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Efficient Investment Portfolios in a Real-Value Environment: Implications for Portfolio Managers and Bond Yields

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ABSTRACT

In early 1997 the U.S. Treasury began issuing inflation-indexed securities. This paper compares efficient portfolios containing an inflation-indexed security to portfolios without such a security. Inflation risk premiums that are required for traditional, nominal, non-indexed debt assets to replace an inflation-indexed security in efficient portfolios are estimated. Results are calculated and compared for the periods 1926-1995, 1950-1995 and 1965-1995.

JEL: G11, G12, D81

Keywords: Real return; Inflation-adjusted; Portfolio management; TIPS (for Treasury Inflation-Protected Securities); Indexation

I. INTRODUCTION

Until early 1997, when the U.S. Treasury issued inflation-indexed bonds, U.S. investment managers had no asset that provided an assured inflation-indexed return[1]. Availability of inflation-indexed securities—constant-dollar-value assets—now offers new opportunities for optimizing portfolio risk-return tradeoff. This also poses new challenges, because some things considered to be true turn out to be false, or at least questionable, in the presence of inflation-indexed securities, when everything is benchmarked in real terms.

In real, constant dollar terms over a multi-period investment horizon, a nominal dollar U.S. Treasury bill, the traditional risk-free asset, turns out to be anything but risk free. This is due to the uncertain future rate of inflation and the turnover of investment at future interest rates that cannot be known in advance.

For the purposes of this study we assume that a security exists that offers a guaranteed fixed return after the effects of inflation. At present, those indexed securities that exist closely approximate, but do not exactly satisfy this ideal, because of lags in making the inflation adjustment[2] and the tax treatment accorded the adjustment.[3] Fluctuations in the market's real rate of return will affect the realized real rate of return, but a buy and hold strategy will minimize variations in the real rate of return. To approximate the actual (and worst case) results that may be expected with the new U.S. Treasury TIPS (Treasury Inflation Protected Securities), we examine the effects of lagging the inflation indexed return by 1, 2, and 3 months.

II. A BRIEF HISTORY OF INFLATION-INDEXED SECURITIES

The U.S. Treasury is a latecomer to offering inflation-adjusted securities. In modern times Finland in 1945 was the first nation to offer inflation adjustment in government financial instruments. Since then, many other nations have issued such debt. Table 1 shows the dates of implementation of inflation indexation in countries whose national governments offer such securities.

In January, 1997 the United States issued its first inflation indexed bonds in two centuries.[4] The initial securities offered were 10-year inflation-indexed notes. This was followed by a 5-year inflation-indexed note and a 30-year bond. These securities are issued with a single price in a Dutch auction, as are the current non-indexed 2- and 5-year notes. Bidding is on the basis of real yield, expressed to three decimal places. The index used to measure inflation is the CPI-U, the non-seasonally adjusted U.S. City Average All Items Consumer Price Index for All Urban Consumers, which is published monthly by the Bureau of Labor Statistics of the U.S. Department of Labor.[5] The market yield on these securities, over the inflation rate, has remained around 3-5/8 percent.

Table 1

Dates of introduction of indexed bonds with inflation rates

Date of Introduction	Country	Type of Indexation	Inflation Rate in Year Prior to Introduction
1945	Finland	Wholesale Prices	6.4%
1955	Israel	Consumer prices	12.3%
1955	Iceland	Consumer prices	0.0%
1964	Brazil	Wholesale prices	69.2%
1966	Chile	Consumer prices	22.2%
1967	Colombia	Wholesale prices	19.7%
1972	Argentina	Wholesale prices	34.8%
1975*	UK	Consumer prices	16.1%
1981	UK	Consumer prices	14.0%
1985	Australia	Consumer prices	4.5%
1989	Mexico	Consumer prices	114.8%
1991	Canada	Consumer prices	4.8%
1994	Sweden	Consumer prices	4.4%
1995	New Zealand	Consumer prices	2.8%

* In 1975 the UK issued non-marketable index-linked national savings retirement bonds ("granny bonds"). Marketable index-linked debt was first issued in 1981.
Source: John Y. Campbell and Robert J. Shiller, "A Scorecard for Indexed Government Debt," paper prepared for the NBER Macroeconomics Annual Conference, March 8-9, 1996. (Table detail suppressed.)

