# An Empirical Examination Of U.S. Pension Funds, Social Security, And Individual Savings

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**Abstract**

*This article has used cointegration and Vector Error-Correction Models(VECM) to examine empirically the causation and/or relationships among pension funds, Social Security, and individual savings from 1980 to 1999. It finds that pension funds, Social Security, and individual savings tend to move together in the ling run. Pension funds influence individual savings in the short-run. In addition, individual savings seem to bear the brunt of adjustments in restoring long-term equilibrium to the retirement system. Finally, the interactive process of short-run (causality) and long-run equilibrium relationship shows that pension funds explain individual savings. Since individual savings bear the brunt of adjustment in restoring to long-run equilibrium it is the most important component in retirement planning.*

## Introduction

Pensions are retirement income contracts, and pension plans are the institutions that provide them. From a finance perspective, pension plans are intermediaries and depositories of household savings invested in the capital markets (Bodie, 1990). Pension funds act as a financial intermediary by collecting members' contributions and investing these funds on a pooled basis for eventual repayment to members in the form of pensions at the end of their working life. Like other institutional investors, pension funds benefit from regular inflows of funds on a contractual basis and from long-term liabilities (that is, with no premature withdrawal of funds), which together imply liquidity risk. Pension funds are unique, however, in that most of their investment and administrative activities are delegated to professional financial intermediaries. Once the income replacement goal of a pension plan has been set, two basic financial decisions must be made, one concerning funding– how much will be set aside during the employee's working years to provide future retirement benefits, the other having to do with investment– how the funds that are set aside will be invested. The type of plan chosen will weigh heavily in how these choices are made (Klumpes and McCrae, 1999).

Munnell and Yohn (1992) note that the proliferation of funded pension plans with early retirement provisions is giving many workers new freedom in choosing when and how to end their careers. They also observe that both the real-world pensions are more complicated than the notions incorporated in the simple model and that these complicating factors make it impossible to determine a priori the effect of pensions on saving. For example, the illiquidity of pen-

*Readers with comments or questions are encouraged to contact the author via email.*

sion promises and uncertainty about the value of future benefits in an inflationary environment raise the question of whether individuals reduce non-pension saving dollar-for-dollar in response to promised future benefits.

Even if individuals do undertake fully-offsetting behavior, however, the risk between pensions and retirement behavior may increase aggregate saving in a growing economy, and, in a world of uncertain lifetimes, the fact that pensions are paid as annuities may reduce national savings. In summary, pension funds contribute to retirement income and influence individual and national savings. Feldstein (1974) has discussed that households whose breadwinners decide to retire earlier can be expected to increase their savings during working years because they must accumulate a larger amount of assets over a shorter working life in order to finance a longer retirement. In addition, Feldstein (1978) finds that the growth of private pensions has not had an adverse effect on savings and may even have increased it by a small amount. This is likely due to liquidity constraints that prevent the young from borrowing to offset forced savings via pension funds.

When the Social Security System was established in 1935, its architects envisioned the creation of a larger reserve fund to ensure the continued financing of the system. A pay-as-you-go(PAYG) system, it would be fed by the contributions of current workers, which would be distributed in turn as benefits to current retirees. Current workers would rely upon their children's generation to finance their retirement benefits. Social Security has features similar to those of government and private employee pension plans, but also has other aspects that makes it different from those plans. For example, Social Security benefit payments are not directly proportional to priori earnings. Low-wage earners receive a much larger proportion than do high-wage earners. In addition, Social Security benefits are provided to society at large rather than to a specific group of employees (Larkins et al, 1999). The increasing generosity of the Social Security system and the increase in life expectancy has added to the cost of financing the system. A 1996 report of the Social Security Board of Trustees predicted that payments made by the Social Security Administration will exceed contributions beginning in 2013. The deficit financed through the Trust Fund[1], will exhaust the Fund by 2029. In the following year, contributions will cover only 75 percent of payments (Social Security Administration, 1996). The U.S. Advisory Council on Social Security in 1996 suggested three plans to modify the U.S. Social Security System: (1) maintain benefits plan, (2) an individual accounts plan, and (3) a personal security accounts plan. All three would increase the number of workers who contribute to the system by extending coverage to all new state and local employees. At the same time, benefits to current and future retirees would be reduced slightly under all the plans through a tax on all Social Security benefits in excess of previously taxed employee contributions.

