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Keynes' Unscientific Theory of Consumption Function and Its False Policy Implication for the Multiplier Effect: A Review of Disaggregated Evidence

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Abstract

The assumption that the Marginal Propensity to Consume (MPC) and the resulting multiplier are fairly stable at the aggregate level irrespective of the time frame, commonly articulated in some post-Keynesian literature and introductory macroeconomic texts and universally used as the building block of fiscal policy decisions, are false concepts. In this enquiry, we examine the robustness of this proposition using disaggregated disposable income to demonstrate that neo-Keynesians' generalization that consumers in different income brackets would react similarly to a change in income is refuted by the weight of historical evidence. We derive estimates of the MPC in the short-run and the long-run using recent data from the US Bureau of Economic Analysis (BEA). We show that the whole is not the sum of its parts when it comes to the MPC. This insight should give teachers a more accurate description of short-run consumption behavior. Our objective is to extend students' understanding of the complexity of the economy and reveal that there are many intricate mysteries that are yet to be expounded (Note 1).

Keywords

MPC, Multiplier, Keynes' General Theory

1. Introduction

John M. Keynes' impact on macroeconomic theory and practice has been omnipresent since the publication of the General Theory in late 1930s. While Keynes' analysis of consumption behavior and conception of the consumption function have been integrated into much of the macroeconomic literature, the Keynesian introspective methodology has not gone unchallenged. Early on, A.C. Pigou, a contemporary colleague of Keynes noted "Mr. Keynes… contrives to be clear-headed without making muddleheaded people hate him" (Skidelsky, 1983, p. 123). Other skeptics of Keynesians' methodology

have pointed out that in economics, as in in other social sciences, the outcome of "thought experiments" is not foreseeable since we have no foreknowledge of how individuals or groups will behave in the context of an ever changing environment. It is therefore not surprising that philosophers and social scientists who rely on objectivity and the scientific method have questioned the Keynesian introspective methodology and its relevance to macroeconomic decision-making. Among many others, Angus Deaton who merited the Nobel Prize in 2015, has been raising serious questions about the relationship between income and consumption in many of his presentations and published works (Deaton, 2010, 2011). Deaton's pioneering empirical work has shifted the emphasis away from the behavior of macro aggregates to the decision-making process at the individual and household levels. We can now agree that a fixed aggregate MPC tells us nothing about economic behavior since the impulsive and perhaps random actions of millions of individual agents may "add up" in such a way that the aggregate MPC appears constant.

2. Overview of the Literature

Empirically, if the Keynesian paradigm was subjected to the more exacting versions of the scientific methodology, as articulated by some classical philosophers (Hume et al., 1888), his hypothesis would have been rejected at the outset. Soon after the publication of the *General Theory*, Machlup (1939, 1943) attempted to qualify Keynes' *multiplier theory* as a gradual process rather than being as an instantaneous episode as conjectured by Keynes. He attempted to lend some credibility to Keynes' consumption theory and make it more convincing by suggesting that other variables such as time lags, unpredictable propensities to consume and random events should be taken into consideration.

In contemporary times, Keynes' hypothesis would fail to meet scientific standards as vigorously defined by such eminent philosophers as Karl Popper, Dennis Phillips and other epistemologists. For instance, in Popper's view, empirical theories such as conjectures about the trajectory of the MPC can only be tested and falsified, but never logically verified. Factually and from the beginning, Keynes' intuitive proposition has been *falsified* through extensive empirical tests and credible corroborations. Therefore, we are inclined to reject Keynes' consumption theory as a scientific paradigm.

The falsity of Keynes' speculation that "if the consumption psychology of the community is such that they will choose to consume, e.g., nine-tenths of an increment of income, then the multiplier k is 10; and the total employment caused by (e.g.) increased public works will be ten times the primary employment provided by the public works themselves" (Hazlitt, 1992, pp. 116-117) is manifestly obvious. Mathematically speaking, if one assumes that MPC is one or near one, then the size of the multiplier approaches infinity—which is an incongruous corollary. Herbener (1992) pointed out there is no "accounting principle" to justify that the MPC is bounded between zero and one. He used US income and consumption data from 1939 through 1960 to show that the MPC ranged from -1.38 in 1945 to 45.33 in 1949.

