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The U.S. Consumption Analysis: Using a Linear Regression Model

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Abstract

Recent U.S. consumption has decreased, although it is the most significant factor in economic growth. Using a linear regression model, this paper shows that consumption is influenced by disposable income, oil price, and recession, but is not influenced by interest rates. It will also discuss policies regarding how to improve consumption. The result that the interest rate does not influence consumption is consistent with the view of John Maynard Keynes, but the Granger Causality test implies that past interest rates might be possible to change current consumption considering time lag.

Introduction

During the Great Recession, which lasted from 2008 to 2009, the deterioration of consumer expenditures lasted longer than in any of the other recessions since the 1970s. This consumption trend assumes the economy needs a great deal of time to fully recover (Petev & Pistaferz, 2012). Figure 1 shows there was a steep downward trend in consumption during financial crisis, and in 60 years the overall spending trend (blue line) has declined. Considering that consumption is a key factor to economic growth in the U.S., the decreasing consumption trend can possibly have a negative impact on economic growth. Consumer spending accounts for about 70% percent of economic activity in the U.S. The Marginal Propensity to Consume (MPC), which is the proportion of additional income that is spent on consumption, is around 0.7 while the European MPC is around 0.2 (Carroll, Slacalek, & Tokuoka, 2014). Compared to other countries, the U.S. consumer expenditure has a considerable portion of earnings and offers increased economic development. Therefore, the government has to promote increased spending. This paper will show factors which influ-

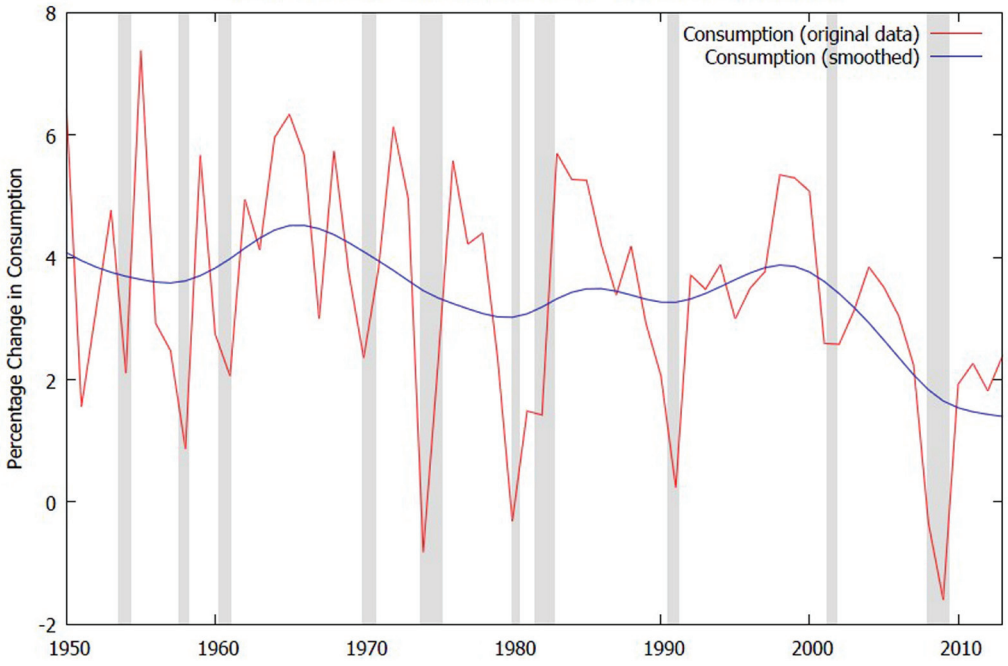

Figure 1. Decomposing Consumption Series (shade: NBER recessions)

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ence consumption using a linear regression model, and based on these components, it will suggest policies the government should conduct to encourage spending.