Issue of inflation-indexed securities by the federal government will likely pave the way for acceptance of privately issued inflation adjusted securities.[6] Also, the current tax treatment of the phantom income from inflation adjustment may serve to focus public attention on how current U.S. tax law penalizes preservation of purchasing power, and thus may eventually help lead to revision of the tax code. In the U.K. there is no tax on the "inflation-induced increase in the nominal principal."[7]

III. MODEL AND DATA

We assume the existence of an inflation indexed security that offers a fixed, guaranteed return of 3.25 percent per annum after inflation, adjusted without a lag.[8] Later we relax this restrictive assumption to consider the effects from adjustment lags of from 1 to 3 months. We ignore taxes because, although taxable investors could be penalized by the taxation of phantom income, institutional investors who are not subject to income tax on investment earnings dominate the investment scene, and individuals can invest using tax-sheltered accounts. We assume that the constant dollar security has zero variance and is uncorrelated with the other financial assets in the portfolio. Although this assumption may not hold exactly, institutional investors can closely approach zero variance and zero correlation with the real returns on other investments by employing a buy-and-hold strategy with the inflation-adjusted asset. A buy-and-hold strategy has the further advantage of minimizing transaction costs and portfolio management costs.

In addition to the constant dollar security we include ***inflation-adjusted*** return indices for five other financial asset classes: (1) U.S. Treasury Bills, (2) Intermediate Government Bonds, (3) Long- Term Corporate Bonds, (4) Common Stocks, and (5) Small Stocks. The classifications we use are those of Ibbotson Associates in their Summary Statistics of Annual Returns, Inflation-Adjusted series. The Ibbotson inflation-adjusted return (real wealth) indices are used to calculate the natural logarithms of one plus the monthly return for each series: ln $(1 + R_t)$ = ln (W_t/W_{t-1}) where R_t is the monthly real return for month t, W_t is the real wealth (total return) index for month t, and W_{t-1} is the real wealth (total return) for month $t - 1$. We use the logarithm of the return ratio for the usual reason that this gives equal weight to gains and losses of the same amount. Ibbotson and Associates construct their inflation-adjusted total return (real wealth) series by dividing the unadjusted indices by the inflation index as follows: $W_t = [I_t/C_t]$ where I_t is the nominal value index, and C_t the index of price level for period t.

We use the Markowitz portfolio model to calculate points along the efficient frontier by maximizing the quadratic objective function

$$\sum_{i-1}^{N} w_i E[r_i] - A \sum_{i-1}^{N} \sum_{j-1}^{N} w_i w_j \hat{\sigma}_{ij} \tag{1}$$

subject to the constraints

$$\sum_{i=1}^{N} w_i = 1\,, \quad w_i \geq 0 \forall i$$

where the r_i, are the natural logarithms of $(1 + R_i)$, w_i, w_j are portfolio weights, and the $\hat{\sigma}_{ij}$ are estimated covariances of the r_i, r_j. This formulation precludes short selling. In the context of institutional investment, short selling is not typically an important consideration, particularly as it is either prohibited or difficult to sell bonds short.[9] The term $\boldsymbol{A}$ is a parameter, the coefficient of risk aversion[10] that imposes a penalty on portfolio variance, $0 \leq \boldsymbol{A} \leq \infty$. A value of $\boldsymbol{A} = 0$ provides the portfolio of maximum return without regard to risk, while an infinite $\boldsymbol{A}$ returns the minimum risk portfolio. Optimization of portfolio weights for a range of $\boldsymbol{A}$ values provides points along the efficient frontier. We use this formulation instead of the one more commonly encountered in textbooks that minimizes risk subject to a set of constraints. The two approaches yield equivalent results. To move from an inefficient point to an efficient point one may move to a higher return for the same risk, or may move to lower risk for the same return.

