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PURCHASING-POWER ANNUITIES: FINANCIAL INNOVATION FOR STABLE REAL RETIREMENT INCOME IN AN INFLATIONARY ENVIRONMENT

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ABSTRACT

This paper explores the desireability and feasibility in the context of the U.S. financial system of purchasing-power annuities (PPA), i.e., retirement annuities offering some kind of consumer price level indexation. After investigating the inadequacies of conventional and equity-based variable annuities in an inflationary environment, the paper assesses the suitability of money market instruments hedged with commodity futures contracts as the asset base for PPA's and considers the possiblity of having life insurance companies and private pension plans offer them to the public. The empirical evidence of the past 26 years indicates that the real (inflation-adjusted) earnings rate which these financial institutions should use in pricing PPA's is at most zero.

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<u>ERRATA</u>

On page 21, line 15, "of T-Bills . . ." should read "of commodity futures . . ."

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Purchasing - Power Annuities: Financial Innovation for Stable Real Retirement Income in an Inflationary Environment

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I. Introduction

In no area of financial planning is the problem created by inflation more acute than in providing for retirement income. The essence of the problem is that a household's needs are defined in terms of real goods and services while conventional private pension plans and contractual savings schemes offer a money fixed stream of benefits. In the U.S. the problem is mitigated somewhat by the fact that Social Security currently does provide a cost-of-living adjustment to its retirement benefits. But for most households, Social Security benefits provide only a "floor" which must be supplemented at least in part with income from other retirement plans. It is no wonder, therefore, that labor unions have started to include a demand for cost-of-living escalators in pension benefits in their recent contract negotiations.

In an inflationary environment, conventional money-fixed pensions and contractual savings plans are risky both as a vehicle for accumulating savings and as a source of retirement benefits. This was one of the considerations which led to the development of equity-based variable annuities (VA's) in the 1950's. At that time it was believed that common stocks could provide a hedge against inflation, in the sense that stock prices would on average increase at the same rate as the prices of consumption goods. By investing a portion of its retirement funds in an equity based VA, it was thought the household could thus protect itself against inflation.[1]

The experience with VA's has been disappointing but not really that surprising. After all, even if it were true, as many hypothesized, that the inflation-adjusted or real rate of return on common stocks is unaffected by the rate of inflation, this would not imply that they are a riskless investment. By switching funds out of money-fixed securities and into stocks, an investor would at best be eliminating his exposure to inflation risk but only at the cost of exposing himself to substantial business and financial risk.[2]

What is needed is a different kind of annuity, which is defined in purchasing-power terms. It is the purpose of this paper to present a proposal for such a financial instrument, which we shall call a purchasing power annuity (PPA), and to explore its feasibility in the context of the U.S. financial system. It would seem that the only asset which could provide a base for such an annuity would be default-free bonds linked to some index of the cost of living.[3] Although proposals for the U.S. government or some other institution to issue such price-indexed bonds have abounded, there is no indication that anyone with the power and authority to implement any of these proposals is inclined to do so.[4]

Given the apparent reluctance, if not outright opposition, on the part of the government and private corporations to the issuance of price-indexed bonds the relevant question is whether there is any other asset, or combination of assets, currently existing in the U.S. financial system which could fulfill the same function. The empirical evidence suggests that the most promising asset base for PPA's is short-term bonds hedged against unanticipated inflation with a small position in a well-diversified portfolio of commodity futures contracts.

The remainder of this paper is organized as follows. In the next part we explore the inadequacies of conventional and equity-based variable annuities in an inflationary environment by contrasting them with a hypothetical PPA. We then try to assess the suitability of money market instruments hedged with commodity futures as the asset base for PPA's, and consider the possibility of having life insurance companies and private pension plans offer them to the public. Finally, we conclude with a brief summary and discussion of the proposal.

II. The Nature of the Problem and the Demand for PPA's

The problems created by conventional annuities in a period of rapid and unpredictable inflation are best considered by dividing a household's lifetime into a pre-retirement (or accumulation) period and a retirement period. We will first focus on the accumulation phase by assuming that the household has decided that it will need a fund of $100,000 in terms of today's purchasing power in order to finance its consumption flow during retirement and that it has 30 years left before then. At an 8% per year rate of inflation the fund would have to have a nominal value of $1,006,266 in it 30 years from now in order for its real value in terms of today's purchasing power to be $100,000; a ratio of roughly 10 to 1.

There are two major problems associated with trying to meet this savings goal with a conventional retirement savings plan, which calls for equal periodic dollar contributions over the working years. The first problem is that the time pattern of contributions in real terms will not in general match the time pattern of the household's real labor income, and the second is that there will be considerable uncertainty about the eventual purchasing power of the dollar amount accumulated in the fund. Both of these problems can be clarified with an example.

Suppose the household is considering investing in a conventional retirement savings plan offering a nominal interest rate of 8% per year and consisting of 30 equal annual contributions. In order to accumulate $1,006,266 by the end of the 30 year period, the annual premium would have to be $8883.

