THE TRADE-OFF BETWEEN PORTFOLIO RETURNS AND INFLATION-HEDGED ASSET CLASSES: A CASE FOR THE CAISSE DE DÉPÔT ET PLACEMENT DU QUÉBEC

by

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DEDICATION

To the glory of my Lord and Saviour Jesus Christ and to the honour of my wife Mabel, my children Gloria, King and Michael who had to endure my long absence from home.

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All errors, omissions and commissions are however solely my responsibility.

ABSTRACT

Inflation poses a challenge especially for investors, with inflation-indexed future obligations. Investors are therefore constantly in search of asset classes that provide some hedge against the menace of inflation. Thus for this group of investors, their overriding motivation will be the selection of assets that can significantly act as a hedge against unexpected inflation. This notwithstanding, portfolio return is equally important for every investor; the investor will obviously not be willing to have a protection against inflation at a high cost to his portfolio return. It is therefore important to constantly assess the impact on a portfolio from the introduction of one asset or the other.

A typical investor is constantly faced with choices between and among different asset classes. Generally, a higher proportion of equities in a portfolio imply a higher long-term return, at the risk of periodic stock market declines. On the other hand, a higher proportion of fixed-income securities (e.g. short-term investments and bonds) ensure steady income at lower risk, but with expectations of a lower return over the long term.

Inflation poses a challenge especially for investors with long-term horizon and also for those with inflation-indexed future obligations. Investors are therefore constantly in search of asset classes that provide some hedge against the menace of inflation.

Pension funds are typically known to have long investment horizon and therefore consider the impact of inflation on their investments critical for their survival. This is especially so for funds whose benefit payments are adjusted in accordance with the rate of inflation in the economy and funds operating in high inflation economics.

Several studies have been conducted in to the impact on the portfolio from the introduction of inflation-hedged assets. The conclusions of these studies however are mixed, it is still not abundantly clear whether or not, the portfolio suffers a loss in return from the inclusion of these assets or if the gains from the inflation hedge outweigh any loss in returns.

This study seeks to make a contribution to the search for the effect on the portfolio performance from the introduction of these relatively new asset classes.

What constitutes inflation-hedged assets differ among investors but for the purposes of this study, they are defined as; all of those assets which are indexed to inflation and are known to have returns that are positively correlated with inflation. The common examples therefore are:

1. Inflation-indexed Bonds
2. Commodities
3. Real estate

In particular, the study sought:

1. To assess the change in portfolio return for a given level of risk from the inclusion of inflation-hedged instruments.
2. To measure the change in the portfolio risk for a given level of return from the introduction of these new asset classes.

The methodology adopted in this study involved the comparison of returns of a reference portfolio with returns from alternative portfolios which include the inflation-hedged asset elasses. The comparison is done using both historieal and ex ante data; the historical analysis covers the twenty-seven (27) year period from 1976 to 2003.

Thc analysis begins with the reference portfolio which has only equity and nominal bond eombinations; thereafter, the constraint is relaxed to allow for a maximum 10% investment in any of the inflation-hedged assets.

The optimiser was used to determine the maximum return to the portfolio subject to the following constraints:

1. Maximum allocation of up to 100% in equity and nominal bonds.
2. Maximum allocation of up to 10% for each alternative asset class under each scenario.
3. No short-selling is allowed; alloeation is either equal to or greater than zero (0) but not greater than one (1) under each scenario of optimisation.

The efficient frontier which shows the maximum return possible for each risk level for all possible combinations of the assets is graphed the same axis to determine the direction and extent of movement. The corresponding weights of the portfolio are observed to determine their contribution to the new portfolio return.

The tests condueted could validate only Real Estate and RRB returns as being explained by variations in the unexpected inflation rate. Though the variations in the return of commodities could not be explained by changes in the unexpected rate of inflation, its impact on the portfolio returns has been positive especially for very high return expectations.

In general, there was not sufficient evidence to reject the hypothesis that inflation-hedged asset classes increase portfolio returns. The return-to-risk profile improved in each case from the inclusion of each asset elass; though the degree of change differed between periods and between asset classes.

The evidence available supports earlier conclusions reached by Fama and Schwert (1977), Grauer and Hakenson (1995) and most recently by Li Victor (2001).

The results obtained from the analysis leads us to eonclude that:

1. Real estate, Commodities, and real return bonds are positively correlated with unexpected inflation; Real estate had a positive eorrelation as high 0.61, commodities 0.32 and real return bonds 0.46 This relationship was however found to be significant only for Real return Bonds and for Real estate.
2. Variations in the return of real estate and real return bonds ean be explained by changes in the unexpected rate of inflation. The beta coefficient which explained the variation between real estate return and unexpected inflation was 1.4 and a high 2.45 for real return bonds. The R-squared of the regression was approximately 0.37 in both regressions. By implication returns on real estate and RRB investment will inerease by more than a unit rise in inflation; alternatively their returns will fall by more than a unit decrease in the inflation rate.
3. Real estate and real return bonds could therefore be used as hedges in the investment portfolio against unexpeeted inflation especially in periods of rising inflation.
4. Real estate and GSCI are negatively correlated with the traditional asset elasses so can be used to reduce portfolio risk without jeopardising the return to the portfolio. Returns inereased between 80 and 100 basis points from the inclusion of these two asset classes.
5. Real return bonds are a marginal contributor to the portfolio returns, adding just about 10 basis points and in some eases no addition.
6. Nominal bonds continue to make significant contribution to the portfolio returns especially during periods of low and stable price levels.

In the light of the above findings, we make the following recommendations to fund managers and portfolio investors:

1. Real estate and real return bonds can be considered as two assets whose returns vary positively with unexpected inflation, therefore investors who are averse to the risk of inflation may consider a portfolio asset-mix including these assets classes.
2. Equities and nominal bonds are major contributors to the return of a portfolio, it is therefore important that their proportions are not varied to the detriment of overall portfolio returns.
3. Real return bonds should be included in the portfolio with caution, especially for investors with no inflation linked liabilities to match. As seen in this paper, various eombinations of the other asset classes ean offer higher returns for the same level of risk but RRBs have a limited horizon of influence.
4. To the extent that real estate and real return bonds can both be used to hedge against unexpected inflation, it would appear that real estate is a better of the two beeause in addition to its hedging advantage, it could also signifieantly improve the return to the portfolio. The correlation between real estate and unexpeeted inflation is however not as strong as that between real return bonds and inflation.

5. In having to choose between the inflation-hedged asset classes, a proper assessment of the exposure of the liabilities to inflation needs to be made. In most cases it would be preferable for inflation-risk averse investors to combine these asset classes in their optimum portfolio.
6. Commodities are able to improve portfolio returns, even though it was not certain from this study to be an inflation hedge; it could improve portfolio returns. The Commodities index used in this study was the most volatile in both periods and it is important that it be combined with lowly correlated asset classes in order to reduce the overall portfolio risk whilst enhancing returns.

SOMMAIRE

L'inflation pose un défi, particulièrement pour des investisseurs avec des engagements futurs indexés à l'inflation, comme par cxemple des fonds de pension. Les investisscurs sont donc constamment à la recherche dc classes d'aetifs fournissant une certaine protection contre la menacc de l'inflation. Ainsi pour ce groupe d'investisseurs, leur motivation sera le choix de classes d'actifs qui peuvent de manière signifieativc agir à titre de protection contre l'inflation non anticipée. Cependant, le rendement de portefeuille est également important pour l'investisseur ; celui-ei ne sera évidcmment pas disposé à avoir la protection d'inflation si celle-ci affecte considérablement son rendement. Il est donc important d'évaluer l'impact marginal sur un portefeuille de l'introduction d'une elasse d'aetifs.

Un investisseur typique est constamment eonfronté aux choix entre différentes classes d'actifs. Généralement, une proportion plus élevée d'actions ordinaires dans un portefeuille implique une rentabilité plus élevée à long terme, au risque d'une baisse ponetuelle du marché des actions. D'autre part, une proportion plus élevée de titres à revenu fixe (par exemple des investissements à eourt terme et des obligations) assure un revenu régulier à un risque inférieur, mais avec une espérance de rendement inférieure à long terme.

Les fonds de pension possèdent généralement un long horizon d'investissement et considèrent done important l'effet de l'inflation sur leurs investissements. C'est spécialement le cas pour les fonds dont le paiement des bénéfices est ajusté selon le taux d'inflation et également pour des fonds opérant dans des économies où l'inflation est élevée.

Plusieurs études ont été faites coneernant l'impact sur le portefeuille de l'introduction des classes d'actifs protégeant contre l'inflation. Les conelusions de ces études sont cependant mitigées, elles ne sont pas claires à savoir si le portefeuille souffre une perte de rendement dû à l'inclusion de cette classe d'actifs ou si les gains découlant de la protection contre inflation sont supérieurs au rendement sacrifié du portefeuille.

Cette étude cherche à apporter une contribution à la recherehe de l'effet sur le portefeuille suite à l'introduction de ces classes d'actifs relativement nouvelles.

La définition des actifs protégeant contre l'inflation diffère selon les investisseurs mais pour les fins de cette étude, ils sont définis comme étant toute classe d'actifs dont le rendement est indexé à l'inflation ou étant reconnue pour avoir des rendements positivement corrélés avee l'inflation. Des exemples sont :

1. Les obligations à rendement réel (ORR)
2. Les matières premières
3. L'immobilier

En particulier, l'étude cherehe à :

1. Evaluer le changement marginal au niveau du rendement d'un portefeuille pour un niveau fixé de risque suite à l'introduction des instruments protégeant contre l'inflation.
2. Mesurer le changement au niveau du risque d'un portefeuille pour un niveau fixé de rendement suite à l'introduetion de ces nouvelles classes d'actifs.

La méthodologie adoptée dans cette étude consiste à faire une comparaison des rendements d'un portefeuille de référence avec les rendements de portefeuilles alternatifs incluant les classes d'actifs protégeant contre l'inflation. La comparaison se fait en utilisant des données historiques et des prévisions. L'analyse historique couvre les vingt-sept (27) années de 1976 à 2003.

L'analyse commence par le portefeuille de référence qui consiste seulement en une combinaison d'aetions et d'obligations. Ensuite, la contrainte est relaxée pour tenir compte d'un investissement maximum de 10% dans n'importe lequel des actifs protégeant contre l'inflation. Un proeessus d'optimisation est utilisé afin de déterminer le rendement maximum du portefeuille sujet aux contraintes suivantes :

1. Allocation maximum jusqu'à 100% d'aetions et d'obligations.
2. Allocation maximum jusqu'à 10% pour ehaque classe alternative d'actifs.
3. Aueune vente à déeouvert n'est permise (l'allocation est supérieure ou égale à zéro (0) mais inférieur à un (1)).

La frontière efficiente est représentée graphiquement sur un seul axe pour mieux constater la direction et l'ampleur des changements de pondération. On observe les poids eorrespondants du portefeuille pour déterminer leur eontribution au nouveau rendement du portefeuille.

Selon les tests effectués, seulement les rendements de l'immobilier et des ORR sont significativement expliqués par des variations du taux d'inflation non antieipée. Même si les variations de rendements des matières premières n'ont pas pu être expliquées par des changements du taux d'inflation non anticipée, leur impact sur les rendements du portefeuille a été positive particulièrement pour des rendements très élevés.

Il était impossible de rejeter l'hypothèse selon laquelle les classes d'actifs protégeant contre l'inflation augmentent les rendements du portefeuille. Le profil de rendement pour un risque fixé s'est amélioré suite à l'inclusion des nouvelles classes d'actifs; bien que l'amplitude des variations ait différé entre les périodes et entre les classes d'actifs.

Les résultats des tests soutiennent les conclusions des études de Fama et Selwert (1977), Grauer et Hakenson (1995), et plus récemment de Li (2001).

Les résultats obtenus à partir de l'analyse permettent de eonclure que :

1. L'immobilier, les matières premières et les ORR sont positivement eorrélés avec l'inflation non anticipée; l'immobilier possède une corrélation positive de 61%, les matières premières de 32% et les ORR de 46%. Ces corrélations sont significatives uniquement pour les ORR et l'immobilier.
2. Les variations du rendement immobilier et des ORR peuvent être signifieativement expliquées par l'inflation non anticipée. Le coefficient bêta expliquant la relation entre l'immobilier et l'inflation non anticipée est 1.4 et de 2.45 pour les ORR, ce qui signifie que les rendements immobilier et des ORR augmentent (diminuent) plus que proportionnellement à une hausse (baisse) de l'inflation. Le pouvoir explicatif de la régression (R^2) était approximativement 37% dans les deux cas.
3. L'immobilier et les ORR peuvent donc être employés comme proteetion eontre l'inflation non anticipée, particulièrement dans des périodes où l'inflation est en hausse.
4. L'immobilier et les matières premières sont négativement eorrélés avec les elasses d'actifs traditionnelles, ainsi elles peuvent être employées pour réduire le risque de portefeuille sans compromettre son rendement. Les rendements ont augmenté entre 80 et 100 points de base suite à l'inclusion de ces deux classes d'actifs.
5. Les ORR contribuent marginalement aux rendements du portefeuille, n'ajoutant seulement que environ 10 points de base au maximum.
6. Les obligations nominales contribuent significativement aux rendements du portefeuille partieulièrement lors des périodes de faible inflation.

Les résultats de la présente étude permettent de faire les reeommandations suivantes aux gestionnaires de fonds et aux investisseurs :

1. L'immobiliers et les ORR peuvent être eonsidérés comme deux classes d'aetifs étant significativement et positivement corrélés avec l'inflation non anticipée, done les investisseurs averses au risque d'inflation peuvent considérer un portefeuille eomprenant ces classes d'actifs.
2. Les actions et obligations nominales constituent les classes d'aetifs du portefeuille, surtout dans les périodes de faible inflation; il est done important que leurs pondérations demeurent relativement inchangées afin de ne pas nuire au rendement du portefeuille.
3. Les ORR devraient être incluses dans le portefeuille avee prudenee, particulièrement pour des investisseurs sans des passifs liés à inflation. La présente étude démontre que des eombinaisons des autres classes d'actifs (c'est-à-dire excluant les ORR) peuvent offrir des rendements plus élevés pour le même niveau du risque. Les ORR possèdent donc un pouvoir limité d'influence sur le rendemcnt d'un portefeuille.