Maximizing a return objective function that contains a risk penalty allows us to develop results for specific coefficients of risk aversion. This offers the advantage of allowing discussion to directly relate risk to the components of each efficient portfolio when discussing the different portfolio weights obtained in the optimization. With the fast calculation engine available in Excel™ Solver add-in, or in the Quattro Pro™ optimizer, there is little reason to prefer the alternative objective function and constraint system.[11]

The reader may have noticed that we do not follow the usual textbook approach, which assumes the existence of a truly risk-free asset, but in practice takes the T-bill rate as proxy for the risk-free asset, and then fits a tangent line from that rate to the efficient frontier that was determined from stock returns alone. We instead employ an equal opportunity optimization in which T-bills must compete with the other assets under consideration.[12] And we include both government and corporate bonds, not solely common stocks, to better simulate what a portfolio manager would do in practice. In a one-holding-period scenario T-bills are risk-free in the sense that the nominal rate the investor will receive is as certain as any payment can be. But, in a multiple-period scenario the rate is not certain because the T-bill investment must be rolled over, and the rate of inflation is uncertain.

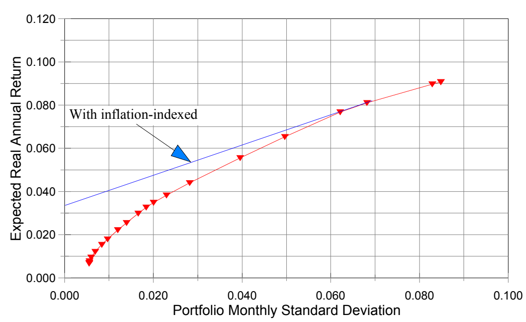
We use logarithms of monthly expected returns, variances and covariances for the optimization. The resulting efficient frontier returns are then converted to normal annual real rates for ease of interpretation. Two sets of optimizations are performed to find paired values of portfolio return and portfolio variance. One set contains the constant dollar asset with the five other assets, the other does not contain the constant dollar asset.

IV. THE 1926-1995 PERIOD

Figure 1 displays a plot of the return-variance pairs for the efficient frontier of portfolios that do not contain the constant dollar asset along with the return-variance set for portfolios that do contain it.

Examination of the graph reveals that portfolios containing the constant dollar asset dominate those that do not, except for high risk portfolios. The constant dollar asset plays the role of risk-free asset, and thus one has a linear combination of the constant dollar asset with portfolios of the other assets that are composed of combinations of large and small stocks. ***The constant-dollar asset dominates T-bills, Intermediate Governments, and Long-Term Corporate bonds.*** From about 8 percent annual rate of return, the overlay follows the efficient frontier of the portfolios that do not contain the constant dollar asset. This is because, for real returns of 8 percent of more, the constant dollar asset is not included in the portfolio holdings, which become 100 percent equity (stock) investments.[13]

Fig. 1: Portfolios 1926-1995



V. THE 1950-1995 PERIOD

Figure 2 contains an overlay of the efficient frontier of portfolios containing the constant dollar asset upon those excluding it for the 1950-1995 period. For this span both are approximately linear, and steeper (return rises faster than variance increases) than the earlier period.

VI. THE 1965-1995 PERIOD

The analysis is repeated for the 1965-1995 period, yielding the results plotted in Figure 3. This is the most recent period of those considered, and thus it should relate more closely to current conditions. For this period both efficient frontiers are approximately linear. This linearity makes possible a simplified analysis.

Fig. 2: Portfolios 1950-1995

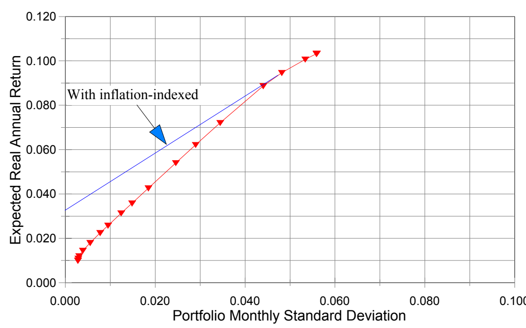
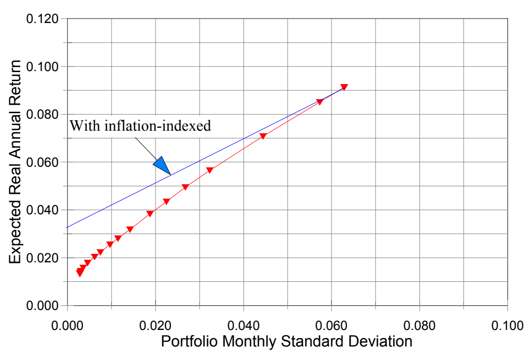


Fig. 3: Portfolios 1965-1995



In the presence of the real return, constant dollar asset, only large and small stocks are included in portfolios. In no case do T-bills, Intermediate Governments, or Long-term Corporates enter the efficient portfolio. It is only in efficient portfolios where there is no constant dollar asset that those traditional instruments are included. In the presence of the constant dollar asset, only those portfolios that are optimal for low aversion to risk (coefficient of risk aversion of less than 0.500) exclude the constant dollar asset.