For most households this would represent an unrealistically high proportion of its current labor income. On the other hand, if the household's nominal labor income keeps pace with inflation during the working years, even with no real income growth, by the end of the period the ratio of premium to income will have shrunk to one-tenth its initial value. Furthermore with the conventional plan the household has no assurance that its savings goal will be met in real terms. Since the rate of inflation is not known with certainty, the real value of the fund at retirement may turn out to be far from 100,000 constant dollars (c$100,000). For example, if the rate of inflation averages 10% per year the real value of the fund will be only c$57,668, while at 6% per year inflation its real value will be c$175,201.

Now let us contrast this conventional money-fixed savings plan with a hypothetical PPA, which calls for a level flow of annual contributions in terms of constant dollars. Since the expected real rate of interest assumed on the conventional plan was zero, let us use that same real rate for the PPA. In order to accumulate c$100,000 at the end of 30 years, the annual premium would have to be c$3333 1/3. At 8% per year inflation the current dollar amount of the premium would start at $3,600 at the end of the first year and climb to $33,542 by the last payment. Assuming the household's labor income remains constant in real terms, the ratio of premium to income remains constant.

Many insurance companies have in recent years taken steps to move partially in the direction of this PPA accumulation idea by including a cost-of-living clause in their insured savings plans, which allows policyholders to increase coverage in accordance with the annual rise in the price level. But typically the interest rate earned under these plans remains fixed in nominal terms, so that although the saver can achieve a better time profile of contributions, he still faces considerable risk of not achieving his ultimate savings goal in real terms.

To deal with this latter problem of a fixed nominal earnings rate insurance companies started offering equity-based variable annuities (VA's) in the 1950's. The impetus for creating these savings plans came from the idea that common stocks are a <u>long-run</u> hedge against inflation, in the sense that over a long holding-period one could count on earning a positive real rate of return, i.e., a nominal rate of at least whatever the rate of inflation turned out to be.

Unfortunately, this idea has only limited merit. Even if it were true that the mean real rate of return on equity was positive regardless of the rate of inflation, if the annual fluctuations around that mean are independently distributed and fairly large, then even with an investment horizon which is far in the future, one can miss one's savings target by quite a bit. For example, suppose we wanted to invest a sum now which would provide us with c$100,000 for retirement 30 years from now. If we could count on a 4% per year real rate of return then we would have to invest $30,832. But if the average compound real rate of return turned out to be off by only 1%, so that we wound up earning only 3 rather than4% per year, we would have only c$74,837 at the end of the 30 year period.

Of course, an equity-based VA offering a mean real rate of return of 4% per year may be an attractive alternative to a conventional annuity offering an expected real rate of return of zero. Furthermore, by dividing its retirement savings between a conventional money-fixed plan and a VA, the household can achieve a better risk-return combination than by investing all of its funds in either one alone. However, no mixture of these two types of savings plans can provide the household with a truly low risk option in real terms.

The need for a PPA alternative to conventional money-fixed annuities and equity-based VA's is even greater in the retirement phase of the household's lifetime. Let us first consider the conventional money-fixed annuity. Even with a deterministic rate of inflation, equal periodic dollar amounts imply a negative "tilt" to the stream of real retirement income, which many households might not want. Moreover, in an environment with an uncertain rate of inflation, both the level and the slope of the real stream of benefits are unpredictable and out of the beneficiary's control.

To illustrate this point let us consider a conventional retirement annuity which is assumed to last 15 years (from retirement until death) at a nominal interest rate of 8% per year and compare it to a hypothetical purchasing-power annuity (PPA) which earns a real interest rate of zero. It is important to stress that in comparing conventional annuities to PPA's, the relevant comparison is not between a conventional money-fixed annuity and the <u>same</u> annuity with an escalator clause. In pension planning as in all other areas of personal finance, there is no free lunch! Assuming that the beneficiary has accumulated $100,00 for retirement, the PPA would pay the annuitant c$6,667 per year, while the conventional annuity would pay $11,683 per year.

Table 1 and Figure 1 show the pattern of real income flows associated with the conventional annuity for various rates of inflation.

If as anticipated the actual rate of inflation over the life of the annuity turns out to be 8% per year then the real value of the conventional annuity flow will start at c$10,818 in the first year and fall to c$3683 in the 15th. While some retirees might view this pattern as preferable to a constant real flow of c$6667 per year, the conventional annuity offers no guarantee that it will be realized. Should the rate of inflation turn out to be 12% per year, the stream of real payments will be both lower and more steeply tilted than anticipated, starting at c$10,431 in year 1 and falling to c$2134 by year 15. Of course, if the retiree is lucky, the rate of inflation might turn out to be less than 8% per year, but most people would prefer not to speculate with their retirement income.

