

**CONSUMER SENTIMENT AND HOUSEHOLD EXPENDITURE:
REEVALUATING THE FORECASTING EQUATIONS**

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Consumer Sentiment and Household Expenditure: Reevaluating the Forecasting Equations

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Abstract

This note reestimates the simple forecasting regressions in Carroll, Fuhrer, and Wilcox (1993) (CFW) which investigate the predictive power of consumer sentiment for consumption growth. Durability in the consumption categories analyzed implies that the error term may be distributed as an MA(1), indicating that ordinary least squares (OLS) estimation is inappropriate when variables lagged one period are used in the forecasting equation. I reestimate the forecasting regressions using nonlinear least squares (NLLS), explicitly accounting for a moving average error structure. In addition, I include two financial indicators as controls in the forecasting regression. These changes produce notable qualitative differences with the results obtained in CFW, and with my own results using OLS. In particular, using NLLS and financial controls, consumer attitudes appear to have little incremental forecasting power for categories of consumption other than motor vehicles.

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1. Introduction

This note reestimates the simple forecasting regressions in Carroll, Fuhrer, and Wilcox (1993) (CFW) which investigate the predictive power of consumer sentiment for consumption growth. In that paper, CFW estimated consumption growth equations using Ordinary Least Squares (OLS). The right hand side variables included the first four lags of the Michigan Consumer Sentiment Index, and as controls, the first four lags of the dependent variable and of the growth in real labor income. They estimate this specification for four categories of personal consumption expenditure: total consumption, motor vehicle consumption, all goods excluding motor vehicle consumption, and services.¹

Based on their OLS estimation results (presented in their Table 1), CFW concluded that sentiment had *incremental* forecasting power for every category of consumption growth except services, a finding which formed the basis for the second part of their paper in which they ask how that statistical relationship should be interpreted.

For the categories of consumption considered, however, there is *a-priori* theoretical reason to expect serial correlation in the error term because the first three

¹Wilcox (1992) argues that partitioning the PCE into these categories better reflects the procedures used by the Bureau of Economic Analysis to estimate consumer spending.

of these categories contain durable goods. According to the permanent income hypothesis, growth in the purchase of durables goods is expected to have a MA(1) error term, displaying first-order negative serial correlation (Mankiw, 1982).² This suggests that the coefficient estimates obtained by CFW using OLS may be inconsistent, since the error term is likely to be correlated with the included variables, especially with their one-period lagged endogenous variable.

There are two possibilities for reestimation that would in theory preserve the consistency of parameter estimates. One is to proceed with OLS estimation, but use only control variables that are lagged at least two periods. This technique has the disadvantage that it eliminates the most recent predictors of consumption growth. Alternatively, OLS estimation can be abandoned for Nonlinear Least Squares (NLLS) so that the error term can be modeled as obeying an MA(1) process, $\varepsilon_t = \nu_t + \theta\nu_{t-1}$. Then, one can explicitly take into account the moving average term as an additional control, so that ν_t is orthogonal to control variables lagged one period even if ν_{t-1} is not.³

²Alternatively, preferences may display habit formation, which would induce first order *positive* serial correlation in the error term. Unlike durability, however, there is no *a priori* reason to expect that habits play an important role in the particular consumption categories analyzed by CFW.

³CFW divided their analysis into two sections. In the first section they ask whether sentiment has any incremental forecasting power for consumption growth by running simple forecasting regressions using OLS estimation. This output is contained in their Table 1. In the second part, based on their OLS estimation in the first part, they take as given the forecasting power

In this note I follow the second procedure of using NLLS, and ask whether reestimating the forecasting equations to take into account the potential moving average structure in the error term changes the fundamental conclusion about the predictive power of consumer sentiment for the growth in consumer spending. I find that it does. If, in addition, financial indicators are used as additional control variables⁴, the overall results (those obtained from explicitly accounting for serial correlation in the error term, and using financial controls) indicate that consumer sentiment has no incremental forecasting power for any category of consumption considered other than motor vehicles.

