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The Effect of Past Income on Current Consumption: Granger Causality and Koyck Distributed Lag Estimation of Consumption Expenditure

T. Lakshmanasamy*

**Formerly Professor, Department of Econometrics, University of Madras, Chennai*
E-mail: tlsamy1960@gmail.com; tlsamy@yahoo.co.in

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Abstract: This paper studies the influence of past incomes on current consumption both at the individual and aggregate levels. The long-term causal relationship between personal disposal income and per capita personal consumption expenditure in India during 1966-2015 is examined using the RBI data on personal disposable income and consumption expenditure. The rate of adjustment between PDI and PPCE is modelled as Koyck distributed lag and the Granger causality approach is used in the empirical estimation. The estimates of Koyck distributed lag model shows that the marginal propensity to consume is 32 percent in the short-run and 93 percent in the long-run. The time required for the first half or 50 percent of the total change in per capita personal consumption expenditure following a sustained unit change in personal disposable income is about 1.6 years and it takes nearly 2.6 years on average for the effects to be fully felt.

Introduction

Earning income and consuming out of it is the beginning of all human economic activities. A man feels a desire and then he makes an effort to satisfy it. When the effort has been made, the result is the satisfaction of his want or desire. The personal consumption expenditure and personal disposal income describe the pattern of a person i.e. what he eats, what he wears, in which type of house he lives in, etc. Such a description gives us the knowledge of the standard of living of the person as well as society. According to Adam Smith: "consumption is the sole purpose of all production". Production increases with an increase in consumption and income. It is the consumption of goods that necessitates their production, the main economic activity. The aggregate consumption expenditure is an important aspect for an economy in development. Consumption expenditure accounts for two-thirds of GDP in most countries and is the most important determinant of welfare. Thus, consumption and consumption expenditure plays an important role in the determination of income, output, employment and growth of a country.

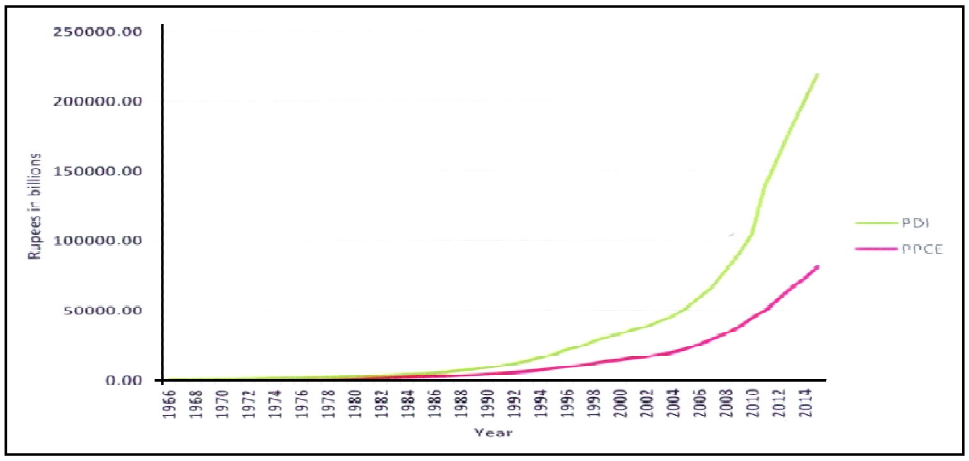
Household consumption expenditures consist of the market prices of all durable and nondurable goods and services purchased by households to satisfy

their needs and wants. The consumer attitudes to saving which is based on consumption decision are very important for capital accumulation, the basis of investment, growth and development. As consumption is the most important single element in aggregate demand, consumption expenditure decides the fate of many macroeconomic policies. Many government policies and programmes are directed towards improving personal consumption expenditures (PCE) and policymakers try to predict how the consumers will behave in the face of income fluctuations. The government formulates its economic policies based on the per capita personal consumption expenditure and disposal income habits of the people, Minimum wages and imposition of taxes are determined by considering the consumption requirements of the public. From the consumption pattern of the people, the government understands the requirements and production of essential and non-essential commodities in the country. From the analysis of income and consumption, the government can know the saving capacity of the public. Therefore, knowledge of the behaviour of per capita personal consumption expenditure (PPCE) is very essential for policy purpose. For this, an understanding of the nature of personal disposal income (PDI) is essential as the behaviour of per capita personal consumption expenditure heavily depends on personal disposable income.