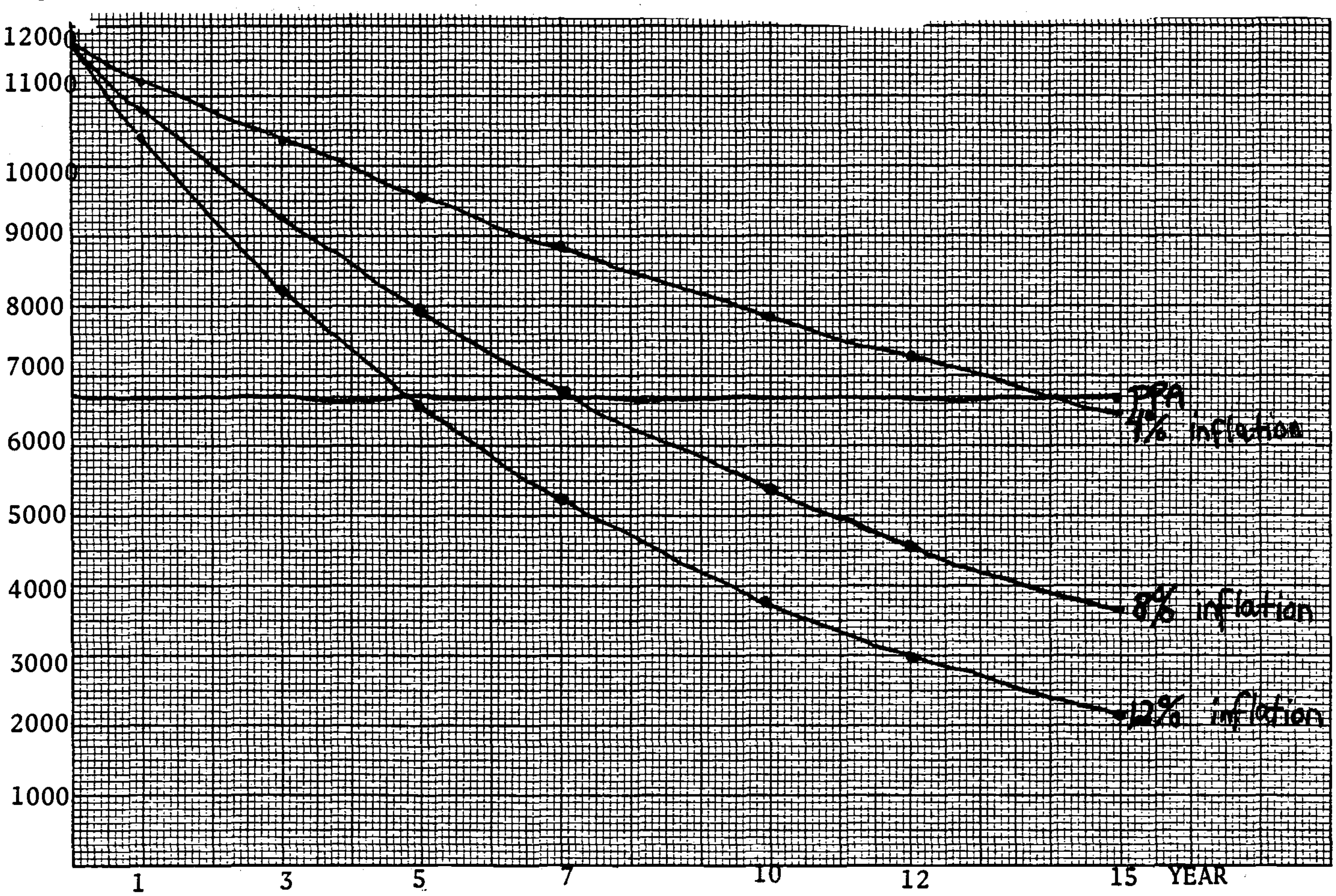
Table 1: Real Value of Cash Flow of $11,683 per year from a Conventional Annuity at Selected Rates of Inflation.

	Rate of Inflation				
Year	4%	6%	8%	10%	12%
1	c$11,234	c$11,022	c$10,818	c$10,621	c$10,431
3	10,386	9,809	9,274	8,778	8,316
5	9,603	8,730	7,951	7,254	6,629
7	8,878	7,770	6,817	5,995	5,285
10	7,893	6,524	5,411	4,504	3,762
12	7,297	5,806	4,639	3,723	2,999
15	6,487	4,875	3,683	2,797	2,134

The symbol c$ stands for constant dollars

Constant dollars

Figure 1



For retirees who like the idea of a real stream of retirement benefits which has a downward tilt, it would be relatively simple to design a PPA with this property. The essential distinguishing feature of the PPA, however, would remain the same: the slope and level of the benefit stream should be fixed in real terms and unaffected by the actual rate of inflation.

Which brings us again to a consideration of equity-based variable annuities. Under a VA the annuitant's retirement fund is invested in a diversified portfolio of common stocks which is managed by the institution offering the annuity. Most of the risk associated with the value of this portfolio and the rate of return on it are passed through to the annuitant. This is accomplished by defining the periodic benefit in terms of a fixed number of annuity units, which are essentially shares of the underlying stock portfolio. The dollar amount of the benefit is then just the fixed number of annuity units times the current market value of a unit.

