

TIME SERIES EVIDENCE ON SOCIAL SECURITY AND PRIVATE
SAVING: THE ISSUE REVISITED

by

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ABSTRACT

This paper revisits the relationship between Social Security wealth and private saving, as investigated by Feldstein (1974, 1982, and 1996). The focus is on re-examining Feldstein's 1996 contribution to determine whether appropriate time-series methodology was employed. Our motivation is that macroeconomic time series, including those examined by Feldstein, are often nonstationary. When nonstationary series are included in an econometric model, the validity of the resulting test statistics – and in some cases the estimated coefficients themselves – are compromised. Given the current discussion on reform of the Social Security system, it is imperative to review critically the existing empirical evidence on the economic impact of the Social Security system, to ensure that policy actions are well-informed. (*JEL* category H55)

INTRODUCTION

In the current political discussion concerning the reform of the U.S. Social Security system, it is imperative to review critically the existing empirical evidence on this issue. Discussion of how to deal with the problems facing Social Security should be supported by empirical evidence, and any such evidence used to justify policy actions must have sound theoretical underpinnings.

One of the key issues in Social Security reform concerns the impact of the Social Security system on private saving in the U.S. economy. M. Feldstein (1974) initially addressed this issue within the confines of a time-series analysis, and found that Social Security depressed personal saving by 30 to 50 percent. Feldstein (2005) reiterated his position on this issue in his Presidential Address to the American Economic Association at their annual meeting. A reduction in saving of this magnitude has serious consequences for capital formation and growth of output in the U.S.

Feldstein's pioneering work led to a number of criticisms and further empirical research on the extent to which Social Security wealth crowds out private saving. Criticism focused primarily on the theoretical specification of Feldstein's original test equation and, in particular, on the way the Social Security wealth variable was calculated. Leimer and Lesnoy (1982) identified this calculation error; based on corrected data and an extended sample they found no evidence of a statistically significant negative impact of Social Security on saving. Feldstein (1982) acknowledged the error in calculation of the Social Security wealth data, but rejected Leimer and Lesnoy's statistical results on grounds that they incorrectly account for a significant change in Social Security benefit rules in 1972. In his 1996 article, Feldstein reexamined the

results of his original 1974 study while including an additional 21 years of time-series data. He concluded by suggesting that the Social Security system led to a reduction of 56 percent in private saving.

To our knowledge, there has been no further discussion about the validity of the time-series methodologies used in Feldstein's 1974 and 1996 articles. Feldstein (1982) acknowledges that there exist limitations in using time-series data in analyzing the relationship between Social Security and private saving. One of these limitations is too little variation in test variables. In this paper, we highlight a much more serious problem associated with incorrectly specified time-series models: nonstationarity of the test data may render ordinary least squares (OLS) estimation results meaningless.

The objective of this paper is to re-examine the data and econometric models from Feldstein (1996) to ensure the methodologies used therein are sound. We are motivated by two features of the Feldstein data and estimation results. First, several data series that Feldstein incorporated into his econometric models typically are nonstationary when expressed in levels; inclusion of nonstationary variables may invalidate tests of statistical significance. Second, several of Feldstein's econometric models exhibit extremely high R-squared values; this suggests the problem of spurious correlation, in which both the test statistics and coefficient estimates are invalid. Correct model specification is critical if any meaningful policy implications are to be drawn from the model estimates.

This paper is divided into three sections. Initially, key methodological issues in time-series analysis are outlined and their implications for the interpretation of empirical results are stated. Thereafter, the model estimates are reported and analyzed. The overall conclusions

concerning the main results of this study and its comparisons with Feldstein's (1996) are presented in the final section of this paper.

TIME-SERIES TESTING METHODOLOGY

There are several preliminary steps to using time-series data in econometric analyses. Initially it is essential to determine the form in which the data can be used for any subsequent estimation; in many instances using macroeconomic data in their levels leads to serious econometric problems. Time-series data typically contains a trend, which must be removed prior to undertaking any estimation. The traditional detrending procedure separates the trend from the cyclical component of the series. This procedure is appropriate for trend stationary (TS) time-series. However, many macroeconomic time-series are difference stationary (DS).¹ DS type time-series are nonstationary and they contain unit roots.² The DS type sequences must be differenced prior to any meaningful econometric estimation. If ordinary least squares (OLS) estimation techniques are applied to undifferenced DS type sequences, resulting error terms are serially correlated. This renders any subsequent hypothesis tests unreliable.