The disposable personal income is often monitored as one of the many key economic indicators used to gauge the overall state of the economy. Disposable income is the amount available with households for consumption spending and saving, after accounting for taxes. Figure 1 depicts the growth of the personal disposal income and per capita personal consumption expenditure and their relationship over time in India. Both PDI and PPCE have been increasing over time, but since the beginning of the 21st century, the growth in personal income and consumption have been exponential. Moreover, the growth in PDI has been much higher than that of PPCE in post-2000s.

The relationship between per capita personal consumption expenditure and personal disposal income plays a central role in both macroeconomics and microeconomics. Macroeconomists are interested in aggregate consumption as aggregate consumption determines aggregate saving and aggregate saving is the national supply of capital, and hence aggregate consumption and saving behaviour have a powerful influence on an economy's long-term productive capacity and growth. Since consumption expenditure accounts for most of the national output, understanding the dynamics of aggregate consumption expenditure is essential to understanding macroeconomic fluctuations and the

Figure 1: Growth of Per Capita Personal Consumption Expenditure and Personal Disposal Income in India



Source: RBI: Handbook of Statistics on Indian Economy.

business cycle. Microeconomists study consumption behaviour to understand household spending behaviour, know other microeconomic behaviour such as job seeking or educational attainment, examine household preparedness for retirement use consumption data to measure poverty, or to test theories of competition in retail industries.

According to the Keynesian theory of consumption function, the relationship between income and consumption is determined by absolute income as the current real income is the primary mover of consumption. Accordingly, individuals take their consumption decisions taking into account the current disposable income and consumption is an increasing function of real disposable income. As the disposable income increases, so will the consumption expenditure but as a decreasing proportion of income. ln other words, the marginal propensity to consume is less than one, $0<\Delta C/\Delta Y<1$. While Keynes recognised that many subjective and objective factors including interest rate and wealth influence the level consumption expenditure, he emphasised that it is the current level of income on which the consumption spending of an individual and the society depends. Keynes states: "The amount of aggregate consumption depends mainly on the amount of aggregate income. The fundamental psychological law, upon which we are entitled to depend with great confidence both a priori from our knowledge of human nature and the detailed facts of experience is that men (and women, too) are disposed, as a rule and on an average to increase their consumption as their income increases, but not by as much as the increase in their income".

The above statement by Keynes on consumption behaviour implies that more the income in a period one has, the more is likely to be his consumption expenditure in that period, in any period the rich people tend to consume more than the poor people do, the average propensity to consume (APC) falls as income increases, the marginal propensity to consume (MPC) is less than the average propensity to consume (APC), and the proportion of income that is saved increases with the increase in income. However, the current consumption is not dependent only on the current income, past incomes may also influence the current consumption. Even though the past incomes influence the current consumption, it is not certain and clear how far the past influences persist and the nature of the period-specific influences on current income.

What is required is a model that would capture the influence of previous years income and their behaviour on the current consumption over time both at the individual and aggregate levels. Whether the PDI and PPCE have a long-term relationship? If so, what is the number of past values of income that influences current consumption? If PPCE depends on long-run income, whether there is short-run disequilibrium? What is the rate of adjustment between PDI and PPCE in the long-run? Does PCE also influence PDI? To address these issues, this study examines the short and long-term causal relationship between per capita personal consumption expenditure and personal disposable income in India. The data on income and consumption expenditure are sourced from the RBI statistics for the period 1966 to 2015 and the Koyck distributed lag model and Granger causality is used in the empirical estimation.

