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Forecasting for Protein Food Items Productions in India: Granger Co-integration Test for VECM

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Abstract : Vector error correction model (VECM) that can be used for data series that are non-stationary and have co-integration relationships (long-term relationships). This study included one variable and the model VAR (vector autoregressive) has been used. Before the model is selected, the static data must be examined. In testing static data, a combination of time series plots, ACF's correlograms, and unit root tests can be used. The next step is to test co-integration to analyze the long-term relationship between the variables used in this study. When the data is orderly stationary and has a co-integration relationship as large as r, the model VAR that is being used is the vector error correction model (VECM). The data being analyzed in this study is protein food production. The data used in this study were obtained from 1985–2019.

Index Terms: **Food Production, Granger Co-integration Test VECM**

1.INTRODUCTION

In 1980, Sims (Christopher Sims) introduced VAR model into economic field and promoted the widespread application in dynamic analysis of economic system. VECM model econometricians and Statistician point out a method to establish the relational model among the variables in a non-structural way. The VAR model is established based on the statistical properties of data. In the VAR model, each endogenous variable in the system is considered as the lagged value of all endogenous variables in the system; thus the Univariate autoregressive model is generalized to the "vector" autoregressive model consisting of multivariate time series variables.

Engle and Granger combined cointegration and error correction models, to establish the trace error correction model. As long as there is a cointegration relationship between variables, the error correction model can be derived from the autoregressive distributed lag model. Because there is a cointegration relationship in the VEC model, when there is a large range of short-term dynamic fluctuation, VEC expressions can restrict long-term behavior of the endogenous variables and be convergent to their cointegration relation.

2.LITERATURE REVIEW

Kasimati (2011) used tourism arrivals as a proxy of Greece's tourism activity and suggested that although a co integrating relationship exists between tourism and growth, no causal links exist between them. Within this context, the present study not only updates the evidence for Greece, but also provides exhaustive evidence from the application of multivariate co integration with real effective exchange rate, vector auto-regression (VAR) with an error-correction mechanism, causality testing, innovation accounting, variance decomposition and finally generates forecasts within the framework of the VAR/VEC approach not only at aggregate but also at disaggregate levels

Utilized VAR and VECM (vector error correction model) to analyzed the short-term dynamic influence of hanges in oil prices, coal prices, natural gas prices, electricity prices, and carbon emissions quota on carbon emissions prices. Niaz Bashiri Behmiri et al. Was Studied the Granger causality relationships among the US income, energy consumption, and carbon emissions based on the Vector Autoregression Model (VAR)

3. RESEARCH METHODOLOGY

3.1 Augmented Dickey-Fuller Test and KPSS Test:

Model for forecasting purposes in time series analysis, require a stationary time series for better prediction. So the first step to work on modelling is to make a time series stationary. Testing for stationary is a frequently used activity in autoregressive modeling performs various tests like the kwiatkowski-Phillips-Schmidt-Shin test (KPSS test) and Augmented Dickey-Fuller. This article is more focused on the Dickey-Fuller test. The article will see the mathematics behind the test and how we can implement it in a time series.

ADF (Augmented Dickey-Fuller) test is a statistical significance test which means the test will give results in hypothesis tests with null and alternative hypotheses. Before going into the ADF test, we must know about the unit root test because the ADF test belongs to the unit root test.

Unit Root Test:

A unit root test tests whether a time series is not stationary and consists of a unit root in time series analysis. The presence of a unit root in time series defines the null hypothesis, and the alternative hypothesis defines time series as stationary.

$$y_t = D_t + z_t + \varepsilon_t$$

Where,

D_t - Deterministic component.

z_t - Stochastic component.

ε_t - Stationary error process.

Granger causality-general:

Using the notation introduced above, 'Y does not cause X' w.r.t the information set J_n if

$$F\left(\frac{X(t)}{J_n}\right) = F\left(\frac{X(t)}{J_n^*}\right), t > n \text{ ..... (1)}$$

Where $F\left(\frac{X(t)}{\ldots}\right)$ is the conditional probability distribution function probability density function (p.d.f.) of X.

