On the dynamics of energy consumption and employment in public and private sector.

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Abstract

This study intended to analyze the direction of Granger-causality between energy consumption and employment in public and private sector. We have adopted DL approach for Granger-causality analysis. We found from the whole analysis that there is evidence of bidirectional causality between energy consumption and employment in organized public and private sector. Therefore our study supports for our third testable hypothesis i.e., "feedback hypothesis".

Keywords: Energy consumption, employment in public and private sector, Granger-causality.

JEL classification code: C22, J45, J48.

I. Introduction

The relationship between energy consumption, economic growth and employment and the policy implications of the empirical findings has been comprehensively examined within the energy economics literature. Griffin and Gregory (1976), Berndt and Wood (1979), and Berndt (1980, 1990) emphasize the substitutability or complementarity between energy and the factors of production and the interplay with technical progress and productivity within a neoclassical theory of economic growth. Whereas, Bergman (1988), Jorgenson and Wilcoxen (1993), Kemfert and Welsch (2000), and Smulders and de Nooij (2003), among others, explore the role of energy within a general equilibrium framework. While the work cited above has been important in understanding the role of energy in the economy, there has been a growing literature on the causal relationship between energy consumption and economic growth utilizing a variety of time series econometric techniques. This study has also made an effort in the direction of examine the role played by energy in employment sector of India in bivariate framework.

Rest of the paper is organized as follows. Second section presents a comprehensive literature review followed by data source objectives and estimation methodology in section third. Section forth presents the data analysis and results followed by conclusions in the fifth section.

II. Literature review

We can classify the studies to date into four groups on the basis of their findings. First, a large number of studies find unidirectional causality running from electricity or energy consumption (both aggregate and disaggregate level) to GDP or employment. Studies worthy of mention include those by Altinay and Karagol (2005) for Turkey, which find strong evidence for the period 1950-2000, Lee and Chang (2005) in Taiwan for the period 1954-2003, Shiu and Lam (2004) in China for 1971-2000, and Soytas and Sari (2003) for Turkey, France, Germany and

Japan, Wolde-Rufale (2004) in Shanghai for the period 1952-1999, Morimoto and Hope (2004) in Sri-Lanka for the period 1960-98.

Second, those that finds unidirectional causality running from economic growth or gross domestic product to electricity or energy consumption. These include Ghosh (2002) in India for the period 1950-1997, Cheng (1999) in India for the period 1952-1995, Fatai et al. (2004) in New Zealand and Australia for the period 1960-1999, and Hatemi and Irandoust (2005) in Sweden for the period 1965-2000, Cheng and Lai (1997) in Taiwan for the period 1954-1993, Chang and Wong (2001) in Singapore for the period 1975-1995 and Aqeel and Butt (2001) in Pakistan for the period 1955-1996.

A third group comprises studies that find bi-directional causality. This include Soytas and Sari (2003) for Argentina, Oh and Lee (2004) for Korea in 1970-1999, Yoo (2005) also for Korea in 1970-2002 and Glasure (2002) in South Korea for the period 1961-1990, Jumbe (2004) in Malawi for the period 1970-1999, Ghali and El-Sakka (2004) in Canada for the period of 1961-1997, Hwang and Gum (1992) in Taiwan for the period 1961-1990.

And the last group comprises studies that find no causal linkages between energy or electricity consumption and economic growth, such as Cheng (1995) in US for the period 1947-1990, and Stern (1993) in USA for the period 1947-1990, Akarca and Long (1980) in US for the period 1950-1968 and 1950-1970, Yu and Hwang (1984) in US for the period 1947-1979.

III. Objective, data, hypothesis and estimation methodology

The first subsection of this section presets about the objective set for this study and the source of data followed by hypothesis formulation in second sub section and in third subsection methodology to be used for estimation has been presented.

III.I. Objectives and data

In this we have tried to estimate the direction of causality among private sector employment, public sector employment and energy consumption. This objective is justified as best of my knowledge this kind of study has not been conducted so for in India.

We have sourced data from Hand Book of Statistics of Indian Economy by Reserve Bank of India (RBI). Time period of this study is 1971-2006.

III.II. Testable hypothesis formulation

The direction of causality between energy consumption and economic growth, measured by either employment or real output, can be summarized in four testable hypotheses mentioned as follows.