Review of Literature

Fisher (2006) examines how household income imputation affects consumer expenditure in Britain. The study compares the distributions of household consumption expenditure before and after income imputation and explores how measures of well-being - poverty rate - are affected by the introduction of income imputation. The study observes that the effect of adopting income imputation is that there may be a break in time series data that use multiple years of consumption expenditure data.

Adams and Cuecuecha (2010) analyse the effects of receipts of internal and international remittances on the marginal spending behaviour of household in Guatemala using a multinomial logit model and two stage multinomial selection model. The study finds that households spend less at the margin on important investment goods from the remittances received.

Khan and Ahmad (2014) examine the relationship between income and consumption in Pakistan using cross-sectional data for the period 1980 to 2012. The findings are in line with the Keynesian psychological law of consumption that consumption is a positive function of income. The estimated coefficient of income is a statistically significant 0.86. The consumption potential is higher in higher-income households as income increases consumption also increases but as income decreases, consumption does not decrease in the same proportion.

In the Indian context, Mangla (2011) studies the relationship between import and personal disposable income in the post-reform period from 1991 to 2008. The study estimates the marginal propensity to import and the sensitivity of imports for personal disposable income. The study estimates the marginal propensity to import to be 0.2955, meaning that in the post-reform period Indian households spent a sizable 29.55 percent of their disposable income on import goods.

Mallik and Pradhan (2012) analyse the causal relationship between per capita consumption expenditure and personal income in India for the period of 1950 to 1993. The study uses the Granger causality method to identify the causality between per capita personal consumption expenditure and personal disposal income and the Koyck distributed lag model to estimate the period for adjustment of per capita personal consumption expenditure on personal disposable income. The study finds a unidirectional causality that runs from per capita consumption expenditure to personal disposable income. The Koyck model shows that the mean lag is 30 percent implying that per capita personal consumption expenditure adjusts to personal disposable income over a relatively long period of time. A one percent change in per capita disposal income leads to a 16 percent response in per capita personal consumption expenditure in India. The paper also reports that Indian people spend a major part of income on consumption expenditure with a very negligible share in saving.

Data and Methodology

The data used in this study is a macro-level time series data on per capita personal consumption expenditure and per capita disposal income of households obtained from the Reserve Bank of India Handbook of Statistics on Indian Economy for the period from 1966 to 2015. The data are adjusted to 2011 base year. The per capita personal consumption expenditure (PPCE) is the market value of all the goods and services including durable products purchased by households during a year divided by the population. The personal disposable

income (PDI) is the amount of money that household have available for spending and saving after income taxes have been accounted for. In the empirical analysis, the causal relationship between personal disposal income and per capita consumption expenditure is examined by the Granger causality test and the short and long-run effects of personal disposal income on per capita personal consumption expenditure is estimated by the Koyck distributed lag model.

Koyck Distributed Lag Model

The Koyck model is a geometric distributed lag model which describes the current value of the dependent variable as a function of current and past values of the independent variables, where the lag coefficients decay geometrically. The parsimonious Koyck distributed lag model is specified as:

$$y_t = \alpha + \beta_0 x_t + \beta_1 x_{t-1} + \beta_2 x_{t-2} + \ldots + u_t \quad (1)$$

The coefficient β_0 is the short-run or impact multiplier as it measures the change in the mean value of y following a unit change in x in the same time period. If there is a change in x is maintained at the same level thereafter, then $\Sigma_{i=0}^{k}\beta_i$ is the long-run or total distributed lag multiplier which measures the changes in the mean value of y in the following k periods.

Assuming that the βs are all of the same sign, the geometric decline in lag coefficients can be specified as:

$$\beta_k = \beta_0 \lambda^k \qquad 0 < \lambda < 1 \quad (2)$$

where λ is the rate of decline or decay of the distributed lag. Since $\lambda<1$, the weight to the distant β's is lesser than the current one. Therefore, each successive β coefficient is numerically less than each preceding β's i.e. current and immediate past income are expected to affect current consumption expenditure more heavily than income in the distant past. The long-run multiplier is given by:

$$\Sigma_{k=0}^{\infty}\beta_k = \beta_0 + \lambda\beta_0 + \lambda^2\beta_0 + \ldots + \lambda^\infty\beta_0 \quad (3)$$

$$= \beta_0(1 + \lambda + \lambda^2 + \ldots + \lambda^\infty) \quad (4)$$

$$= \beta_0\left(\frac{1}{1-\lambda}\right) \quad (5)$$

As a result, the Koyck distributed lag model can be specified as:

$$y_t = \alpha + \beta_0 x_t + \beta_0 \lambda x_{t-1} + \beta_0 \lambda^2 x_{t-2} + ... + u_t \quad (6)$$