4. Si un ehoix devait être fait entre l'immobilier et les ORR, il est évident que l'immobilier offre une contribution plus optimale que les ORR, puisque en plus de son avantage de protection, l'immobilier peut améliorer significativement le rendement du portefeuille.
5. Avant de choisir entre les classes d'aetifs protégeant contre l'inflation, une évaluation appropriée de l'exposition des passifs à l'inflation doit être faite. Dans la plupart des cas, il serait préférable que les investisseurs combinent ces classes d'actifs dans leur portefeuille optimum.
6. Les matières premières peuvent améliorer les rendemcnts de portefeuille, quoique les résultats de cette étude ne démontrent pas clairement qu'ellcs offrent une protection contre l'inflation. Elles pourraient améliorer le rendement d'un portefeuille. L'indice des matières premières utilisé dans cette étude était le plus volatile lors des deux périodes, et il est important qu'il soit combiné avec les classes d'actifs peu corrélées afin de réduire lc risque du portefeuille global tout en augmentant le rendement.

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1. INTRODUCTION & BACKGROUND OF STUDY

1.1 INTRODUCTION

Investing requires a ehain of eonsiderations and actions by the investor; the development of investment objectives, investment policy, investment portfolio, the measurement of returns and associated risks. Each of these proeesses is dynamic and requires constant updating of information and consequent review of earlier positions.

The theory of finance teaches that higher return assets are usually also assets with relatively higher risk, therefore investors seeking higher returns need to look out for risky assets. The further an investor moves away from risky assets, the more likely it is that he would be settling for lower returns.

Portfolio theory on the other hand extends the above maxim by demonstrating that an investor could significantly reduce the overall risk of his portfolio without jeopardising his overall rate of return significantly. To do this suceessfully however, the investor must select assets with imperfect eorrelation and combine them in proportions that will yield the optimal portfolio.

Asset class selection therefore emerges as a very important function in the investment process; it has to be based on a fundamental understanding of the risk and potential reward of eaeh investment, all from a long-term perspective.

A portfolio is a set of various investments, whieh an investor ereates in order to minimise risks connected with investing and also to find the best possible proportion between risks and returns. Sinee the investor is risk averse, he will create a portfolio with the aim of achieving the largest return for minimum risk.

The expected yield of a portfolio is the weighted average of the expected returns of assets in the portfolio; where the weights are the proportions of individual investments in the portfolio.

Evidently, the return on a portfolio is as much a function of the assets selected as their mix in the portfolio.

A typical investor is therefore constantly faced with choices between and among different asset classes. The commonly known asset classes include the following:

- Cash
- Bonds
- Equities
- Private equity
- Real estate
- Commodities
- Hedge Funds

An investor is expected to establish the expected return (growth) and the potential risk associated with each asset before making a decision on its inclusion or otherwise in his portfolio. There are generally accepted risk-return characteristics associated with the above asset classes even though the degree will differ depending on the character of the elements forming the asset class.

The addition or subtraction of an asset class cannot be done without due regard to its marginal contribution to risk and return of the overall portfolio. It is against this background that the subject of portfolio selection has received and will continue to attract a lot of discussion among investment professionals and practitioners.

1.2 INVESTMENT AND INFLATION

Investing usually involves a time horizon which is the period between the placement of the funds and the realisation of the investment; in some cases this time is very short and insignificant, in other cases, the time horizon is so long that it cannot be ignored in the investment decision making process.

Pension funds are typically known to have long investment horizon and therefore eonsider the impact of inflation on their investments critical for their survival. This is cspecially so for funds whose benefit payments are adjusted in accordance with the rate of inflation in the economy.

Inflation is defined as a sustained increase in the general level of prices of goods and serviccs. When investors postpone consumption, they are very much concerned about the value of their future earnings; they would rather protect their purchasing power than to have it eroded by inflation.

The diffcrence between an investment asset denominatcd in nominal terms and a similar asset denominated in real terms, is supposed to equal the implicd (expected) rate of inflation in the economy over the given period. Invcstors who accept to invest in assets whose cash flows are not linked to any inflation index may be said to be betting on two issues:

1. They have succcssfully estimated the expected inflation and priced it in thcir investments and or,
2. They believe the implied inflation will be equal or less than the actual (realised) inflation over the period.

Thus whilst an indexcd bond offers protection to its holders against positive unexpected inflation, holders of the conventional bond have no such protection. In fact, holders of long-term nominal seeurities will suffer an erosion of purchasing power when inflation exceeds expeetations. On the other hand, they will achieve some gains in their portfolio if realised inflation turns out lower than was expected. Evidently there is an inflation risk from holding assets which do not offer any hedge against unanticipated inflation.

Several studies have been conducted to provide evidence that the rational investor will demand a reward for bearing the risk of unexpeeted inflation, known as the inflation risk premium. Further, because inflation uncertainty generally increases with maturity, the inflation risk premium is expected to be higher for longer maturity assets.

Thus if long-term investors such as Pension funds shy away from assets that provide no hedge against inflation, they may also be loosing some returns.

Indexed linked bonds are not the only alternative investments that are attracting the interest of investors in search of protection against inflation, real estate and commodities have also gained importance in the portfolio of many investors recently. This is mainly because these asset classes have been identified as major sources of portfolio diversification and in addition provide protection against inflation.

Inflation poses a challenge especially for investors, with inflation-indexed future obligations. Investors are therefore constantly in search of asset classes that provide some hedge against the menace of inflation. Thus for this group of investors, their overriding motivation will be the selection of assets that can significantly act as a hedge against unexpeeted inflation. This notwithstanding, portfolio return is equally important for every investor; the investor will obviously not be willing to have a protection against inflation at a high cost to his portfolio return. It is therefore important to constantly assess the impact on a portfolio from the introduction of one asset or the other.

1.3 THE CAISSE DE DÉPÔT ET PLACEMENT DU QUÉBEC

The Caisse de dépôt et placement du Québec (Caisse), Canada, is the largest institutional investor in Canada. It has under management nineteen (19) institutions made up mainly of pension and other type of insurance funds. These institutions described as Depositors by the Caisse collect contributions and premiums from their members towards their future security; the monies collected are deposited with the Caisse whose duty it is to invest the funds in accordance with the investment policy of the particular client. As at December 31, 2003, the Company had a net asset base of 89.4 billion Canadian Dollars under management.

The Caisse provides several services to her clients; these inelude:

1. Advisory serviees during the development or review of the depositor's investment policy.
2. Periodieal provision of risk and return forecasts for each asset class to the depositor.
3. Conducting risk and return simulations based on the various asset allocations.
4. Preparation of studies and presentations on subjects and issues related to the depositor's investment poliey, such as the possibility of adding new asset classes.
5. Design of produets adapted to its depositors' needs
6. Management of depositors' portfolios in accordanee with the defined investment policy of the investor.
7. Reporting to the depositor on the return obtained the souree of the return, the value added or lost in relation to the market and the risk assumed, along with a comparison with other asset managers.

The depositor's investment policy is the result of its own expertise and adviee from the Caisse. It is based on the depositor's needs, time horizon and risk tolerance and is revised at least every three years.

To fulfill their financial obligations, depositors determine a long-term return assumption. On the basis of this assumption and the characteristics of the plan, the Caisse develops various scenarios for asset allocation, i.e. the different weighting of the specialized portfolios (asset elasses) in whieh a depositor plans to invest its holdings. Each seenario reflects not only an expected return but also a level of risk related to market volatility.

Generally, a higher proportion of equities in a portfolio imply a higher long-term return, at the risk of periodic stoek market deelines. On the other hand, a higher proportion of fixed-income securities (e.g. short-term investments and bonds) ensure steady ineome at lower risk, but with expectations of a lower return over the long term.

The Caisse works elosely with the depositor to establish the asset allocation that will offer the best risk-return ratio. Upper and lower limits are defined as a means of monitoring any future

changes to the weighting of each specialized portfolio. The market index associated with each of the specialized portfolios is used to evaluate the return in the light of market developments.

Evidently the Caisse is committed to helping its clients achieve the highest rates of return with the least possible risk on their investments. The choice of an asset allocation policy is the responsibility of the depositor but the Caisse is interested in providing the investor with relevant information that will assist them in arriving at the best decision.

The subject of this study will without doubt be of much significanee to the Caisse and its Clients. This is especially so because some clients of the Caisse have liabilities which are linked to the rate of inflation. Their benefit payments are adjusted when the rate of inflation exeeeds the 3% point up to a cap of 5%. Fund administrators obviously would prefer to match their assets to their liabilities; this neeessitates the search for asset classes that are positively correlated with the rate of inflation.

1.4 STATEMENT OF PROBLEM

Several studies have been conducted in to the impact on the portfolio from the introduction of inflation-hedged assets. The conclusions of these studies however are mixed, it is still not abundantly clear whether or not, the portfolio suffers a loss in return from the inclusion of these assets or if the gains from the inflation hedge outweigh any loss in returns.

What constitutes inflation-hedged assets differ among investors but for the purposes of this study, they are defined as; all of those assets which are indexed to inflation and are known to have returns that are positively correlated with inflation. The common examples therefore are:

1. Inflation-indexed Bonds
2. Commodities
3. Real estate without leverage

The above asset elasses are nevertheless gaining importance in many investment portfolios, the depositors of the Caisse not being an exeeption.

This study is therefore motivated by the above background and the need to make a contribution to the seareh for the effeet on portfolio risk and return from these inflation-hedged asset elasses.

In partieular, the study will seek to:

1. To assess the ehange in portfolio return for a given level of risk from the inelusion of inflation-hedged instruments.
2. To measure the change in the portfolio risk for a given level of return from the introduetion of these new asset elasses.

1.5 STATEMENT OF HYPOTHESIS

Inflation-hedged assets improve the return-to-risk profile of the portfolio

1.6 OBJECTIVES OF THE STUDY

1. To provide a framework to investors in the choice of the optimum portfolio
2. To assist in minimising the loss of return on portfolio if any, from asset selection and mix.
3. To bring out any early warning signals to elients who intend to invest more in the above assets
4. To contribute to the subject of risk-return relationships in portfolio theory.
5. To provide a pragmatic framework for fund managers like the Caisse in its dealings with its clients.
6. To make relevant deductions for the improvement of fund management in the less developed countries like Ghana.

2. LITERATURE REVIEW

2.1 PORTFOLIO THEORY

Portfolio theory provides the framework for all investment activity whether the activity is being done by the informed or uninformed investor. According to theory, all investors face a trade-off between risk and expected return and will shift funds from one asset class to another in order to improve return or reduce risk.

A risky investment portfolio can be characterized by its reward-to-variability ratio. Investors would prefer a high reward-variability ratio, beeause that means higher expeeted returns for any level of risk.

An investor's preferred ehoice among the portfolios on the eapital allocation line will depend on risk aversion. Risk-averse investors will weight their complete portfolios more heavily toward less risky assets such as Treasury bills. Risk-tolerant investors will hold higher proportions of their complete portfolios in the risky asset.

The capital market line is the eapital allocation line that results from using a passive investment strategy that treats a market index portfolio sueh as the Standard & Poor's 500 as the risky asset. Passive strategies are low-cost ways of obtaining well-diversified portfolios with performance close to that of the market as a whole.

The variance of a portfolio is the sum of the contributions of the component asset elass varianees plus terms involving the correlation among the asset elasses

Even if eorrelations are positive, the portfolio standard deviation will be less than the weighted average of the component standard deviations, as long as the assets are not perfectly positively correlated. Thus, portfolio diversification is of value as long as assets are less than perfectly correlated.

The contribution of an asset to portfolio variance depends on its correlation with the other assets in the portfolio, as well as on its own variance. An asset that is perfectly negatively correlated with a portfolio can be used to reduce the portfolio varianee to zero; therefore it can serve as a perfect hedge.

The efficient frontier of risky assets is the graphical representation of the set of portfolios that maximizes portfolio expected return for a given level of portfolio standard deviation. Rational invcstors will choose a portfolio on the efficient frontier.

2.2 INVESTMENT POLICY

Brinson, Hood and Beebower (1986) used historical investment data on U.S. corporate pension plans to determine which investment decisions had the greatest impact on the magnitude of total return and on the risk of a portfolio. Their task was to rank in order of importance the decisions made by investment clients and managers and then to measure the overall importance of these decisions to actual plan performance. Using data from 91 pension plans over a 10-year period beginning from 1974, they ealculated the total return over the 10-year period for each of the 91 portfolios and sought to segregate the effeet of active management and investment policy on the portfolio performance. They observed that, investment policy explains the variability of return and therefore it was important for institutional invcstors to dedieate more resources to the policy allocation decision.

Designing a portfolio usually involves four major steps:

1. deciding which asset class to include and not to include in the portfolio
2. deciding upon the normal, or long-term weights for each of the asset classes allowed in the portfolio
3. strategically altering the investment mix away from normal in an attempt to capture exeess returns from short-term fluctuations in asset elass prices (market timing); and
4. Selccting individual securities within an asset class (security seleetion).

Evidently the first two deeisions above are part of investment policy (strategic decision) whilst the remaining two belong to the domain of investment strategy (tactical deeision).