The first, hypothesis is the "growth hypothesis" which suggests that energy consumption contributes directly to economic growth within the production process. In this case, the policy implication is that energy conservation policies which reduce energy consumption may possibly reduce real output. The growth hypothesis is supported if there is unidirectional Granger-causality running from energy consumption to real output or employment. Example of this types of studies are Altinay and Karagol (2005), Lee and Chang (2005), Shiu and Lam (2004), and Soytas and Sari (2003), Wolde-Rufale (2004), Morimoto and Hope (2004).

The second, hypothesis is the "conservation hypothesis" which implies that energy conservation policies designed to reduce energy consumption and waste may not reduce real output. Unidirectional Granger-causality running from real output or employment to energy consumption would lend support for the conservation hypothesis. Examples of such kind of studies are Ghosh (2002), Cheng (1999), Fatai et al. (2004), Hatemi and Irandoust (2005), Cheng and Lai (1997), Chang and Wong (2001) and Aqeel and Butt (2001).

The third, hypothesis is the "feedback hypothesis" which asserts that energy consumption and real output or employment are interdependent and act as complements to each other. The existence of bidirectional Granger-causality between energy consumption and real output or employment substantiates the feedback hypothesis. Examples of this hypothesis are Soytas and Sari (2003), Oh and Lee (2004), Yoo (2005), Glasure (2002), Jumbe (2004), Ghali and El-Sakka (2004), and last but not least Hwang and Gum (1992).

Finally, the fourth hypothesis is the "neutrality hypothesis" which suggests that energy consumption as a relatively minor factor in the production of real output in which case energy conservation policies may not adversely impact real output and hence employment. The absence of Granger-causality between energy consumption and real output or employment is supportive of the neutrality hypothesis. Examples of this hypothesis are Cheng (1995), Stern (1993), Akarca and Long (1980), and last but not least Yu and Hwang (1984).

III.III. Estimation methodology

In the present study energy consumption has been measured by Electric power consumption (kWh per capita) as % of GDP, and employment (in millions) has been considered in two sectors private and public organized sector. All variables have been analyzed by making them in natural logrthism form as it minimizes the fluctuations in the series and makes the series of less order of autoregressive. To know the causality among the test variables the standard test to be used in the study is Engle-Granger approach in VECM framework. But this approach requires certain pre-estimations (like testing the stationarity of the variables included in the VECM analysis and seeking the cointegration of the series) without which, conclusions drawn from the estimation will not be valid. Granger non-causality test in an unrestricted VAR model can be simply conducted by testing whether some parameters are jointly zero, usually by a standard (Wald) F-test. This approach in integrated or cointegrated systems has been examined by Sims et al. (1990) and Toda and Phillips (1993). These studies have shown that the Wald test for non-causality in an integrated or cointegrated unrestricted VAR system will have nonstandard limit distributions.

These results have given rise to alternative testing procedures, such as Toda and Phillips (1993) and Mosconi and Giannini (1992), but they require sequential testing and are computationally burdensome. Toda (1995) has shown that pretesting for cointegration rank in Johansen-type error correction mechanisms (ECMs) are sensitive to the values of the nuisance parameters, thus causality inference based upon ECM may be severely biased. Toda and Yamamoto (1995) and Dolado and LÄutkepohl (1996) propose a method of estimating a VAR for series in levels and test general restrictions on the parameter matrices even if the series are integrated or cointegrated. This method is theoretically simpler and computationally relatively straightforward in causality tests. They develop a modified version of the Granger causality test which involves a modified Wald (MWALD) test in an intentionally augmented VAR model. Once the optimal order of the VAR process, p, is selected, Toda and Yamamoto (TY) (1995) propose estimating a $VAR(p + dmax)$ model where $dmax$ is the maximal order of integration that we suspect might occur in the true generation process. Linear or nonlinear restrictions on the first p coefficient matrices of the model can therefore be tested using standard Wald (F-) tests ignoring the last $dmax$ lagged vectors of the variables. Dolado and LÄutkepohl (DL) (1996) also propose estimating an augmented VAR with the difference that they add only one lag to the true lag length of the model. One estimates the VAR(p+1) model and perform the standard Wald (F-) tests ignoring the last lag of the vector. The advantage of DL and TY are that they are computationally relatively simple and do not require pretesting for integration or cointegration of the data series. These tests are especially attractive when one is not sure whether series are stationary or integrated of order one. Toda and Yamamoto (1995) proves that the Wald (F-) statistic used in this setting converges in distribution to a χ^2 random variable, no matter whether the process is stationary or nonstationary. The preliminary unit root and cointegration tests are not necessary to implement the DL test, since the testing procedure is robust to the integration and cointegration properties of the process. Consider the following VAR(p) model:

$$Y_{(t)} = \gamma + A_1 Y_{(t-1)} + ... + A_p Y_{(t-p)} + \varepsilon_t \text{..................}(1)$$