As the parameters of the Koyck equation are highly non-linear in form, the conventional OLS estimation is not applicable. Hence, a Koyck transformation of the equation by lagging by one time period and pre-multiplying by λ gives:

$$\lambda y_{t-1} = \lambda\alpha + \lambda\beta_0 x_{t-1} + \lambda^2 \beta_0 \lambda x_{t-2} + \lambda^3 \beta_0 x_{t-3} + ... + \lambda u_{t-1} \quad (7)$$

On subtraction, the transformed Koyck equation can be specified as:

$$y_t = \alpha(1-\lambda) + \beta_0 x_t + \lambda y_{t-1} + v_t \quad (8)$$

where $v_t = (u_t - \lambda u_{t-1})$, a moving average of u_t and u_{t-1}. Compared to the estimation of infinite number of parameters in the original Koyck equation, the Koyck transformation of the distributed lag equation need to estimate only three unknowns: α, β_0 and λ as the lagged *x*'s are replaced now by a single variable y_{t-1}.

As λ measures the speed of adjustment, the higher the value of λ the lower the speed of adjustment, and the lower the value of λ the greater the speed of adjustment. The median lag is the time required for the first half or 50 percent of the total change in *y* following a unit sustained change in *x*. For the Koyck model, the median lag is given by:

$$median\ lag = (-\log 2/\log \lambda) \quad (9)$$

The average lag is given by:

$$mean\ lag = \Sigma_0^\infty k\beta_k / \Sigma_0^\infty \beta_k \quad (10)$$

which is simply the lag-weighted average of time, with respective coefficients serving as weights. In short, it is a lag-weighted average of time. For the Koyck model, the mean lag is λ/(1-λ), thus if λ= ½, the mean lag is 1.

Empirical Analysis

Table 1 presents the descriptive statistics of the variables per capita personal consumption expenditure and personal disposable income in the empirical estimation of the Koyck distributed lag model. As the data are time series, the stationary of the variables i.e. the presence of unit root, have to be checked for stationary by the Augmented Dickey-Fuller unit root test. The ADF results presented in Table 2 shows that the variables are non-stationary at levels and becomes stationary at the first difference at 5 per cent level of significance.

Table 1
Descriptive Statistics of the Variables

Variable	*Description*	*Mean (SD)*	*Log value*
PPCE	Per capita personal consumption expenditure (Rs. billion)	14040.09 (80775.60)	8.369 (1.718)
PDI	Personal disposable income (Rs.billion)	21415.00 (34845.82)	8.5695 (1.870)

Source: RBI: Handbook of Statistics on Indian Economy.

Table 2
ADF Unit Root Test for Stationarity

Variable	*ADF with trend*		*ADF with intercept*		*ADF with trend and intercept*	
	At level	*At 1st difference*	*At level*	*At 1st difference*	*At level*	*At 1st difference*
lnPPCE	0.49 (0.98)	-3.92 (0.00)	-3.39 (0.06)	-3.88 (0.02)	2.38 (0.99)	-0.40 (0.05)
lnPDI	1.36 (0.99)	-5.85 (0.00)	-3.24 (0.08)	-6.13 (0.00)	1.58 (0.99)	-0.71 (0.03)

Note: p-values in parentheses.