The actual determination of whether a variable is TS or DS is based upon the results of unit root tests. Numerous unit root tests have been presented in economic literature; the most common test, and the one we utilize, is the augmented Dickey-Fuller test.³ If one can reject the null hypothesis that a series possesses a unit root, then the series is TS, or integrated of order zero (I(0)). If one cannot reject the null of a unit root, then the series is DS. Subsequent unit root tests on differenced DS series determine the form in which the data may be used in regressions. The most common occurrence is that first differences of DS series are stationary; in

this case the series is said to be integrated of order one (I(1)) and no further differencing of the data or unit root testing is required.

When multiple individual time-series variables are found to be integrated of order one, an additional test is required to determine whether long-term relationships exist among the variables. Cointegration tests indicate the presence of such stable long-term relationships. Different estimation procedures are required for cointegrated variables than for non-cointegrated DS series.

TEST RESULTS AND THEIR DISCUSSION

In order to replicate closely the test results of Feldstein (1996), the following variables are used in the subsequent estimations:

C_PER_CAP = real consumer expenditures per capita

YD_PER_CAP = real disposable income per capita

W = stock of household wealth, excluding Social Security wealth

SSW = Social Security wealth

SSWN = net Social Security wealth

RET_EARNINGS = undistributed corporate profits with inventory valuation and capital consumption adjustments.⁴

Annual time-series data are used for all test variables. Data for consumer expenditures, disposable income, retained earnings, and population are taken from Bureau of Economic Analysis National Income and Product Accounts (NIPA) tables. Dollar values are converted to 1987 dollars using implicit GDP deflators provided in the NIPA tables. Data on wealth and Social Security wealth are taken from Feldstein (1996).⁵ Following Feldstein's testing

framework, the sample period ranges from 1930 to 1992, omitting the years 1941 through 1946. All the test results are summarized in the Appendix.

Tables 1 and 2 replicate the ‘main’ regressions from Feldstein (1996). There are two things worth noting in each case. First, the R-squared values for both regressions are exceptionally high; this suggests that the regressions are spurious which, indeed, they are. Second, unlike in Feldstein’s regressions [c.f. Table 1 p. 157, Equations 1.1 and 1.7 in Feldstein (1996)] neither the coefficient on SSW nor SSWN is statistically significant.⁶

The fundamental methodological problem with Feldstein’s analysis is the use of OLS to analyze the relationship between several nonstationary variables. There are four cases to consider when working with nonstationary variables (Enders, 2004).

1. When all variables are stationary, the classical regression model (i.e., OLS) is appropriate.
2. When the sequences of the dependent and explanatory variables are integrated of the different orders, regression results using such variables are meaningless.
3. When the sequences are integrated of the same order and the residual sequence contains a stochastic trend, the regression is spurious (Granger and Newbold, 1974). The results from such spurious regressions are meaningless in that all errors are permanent.
4. The nonstationary sequences are integrated of the same order and the residual sequence is stationary; that is, the sequences are cointegrated. This necessitates the estimation of an error-correction model.

Feldstein’s regressions fall under the third case in most instances, and the second case in all other instances. Table 3 provides augmented Dickey-Fuller test results for the null hypothesis that per capita consumption, wealth, per capita disposable income, SSW, SSWN, and retained

earnings possess a unit root. That is, the null is that the sequences from these variables are stationary in levels. Except for retained earnings, the null is rejected in each case. Table 4 provides augmented Dickey-Fuller test results for the null hypothesis that the above nonstationary sequences are, instead, stationary in first differences. In each case the sequences are shown to be $I(1)$.

This highlights one difficulty with the Feldstein results. The dependent variable and at least one independent variable in each regression is $I(1)$, while retained earnings is $I(0)$. As indicated in Case 2, above, analysis of OLS results from regressions where variables are integrated of different orders is meaningless. Equations 1.6 (Table 1 p. 157) and 2.6 (Table 2 p. 161) in Feldstein (1996) suffer from this problem.⁷

Cointegrating relationships between the sequences are ruled out through Johansen's (1988) cointegration tests. Although there exists a number of cointegration tests, such as the Engle and Granger (1987) method and the Stock and Watson (1988) test, Johansen's test has a number of desirable properties, including the fact that all test variables are treated as endogenous variables.⁸ Tables 5 and 6 provide test results; the null hypotheses that there are no cointegrating equations cannot be ruled out.

