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Measuring the US marginal propensity to consume

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Abstract

The marginal propensity to consume (MPC) is a crucial variable in macroeconomics, and is critical for calculating the income effects of a given fiscal policy stance. This paper computes for the US three degrees of MPC: immediate, or instantaneous, intermediate, or after a lag of one year, and long term, at the steady-state. All three are statistically significant and they sway gradually from lowest to highest. Although the evidence on co-integration between actual income and actual consumption is weak, the Error-Correction Model and a bootstrapping procedure permit a very strong reversal of the evidence.

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1. Introduction

The marginal propensity to consume (MPC) is an important parameter in macroeconomics. It is directly applicable to policy issues. For example, it allows to identify the multiplier effect of a tax cut, of transfers, of higher government expenditures, especially spending on infrastructure, and on social insurance. There are two main competing theories that help to determine the magnitude of the macro MPC: Keynes' absolute income theory, and Friedman's permanent income theory. In 1936, Keynes stated his key psychological consumption function and argued that consumption depends on current income, and that the proportionality factor is less than one-for-one. In 1957, Friedman, on the other hand, demonstrated that consumption ought to depend on perceived permanent income. The two theories use the same mathematical formulation for consumption C with, however, different definitions for income Y:

$$C_t = \alpha + \beta Y_t + \varepsilon_t \qquad (1)$$

For both Keynes and Friedman the parameter β is the MPC. For Keynes Y is current income. For Friedman Y is permanent income. In addition Keynes' MPC is predicted to be much lower than Friedman's MPC which should approach 1. The two theories can be reconciled by noting that Keynes' MPC is for the short run and that Friedman's MPC is for the long term. The short run MPC can be estimated by equation (1) in first differences:

$$\Delta C_t = \alpha + \beta \Delta Y_t + \varepsilon_t \qquad (2)$$

The long term MPC is estimated by finding co-integration in equation (1), granted that C and Y are integrated of order 1. The two MPC belong to the same equation if one considers the Error-Correction Model (ECM):

$$\Delta C_t = \beta \Delta Y_t + \gamma \Delta C_{t-1} + \lambda C_{t-1} - \lambda\delta - \lambda\theta Y_{t-1} + \varepsilon_t \qquad (3)$$

Here, β is Keynes' short run MPC, $\beta/(1-\gamma)$ is the intermediate run MPC, and θ is Friedman's long run MPC. The parameter λ is the speed of adjustment to the long run. The parameter δ is the long run Average Propensity to Consume (APC), and $\lambda\delta$ is the short run APC. It is expected that $\beta \le \beta/(1-\gamma) \le \theta$ because the longer run adjustment is higher than the shorter run one, for the same reason that long run elasticities are higher than short run elasticities in micro economic theory.

In order to approximate permanent income researchers assumed a geometrically declining weighting scheme, or a geometric distributed lag process, for past income (Venieris and Sebold, 1977). This amounts to including the lagged consumption variable in the regression. Other justifications for including lagged consumption are adaptive expectations of income or a stock adjustment model of consumption (Venieris and Sebold, 1977; Pindyck and Rubinfeld, 1991). The effort to include lagged consumption is not benign and was a reaction to severe serially correlated errors in level regressions such as in model (1). Granted that, the inclusion of lagged consumption ΔC_{t-1} in equation (3) is hence defensible.

Theoretically the MPC is either zero or one, or anywhere in between. It is expected to be zero for anticipated transitory income shocks, and one for unanticipated permanent income shocks (Jappelli and Pistaferri, 2010). Hence the MPC out of permanent income shocks is deemed to be higher than the MPC out of transitory income shocks. Early estimates of the MPC are 0.89 (Shapiro, 1978), and 0.9 (Dornbusch and Fischer, 1987), both with annual data. However, Engle and Granger (1987) find an MPC of 0.23 with quarterly data, and Carroll et al. (2017) locate the MPC between 0.2 and 0.6 for micro household evidence and for transitory income changes. The MPC can reach 0.9 for total personal consumption expenditures. The long term estimate of the MPC in this paper is around 0.9, which implies that most long run shocks were permanent in nature. It is below one for two reasons. High-income, high-wealth individuals have a lower MPC than unemployed low-income and low-wealth individuals (Fisher et al., 2020). And it is possible for permanent shocks to be self-insured because of family ties and intergenerational transfers. The presence of liquidity constraints, especially for low-income individuals, produces a lower aggregate MPC, and a differential effect of positive versus negative income shocks (Jappelli and Pistaferri, 2010).