The logic underlying expression (1) is straightforward. The conditional p.d.f. of X is the same, whether the conditioning set is J_n or J_n^*. Thus, the additional information about $Y^{(n)}$ contained in J_n is irrelevant to future behaviour of X(t).

Granger causality in the mean:

We say that 'Y does not cause X in the mean' w.r.t. J_n if:

$$\sigma^2\left[X(n+1)/J_n\right] = \sigma^2\left[X(n+1)/J_n^*\right] \text{ ..... (2)}$$

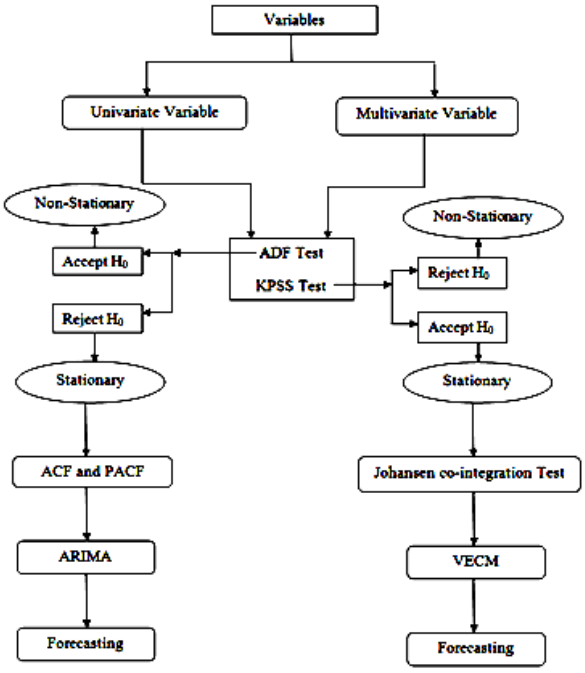
Where $\sigma^2\left[X(n+1)/J_n\right]$ is the variance of the one-step ahead forecast of X(n+1) made at time n, based on the information set J_n. Of course $\sigma^2\left[X(n+1)/J_n^*\right]$ is the corresponding variance when the information set is J_n^*.

Expression (2) can thus be interpreted to mean that the extra information about $Y^{(n)}$ contained in J_n does not reduce the variance of the forecast error. Consequently if:

$$\sigma^2\left[X(n+1)/J_n\right] < \sigma^2\left[X(n+1)/J_n^*\right] \text{ ..... (3)}$$

We say that 'Y Granger-causes X (in the mean)'.

Flow Chart:



4. RESULTS AND DISCUSSION

Stationary Test For Protein Food Items Future And Spot Production :

The Protein Production futures and spot are checked for stationary testing for the Augmented Dickey Fuller test and KPSS test. The results are reported in the table below:

4.1 Augmented Dickey-Fuller test:

Unit Roots Test

H_0: There is a unit root for the series.

H_1: There is a no unit root for the series. The series is Stationary.

As the computing p value is lower than the significance level alpha =0.05,one should reject the null hypotheses H_0, and accept the alternative hypothesis H_1.

4.1.1 Results of p value of Study Variables

Table 1. Protein Production	test statistic	Level of Significance	p-value	Null Hypothesis	Unit Root Test
D_D_ Milk (Million Tones)	-5.75198	5%	4.623e-007	Rejected	Stationary
D_D_ Eggs (Billion Nos.)	-9.46229	5%	1.709e-017	Rejected	Stationary
D_D_ Fish (Tones)	-7.0519	5%	2.395e-010	Rejected	Stationary
D_D_ Future _Milk	-10.194	5%	7.896e-020	Rejected	Stationary
D_D_ Future_ Eggs	-7.0778	5%	2.037e-010	Rejected	Stationary
D_D_ Future_ Fish	-7.39534	5%	2.706e-011	Rejected	Stationary