Let us illustrate the VA and its drawbacks with a concrete example. Since there are some differences in the kinds of VA's offered, we will focus on a hypothetical one, which typifies the species. As in the case of the conventional, money-fixed annuity, let us assume that our household has accumulated $100,000 in its retirement fund and is purchasing a 15 year annuity. The insurance company uses this money to buy a portfolio of stocks and sets the initial number of annuity units or "shares" at 10,000, each thus having an initial value of $10. It then determines an assumed earnings rate in order to compute the amount of the periodic payment in terms of annuity units. Let us assume a 4% per year rate, which represents a "conservative" judgement on the part of the company as to the average real rate of return which will be earned on the stock portfolio. The annuity benefit will then be 899.4 annuity units per year.

Now if the total real rate of return (dividends plus capital gains) on the stock portfolio year after year turned out to be 4% (which implies a nominal rate of return equal to 4% plus the rate of inflation), then the nominal value of the portfolio would exactly keep pace with inflation and the real income stream from the VA would be a level c$8994 per year. Even if the nominal market value of the stock portfolio did not exactly keep pace with inflation on an annual basis, but did so "on average" with relatively small annual deviations from the trend, the VA would still be relatively attractive.

The actual experience with VA's, however, has been disappointing. Figure 2 and Table 2 present the experience of the College Retirement Equities Fund (CREF), which pioneered the VA. The value of an annuity unit at CREF's inception on July 1, 1952 was set at $10, which in terms of 1967 purchasing power was worth c$12.52. Since that time its real value has fluctuated considerably in value from year to year, trending its way to a peak of c$31.92 in 1967 and then falling back to c$11.86 by 1978. It is ironic and expecially disappointing that it has done particularly poorly in the last ten years, the period of the most rapid inflation.

Imagine the plight of a CREF beneficiary who started receiving his benefits in 1967, when the current dollar value of an annuity unit was $31.92. Assuming he had accumulated $100,000 in his fund prior to retirement, he would have been entitled to a monthly benefit of 19.103 annuity units, with a current dollar value of $609.76 per month.[6] In 1978 his monthly benefit would have been $444.72 in current dollars and only c$226.56 in terms of 1967 purchasing power.

Figure 2 **Changes in TIAA and CREF Income Amounts and the Consumer Price Index**
(Initial incomes $10 per month beginning July 1, 1952)

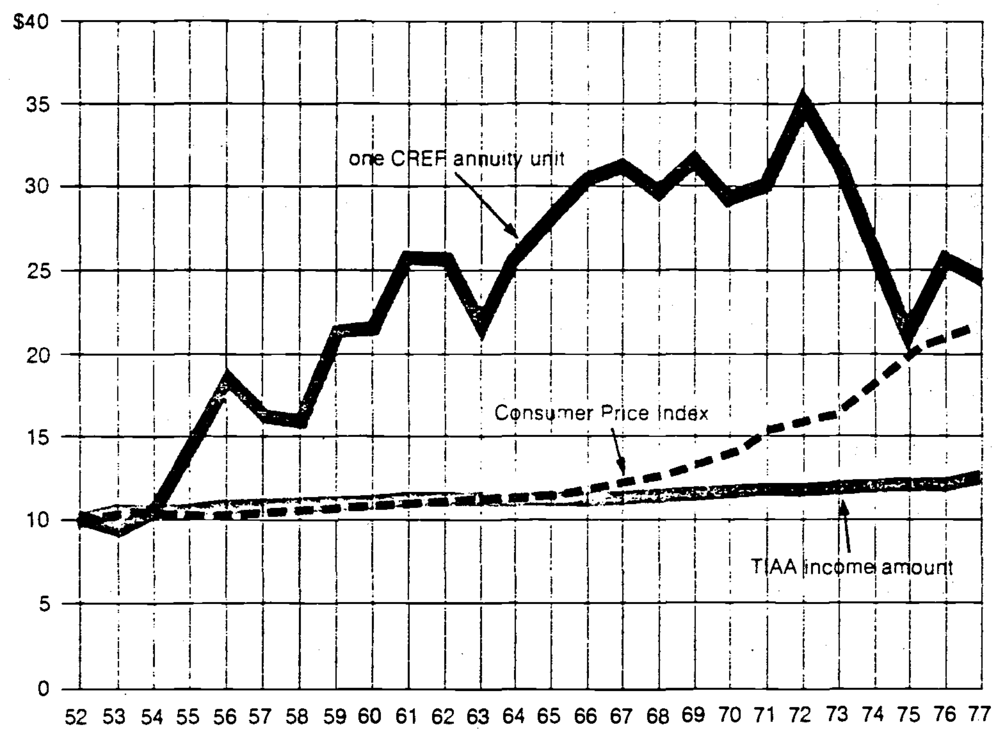


Table 2 CREF ANNUITY UNIT VALUES SINCE 1952
(Annuity Year: May through April)

	Current dollars	Constant dollars (base year: 1967)		Current dollars	Constant dollars (1967)		Current dollars	Constant dollars (1967)
1952	$10.00	c$12.52	1961	$26.25	c$29.29	1970	$28.91	c$24.82
1953	9.46	11.78	1962	26.13	28.86	1971	30.64	25.20
1954	10.74	13.34	1963	22.68	24.67	1972	35.74	28.53
1955	14.11	17.58	1964	26.48	28.49	1973	31.58	23.84
1956	18.51	22.62	1965	28.21	29.82	1974	26.21	17.74
1957	16.88	19.96	1966	30.43	31.29	1975	21.84	13.49
1958	16.71	19.28	1967	31.92	31.92	1976	26.24	15.37
1959	22.03	25.22	1968	29.90	28.66	1977	24.80	13.61
1960	22.18	25.05	1969	32.50	29.54	1978	23.28	11.86

Source: Figure 2 is taken from TIAA-CREF (13), p.9 and Table 2 is based on TIAA-CREF (14), p. 19.