Where Y_t, γ, and $\varepsilon_t \sim (0,\Omega)$ are n-dimensional vector and A_k is an n×nmatrix of parameters for lag k. to implement the TY test the following augmented VAR(p+d) model to be utilized for the test of causality is estimated,

$$Y_{(t)} = \hat{\gamma} + \hat{A}_1 Y_{(t-1)} + ... + \hat{A}_p Y_{(t-p)} + \hat{A}_{p+d} Y_{(t-p-d)} + \hat{\varepsilon}_t \text{..................}(2)$$

Where the circumflex above a variable denotes its Ordinary Least Square (OLS) estimates. The order p of the process is assumed to be known, and the d is the maximal order of integration of the variables. Since the true lag length p is rarely known in practice, it can be estimated by some consistent lag selection criteria. In the present study we have used SIC (preferably) and AIC. It is important to note that if the maximal order of integration is d=1, then TY test becomes similar to DL test. The j^{th} element of Y_t dose not Granger-cause the i^{th} element of Y_t, if the following null hypothesis is not rejected:

H_o: The row i, column j element in A_k equals zero for k= 1,…,p.

The null hypothesis is tested by Wald (F-) test which is named modified Wald (MWALD) test in case of the augmented VAR outlined above.

For example, in a bivariate VAR model with the optimal lag length, suppose it is 3, Eq. (2) is re-estimated by OLS setting the lag length 4 (3+1) as suggested by DL test.

$$\begin{bmatrix} LX_t \\ LY_t \end{bmatrix} = \begin{bmatrix} a_{10} \\ a_{20} \end{bmatrix}_x + \begin{bmatrix} a_{11}^1\, a_{12}^1 \\ a_{21}^1\, a_{22}^1 \end{bmatrix} \begin{bmatrix} LX_{t-1} \\ LY_{t-1} \end{bmatrix} + \begin{bmatrix} a_{11}^2\, a_{12}^2 \\ a_{21}^2\, a_{22}^2 \end{bmatrix} \begin{bmatrix} LX_{t-2} \\ LY_{t-2} \end{bmatrix} + \begin{bmatrix} a_{11}^3\, a_{12}^3 \\ a_{21}^3\, a_{22}^3 \end{bmatrix} \begin{bmatrix} LX_{t-3} \\ LY_{t-3} \end{bmatrix} + \begin{bmatrix} a_{11}^4\, a_{12}^4 \\ a_{21}^4\, a_{22}^4 \end{bmatrix} \begin{bmatrix} LX_{t-4} \\ LY_{t-4} \end{bmatrix} + \begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \end{bmatrix}$$

Where L denotes logarithms of X and Y variables. The hypothesis that X variable dose not Granger-cause Y can be constructed as:

$$Ho: a_{12}^1 = a_{12}^2 = a_{12}^3 = 0$$

Whereas the hypothesis that Y variable does not Granger-cause X can be constructed as:

$$Ho: a_{21}^1 = a_{21}^2 = a_{21}^3 = 0$$

and these joint hypothesis can be tested by MWALD test.

Finally, stability of VAR analysis has been performed as in order to draw valid conclusions from the above system, it is necessary that the VAR be stable or stationary. If the estimated VAR is stable then the inverse roots of characteristics Autoregressive (AR) polynomial will have modulus less than one and lie inside the unit circle. There will be *kp* roots, where *k* is the number of endogenous variables and *p* is the largest lag.VAR stability has been checked by ignoring last lag from the analysis as to test the joint hypothesis last lag is ignored.

IV. Data analysis and results interpretation

To proceed for analyzing Granger-causality in DL framework we require a prior knowledge of lag length to be included in VAR framework. Since we do not have any idea about that therefore we have carried out lag length selection test for max 3, max 4 and max 5 lags.

Results of lag length are reported in the table 1. It is evident from the table that in all three cases most of the criteria suggest one lag but some suggests lag length two. Therefore, we have used both lag length for analysis purpose. Following DL approach when some criteria suggest one lag we have used two lags in VAR and to analyze Granger-causality last lag has been left in calculating MWALD test. Results of VAR with two lags are reported in table 2.