After 1987, an abundant literature on the permanent income hypothesis burgeoned. The original paper by Flavin (1981) sparked a series of research papers that adopted her own methodology about the permanent income theory. For example DeJuan authored or co-authored more than six papers on the subject, with mixed success. One of the most recent is DeJuan *et al.* (2016). The underlying model maximizes discounted utility of consumption, subject to a budget constraint, estimates an ARIMA model for disposable income, and calculates the revision in expectations of income. Then the change in consumption is regressed on the change in income expectations. Although the reduced form model does not include financial wealth, real wealth, real interest rates, and liquidity constraints, consumption was found to have excess sensitivity to these variables (Campbell and Mankiw, 1989; Azar, 2009; De Bonis and Silvestrini 2012; and Cho and Rhee, 2017).

This paper has at least four contributions. The first one is to estimate the three degrees of the MPC, from short run to long run, as specified by regression (3). The second is to give more weight to annual near-century sampling frequency. The third is to show that higher frequency data, i.e. quarterly and monthly, do not add information and, moreover, are misleading. The fourth is to check for the robustness of the model (1) by resampling, or bootstrapping.

The paper is organized as follows. In section 2 the evidence on co-integration for equation (1) is rehearsed. In section 3 the bootstrap results on the same equation are presented. The last section concludes.

2. The evidence on co-integration

First, the source of the data is acknowledged. Consumption is defined as the US annual real personal consumption expenditures in 2012 dollars, and income is defined as the US annual real personal disposable income in 2012 dollars. The two series are retrieved from the web site of the Federal Reserve Bank of Saint Louis (FRED).[2] Exhibit I draws the paths of the two variables. Consumption is seen to fall below disposable income. The data span the period 1929 till 2019, with 91 observations. The two variables are not divided by population in order to avoid the econometric complication that the same variable, here population, appears with the same sign on both sides of the regression (Azar, 2020). The quarterly and the monthly data are from the same source.[3] The quarterly data span the period 1947Q1 till 2020Q3, with 295 observations. The monthly data span the period 1959M1 till 2020M10, with 742 observations.

We choose to work with annual values instead of monthly or quarterly values because there is evidence that a relatively small annual sample is more desirable than a larger monthly or quarterly sample for co-integration purposes (Shiller and Perron, 1985; Hakkio and Rush, 1991;

[2] The BEA account codes are A067RX for annual disposable income, and DPCERX for annual consumption expenditures. The FRED codes are A067RX1A020NBEA and PCECCA respectively.

[3] The BEA account codes are A067RX for quarterly disposable income, and DPCERX for quarterly consumption expenditures. The FRED codes are DPIC96 and PCECC96 respectively. The BEA account codes are A067RC for monthly disposable income, and DPCERC for monthly consumption expenditures. The FRED codes are DSPI and PCE respectively.

Lahiri and Mamingi, 1995; Otero and Smith, 2000). When applied to long run Purchasing Power Parity, Taylor and Taylor (2004) and Verbeek (2012) advocate more annual data. In Tang (2006) little incremental information is provided by higher frequency samples. For a different and contrasting view see Zhou (2001). As will be seen shortly, quarterly and monthly data do not add information, and are moreover misleading, which supports the view that working with annual data is preferable.