Although equity-based VA's have failed to provide a source of stable real retirement income, the basic principle behind them could be applied in creating an annuity with characteristics similar to the hypothetical PPA described before. All that is needed is an asset offering a more stable real rate of return than common stocks.

III. Money Market Instruments as an Asset Base for PPA's

The only assets which could offer a completely satisfactory investment base for PPA's would be securities explicitly linked to the consumer price level, such as index bonds or price-level-adjusted mortgages. In lieu of such index-linked securities, recent historical evidence suggests that the most promising asset base for PPA's in the U.S. is short-term bonds hedged against unanticipated inflation with a small position in a well-diversified portfolio of commodity futures contracts. Unlike index bonds, these securities cannot provide a completely risk-free real rate of return. They can, however, be used to produce a much more stable real rate of return than can be earned on the traditional pension fund assets: long-term bonds and common stocks; and unlike index bonds they do already exist.

Table 3 presents the year-by-year real rates of return one would have earned on various categories of investments during the 26-year period from January 1953 through December 1978. The first column is the real rate of return on a policy of "rolling-over" 30-day Treasury Bills. Fama[6] maintains that the nominal rate of return on 30-day T-Bills is determined as the sum of a time-invariant real rate plus the market's expectation of the rate of inflation over the coming month. If the market's short-run inflation expectations are fairly accurate then the annual real rate of return reported in column 1 should not vary much over time. Indeed, over the period investigated by Fama, 1953 to 1972, the real rate on 30-day Bills averaged 1% per year and had a standard deviation of only 0.69%. But as the last column in Table 3 shows, a serious escalation in the rate of inflation occurred in 1973 and 1974, and the real rate of return on Bills has not been able to recover since then. The mean real rate of return during the 1973-1978 period was -1.62% with a standard deviation of 1.29%.

Table 3: Annual Real Rates of Return: 1953-1978

Year	(1) 1 Month Bills	(2) 1 Year Bills	(3) (per cent per year) Bonds	(4) Stocks	(5) Commodity Futures	(6) Inflation
1953	1.19	1.48	2.99	-1.60	-3.46	0.62
1954	1.37	1.84	7.73	53.39	13.24	-0.50
1955	1.20	1.03	-1.66	31.07	-7.62	0.37
1956	-0.36	-0.29	-8.22	3.60	12.24	2.86
1957	0.12	0.18	4.30	-13.40	-5.04	3.02
1958	-0.22	0.79	-7.72	40.88	-3.47	1.76
1959	1.43	1.63	-3.70	10.30	-2.84	1.50
1960	1.16	3.38	12.12	-1.00	-3.93	1.48
1961	1.45	2.00	0.30	26.05	0.02	0.67
1962	1.49	1.91	5.60	-9.83	-2.39	1.22
1963	1.45	1.38	-0.43	20.81	1.52	1.65
1964	2.32	2.58	2.29	15.11	4.58	1.19
1965	1.97	2.04	-1.19	10.33	5.13	1.92
1966	1.36	1.45	0.29	-12.98	9.70	3.35
1967	1.14	1.84	-11.87	20.32	-0.06	3.04
1968	0.47	0.92	-4.76	6.05	-3.18	4.72
1969	0.44	0.20	-10.55	-13.77	12.19	6.11
1970	0.99	2.61	6.27	-1.40	-1.62	5.49
1971	1.00	1.73	9.55	10.59	-1.66	3.36
1972	0.42	0.91	2.20	15.06	29.55	3.41
1973	-1.72	-2.92	-9.11	-21.56	72.68	8.80
1974	-3.74	-4.45	-7.00	-34.47	15.04	12.20
1975	-1.13	0.06	2.04	28.21	-10.03	7.01
1976	0.26	1.43	11.39	18.16	4.56	4.81
1977	-1.55	-1.83	-6.97	-13.07	5.55	6.77
1978	-1.83	-1.72	-7.34	-2.42	18.54	9.03
Mean	0.41	0.78	-0.52	7.09	6.13	3.69
Standard Deviation	1.41	1.79	6.89	20.13	16.34	3.12
1953-72 Subperiod						
Mean	1.02	1.48	0.18	10.48	2.65	2.36
Standard Deviation	0.69	0.89	6.59	18.19	8.89	1.73
1973-78 Subperiod						
Mean	-1.62	-1.57	-2.83	-4.19	17.72	8.10
Standard Deviation	1.29	2.09	8.00	23.87	28.71	2.53

Sources: The data on 1 month bills, 20 year bonds, and stocks are from Ibbotson and Sinquefield, Stocks, Bonds, Bills and Inflation, Financial Analysts Research Foundation, 1977, updated using the Wall Street Journal

The 1-year bill rate series is from Salomon Brothers, Analytical Record of Yields and Yield Spreads. The commodity futures series was derived from price data in the Wall Street Journal using a method explained in the text.