Surprisingly, personal savings in the United States, defined as disposable personal income less personal expenditures, has declined steadily in good economic times. From a peak of $264.1 billion in 1992, total personal savings dropped to $158.5 billion in 1996, and $102.1 billion in 1998 (Department of Commerce, 1998). According to the life-cycle hypothesis, there are more households of working age (typically savers, although holding lower levels of wealth that rise until dissaving starts later in life), and fewer older households (typically dissavers, although with larger wealth to income ratios). In equilibrium, a growing population is associated with higher output and a higher savings ratio. In a steady state, however, the growth of income is equal to the growth of wealth (Porterba, 1994). Faster population growth is associated with faster growth of output (the natural growth rate), higher savings rate, and a lower wealth/income ratio. Slower population growth is characterized by the reverse. On the one hand, Modigliani (1986) produces cross-section evidence of a positive relationship between savings rates and growth rates for the Organization of European Cooperation and Development (OECD) countries. On the other, although U.S. results from 1977 to 1992 showed a positive relationship, the key coefficient was insignificant.

**Analysis**

The manifest goal of a pension plan in combination with Social Security retirement benefits and private savings is to replace an employee's pre-retirement earnings (Bodie, 1990). Employers, however, also use pension plans as a device to attract, retain, and motivate employees and eventually to encourage them to retire. In addition, the accumulation of pension assets contributes to stimulating aggregate savings. There is, thus a positive link between aggregate savings and funded pensions (Bailliu and Reisen, 1998). Again, individuals save during their working lives to finance their consumption during retirement.[2] Bailliu and Reisen (1998) further argue, however, that the desire to increase aggregate savings by promoting the development of funded pensions has been based on very limited empirical evidence. Similarly, Samwick (2000) finds that, there is little evidence that countries that implement defined-contribution reforms have higher trends in saving rates after the reform.

The nature of the links between U.S. pension funds, Social Security, and individual savings is giving rise to increasing debate. This could have both short- and long-term economic consequences for workers and for the U.S. economy. The purpose of this study, therefore, is to address these problems and examine the empirical relationship between U.S. pension funds and individual savings in a multivariate context by bringing in the influence of Social Security as a third variable. To this end, various developed time-series techniques, such as unit root testing, multivariate cointegration and vector error-correction models are introduced and illustrated with economic intuition of short- and long-run relationships of U.S. pension funds, individual savings, and Social Security for the sample period from 1980 to 1999. Quarterly data of the series are obtained from various publications of the economic report of the President. All the series are published in constant 1992 dollars.

*Data Description*

Pension funds are the receipts of private noninsured pension funds. They include employer contributions (*defined benefits*), employee contributions (*defined contributions*), investment income, net profit on sale of assets, and other receipts. They cover all pension funds of corporations, non-profit organizations, unions and multi-employer groups, except those managed by insurance companies. Also included are deferred profit sharing plans. Health, welfare, and bonus plans are excluded. Finally, we include assets from 401(K) plans, which are voluntary pension plans. Social Security includes receipts for old age, survivors, and disability insurance. Personal savings is defined as disposable personal income less personal expenditures. The following items are included in personal expenditures: personal consumption expenditures, interest paid by persons, personal transfer payments to the rest of the world (net). Personal savings will increase by the amount of the difference between the increase in personal income and the increase in personal outlays. The studies by Bailliu and Reisen (1998) and Bodie (1990) used similar definitions.

The Granger representation theorem is used to test the following hypotheses in our vector error-correction model (VECM).[3] First, the three series have significant error-correction terms derived from long-run cointegrating relationship via the Johansen maximum likelihood procedure. Second, there are significant positive causalities (short-run relationships) among the three series. This will help us to distinguish between "short-run" and "long-run" Granger causality. Finally, there are significant interactive forces among the three series: U.S. pension funds, Social Security, and individual savings in joint short-run (causality) and long-run equilibrium are related. The following sections provide a brief, intuitive empirical methodology and discuss the empirical findings, then set forth the study's conclusions.