The next section presents the results of using NLLS to estimate basic forecasting equations for consumption growth, and compares them with the results of

of sentiment, and ask whether it can be attributed to the fact that sentiment may forecast current income growth. This output is contained in their Table 2. In this second part of their analysis, the authors recognize the possibility of a moving average error structure for reasons other than durability: they note that if consumption decisions are made continuously, but the data are measured as time aggregates, the observed spending series would follow an IMA(1,1), leading to first-order serial correlation in the growth of spending. In fact, the authors originally suggested estimating the error term as an MA(1) (and they do so in obtaining their Table 2 output) to address first-order serial correlation that could arise from time aggregation. The exercise I perform in this note is simply to apply their insight on the treatment of the error term to estimating the type of simple forecasting regressions presented in the first part of their paper.

⁴Some authors (notably Leeper, 1992) have suggested that the explanatory power of consumer sentiment for some real variables (e.g. unemployment and industrial production) may be significantly diminished by the inclusion of financial indicators. The explanation often given is that financial indicators are available on an almost continuous basis, and may include much of the incremental information contained in consumer sentiment indexes which are themselves available on a more timely basis than other macroeconomic aggregates (such as, e.g., personal income).

OLS estimation, appropriate if the error term is serially uncorrelated. The final section concludes.

2. Simple forecasting regressions using NLLS

In this section I compare the output of simple forecasting regressions when the error term is modeled as following an MA(1) ($\varepsilon_t = \nu_t + \theta\nu_{t-1}$ below) with the results when the error term is presumed to follow a serially uncorrelated process.

I estimate the following regression equation,

$$\Delta \ln(C_t) = \alpha_0 + \sum_{i=1}^n \beta_i S_{t-i} + \gamma Z_t + \varepsilon_t, \quad (2.1)$$

where, S is the index of consumer sentiment as measured by the Michigan Index of Consumer Sentiment, and Z is a vector of control variables. Following CFW, 2.1 is estimated for separate categories of consumption, with the control variables equal to lags 1 through 4 of the dependent variable and lags 1 through 4 of real labor income growth.⁵

Since durability is theoretically not a problem for services, I estimate 2.1 for the

⁵Labor income is defined as wages and salaries plus transfers minus personal contributions for social insurance, deflated by the implicit deflator for total PCE. Data is quarterly, chain weighted data, running from 1959:1 to 1992:2.

first three categories in CFW: total consumption, motor vehicle consumption, and goods other than motor vehicles.⁶ An appendix at the end of the text describes the data.

The results are presented in Tables 1 and 2. The tables compare the outcome of estimating 2.1 by OLS, with that obtained from estimating the equation by NLLS, modeling the error term as obeying an MA(1) process. In Table 1, the control variables included in Z are those specified in CFW: the first four lags of the dependent variable and the first four lags of real labor income growth. Table 2 follows the suggestion of Leeper (1992) and adds two financial indicators to the list of controls, the real Standard and Poor 500 stock index, and the six month t-bill rate.

The first two columns of both tables show the results of consumption growth as a function of sentiment lags without the control variables. Using OLS and NLLS, each column presents the adjusted R^2 with p - values for the joint marginal significance of the sentiment lags in parenthesis. Using either estimation technique, the results are very similar to those obtained in CFW and corroborate their finding that sentiment, taken on its own, has strongly significant predictive

⁶The results for services using NLLS were qualitatively similar to those in CFW which suggest that sentiment has little incremental forecasting power for that category of consumption.

power for each category of consumption. Lagged values of the Michigan index in these regressions explain about 14 percent of the regression variance for total real personal consumption expenditure with either estimation technique. Note that since these equations do not include the lagged endogenous variable, there is little reason to expect these parameter estimates to be inconsistent using OLS even if there was serial correlation in the error term.⁷

The third column in both tables shows the coefficient estimate for the moving average parameter from the NLLS regressions in the first two columns, with *p* - values in parenthesis. The coefficient is strongly significant for motor vehicles and exhibits evidence of negative serial correlation as would be expected from the durability of the good. For goods excluding motor vehicles, the MA coefficient is significant at the 10% level, but the positive sign of the coefficient suggests habit formation may dominate durability for this consumption category.

The last three columns of Table 1 give the results of estimating 2.1 using the CFW controls of lagged real labor income growth, and the lagged dependent

⁷CFW performed a standard Newey-West correction of the standard errors as a precaution, which they then simply carried over to their OLS regressions using lagged endogenous variables as controls. In order to make my results comparable with theirs, I also performed the Newey-West correction (allowing serial correlation up to lags = 4 as they do) in each of my OLS regressions. Of course, this is technically inconsistent with the use of OLS to estimate the fully-specified equation with control variables. In those regressions, if the serial correlation which would warrant a Newey-West correction is actually present, then either the lagged endogenous variables should be eliminated as controls, or the moving average structure of the error term should be estimated explicitly, in which case OLS is not appropriate.

variable. For comparison with CFW, the numbers in the columns give the *increment* to the adjusted R^2 from adding the four sentiment lags to the regression of consumption growth on the controls. In parentheses are p - *values* for the joint marginal significance level of the four sentiment lags.