The notion of a stable MPC, which is founded on inductive methodology, is at best a speculative

proposition. Nearly two hundred years before the publication of Keynes' influential work, David Hume (1888) had cautioned that the problem of inductive logic is that "instances, of which we have had no experience, must resemble those of which we have had experience, and that the course of nature continues always uniformly the same" (Selby-Bigge, 1986, p. 104). Therefore, limited evidence of a stable MPC in short instances at one level (aggregate) cannot logically be worked into a universal theory. In an evolving economy, we should hesitate to presume anything is "fixed"; a constant MPC evident in today's data does not necessarily imply it will remain so indefinitely.

Recently, the irregular behavior of the MPC by income class, regional and country differences and the phase of economic development are being robustly and progressively questioned in the more insightful approaches that have used more reliable microeconomic data in testing the Keynes' theory and its implications. This research also has had important implications for the shape and behavior of the utility function, since the value of the MPC emerging from the utility-maximization exercise depends in part on the exact formulation of the utility function. This outcome has contributed to academic debates in the context of the Permanent Income Hypothesis. Nevertheless, the simplicity and established popularity of the theory has served to divert objective and impartial analysis of typical consumption behavior by households. Sadly, the intransigent fascination with Keynes' simplistic model by many well-known contemporary authors of introductory principles of economics texts continue to severely obstruct academic literacy, modelling innovations and policy design. In an intensive reappraisal of the Keynesian multiplier theory and the related literature, Ahiakpor (2001, p. 768) categorically rejects Keynes' multiplier theory (based on a stable MPC). He correctly argues that Keynesian theory seems "plausible only because both its proponents and previous critics have failed to ask the pertinent questions to help unmask its fundamental misconception of the economic process, especially the concurrent nature of production and subsequent exchange rather than a unidirectional one".

In this reevaluation article, we review the robustness of the "constant MPC" hypothesis. We began by reviewing selected insights from recent research findings. In the following segments, we extend the discussion by exploring current data on consumption and disposable income for the US. We provide a simple empirical framework which demonstrably falsifies Keynes assessment of the MPC. We end the article with implications and recommendations for future research.

3. The Factual Causality between Consumption and Income

While a significant causal relationship between income and consumption seems theoretically and empirically reasonable, there is no scientific foundation to support the notion that changes in the level of income changes consumption spending by a predictable amount at every stage. The failure of Keynes hypothesis in explaining the post-war consumption and saving behavior in the United States and elsewhere in Europe prompted much debate soon after the publication of the *General Theory*. In a treatise published in 1947, A.C. Pigou criticized Keynes for ignoring the "wealth effect" in the consumption function. Pigou submitted that in due time, as a result of a falling price level, the wealth

effect would stimulate consumption as well the MPC. Nobel Prize laureate, Paul Samuelsson (1943) questioned the stability of the Keynesian consumption function and proposed a "ratchet model" with the implication that during an economic recession household are reluctant to abandon their consumption habits in response to declining levels of spendable income. Soon after, other economists including Brady and Friedman (1947), Duesenberry (1948), Modigliani (1949) and Katona and Mueller (1953, 1956), offered competing hypotheses about consumers' consumption behavior during the post-war era. Friedman's Permanent Income Hypothesis, which initially gained considerable support in the macroeconomic literature, conjectures that it is the permanent income that drives consumption behavior rather than current income.