**Empirical Methodology**

Evidence put forward by Engle and Granger (1987) shows that cointegration among economic variables rules out the possibility of the estimated relationship, being "spurious." Although cointegration indicates the presence or absence of Granger causality, it does not show causality between variables. The VECM derived from long-run cointegrating vectors can be used to detect the direction of causality. If we have co-movements between U.S. pension funds, Social Security, and individual savings, they may trend together in finding a long-run stable equilibrium, according to the Granger representation theorem. I constructs an error correction model(ECM) through the following testing relationships:

$$\Delta Pf_t = \psi_1 + \alpha_1 e_{t-1} + \text{lagged } (\beta_1 \Delta Pf_t, \gamma_1 \Delta ss_t, \delta_1 \Delta sa_t) + u_{t,1} \quad (1)$$

$$\Delta ss_t = \psi_2 + \alpha_2 e_{t-1} + \text{lagged } (\beta_2 \Delta Pf_t, \gamma_2 \Delta ss_t, \delta_2 \Delta sa_t) + u_{t,2} \quad (2)$$

$$\Delta sa_t = \psi_3 + \alpha_3 e_{t-1} + \text{lagged } (\beta_3 \Delta Pf_t, \gamma_3 \Delta ss_t, \delta_3 \Delta sa_t) + u_{t,3} \quad (3)$$

Where ($pf_t$, $ss_t$, $sa_t$) are real pension funds, Social Security, and individual savings, respectively, $\Delta$ is a difference operator, $e_t$, refers to the error-correction term(s) derived from long-run cointegrating relationships via the Johansen maximum likelihood procedure, and $u_{ti}$, s (i=1,2,3) are serially uncorrelated random error terms with mean zero. Therefore, equation (1), will be used to test causation from Social Security and individual savings to pension funds, equation (2) will be used to test causality from pension funds and individual savings to Social Security, and equation (3) will test causality from pension funds and Social Security to individual savings.[4]

Moreover, the direction of causality among the series in the ECM allows us to distinguish between "short-run" and "long-run" Granger causality. When the series are cointegrated, the short-term deviations from this long-run equilibrium will feed back on the changes in the dependent variable (say, the change in the pension funds) and be driven directly by this long-run equilibium error, which then is responding to this feedback. The *F*-tests of the "differenced" explanatory variables give us an indication of the "short-term" causal effects, whereas the "long-run" causal relationship is implied through the significance or otherwise of the *t*-tests of the lagged error-correction terms (ECTs). These contain the long-term information since they are derived from the long-run cointegrating relationships (Masih and Masih, 1998). The coefficient of the lagged error-correction term is a short-term adjustment coefficient and represents the proportion by which the long-run disequilibrium (imbalance) in the dependent variable is being corrected in each short period. Nonsignificance or elimination of any of the lagged error-correction terms affects the implied long-run relationship and may be a violation of the theory (Thomas, 1993).

**Empirical Findings**

A necessary but insufficient condition for cointegration is that all series (pension funds, individual savings, and Social Security) share common integrational properties (i.e., integrated of the same order). Prior to testing for cointegration, I investigated the integrational properties of each of the variables by applying a battery of unit-root testing procedures. Based on the augmented Dickey-Fuller and Phillips-Perron tests presented in Table 1 (see Dickey and Fuller 1981; Perron, 1988; Phillips and Perron, 1988), I could not find any significant evidence that ($pf_t$, $sa_t$, $ss_t$) were not integrated of order one or I(1).[5] This implies that all the series were integrated in the first difference. Tests for higher orders of