Column 2 shows that by increasing the maturity of the Treasury Bills from a month to a year, an investor would have raised both his mean annual real rate of return and its standard deviation. During the 1953-1972 period the mean would have increased by 46 basis points and the standard deviation by 20. Over the 1973-78 period the difference in the means is only 5 basis points, while the difference in standard deviations is 80.

Column 3 presents the real rate of return an investor would have earned by investing in U.S. Treasury bonds with a 20-year maturity. The assumption underlying this series is that the investor bought a 20-year bond at the beginning of each year and sold it at the end. His return therefore includes both coupon interest and capital gains or losses. As the relatively low mean and high standard deviation in both subperiods indicate, the past 26 years was a bad time for the investor in long-term bonds. Capital losses caused by unanticipated increases in long-term interest rates tended to cancel the coupon yield over this period. While it is probably reasonable to expect the mean real rate of return to be higher in the future, as long as interest rates remain volatile the standard deviation will remain high.

Column 4 presents the real rate of return on the Standard and Poor's Composite Index of common stocks, which is a value-weighted stock portfolio of the 500 largest corporations in the U.S.. The return includes dividends and capital gains. As in the cases of bills and bonds there is a dramatic decline in mean and increase in standard deviation going from the 1953-72 to the 1973-78 subperiod. The mean falls from 10.48% per year to -4.19%, while the standard deviation rises from 18.19% to 23.87%. Looking at the year-by-year returns it is clear that stocks did especially badly in years in which the rate of inflation was high. Thus contrary to the usual assumption made in the economics literature, that the real return on stocks is uncorrelated with inflation, the data indicate a negative correlation.[7] To verify this negative correlation, we present in Table 4 the correlation coefficients of the annual returns series reported in Table 3. The correlation coefficient between the real rate of return on common stocks and the rate of inflation was -.562 during the 1953-72 subperiod and -.768 during the 1973-78 subperiod. During the entire 26-year period stocks seem to have behaved more like a money-fixed security than a claim to a real asset.

Summarizing the data we have examined so far, it is clear that bills have offered a far more stable annual real rate of return than long-term bonds or stocks. Furthermore, the 1 month bills are more stable than 1 year bills. But there is still variation in the real return on 1-month bills, which is caused primarily by variation in the rate of inflation as revealed by the high negative correlation coefficients in the upper right hand corners of the matrices in Table 4. During the 1973-78 subperiod that correlation was -.967, indicating that 93.5% of the variance of the real rate of return on 1-month bills could be explained by inflation. We will now consider how much of the variance of the real return on bills could have been diversified away by using commodity futures contracts.

Table 4 - Correlation Matrix of Real Rates of Return

a. 1953-1978

	1 Year Bills	20 Year Bonds	Stocks	Commodity Futures	Inflation
1 Month Bills	0.930	0.438	0.459	-0.417	-0.877
1 Year Bills		0.585	0.524	-0.547	-0.821
20 Year Bonds			0.223	-0.333	-0.404
Stocks				-0.343	-0.612
Commodity Futures					0.455

b. 1953-1972

	1 Year Bills	20 Year Bonds	Stocks	Commodity Futures	Inflation
1 Month Bills	0.740	0.352	0.097	-0.141	-0.442
1 Year Bills		0.583	0.103	-0.259	-0.302
20 Year Bonds			-0.075	-0.106	-0.295
Stocks				0.052	-0.562
Commodity Futures					0.205

c. 1973-1978

	1 Year Bills	20 Year Bonds	Stocks	Commodity Futures	Inflation
1 Month Bills	0.941	0.760	0.797	-0.212	-0.967
1 Year Bills		0.870	0.932	-0.494	-0.915
20-Year Bonds			0.774	-0.531	-0.715
Stocks				-0.571	-0.768
Commodity Futures					0.325

Column 5 in Table 3 presents the year-by-year annual rate of return one would have earned on a well-diversified portfolio of commodity futures contracts over the 1953-78 period.[8] The rate of return on a futures contract was measured as the proportional change in the futures price over the holding period. The series was generated by assuming a buy-and-hold strategy whereby contracts were entered into at quarterly intervals, held for three months, and then liquidated. The number of commodities increases from 13 in 1953 to 22 by the end of the period. Table 5 presents the list of commodities and the year in which each was added to the portfolio. The portfolio was assumed to consist of equal dollar amounts invested in each commodity.

The rates of return for commodity futures listed in Column 5 of Table 3 must be interpreted somewhat differently from the real rates in columns 1 through 4. When an investor takes a long position in a futures contract, he does not buy it in the sense that he would buy a stock, a bond, or the physical commodity itself. Rather, he agrees to purchase the commodity for a specified price at a certain point in the future. The commodities exchange, which acts as an intermediary, requires all parties to a futures contract to post bond which is called "margin," to guarantee performance. But investors are permitted to post Treasury Bills, on which they continue to earn the interest, so the funds used as margin are therefore not strictly speaking an investment in commodity futures. The rate of return reported in column 5 should, therefore, be interpreted as the <u>addition</u> to an investor's total investment portfolio rate of return which he would have earned in each year had he taken a position in commodity futures equal to the value of his total investments in other assets. Alternatively, it can be interpreted as the additional rate of return one would have earned on the Treasury Bills posted as margin, assuming the amount posted was equal to 100% of the face value of the contracts.