Finally, it is very likely that Feldstein's (1996) estimates suffer by problems of spurious correlation due to R-squared exceeding 0.99, as reported by Feldstein on page 153. In order to verify that Feldstein's regressions are in fact spurious, we show that the residual sequences from his specifications contain stochastic trends. The results provided in Table 7 suggest that the residuals from the regressions in levels are nonstationary, while the results in Table 8 indicate that the residuals are stationary in first differences. Thus, Feldstein's estimations are spurious in the Granger and Newbold (1974) sense.

The typical method for estimating relationships between nonstationary sequences of data is to estimate the regression equations in first differences. For the sake of completeness, we re-estimate the principal equations from Feldstein (1996), with data in first differences rather than in levels. The results of these regressions are summarized in Tables 9 and 10. Test results indicate that increases in the rate of SSW accumulation (gross or net) affect positively the consumption rate, and therefore, affect negatively the savings rate. The test results are, however, statistically insignificant. Perhaps more importantly, the coefficient estimates – estimated effects of changes in rates on a rate – are difficult to interpret in practice.

CONCLUSIONS

This paper investigates the relationship between Social Security and saving within the testing framework outlined by Feldstein (1996). While previous criticisms of Feldstein's work centered primarily on his model specification, the focus of this paper is on the time-series methodology used by Feldstein and on its implications for the reported test results.

Our test results are striking. We find the original time-series methods used by Feldstein (1996) lacking in a number of important aspects. First, augmented Dickey-Fuller tests of the data indicate that all but one of the time series are nonstationary, or integrated of order one. The exception is RET_EARNINGS, which is $I(0)$. Given the fact that the data are of different orders of integration, regression results using such data are meaningless. Equations 1.6 (Table 1, p.157) and 2.6 (Table 2, p. 161) in Feldstein's (1996) study suffer from this particular problem.

Second, we use Johansen's (1988) cointegration testing framework to determine the absence or the presence of the cointegrating relationship among all test variables. Given the

cointegration test results, the null hypothesis that there are no cointegrating equations cannot be ruled out.

Third, R-squared values reported by Feldstein (1996, p. 153) all exceed 0.99. Given this fact, it is very likely that the test equations suffer from spurious correlation problems. Our estimates show that the residual sequences from Feldstein's specified models contain stochastic trends. Residuals from the regressions in levels are nonstationary, while the same residuals from the regressions in first differences are stationary. Consequently, Feldstein's estimations are spurious in Granger and Newbold (1974) sense. This fact makes the estimates reported by Feldstein meaningless as all errors are permanent.

Finally, given the fact that the time-series data used by Feldstein (1996) are, for the most part, nonstationary, we re-estimate the principal regression equations in first differences. Given this appropriate method of estimating equations that contain nonstationary time-series data, we find no evidence of a statistically significant negative impact of the rate of the SSW accumulation on the saving rate. This result by itself is striking. It simply means that given the appropriate method of time-series investigation of the data, there is no statistical evidence of a negative impact of Social Security on saving within the investigative framework deployed by Feldstein. Consequently, much caution should be exercised when policy conclusions are based on the results of Feldstein's 1996 study.

APPENDIX

Regression Results – Levels

Table 1 Regression vs. SSW -- Levels

Dependent Variable: C_PER_CAP

Method: Least Squares

Sample: 1930 1940 1947 1992

Included observations: 57

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	424.9613	161.4912	2.631482	0.0112
YD_PER_CAP	0.703456	0.079332	8.867232	0.0000
YD_PER_CAP(-1)	0.125018	0.081194	1.539738	0.1297
W	0.001642	0.033495	0.049010	0.9611
SSW	0.032210	0.042955	0.749847	0.4567
R-squared	0.998623	Mean dependent var		7716.665
Adjusted R-squared	0.998517	S.D. dependent var		3186.986
S.E. of regression	122.7372	Akaike info criterion		12.54160
Sum squared resid	783349.9	Schwarz criterion		12.72081
Log likelihood	-352.4356	F-statistic		9426.217
Durbin-Watson stat	0.567487	Prob(F-statistic)		0.000000