Table1: lag length selection test

Lag	LL	LR	FPE	AIC	HQIC	SBIC
Maximum lag 3						
0	58.10325	NA	0.000114	-3.400197	-3.309499	-3.369680
1	162.8013	190.36*	2.56e-07	-9.503110	-9.231018*	-9.411559*
2	167.2220	7.50185	2.51e-07*	-9.528609*	-9.075122	-9.376024
3	168.9078	2.65641	2.91e-07	-9.388354	-8.753472	-9.174736
Maximum lag 4						
0	58.1026	NA	0.000103	-3.506410	-3.414802	-3.476045
1	158.154	181.343*	2.54e-07	-9.509604	-9.234779*	-9.418507*
2	162.904	8.015813	2.4e-07*	-9.55649*	-9.098444	-9.404658
3	164.498	2.490307	2.86e-07	-9.406099	-8.764839	-9.193539
4	167.142	3.801710	3.16e-07	-9.321390	-8.496914	-9.048100
Maximum lag 5						
0	57.3533	NA	9.64e-05	-3.571180	-3.478665	-3.541023
1	154.381	175.277*	2.39e-07*	-9.57299*	-9.295443*	-9.482516*
2	158.373	6.696082	2.40e-07	-9.572466	-9.109890	-9.421678
3	159.661	1.993794	2.89e-07	-9.397477	-8.749870	-9.186373
4	161.319	2.353231	3.42e-07	-9.246377	-8.413740	-8.974958
5	165.224	5.039317	3.55e-07	-9.240279	-8.222610	-8.908544
* indicates lag order selected by the criterion						
LR: sequential modified LR test statistic (each test at 5% level), FPE: Final prediction error, AIC: Akaike information criterion, SC: Schwarz information criterion, and HQ: Hannan-Quinn information criterion.						

Table 9: Result of VAR analysis

Vector Auto regressive Estimates (Standard errors in ( ))		
Independent variables (k)	Dependent variables	
	LNELECTRICITYCONSPC	LNPRIVATEEMPLOY
LNELECTRICITYCONSPC(-1)	0.769964* (.177534)	-0.074006 (.0924115)
LNELECTRICITYCONSPC(-2)	0.258077 (.1892224)	0.141566 (.0984957)
LNPRIVATEEMPLOY(-1)	-0.452983 (.340772)	0.898040* (.1773815)
LNPRIVATEEMPLOY(-2)	0.067595 (.2952527)	-0.105594 (.1536874)
C	0.725408* (.1979559)	0.232711* (.1030417)
VAR Model summary		
R-squared	0.982751	0.967196
Adj. R-squared	0.980372	0.962671
Sum sq. resids	0.028901	0.007831
S.E. equation	0.031569	0.016433
F-statistic	413.0596	213.7581
Log likelihood	71.94988	94.14886
Akaike AIC	-3.938228	-5.244051
Schwarz SC	-3.713763	-5.019586
Note: (1)*, **and ***denotes significant at 1%, 5%, and 10% level respectively; (2) (k) denotes lag length.		
Source: Author's calculation		

Results of Granger-causality analysis are reported in the table 3.

Table 3: Granger-causality analysis

VAR Granger Causality (Modified Wald test/χ^2)		
	LNELECTRICITYCONSPC	LNPRIVATEEMPLOY
LNELECTRICITYCONSPC	------	3.911827**
LNPRIVATEEMPLOY	5.206833**	
Note: (1) **denotes significant at 5%; (2) (k) denotes lag length.		
Source: Author's calculation		

It is evident from the table that there is bidirectional causality between energy consumption or electricity consumption and organized sector employment.

Further, to validate these results we have carried out VAR stability test. Result of VAR stability analysis is presented in the following table 4.

Table 4: VAR stability analysis

Roots of Characteristic Polynomial and Lag specification (1, 1)	
Endogenous variables: LNGDPPC LNCO2EMMISIONPC LNELECTRICITYCONSPC	
Root	Modulus
0.938494 - 0.083431i	0.942195
0.938494 + 0.083431i	0.942195
Note: No root lies outside the unit circle therefore VAR satisfies the stability condition.	
Source: Author’s calculation	

It is evident from the table 4 that since no root lies outside the unit circle therefore we can conclude that VAR is stable and results reported in Granger-causality analysis are valid.

Finally to see the robustness of the results of Granger-causality analysis we have used lag three in VAR (since two lags information criteria suggests and plus one following DL approach). Result of VAR with lag length three is reported in table 5.