All the same, consumption theories that use permanent income or life-cycle income as a determinant of consumption have proved inadequate in explaining the behavior of the MPC over the short horizon. These theories often subsume a world of certainty in which individuals have perfect information about their future income, the direction of interest rates, and the availability of credits, life expectancy and so on. Tobin (1958), a celebrated Keynesian and a Nobel Laureate, questioned aspects of Keynes' consumption theory as it related to large expenditures on consumer durables such as cars, boats, etc. and developed a sophisticated model famously known as the "Tobit Regression" to better explain the relation between income and consumption. Empirical estimates of the MPC by Watts (1958) and Bodkin (1959) did not support a predictable and stable MPC. In fact, Watts' statistical study (1958) indicated that the behavior of the MPC was asymmetrical depending on whether changes in income were perceived to be positive or negative. Watts' research is consistent with further evidence reported by Jonathan Parker (1999) and Nicholas S. Souleles (1999). These authors demonstrated that consumers' spending behavior was particularly sensitive to the timing of changes in income.

In a re-evaluation of these theories, Robert Hall (1976) used the Euler equation (Note 2) to argue that the consumption function, as it related to data from the United States, could be modelled as a random walk. He proposed that consumers attempt to maximize their intertemporal utility when the real interest rate is assumed to remain constant. Recall that in the context of a random walk model, the best predictor of consumption in the next period is the change in consumption in the previous period. Despite its simple construct, tests of Hall's hypothesis have been statistically intractable (see Mei, 2012).

In a more formative study, Princeton economist Hseih (2003, pp. 397-405) showed that changes in household spending in response to changes in income was only predictable when income changes were "large and transparent".

More recently, Carrol, Slecalek and Tokuoka (2014) demonstrate that in developing countries with skewed distribution of wealth, the consumption function is concave which evidently implies that low wealth families have a higher MPC when compared to wealthier cohorts. Furthermore, they report that the "aggregate MPC is considerably lower than the estimates reported in the empirical literature" (p. 2). These authors suggest that the aggregate MPC does not vary over the business cycle. Furthermore, they

report that "neither the mean value of MPC nor the distribution of MPC changes much when the economy switches from one state to another" (p. 5).

4. Recent Evidence from Federal Reserve and CES Data

We now seek to evaluate the recent dynamics of the MPC using both the conventional consumption function model as well as our own construct. We first look at data from the US Bureau of Economic Analysis (BEA) (via the Federal Reserve Bank of St. Louis FRED database) for an extensive period (1930-2015) This dataset contains aggregate real personal consumption expenditure (C_t), at annual frequency, in billions of chained 2009 dollars. The dataset also contains aggregate real disposable personal income (Y_t), at annual frequency, in billions of chained 2009 dollars (Note 3).

We also consider annual data from the US Consumer Expenditure Survey (CES) for a much shorter time period (1985-2014). This data is available from the Bureau of Labor Statistics (BLS) website. Two particular series are relied upon: average disposable income (income after taxes) and average total consumer expenditure. This data is appropriate to our query because the CES measures spending habits, income levels and several characteristics of US households. The BLS data retrieval tool allows us to sort the surveyed households into different categories before extracting their average disposable income (income net of taxes) and spending levels. We choose to group the households by pre-tax income ranges with an additional group consisting of all the households. It is therefore possible to evaluate the "stable MPC hypothesis" for each income subgroup (at a more "micro" level). We explore properties of this data set for the 1985-2014 period, but choose to pay particular attention to the 2001-2014 time period where more comprehensive data is available.

5. Methodology

We first consider the longer aggregate dataset (1930-2015) from the BEA (see Figure 1).