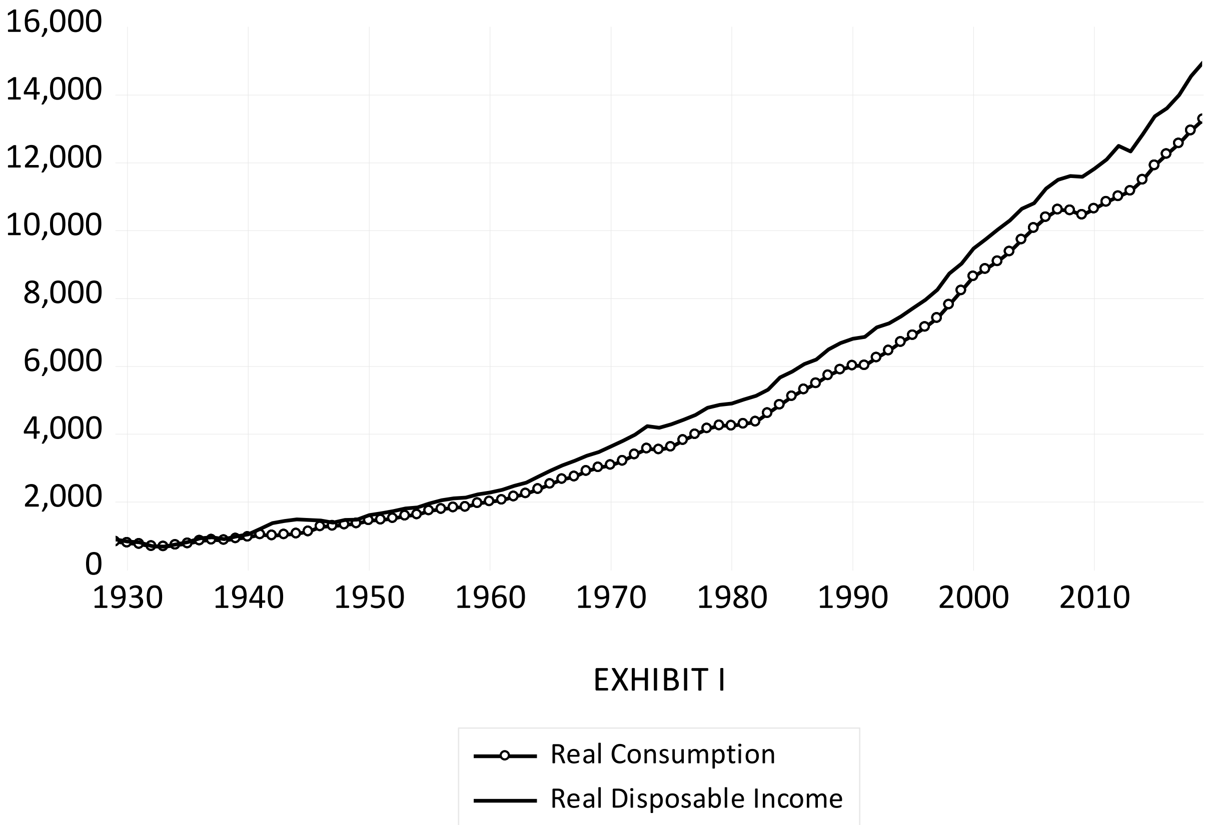

EXHIBIT I

Engle and Granger propose among others three methods to test for co-integration: a residual-based unit root test, the figure for the Durbin-Watson statistic, and the statistical significance of the lagged co-integration residual. We will add a fourth test which is known as the bounds test in an auto-regressive distributed lag (ARDL) econometric procedure.

Four residual-based unit root tests will be utilized: two Engle-Granger tests, and two Phillips-Ouliaris tests. The null hypothesis is no-cointegration. The Engle-Granger tau-statistic has a p-value of 0.1777. The Engle-Granger z-statistic has a p-value of 0.1197. The Phillips-Ouliaris tau-statistic has a p-value of 0.1516. The Phillips-Ouliaris z-statistic has a p-value of 0.1006. Therefore all four tests fail to reject the null hypothesis of no-cointegration. See Table 1. The four tests reject the null for monthly data (Table 1). The two Engle-Granger tests fail to reject the null for quarterly data (Table 1). The two Phillips-Ouliaris tests reject the null for quarterly data (Table 1).

The actual Durbin-Watson statistic of the annual regression is 0.350828, while the 10% critical value is 0.322. The 5% and 1% critical values are all less than 0.322. Therefore the null of no-cointegration is rejected. No-cointegration is also rejected for quarterly and monthly data. See Table 1.

Table 1: Co-integration tests, adjustment to the long run, and estimates of the MPC.