Measuring Influential Factors on Consumption

A Theoretical Model

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$$(1)\quad C_t=\beta_0+\beta_1 Yd_t+\beta_2 r_t+\beta_3 Oil_t+\beta_2 R_1+e_t$$

The dependent variable measured for this paper is the consumption in unit of percentage change. As John Maynard Keynes (1973) first mentioned in the consumption function, disposable income is one of the most important factors as an independent variable. When disposable income increases, people can afford to consume more, expecting a positive sign of the coefficient. To avoid a non-stationary time series problem and interpret the implication of the coefficient properly, the unit is the percent change of disposable income. This paper assumes that the interest rate (r) can affect the dependent variable with negative correlation. This is because when the interest rate increases, people can save more to get higher interest; when the mortgage rate is low, people will be more apt to buy houses because of the low interest rate. The oil price has a dollar unit per barrel and is predicted to have a negative sign because Mehra and Petersen (2005) stated that oil price increases have a negative effect on spending. Moreover, recently declining crude oil prices from the fourth quarter of 2014 have also influenced consumption. Eric Morath (2014) argues "Spending is being boosted by falling oil prices." In this sense, it is worthwhile to include crude oil price as an independent variable to apply and observe the recent trends of oil prices. In recession periods, people tend to spend less to protect themselves against the danger of economic risk and postpone purchases after recessions. If a year had a recession period of over six months, this year is assigned a 1 as a dummy variable.

Estimating Regression Line

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$$(2)\quad C_t=2.4+0.67Yd_t+0.03r_t-0.01Oil_t-1.24R_1$$

Each coefficient's interpretation is the following: The 1% increase in disposable income raises consumption by 0.67%, and the 1% point increase in interest rates brings a 0.03% increase in consumption. When the crude oil price increases by one dollar, people spend less by 0.01%. In the recession period, consumer spending decreased by 1.24%.

Sensitivity Analysis

To check the fit of the estimated equation and degree of reliability, this paper conducted several sensitivity analyses with the results in Table 1. An asterisk in the p-value row indicates how the coefficient is significant. As the table shows, the interest rate is not statistically significant and has an unexpected positive sign.

Except for the coefficient of interest rates, the other coefficients are statistically significant: disposable income and recession are at the 1% level and oil price is at the 5% level. In macroeconomics, the components of GDP or total income are given by Equation 3. This insignificant relationship between interest rate and consumption confirms that the interest rate (r) has a large impact on investment, (I), not consumption, (C), as income Equation 3 indicates in macroeconomics.

$$(3)\quad Y = C(Y-T) + I(r) + G + NX(\Xi)$$

The adjusted R-squared is 0.72 and the p-value of the F test is almost zero, which can reject the null

Table 1

Summary Statistics : Annual Time Series 1950-2013

	Const	Yd_t	r_t	Oil_t	R_1
coefficient	2.4	0.67	0.03	-0.01	-1.24
std. error	0.36	0.09	0.05	0.005	0.37
t-ratio	6.60	7.84	0.72	-2.01	-3.38
p-value	1.30e-08***	9.95e-011***	0.4773	0.0489**	0.0013***
VIF	--	1.402	1.132	1.251	1.24

F(3, 60)	37.76	P-value(F)	1.20e-15
R-squared	0.72	**R**-squared	0.70
Durbin-Watson	2.35	White's test for heteroskedasticity	p-value = 0.95

Source: Author calculations.
*** Significant at the 1 percent level.
** Significant at the 5 percent level.

hypothesis that all coefficients are equal to zero. Both results mean that the overall fit is good. The Durbin-Watson test for detecting serial correlation shows 2.35. It is greater than the upper critical value of the 1% one sided test (1.57), which cannot reject the null hypothesis of no positive serial correlation. The p-value of White's test for heteroskedasticity is 0.95 and we cannot reject the null hypothesis of homoscedasticity, implying that there is no heteroskedasticity. To test the existence of multicollinearity, Variance Inflation Factor (VIF) is useful as an indicator of the test. The values of VIF of all coefficients are around 1, which means there is no multicollinearity. These sensitivity analyses demonstrate that this equation is reliable overall.

Policies to Promote Consumption

Considering the decreasing trend of consumption and that consumer spending is a key driver of economic growth, the government must encourage public consumption. In order to increase demand of goods and services, the government can decrease oil prices by increasing oil production. However, the crude oil price is influenced by international oil production as well. Also, the value of the Oil coefficient is so small that this paper will focus on disposable income policies.