4.2 KPSS TEST:

Unit Roots Test

Null hypothesis : Stationary

Alternative hypothesis: non-Stationary

Table: 4.1.2 KPSS test

	T - statistics	**Significance level**	**P-value**	**H_0 Accept / Reject**	**Unit Root Test**
D_D_ Milk (Million Tones)	0.243482	1% = 0.1714 5% = 0.462 10% = 0.353	0.10	Accept H_0	Stationary

D_D_ Eggs (Billion Nos.)	0.323724	1% = 0.1714 5% = 0.462 10% = 0.353	0.10	Accept H_0	Stationary
D_D_ Fish (Tones)	0.069307	1% = 0.1714 5% = 0.462 10% = 0.353	0.10	Accept H_0	Stationary
D_D_ Future _Milk	0.302891	1% = 0.1714 5% = 0.462 10% = 0.353	0.10	Accept H_0	Stationary
D_D_ Future_ Eggs	0.295328	1% = 0.1714 5% = 0.462 10% = 0.353	0.10	Accept H_0	Stationary
D_D_ Future_ Fish	0.292755	1% = 0.1714 5% = 0.462 10% = 0.353	0.10	Accept H_0	Stationary

Result:

Before doing co integration analysis it is important to do unit root analysis to identify the stationary and order of integration. The above table reports the unit root analysis of log values of Protein Food Items Spot and Future. using Augmented Dickey Fuller tests and KPSS Test. The results reveal that all the series are non stationary at levels as test statistics are greater than the critical values. However by taking the first difference all the series are found to be non-stationary. Then by taking the second order differential all series are found be Stationary. Thus the null hypothesis is rejected and the log values of future, spot prices are found to be stationary at Second difference and are integrated in the order of two.

4.3 Johansen co-integration Test:

After confirming the stationary of gold futures and spot prices, Johansen's and Julies us co integration test is 4.1.3

4.1.3 Johansen co- integration test

performed and are reported in the table below:

The null hypothesis is framed as follows:

H0: There is no co-integration equation.

Decision Criteria:

Reject at the 5% Level

Reject the Null Hypothesis if the p- value of the Trace and Max Statistics > 0.05 critical value, otherwise fail to reject the null hypothesis.

Table: 4.1.3

Result of Johansen Co Integration Analysis of Spot and Future Productions by protein food items in India:

Variable	**Rank**	**Eigen value**	**Trace Test**	**p-value**	**Lmax test**	**p-value**	**H_0**	**co-integrated**	**Long run / short run relationship**
D_D_ Milk (Million Tonnes)	0	0.99901	233.58	0.000	214.34	0.000	Reject	co-integrated	Long run relationship
D_D_ Future _Milk	1	0.46237	19.238	0.000	19.238	0.000	Reject	co-integrated	Long run relationship
D_D_ Eggs (Billion Nos.)	0	1.000	413.58	0.000	393.06	0.000	Reject	co-integrated	Long run relationship
D_D_ Future_ Eggs	1	0.48407	20.515	0.000	20.515	0.0000	Reject	co-integrated	Long run relationship
D_D_ Fish (Tonnes)	0	0.9999	375.72	0.000	347.58	0.0000	Reject	co-integrated	Long run relationship
D_D_ Future_ Fish	1	0.64536	32.137	0.000	32.137	0.000	Reject	co-integrated	Long run relationship

Result:

The Co integration between spot and future Production was tested with unrestricted Co-Integration trace Statistics and Maximum Eigen Value. It also estimates the rank (r) of given time series matrix with the confidence level. Both λ trace and λ max are used to interpret whether the null hypothesis of r=0 is rejected at 5 % level and not rejected when r =1 for the analysis and the result was drafted in table. That is even if there are shocks in the short run, which may affect movement in the individual series, they would converge with time in the long run.

Thus, the result reveals that the null hypothesis is rejected, there exists a co integration relationship between the spot and future Production in Protein Food Items justifying the use of VECM for showing Long Run dynamics.