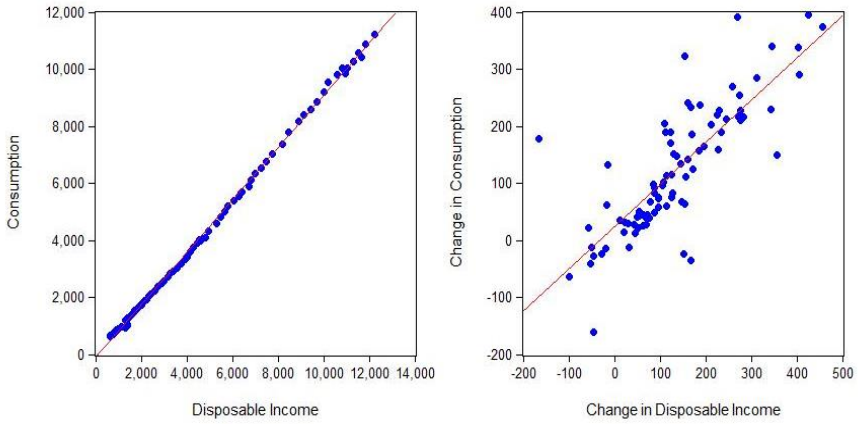


Figure 1. Aggregate Consumption Spending and Disposable Income, 1929-2015, $Billions, 2009 Chained Dollars

Source: Federal Reserve Bank of St. Louis (2016).

We begin by testing the input data for stationarity by evaluating the Augmented Dickey-Fuller (ADF) statistic (which tests for the presence of a unit root). Observing that the ADF statistic for both the income and the consumption series are greater than the test critical values, we fail to reject the null hypotheses that a unit root is present and conclude that the level data is nonstationary. We also test the data for stationarity in first differences (Note 4). For both income and consumption, the null hypothesis of a unit root is rejected at 99% level. Similar results are observed when the data consists of first differences of income and consumption with the trend component included. Likewise, natural logarithmic (ln) transformation of the data in levels are non-stationary but stationary in first-differences. Based on these results, we fit an Error Correction Model (ECM) to the aggregate data to evaluate the aggregate MPC from 1930 through 2015:

$$\Delta \ln(C_t) = c_0 + c_1 \Delta \ln(Y) + c_2 Gap(-1) + e_t \quad (1)$$

$\Delta \ln(C_t)$ is the first difference of $\ln(C_t)$, which approximately equals the growth rate of consumption spending. $\Delta \ln(Y_t)$ is the first difference of $\ln(Y_t)$, which is approximately the growth rate of disposable income. $Gap(-1) = \ln(Y_{t-1}) - \ln(C_{t-1})$ is the difference between log disposable income and log consumption last period. The ECM model provides estimates of both the short-run and the long-run effects of changes in disposable income on consumption expenditures. In this formulation, the coefficient of $\Delta \ln(Y)$ in the right-hand-side of equation (1) should approximate the short-run MPC, while the coefficient of Gap(-1) indicates the speediness to which consumption and income and consumption converge to their long-run equilibrium levels. The error term (e_t) represents shock events that are likely to impact consumption behavior. The estimated results shown in the following table from the error correction model yield estimates for both the short-run MPC (0.509) and the speediness of convergence of consumption and income in the long-run (0.13).

Table 1. The MPC Estimate from the Error Correction Model for US: (1930-2015)

Variable	Coefficient	Std. Error	t-statistic	Prob.
Constant	-0.001147	0.005922	-0.193632	0.8469
$\Delta \ln(Y_t)$	0.518417	0.058650	8.839172	0.0000
Gap(-1)	0.130655	0.041667	3.135678	0.0024
R-squared	0.509363	Mean dependent var		0.030980
Adjusted R-squared	0.497541	S.D. dependent var		0.029465
S.E. of regression	0.020886	Akaike info criterion		4.865209
Sum squared residuals	0.036207	Schwarz criterion		4.779592
Log likelihood	212.2040	Hannan-Quinn criterion		4.830752
F-statistic	43.08395	Durbin-Watson statistic		1.216851
Prob(F-statistic)	0.000000	(Note 5)		

From these results, we can also compute a "factor of proportionality" = exp(coefficient on constant/coefficient on Gap(-1)) = 0.991. This estimate suggests that we can expect US consumers to spend approximately 99.1% of their income in the long-run. When compared to the long-run estimate of the MPC in a simple regression of spending on income (shown below), the approximate MPC from the error correction model is approximately 20% higher. Note that this data set contains some extreme economic shocks (recessions and high inflation periods) which may impact the numerical findings. Exploring more consistent data ranges using an error-correction model is left for another study. Nonetheless, this result is more revealing of the proper relationship between changes in income and changes in consumption at a disaggregated level at different income brackets.

