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Co-Integration and Causality Analysis of Dynamic Linkages between Gross Domestic Product and Household Final Consumption: Evidence from an Emerging Economy

Syed Zulfiqar Ali Shah[1], Safdar Butt[2] and Rizwan Mushtaq[3+]

[1,3] International Islamic University, Islamabad, Pakistan

[2] Mohammad Ali Jinnah University, Islamabad

Abstract. This paper articulates the causal relationship between household final consumption and Gross Domestic Product per capita of India. Granger causality test was applied to test the causality direction and found no evidence of uni-directional or bi-directional Granger Causality between consumption and Gross Domestic Product per capita in both cases. Engle Granger, Co-integration and Error Correction model were also applied to find out the short run and long run relationship. There exists long run relationship between these two variables, and these converge towards equilibrium after short run deviation in Indian economy.

Keywords: Granger Causality, Co-Integration, Per Capita Consumption, Gross Domestic Product per Capita.

1. Introduction

This study is based on examining the relationship between income and consumption series of India covering a period of 30 years, from 1980 to 2009 in an attempt to determine the relationship between the country's household final consumption and per capita household GDP. The studies present the association at aggregate levels and try to explore the dynamic relationship between these two important indicators at macroeconomic levels. In view of the importance of the relationship of income and consumption at micro levels, it is hoped that this study may be able to serve as a basis for future research in this area and for economists to draw up policies which will improve the structure of economy both at aggregate and at individual levels. For that purpose we have examined the relationship of household final consumption per capita and household per capita GDP of Indian economy. India is located in the south Asia, most populous democracy of the world and second largest populous country having population of over 1.2 billion people. According to International Monetary Fund the nominal worth of its economy is US$1.843 trillion. This makes it the tenth largest economy of the world in terms of exchange rates, and third largest economy in terms of PPP with purchasing power parity assessed at US$4.469 trillion. Its GDP has an annual growth of 5.8%. If we look at the consumption patterns of India, it was the fifteenth largest importer in 2009, its major imports being gems, machinery, crude oil, fertilizer and chemicals. According to the report of Price water house Coopers[1] presented in 2011, by 2045 Indian GDP at purchasing power parity can surpass that of United States. It is expected that the Indian GDP will grow at an annualized average of 8%, in the upcoming four decades, making it potentially the fastest growing economy in the world till 2050. These factors are the key determinants that influenced our decision to study this country's economic indicators. This paper is organized into four sections. The first part presents an introduction, the second includes, and the third depicts the data and econometrics methodology used in the study while the fourth section comprises the concluding remarks of this particular study.

2. Review of Literature

There is generally a dearth of literature regarding the relationship between per capita consumption and gross domestic product. The authors could not trade any conclusive debate and study on this important

[+] Corresponding author. Tel: +923006570922, *E-mail address*: rizwanhcc@gmail.com

[1] Price water house Coopers (trading as PwC) "is a global professional services firm headquartered in London, United Kingdom. It is the world's largest professional services firm measured by 2011 revenues and one of the "Big Four" accountancy firms".

relationship. However, as we pointed out earlier, some research studies relating to the relationship between these factors at aggregate levels do exist. We also find some studies which are particularly focused on a given indicator of consumption to assess its relationship with income. The causal relation between consumption of energy and income has been investigated by many researchers like Backus (1986) and Ambler (1987), Abosedra, and Baghestani (1991) including the studies of contrary findings on the relation between GNP to energy consumption by Kraft and Kraft (1978) provide opposite estimations from Akarca and Long (1980), Yu and Hwang (1984), Yu and Choi (1985), and Erol and Yu (1987b).

Yu and Jin (1992) tested the data by using bivariate cointegration between the consumption of energy on the one hand and employment and income on the other with the help of Engle- Granger two step approaches. They used monthly data of United States from 1974 to 1990. The authors found that these underlying variables are trended, but they also shared common integrational properties. They found no evidence of co-integration between any of selected variables. This study might also be viewed from the aspect of Steadiness in the income hypothesis with existing evidence on the relation between consumption and income[2]. This hypothesis was tested by Friedman (1957) in a volume titled: "A Theory of the Consumption Function". This paper analyze the context of a model that tests for Granger Causation between Per Capita household final consumption and real income (per capita GDP) for highly populated, growing and emerging economy, Using the concept of cointegration. in this study we apply the other different types of econometrics tools and techniques to know the relationship within temporal "causal" framework.

3. Data and Econometric Methodology

We have selected, and obtained the data about certain indicators, from the official web site of World Bank. Different econometrics techniques were used to investigate the significance of the relationship between these underlying variables. In the first step of data analysis, series were tested for stationarity. Testing data for stationarity is very important in research where the underlying variables are based on time. Moreover, there are so many applications of time series data in many areas, such as examining the relationship between wages and house prices, profits and dividends and consumption and GDP. On of the important taste of econometrics is to determine the most suitable form of the trend in the data. The trending behavior or non-stationarity in the mean is almost shown in all of the economic and financial time series. For example the asset prices, exchange rates and the macroeconomic aggregates like GDP. This issue attracted a lot of discussion in the beginning of the 1970's decade.

4. Augmented Dickey-Fuller Test

(1)

Data about certain indicators of study does not become stationary at (which) level and at first difference, so we carry on our analysis towards second difference. Table: 1-1 Augmented Dickey Fuller Test at Second Difference depicts the output of ADF at second difference with intercept. Here the series becomes stationary significantly at at 1% as the t-value of GDP is (-8.935281) and the critical value at 1% significance level is (-3.699871). The t-value is less than the critical value, it falls at left hand side of the critical value so we can reject null hypothesis. It might be possible to say that the series of GDP does not have a unit root at second difference. Calculated value of consumption is (-10.25461) and critical value at 1% significant level is (-3.699871), so Rejecting the null hypothesis with a connclution that there is no unit root in the consumption series, and is stationary at second difference at 1% significant level.