For 1950-1995 Long-term Corporates are not included in either efficient set. Given the amount of such securities actually included in institutional portfolios this is an interesting result. It raises questions about the traditional management practices of funds that invest in corporate bonds—and that would include most of them. Even in the 1926-1995 period Long-term Corporates are included in the efficient portfolios for only a narrow range of risk aversion coefficients (0.75 to 2.00). We reiterate that it is not our purpose to account for asset prices, but to suggest that investors who take real returns as given should consider the implications of our results.

The 1965-1995 period offers perhaps the most interesting results. In no efficient portfolio are either Long-term Corporates or Large Stocks included. But small stocks are included in all efficient portfolios, whether with or without the real return asset. When the assumed constant dollar asset is available, efficient portfolios for the 1965-1995 period consist exclusively of the constant dollar asset and Small Stocks.

These empirical results suggest some questions. What return would be necessary, given the risk characteristics of Intermediate Governments and Long-term Corporates, for them to be included in the efficient portfolio in place of the inflation-indexed, constant dollar asset? The answer can provide a benchmark for the amount of price premium that the inflation-indexed security could command in the market over those securities. To address this question we concentrate on the 1965-1995 period because it is more recent and thus is more similar to the present economy. Table 2 contains the summary results for Intermediate Governments and Long-term Corporates.

Table 2
Yield premia required for IntGov and LTCorp to
drive RealRtn from efficient portfolio

	Portfolio Weights				Portfolio Weights		
Coef RiskAver = 0.750							
IntGov BasisDif	IntGov	RealRtn	SmStock	LTCorp BasisDif	LTCorp	RealRtn	SmStock
19.25	0.000000	0.216925	0.783075	50	0.000000	0.216925	0.783075
29.25	0.013237	0.204343	0.782421	75	0.054835	0.168523	0.776641
39.25	0.197760	0.028942	0.773298	100	0.240331	0.004792	0.754877
44.25	0.232870	0.000000	0.767130	125	0.279881	0.000000	0.720119
				150	0.314956	0.000000	0.685045
Coef RiskAver = 1.000							
IntGov BasisDif	IntGov	RealRtn	SmStock	LTCorp BasisDif	LTCorp	RealRtn	SmStock
19.25	0.000000	0.412694	0.587306	50	0.000000	0.412694	0.587306
29.25	0.009928	0.403257	0.586816	75	0.041126	0.376393	0.582481
39.25	0.148320	0.271707	0.579973	100	0.180248	0.253594	0.566158
44.25	0.217470	0.205975	0.576555	125	0.319065	0.131065	0.549870
69.25	0.443869	0.000000	0.556131	150	0.457577	0.008804	0.533618
				175	0.491906	0.000000	0.508094

Table 2 (Continued)

Coef RiskAver = 1.500

IntGov BasisDif	IntGov	RealRtn	SmStock	LTCorp BasisDif	LTCorp	RealRtn	SmStock
19.25	0.000000	0.608462	0.391538	50	0.000000	0.608462	0.391538
29.25	0.006618	0.602171	0.391210	75	0.027417	0.584262	0.388321
39.25	0.098880	0.514471	0.386649	100	0.120165	0.502396	0.377438
44.25	0.144980	0.470650	0.384370	125	0.212710	0.420710	0.366580
69.25	0.375177	0.251834	0.372989	150	0.305051	0.339203	0.355746
94.25	0.604867	0.033501	0.361633	175	0.397191	0.257874	0.344935
119.25	0.654753	0.000000	0.345247	200	0.489130	0.176722	0.334148
				225	0.580869	0.095747	0.323384
				250	0.672409	0.014948	0.312643
				275	0.703475	0.000000	0.296525