The relevant comparison is between columns 4 (showing the outcome using OLS) and 5 (showing the outcome using NLLS). The use of NLLS to estimate the moving average parameter does not significantly affect the predictive power of lagged sentiment for the growth in automobile purchases. It does, however, substantially reduce the statistical significance of lagged sentiment for total consumption (though the lags remain jointly significant at the 5 percent level) and it eliminates the explanatory power of lagged sentiment for goods excluding motor vehicles. In this last instance, when OLS estimation is performed, the lags of sentiment are jointly significant at the 1 percent level; whereas NLLS estimation produces a p - *value* of 0.37 for the sentiment lags.

The sixth column of each table gives the estimate of the moving average parameter from the NLLS estimation of consumption growth using the controls and the sentiment lags. Relative to column three, the moving average parameter is now negative and strongly significant for both total and motor vehicle consumption. For goods other than motor vehicle consumption, the MA parameter is imprecisely

estimated, indicating that it is highly correlated with the control variables.

Table 2 gives the results of estimating 2.1 when the real S&P 500 index and the six month t-bill rate are added to the list of controls. (For ease of comparison, the first three columns of Table 2 repeat the results in the first three columns of Table 1, where consumption growth is estimated as a function of sentiment lags, without the controls).

Using the financial controls and NLLS, the lags of sentiment remain jointly significant only for motor vehicles, and the moving average parameter is again strongly significant for both the total consumption category and the motor vehicle consumption category. Accounting for the moving average term eliminates the predictive power of consumer sentiment for total consumption: when OLS estimation is used, the p -value for the joint significance of the sentiment lags is less than 0.000. In contrast, when NLLS estimation is used, the lags of sentiment are no longer jointly significant at the 10 percent level. In addition, NLLS estimation leads to a negative increment in the adjusted R^2 statistic for goods other than motor vehicles.

In summary, sentiment appears to have little forecasting power for any category of consumption growth other than motor vehicles when both financial indicators and a moving average error structure are accounted for.

3. Conclusions

In previous work, Carroll, Fuhrer and Wilcox (1993) have evaluated the predictive power of consumer sentiment for consumption growth by estimating simple prediction equations using OLS. In doing so, they concluded that sentiment had incremental forecasting power for the growth in purchases for every consumption category they considered except services.

Durability in the consumption categories they analyzed makes a strong theoretical case for the presence of first-order serial correlation in the error term, implying it should be distributed as an MA(1). Consequently, their estimates using OLS may be inconsistent because one-period lagged dependent variables are included as controls.

One way to in principle obtain consistent parameter estimates is to explicitly model the error term as obeying an MA(1) process. This note adopts this approach. I reestimate the CFW regressions, explicitly accounting for the possibility of a moving average error term by using Nonlinear Least Squares estimation. This produces a significant qualitative difference with the results obtained using OLS estimation. The inclusion of the lagged moving average term in the regression diminishes or eliminates the statistical significance of sentiment for every category

of consumption except motor vehicles. When financial indicators are included in the list of controls (as suggested by authors like Leeper (1992)), NLLS estimation indicates that sentiment has no incremental forecasting power for the growth in any category of consumption expenditure except motor vehicles.

Data Appendix

The dependent variable in each regression is the log-difference of real personal consumption expenditure (PCE), available at quarterly frequency. Three categories of PCE are used - total, motor vehicles, and goods excluding motor vehicles - instead of the more conventional categories (durables and nondurables plus services). The source of the data is the Bureau of Economic Analysis. The PCE for motor vehicles is calculated from the unit sales of new cars and trucks; PCE for other goods is estimated from the monthly retail sales data. All regressions are run at quarterly frequency.

The sentiment measure is from the University of Michigan's index of consumer sentiment.