Table: 3-1 Augmented Dickey Fuller Test at Second Difference

Variables	t-statistics	Level of significance	Critical value
		1% Critical Value	-3.699871
ADF test statistic-GDP	-8.935281	5% Critical Value	-2.976263

[2]Permanent Income Hypothesis states that "consumption is a stable function of absolute real income and that this function can be identified with the regression of consumption on income computed from either., budget studies or time series." For detail you can see Friedman (1957). Volume Title: A Theory of the Consumption Function.

		10% Critical Value	-2.627420
		1% Critical Value	-3.699871
ADF test statistic-Cons	-10.25461	5% Critical Value	-2.976263
		10% Critical Value	-2.627420

4.1. Granger-Causality Test

Pair-wise Granger Causality Tests does not show any kind of Granger Causality from either direction. Hence it can be concluded that there is no uni-directional or bi-directional Granger Causality between Gross Domestic Product and household final consumption of India. Some sort of uni-directional relationship is reported from the direction of GDP towards Consumption, but it is not statistically significant at 0.05.

Table 3-2Pairwise Granger Causality Tests

Sample: 1980 2009
Lags: 2

Null Hypothesis:	**Obs**	**F-Statistic**	**Probability**
GDP does not Granger Cause CONS	28	2.71234	0.08757
CONS does not Granger Cause GDP		0.32393	0.72655

4.2. Engle and Granger, Procedure of Co-Integration

Co-integration between GDP & Consumption series of India is tartan with procedure proposed by Engle Granger. They purposed a three step process to measure the data for co-integration. In step one we find the order of integration, in step two least square regression and in step three stationarity of residuals obtained from second step are tested. ADF test was applied to test the series for stationary for that purpose. Both economic indicators are found non-stationary at levels and also at first difference. However they attains the stationary by taking second difference, hence it might be possible to say that GDP/capita and Consumption/capita of India are co-integrated at second order I(2). A long run relationshop exists between these two variables, and these converge towards equilibrium after short run deviation in Indian economy. Table 1-3 represents the Augmented Dickey Fuller test results.

Table 3-3

Null hypothesis: D(GDP,2) has a unit root
Lag Length: 0 (Automatic based on SIC, MAXLAG=7)

		t-Statistic	**Prob.***
Augmented Dickey-Fuller test statistic		-8.935281	0.0000
Test critical values:	1% level	-3.699871	
	5% level	-2.976263	
	10% level	-2.627420	
Null Hypothesis: D(CONS,2) has a unit root			
Augmented Dickey-Fuller test statistic		-10.25461	0.0000
Test critical values:	1% level	-3.699871	
	5% level	-2.976263	
	10% level	-2.627420	

4.3. Testing Residuals for Stationarity

Residuals of regression are tested via Augmented Dickey-Fuller test without intercept and without time trend at level. Here the residuals are found to be non-stationary at any significant level. Instead of using

Normal ADF critical values to decide whether series is stationary or not, critical values for the null or no co-integration are used. Calculated t-value as shown in Table 1-4 is (-2.03386) and the critical values are less than this value so, the null hypothesis is rejected and it is concluded that the series of residuals is non-stationary and has a unit root. The possible conclusion on the basis of econometrics tools would be that GDP/capita and Household Final Consumption/capita of India has no co-integration and does not have long run relationship, and it therefore has nothing to say about whether x and y have an equilibrium relationship.

Table 3-4

Null Hypothesis: RESIDS has a unit root

		t-Statistic
Augmented Dickey-Fuller test statistic		-2.03386
Critical values for Co-Integration*	1% level	-4.07
	5% level	-3.37
	10% level	-3.3

*Critical values for Co-Integration are used here instead normal critical values for ADF.

4.4. Error Correction Model

The Error Correction Model sometimes termed as equilibrium correction model, and the two terms can be used interchangeably. If the variables are co-integrated than to estimate the error correction model the residuals from equilibrium regression is used and also for the analysis of long run and short run effects of the variables as well as to see the adjustment coefficient. Here the short run impact of GDP on Consumption is estimated equal to (0.1302050599) and the adjustment co-efficient or feedback effect is measured (-0.3186113435). These results are not surprising as our variables of concern are not co-integrated and don't have need of equilibrium correction model. Estimated equation of error correction model and output of the model is depicted below.

DCONS = 0.1302050599*DGDP - 0.3186113435*LAGRESID

Table 3-5 Estimated Equation of Error Correction Model

Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
DGDP	0.130205	0.006844	19.02532	0.0000
LAGRESID	-0.318611	0.168578	-1.889992	0.0695
R-squared 0.860916				

5. Conclusion

This study used historical data of Gross Domestic Product per capita and household final consumption expenditures per capita of India for the period of 1980-2009. The aim of this study was to examine the co-integration between these two variables. Error Correction Model was also the part of analysis but the results of this model were not significant because of non-staionarity of the residuals of co-integrated indicators. Some evidence of short run impacts of income on consumption was found; however there was no statistically significant impact of income on consumption in the long run. The direction of short- and long run causality is explained by the Vector Error-Correction Model. On the basis of our econometrics analysis it might be possible to conclude that, all the variables lack the causality. In other words, all the variables of concern in this study analyze the impact on the long run equilibrium due to the short run adjustments in different proportions. In future, research might be conducted by using other advanced econometrics techniques in the multivariate framework and by including more countries in the sample.

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