We now consider the shorter dataset from the CES. Here, we take a simpler approach and focus on OLS models to extract estimates of the MPC. Two models are considered:

$$C_t = c_0 + MPC_{LR} \times Y_t + e_t \quad (2)$$

C_t represents average consumption spending, c_0 represents an autonomous level of consumption, MPC_{LR} is the long-run marginal propensity to consume and Y_t represents average disposable income. We note that equation (2) is representative of the formulation of the relationship between income and consumption in much of the undergraduate textbooks. To correct for spurious results (stemming from trended data) we also estimated the parameters of equation (3) below which is based on first differences of income and consumption.

$$\Delta C_t = a_0 + MPC_{SR} \times \Delta Y_t + e_t \quad (3)$$

In this equation, a_0 is a constant parameter, MPC_{SR} is the marginal propensity to consume over the short run and ΔY_t is the yearly changes in disposable income. These two formulations differ in that the first equation assumes a fixed level of autonomous consumption (c_0) while the second equation accommodates persistent movements in autonomous consumption within the parameter a_0. Speculation about shifts in autonomous consumption was first raised by Peter Temin's *Did Monetary Forces Cause the Great Depression*? (1976) who posited that shifts in the consumption function was central in the intensification of the contraction from 1929 to 1933. In a paper published by the National Bureau of Economic Research, Robert Hall (1986, pp. 237-266) produced results similar to Taman's work. He showed that significant shifts in the consumption/GNP relation played a decisive role in setting off the Great depression. Previously, Temin's critics, Thomas Mayer (1978) and Barry Anderson and James Butkiewicz (1980), had demonstrated that consumption functions of various types had important negative residuals in 1930.

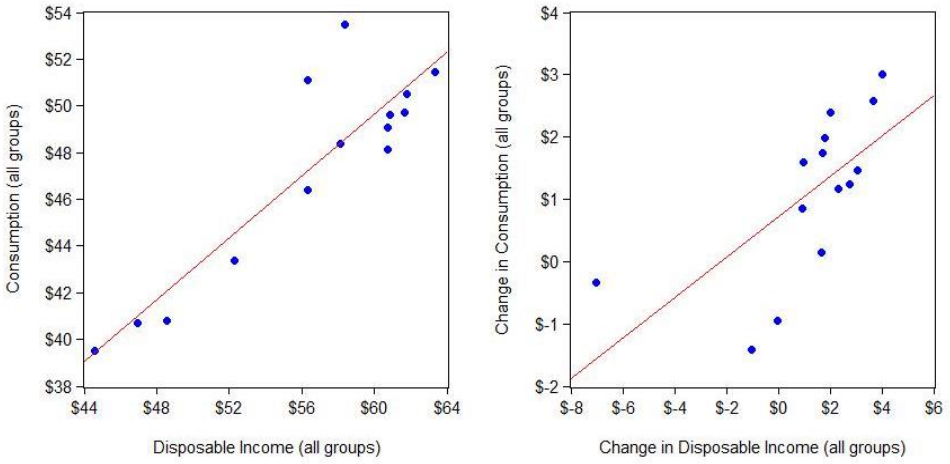
We might think of equation (2) as representing aggregate consumption over the longer term which is used in Keynesian economic models. We might think of equation (3) as that reflecting consumer behavior and how spending patterns change in response to immediate income shifts. As such, they produce different estimates of the MPC, with the estimate from equation (2) sometimes called the "long-run MPC" (MPC_{LR}) and the estimate from equation (3) called the "short-run MPC" (MPC_{SR}). If the MPC is constant, we would expect data points for spending and disposable income to fall on a

straight line for at least one of the two linear functions. To visually identify this trend, we generated simple scatter plots (with linear trend lines) and used simple OLS to produce estimates of the MPC.