The control variables include log difference of real labor income, the 3 month treasury bill rate, and Standard and Poor's 500 composite stock price index (1941- 43=10). The labor income data is defined as wages and salaries plus transfers minus personal contributions for social insurance. These components are quarterly and taken from the National Income and Product Accounts (NIPA) data. The 3 month t-bill rate is available on a monthly basis from the Board of Governor's of the Federal Reserve System. The stock price index is monthly and is available from the Wall Street Journal and the Financial Times.

All nominal numbers are deflated by the PCE implicit price deflator (1992=100). The deflator is quarterly and taken from the National Income and Product Accounts (NIPA) data. The data reflects the revisions made by the Department of Commerce in September, 1993.

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Table 1**Reduced-Form Evidence: Adjusted R^2 and Incremental Adjusted R^2 's From Simple Prediction Equations**

$$\Delta \log (C_t) = \alpha_0 + \sum_{i=1}^4 \beta_i S_{t-i} + \gamma Z_t + \epsilon_t$$

Row	Category of Real PCE	Adjusted R^2		MA(1)	Incremental Adj. R^2		MA(1)
		OLS	NLLS	Param.	OLS	NLLS	Param.
1	Total	0.14 (0.000)	0.13 (0.000)	-0.02 (0.862)	0.05 (0.002)	0.09 (0.035)	-1.04 (0.000)
2	Motor Vehicles	0.04 (0.000)	0.18 (0.000)	-0.46 (0.000)	0.11 (0.000)	0.11 (0.002)	-0.57 (0.015)
3	Goods Excluding Motor Vehicles	0.12 (0.000)	0.14 (0.002)	0.15 (0.068)	0.004 (0.010)	0.004 (0.367)	0.199 (0.600)

Notes: NLLS estimation is used when $\epsilon_t \sim \text{MA}(1)$ is assumed and OLS estimation is used when ϵ_t is assumed to be serially uncorrelated. The regressions underlying the adjusted R^2 's reported in the first two columns used only lagged values of consumer sentiment as independent variables. The regressions underlying the adjusted R^2 's reported in the fourth and fifth columns used the controls in addition to sentiment. The controls are lags 1 through 4 of growth in real labor income, and of the control variable. The numbers in parentheses are p values of the joint significance of the lags of sentiment. The 3rd and 6th columns are coefficient estimates of MA(1) parameter from the NLLS regression in columns 2 and 4 respectively. The numbers in parentheses for these columns are p values associated with the respective moving average parameter estimate. Hypothesis tests were conducted using a heteroscedasticity robust covariance matrix.

Table 2**Reduced-Form Evidence: Adjusted R² and Incremental Adjusted R²'s From Simple Prediction Equations**

$$\Delta \log (C_t) = \alpha_0 + \sum_{i=1}^4 \beta_i S_{t-i} + \gamma Z_t + \epsilon_t$$

Row	Category of Real PCE	Adjusted R ²		MA(1)	Incremental Adj. R ²		MA(1)
		OLS	NLLS	Param.	OLS	NLLS	Param.
1	Total	0.14 (0.000)	0.13 (0.000)	-0.02 (0.862)	0.02 (0.000)	0.07 (0.101)	-1.06 (0.000)
2	Motor Vehicles	0.04 (0.000)	0.18 (0.000)	-0.46 (0.000)	0.06 (0.000)	0.15 (0.000)	-1.07 (0.000)
3	Goods Excluding Motor Vehicles	0.12 (0.000)	0.14 (0.002)	0.15 (0.068)	0.01 (0.717)	-0.02 (0.873)	0.139 (0.685)

Notes: NLLS estimation is used when $\epsilon_t \sim \text{MA}(1)$ is assumed and OLS estimation is used when ϵ_t is assumed to be serially uncorrelated. The regressions underlying the adjusted R²'s reported in the first two columns used only lagged values of consumer sentiment as independent variables. The regressions underlying the adjusted R²'s reported in the fourth and fifth columns used the controls in addition to sentiment. The controls are lags 1 through 4 of the control variable, of the growth in real labor income, of the three month treasury bill rate, and of the real Standard & Poor's 500 Composite stock index. The numbers in parentheses are *p* values of the joint significance of the lags of sentiment. The 3rd and 6th columns are coefficient estimates of MA(1) parameter from the NLLS regression in columns 2 and 4 respectively. The numbers in parentheses for these columns are *p* values associated with the respective moving average parameter estimate. Hypothesis tests were conducted using a heteroscedasticity robust covariance matrix.

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