Disposable income is a big portion of consumption change, and therefore raising income is a substantially effective way to increase consumption and further economic growth. The policies can be implemented through different means in both the short and long run. In the short run, the government can decrease the income tax. As Equation 3 indicates, the function of consumption (C) is composed of disposable income (Y-T) and it is influenced by tax (T). If the government gives tax cuts, it will lead to increased disposable income as well as consumption. In 1964, President Kennedy made substantial cuts to personal income tax and growth in real GDP raised from 5.3% to 6.0% in a year along with increased consumption (Mankiw, 2010). As President Kennedy's economic policy of tax cuts shows, reducing taxes can bring about an economic boom and a decline in the unemployment rate.

To effectively increase consumption, the government can decrease income tax, especially to low income classes because the MPC of the lower income group is bigger than that of a high income group. If lower income groups receive tax cuts, they will consume more than the high income bracket. Considering the tax multiplier in Equation 4, if the MPC is higher (low income group), the change of increase in income resulting from a $1 decrease in taxes is greater than that for a high income group. Thus, with increased income, the lower income group will spend more than the other. Therefore, more tax cuts to the low income group encourage them to promote expenditure effectively in the short run.

$$(4)\quad {}^{\Delta Y}/_{\Delta T} = {}^{-MPC}/_{1-MPC}$$

In the long run, the government has to increase employment rates because when people get jobs and earn money, they will consume. Using the data set of the original consumption (C) and an additional dataset of unemployment rates, the correlation between two variables is around -0.32, which is significant at the 1% level. It implies that policies that raise employment rates increase not only consumption, but also economic growth. To expand employment, the government can manage employment agencies more efficiently to match jobs between potential workers and employers. The agencies disseminate information about job vacancies and thus help the unemployed to find appropriate jobs quickly. In addition, the government has to give a chance for the unemployed to participate in retraining programs. This can also relieve problems from sectoral shifts, changes in demand among industries and regions. Both employment agencies and retraining programs help to decrease frictional unemployment, which occurs during the job search process.

Conclusion

This paper has shown key factors of aggregate consumption such as disposable income, crude oil prices, and recession, but not the interest rate in accordance with the macroeconomic model of GDP, Equation 3. The estimated regression model documented that the coefficient of disposable income takes a big share of influence on consumption among other independent variables, and practical policies were mentioned to increase disposable income.

Although the data set and estimated equation indicate that interest rates do not influence consumption, there is still a question about this result as the correlation between interest rates and consumption can possibly exist: if the interest rate is high, will people save more and consume less to receive interest, or if mortgage rates are low, will people buy houses due to reducing the burden of paying higher interest rates? To confirm the correlation between interest rates and consumption, this paper conducts the Granger Causality test, which shows bilateral ways of interaction between two variables considering time lag.

$$(5)\quad r_t=\beta_o+\beta_1 C_{t-1}+\ldots+\beta_4 C_{t-4}+\beta_5 r_{t-1}+\ldots+\beta_8 r_{t-4}+\varepsilon_t$$

All lags of Consumption $F(4, 51) = 0.39399\ [0.8120]$

$$(6)\quad C_t=\beta 0+\beta 1 r_{t-1}+\ldots+\beta 4 r_{t-4}+\beta 5 C_{t-1}+\ldots+\beta 8 C_{t-4}+\varepsilon t$$

All lags of Consumption $F(4, 51) = 0.39399\ [0.8120]$

The p-value (0.8120) of the F test from Equation 5 means that consumption does not Granger cause interest rates because it cannot reject the null hypothesis that all lagged coefficients of C are equal to zero. However, the p-value (0.0140) of Equation 6 shows that interest rates do Granger cause consumption. This result implies that past interest rates might be able to change current consumption. If we analyze this relation in different ways (for example, dividing the time period of several years' duration or choosing other interest rates as indicators instead of 3-month treasury bills) there may be a different result. In this sense, it is worth analyzing the relation between interest rates and consumption in future research.

Appendix

Running a Regression Without Interest Rate Variable

The interest rate can be an irrelevant variable in the original model because the p-value is too high. Simply removing the irrelevant variable is not an appropriate treatment, but this paper will show how the result changes and try what could be done.