Table 5: Result of VAR analysis

Vector Auto regressive Estimates (Standard errors in ( ))		
Independent variables (k)	Dependent variables	
	LNELECTRICITYCONSPC	LNPRIVATEEMPLOY
LNELECTRICITYCONSPC(-1)	0.679820* (.186185)	-0.056749 (.0926244)
LNELECTRICITYCONSPC(-2)	0.078379 (.218711)	0.098873 (.1088056)
LNELECTRICITYCONSPC(-3)	0.306884 (.2048996)	0.004186 (.1019346)
LNPRIVATEEMPLOY(-1)	-0.626744 (.3923115)	1.065246* (.1951694)

LNPRIVATEEMPLOY(-2)	-0.215191 (.446467)	-0.214712 (.222111)
LNPRIVATEEMPLOY(-3)	0.259528 (.2928964)	-0.016332 (.1457118)
C	1.027922* (.2843823)	0.209831 (.1414762)
VAR Model summary		
R-squared	0.981595	0.969793
Adj. R-squared	0.977348	0.962822
Sum sq. resids	0.026701	0.006608
S.E. equation	0.032047	0.015943
F-statistic	231.1130	139.1218
Log likelihood	70.64752	93.68774
Akaike AIC	-3.857425	-5.253802
Schwarz SC	-3.539984	-4.936362
Note: (1)*, **and ***denotes significant at 1%, 5%, and 10% level respectively; (2) (k) denotes lag length.		
Source: Author's calculation		

Results of Granger-causality analysis has been presented in table 6.

Table 6: Granger-causality analysis

VAR Granger Causality (Modified Wald test/χ^2)		
	LNELECTRICITYCONSPC	LNPRIVATEEMPLOY
LNELECTRICITYCONSPC	------	8.188430**
LNPRIVATEEMPLOY	6.323005**	-------------
Note: (1) **denotes significant at 5% level; (2) (k) denotes lag length.		
Source: Author's calculation		

It is evident from table 6 that in this case also we find bidirectional causality between energy or electricity consumption and organized private sector employment.

Again to see the validity of the Granger-causality results we have carried out VAR stability analysis. Result of VAR stability is reported in table 7.

Table 7: VAR stability analysis

Roots of Characteristic Polynomial and Lag specification (1, 2)	
Endogenous variables: LNELECTRICITYCONSPC, LNPRIVATEEMPLOY	
Root	Modulus
0.916431 - 0.105078i	0.922435
0.916431 + 0.105078i	0.922435
-0.306187	0.306187
0.141329	0.141329
Note: No root lies outside the unit circle therefore VAR satisfies the stability condition.	
Source: Author's calculation	

It is evident from the table 7 that in this case also no root lies outside the unit circle therefore we can conclude that VAR is stable and results reported in Granger-causality analysis are valid.

In the next step to analyze the direction of causality between energy or electricity consumption and public sector employment again we have carried out lag length selection test using maximum lag length 3, 4 and 5. Results of lag length selection are reported in table 8.

Table 8: lag length selection test

Lag	LL	LR	FPE	AIC	HQIC	SBIC
Maximum lag 3						
0	72.2585	NA	4.85e-05	-4.258089	-4.167392	-4.227572
1	161.883	162.954	2.71e-07	-9.447477	-9.17538*	-9.355926
2	167.814	10.063*	2.4e-07*	-9.56445*	-9.110960	-9.41186*
3	171.450	5.73097	2.49e-07	-9.542444	-8.907562	-9.328826
Maximum lag 4						
0	72.9503	NA	4.07e-05	-4.434394	-4.342786	-4.404029
1	157.570	153.374	2.64e-07	-9.473152	-9.198326	-9.382055
2	164.519	11.726*	2.2e-07*	-9.65743*	-9.19939*	-9.50560*
3	167.659	4.90688	2.35e-07	-9.603707	-8.962448	-9.391148
4	169.992	3.35314	2.65e-07	-9.499496	-8.675019	-9.226205
Maximum lag 5						
0	76.2856	NA	2.84e-05	-4.792621	-4.700106	-4.762463
1	155.560	143.206	2.21e-07	-9.649041	-9.371496	-9.558568
2	165.624	16.881*	1.5e-07*	-10.0403*	-9.57768*	-9.88947*
3	168.126	3.87368	1.67e-07	-9.943600	-9.295993	-9.732496
4	170.755	3.73104	1.86e-07	-9.855128	-9.022490	-9.583709

5	175.103	5.61069	1.88e-07	-9.877598	-8.859930	-9.545864
* indicates lag order selected by the criterion						
LR: sequential modified LR test statistic (each test at 5% level), FPE: Final prediction error, AIC: Akaike information criterion, SC: Schwarz information criterion, and HQ: Hannan-Quinn information criterion.						