Coef RiskAver = 2.500

IntGov BasisDif	IntGov	RealRtn	SmStock	LTCorp BasisDif	LTCorp	RealRtn	SmStock
19.25	0.000000	0.765077	0.234923	50	0.000000	0.765078	0.234923
29.25	0.003971	0.761303	0.234726	75	0.016451	0.750557	0.232992
39.25	0.059328	0.708683	0.231989	100	0.072100	0.701438	0.226463
44.25	0.086988	0.682390	0.230622	125	0.127626	0.652426	0.219948
69.25	0.225106	0.551101	0.223793	150	0.183031	0.603522	0.213447
94.25	0.362920	0.420100	0.216980	175	0.238315	0.554724	0.206961
119.25	0.500431	0.289388	0.210181	200	0.293478	0.506033	0.200489
144.25	0.637641	0.158962	0.203398	225	0.348522	0.457448	0.194030
169.25	0.774550	0.028821	0.196629	250	0.403445	0.408969	0.187586
194.25	0.812896	0.000000	0.187104	275	0.458250	0.360594	0.181156
				300	0.512937	0.312324	0.174739
				325	0.567506	0.264158	0.168337
				350	0.621958	0.216095	0.161948
				375	0.676293	0.168135	0.155573

Coef RiskAver = 5.000

IntGov BasisDif	IntGov	RealRtn	SmStock	LTCorp BasisDif	LTCorp	RealRtn	SmStock
19.25	0.000000	0.765077	0.234923	75	0.000000	0.882539	0.117461
29.25	0.003971	0.761303	0.234726	125	0.063813	0.826213	0.109974
39.25	0.059328	0.708683	0.231989	175	0.119157	0.777363	0.103480
44.25	0.086988	0.682390	0.230622	225	0.174261	0.728724	0.097015
69.25	0.225106	0.551101	0.223793	275	0.229125	0.680297	0.090578
94.25	0.362920	0.420100	0.216980	325	0.283753	0.632079	0.084168
119.25	0.500431	0.289388	0.210181	375	0.338146	0.584068	0.077786
144.25	0.637641	0.158962	0.203398	425	0.392307	0.536262	0.071432
				475	0.446237	0.488659	0.065104
				525	0.499939	0.441258	0.058803
				575	0.553415	0.394057	0.052529
				625	0.606666	0.347054	0.046281

Figures 4 through 6 show efficient frontier composition when the return on IntGov (Intermediate Term Governments) is varied to determine at what return these enter the efficient portfolio and at what return they drive the constant dollar asset from the portfolio. The bonds are not free of variation in return and thus they are not free of risk. Therefore, for them to enter the efficient portfolio they will have to offer a superior risk:return combination. We consider a range of risk, with the coefficient of risk aversion at 0.75, 1.00, 1.50, 2.50, and 5.00 (note that we plot only three of these). The lowest value is 0.75 because that is the coefficient for which an asset other than SmlStocks (Small Stocks) enters the efficient set. A value of 5.00 represents a high degree of risk aversion, one in which variance imposes a penalty in the optimization that is five times the positive weighting of expected return.

It is noteworthy that for every level of risk aversion we consider Intermediate Government Bonds must yield an annual return premium of more than 29 basis points over the constant dollar asset to enter the efficient portfolio in any amount. In the case of low risk aversion, 0.75, the inflation indexed security (RealRtn) is driven out of the portfolio at a real yield differential of between 39.25 and 44.25 basis points. But when we examine the situation for high aversion to risk (5.00) even at a real yield differential of 144.25 basis points, almost 16 percent of the portfolio remains in the indexed security.