In Table 2, the levels of all coefficients decrease slightly compared with Table 1. Adjusted R-squared increases marginally, and the values of Durbin-Watson and VIF of each variable decrease slightly as well. Generally, there is no big difference in statistical significance in the models between including and excluding the interest rate.

Table 2

Summary Statistics Without Interest Rate Variable: Annual Time Series 1950-2013

	Const	Yd_t	Oil_t	R_1
coefficient	2.47	0.69	-0.01	-1.17
std. error	0.35	0.83	0.005	0.35
t-ratio	7.16	8.25	-1.91	-3.32
p-value	1.36e-09***	1.87e-011***	0.0608*	0.0015***
VIF	--	1.332	1.196	1.161

F(3, 60)	50.58468	P-value(F)	1.98e-16
R-squared	0.716652	**R**-squared	0.702485
Durbin-Watson	2.30	White's test for heteroskedasticity	p-value = 0.98

Source: Author calculations.
*** Significant at the 1 percent level.
* Significant at the 10 percent level.

Running a Regression Without Recession Variable

The recession and consumption variable might affect each other because the change in consumption is influenced by recession at first, but over time, decreased consumer spending can deepen recession. By eliminating the recession variable, this paper will observe how outcome will change.

Table 3

Summary Statistics Without Interest Rate Variable: Annual Time Series 1950-2013

	Const	Yd_t	r_t	R_1
coefficient	2.12	0.78	-0.01	-0.01
std. error	0.38	0.09	0.05	0.01
t-ratio	5.53	8.99	-0.17	–1.84
p-value	7.45e-07***	1.02e-012***	0.8636	0.0703*
VIF	--	1.217	1.052	1.251

F(3, 60)	39.66354	P-value(F)	2.96e-14
R-squared	0.664787	**R**-squared	0.648026
Durbin-Watson	2.01	White's test for heteroskedasticity	p-value = 0.55

Source: Author calculations.
*** Significant at the 1 percent level.
* Significant at the 10 percent level.

Compared to Table 1, the statistical analyses excluding recession show that the p-values of the coefficient of interest rates and Oil increase, which further reduces statistical significance. Adjusted R-squared decreases by 0.05 and the values of VIF of disposable income and interest rate coefficients decrease in small amounts. The interest rate is still statistically insignificant and the overall fit of a regression decreases.

Data Sources

Consumption: Percent change of real personal consumption expenditures (Sources: Federal Reserve Bank of St. Louis' *Real Personal Consumption Expenditures.*)

Disposable Income: Percent change of real disposable personal income (Sources: Federal Reserve Bank of St. Louis' *Real disposable personal income: Per capita.*)

Interest Rate: Percent of 3-month treasury bill (Sources: Federal Reserve Bank of St. Louis' *3-Month Treasury Bill: Secondary Market Rate*.)

Oil: Real crude oil in US dollars per barrel (Sources: ChartsBin's *Historical Crude Oil prices, 1861 to Present.*)

Recession: A dummy variable equal to 1 if recession, 0 otherwise (Sources: National Bureau of Economic Research's *US Business Cycle Expansions and Contractions.*)

Unemployment Rate: Percent of unemployment rate (Sources: Federal Reserve Bank of St. Louis' *Civilian Unemployment Rate.*)

References

Carroll, C. D., Slacalek, J., & Tokuoka, K. (2014). The distribution of wealth and MPC: Implications of new European data. *The American Economic Review, 104*(5), 107-111. doi:10.1257/aer.104.5.107

Keynes, J. M. (1973). *The general theory of employment, interest, and money*. London, England: Macmillan.

Mankiw, N. G. (2010). *Macroeconomics* (7th ed.). New York, NY: Worth Publishers.

Mehra, Y. P. & Peterson, J. D. (2005). Oil prices and consumer spending. *Federal Reserve Bank of Richmond Economic Quarterly, 91*(3), 53-72.

Morath, E. (2014, December 23). U.S. consumer spending accelerates in November. *Wall Street Journal*. Retrieved from http://on.wsj.com/1xdCW4k

Petev, I. D. & Pistaferz, L. (2012). *Consumption in the Great Recession*. Stanford, CA: Stanford Center on Poverty and Inequality.