Table 2 Regression vs. SSWN -- Levels

Dependent Variable: C_PER_CAP

Method: Least Squares

Sample: 1930 1940 1947 1992

Included observations: 57

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	417.4951	123.3885	3.383582	0.0014
YD_PER_CAP	0.709980	0.079406	8.941102	0.0000
YD_PER_CAP(-1)	0.122633	0.080210	1.528898	0.1324
W	0.000515	0.031318	0.016448	0.9869
SSWN	0.045549	0.046433	0.980966	0.3312
R-squared	0.998633	Mean dependent var		7716.665
Adjusted R-squared	0.998528	S.D. dependent var		3186.986
S.E. of regression	122.2728	Akaike info criterion		12.53402
Sum squared resid	777433.2	Schwarz criterion		12.71323
Log likelihood	-352.2195	F-statistic		9498.054
Durbin-Watson stat	0.572173	Prob(F-statistic)		0.000000

Augmented Dickey-Fuller Unit Root Test

Null Hypothesis: Variable has a unit root

Exogenous: Constant, Linear Trend

Lag Length: 1 (Automatic based on SIC, MAXLAG=10)

Table 3 Augmented Dickey-Fuller Test

Variable	Augmented Dickey-Fuller Test Statistic Critical Values – 5% level	t-statistic	Prob.*
W	-3.492149	-2.005268	0.5857
C_PER_CAP	-3.492149	-1.555593	0.7978
YD_PER_CAP	-3.492149	-2.001797	0.5876
SSW	-3.492149	-1.068945	0.9250
SSWN	-3.492149	-0.956413	0.9416
RET_EARNINGS	-3.492149	-4.560140	0.0030

Null Hypothesis: Variable has a unit root

Exogenous: Constant, Linear Trend

Lag Length: 0 (Automatic based on SIC, MAXLAG=10)

Table 4 Augmented Dickey-Fuller Test

Variable	Augmented Dickey-Fuller Test Statistic Critical Values – 5% level	t-statistic	Prob.*
ΔW	-3.492149	-8.621307	0.0000
ΔC_PER_CAP	-3.492149	-5.733633	0.0001
ΔYD_PER_CAP	-3.492149	-6.199537	0.0000
ΔSSW	-3.492149	-5.411395	0.0002
$\Delta SSWN$	-3.492149	-5.596096	0.0001

* MacKinnon (1996) one-sided p-values

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Johansen Cointegration Test

Sample (adjusted) 1932-1940 1947-1992
 Included observations: 55 after adjustments
 Trend assumption: Linear deterministic trend (restricted)
 Series: C_PER_CAP, YD_PER_CAP, W, SSW

Table 5 Unrestricted Cointegration Rank Test (Trace)

Hypothesized # of C.E.'s	Trace Statistic	0.05 Critical Value	Prob.*
None	56.99036	63.87610	0.1656
At most 1	23.37459	42.91525	0.8633
At most 2	11.29186	25.87211	0.8581
At most 3	3.816620	12.51798	0.7685

Sample (adjusted) 1932-1940 1947-1992
 Included observations: 55 after adjustments
 Trend assumption: Linear deterministic trend (restricted)
 Series: C_PER_CAP, YD_PER_CAP, W, SSWN

Table 6 Unrestricted Cointegration Rank Test (Trace)

Hypothesized # of C.E.'s	Trace Statistic	0.05 Critical Value	Prob.*
None	58.12762	63.87610	0.1385
At most 1	24.12917	42.91525	0.8312
At most 2	11.87508	25.87211	0.8206
At most 3	4.741767	12.51798	0.6338

* MacKinnon-Haug-Michelis (1999) p-values
 * MacKinnon-Haug-Michelis (1999) p-values

Augmented Dickey-Fuller Unit Root Test

Null Hypothesis: Variable has a unit root

Exogenous: Constant, Linear Trend

Lag Length: 0 (Automatic based on SIC, MAXLAG=10)

Table 7 Augmented Dickey-Fuller Test

Variable	Augmented Dickey-Fuller Test Statistic Critical Values – 5% level	t-statistic	Prob.*
SSW_LEVEL_RESID	-3.493692	-2.818469	0.1972
SSWN_LEVEL_RESID	-3.493692	-2.847817	0.1873