Table 5: List of Commodity Futures Contracts Included in the Portfolio

Commodity	Year in which it first entered the portfolio
Wheat	1953
Corn	1953
Oats	1953
Soybeans	1953
Soybean Oil	1953
Soybean Meal	1953
Potatoes	1953
Wool	1953
Cotton	1953
Eggs	1953
Cocoa	1953
Copper	1953
Sugar	1953
Silver	1963
Cattle	1964
Platinum	1964
Pork Bellies	1964
Hogs	1966
Orange Juice	1966
Broilers	1968
Lumber	1969
Plywood	1970

Our principal interest in commodity futures contracts is to determine whether they can be used to reduce the variance of the real return on 1-mon+' T-Bills. Their effectiveness for this purpose is determined by the degree of correlation between their rate of return and the real return on T-Bills.[9] Indeed, the square of the correlation coefficient measures the proportional reduction in the variance of the real rate of return on T-Bills attainable by combining them with the variance-minimizing proportion of commodity futures contracts. This optimal proportion is equal to the negative of the correlation coefficient multiplied by the ratio of the standard deviation of the real return on T-Bills to the standard deviation of the rate of return on commodity futures. Using the parameters estimated over the entire 26 year period 1953-78 and reported in Tables 3 and 4, we find a correlation coefficient of -.417 and standard deviations of 1.41% and 16.34% respectively. The variance-minimizing proportion of T-Bills was therefore 3.6%, and the proportional reduction in variance 17.4%. This implies that the standard deviation of the real return on the resulting minimum-variance portfolio is 1.28% vs 1.41% on 1-month T-Bills. The mean real rate of return on the minimum-variance portfolio is 0.63% per year vs 0.41% on 1-month T-Bills.

Thus by adding a small position (3.6%) in commodity futures to 1-month T-Bills one could have attained both a smaller standard deviation and a higher mean during the 1953-1978 period.

It would seem that T-Bills hedged against unanticipated inflation with commodity futures offers a relatively stable real rate of return. But even the hedged T-Bills had a disappointingly low mean real rate of return of -0.98% per year in the 1973-78 subperiod. While this is considerably better than the -1.62% on unhedged T-Bills, it is still low.

Some improvement in yield can be obtained by investing in other money-market instruments such as corporate commercial paper and negotiable certificates of deposit, and in long-term floating-rate notes and bonds whose interest rates are tied to short-term rates. These debt instruments are only slightly riskier than T-Bills, and institutional investors such as insurance companies have traditionally been willing to assume that extra risk. Over the past ten years the average yield spread between 90-day commercial paper and T-Bills has been about 1% per year although recently the spread has been narrowing.

Were life insurance companies to offer PPA's to the public, the most natural use for the funds raised would probably be to make long-term floating-rate loans to their traditional borrowers. As is the case with the floating-rate notes recently issued by financial institutions, the interest rate could be set at some premium above the 6-month Treasury Bill rate. If, as in the past, the Treasury Bill rate were to more or less match the concurrent rate of inflation, the premium would represent the real interest rate on the loan. Under these circumstances even after expenses PPA's might well be expected to earn at least a zero real rate of return.

A question which should be addressed in the case of stock insurance companies (as opposed to mutual companies) is who should bear the risk associated with possible deviations of the real rate of return from the assumed rate - the insurance company or the policyholders? The risk could easily be passed through to policyholders by offering PPA's as variable annuities, similar in design to equity-based VA's, but based on a portfolio consisting primarily of money-market instruments and long-term floating rate debt instead of common stocks. On the other hand, one of the traditional functions of stock life insurance companies has been to transfer risk from the policyholders to the shareholders. As long as PPA's are fairly priced, these companies should be willing to offer them with a purchasing power guarantee and bear the residual investment risk themselves.

IV. PPA's and Corporate Defined - Benefit Pension Plans.

We have been considering the possibility of life insurance companies offering PPA's to the public as discretionary annuities, but in the U.S. most private retirement income is provided by defined-benefit pension plans. Many of these plans already offer a kind of de facto purchasing-power guarantee to their employees through a benefit formula which bases the monthly retirement payment on the employee's wage just prior to retirement. Since wages and consumer prices are highly correlated in the long run, workers covered by such plans can at least count on purchasing-power protection of pension benefits during the pre-retirement years.

But very few pension plans offer a cost-of-living escalator during the retirement phase. In recent years some corporations, under pressure from labor unions, have made one-time increases in pensions being paid to retired employees, and if inflation persists at anything like its current rate it seems likely that union pressure in this direction will increase. The analysis presented in this paper suggests that corporate pension plans could meet these union demands by offering a PPA option to their employees at retirement. Employees could be offered a choice between a conventional money-fixed annuity or a PPA, both of which would cost the employer the same amount of money to fund.