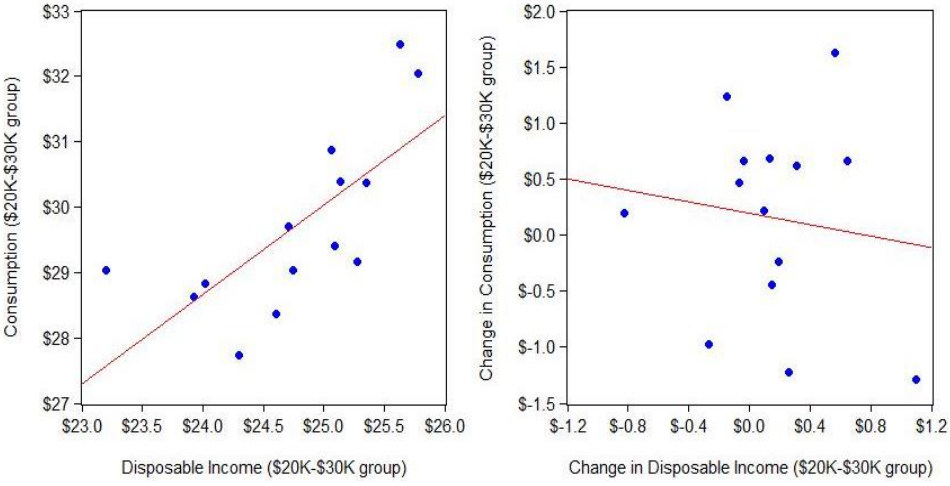
Early data (1985-2000) covering all income groups shows a strong linear relationship between consumption spending and disposable income. It appears that equation (2) fits the data quite well during this period. The OLS estimate for the long-run MPC for this period is 0.793 and is highly significant (see Table 2). As expected, a lesser linear relationship appears to exist between changes in spending and changes in disposable income. We would hesitate to immediately assume that equation (3) is an appropriate model during this period. It is highly plausible that a potentially-omitted factor, such as a measure of income distribution that influences consumption changes needs to be incorporated. Moreover, stochastic spending/income shocks are quite strong which consistently impact the short-run MPC. Despite the additional variation, our enquiry produces a significant OLS estimate of the short-run MPC of 0.48. These numbers are consistent with the overall expectations of a significant MPC value between 0 and 1 and in-line with the estimates obtained from the ECM model reported in Table 1.

Table 2. OLS Estimates of the MPC: 1985-2000 and 2001-2014

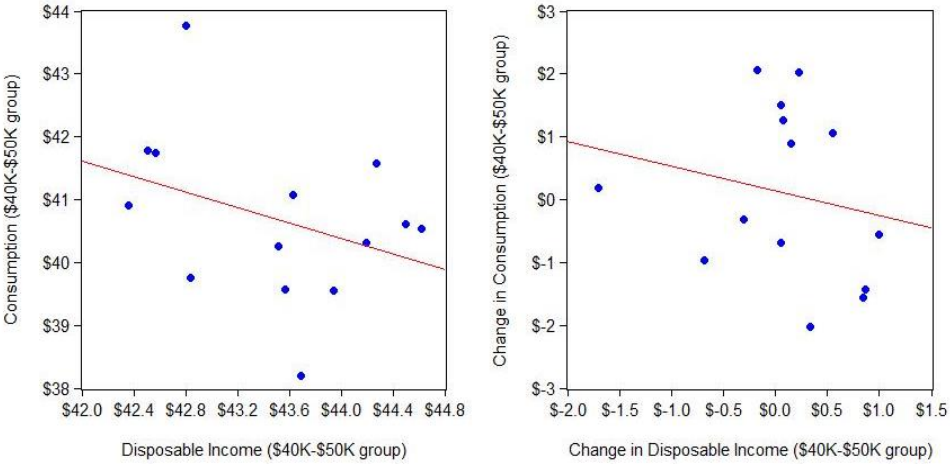
	Levels (Equation (2))			Differences (Equation (3))		
	OLS Estimate of Long-run MPC	Std. Error	Significance	OLS Estimate of Short-run MPC	Std. Error	Significance
1985-2000:						
All	0.793	0.016	***	0.484	0.140	***
2001-2014:						
Income Group						
All	0.662	0.093	***	0.325	0.104	***
< $5K	-0.459	0.341		-0.085	0.400	
$5K-$10K	7.196	1.486		1.113	2.522	
$10K-$15K	1.923	0.756	**	0.275	1.266	
$15K-$20K	2.065	0.763	**	0.836	1.470	
$20K-$30K	1.368	0.384	***	-0.255	0.562	
$30K-$40K	0.733	0.525		-0.500	0.582	
$40K-$50K	-0.616	0.465		-0.393	0.556	
$50K-$70K	-0.333	0.201		-0.103	0.281	
$70K-$80K	-0.143	0.181		0.120	0.250	
$80K-$100K	-0.165	0.145		0.080	0.234	
$100K-$120K	-0.190	0.107		-0.091	0.145	
$120K-$150K	-0.133	0.121		-0.010	0.205	
> $150K	-0.018	0.070		0.089	0.058	



