-agricultural products and facilities. For emerging countries, it is somewhat vital to build sensible distribution of sources between sectors to induce growth. Though the countries have been developed, the comparative significance of agriculture on the economy is getting reduced. In Sri Lanka, agriculture sector subsidizes about 6.9% to the countrywide GDP out of that the fisheries subdivision gives around 1.3% and the livestock sector signifies for 0.6%. More than 25% of Sri Lankans are engaged in the agrarian sector. Even though Sri Lanka is a productive tropical land with the possibility for the crop growing and dispensation of a diversity of harvests, problems such as lower productivity and profitability hinder the development of the sector.

The arrangement of agrarian maintenances and encouragements in Sri Lanka has experienced a considerable transformation in agreement with the industry-established expansion labors, and responsibilities. However, agriculture still grips its significant place particularly in the total employment of Sri Lanka. The goal of this paper is to examine the inter associations among the three chief sectors of Sri Lanka's economy, specifically the agriculture, industry and services, and decide whether agriculture has profited from and/or else funded to the development of the industry and services sector. For this persistence, the relationships and causality among the three main sectors and GDP were examined using a vector autoregression (VAR) model for the period 196-2017. As a result of expending a VAR model, all variables are deliberated to be possibly endogenous, and we perceived the short and long run reactions to shocks and causality between the sectors.

II. REVIEW OF LITERATURE

Siboleka et al. (2014) studied whether there is a causal and longtime association among agriculture and industrial segments of Namibia above the period 1981-2012. The unit root, correlation and granger causality examinations were used and decided no causal association among agriculture and manufacturing in Namibia, and demanded that suitable strategy involvements are obligatory to impact how the two segments should profit from each other so as to upkeep abilities for together continuous employment prospects and economic development in Namibia.

Gülistan et al. (2008) observed the causal relationship among principal energy consumption (EC) and real Gross National Product (GNP) for Turkey for 1970-2006, using unit root test, Augmented Dickey-Fuller (ADF), Phillips-Perron (PP), Johansen co-integration test and Pair-wise Granger causality tests. Their consequences designate that two sequence are cointegrated and there is a bi-directional causality from EC to GNP and other way around. Which indicates that an upsurge in EC directly disturbs economic progress and also economic development motivates additional EC. They decided that energy is a warning issue to economic development in Turkey and therefore, tremors to energy source will have a negative influence on economic development.

Adenomon and Oyejola (2013) considered the influence of agriculture and industry on GDP in Nigeria for the period of 1960-2011, engaging VAR model. The consequences of VAR model designated that agriculture subsidized about 58% to GDP, while industry subsidized about 32%. In decision, they suggested that distinct incentives should be specified to agriculture sector and infrastructural amenities to enhance the expansion, though new methods should also be followed for industry segment.

III. MATERIAL AND METHODOLOGIES

Yearly data of GDP and essential sectors (agriculture, industry and services) for the period of 1960-2017 were utilized in the study. Data were gained from Annual Report of World Bank Economic Indicators and Annual Report of Central Bank of Sri Lanka. Agriculture sector encompasses agriculture and livestock production, forestry and fishing; industry includes mining, manufacturing, energy, gas and water, construction, bulk and retail business; and services sector covers facilities of hotels and restaurants, transport and communication, monetary organization, proprietorship of residences, commercial and individual services, attributed bank services, administration services and private non-profitable foundations. Stationary characteristic of the time series data has to be tested with the intention of avoid influenced assumptions in the study. Therefore, Augmented Dickey-Fuller (ADF) unit root test was implied to inspect stationarity (Rahman M, Rahman S, Hai-Bing W., 2011). Then, the maximum lag length was obtained from VAR lag order criteria of least values for Information criterions.

In the following stage, Johansen Cointegration test was applied to conclude probable cointegration relationship among the series. Here, cointegration relationship is exposed as below, and if the stationary is satisfied for error terms, two series is settled cointegrated.

$$Y_t = \alpha X_t + \varepsilon_t$$

H_0: α =0 (no cointegration between series)

H_A: $\alpha \neq 0$ (series are cointegrated)

The rejection of null hypothesis shows the cointegration of series, which illustrates that the series proceed combined action in the long run. Conversely, this examination does not expose the direction of the association. The most appropriate method that can be used for this determination is Granger causality test. With the aim of testing for Granger causality, we will evaluate a VAR model as below (Engle, R. F., and Granger, C. W. J).

$$Y_t = a_{0+}\ a_1 Y_{t-1} + \ldots\ldots + a_p Y_{t-p} + b_1 X_{t-1} + \ldots\ldots + b_p X_{t-p} + \upsilon_t$$

$$X_t = c_{0+}\ c_1 X_{t-1} + \ldots\ldots + c_p X_{t-p} + d_1 Y_{t-1} + \ldots\ldots + d_p Y_{t-p} + \zeta_t$$

Here, checking H_0: $b_i = 0$ against H_A: At least one $b_i \neq 0$ is a test that X does not Granger-cause Y. Likewise, checking H_0: $b_i = 0$ against H_A: At least one $b_i \neq 0$ is a test that Y does not Granger-cause X , $\forall\ i = 1, 2, \ldots, p$.