In another study by Ronald and Dale (1999) on the importance of investment policy in the investment process, they found out that policy explains on average approximately 100% of investment returns. If a manager succeeds in adding value, the percentage explaincd can drop to as low as 85% when risk is not incorporated, and cven to 75% on a risk-adjusted basis. If the manager fails to add value, policy can explain as mueh as 135% of return unadjusted for risk, or 165% risk-adjusted; the difference betwcen these percentagcs and 100% is explained by manager value reduced through timing, selection, and/or costs. In other words, if a manager neither adds nor reduces value, policy explains 100% of performance.

If managers add value, the fraction of return explained by policy decreases, with thc balance explained by the amount of value added. If managers diminish value, policy explains more than 100%, with the balance explained by the amount subtracted.

The above studies, no doubt underscore the importance of investment policy in determining portfolio return. The process of designing, adopting and implementing an investment policy itself can be long and arduous nevertheless essential.

In general the process of devcloping a good investment policy will include the following stages and elements:

- Determination and assessmcnt of investor's objectives.
- Development of investor's investment parameters. These parameters would be very client-specifie and elearly emphasize the elient's risk-return relationship. It would include analyzing risk tolerance, time horizon, liquidity and marketability issues, and asset-class issues.
- Definition of securities investment guidelines. These guidelines must be specific enough to define the boundaries of the playing field for hired fund managers. They must provide clear guidanee so that a money manager knows how to proceed with the portfolio, yet

broad enough so as not to imply that an outside fund manager is using too much discretionary authority.

- The guidelines should specify the types of investments that ean be used. For example, acccss to mutual funds, stocks, bonds and money market accounts may bc allowable, while derivatives, futurcs and commodities may not be. Also, some clients may request a socially responsible investment strategy, such as no investments in alcohol or tobacco stocks.
- Seleetion of money managers; define investment and asset allocation eriteria to determine the types of money managers that should be hired. A watch-list would be ereated, specifying industry-objectivc criteria as to when a manager should be replaccd. Performance benchmarks that may signal time to replace a fund manager.
- Method of monitoring money managers. Define a process for managing the elient's investment results regularly. This would include a detailed review with the client annually, quarterly or monthly.

The end result of an investment policy therefore is the construction of an investment portfolio that corresponds to the policy a review of the poliey in line with new developments and aspirations.

2.3 INVESTMENT PORTFOLIO & INFLATION

The construction of an investmcnt portfolio and the ability of the returns to withstand the impact of inflation have rceeived much attention from financial economists.

There is however hardly a conscnsus on the extent to which one asset or the other affects the overall return of the portfolio.

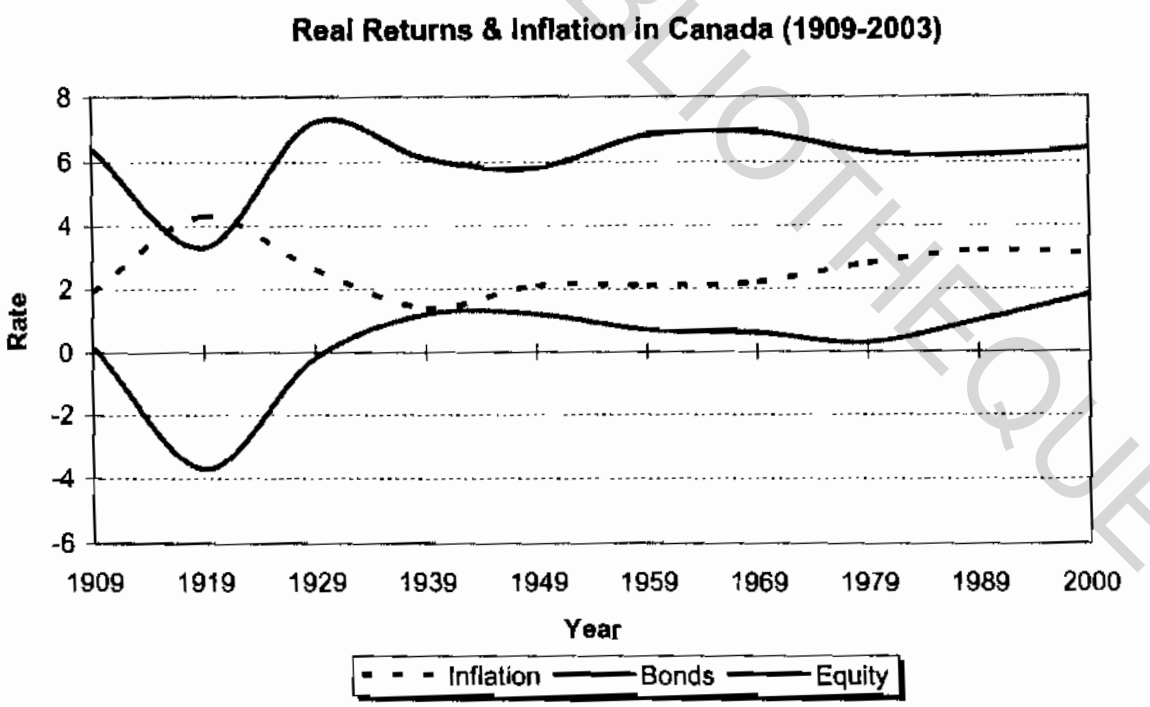
The subjcct of inflation and its impact on the future income of investors has gained much currency in recent timcs because of the abundant evidence that the world economy has since thc last few decades experienced unprecedented inflation.

Inflation indices provide the benchmark needed to compare purchasing power over time; if inflation were low, this would not matter but from 1900 to 2000, even in the lowest inflation country, consumer prices rose by 2.2% per year.-»Dimson, Marsh and Staunton (2002). In a study conducted on inflation in sixteen countries around the world, the authors came out with revealing insights on the effect of inflation on investment assets. The geometric mean of inflation for the period 1900-2000 ranged from a low 2.2% for Switzerland, to a high 9.1% for Italy. The rate for Canada and the U.K was 3.1% and 4.1% respectively.

Therefore for even short-term assets such as T-Bills, the annualised real return was just 1% for both U.K and U.S investors. For the relatively high inflation countries like Germany, France, Italy, Belgium and Japan, the real return on their bills for the 101 year period from 1900-2000 was negative.

The graph below depicts the trend of real returns on the traditional assets of equity and nominal return bonds in Canada for the 101 year period from 1909 to 2000.

FIGURE 1



Source: *Dimson, Marsh and Staunton (2002).*

Evidently the return on both assets tend to follow an inverse pattern to the inflation rate; periods of rising inflation such as between 1909 and1919 and between 1969 and 1979 have been marked by declines in the real value of returns with bond returns suffering the most decline. On the average, bonds lost nearly 64% of their nominal return compared to 34% decline for the equity investment within the 101 year period. Dimson, Marsh & Staunton, (2002).

In the light of these observations, and the fear that future trends for global inflation will in fact continue to be on the upward, a deep search has began for investments that could provide a hedge against inflation.

There is however a school of thought which believes that inflation is not all together a waster of returns but could also be a souree of additional return to those who are willing to bear the risk. The purpose of this study is therefore to assess the impact of the relatively new asset classes on the traditional portfolio.

2.4 REAL RETURN BONDS AND THE PORTFOLIO

Real return bonds have their cash flows linked to movements in a specific pricc index, with the aim of providing investors with a means to protect the real value of their savings. The concept of indexation is believed to have been proposed by Alfred Marshall way back in 1886 but it was not until the second half of the twentieth century that indexed bonds gained prominence in financial markets basically in response to the high rates of inflation experienced in a number of countries. Deacon, Derry & Mirfendereski, (2004).

Argentina, Brazil and Mexico were among the first countries to introduce these securities in the 1950s but more recently other countries like the UK (1981), Australia (1985), Canada (1991), Sweden (1994), USA (1997), and France (1998) have also issued inflation linked seeurities.

In spite of their newness on the markct scene, these assets have proved interesting and have as a result attracted much attention especially in comparison to the nominal bonds.

The yield on a nominal bond comprise of three main elements, viz;

1. The real yield required by investors,
2. The average future inflation expected by investors and
3. The unexpeeted inflation risk premium required by investors

Aeeording to Shen (1995) sinee both nominal and real bonds are actively being traded on the financial markets, the nominal and real yields can be observed directly. The difference in the yields of nominal and real bonds, therefore, is simply the sum of expected inflation and the inflation risk premium. E.g. if the real yield for a 10-year inflation-indexed government bond is 3.5%, then it is reasonable to assume that the real yield eomponent in a 10-year nominal government bond is also 3.5%. Therefore if the observed market yield for the 10-year nominal government bond is 6%, then the difference of 2.5% should be the sum of only two components: the expected future inflation and the inflation risk premium. In this regard, if the expected future inflation component can be separated the remaining part of the yield difference will be the inflation risk premium in the nominal bond.

Using data from the U.K nominal and real government bond markets, Shen estimated the inflation risk premium for U.K 10-year nominal gilt to be between 0.7 and 1.4%; for 20-year gilts, the range was between 1 to 1.6%. The conclusion drawn was that a government could save interest expenses by inereasing the proportion of its debt in real bonds; for example if the U.K government were to switch one (1) billion pounds of outstanding debt from nominal 20-year gilts to indexed 20-year gilts, it could save between 10 to 16 million pounds sterling in interest payment annually.

Though Shen's study was not undertaken from the view point of the investor, its conelusion is significant especially because, it provides a fair estimate of the loss in investmcnt income to investors who move away from the purchase of nominal bonds to the purchase of inflation-indexed bonds; the subject of this study.

Teïletche and Nehls-Obégi (March 2001) also undertook a study into inflation-linked bonds and optimum asset allocation. The objective of their study was to determine investor interest in the bonds; they nevertheless eoncluded that investing in inflation-linked bonds leads to more efficient portfolios than those including only conventional bonds.

They demonstrated that the substitution between inflation-linked and conventional bonds allows investors to have portfolios with a better return-to-risk profile. They did so by drawing on data from the three markets of the United States, the United Kingdom and France.

They carried out an optimal allocation on the three markets United Kingdom, United States and France, by drawing on three assets:

1. a stock market asset;
2. an inflation-linked government bond;
3. a non-indexed (conventional) government bond, with a similar maturity to an inflation-linked bond.

Teïletche and Nehls-Obégi found out that although the inflation-linked Gilt has a slightly lower average yield than the conventional Gilt, the volatility of its returns is significantly lower than that of investments in eonventional Gilts: the standard deviation of returns on investment in conventional Gilts was 4.2 against only 3.2 for returns on investment in indexed Gilts. The correlation of returns on investments in Gilts and in equities was 0.3, very elose to that of returns on an investment in inflation-linked Gilt with one in equities.

They next presented the efficient frontiers of portfolios made up of the stock market asset and a bond, first with the conventional bond, then with the inflation-linked bond. They observed again that for all the three markets (UK, USA and France) the efficient frontier of portfolios with the inflation- linked bond was superior to that in which there was no inflation-linked bond. The two portfolios had the same equity/bond weighting, the same return, but the substitution between standard bonds and inflation-linked bonds allowed risk to be lowered. They did not see any loss

in revenue from the introduction in inflation-indexed bonds; in fact they observed a superior performance.

It has been established by many other studies that the narrowness of the market and the relative newness of the inflation-indexed bonds make them relatively less liquid. Investors in the real bonds therefore have to be entieed with liquidity premium to invest in them; the yield on real bonds is therefore unjustifiably high.

Admittedly, the liquidity premium is difficult to measure nevertheless it partially aecounts for the narrow spread in yields between the nominal bond and the real bond. It is doubtful though if the liquidity premium will remain signifieant in the long-run.

2.5 Real Estate and The Portfolio

Several studies have been conducted on the relationship between real estate returns and inflation. The main focus of most of these works has been to demonstrate that real estate investments provided an effective hedge against both expected and unexpected inflation.

Fama and Schwert (1977) tested the inflation hedge ability of residential real estate, Treasury bills, corporate bonds, government bonds, common stocks and labour income. They eoncluded that private residential real estate is a good hedge against both expeeted and unexpected inflation.

Harzell, Hekman and Miles (1987) examined the benefits of including real estate in portfolios and coneluded that commereial real estate does in fact, act as a good hedge against both expected and unexpected inflation.

Rubens, Bond and Webb (1989) also undertook a study to establish the inflation hedging ability of real estate. They used three different types of real estate; residential, commereial and farmland and four types of financial assets both as individual assets and parts of portfolios. They found out

that all three types of real estates are at least partial hedges against inflation. Furthermore, portfolios which include real estate realises an increase in inflation hedge.

Grauer and Hakensson (1995) wrote a paper on the gains from diversifying into real estate. They compared the investment policies and returns for portfolios of stocks and bonds with and without real estate. They concluded that

1. The gains from adding real estate on a passive basis to portfolios of either US or global financial assets were relatively modest.
2. The gains from adding real estate to the universe of US financial assets under an active strategy were rather larger, especially for very risk averse strategies.
3. The gains from adding US real estate to a universe of global financial assets under an active strategy were mixed; although generally favourable for the highly risk averse strategies.

2.6 COMMODITIES AND THE PORTFOLIO

JP Morgan (2004) put up an article which by all purposes promotes the inclusion of commodities in a portfolio for several reasons. They believed that from a strategic perspective, benchmark allocations of funds to commodities have the potential to both enhance returns and reduce portfolio risk. They supported the above assertion by the historical absolute returns on commodity indices which have been higher than that of government bonds and only slightly lower than on equities.

Investment professionals have described commodities as sharing many characteristics of foreign exchange, such as volatility and liquidity, which make them good vehicles for active trading. In addition, there exists a significant positive correlation between currency and commodity markets, since most commodities are priced in dollars this opens up a number of cross-market trading opportunities for commodity investors.

JP Morgan argues that the more compelling strategic role for commodities lies in their insurance value: commodities are amongst the best hedges against geopolitical risk and inflation surprises.