	Annual data	Quarterly data	Monthly data
Engle-Granger tau-statistic	-2.794013 (0.1777)	-1.039432 (0.8943)	-9.070372 (0.0000)
Engle-Granger z-statistic	-15.35426 (0.1197)	-17.28107 (0.0914)	-154.4112 (0.0000)
Phillips-Ouliaris tau-statistic	-2.880861 (0.1516)	-7.251694 (0.0000)	-9.012173 (0.0000)
Phillips-Ouliaris z-statistic	-16.16515 (0.1006)	-107.0390 (0.0000)	-152.0733 (0.0000)
Durbin-Watson statistic	0.350828	0.704454	0.426643
ARDL F-test	3.693820	15.95482	25.76204
t-statistic on lagged cointegration residual	-3.368279 (0.0011)	6.942562 (0.0000)	-8.803255 (0.0000)
Adjustment to the long run	6.656 years	Anomalous	1.8207 years
Short run MPC	0.494897 (t-stat: 4.597922)	-0.538123 (t-stat: -14.83840)	-0.381378 (t-stat: -15.55048)
Intermediate run MPC	0.75995 (t-stat: 4.905479)		
Long run MPC	0.918605 (t-stat: 37.42095)	0.702958 (t-stat: 1.945050)	0.943543 (t-stat: 57.74658)

Notes: Actual p-values in parentheses. All the three ARDL F-tests are significant with a marginal significance level less than 1%.

The actual F-statistic for the annual ARDL procedure provides very weak evidence for co-integration. However, the same F-statistic has a p-value less than 1% for both quarterly and monthly data. See Table 1.

The t-statistic on the lagged annual co-integration residual has a p-value of 0.0011. Therefore there is strong evidence for co-integration. However, the coefficient on this lagged residual is -0.150248, implying a total adjustment to the long run within 6.656 years (=1/0.150248), which is relatively long (see Table 1). The coefficient on the lagged quarterly co-integration residual is surprisingly positive and statistically significant which is anomalous. The coefficient on the lagged monthly co-integration residual is negative and statistically significant and implies an adjustment to the long run less than 2 years, which is notably fast. See Table 1.

The results in Table 2 are the empirics of estimating equation (3) with annual data by non-linear least squares, adjusted by robust HAC standard errors. These results are interesting on their own and serve to delineate the MPC. There are three estimates of the MPC. The first one is the short run MPC measured by C(1), i.e. 0.494897. The second one is the intermediate MPC, calculated by C(1)/(1-C(2)), i.e. 0.494897/(1-0.348773)=0.75995. The third one is the long run

MPC, assessed by C(5), i.e. 0.918605. All three estimates are statistically significant. As expected the long run MPC is higher than the intermediate MPC, which is higher than the short run MPC. The consumption multiplier has a current and an immediate value of 1.9798, an intermediate (one year later) value of 4.1658, and a steady state or long term value of 12.2858. Maybe the long run is not attainable because the economy will be subject to interim shocks which mitigate and swerve the multiplier effect.

Another anomalous finding in monthly and quarterly error-correction regressions is that the immediate impact is negative and statistically significant (Table 1), which is contrary to expectations and intuition. Therefore the general conclusion is that the monthly and quarterly data do not add information and are misleading.

Table 2: Error-Correction Model. Consumption is C, and disposable income is Y. The operator Δ is for first-differencing.

Dependent Variable: Δ(C)
Method: Least Squares (Gauss-Newton / Marquardt steps)
Sample (adjusted): 3 91
Included observations: 89 after adjustments
Convergence achieved after 5 iterations
HAC standard errors & covariance

$$\Delta(C)= C(1)*\Delta(Y) + C(2)* \Delta(C(-1)) + C(3)*(C(-1)) - C(3)*C(4) - C(3)*C(5)*(Y(-1))$$