Given that the first difference series is stationary, the direction of the causal relationship between PDI and PPCE is to be tested. The Granger causality test suggests that a variable x causes another variable y if the latter can be predicted well from past values of x and y than from the past value of y alone. Similarly, y causes x if the x variable can be predicted well not only from its past value but also from the lagged values of y. If x causes y and y does not cause x, then x is said to be causing y unidirectionally or there is one-way causation from x to y. If x causes y and y causes x, then there is bidirectional causality or feedback between them. For an empirical verification of Granger causality, it is necessary to estimate two regressions of the following form:

$$PPCE_t = \Sigma_{i=1}^{n} \alpha_i PDI_{t-1} + \Sigma_{i=1}^{n} \beta_j PPCE_{t-1} + u_{1t} \quad (11)$$

$$PDI_t = \Sigma_{i=1}^{n} \gamma_i PPCE_{t-1} + \Sigma_{i=1}^{n} \delta_j PDI_{t-1} + u_{2t} \quad (12)$$

where u_{1t} and u_{2t} are mutually uncorrelated white noise series. Under the hypothesis that PDI causes PPCE, the null hypothesis is: $\alpha_i = \gamma_i = 0$. which may be rejected in favour of the alternative hypothesis: $\alpha_i = 0$ and $\gamma_i \neq 0$.

As a precondition to applying Granger causality test a lag length of two is chosen based on the Akaike information criteria. The results of Granger causality test are presented in Table 3. The null hypothesis that PDI does not Granger cause PPCE is rejected at the 5 percent level of significance whereas the null that PPCE does not Granger cause PDI cannot be rejected even at the 10 percent level. Therefore, there is a one-way or unidirectional causality running from personal disposable income to per capita personal consumption expenditure.

Table 3
Granger Causality test

Hypothesis	*F-statistic*	*p-value*
lnPDI does not Granger cause lnPPCE	15.33**	0.00
lnPPCE does not Granger cause lnPDI	0.92	0.40

The estimating empirical Kyock distributed lag model is specified as:

$$\ln PPCE = \alpha + \beta_0 \ln PDI_t + \lambda \ln PPCE_{t-1} + v_t \qquad (13)$$

Table 4 presents the estimates of the Koyck distributed lag model. The estimated coefficients of PDI and one period lagged PPCE is positive and statistically significant at 1 percent level. The short-run effect of personal disposable income on per capita personal consumption expenditure or the marginal propensity to consume is 32 percent. A one percent increase in current year income increases household consumption expenditure by about 32 percent, while one percent increase in previous year income via lagged consumption expenditure increases current year household consumption expenditure by 65 percent. The long-run multiplier is obtained by dividing the short-run consumption function by (1-λ), [0.324/(l-0.650)]=0.925. Thus, the long-run impact of an increase in income over time is about 93 percent. The reason for such a difference between the short-run and long-run MPC can be attributable to the median and mean lags. The median lag period is 1.6 years which shows that 50 percent of the total change in per capita personal consumption expenditure is accomplished in about one and a half years following a unit sustained increase in personal disposable income. The mean lag period is 2.6 years which shows that on an average it takes more than two and half years for the effects of changes in personal disposable income to be felt on per capita personal consumption expenditure.

Table 4
Estimates of Koyck Distributed Lag Model

Variable	*Coefficient*	*Std. Error*	*t-statistic*	*p-value*
lnPDI	0.324*	0.075	4.307	0.0001
$lnPPCE_{t-1}$	0.650*	0.082	7.909	0.000
Constant	0.230*	0.043	5.369	0.000
R-square	0.999	Durbin-Watson test	1.893	

Note: * significant at 1 percent level.

Conclusion

The objective of this study is to analyse the causal relationship between personal disposal income and per capita personal consumption expenditure in India during 1966-2015. The current consumption is not only influenced by current income but also past incomes. Therefore, this study follows the Koyck distributed lag model which is a parsimonious model of finite lags providing short and long-run income effects on consumption. The estimates of Koyck distributed lag model shows that the marginal propensity to consume is 32 percent in the short-run and 93 percent in the long-run. The time required for the first half or 50 percent of the total change in per capita personal consumption expenditure following a sustained unit change in personal disposable income is about 1.6 years and it takes nearly 2.6 years on average for the effects to be fully felt.

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