Null Hypothesis: Variable has a unit root

Exogenous: Constant, Linear Trend

Lag Length: 0 (Automatic based on SIC, MAXLAG=10)

Table 8 Augmented Dickey-Fuller Test

Variable	Augmented Dickey-Fuller Test Statistic Critical Values – 5% level	t-statistic	Prob.*
ΔSSW_LEVEL_RESID	-3.496960	-7.772658	0.0000
ΔSSWN_LEVEL_RESID	-3.492149	-7.723159	0.0000

* MacKinnon (1996) one-sided p-values

* MacKinnon (1996) one-sided p-values

Regression Results – First Differences

Table 9 Regression vs. SSW -- First Differences

Dependent Variable: D(C_PER_CAP)

Method: Least Squares

Date: 04/20/05 Time: 14:28

Sample (adjusted): 1931 1940 1947 1992

Included observations: 56 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	7.217713	18.47296	0.390718	0.6976
D(YD_PER_CAP)	0.622051	0.064941	9.578689	0.0000
D(YD_PER_CAP(-1))	0.016935	0.060135	0.281608	0.7794
D(W)	0.039095	0.037335	1.047146	0.3000
D(SSW)	0.140774	0.073532	1.914458	0.0612
R-squared	0.774721	Mean dependent var		161.0597
Adjusted R-squared	0.757052	S.D. dependent var		190.8101
S.E. of regression	94.04976	Akaike info criterion		12.01057
Sum squared resid	451113.2	Schwarz criterion		12.19141
Log likelihood	-331.2960	F-statistic		43.84654
Durbin-Watson stat	2.225513	Prob(F-statistic)		0.000000

Table 10 Regression vs. SSWN -- First Differences

Dependent Variable: D(C_PER_CAP)

Method: Least Squares

Date: 04/20/05 Time: 14:30

Sample (adjusted): 1931 1940 1947 1992

Included observations: 56 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	12.17266	18.18039	0.669549	0.5062
D(YD_PER_CAP)	0.639323	0.063929	10.00046	0.0000
D(YD_PER_CAP(-1))	0.034020	0.058929	0.577305	0.5663
D(W)	0.041712	0.037751	1.104933	0.2744
D(SSWN)	0.130858	0.085238	1.535199	0.1309
R-squared	0.769197	Mean dependent var		161.0597
Adjusted R-squared	0.751095	S.D. dependent var		190.8101
S.E. of regression	95.19583	Akaike info criterion		12.03479
Sum squared resid	462174.6	Schwarz criterion		12.21563
Log likelihood	-331.9743	F-statistic		42.49201
Durbin-Watson stat	2.181053	Prob(F-statistic)		0.000000

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END NOTES

¹ The main difference between these two types of time-series variables is the fact that TS type variables return to the deterministic trend function, whereas no such tendency exists with the DS type of time-series variables. Nelson and Plosser (1982) and McCallum (1993) provide a more detailed explanation of this point.

² A time-series variable is weakly stationary if its mean, variance, and covariance are finite, and if all of these are independent of time. If the variance increases over time, then the time-series becomes explosive. Given this fact, such time-series variables should not be used for hypothesis testing. For a further explanation of this point see Stock and Watson (1988), among others.

³ Detailed explanations of these tests can be found in Dickey and Fuller (1979), Holden and Thompson (1992), and others.

⁴ All data used in this article are available to interested readers upon request.

⁵ The data on SSW and SSWN are taken verbatim from Feldstein (1996). The other series are defined the same as those from Feldstein (1974, 1996), however we do not have access to his original data. Insofar as historical data may have been adjusted in the past decade, or that we obtain data from slightly different sources, our data on per capita real consumption, per capita real disposable personal income, and retained earnings are not identical to those used in Feldstein 1996.

⁶ The coefficient on SSW is 0.032, vs. 0.041 in Feldstein (1996). The coefficient on SSWN is 0.046, vs. 0.030. Our coefficients differ from Feldstein's, due to the aforementioned use of an alternative data source for per capita real consumption and per capita real disposable income.

⁷ The remaining variables from Feldstein (1996) were not tested for stationarity.

⁸ For a further discussion of Johansen's (1988) cointegration test and its advantages, see Gonzalo (1994).