At each situation, a rejection of the null suggests there is Granger causality.

IV. FINDINGS, RESULTS AND DISCUSSION

Primarily, the time series plots of each data series were plotted and their trend patterns were observed for assessing for stationarity in variance.

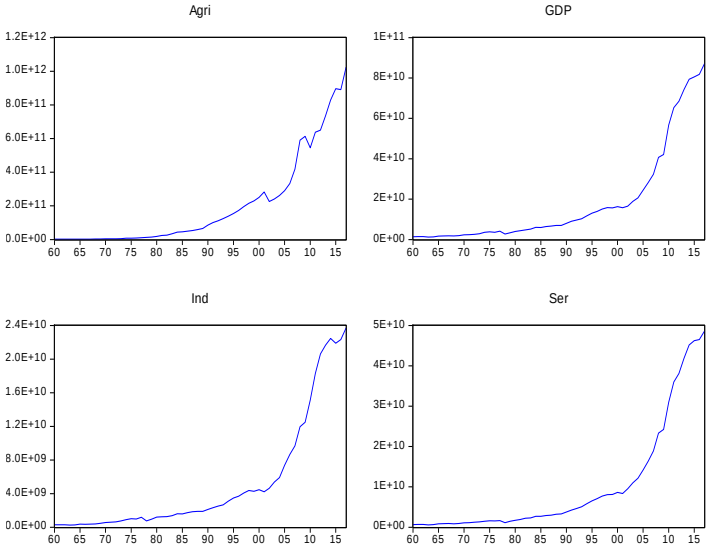

Figure 1: Time Series plots of agriculture (AGR), GDP, industry (IND) and Services (SER)

From Figure 1, it is realized that the all four series have amplified with the similar pattern though the agricultural sector show some fluctuations than the series of other sectors in Sri Lanka's case, and all the series appear to be non-stationary. As previously recognized, stationary time series incline to return its mean value and oscillate about it with a constant array. Instead, a non-stationary variable converts stationary after it is differenced, in which case the first order differencing frequently be sufficient. Stationary of a variable depends on whether it has a unit root or not. In the Table 1, the outcomes of unit root test found using Augmented Dickey-Fuller (ADF) and Phillips Perron (PP) are specified for both level and first difference of the series (Phillips, P. C. B., and Perron, P.)

Table1: Augmented Dickey-Fuller Test Results of Variables in Level and First Difference

Variables	Augmented Dickey–Fuller	Phillips Perron	Result
GDP	1.0000	0.9998	Non-stationary
AGR	1.0000	1.0000	Non-stationary
IND	0.9956	0.9989	Non-stationary
SER	1.0000	0.9998	Non-stationary
Δ GDP	0.0002 ***	0.0000 ***	Stationary
Δ AGR	0.0000 ***	0.0000 ***	Stationary
Δ IND	0.0107 ***	0.0105 ***	Stationary
Δ SER	0.0310***	0.0004 ***	Stationary

*refers that all the first difference ADF regressions have a significant unit root coefficient at 5% and 1% levels. Δ refers to the first difference.

From Table 1, the null hypothesis that the series are non-stationary is not rejected at levels for all variables. But, after taking their first differences, the null hypothesis is rejected for all variables, in which case the series turn out to be stationary and variables are integrated at order one. After enquiring the stationarity of the variables, the following step is to put on Johansen co-integration test, which needs the presence of adequate amount of time lags. The optimal lag lengths are identified using LR, FPE, Akaike, Schwarz and Hannan-Quinn information criteria by choosing the least of them (Ferreira, 2009). And the results suggest the optimal lag interval is (1,4). Test results are given in Table 2.