Over the past thirty years, US stocks have posted negative returns in nine years: 1973, 1974, 1977, 1981, 1990, 1994, 2000, 2001 and 2002. All but one of those years (2001) has been aeeompanied by a signifieant rise in oil priees. Given the link between oil priees, inflation, and equity market performance, it is no surprise that commodity indices generated positive returns in all but two of these nine years.

Commodities are known to have provided an effective hedge against unexpected inflation especially in the USA. Since 1990, US inflation has surprised to the upside five times over that period, 1990, 1996, 1999, 2000 and 2002. In each of those years, commodities have generated positive returns. Thus in their opinion, a relatively small allocation to commodities could provide decent portfolio insulation against an inflation shock.

A survey conducted for the Global Investor (2001) on the case for investing in commodities yielded the following responses:

Claydon of the Goldman Saehs Commodities Index said a passive allocation to commodities generates significant, equity-like returns but, more importantly, it produces its highest returns at points when equity and bonds are doing poorly. As well as being negatively correlated, commodity markets are liquid, enabling large investments to be made in a short period of time without significantly moving the market.

Zuagg of Watson Wyatt, Zurich believed that, there is a rapidly growing appetite for altcrnative investments amongst pension funds; interest in commodities is growing fast as part of this trend. Hc does not reeommend commodities as an asset class to improve returns, instead, because it reduces downside risk and acts as a good hedge when everything clse is going down can therefore be seen as a good diversifier.

According to Claydon, there is a convenience yield inherent in a commodity future collateralised investment; which is quite different from physically buying individual commodities.

Claydon indicated that in 2000 the Goldman Sachs Commodities Index (GSCI) was up 49.7%. A 5% allocation of a portfolio added 250 basis points in positive returns to the overall performance of a portfolio; with increasing investor interest in alternative investments, they believe that a separate allocation to commodities as an asset class should be a central consideration.

They were conscious of the risk in investing in the individual commodities, their preference is for investing in index futures or index certificates which they believe is easier to control and a better way to gain exposure.

By investing in individual commodities, the investor runs several risks, most obviously the fact that individually commodities are much more volatile and unpredictable. For example, crude oil sometimes approaches 50% volatility as an individual item. In addition, commodity sectors perform differently depending on the composition of world growth. In this way, factors such as demand in manufacturing or in the emerging markets economies have an impact in terms of which commodity seetors move.

Each commodity has got its own supply and demand characteristics which vary, but diversifieation benefits are one of the main attractions of commodities to pension funds. Investing in collateralised commodity futures rather than individual commodity stocks adds to this diversification as well as aeting as a better hedge too.

Another strong reason in favour of commodities is that they are especially useful as a hedge at the stage of the business cycle when equities are vulnerable to rising interest rates. Traditionally, at such a juncture, the investor would typically move back into cash, but it is precisely during such periods that it is believed commodities generate their best returns. As a result, during those periods, commodities can offset the risks and the losses to the rest of a portfolio. It is believed that Commodities do well when the economy is over heating, while bonds do well when the economy is operating below trend.

Even though so much has been said in favour of commodities in the portfolio, the writers have been cautious in proposing a large asset allocation to commodities. The recommended

proportions have ranged from a low 2% to a maximum of 10%. Evidently, there is an optimum asset alloeation beyond whieh the portfolio suffers, it is therefore important to find out the impact on the portfolio from investing in commodities.

These studies appear to provide the motivation for increased investor interest in these assets, the purpose of this study is therefore to determine the change in portfolio returns if any from the inclusion of these assets in the portfolio. The need to explore the subject appears even more pertinent when viewed from the position that most of the above comment are being made by fund managers like the Goldman Sachs who have a vested interest in the trading of some of these alternative assets.

3. DATA & METHODOLOGY

3.1 DATA DESCRIPTION AND ANALYSIS

The study covered the period from 1976 to 2003; this period is considered significant for most studies on the subject of inflation because it was characterised by relatively high inflation rates in the world economy. The Canadian economy was no exception as exemplified by the historical inflation figures for the period (Appendix A).

The Caisse, praetices passive investment management and therefore invests its funds mainly in indices. Historical returns for these indices were therefore used for the analysis.

The SC Universe is the bond index whieh mirrors the total return performance of the Canadian bond market. The Scotia Capital Universe Bond Index (SC Universe) is eapitalization-weighted, with more than 950 Canadian bonds, and includes high quality bonds with terms-to-maturity of greater than one year.

The SC Universe Bond Index is the hroadest and most widely used measure of Canadian bond market performanee in the world.

The S&P/TSX, S&P 500 and MSCI EAFE were selected for the equity asset class; all three are broad market indices that mirror stock market performance in the world economy.

The Standard and Poor Toronto Stock Exehange (S&P/TSX) Composite Index , is a broad market indicator that represents around 225 of the largest traded companies and gives a snapshot representation of the Canadian Stock market activity.

Standard and Poor (S&P) 500 is widely regarded as the best single gauge of the U.S. equities market, this world-renowned index includes a representative sample of 500 major eompanies in leading industries of the U.S. economy. Although the S&P 500 foeuses on the large-cap segment

of the market, with over 80% coverage of U.S. equities, it is considered an ideal proxy for the total U.S market.

The Morgan Stanley Capital International (MSCI) EAFE Index includes just over 1000 companies representing 21 countries from the stock markets of Europe, Australia and the Far East. The MSCI EAFE index is a widely accepted benchmark of foreign stocks and represents approximately 85% of the total market capitalization in those countries.

Historical Real Estate returns were obtained from the Investment Property Databank (IPD), Russell and Morguard databases which compile indices on the property market of Canada. The index provides historical returns on the composite real estate assets (Retail, Office and Industrial) as well as returns on the individual elements. For this study the composite non-leveraged returns data (return on all categories of investment in properties) was used since the institutional investor will usually hold a real estate portfolio of all the various elements.

The Goldman Sachs Commodity Index (GSCI) which is the selected index for commodity futures contracts was used to gauge the performance of the commodity asset class. The index is heavily weighted in favour of crude oil and therefore its performance is strongly linked to the price fluctuations in the oil market.

The Scotia Capital real return bond (SCRRB) index of Canada was used to determine the performance of inflation-indexed bonds in the portfolio.

Inflation data is the rate of inflation as measured by the changes in the consumer price index (CPI) for Canada.

Except for real estate data, which was obtained from IPD, Russell and Morguard databases, all other data was sourced from the Rimes and Bloomberg databases. Furthermore, while all asset returns were available in monthly figures, real estate data was available only in quarterly and annual figures. It was therefore pertinent to transform all the other returns into quarterly and annual returns for the purpose of consistency and ease of comparison.

We were able to obtain data from 1976 for all the asset classes except for the Real Return Bonds. Real Return bonds were first issued in Canada in 1991; data was therefore available only from 1992. The impact of real return bonds on the reference portfolio could therefore be assessed only after 1992 which comparatively was a period of low inflation.

The total return (income flows and capital appreciation) figures were obtained for each asset class. For all asset returns which were reported in US dollars, the effect of currency movements was eliminated by fully hedging the returns in Canadian dollars.

3.1.1 Unexpected Inflation

Unexpected inflation (X) is defined below as the difference between the observed inflation (**P**) at time **t** and the expected inflation (**Y**) at time t_{-1}. (Computed unexpected inflation data in appendix A.)

$$X_t = P_t - Y_{t-1}$$

Two commonly used proxies in the financial literature as proxy for expected inflation are Consensus data on inflation and the Treasury Bill Yields. For Canada, consensus data was not available from 1976 so it was impractieable to adopt it as a proxy for this study.

The 91-day Treasury bill yields were therefore used as the proxy for the level of expected inflation in Canada for the period 1976 to 2003. Li (2001) had used the three months treasury-bill yields as proxy in Canada for a similar study covering the period 1974 to 1999.

The suitability of the T-Bill yields as a proxy was tested by running a simple linear regression between the observed inflation and Treasury bill rate as in the model below:

$$P_0 = a + bY + e$$

Where P_0 is the observed inflation rate for period T_0, and Y is the yield on the three month Treasury bill in period T_{-1}.

The regression yielded the following result:

$$Y = \underset{(-0.89)}{-0.01} + \underset{(5.64)}{0.67X}$$

The t-statistics are in parenthesis and italics; at 95% confidence level and with 27 observations less one degree of freedom, the t-critical is 2.056. Thus we cannot reject the hypothesis that the intercept is equal to zero but we reject the hypothesis that the coeffieient of X is equal to zero. In testing whether the X coefficient above is equal to one, the t-computed is 2.75 and is significant. The above test therefore leads to the same conelusion as in Fama and Schwert (1977); the three month Treasury bill is a good proxy for expected inflation in Canada for the period 1976 to 2003. The correlation coefficient between observed inflation and expected inflation as measured by T-Bill yields in the model was 0.75 and the R^2 is a relatively high 0.56 suggesting a fairly high explanatory power of the model. On the basis of this, we adopted the yield on the three (3) month Treasury bill as a proxy for expected inflation.

3.2 INFLATION-HEDGE ABILITY OF ASSET CLASSES

In determining the inflation hedge ability of an asset class, the model of Fama and Schwert (1977) was used. In their model they conducted a simple linear regression of the returns of the asset class on expected and unexpected inflation. For an asset to provide hedge against inflation, its return must have a positive relationship with unexpected inflation (X) as defined in the following model.

To this end we carried out a regression of all the assets with expected and unexpected inflation using the model below:

$$R(i) = a + b(X) + g(Y) + e$$

Where: R; is the return on the asset class i

X; is the rate of unexpected inflation and

Y; is the rate of expected inflation.

The coefficient b, provides a fair estimate of the inflation hedge ability of the assets; a negative sign indicates an inverse relationship between the asset's returns and unexpected inflation. When unexpected inflation increases, the return on the asset will decline; such assets will not be a good hedge against the risk of inflation on the contrary, assets with significant positive coefficients could be said to have inflation hedge ability.

Table 1 below summarises the regression results obtained for the test of inflation-hedge ability:

TABLE 1:

REGRESSION STATISTICS: ASSETS ON UNEXPECTED & EXPECTED INFLATION

Period	1	2	1	2	1	2	1	2	1	2
	a		b		g		R^2		SE	
SC Universe	0.02	0.00	-0.95	0.94	0.60	2.62	0.19	0.23	0.07	0.06
t-stat	*0.60*	*-0.03*	*-2.19*	*1.25*	*1.58*	*2.31*				
S&P/TSX	0.17	0.04	1.27	1.75	0.09	2.82	0.06	0.09	0.17	0.17
t-stat	*2.03*	*0.24*	*1.27*	*0.8*	*0.10*	*0.86*				
S&P 500	0.07	0.03	-0.50	1.69	0.70	3.19	0.04	0.08	0.17	0.21
t-stat	*0.86*	*0.18*	*-0.50*	*0.65*	*0.80*	*0.82*				
MSCI EAFE	0.07	-0.02	-0.10	2.12	0.35	3.42	0.01	0.11	0.18	0.19
t-stat	*0.76*	*-0.13*	*-0.09*	*0.88*	*0.36*	*0.94*				
Real Estate	0.11	0.20	1.44	1.12	0.56	-1.84	0.36	0.41	0.06	0.06
t-stat	*3.59*	*4.04*	*3.84*	*1.51*	*1.71*	*-1.66*				
GSCI	0.26	0.24	1.66	3.57	-0.37	0.55	0.06	0.10	0.23	0.31
t-stat	*2.22*	*0.92*	*1.17*	*0.92*	*-0.30*	*0.09*				
RRB		0.05	n/a	2.45	0.81	2.73	0.37	0.30	n/a	0.08
t-stat		*0.69*	n/a	*2.47*	*0.90*	*1.83*				

a = Intereept, b = coefficient for unexpeeted inflation X

g = coefficient for expected inflation Y,

SE = Standard error of the regression.

Period 1 = 1976 to 2003

Period 2 = 1992 to 2003

It can be seen from Table 1 above that, the regression results was statistically significant for Real estate in the first period but not for the second period even though it maintained a positive sign in both periods. Real Return bonds which were available only for the second period (1992 to 2003) posted a statistical significant correlation coefficient with unexpected inflation.

The nominal bond returns (SC Universe) also showed a high negative regression coefficient of b = -0.95 in the first period which was statistically significant; evidence of its inability to protect investors against unexpected inflation. In the second period, the sign of the coefficient changed to positive even though was not significant.

For the other asset classes, the results obtained in both periods could not explain the variation in their returns. Evidently, factors other than the unexpected rate of inflation could be responsible for their behaviour within these periods.

It is important to recall that the mean observed inflation rate in the first period was a high 4.5% compared to a lower rate of 2.0% for the second period. Inflation volatility (table 2) was higher in the first period than in the second period; the results of the regression therefore appear to indicate that variations in real estate returns are better explained by inflation during periods of higher inflation rates than in lower and stable inflation periods.

Table 2, below shows the mean and standard deviations computed for the two historical periods and also the forecast estimates used in the analysis.

TABLE 2:

MEAN & STANDARD DEVIATION OF ASSET CLASSES

Period	Mean			Std Dev.		
	Ex Post		Ex Ante	Ex Post		Ex Ante
	1	2	3	1	2	3
SC Universe	11.0%	9.0%	4.5%	8.0%	6.87%	4.6%
S&P/TSX	12.6%	10.7%	6.8%	16.2%	16.58%	16.7%
S&P 500	15.3%	12.4%	7.3%	16.2%	19.37%	17.8%
MSCI EAFE	10.0%	6.6%	8.0%	17.4%	18.44%	19.7%
Real Estate	10.1%	7.2%	9.0%	7.6%	7.66%	12.9%
GSCI	15.6%	13.6%	6.3%	23.2%	29.35%	12.0%
RRB	n/a	8.8%	4.9%	n/a	9.43%	4.9%
Unexpected Inflation	-3.8%	-3.7%		3.3%	1.22%	
Observed Inflation	4.5%	2.0%		3.3%	2.72%	

It can be seen that the first period (1976 to 2003) is characterised by higher inflation, and higher asset returns than was the case in the second period (1992 to 2003).