**Table 1**
**Tests of the unit root hypothesis I 1980 to IV 1999**

| Levels | Augmented-Dickey-Fuller (ADF) | | | | | | Phillips-Perron | | |
|---|---|---|---|---|---|---|---|---|---|
| | $T_\mu$ | $T_t$ | $Z(\alpha)$ | $Z(t_\alpha)$ | $Z(\phi_1)$ | $Z(\alpha^*)$ | $Z(t_{\alpha^*})$ | $Z(\phi_2)$ | $Z(\phi_3)$ |
| Pension Funds (pf) | -0.78 | -0.93 | -0.48 | -0.85 | 8.08* | -16.91* | -3.41** | 5.70** | 3.5 |
| Individual Savings (sa) | -1.58 | -2.25 | -1.30 | -0.73 | 5.45** | -13.88** | 0.58 | 4.03 | 2.16 |
| Social Security (ss) | -0.43 | -0.80 | -1.11 | -1.39 | 3.79 | -10.78*** | -3.20** | 2.65 | 1.89 |
| First Differences (Δ) | | | | | | | | | |
| Pension Funds (pf) | -6.20 | -7.50 | -27.08 | -7.20 | 18.20 | -20.01 | -10.20 | 13.40 | 8.75 |
| Individual Savings (sa) | -4.55 | -4.19 | -13.84 | -5.09 | 10.40 | -10.78 | -4.04 | 6.50 | 5.59 |
| Social Security (ss) | -3.81 | -6.02 | -17.71 | -6.91 | 16.60 | -14.60 | -5.00 | 4.77 | 6.35 |

NOTE: The sample consists of lagged quarterly time series observations (1980 to 1999). Descriptions and sources of all data have already been defined. The optimal lag used for conducting the Augmented Dickey-Fuller test statistic was selected on minimizing an optimal criteria (Akaike's Final Prediction Error (FPE) using a range of lags. The truncation lag parameter used for Phillips-Perron tests was selected using a window choice of $w(s,L) = 1\ [s/(L+1)]$ where the order is the highest significant lag from either the autocorrelation or partial autocorrelation for all unit-root testing procedures are available upon request. Approximate critical values, for n=80 observations, at conventional significance levels appear below presented for levels tests only * ; ** ; and *** indicate significance at the 1%, 5% and 10% respectively.

| Significance-Level | $T_\mu$ | $T_t$ | $Z(\alpha)$ | $Z(t_\alpha)$ | $Z(\phi_1)$ | $Z(\alpha^*)$ | $Z(t_{\alpha^*})$ | $Z(\phi_2)$ | $Z(\phi_3)$ |
|---|---|---|---|---|---|---|---|---|---|
| 1% | -4.25 | -3.70 | -22.20 | -4.28 | 7.78 | -17.03 | -3.65 | 8.11 | 10.30 |
| 5% | -3.50 | -3.00 | -16.98 | -3.50 | 5.06 | -12.40 | -2.90 | 5.58 | 7.09 |
| 10% | -3.18 | -2.60 | -15.10 | -3.18 | 4.00 | -10.04 | -2.60 | 4.47 | 5.70 |

integration were also applied using the procedure outlined by Dickey and Pantula (1987). Several other tests that were applied confirmed the finding that ($pf_t$, $sa_t$, $ss_t$) were difference stationary time- series processes. These results are not surprising given Nelson and Plosser's (1982) findings that most macroeconomic aggregates are difference stationary processes.

Having found common integrational properties for these variables, I then proceeded to test for the presence of cointegration in the vector ($pf_t$, $sa_t$, $ss_t$ ) by using Johansen and Juselius's (1990) multivariate maximum likelihood estimator (MLE) procedure.[6]

Results of Johansen and Juselius's likelihood ratio (LR) and trace tests are presented in Table 2. The result shows that there is at most one cointegrating relationship because the null hypothesis of $r=0$ is clearly rejected in favor of $r=1$, but $r \leq 1$ cannot be rejected by the 95% critical values. Given that $(n-r)$ common trends exist within the system, I can conclude that one independent common trend exists for U.S. pension funds, individual savings and Social Security. There is thus, a greater chance that all the series may be moving together in the long run. Once the cointegrating vector was identified I tested zero restrictions using a chi-square test to see whether each of the variables entered the relationship significantly. The chi-square tests show that only pension funds and individual savings entered the cointegrating vector significantly since each restriction was rejected at the 5% level or higher.