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	0.494897	0.107635	4.597922	0.0000
C(2)	0.348773	0.080720	4.320801	0.0000
C(3)	-0.150248	0.064505	-2.329237	0.0222
C(4)	-61.65846	52.82430	-1.167237	0.2464
C(5)	0.918605	0.024548	37.42095	0.0000
R-squared	0.812550	Mean dependent variable		140.3793
Adjusted R-squared	0.803624	S.D. dependent variable		123.2710
S.E. of regression	54.62668	Akaike information criterion		10.89346
Sum squared residuals	250662.2	Schwarz information criterion		11.03327
Log likelihood	-479.7590	Hannan-Quinn information criterion		10.94982
Durbin-Watson stat	1.783715			

3. The evidence from resampling

Encouraged by the statistical significance of the Error Correction Model (ECM), we shall estimate equation (1) by resampling with replacement, a procedure also known as bootstrapping. See Table 3. In this table there are six variables. The ranges of β or long run MPC, in column 2, are estimated with a high degree of precision. For annual bootstraps the minimum is 0.894273 and the maximum is 0.917734. The standard error of β varies between 0.002269 and 0.003945. The standard error in the initial OLS level regression is 0.003055, and falls within the same range. This shows that although the initial OLS regression suffers from severe positive autocorrelation with a Durbin-Watson statistic of 0.350828, the standard error is estimated with the same uncertainty. One would have expected the standard error to be significantly downward biased.

The minimum t-statistic of β is 231.2270 which is extremely significant. This is also apparent from the very high values of the adjusted R-Squares (not reported). The Durbin-Watson statistic ranges between 1.161494 and 2.617001. The 1% critical value of the Durbin-Watson is 1.496 below which there is evidence of positive serial correlation. The number of estimates below 1.496 in the simulation is 9 out of 990, or 0.9091%. The other 1% critical value is 2.504 above which there is evidence of negative autocorrelation. The number of estimates above 2.504 in the simulation is 7 out of 990, or 0.707%. Therefore one can conclude that the distribution of the Durbin-Watson statistic in the simulation obeys perfectly the theoretical distribution. Finally an Engle-Granger tau test was carried out on the residuals. The maximum tau statistic is -6.041102 while the 1% critical value is -4.32 (Brooks, 2014). This shows that all regressions produce stationary residuals, and are co-integration regressions, and this finding corroborates with the Durbin Watson tests. The simulation results should motivate researchers to carry out regularly bootstrapping in order to test more strongly for co-integration. No additional content is provided by quarterly and monthly bootstraps (Table 3).

Table 3: Results of resampling with replacement (or bootstrapping).

	Annual data	Quarterly data	Monthly data
Range of cointegration vector	0.894273-0.917734	0.870141-0.914995	0.865860-0.903709
Range of standard error of vector	0.002269-0.003945	0.001475-0.005763	0.003457-0.00732
Minimum t-statistic of vector	231.2270	151.9143	231.2393
Range of the Durbin-Watson statistic	1.161494-2.617001	1.180386-2.409427	1.251572-2.283526
Maximum Engle-Granger t-statistic on the lagged cointegration residual	-6.041102	-11.01383	-14.66749
Number of replications	990	3234	8151

Note: The 1% critical value for the Engle-Granger t-statistic is -4.32.

4. Conclusion

The objective of this paper is to estimate the Marginal Propensity to Consume (MPC) for the US. Three estimates are found from the implied Error-Correction Model. The first one is the current MPC, the second one is the one-year-after MPC, and the last one is the steady state long run MPC. The three estimates follow an ascending pattern. However, two residual-based Engle-Granger tests and two residual-based Phillips-Ouliaris tests, the Durbin-Watson statistic, and the ARDL bounds test all fail to reject no co-integration. This has prompted us to resample with replacement. The final results of this bootstrapping procedure point strongly in favor of co-integration. The general conclusion is that the consumption multiplier effect is at least 2 and at most 12, figures that are economically and statistically significant. This paper has some four contributions. The first is to estimate the three degrees of the MPC, from short run to long run. The second is to give more weight to annual near-century sampling frequency. The third is to show that higher frequency data, i.e. quarterly and monthly, do not add information and, moreover, are misleading. The fourth is to check for the robustness of the long run model by resampling, or bootstrapping. Researchers are encouraged to resort to bootstrapping, like the one carried out in this paper, in order to test more efficiently for co-integration. An avenue of future research is to consider other determinants of the MPC. Wealth, and developments in the stock market, are natural candidates.