TABLE 3:

CORRELATION COEFFICIENTS

CORRELATION MATRIX

1976-2003

	SC Universe	S&P/TSX	S&P 500	MSCI EAFE	Real Estate	GSCI	RRB	Inflation Observed	Unexpected Inflation	Expected Inflation
SC Universe	1.00									
S&P/TSX	-0.01	1.00								
S&P 500	0.40	0.56	1.00							
MSCI EAFE	0.14	0.65	0.64	1.00						
Real Estate	-0.35	-0.01	-0.01	0.15	1.00					
GSCI	-0.18	0.37	-0.05	0.04	-0.04	1.00				
RRB	n/a	n/a	n/a	n/a	n/a	n/a	n/a			
Inflation	0.04	0.15	-0.06	-0.04	0.45	0.13	n/a	1.00		
Unexpected Inflation	-0.42	0.25	-0.12	-0.03	0.58	0.24	n/a	0.41	1.00	
Expected Inflation	0.33	-0.01	0.17	0.07	0.20	-0.09	n/a	0.75	-0.12	1.00

1992-2003

	SC Universe	S&P/TSX	S&P 500	MSCI EAFE	Real Estate	GSCI	RRB	Inflation Observed	Unexpected Inflation	Expected Inflation
SC Universe	1.00									
S&P/TSX	0.17	1.00								
S&P 500	0.26	0.62	1.00							
MSCI EAFE	0.05	0.89	0.76	1.00						
Real Estate	-0.20	-0.15	0.09	-0.04	1.00					
GSCI	-0.11	0.33	-0.12	0.03	-0.05	1.00				
RRB	0.73	0.44	0.13	0.24	-0.09	0.36	1.00			
Inflation	0.18	0.08	-0.34	-0.19	-0.05	0.76	0.66	1.00		
Unexpected Inflation	0.04	0.14	0.09	0.15	0.61	0.32	0.46	0.39	1.00	
Expected Inflation	0.52	0.17	0.19	0.19	-0.63	-0.12	0.19	-0.11	-0.48	1.00

From the correlation matrix above we see a negative correlation between the returns on Real estate, GSCI and the traditional asset classes of equity and nominal bonds; by implication, these assets will be good diversifiers in a mixed-asset portfolio.

It is also significant to note that Real estate and GSCI and RRB returns remained positively correlated with unexpected inflation in both periods even though from the regression analysis unexpected inflation is not a significant explanatory variable for the variation in GSCI and for Real estate returns under low inflation periods.

3.3 PORTFOLIO RISK AND RETURN

For each portfolio, the annual rate of return is defined as:

$$r_p = \sum_{i=1}^{n} w_i \cdot r_i$$

Where rp; is the portfolio expected return.

wi the weight of asset class i in the portfolio

r_i is the rate of return on the asset class

The portfolio risk is given by:

$$\sigma_p = \sqrt{\left(\sum_{i=1}^{n} w_i^2 \sigma_i^2 + 2 \sum_{\substack{j,k=1 \\ j \neq k}}^{n} w_j w_k \mathrm{Cov}(r_j, r_k) \right)}$$

Since real return bond data was available only from 1992, it was thought prudent to phase the analysis from 1976 to 2003 excluding real return bonds; and from 1992 to 2003 including real return bonds.

3.4 METHODOLOGY

The methodology adopted in this study involved the comparison of returns of a reference portfolio with returns from alternative portfolios which include the inflation-hedged asset classes. The comparison is done using both historical and ex ante data; the historical analysis covers the twenty-seven (27) year period from 1976 to 2003.

The analysis begins with the reference portfolio which has only equity and nominal bond combinations; thereafter, the constraint is relaxed to allow for a maximum 10% investment in any of the inflation-hedged assets.

The optimiser was used to determine the maximum return to the portfolio subject to the following constraints:

1. Maximum allocation of up to 100% in equity and nominal bonds.
2. Maximum allocation of up to 10% for each alternative asset class under each scenario.
3. No short-selling is allowed; allocation is either equal to or greater than zero (0) but not greater than one (1) under each scenario of optimisation.

The efficient frontier which shows the maximum return possible for each risk level for all possible combinations of the assets is graphed the same axis to determine the direction and extent of movement. The corresponding weights of the portfolio are observed to determine their contribution to the new portfolio return compared to the reference portfolio for eaeh given level of risk.

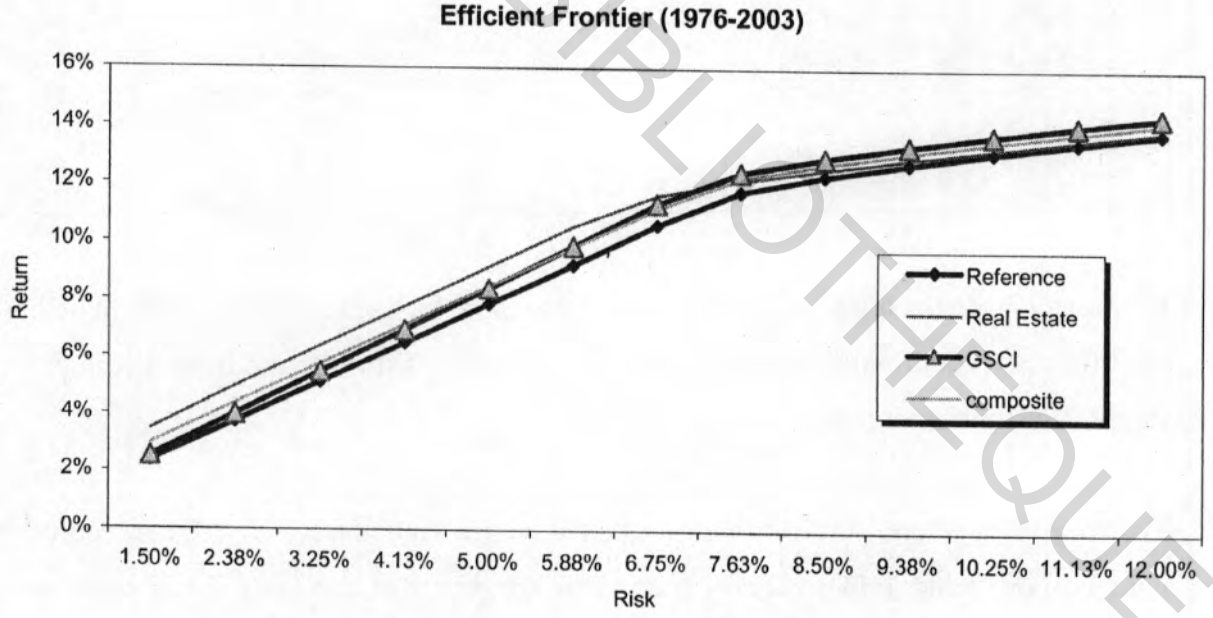
4. THE EFFICIENT PORTFOLIO & THE INFLATION-HEDGED ASSETS

4.1 EFFICIENT PORTFOLIOS (EX-POST)

The next stage in this study was the construction of hypothetical portfolios using the data obtained and the relevant statistics computed. This analysis was carried out in three phases.

In the first stage, we constructed efficient portfolios using the statistics obtained from the period from 1976 to 2003 (excluding RRB); the second phase involved the same analysis but this time, from 1992 to 2003 when data was available for the RRB. In the third stage, we used forecasts from the Policy Research Department of the Caisse to undertake the analysis.

FIGURE 2



The reference portfolio is a combination of only the traditional assets of equity and nominal bonds; for low risk and return rates, the efficient portfolios are dominated by the nominal bonds; but as the proportion of equity increases, the portfolio return increases until the maximum return

is attained at 13.8% with a portfolio of 68% equity and 32% in nominal bonds for the maximum risk level of 12%. This frontier therefore defines the base case scenario facing the investor.

On the assumption that the portfolio asset weights are varied to include a maximum of 10% in Real Estate investment, the efficient frontier is seen to shift outward for every level of expected risk even though the degree of shift diminishes and approaches zero for very high expected return levels.

TABLE 4:
ADDITIONAL RETURN FROM ALTERNATIVE ASSET CLASS (1976-2003).

RISK	REAL ESTATE	COMMODITIES	RRB	COMPOSITE
1.50%	1.1%	0.2%	n/a	0.6%
2.38%	1.2%	0.3%	n/a	0.6%
3.25%	1.3%	0.4%	n/a	0.6%
4.13%	1.3%	0.5%	n/a	0.6%
5.00%	1.3%	0.5%	n/a	0.6%
5.88%	1.3%	0.6%	n/a	0.6%
6.75%	1.0%	0.7%	n/a	0.6%
7.63%	0.4%	0.7%	n/a	0.5%
8.50%	0.2%	0.6%	n/a	0.4%
9.38%	0.2%	0.6%	n/a	0.4%
10.25%	0.1%	0.6%	n/a	0.4%
11.13%	0.1%	0.6%	n/a	0.4%
12.00%	0.1%	0.6%	n/a	0.3%

Real estate made the highest contribution of 1.3% more for each standard deviation below 6.75% thereafter its contribution declined and the portfolio with commodities became the most significant contributor to the reference portfolio.

The maximum return portfolio yields 13.88% with a combination of 70% in equity, 20% in nominal bonds and 10% in Real Estate. This suggests that the portfolio is improved by the inclusion of real estate in the portfolio; this means, in addition to its inflation hedge ability, real estate improves the portfolio return.

When the reference portfolio is varied by the inclusion of commodities, similar results are observed; there is a bodily shift of the frontier outwards, suggesting that for all risk levels, the

is attained at 13.8% with a portfolio of 68% equity and 32% in nominal bonds for the maximum risk level of 12%. This frontier therefore defines the base case scenario facing the investor.

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4.13%	1.3%	0.5%	n/a	0.6%
5.00%	1.3%	0.5%	n/a	0.6%
5.88%	1.3%	0.6%	n/a	0.6%
6.75%	1.0%	0.7%	n/a	0.6%
7.63%	0.4%	0.7%	n/a	0.5%
8.50%	0.2%	0.6%	n/a	0.4%
9.38%	0.2%	0.6%	n/a	0.4%
10.25%	0.1%	0.6%	n/a	0.4%
11.13%	0.1%	0.6%	n/a	0.4%
12.00%	0.1%	0.6%	n/a	0.3%

Real estate made the highest contribution of 1.3% more for each standard deviation below 6.75% thereafter its contribution declined and the portfolio with commodities became the most significant contributor to the reference portfolio.

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When the referenee portfolio is varied by the inclusion of commodities, similar results are observed; there is a bodily shift of the frontier outwards, suggesting that for all risk levels, the

return to the portfolio is enhanced by the inclusion of commodities. The highest return to the portfolio occurs with, 68% in equity, 22% in nominal bonds and 10% in commodities. Maximum portfolio returns is higher at 14.37% compared to 13.8% for the reference and 13.88% for the portfolio with real estate.

The composite portfolio is a combination of real estate and commodities to a maximum of 10% in the portfolio together with the traditional equity and nominal bonds.

As shown in Figure 2 above, the efficient frontier shifts out above the reference portfolio but below the frontier which has only real estate. The maximum portfolio return is 14.14% with a combination of 69% in equity, 21% in nominal bonds and 10% in the alternative assets.

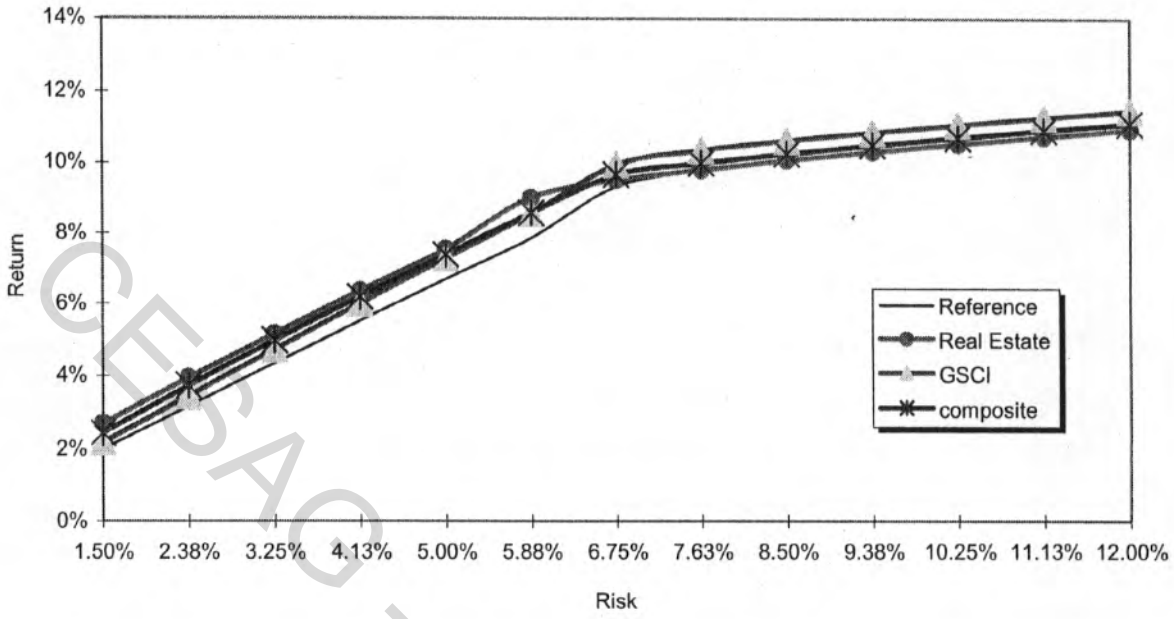
It is significant to note that in all the above seenarios, the proportion of equity has remained above 50% in the asset-mix for higher return/risk points, suggesting that equity is a major contributor to portfolio performanee. The proportion of nominal bonds has had to be redueed to make room for the alternative assets and in each ease, the efficient frontier was enhanced. The trade-off in the asset-mix has in the greater part been between nominal bonds and the alternative assets. Thus to the extent that nominal bonds do not offer protection against inflation, the inelusion of the new asset classes appear to enhance portfolio returns whilst at the same time provide a hedge against unanticipated inflation.