Temporal test estimates of Granger causality provided by the VECM, described by equations 1-3, are summarized in Table 3. Given the importance of selecting the appropriate lag structure, I employed a parsimonious criterion based on minimizing the Akaike's final predictor error (FPE) criteria. From the findings of Table 2, I then extracted the error-correction terms from the underlying cointegrating vector for U.S. pension funds, individual savings, and Social Security. A significant ECT exists for only individual savings. The intuition behind this finding is that, over time, whenever there is a deviation from the equilibrium cointegrating relationship as measured by the ECTs ($e_t = sa_t - pf_t - ss_t$, for individual savings) the changes in individual savings bear the brunt of adjustments in restoring long-term equilibrium within the retirement system (see column two of Table 3).

Column one of Table 3 shows the short-run causality running from pension funds to individual savings and not vice versa. Thus, pension funds significantly influence (causes) U.S. individual savings in the short-run. The findings in columns one (causality test) and two of Table 3 support the result in column three of Table 3 (i.e., joint short-run and long-run relationship). Thus, the interactive analysis of short-run (causality) and long-run equilibrium relationship shows that pension funds explain individual savings.

Since the VECM was estimated by the ordinary least squares (OLS), the test statistics may be prone to inconsistencies due to nonspherical disturbances. A battery of diagnostic tests was thus applied for each equation. In general, none of these tests, given the power for which they are designed over the sample, could find any significant evidence of departures from standard assumptions.[7]

## Conclusions

In this article, we used time-series techniques such as unit-root testing, multivariate cointegration, and vector error-correction models to empirically examine the nature and extent of the relationships that govern the United States's pension funds, Social Security, and individual savings. These procedures were used to expose additional channels of causation among the series in the short-run, long-run, and joint short-run and long-run relationships.

**Table 2**
**Johnsen's test for multiple cointegrating relationships and tests of restrictions on cointegrating vector(s) 1980 to 1999.**

| | Test Statistic | | | $\chi^2$ test of restrictions | | |
|---|---|---|---|---|---|---|
| $H_0$ and $H_1$ | Optimal lag used in VAR | Max Eigen Value | Trace | pf = 0 | sa = 0 | ss = 0 |
| r = 0, r = 1 | 1 | 30.40** | 38.90** | 5.76⁺ | 3.68≠ | 1.18 |
| r ≤ 1, r ≤ 2 | | 7.95 | 8.20 | | | |
| r ≤ 2, r ≤ 3, | | 0.68 | 0.68 | | | |

NOTES: r indicates the number of cointegrating relationships. The optimal lag structure for the VAR was selected by minimizing the Akaike's FPE criteria. All estimated coefficients of the cointegrating vectors are available on request. Critical values are sourced from Johansen and Juselius (1990).
**indicates rejections at the 95% critical values.
+ and ≠ indicate significance at the 1% and 5% levels, associated with a chi-square statistic with 1 degree of freedom, testing the restriction that each of the variables in the cointegrating vector(s) including [pf, sa, ss] is statistically equivalent to zero.

**Table 3**
**Temporal Causality results based on the vector error correction models (VECM) I 1980 to IV 1999**

*Source of Causation*

| | Column (1) Short-run | | | Column (2) ECT | Column (3) Joint short-run/ECT | | |
|---|---|---|---|---|---|---|---|
| | Δpf | Δsa | Δss | ($e_{t-1}$) | (Δpf, $e_{t-1}$) | (Δsa, $e_{t-1}$) | (Δss, $e_{t-1}$) |
| | F-statistic | | | t-statistic | F-statistic | | |
| Dependent Variable | | | | | | | |
| Δpf | — | 0.58 | 1.04 | -1.04 | — | 0.70 | 1.05 |
| Δsa | 3.24** | — | 0.95 | -2.16** | 2.45** | — | 1.28 |
| Δss | 1.18 | 0.78 | — | 0.84 | 0.80 | 1.17 | — |

NOTES: The ECT's is ($e_{t-1}$) were derived by normalizing the one or more cointegrating vectors on pf, resulting in r number of residuals. Figures beneath them are estimated t-statistic testing the null that they are each statistically significant. All other estimates are asymptotic Granger F-statistics. The ECT's were also checked for stationarity by way of unit-root testing procedures applied earlier and inspection of their autocorrelation functions respectively. The VECM's were based on an optimally determined criteria. (Akaike's FPE) for the lag structure, and a constant.
*, ** and *** indicate significance at the 1%, 5% and 10% levels.