It is evident from table 8 that in all cases (except for maximum lag 3) there is harmony among the different information criteria which suggest that in VAR lag length to be used is two. Again following DL approach we have estimated VAR employing lag length 3 i.e., 2+1.

Result of VAR estimates are reported in table 9.

Table 9: Result of VAR analysis

Vector Auto regressive Estimates (Standard errors in ( ))		
Independent variables (k)	Dependent variables	
	LNELECTRICITYCONSPC	LNPBLICEMPLOY
LNELECTRICITYCONSPC(-1)	0.793412* (.1783723)	0.184355** (.0870984)
LNELECTRICITYCONSPC(-2)	0.080038 (.2607758)	-0.019553 (.1273356)
LNELECTRICITYCONSPC(-3)	-0.159887 (.1648124)	-0.145120*** (.0804771)
LNPBLICEMPLOY(-1)	0.631887*** (.3580279)	0.956243* (.1748234)
LNPBLICEMPLOY(-2)	0.244359 (.5617617)	-0.098947 (.2743057)
LNPBLICEMPLOY(-3)	-0.431682 (.3380821)	0.042756 (.165084)
C	-0.413626** (.1856134)	0.231615** (.0906342)
VAR Model summary		
R-squared	0.983581	0.988903
Adj. R-squared	0.979792	0.986343
Sum sq. resids	0.023821	0.005680
S.E. equation	0.030269	0.014780
F-statistic	259.5860	386.1800
Log likelihood	72.53116	96.18668
Akaike AIC	-3.971586	-5.405253
Schwarz SC	-3.654145	-5.087812
Note: (1)*, **and ***denotes significant at 1%, 5%, and 10% level respectively; (2) (k) denotes lag length.		

Source: Author’s calculation

In the next step we have carried out Granger-causality analysis following DL approach i.e., MWALD test has been employed to test for causality by leaving last lag from the model. Results of MWALD test are reports in table 10.

Table 10: Granger-causality analysis

VAR Granger Causality (Modified Wald test/χ^2)		
	LNELECTRICITYCONSPC	LNPBLICEMPLOY
LNELECTRICITYCONSPC	------	6.170165**
LNPBLICEMPLOY	11.18331*	---------------------
Note: (1)*and **denotes significant at 1% and 5% level respectively.		
Source: Author’s calculation		

It is evident from the table 10 there is evidence of bidirectional causality between electricity or energy consumption and public sector employment.

In the final step we have carried out VAR stability analysis in order to validate the results reported by Granger-causality analysis. Result of VAR stability is reported in table 11.

Table 11: VAR stability analysis

Roots of Characteristic Polynomial and Lag specification (1, 2)	
Endogenous variables: LNELECTRICITYCONSPC, LNPBLICEMPLOY	
Root	Modulus
0.875645	0.875645
0.710956	0.710956
0.491828	0.491828
-0.113634	0.113634
Note: No root lies outside the unit circle therefore VAR satisfies the stability condition.	
Source: authors calculation	

It is evident from the table that no root lies outside the unit circle therefore stability condition of VAR has been satisfied.

V. Conclusions

Unlike previous studies for India which have focused on energy consumption and economic growth we have put our effort to focus on energy consumption and employment. To analyze the direction of Granger-causality we have adopted DL approach not only because it simplifies the complications of pretesting procedure of traditional Granger-causality but also as it has other certain advantages over that. It is evident from whole analysis that there is bidirectional causality between energy consumption and employment in organized public and private sector. Therefore our study supports for our third testable hypothesis i.e., "feedback hypothesis". This implies that energy consumption and employment in organized public and private sector are interdependent therefore they act as complements to each other. However, it should be noted that energy consumption in economic activity should not extensively be used as factor of generating employment as it has environmental consequences too. We should always be looking forward to alternative renewable energy sources and improving upon efficiency of energy production and energy consumption to enhance future prospects of economic growth and employment. Future research into the various disaggregated energy sources within each sector by state may provide additional insight on the relative impact of energy consumption patterns on economic growth and employment. Such efforts would also provide valuable information in the development of a more prudent and effective energy and environmental policies for the India.

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