4.2 EFFICIENT PORTFOLIOS EX-POST 1992-2003

The second stage of the study covered the period 1992 to 2003. Comparatively lower returns were reeorded for all the assets within this period (see Table 2) and the average rate of inflation was much lower than the period from 1976 to 2003.

FIGURE 3

Efficient Frontier (1992-2003)



The graph of the efficient frontiers as presented above appear to exhibit similar patterns with the earlier analysis based on the data from 1976 to 2003. It can be seen from the graph that the portfolio with real estate was only above the reference portfolio for lower return and risk levels. In fact for portfolio returns beyond 10%, the efficient portfolio did not contain any real estate; it reverts to the reference efficient frontier. The highest portfolio return was 10.91%, with an asset-mix of 59% equities and 41% nominal bonds, 0% real estate. (Details of weights in Appendix D).

The GSCI index remained a strong contributor to portfolio returns and therefore was retained in the portfolio asset mix. The portfolio including commodities yields the highest return of 11.44% compared to 10.91% for the reference portfolio.

Table 5 below shows the change in returns to the portfolio compared to the reference portfolio at each risk level:

TABLE 5:

ADDITION TO PORTFOLIO RETURNS FROM ASSET CLASS (1992-2003)

RISK	REAL ESTATE	COMMODITIES	RRB	COMPOSITE
1.50%	0.7%	0.2%	0.0%	0.4%
2.38%	0.8%	0.3%	0.0%	0.6%
3.25%	0.8%	0.4%	0.0%	0.6%
4.13%	0.8%	0.5%	0.0%	0.7%
5.00%	0.9%	0.6%	0.0%	0.7%
5.88%	1.1%	0.7%	0.0%	0.7%
6.75%	0.2%	0.6%	0.0%	0.3%
7.63%	0.0%	0.6%	0.0%	0.2%
8.50%	0.0%	0.5%	0.0%	0.2%
9.38%	0.0%	0.5%	0.0%	0.2%
10.25%	0.0%	0.5%	0.0%	0.2%
11.13%	0.0%	0.5%	0.0%	0.2%
12.00%	0.0%	0.5%	0.0%	0.2%

Real return bonds had no positive impact on the reference portfolio, for all risk and return profiles, the portfolio asset mix retained only a combination of equities and conventional bonds as in the reference efficient frontier.

The composite portfolio efficient frontier which could include up to 10% for all the new asset classes together remained above the reference efficient frontier throughout but its contribution was below the contribution of the portfolio with commodities especially for risk levels beyond 6.75%.

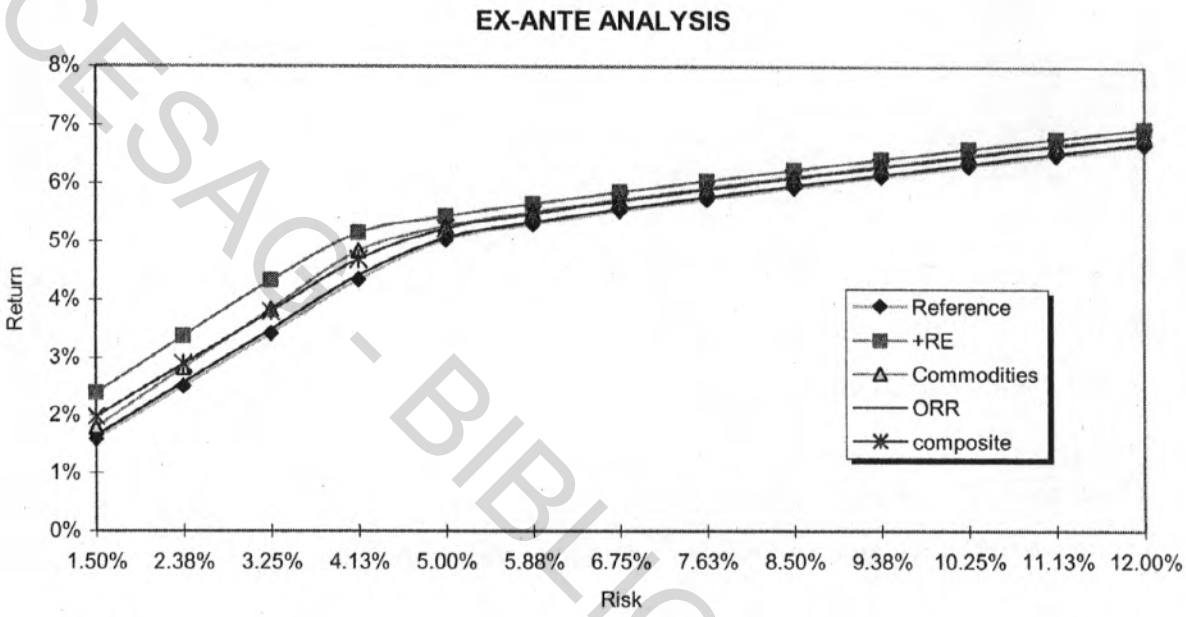
The proportion of nominal bonds in the efficient portfolios was significantly higher than the earlier period studied. Nominal bonds averaged 40% in the portfolio as compared to 30% in the 1976 to 2003 period.

The results of the second phase appears to give credence to the trade-off hypotheses, the optimal portfolio would rather exclude real return bonds than reduce the portfolio returns from the inclusion of the RRB. It appears from the above observation that nominal bonds and equities remain major contributors to portfolio return.

4.3 EFFICIENT PORTFOLIOS EX-ANTE

The third phase of the study was to construct the portfolio using forecasts for the expected risks and return from the asset classes. These estimates were obtained from the Investment Policy Research Department of the Caisse.

FIGURE 4



The graph of efficient frontiers above differs significantly from the earlier ones; unlike the previous scenarios, real return bonds have proven to be a positive contributor to portfolio return in this scenario. The efficient portfolio included the maximum 10% allocation to real return bonds at each level of expected risk.

Table 6 shows the addition in returns to the reference portfolio from the inclusion of each asset class:

TABLE 6:

ADDITION TO RETURN FROM ASSET CLASS

RISK	REAL ESTATE	COMMODITIES	RRB	COMPOSITE
1.50%	0.8%	0.2%	0.1%	0.4%
2.38%	0.9%	0.3%	0.1%	0.4%
3.25%	0.9%	0.4%	0.1%	0.4%
4.13%	0.8%	0.5%	0.1%	0.3%
5.00%	0.4%	0.2%	0.0%	0.2%
5.88%	0.4%	0.2%	0.0%	0.2%
6.75%	0.3%	0.2%	0.0%	0.2%
7.63%	0.3%	0.2%	0.0%	0.2%
8.50%	0.3%	0.2%	0.0%	0.2%
9.38%	0.3%	0.2%	0.0%	0.2%
10.25%	0.3%	0.2%	0.0%	0.2%
11.13%	0.3%	0.2%	0.0%	0.2%
12.00%	0.3%	0.2%	0.0%	0.2%

Significant gains were made to the reference portfolio from the inclusion of Real estate, commodities and the composite index, adding between 20 to 30 basis points more to the reference portfolio at each risk level. Real return bonds made a modest addition of just 10 basis points at the low standard deviations and no contribution for higher standard deviations.

For the low risk portfolios, bonds constituted an average of 70%, equity 20% and the alternative asset class 10%.

For investors seeking high portfolio returns the proportion of equity in the portfolio becomes significant.

The contribution of commodities and the composite portfolio appear to be consistent, adding on average 20 basis points to the reference portfolio for each risk level.

Putting together the above observations the following deductions can be made:

- In the three seenarios studied, nominal bonds and equities have maintained relatively high returns.
- Real estate posted strong returns in the early 1970s averaging 10% however in the period after 1992 when it recorded relatively lower returns and consequently had minimal impact on the portfolio.
- Commodities had remained a significant eontributor to portfolio returns under all three scenarios.
- Historical data on real return bonds did not appear to support their ability to impact significantly on the portfolio. Nevertheless if the expectations of declining returns in all the other asset classes hold sway, real estate could be seen as an asset class that could make some marginal contribution to the traditional portfolio. It is evident however that, investing in real return bonds should be motivated more from the objective of seeking to match the investor's liabilities to his assets. For investors seeking very high rates of return to their portfolios it is doubtful from the above analysis if real return bonds will be a good asset class.

5. CONCLUSION & RECOMMENDATION

5.1 CONCLUSION

The objective of this study was to determine the extent to which portfolio return is affected by the inclusion of inflation-hedged asset classes.

To this end, it was important to first establish the inflation hedging status of the assets, we did so by finding out the degree of variation between the assets and unexpected inflation which in fact is the main inflation risk facing the investor.

The tests conducted could validate only Real Estate and RRB returns as being explained by variations in the unexpected inflation rate. Though the variations in the return of commodities could not be explained by changes in the unexpected rate of inflation, its impact on the portfolio returns was positive especially for higher risks.

In general, there was not sufficient evidence to reject the hypothesis that inflation-hedged asset classes increase portfolio return-to-risk profile. The return-to-risk profile improved from the inclusion of each asset class; though the degree of change differed between periods and between asset classes.

The evidence available supports earlier conclusions reached by Fama and Schwert (1977), Grauer and Hakenson (1995) and most recently by Li Victor (2001).

The results obtained from the analysis leads us to conclude that:

1. Real estate, Commodities, and real return bonds are positively correlated with unexpected inflation; Real estate had a positive correlation as high 0.61, commodities 0.32 and real return bonds 0.46 This relationship was however found to be significant only for Real return Bonds and for Real estate.

2. Variations in the return of real estate and real return bonds can be explained by changes in the unexpected rate of inflation. The beta coefficient which explained the variation between real estate return and unexpected inflation was 1.4 and a high 2.45 for real return bonds. The R-squared of the regression was approximately 0.37 in both regressions. By implication returns on real estate and RRB investment will increase by more than a unit rise in inflation; alternatively their returns will fall by more than a unit decrease in the inflation rate.
3. Real estate and real return bonds could therefore be used as hedges in the investment portfolio against unexpected inflation especially in periods of rising inflation.
4. Real estate and GSCI are negatively correlated with the traditional asset classes so can be used to reduce portfolio risk without jeopardising the return to the portfolio. Returns increased between 80 and 100 basis points from the inclusion of these two asset classes.
5. Real return bonds are a marginal contributor to the portfolio returns, adding just about 10 basis points and in some cases no addition.
6. Nominal bonds continue to make significant contribution to the portfolio returns especially during periods of low and stable price levels.

5.2 RECOMMENDATIONS

In the light of the above findings, we make the following recommendations to fund managers and portfolio investors:

1. Real estate and real return bonds can be considered as two assets whose returns vary positively with unexpected inflation, therefore investors who are averse to the risk of inflation may consider a portfolio asset-mix including these assets classes.
2. Equities and nominal bonds are major contributors to the return of a portfolio, it is therefore important that their proportions are not varied to the detriment of overall portfolio returns.
3. Real return bonds should be included in the portfolio with caution, especially for investors with no inflation linked liabilities to match. As seen in this paper, various

combinations of the other asset classes can offer higher returns for the same level of risk but RRBs have a limited horizon of influence.

4. To the extent that real estate and real return bonds can both be used to hedge against unexpected inflation, it would appear that real estate is a better of the two because in addition to its hedging advantage, it could also significantly improve the return to the portfolio. The correlation between real estate and unexpected inflation is however not as strong as that between real return bonds and inflation.
5. In having to choose between the inflation-hedged asset classes, a proper assessment of the exposure of the liabilities to inflation needs to be made. In most cases it would be preferable for inflation-risk averse investors to combine these asset classes in their optimum portfolio.
6. Commodities are able to improve portfolio returns, even though it was not certain from this study to be an inflation hedge; it could improve portfolio returns. The Commodities index used in this study was the most volatile in both periods and it is important that it be combined with lowly correlated asset classes in order to reduce the overall portfolio risk whilst enhancing returns.

5.3 RELEVANCE TO THE LESS DEVELOPED COUNTRIES (LDC): THE CASE OF GHANA

This study was conducted in Canada using market data from the developed economies; the conclusions reached are all the same pertinent even to the LDCs.