(a) All Income Groups



(b) $20K-$30K Income Group



(c) $40K-$50K Income Group

Figure 2. Aggregate Consumption Spending and Disposable Income by Income Group, 2001-2014, $Thousands

Source: Bureau of Labor Statistics (2016).

When we focus only on the most recent period (2001-2014), a somewhat different picture emerges. Visual inspection of the data again shows a strong relationship between consumption and disposable income described by equation (1), but there is much more additional variation in consumption to explain, with particularly extreme movements in 2009-2010 and 2013-2014 (see Figure 2a, left graph). At first glance, we might hesitate to adopt equation (2) for this period without further testing. Results for changes in consumption and changes in disposable income are similar to those for the early period. Because of too much variation in the data, it is implausible that equation (3) captures the real but unobserved relationship between the two variables (see Figure 2a, right graph). Estimates of the long-run and short-run MPCs (covering all households) during the 2001-2014 period are 0.66 and 0.33 respectively (see Table 2). Although, both estimates are statistically significant, they are lower than those from the 1985-2000 period. This finding suggests that the MPC has drifted in the latter period. A simple t-test that the long-run MPC estimate from this latter period equals that from the earlier period can be rejected at the 5% level (but not at the 10% level). For the short-run MPC, we can reject the hypothesis that the latter period estimate equals the earlier period estimate at the 1% level (but not at the 5% level). These different estimates contradict the hypothesis that the MPC is fixed.

When we evaluate equation (2) and equation (3) for separate income groups during the 2001-2014 period, we fail to achieve consistent and, in many cases, significant estimates of the long-run and short-run MPCs. Figure 2b and 2c show the spending and disposable income data for the \$20K-\$30K and the \$40K-\$50K income groups as examples to illustrate how different data for these groups can be (figures for the other income groups are available upon request). Table 2 reports the OLS estimates for this dataset. Notably, estimates of the long-run MPC generally decline with income level. Significant, positive estimates are found only for low income levels (\$10,000-\$30,000 in pre-tax income). These MPC estimates all exceed 1 (likely due to the role of credit for low-income households). For income levels greater than \$30,000, estimates of the long-run MPC are not statistically different from zero. As shown in Table 2, the MPC for higher income groups have turned negative in recent years.

Note that estimates for the short-run MPC are never statistically different from zero for all income brackets. Once again, either there are other explanatory variables to consider, or there exist exceptionally volatile stochastic shocks to consumption/income which distort the estimates. However, a more likely scenario is that the MPC is just not constant. Therefore, we would not immediately accept equation (1) or equation (2) at a more "micro" level without further analysis. This exercise also shows that the relationship between spending and disposable income evident at more "micro" levels (outside the 0-1 range) tends to be statistically insignificant in many cases. By contrast, estimates of the MPC at more "macro" levels (within the 0-1 range) turn out to be highly significant. Once again, it is apparent from our investigation that modeling the behavior of the whole fails to provide an objective understanding of the behavior of the constituting parts.