Fig. 4: IntGov vs RealRtn Tradeoff

1965-95, CRA = 0.75

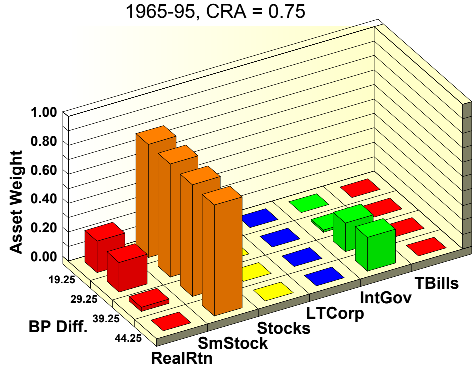


Fig. 5: IntGov vs RealRtn Tradeoff
1965-95, CRA = 1.50

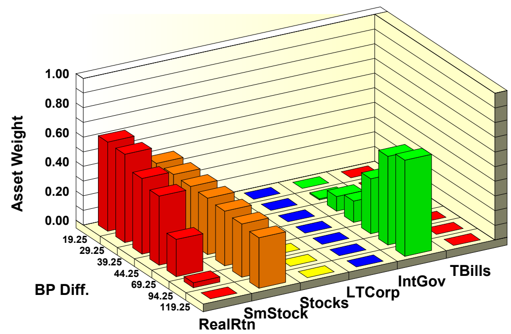
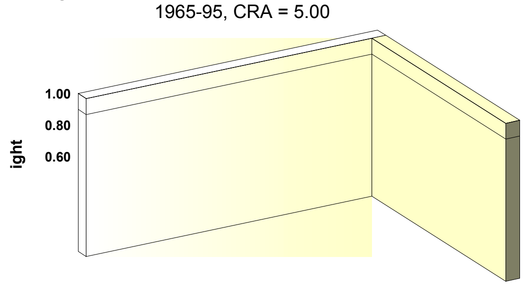


Fig. 6: IntGov vs RealRtn Tradeoff
1965-95, CRA = 5.00



Figures 7 through 9 display efficient frontier composition when the return on LTCorp (Long Term Corporate bonds) is varied to determine at what return these enter the efficient portfolio and at what return, if any, they drive the constant dollar asset from the portfolio. Over the range of risk aversion considered, a real yield differential of at least 75 basis points over the constant dollar asset is required before the LTCorp asset enters the efficient set. In the case of great risk aversion (5.00) it takes between 75 and 125 basis points differential before LTCorp enters the portfolio.

For low aversion to risk (0.75) LTCorp drives the constant dollar asset out of the portfolio at a basis point differential of 125. For moderate risk aversion (1.00 to 1.50) LTCorp drives the indexed security out at yield differentials of 175 and 275 points, respectively. For high coefficients of risk aversion— 2.50 to 5.00—the constant dollar asset is not driven below 16.8

percent or 34.7 percent even at real yield differentials of 375 or 625 basis points. A real yield differential of these amounts is hard to imagine, even in extreme states of the economy.

Fig. 7: LTCorp vs RealRtn Tradeoff
1965-95, CRA = 0.75

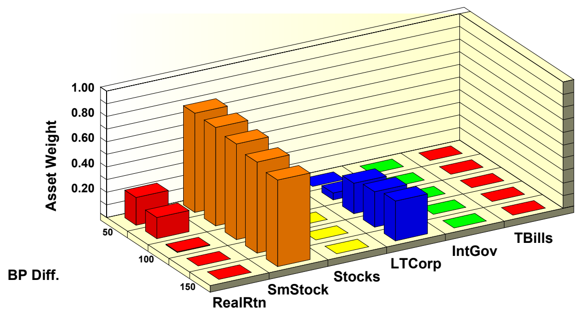


Fig. 8: LTCorp vs RealRtn Tradeoff
1965-95, CRA = 1.50

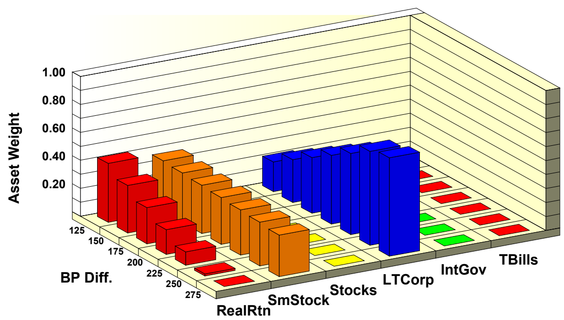
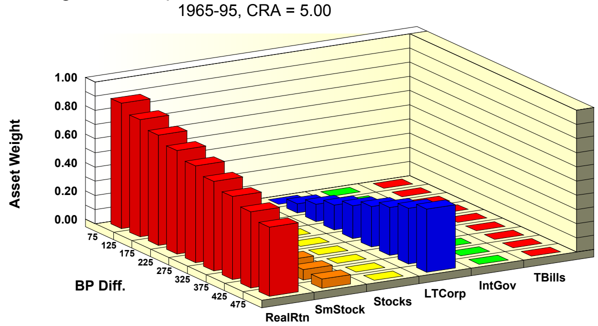