Table 2: Cointegration Test Results

Unrestricted Cointegration Rank Test (Trace)				
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.580799	107.4944	47.85613	0.0000
At most 1 *	0.518111	62.28539	29.79707	0.0000
At most 2 *	0.284566	24.32322	15.49471	0.0018
At most 3 *	0.124436	6.910153	3.841466	0.0086
Trace test indicates 4 cointegrating eqn(s) at the 0.05 level * denotes rejection of the hypothesis at the 0.05 level **MacKinnon-Haug-Michelis (1999) p-values				
Unrestricted Cointegration Rank Test (Maximum Eigenvalue)				
Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None	0.580799	45.20899	27.58434	0.0001
At most 1	0.518111	37.96217	21.13162	0.0001
At most 2	0.284566	17.41306	14.26460	0.0154
At most 3 *	0.124436	6.910153	3.841466	0.0086
Max-eigenvalue test indicates 4 cointegrating eqn(s) at the 0.05 level * denotes rejection of the hypothesis at the 0.05 level **MacKinnon-Haug-Michelis (1999) p-values				

Both Trace and Eigenvalue statistics designate that there are 4 co-integrating equations at 1% significance level respectively. Consequently, the results of Johansen co-integration test display a long-running relationship between sectoral and GDP series (Konya, 2004). In the following step, we used Granger Causality Wald Test and the outcomes are specified in Table 3.

Table 3: VAR Granger Causality/Block Exogeneity Wald Tests

Dependent variable	Excluded	Chi-sq	df	Prob.
D_GDP	D_AGR	29.37189	4	0.0000
	D_IND	6.211488	4	0.0448
	D_SER	0.193923	4	0.9076
D_AGR	D_GDP	8.451694	4	0.0146
	D_IND	3.008671	4	0.2222
	D_SER	6.303073	4	0.0428
D_IND	D_GDP	3.652795	4	0.1610
	D_AGR	13.35673	4	0.0013
	D_SER	0.802702	4	0.6694
D_SER	D_GDP	0.474148	4	0.7889
	D_AGR	30.77371	4	0.0000
	D_IND	13.54192	4	0.0011

From Table 3, it is obvious that agriculture is granger cause to GDP and services, while the reverse is moreover true (bi-directional causality exists between agriculture sector and two of the series, D_GDP and D_SER). Also agriculture is a granger cause to industry in an uni-directional way. Industrial sector is a granger cause to GDP and services sector uni-directionally while the reverse is not true. To discover the active structures of the series, Impulse Response Functions (IRFs) are calculated. IRFs display the influence of a shock in an exogenous variable upon endogenous variable over a period of time (20 years in current study).

From Figure 2, we found the indications from the impulse response examination on the convergent and deviating impact of the agricultural, industrial and service sector from previous shock on GDP. Therefore, industry, services and GDP respond to the variation in agriculture, and this result reduces only afterward 10 years.

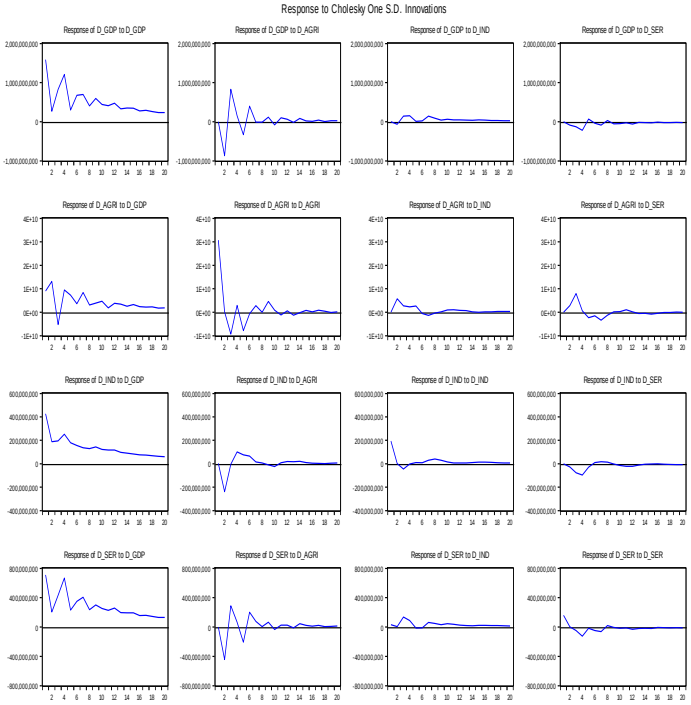

Figure 2: Impulse response analysis for different variables

The variance decomposition test was then performed to recognize the magnitude of effects. In this investigation, it would be further appropriate to consider the 10th period as the effects of shock diminish in this period (Wang SL, McPhail L., 2012). Hence, GDP is explained 77.11% by itself, 20.81% by agriculture, 1.001% by industry and 1.09% by services sectors. Agriculture is described mostly by itself during the period. Industry is explained 76.31% by GDP, 13.34% by agriculture, 7.37% by itself and 2.98% by services sectors. Finally, services sector is explained 78.71% by GDP, 17.31% by agriculture, 1.68% by industry and 2.31% by itself. This information supports the consequences of granger causality investigation.