6. Conclusion

John M. Keynes' consumption theory and the multiplier effect has gained much traction in much of macroeconomics literature due to his convincing observation that when a fraction of marginal income is spent by consumers, it creates long-lasting streams of marginal revenues for vendors and producers who provide the products and services. However, Keynes' proposition is far from being a universal certainty. Much of the empirical research and our investigation strongly contradicts the prevalent view that the MPC can be assumed to remain fixed either in the short-run or the long-run. Decades after the publication of the *General Theory*, macroeconomic theorists and practitioners appear to have reached some consensus that there is a critical need for a paradigm shift in macroeconomic theory and application of policy. We submit that Keynes multiplier effect makes sense only if it targets a closed economy where the initial spending stimulus could sprout into subsequent rounds of income and subsequent expenditures. As Professor Deaton (2010) has put it, there is no assurance that a fiscal and monetary experiment that worked once will produce the same results if tried again.

The evidence presented in our paper questions the validity of some fundamental aspects of the Keynesian consumption theory. Several noted economists, among them the former Governor of the Federal Reserve System, questioned the soundness of massive debt financing and subsequent spending to expand home ownership. In his testimony before the US Senate Banking Committee, he admitted that "we were wrong". Alan Greenspan, was uncharacteristically candid when he stated that "an ideology is a conceptual framework with the way people deal with reality. Everyone has one. You have to—to exist, you need an ideology. The question is whether it is accurate or not. And what I'm saying to you is, yes, I found a flaw. I don't know how significant or permanent it is, but I've been very distressed by that fact".

As stated at the outset, we have affirmatively discovered that the Keynesian ideology is empirically flawed at the disaggregated level. Since the crash of 2008, governments and central banks in the United States, the European Union, China, Japan and elsewhere, have been using unprecedented fiscal and monetary stimulus to revive their respective economies. Although marginally effective, these interventions do not seem to have turned the corner. The recession that began in late 2007 has resulted in massive income and wealth redistribution from the lower and middle brackets with high MPC to high income earners who have been reluctant to put their newly gained fortune to work. As a result, there has been little progress in revitalizing consumption, formation of high-wage jobs and real economic growth. What is worse, these policies have produced more uncertainty, fear, and loss of confidence in government policy decisions.

As models with a constant MPC are taught to undergraduate students, the limitations of the hypothesis should be clearly explained so that the next generation of economists do not repeat our mistakes. Describing the recent shifts in the data and referring to Hume's "problem of induction" is an opportunity for educators to highlight the importance of the Philosophy of Science to economic models. Showing that "the whole is not the sum of its parts" when it comes to the MPC gives teachers the

chance to extend students' understanding of the complexity of the economy and provide some evidence them that there are still mysteries in the economy which are yet to be explained.

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Notes

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Note 2. Euler's equation is based on the assumption that consumers typically attempt to equalize the marginal rate of substitution between consumption in the current year and the present value of consumption in the coming year.

Note 3. US Bureau of Economic Analysis, Real Personal Consumption Expenditures [PCECCA], retrieved from FRED, Federal Reserve Bank of St. Louis https://www.research.stlouisfed.org/fred2/series/PCECCA US Bureau of Economic Analysis, June 10, 2016. Real disposable personal income [A067RX1A020NBEA], retrieved from FRED, Federal Reserve Bank of St. Louis https://www.research.stlouisfed.org/fred2/series/A067RX1A020NBEA, June 10, 2016. "Chained 2009 dollars" are dollar figures adjusted for inflation using 2009 as the base year.

Note 4. First difference (year-to year change) is used to generate a stationarity time series data with a stable mean and variance remain over time.

Note 5. Akaike Information Criterion (AIC) and Schwarz Criterion (SC) are used to discover if the addition of a new independent variable improves the accuracy of the designated model. Both methods have been found useful in dealing with time-series data that are contaminated with statistical noise and measurement errors. Factor of proportionality demonstrates the ratio between consumption and income which are assumed to be proportional.