Fig. 9: LTCorp vs RealRtn Tradeoff
1965-95, CRA = 5.00



From the above results, it seems clear that an indexed constant dollar security yielding a certain 3.25 percent per annum real return should play a part in virtually all portfolios, and the role will be greater as aversion to risk increases. In those cases where aversion to risk is low to moderate, historical data suggest that Intermediate Term Government bonds and Long Term Corporate bonds are unlikely to yield more than common stocks, either large or small. Therefore, it is unlikely that either bond will figure prominently in portfolios when asset managers are free to choose constant dollar assets instead. We predict that, when investors become aware of the advantages of indexed assets, it is likely that portfolio management practices will change significantly, or that the real yields on TIPS will fall as investors seek them in preference to traditional instruments. Given the large yield differentials traditional instruments would have to offer to be competitive with inflation indexed securities we believe a decline in real yields on TIPS to be the more likely scenario.

VII. LIQUIDITY CONCERNS

There may be questions about the liquidity of inflation-indexed securities. If a liquid market does not exist, how long will it take for one to develop? Such questions require us to look into the future, yet it is not possible to gauge the likelihood of a liquid market except through experience.[14] Therefore, Table 3 may be indicative.

Table 3
Size and liquidity of selected indexed government bond markets

	Australia	Canada	Israel	New Zealand	Sweden	UK
Outstanding ($ billions)	2.3	3.8	25.1	0.006	3.6	56.8
Outstanding (% of market-able debt)	3.8%	1.2%	86%	<1%	3.2%	15.3%
Average daily turnover 1994 ($ millions)	21.9	16.6	13.2	small	small	256.2

Source: Bank of England (1995), Appendix B. (Cited in Campbell, John Y. and Robert J. Shiller, "A Scorecard for Indexed Government Debt," in a paper prepared for the NBER Macroeconomics Annual Conference, March 8-9, 1996.)

In Israel, a small economy long afflicted with high inflation, inflation-indexed securities account for 86 percent of outstanding debt, with a modest daily turnover. In the U.K., arguably more similar to the U.S., such securities account for 15.3 percent of outstanding debt, with £256.2 million in daily turnover, or some 0.45 percent daily turnover of the amount outstanding. If predictions must be made, then we suggest that the U.S. experience will follow that of the U.K. and liquidity will be adequate.

VIII. WHAT IF INFLATION ADJUSTMENT IS DELAYED?

The above portfolio analysis was repeated for the 1965-1995 period assuming the inflation adjustment was lagged by one, two or three months.[15] The results with each lag are efficient frontiers that are simple linear combinations of small stocks and the real-return security offering a constant, inflation-adjusted return. (The results are not displayed here, but will be sent via e-mail to those who request them of the authors, in Quattro Pro or Excel spreadsheet form.)

IX. CONCLUSIONS

Based on advantages suggested from analysis using historical returns data, an inflation-indexed, real-return asset like TIPS should replace the traditional Treasury bill as the notional risk-free asset. This raises questions concerning traditional portfolio management practices, the future form and yields of non-indexed securities, and the yields non-indexed securities will have to offer to be included in institutional portfolios. Our analysis suggests that either the real yields of indexed securities will decline, or the real returns of non-indexed securities will rise, or some combination of these, because the current real yield on TIPS is not in equilibrium vis-à-vis historical real yields on non-indexed securities.

Analysis of the periods 1926-1995, 1950-1995, and 1965-1995 was performed under Markowitz portfolio optimization to find asset weights along the efficient frontier. When a perfectly indexed constant dollar security is available, the remarkable result is that Treasury bills, Intermediate Term Government (IntGov) bonds, and Long-Term Corporate (LTCorp) bonds are not included in most efficient portfolios. This is paradoxical because the latter two securities figure prominently in most institutional portfolios today. Our analysis reveals that, in the presence of the constant dollar security with real yields at current levels, a sizeable interest premium would be necessary for these two securities to enter the efficient portfolio.