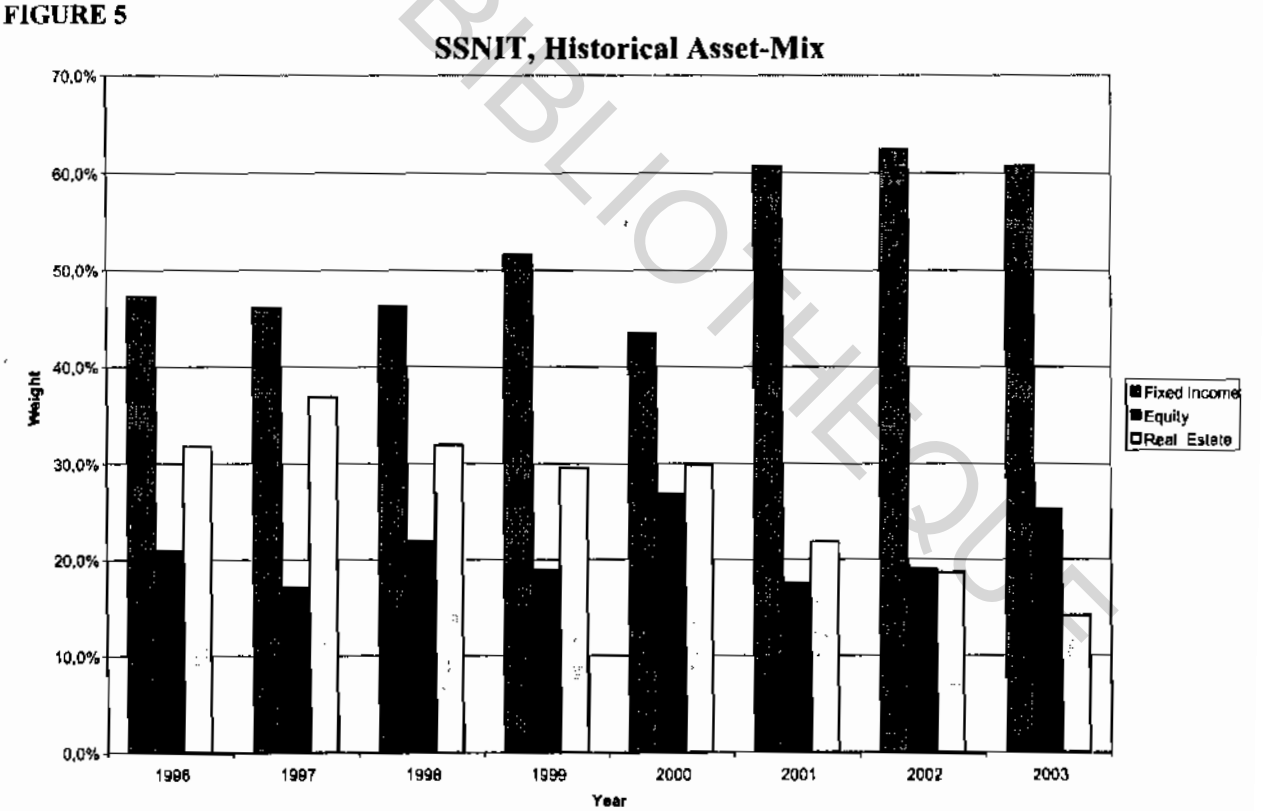
The subject of inflation and its effect on long-term investments is more critical for the economies of the LDCs which are traditionally known to have long periods of double digit inflation rates. Inflation rate in Ghana for example has averaged 25% in the last five years. Reported investment returns especially for long-term investors like the Social Security and National Insurance Trust (SSNIT) have been negative in real terms. SSNIT has therefore been in search for an alternative investment policy and more especially alternative investment products that can assure it of positive returns on its investment portfolio. In pursuance of this, SSNIT has defined the following as its investment objectives:

- To protect the corpus of the assets in the pension scheme
- To protect the purchasing power of those assets.
- To help control the cost of funding pensions through improvement in investment return on a long-term basis.
- To achieve optimum fund ratio as determined from time to time by the Actuary.
- To attain a long-term fund ratio of 90%

It is evident from the above objectives that inflation is a major target variable of the SSNIT investment policy. To this end, any study which makes a contribution to the strategy needed to overcome the menace of inflation should be of much significance to the SSNIT fund.

This study has established the role real estate and real return bonds can play in guaranteeing the purchasing power of the assets of the SSNIT seheme espeeially so when Ghana is known to be experiencing high rates of inflation.

FIGURE 5



Source: *SSNIT Published Reports (2004).*

On average, 52% of SSNIT's investment has been in fixed income instruments made up largely of nominal bonds. 21% was invested in equities and the rest 27% in real estate. The proportion in real estate has been deelining from 1997, declining from about 37% to a low of 14% in 2003. There appears to be a trade-off between real estate proportions and the proportion of fixed income investments.

With the background of the observations made in this study and the knowledge of maero-economic variables in Ghana, the above portfolio proportions and their trend are rather surprising.

The following recommendations can therefore be made to the managers of the SSNIT pension fund:

1. The above asset-mix could account largely for the negative real returns reeorded by the fund within this period. There is an urgent need to re-allocate the assets of the fund.
2. More emphasis on asset elasses that are known to proteet the investor against rising price levels. In this regard some time and resources must be spent analysing asset correlations with unexpected inflation in Ghana so as to make well-informed deeisions.
3. The futures market is non-existent in Ghana and in most LDCs, the option to invest in commodity futures is virtually nil if the fund must be invested only within the boundaries of Ghana. It may however me important at this stage to eonsider some minimum asset allocation off-shore if the investment objective of protecting the value of the asset must be achieved.
4. The declining allocation of the portfolio by SSNIT to real estates may be an indieation of that asset class' non-profitability to SSNIT. Real Estate as an asset class nevertheless remains a profitable sector and SSNIT may have to redefine its approaeh to investment in it so as to benefit from both the returns and inflation-hedge advantage.
5. Equity returns have also proven to be a major contributor to portfolio returns, there is evidence that Ghana Stoek Exchange index has been performing very well in the last few years, and it is recommended that SSNIT allocates more of its funds to the equity asset class so as to improve the overall return on the portfolio.

Limitations of Study:

The findings of the study are however subjeet to some limitations eneountered, key among them was:

1. The unavailability of data especially for real return bonds for the greater part of the period since real return bonds were first issued in Canada only in 1991.
2. The difficulty of finding an accurate measure for expeeted inflation and consequently for unexpected inflation.

These notwithstanding, we believe the study has been approached rigorously so as to make its conclusions largely relevant and reliable.

APPENDIXES

APPENDIX A

HISTORICAL DATA ON ASSET CLASSES AND INFLATION

DATA	SC Universe	S&P/TSX	S&P 500	MSCI EAFE	Real Estate	GSCI	RRB	Inflation Observed	Unexpected Inflation	Expected Inflation
1976	19.05%	11.01%	28.82%	3.94%	10.24%	-8.58%		5.85%		8.84%
1977	6.61%	10.70%	-5.61%	2.90%	14.87%	14.56%		9.47%	0.83%	8.14%
1978	5.42%	29.71%	6.84%	10.73%	11.96%	36.60%		6.41%	0.27%	7.17%
1979	1.44%	44.81%	18.31%	5.93%	13.01%	38.89%		9.76%	2.58%	10.46%
1980	6.57%	30.13%	30.62%	17.09%	23.12%	15.30%		11.11%	0.65%	13.66%
1981	4.20%	-10.24%	-2.94%	3.16%	26.39%	-20.09%		12.18%	1.44%	17.01%
1982	35.36%	5.56%	23.23%	3.05%	1.19%	15.79%		9.24%	-7.77%	14.41%
1983	11.53%	35.49%	22.55%	29.85%	6.69%	20.67%		4.60%	-9.81%	9.60%
1984	14.65%	-2.39%	6.64%	17.00%	12.41%	4.68%		3.69%	-8.11%	9.71%
1985	21.22%	25.06%	33.80%	25.64%	11.48%	14.19%		4.36%	-6.33%	9.84%
1986	14.68%	6.95%	21.58%	38.14%	12.89%	5.92%		4.19%	-6.65%	9.24%
1987	4.03%	5.87%	6.07%	-3.82%	14.62%	26.47%		4.15%	-5.09%	8.24%
1988	9.79%	11.08%	17.91%	37.43%	16.38%	32.79%		3.99%	-4.25%	8.41%
1989	12.80%	21.36%	34.78%	27.15%	16.82%	43.53%		5.23%	-3.18%	10.94%
1990	7.55%	-14.80%	1.49%	-26.67%	4.34%	33.97%		4.97%	-5.97%	12.22%
1991	22.14%	12.02%	34.76%	8.65%	0.17%	-2.57%		3.79%	-8.43%	11.47%
1992	9.85%	-1.43%	11.05%	-6.85%	-5.56%	6.36%	4.07%	2.13%	-9.34%	7.42%
1993	16.14%	32.55%	12.58%	29.06%	-6.45%	-9.00%	21.92%	1.69%	-5.73%	7.11%
1994	-4.30%	-0.18%	1.46%	-0.96%	1.93%	9.29%	-13.51%	0.20%	-6.91%	3.86%
1995	20.65%	14.54%	38.96%	12.25%	5.04%	24.90%	18.54%	1.75%	-2.11%	7.18%
1996	12.27%	28.35%	21.83%	12.53%	6.99%	39.00%	11.68%	2.20%	-4.88%	5.54%
1997	9.65%	14.99%	30.11%	12.62%	18.94%	-10.81%	4.67%	0.75%	-4.79%	2.80%
1998	9.17%	-1.58%	26.70%	12.62%	16.05%	-33.31%	5.95%	1.02%	-1.78%	4.46%
1999	-1.14%	31.70%	20.19%	35.41%	10.52%	46.27%	8.02%	2.58%	-1.88%	4.70%
2000	10.25%	7.41%	-10.20%	-5.37%	11.70%	55.42%	16.61%	3.23%	-1.47%	4.93%
2001	8.06%	-12.57%	-12.39%	-16.20%	10.64%	-29.35%	0.52%	0.70%	-4.23%	5.56%
2002	8.72%	-12.45%	-21.96%	-27.31%	8.68%	37.06%	15.28%	3.68%	-1.68%	2.00%
2003	6.70%	26.73%	30.48%	21.28%	8.24%	25.30%	13.31%	1.99%	-0.01%	2.67%

BIBLIOGRAPHY

BODIE, KANE and MARCUS. *Investments*, 4th Edition, 1999, chapters 2, 4, 5 & 7.

DEACON, DERRY and MIRFENDERESKI. *Inflation-indexed securities*, 2004, p. 1-20.

DIMSON, MARSH and STAUNTON. *Triumph of the optimists*, 2002, chapters 4 & 20.

SIEGEL, J.J. *Stocks for the Long Run*, 2002, p. 25-41; p. 195-201.

KOTHARI and SHANKEN. "Asset Allocation with Inflation-Protected Bonds", *Financial Analysts Journal*, AIMR, 2004, p. 54-70.

NEHLS-OBÉGI and TEILETCHE. "Optimal Asset Allocation: The Contribution of Inflation-Linked Bonds", *CDC Capital Markets Flash*, n°39, 2001.

DOPFEL, Fe. "Asset Allocation in a Lower Stoek-Bond Correlation Environment", *Journal of Portfolio Management*, 2003, p. 25-30.

RAAB, D. "Commodities an overlooked option", *Investment Management Weekly*, February 2004.

CHU, CHENG et.Al. "On The Inflation Risk Premium", *Journal of Business Finance and Accounting*, September 1995, p. 881-892.

SHEN, P. "How Important is the Inflation Risk Premium?", FED Reserve Bank of Kansas City, *Economic Review*, 1998.

RATNER, M. "A Re-examination of Inflation and Asset Returns", *American Business Review*, 1990, p. 80-85.

L'HER, J.-F. and PLANTE, J.-F. "Les obligations à rendement réel", *Research Paper for the Caisse de dépôt et placement du Québec*, Québec, 2004.

WEBB, Jr. "Inflation, Real Wealth, and Real Assets", *Appraisal Journal*, January 1983, p. 115-122.

ENNS, D. "Real Estate, Real Assets and Real Wealth", *Appraisal Journal*, Oetober 1979, p. 532-537.

CRAIG, B. "Why are TIIS Yields So High? The Case of the Missing Inflation-Risk Premium" *Economic Commentary*, FED of Cleveland, March 2003.

FAMA and SCHWERT. "Asset Returns and Inflation", *Journal of Financial Economics*, 1977, 5, p. 115-146.

IBBOTSON and SINQUEFIELD. "Stocks, Bonds, bills and Inflation", *Journal of Business*, January 1976, 49, p. 11-47.

FOGLER, GRANITO and SMITH. "A theoretical Analysis of Real Estate Returns", *Journal of Finance*, 1985, 40-43, 711-19.

HARTZELL, HEKMAN and MILES. "Real Estate Returns and Inflation", *AREUEA Journal*, 1987, p. 15-37.

RUBENS, BOND and WEBB. "The inflation-Hedging Effectiveness of Real Estate", *Journal of Real Estate Research*, 1989, p. 45-55.

MULVEY et.Al. "Commodities and Managed Futures", *The Journal of Alternative Investments*, Vol. 7, 2004, p. 54-69.