References

Azar, S. A. (2009) "Excess Sensitivity of Consumption to the Stock Market." *The Empirical Economics Letters*. 8 (5), 449-457.

Azar, S. A. (2020) "Hypothesis Testing when the Same Variable Appears on both Sides of the Regression." *The Empirical Economics Letters.* 19 (3), 221-225.

Brooks, C. (2014) *Introductory Econometrics for Finance*. 3rd Edition. Cambridge University Press: Cambridge UK.

Campbell, J. Y., & Mankiw, N. G. (1989) "Consumption, Income, and Interest rates: Reinterpreting the Time Series Evidence." *NBER Macroeconomics Annual*, *4*, 185-216.

Carroll, C., Slacalek, J., Tokuoka, K., & White, M. N. (2017) "The Distribution of Wealth and the Marginal Propensity to Consume." *Quantitative Economics*, *8*(3), 977-1020.

Cho, D., & Rhee, D. E. (2017) "Non-linear Adjustments on the Excess Sensitivity of Consumption with Liquidity Constraints." *Applied Economics*, *49*(41), 4180-4187.

De Bonis, R., & Silvestrini, A. (2012) "The Effects of Financial and Real Wealth on Consumption: New Evidence from OECD Countries." *Applied Financial Economics*, *22*(5), 409-425.

DeJuan, J., Wirjanto, T. S., & Xu, X. (2016) "The Adjustment of Consumption to Income Changes across Chinese Provinces." *Annals of Economics and Finance*, *17*(2), 235-253.

Dornbusch, R. & Fischer S. (1987) *Macroeconomics*. 4th edition. McGraw-Hill: New York.

Engle, R. F., & Granger, C. W. (1987) "Co-integration and Error Correction: Representation, Estimation, and Testing." *Econometrica: journal of the Econometric Society*, 251-276.

Fisher, J., Johnson, D., Smeeding, T., & Thompson, J. (2020) "Estimating the Marginal Propensity to Consume Using the Distributions of Income, Consumption, and Wealth." *Journal of Macroeconomics*, 103218.

Flavin, M. A. (1981) "The Adjustment of Consumption to Changing Expectations about Future Income." *Journal of Political Economy*, *89*(5), 974-1009.

Hakkio, C. S., & Rush, M. (1991) "Cointegration: How Short is the Long Run?" *Journal of international Money and Finance*, *10*(4), 571-581.

Jappelli, T., & Pistaferri, L. (2010) "The Consumption Response to Income Changes." *The Annual Review of Economics,* 2, 479--506.

Lahiri, K., & Mamingi, N. (1995) "Testing for Cointegration: Power versus Frequency of Observation—Another View." *Economics Letters*, *49*(2), 121-124.

Otero, J., & Smith, J. (2000) "Testing for Cointegration: Power versus Frequency of Observation—Further Monte Carlo Results." *Economics Letters*, *67*(1), 5-9.

Pindyck, R. S., & Rubinfeld, D. L. (1991) *Econometric models and economic forecasts*. 3rd edition. McGraw-Hill: New York.

Shapiro, E. (1978) *Macroeconomic analysis*. 4th edition. Harcourt Brace Jovanovich: New York.

Shiller, R. and P. Perron (1985) "Testing the Random Walk Hypothesis: Power versus Frequency of Observations." *Economics Letters* 18, 381-386

Tang, T. C. (2006) "Cointegration Analysis on Japan's Aggregate Import Demand Function: Does Data Frequency Matter?" *Labuan Bulletin of International Business and Finance (LBIBF)*, *4*, 19-42.

Taylor, A. M., & Taylor, M. P. (2004) "The Purchasing Power Parity Debate." *Journal of Economic Perspectives*, *18*(4), 135-158.

Venieris, Y. P., & Sebold, F. D. (1977) *Macroeconomics: Models and Policy*. Wiley: New York.

Verbeek, M. (2013) *A Guide to Modern Econometrics*. 4th edition. John Wiley & Sons.

Zhou, S. (2001) "The Power of Cointegration Tests versus Data Frequency and Time Spans." *Southern Economic Journal*, 906-921.