For IntGov to enter the efficient set a ***real*** yield premium of more than 29 basis points is required for all levels of risk aversion we considered. For a low level of risk aversion the IntGov security does not drive the constant dollar asset from the efficient portfolio until the basis point differential is in the range of 39 to 44. But when risk aversion is high, even a real yield differential of 144 basis points only reduces the constant dollar asset to 16 percent of the portfolio.

With LTCorp, it takes a real yield differential of 75 basis points to enter the efficient portfolio. At a low level of risk aversion a yield difference of 125 basis points is required for LTCorp to drive the constant dollar asset from the portfolio entirely. For moderate risk aversion LTCorp needs 175 to 275 basis points real premium to do so. And for high risk aversion the constant dollar asset remains at 16.8 and 34.7 percent of the efficient portfolio even at real yield premiums of 375 and 625 basis points respectively.

The experience of countries that have a relatively long history of inflation-indexed securities, such as Israel and the U.K., suggests that these securities have the potential to become significant in the U.S. financial market. In the U.K., after about fifteen years of inflation-indexed gilts, the liquidity is such that approximately half a percent of the outstanding total turns over daily. And, it seems likely that continued acceptance and growth of U.S. indexed Treasuries will lead to eventual issuance of inflation-indexed corporate securities.

In conclusion, we suggest that money managers consider whether they can re-engineer their portfolios to include inflation-indexed securities. Corporate treasurers should consider whether it is preferable to offer the real yield premium that may be required for continued acceptance of ordinary non-indexed securities, or to offer their own indexed securities.

FOOTNOTES

1. Those who advocate gold as an inflation hedge notwithstanding, precious metals are, at best, an imperfect substitute for inflation-indexed securities. See A.F. Herbst (1983, 1985).
2. In the U.K. there is an 8-month lag in the inflation adjustment.
3. In the U.S. the increment to principal that adjusts for the effects of inflation is subject to income tax as it accrues. Thus, in portfolios that are not tax sheltered, the holder incurs a tax on phantom income for which there is no cash flow until maturity of the instrument. The tax on phantom income is not limited to inflation-adjusted securities. The inflation component of the return on all debt securities is phantom income that is taxable under current tax code.
4. For details of the issue and federal income tax treatment the F*ederal Register* (1997).
5. PSA The Bond Market Trade Association (1996).
6. Campbell and Shiller (1996) state that there were clear signs in the late 1970s and early 1980s that private indexation schemes were getting started.

They cite the 1979 inflation-adjusted mortgages of the Timbers Corporation, a New York real estate development company, and the Utah State Retirement System inflation-indexed mortgage program launched in 1982.

7. Campbell and Shiller (1996) call this a tax subsidy. We suggest that the word subsidy may be somewhat misleading because it is only relief from a tax liability that results from flawed tax law. In relative terms it may be a subsidy vis-à-vis other income sources, but in absolute terms it is not.
8. This is somewhat less than TIPS have yielded since their inception, a rate closer to 3.625 on average.
9. In a sense, if corporations were to issue inflation-indexed bonds, that would be tantamount, in an M&M sense, to stockholders issuing their own indexed bonds. In this paper we take a narrow, purely investor view point. We are not attempting, *a la* CAPM, to determine relative returns. We are taking asset prices and returns as given.
10. See Mao (1969), pp. 281-7.
11. Testing suggests both Excel 97 and Quattro Pro 8 use the same optimizer.
12. The inflation-indexed security provides a better proxy for the ideal risk-free asset, and thus better approximates the textbook assumption.
13. We are abstracting from this consideration, but under the CAPM for real rates above this rate of return, investors would prefer to issue their own indexed bonds, or to buy the leveraged stocks of corporations that issue these bonds on their behalf.
14. Currently, according to *The Wall Street Journal*, indexed Treasury notes and bonds have a bid-asked spread of about 1/32 per 100 of face value. This suggests there may already be good liquidity for these issues.
15. U.K. bonds are adjusted with an eight-month lag, but the U.S. TIPS are adjusted monthly. It is assumed that the computerized resources of the U.S. Treasury and the normal reporting of price indices would require at most a three-month lag to perform any adjustments for errors in reporting.

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