V. SUMMARY AND CONCLUDING COMMENTS

One need not subscribe to the entire proposal presented in this paper in order to endorse parts of it. In this last section we will summarize the proposal, highlighting the separability of its components.

1. It would be desirable for financial intermediaries to offer households a contractual retirement savings plan where both the nominal premiums paid in and the dollar value of the annuity benefits received were scheduled to increase at the rate of inflation expected to prevail over the duration of the plan. During the accumulation period, it would be relatively easy to adjust the premiums to the actual rate of inflation experienced. During the benefit phase, it would be especially desirable to have an annuity whose dollar value was adjusted at least approximately in accordance with the actual rate of inflation experienced.

2. Because there are no securities in the U.S. capital markets which offer a riskless real rate of return, PPA's might best be offered as variable annuities with most of the investment risk passed through to the policyholders. This risk could be minimized by using money-market instruments hedged against unanticipated inflation with a small amount of commodity futures contracts as the asset base. The mean real rate of return on such a portfolio over the past 26 years has been about zero, suggesting that if stock insurance companies were to underwrite PPA's, the real earnings rate which they would use in pricing their policies would be at most zero.

3. In response to the growing demand by labor unions to include a cost-of-living escalator in defined-benefit pension plans, employers could offer employees a PPA option which costs them the same as a conventional annuity.

FOOTNOTES

[1] See Greenough (9) for a more complete explanation of the VA idea.

[2] See Bodie (2) and (4) for a more complete discussion of this point.

[3] See Munnell (11) and Pesando (12).

[4] See Blinder (1), Fischer (7), Friedman (8), and Modigliani and Lessard (10) for a discussion of some of these proposals.

[5] See Friedman (8)

[6] The calculation was made according to the following explanation given in TIAA-CREF (15).

Using current mortality rates for male and female annuitants, the actuaries estimate that for a husband and wife both aged 65 there must be $164 on hand earning 4% a year (after expense charges) to pay them $1 monthly under the Joint and 2/3 to Survivor option.* The Annuity Factor then is 164 for this method of payment to a couple aged 65. Dividing the annuity owners accumulated retirement fund by 164 gives the amount of monthly income payable to the couple as a Joint and 2/3 to Survivor annuity. Or, stated another way, each $16,400 of accumulated value would provide this couple an initial income of $100 a month.

To illustrate the conversion of accumulation units to annuity units, suppose that on April 1, 1978 you and your spouse were age 65 and began receiving a CREF monthly income under the Joint and 2/3 to Survivor option mentioned previously.

a. Assume that on April 1 the total value of your accumulation units was $50,000.

b. The value of your accumulation units would have been divided by the Annuity Factor of 164 to determine the initial amount of monthly income payable under the option selected

   $50,000 ÷ 164 = $304.88 monthly.

c. To determine the number of annuity units that would be used each month to measure the changing value of your share in CREF's experience, the $304.88 would then have been divided by the current value of the annuity unit ($23.28 as of April 1, 1978).

Thus your accumulation units would have been converted into a series of 13.096 annuity units payable each month as long as both you and your spouse live, and a series of 8.731 annuity units -- 2/3 of 13.096 -- payable to the survivor each month for life following the death of either you or your spouse with payments in any event guaranteed to continue for a minimum of ten years. The monthly income of $304.88 (13.096 X $23.28) would continue until the next yearly revaluation of the annuity unit, at which time your monthly income for the succedding year would be determined by multiplying your 13.096 annuity units by the new annuity unit value. The amount of your check would thus change on May 1 each year.

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*This option pays a life time income to husband and wife, with the amount reducing by a third at the death of either. If both die within the first ten years of payments, the two-thirds benefit continues to their named beneficiary for the balance of the ten-year period.

[7]See Bodie (3) for a more complete discussion of this point.

[8]For a more complete description of the commodity futures series see Bodie and Rosansky (5).

[9]Proof: Let s_p^2 be the variance of the real rate of return on an investment in T-Bills hedged with commodity futures contracts, and let x be the ratio of the face value of the position in futures to the investment in T-Bills. Then:

$$s_p^2 = x^2 s_C^2 + 2x s_{CT} + s_T^2$$

where s_C^2 is the variance of the rate of return on commodity futures, s_T^2 the variance of the real rate of return on T-Bills, and s_{CT} the covariance between them. The variance minimizing ratio, x^*, is found by setting the derivative of s_p^2 with respect to x equal to zero:

$$\frac{ds_p^2}{dx} = 2x s_C^2 + 2s_{CT} = 0$$

$$x^* = -\frac{s_{CT}}{s_C^2}$$

Substituting this value for x back into the expression for s_p^2 we find that the resulting minimized variance is:

$$s^2_{min} = - \frac{s^2_{CT}}{s^2_C} + s^2_T$$

The proportional reduction in the variance of the real rate of return on the T-Bills is therefore:

$$\frac{s^2_T - s^2_{min}}{s^2_T} = \frac{s^2_{CT}}{s^2_C \, s^2_T}$$

which is the square of the correlation coefficient between the real rate of return on T-Bills and the rate of return on commodity futures.