APPENDIX B

APPENDIX B1
HISTORICAL ANALYSIS (1976-2003): PORTFOLIO RETURN, RISK & WEIGHTS

Efficient Porfolio only with Traditional Asset Classes

RETURN	RISK	BONDS	EQUITY	ALTERNATIVE	TOTAL
2.36%	1.50%	17%	4%	n/a	20.89%
3.73%	2.38%	26%	7%	n/a	33.07%
5.11%	3.25%	36%	9%	n/a	45.25%
6.48%	4.13%	46%	11%	n/a	57.43%
7.86%	5.00%	56%	14%	n/a	69.61%
9.23%	5.88%	66%	16%	n/a	81.80%
10.61%	6.75%	75%	19%	n/a	93.98%
11.75%	7.63%	70%	30%	n/a	100.00%
12.30%	8.50%	60%	40%	n/a	100.00%
12.73%	9.38%	52%	48%	n/a	100.00%
13.11%	10.25%	45%	55%	n/a	100.00%
13.47%	11.13%	38%	62%	n/a	100.00%
13.80%	12.00%	32%	68%	n/a	100.00%

Efficient Portfolio when Real Estate is Added

RETURN	RISK	BONDS	EQUITY	ALTERNATIVE	TOTAL
3.46%	1.50%	18%	4%	10%	31.78%
4.95%	2.38%	29%	6%	10%	44.94%
6.37%	3.25%	39%	9%	10%	57.54%
7.77%	4.13%	49%	11%	10%	69.96%
9.16%	5.00%	59%	14%	10%	82.29%
10.55%	5.88%	68%	16%	10%	94.58%
11.62%	6.75%	63%	27%	10%	100.00%
12.13%	7.63%	53%	37%	10%	100.00%
12.54%	8.50%	46%	44%	10%	100.00%
12.90%	9.38%	39%	51%	10%	100.00%
13.24%	10.25%	33%	57%	10%	100.00%
13.57%	11.13%	27%	63%	10%	100.00%
13.88%	12.00%	20%	70%	10%	100.00%

Efficient Portfolio when Commodity is Added

RETURN	RISK	BONDS	EQUITY	ALTERNATIVE	TOTAL
2.52%	1.50%	17%	3%	2%	21.82%
3.99%	2.38%	26%	5%	3%	34.55%
5.46%	3.25%	36%	7%	5%	47.27%
6.93%	4.13%	46%	8%	6%	60.00%
8.40%	5.00%	55%	10%	7%	72.73%
9.87%	5.88%	65%	12%	8%	85.46%
11.35%	6.75%	75%	14%	10%	98.18%
12.42%	7.63%	62%	28%	10%	100.00%
12.93%	8.50%	53%	37%	10%	100.00%
13.34%	9.38%	45%	45%	10%	100.00%
13.71%	10.25%	37%	53%	10%	100.00%
14.05%	11.13%	29%	61%	10%	100.00%
14.37%	12.00%	22%	68%	10%	100.00%

Efficient Portfolio when all are included

RETURN	RISK	BONDS	EQUITY	ALTERNATIVE	TOTAL
2.97%	1.50%	18%	3%	7%	26.64%
4.37%	2.38%	27%	4%	8%	38.91%
5.75%	3.25%	36%	6%	8%	51.06%
7.13%	4.13%	46%	8%	9%	63.17%
8.49%	5.00%	56%	10%	10%	75.26%
9.83%	5.88%	65%	12%	10%	87.26%
11.16%	6.75%	75%	14%	10%	99.20%
12.22%	7.63%	60%	30%	10%	100.00%
12.72%	8.50%	51%	39%	10%	100.00%
13.12%	9.38%	43%	47%	10%	100.00%
13.49%	10.25%	36%	54%	10%	100.00%
13.82%	11.13%	28%	62%	10%	100.00%
14.14%	12.00%	21%	69%	10%	100.00%

APPENDIX B2
HISTORICAL ANALYSIS (1992-2003): PORTFOLIO RETURN, RISK & WEIGHTS

Efficient Portfolio only with Traditional Asset Classes

RETURN	RISK	BONDS	EQUITY	ALTERNATIVE	TOTAL
2.00%	1.50%	20%	2%	n/a	22.93%
3.17%	2.38%	32%	4%	n/a	36.31%
4.34%	3.25%	44%	5%	n/a	49.68%
5.51%	4.13%	56%	7%	n/a	63.06%
6.68%	5.00%	68%	8%	n/a	76.44%
7.85%	5.88%	80%	10%	n/a	89.81%
9.31%	6.75%	85%	15%	n/a	100.00%
9.77%	7.63%	72%	28%	n/a	100.00%
10.06%	8.50%	64%	36%	n/a	100.00%
10.30%	9.38%	58%	42%	n/a	100.00%
10.51%	10.25%	52%	48%	n/a	100.00%
10.72%	11.13%	46%	54%	n/a	100.00%
10.91%	12.00%	41%	59%	n/a	100.00%

Efficient Portfolio when all are included

RETURN	RISK	BONDS	EQUITY	ALTERNATIVE	TOTAL
2.44%	1.50%	21%	2%	5%	27.56%
3.73%	2.38%	33%	4%	5%	41.69%
4.98%	3.25%	45%	5%	6%	55.72%
6.18%	4.13%	57%	7%	6%	69.51%
7.38%	5.00%	69%	8%	6%	83.15%
8.56%	5.88%	81%	9%	6%	96.71%
9.65%	6.75%	74%	20%	6%	100.00%
9.98%	7.63%	65%	29%	6%	100.00%
10.25%	8.50%	62%	35%	3%	100.00%
10.48%	9.38%	56%	41%	3%	100.00%
10.69%	10.25%	50%	47%	3%	100.00%
10.89%	11.13%	44%	53%	3%	100.00%
11.08%	12.00%	39%	58%	3%	100.00%

Efficient Portfolio when Commodity is Added

RETURN	RISK	BONDS	EQUITY	ALTERNATIVE	TOTAL
2.18%	1.50%	20%	2%	2%	24.05%
3.45%	2.38%	32%	4%	2%	38.07%
4.72%	3.25%	44%	5%	3%	52.10%
6.00%	4.13%	56%	6%	4%	66.12%
7.27%	5.00%	67%	8%	5%	80.15%
8.54%	5.88%	79%	9%	6%	94.17%
9.94%	6.75%	76%	14%	10%	100.00%
10.33%	7.63%	64%	26%	10%	100.00%
10.60%	8.50%	56%	34%	10%	100.00%
10.83%	9.38%	50%	40%	10%	100.00%
11.04%	10.25%	43%	47%	10%	100.00%
11.24%	11.13%	38%	52%	10%	100.00%
11.44%	12.00%	32%	58%	10%	100.00%

Efficient Portfolio when ORR is Added

RETURN	RISK	BONDS	EQUITY	ALTERNATIVE	TOTAL
2.00%	1.50%	20%	2%	0%	22.93%
3.17%	2.38%	32%	4%	0%	36.31%
4.34%	3.25%	44%	5%	0%	49.68%
5.51%	4.13%	56%	7%	0%	63.06%
6.68%	5.00%	68%	8%	0%	76.44%
7.85%	5.88%	80%	10%	0%	89.81%
9.31%	6.75%	85%	15%	0%	100.00%
9.77%	7.63%	72%	28%	0%	100.00%
10.06%	8.50%	64%	36%	0%	100.00%
10.30%	9.38%	58%	42%	0%	100.00%
10.51%	10.25%	52%	48%	0%	100.00%
10.72%	11.13%	46%	54%	0%	100.00%
10.91%	12.00%	41%	59%	0%	100.00%

Efficient Portfolio when all are included

RETURN	RISK	BONDS	EQUITY	ALTERNATIVE	TOTAL
2.44%	1.50%	21%	2%	5%	27.56%
3.73%	2.38%	33%	4%	5%	41.69%
4.98%	3.25%	45%	5%	6%	55.72%
6.18%	4.13%	57%	7%	6%	69.51%
7.38%	5.00%	69%	8%	6%	83.15%
8.56%	5.88%	81%	9%	6%	96.71%
9.65%	6.75%	74%	20%	6%	100.00%
9.98%	7.63%	65%	29%	6%	100.00%
10.25%	8.50%	62%	35%	3%	100.00%
10.48%	9.38%	56%	41%	3%	100.00%
10.69%	10.25%	50%	47%	3%	100.00%
10.89%	11.13%	44%	53%	3%	100.00%
11.08%	12.00%	39%	58%	3%	100.00%

APPENDIX B3
EX ANTE ANALYSIS: PORTFOLIO RETURN, RISK & WEIGHTS

Efficient Portfolio only with Traditional Asset Classes

RETURN	RISK	BONDS	EQUITY	ALTERNATIVE	TOTAL
1.58%	1.50%	32%	2%	0%	33%
2.50%	2.38%	50%	2%	0%	52%
3.42%	3.25%	68%	3%	0%	72%
4.34%	4.13%	87%	4%	0%	91%
5.02%	5.00%	84%	16%	0%	100%
5.30%	5.88%	75%	25%	0%	100%
5.52%	6.75%	67%	33%	0%	100%
5.73%	7.63%	60%	40%	0%	100%
5.92%	8.50%	54%	46%	0%	100%
6.11%	9.38%	48%	52%	0%	100%
6.30%	10.25%	42%	58%	0%	100%
6.48%	11.13%	36%	64%	0%	100%
6.66%	12.00%	30%	70%	0%	100%

Efficient Portfolio when Real Estate is Added

RETURN	RISK	BONDS	EQUITY	ALTERNATIVE	TOTAL
2.38%	1.50%	33%	2%	10%	46%
3.38%	2.38%	53%	4%	10%	67%
4.33%	3.25%	72%	5%	10%	87%
5.15%	4.13%	76%	14%	10%	100%
5.43%	5.00%	67%	23%	10%	100%
5.65%	5.88%	60%	30%	10%	100%
5.85%	6.75%	54%	36%	10%	100%
6.04%	7.63%	48%	42%	10%	100%
6.23%	8.50%	42%	48%	10%	100%
6.41%	9.38%	36%	54%	10%	100%
6.59%	10.25%	30%	60%	10%	100%
6.77%	11.13%	24%	66%	10%	100%
6.95%	12.00%	19%	71%	10%	100%

Efficient Portfolio when Commodity is Added

RETURN	RISK	BONDS	EQUITY	ALTERNATIVE	TOTAL
1.78%	1.50%	31%	1%	6%	37%
2.82%	2.38%	49%	1%	9%	59%
3.83%	3.25%	68%	2%	10%	80%
4.84%	4.13%	84%	6%	10%	100%
5.26%	5.00%	71%	19%	10%	100%
5.50%	5.88%	63%	27%	10%	100%
5.72%	6.75%	56%	34%	10%	100%
5.92%	7.63%	50%	40%	10%	100%
6.11%	8.50%	44%	46%	10%	100%
6.30%	9.38%	38%	52%	10%	100%
6.48%	10.25%	32%	58%	10%	100%
6.66%	11.13%	26%	64%	10%	100%
6.84%	12.00%	21%	69%	10%	100%

Efficient Portfolio when RRB is Added

RETURN	RISK	BONDS	EQUITY	ALTERNATIVE	TOTAL
1.63%	1.50%	24%	1%	10%	35%
2.56%	2.38%	43%	1%	10%	54%
3.49%	3.25%	61%	2%	10%	74%
4.41%	4.13%	80%	3%	10%	93%
5.06%	5.00%	74%	16%	10%	100%
5.33%	5.88%	65%	25%	10%	100%
5.55%	6.75%	57%	33%	10%	100%
5.76%	7.63%	51%	39%	10%	100%
5.96%	8.50%	44%	46%	10%	100%
6.15%	9.38%	38%	52%	10%	100%
6.33%	10.25%	32%	58%	10%	100%
6.52%	11.13%	26%	64%	10%	100%
6.70%	12.00%	20%	70%	10%	100%

Efficient Portfolio when all are included

RETURN	RISK	BONDS	EQUITY	ALTERNATIVE	TOTAL
1.97%	1.50%	30%	0%	10%	40%
2.89%	2.38%	49%	1%	10%	60%
3.79%	3.25%	68%	2%	10%	80%
4.69%	4.13%	86%	3%	10%	99%
5.22%	5.00%	72%	18%	10%	100%
5.48%	5.88%	64%	26%	10%	100%
5.69%	6.75%	57%	33%	10%	100%
5.90%	7.63%	50%	40%	10%	100%
6.09%	8.50%	44%	46%	10%	100%
6.28%	9.38%	38%	52%	10%	100%
6.47%	10.25%	32%	58%	10%	100%
6.65%	11.13%	26%	64%	10%	100%
6.83%	12.00%	20%	70%	10%	100%

BIBLIOGRAPHY

BODIE, KANE and MARCUS. *Investments*, 4th Edition, 1999, chapters 2, 4, 5 & 7.

DEACON, DERRY and MIRFENDERESKI. *Inflation-indexed securities*, 2004, p. 1-20.

DIMSON, MARSH and STAUNTON. *Triumph of the optimists*, 2002, chapters 4 & 20.

SIEGEL, J.J. *Stocks for the Long Run*, 2002, p. 25-41; p. 195-201.

KOTHARI and SHANKEN. "Asset Allocation with Inflation-Protected Bonds", *Financial Analysts Journal*, AIMR, 2004, p. 54-70.

NEHLS-OBÉGI and TEILETCHE. "Optimal Asset Allocation: The Contribution of Inflation-Linked Bonds", *CDC Capital Markets Flash*, n°39, 2001.

DOPFEL, Fe. "Asset Allocation in a Lower Stock-Bond Correlation Environment", *Journal of Portfolio Management*, 2003, p. 25-30.

RAAB, D. "Commodities an overlooked option", *Investment Management Weekly*, February 2004.

CHU, CHENG et.Al. "On The Inflation Risk Premium", *Journal of Business Finance and Accounting*, September 1995, p. 881-892.

SHEN, P. "How Important is the Inflation Risk Premium?", FED Reserve Bank of Kansas City, *Economic Review*, 1998.

RATNER, M. "A Re-examination of Inflation and Asset Returns", *American Business Review*, 1990, p. 80-85.

L'HER, J.-F. and PLANTE, J.-F. "Les obligations à rendement réel", *Research Paper for the Caisse de dépôt et placement du Québec*, Québec, 2004.

WEBB, Jr. "Inflation, Real Wealth, and Real Assets", *Appraisal Journal*, January 1983, p. 115-122.

ENNS, D. "Real Estate, Real Assets and Real Wealth", *Appraisal Journal*, October 1979, p. 532-537.

CRAIG, B. "Why are TIIS Yields So High? The Case of the Missing Inflation-Risk Premium" *Economic Commentary*, FED of Cleveland, March 2003.

FAMA and SCHWERT. "Asset Returns and Inflation", *Journal of Financial Economics*, 1977, 5, p. 115-146.

IBBOTSON and SINQUEFIELD. "Stocks, Bonds, bills and Inflation", *Journal of Busines* January 1976, 49, p. 11-47.

FOGLER, GRANITO and SMITH. "A theoretical Analysis of Real Estate Returns", *Journal* *Finance*, 1985, 40-43, 711-19.

HARTZELL, HEKMAN and MILES. "Real Estate Returns and Inflation", *AREUEA Journa* 1987, p. 15-37.

RUBENS, BOND and WEBB. "The inflation-Hedging Effectiveness of Real Estate", *Journal* *Real Estate Research*, 1989, p. 45-55.

MULVEY et.Al. "Commodities and Managed Futures", *The Journal of Alternative Investment* Vol. 7, 2004, p. 54-69.