4.4 Vector Error Correction Model for Future and Spot

Protein Food Items Production:

Vector (r) Trace Statistics (λ trace) Maximal Eigen Value(λ max) 5% Critical Value for Trace Statistics 5%Critical Value for Max Eigen. After confirming co integration between spot and future Production , Vector

Error Correction Model is used to analyze the long run causality and Wald Test is performed to analyze the short run dynamics of the series. Results of Vector Error Correction Model and Wald Test are reported in the table below:

Table:4.1.4

lags scores:

Lags	loglik	p(LR)	AIC	BIC	HQC
1	-227.47003	-	16.841877	18.765655	17.479555
2	-82.04435	0.00000	10.002772*	13.575503*	11.187031*

Table:4.1.5

Forecast table for All Protein Food production in India

Year	Actual Milk	Future Milk	Actual Egg	Future Egg	Actual Fish	Future Fish
	Million Tones		Billion		Tones	
2020	10.5631	9.15131	9.90775	12.8638	888.245	495.777
2021	11.4258	11.8507	10.8925	8.17513	806.042	1134.15
2022	11.3407	11.0580	10.9469	12.3934	802.569	594.005
2023	11.7741	11.6090	11.2588	10.0710	901.650	932.168
2024	12.0233	11.9394	11.6186	11.8850	846.196	878.476
2025	12.2928	12.1150	11.8308	11.4132	912.384	822.351
2026	12.5915	12.4704	12.1920	12.0147	919.935	965.990
2027	12.8616	12.7189	12.4388	12.2371	932.044	886.947
2028	13.1476	13.0092	12.7605	12.4968	968.529	957.049
2029	13.4279	13.2922	13.0394	12.8523	975.400	971.954
2030	13.7088	13.5708	13.3392	13.0862	1003.21	973.732
2031	13.9906	13.8547	13.6310	13.4223	1022.44	1017.98
2032	14.2716	14.1354	13.9243	13.6874	1040.76	1021.22
2033	14.5530	14.4174	14.2188	13.9954	1064.41	1049.07
2034	14.8342	14.6992	14.5113	14.2808	1082.54	1069.96
2035	15.1155	14.9808	14.8056	14.5761	1104.18	1086.28
2036	15.3968	15.2626	15.0987	14.8685	1124.66	1111.22
2037	15.6781	15.5443	15.3925	15.1606	1144.68	1128.79
2038	15.9594	15.8260	15.6859	15.4541	1165.80	1150.29
2039	16.2407	16.1077	15.9795	15.7461	1185.91	1171.09
2040	16.5219	16.3894	16.2731	16.0393	1206.60	1190.70
2041	16.8032	16.6712	16.5666	16.3317	1227.15	1211.99
2042	17.0845	16.9529	16.8602	16.6245	1247.57	1232.00
2043	17.3658	17.2346	17.1537	16.9171	1268.21	1252.60
2044	17.6471	17.5163	17.4473	17.2098	1288.66	1273.18
2045	17.9284	17.7981	17.7408	17.5025	1309.21	1293.49
2046	18.2096	18.0798	18.0344	17.7952	1329.75	1314.11
2047	18.4909	18.3615	18.3279	18.0879	1350.25	1334.52
2048	18.7722	18.6432	18.6215	18.3806	1370.80	1355.01
2049	19.0535	18.9249	18.9150	18.6733	1391.31	1375.51
2050	19.3348	19.2067	19.2086	18.9660	1411.84	1395.96

Conclusion:

VECM forecast of All Protein food items Production shows a upward trend, with graph. Interestingly, both forecasts are moving exactly the opposite direction at the initial stage, but only the increasing Production of all spot food items is also increasing of Future Food Items Production. Thus, empirical cause and effect is very evident for those two relations, Spot and Future Protein Food Items Production. It is fruitful for future researchers to explore such phenomenon, critically important to the fiscal policy decisions.

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