The empirical results demonstrate that U.S. pension funds, individual savings, and Social Security tend to move together in the long run. Second, pension funds influence individual savings in the short-run. This result supports the study of Bailliu and Reisen (1998), which found that pension funds stimulate aggregate savings, and not vice versa. However, Social Security appears to explain none of the series in the short-run nor long-run. Finally, the interactive analysis of short-run (causality) and long-run equilibrium relationship shows that pension funds explain individual savings. Since individual savings bear the brunt of adjustments in restoring to long-run equilibrium it is the most important component in retirement planning.

**Suggestions for Future Research**

The next research needs to move away from the "three-legged stool"- pension funds, Social Security, and individual savings- to "four-legged stool" or multi-legged stool to ensure stable retirement planning. The "four-legged stool" includes the following variables; pension funds, Social Security, individual savings, and after-retirement income. Other retirement wealth accumulation or holdings such as stocks and bonds, and home equity can also strengthen retirement income. Therefore, more legs in the retirement planning stool are better than fewer legs.

**End Notes**

1. Beginning in 1983, the United States undertook a program to accumulate a large trust fund by raising taxes well above the prevailing financing needs of the system. The money in this trust fund is invested in government securities.
2. The life-cycle hypothesis was first developed by Modigliani and Brumberg (1954) and later generalized by Feldstein (1974).
3. Although asymptotic properties of Engle-Granger test have been examined, not enough is known for one to assert that it is robust to various departures from normality. This makes statistical inference problematic and weakens results derived from the test. Moreover, the Engle-Granger procedure does not account for the possibility of multiple cointegrating relationships and hence all the possible dynamic interactions that could exist between two or more time series.
4. A consequence of relationships described by equations 1-3 is that either $pf_{t-1}$, $ss_{t-1}$, $sa_{t-1}$, or combination of any of them must be caused by $e_{t-1}$, which is itself a function of $pf_{t-1}$, $ss_{t-1}$, $sa_{t-1}$. Intuitively, if [$pf_t$, $ss_t$, $sa_t$] share a common trend, then the current change in $pf_t$ (say, the dependent variable) is partly the result of $pf_t$ trending the value of $ss_t$ and $sa_t$ (say, the independent variables) through the $e_{t-1}$. The VECM opens up an additional channel for Granger causality to emerge, a channel, completely ignored by the standard Granger and Sims tests. The Granger-causality (or endogeneity of the dependent variable) can be exposed either through the statistical significance of (i) the lagged $e_{ts}$ ($\alpha$s) by a *t*-test; (ii) a joint test applied to the significance of the sum of the lags of each explanatory variable ($\beta$s,$\gamma$s) in turn, by a joint $F$ or Wald $\chi^2$ test, or (iii) a joint test of all the set of terms just described in (i) and (ii) by a joint $F$ or Wald $\chi^2$ test, i.e., taking each of the parenthesized terms separately: the ($\gamma$s, $\alpha$s) and ($\delta$s, $\alpha$s) in equation 1; the ($\beta$s, $\alpha$s) and ( $\gamma$s, $\alpha$s) in equation 2; and the ($\beta$s, $\alpha$s) and ($\gamma$s, $\alpha$s) in equation 3. The nonsignificance of both the $t$ and $F$ or Wald $\chi^2$ tests in the VECM indicates econometric exogeneity of the dependent variable.
5. Using the appropriate notation, a series $x_t$ is said to be integrated of order $d$, if it has an invertible ARMA representation after being differenced $d$ times. For example, a stationary series is indicated by I(0), whereas a nonstationary series in levels but stationary in first difference is indicated by I(1).

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**Notes**

6. Detailed discussion of the Johansen procedure can be found in Cuthbertson et al. (1992), and wide-ranging surveys by Clements (1989) and Muscatelli and Hurn (1992).
7. A full set of results of diagnostic tests for each VECM is available upon request from the author.

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