Table 4: Results of Variance Decomposition

Variance Decomposition of D_GDP:					
Period	S.E.	D_GDP	D_AGRI	D_IND	D_SER
1	1.59E+09	100.0000	0.000000	0.000000	0.000000
2	1.83E+09	77.24725	22.41346	0.122016	0.217275
3	2.18E+09	68.75268	30.22447	0.528194	0.494658
4	2.51E+09	74.95326	23.14616	0.777728	1.122857
5	2.55E+09	73.97439	24.10538	0.755867	1.164364
6	2.67E+09	73.98670	24.23125	0.697893	1.084166
7	2.77E+09	75.36623	22.59971	0.922628	1.111428
8	2.80E+09	75.79837	22.10289	0.999291	1.099446
9	2.86E+09	76.68871	21.25102	0.976374	1.083898
10	2.90E+09	77.10556	20.80529	1.000488	1.088657
11	2.93E+09	77.43223	20.48544	1.006451	1.075879
12	2.97E+09	77.91931	19.99250	1.003579	1.084613

Variance Decomposition of D_AGRI:					
Period	S.E.	D_GDP	D_AGRI	D_IND	D_SER
1	3.20E+10	8.033411	91.96659	0.000000	0.000000
2	3.52E+10	20.51209	76.20558	2.649612	0.632724
3	3.78E+10	19.79300	72.33190	2.819627	5.055475
4	3.91E+10	24.31479	67.98490	2.961234	4.739079
5	4.07E+10	25.67400	66.47457	3.149314	4.702116
6	4.09E+10	26.22785	65.84943	3.133532	4.789190
7	4.20E+10	28.90429	62.83997	3.072302	5.183437
8	4.21E+10	29.26520	62.43974	3.060089	5.234970
9	4.26E+10	29.50805	62.35982	3.000237	5.131896
10	4.29E+10	30.33550	61.58268	3.012927	5.068884
11	4.29E+10	30.41034	61.41430	3.060811	5.114548
12	4.31E+10	30.92584	60.92925	3.071523	5.073390

Variance Decomposition of D_IND:					
Period	S.E.	D_GDP	D_AGRI	D_IND	D_SER
1	4.68E+08	82.93148	0.004362	17.06416	0.000000
2	5.58E+08	69.51975	18.26519	11.97253	0.242532
3	5.98E+08	71.25486	15.91376	10.97607	1.855313
4	6.64E+08	72.27333	15.21607	8.916436	3.594164
5	6.92E+08	73.12313	15.18717	8.219831	3.469877
6	7.13E+08	73.78413	15.15959	7.766165	3.290111
7	7.27E+08	74.52167	14.62650	7.634518	3.217315
8	7.39E+08	75.05024	14.13682	7.666744	3.146201
9	7.54E+08	75.82082	13.61413	7.536336	3.028706
10	7.64E+08	76.30809	13.34315	7.368548	2.980214
11	7.74E+08	76.78457	13.03254	7.198448	2.984446
12	7.83E+08	77.18623	12.78755	7.035177	2.991045

V. CONCLUSION

This study inspected the causal relationship among GDP, agriculture, industry and services sectors in Sri Lanka for the period of 1960-2017. A long run equilibrium relationship was identified between these variables. Then, to test the nature of the association, granger causality/block exogeneity Wald test was implied and a bi-directional relationship was detected from agriculture to GDP and service sector, also an uni-directional relationship was detected from agriculture to industrial sector, which designates that agriculture provokes the development of other sectors. According to the CIA (Central Intelligence Agency) annual report 2017, GDP composition of Sri Lanka is contributed 7.8% by agriculture, 30.5% by industry and 61.7% by the services sector. Sri Lanka's agriculture sector built a more important influence to GDP than it does today. Particularly, from the year early 1980s ahead, consecutive governments have frustrated to monitor a diverse, yet slightly industrialized development progress, and accordingly, agriculture's portion in GDP has declined from 33.53% in 1974 to 7.5% in 2012, which illustrates that the significance of this sector has moved to the other main sectors of Sri Lanka's economy and contributed to their development, as per the requirement. The deficiency of private investment in agriculture because of indeterminate strategies restricts the development of the sector. Also the imports of food including wheat, lentils, sugar, fruit, milk, and dairy products enlarged by nearly 9% in 2017. The challenge opposite the country is to recover and reestablish agriculture, upsurge manufacture and decrease the gap among existing harvests and the accurate possibilities, alter agricultural organizations and cropping arrangements and improve a recognized background to sustenance a supplementary creative and commercialized agriculture. These implications can be well established through better ideas of policy makers and strategy builders.

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