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Portfolio Diversification with Life Settlements: An Empirical Analysis Applied to Mutual Funds

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This article examines the formation of efficient portfolios using mutual funds that invest in life settlements in combination with fixed-income and equity index funds. We investigate the optimal weighting of these assets and their contribution to performance and portfolio risk. We find a significant negative correlation between the selected life settlement funds and certain U.S. and European fixed-income and equity funds. Furthermore, these correlations are lower than the correlations between the index funds that replicate each other. These results suggest that life settlement funds are an appropriate financial instrument to achieve greater diversification for a portfolio made up of a fund of funds and to improve fund performance as they provide a fixed return with a lower level of risk.
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Introduction

Life settlements are financial assets that are created when a life insurance policyholder sells his or her policy to a financial intermediary. Typically, a life settlement is created when an insured falls seriously ill and his or her life expectancy changes. Faced with greater liquidity demands, the insured may sell his or her policy to the secondary market to obtain a greater settlement value than the surrender value. Financial institutions buy these life insurance policies for a single cash payment greater than the perceived surrender value and thus obtain the right to compensation at the date of death of the insured. The present value of insurance policies and life settlements depends on the life expectancy of the insured as well as other economic and financial variables (e.g. business growth, interest rates, etc.). Financial intermediaries thus use life settlements to improve the profitability of their investment portfolio. A dynamic secondary market for this financial asset continues to develop in the United States, where investment classes are not limited to equities, bonds or traditional financial asset classes. Life settlements have also begun to find their way into mutual fund portfolios (i.e. life settlements funds).

When a mutual fund purchases a portfolio of policies, it acquires the obligations and rights of each contract (i.e. payment of annual premiums and the collection of the face value of the policy). In the United States and the United Kingdom, a life settlement market provides liquidity to severely ill insureds as a result of the review of their risk of mortality. This review has generated different indices and derivative financial assets, giving rise to the possibility of securitising portfolios. Therefore, we investigate whether the inclusion of life settlements in the formation of efficient portfolios contributes significantly to the mitigation of market risk with respect to other financial assets. Specifically, we examine the relation between the low correlation coefficients of the life settlements and other financial assets.

This study therefore contributes to the literature by building efficient frontiers from the correlation matrix between life settlements and other financial instruments and then calculating the optimal weights of life settlements in the investment portfolios. We thus complement and quantify the previous work of Dorr[1] who argues that life settlements provide an opportunity to generate efficient borders and build better portfolios. We also extend the sample period in the analysis of correlations between products based on life expectancy and other assets.[2] In addition, we verify the recent contribution of Braun *et al*.[3] who finds that life settlements have excellent qualities for diversification.

The remainder of the paper is organised as follows. The next section provides a description of life settlements and the role of the secondary market. The subsequent section offers a review of the literature on life settlements and the creation of efficient portfolios. The following section introduces the sample, the hypothesis and the methodology used in the optimisation of life settlement portfolios. The penultimate section shows the results of the model for the acquisition of efficient portfolios that invest in life settlement funds. Finally, the last section summarises the main conclusions.

Life settlements: Concept and markets

Life settlements

In life settlements, the most common policies are perpetual insurances that cover the risk of death over the insured's entire lifetime, namely, both universal and variable life insurance policies. In these policies, periodic premiums cover the cost of the life insurance, and the surplus can be invested in mutual funds. In the U.S. market, the surplus from the premiums is invested in fixed income funds and makes up the effective value of the policy, which is different from the *face value* (i.e., the value that is guaranteed by the insurance company). The policyholder can withdraw or borrow and pay back money from the investment fund. The policies (universal and variable) normally introduce a clause that allows the policyholder to cash in his or her life insurance policy for its *surrender value*.

The life settlements market

Life insurance policies can be sold to third parties who purchase the obligations and the benefits of these policies. When a policyholder has a need for money that is even

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1 Dorr (2008).
2 Rosenfeld (2009).
3 Braun *et al*. (2011).

more urgent than the need for the policy coverage, he or she has the option to sell the policy in the secondary market for a value that is greater than the liquidation value.[4] Liquidation, or surrender, values are based on the assumption of normal health and life expectancy. Thus, the life settlements market seeks to do business with policyholders who unexpectedly fall seriously ill and face a significantly reduced life expectancy.

Both Doherty and Singer and Frank[5] find that the life settlement secondary market provides liquidity to an illiquid market and offers policyholders who wish to cash in their policies a better alternative to surrendering their policies to the insurance company. In addition, the secondary market has a beneficial effect on the primary market in so far as the number of people who are willing to purchase policies increases.

However, clear regulations are required to avoid conflicts of interest. The literature discusses the legality and ethics of the life settlement industry since the emergence of the secondary market.[6] Legal problems arising from the implementation of secondary markets for these assets have led to the implementation of a regulatory framework as well as various judicial interpretations on its legality.[7]

According to Frank,[8] in a fully regulated environment and with sufficiently informed clients regarding the nature of the transactions, the secondary market provides marked benefits for its participants, including sellers, buyers and intermediaries. Aside from the policyholders who settle their policies, the main agents in the market are the end investors who buy life settlements—namely, fund managers and investment banks. Other stakeholders who benefit from the existence of the secondary market serve as control agents (i.e. consultants who specialise in financial and actuarial analysis of mortality), healthcare professionals (who issue medical reports to calculate the value of the policies), legal services providers (who give legal advice to the parties) and rating agencies that evaluate the risk of the fund issuers.

Literature review

We review the literature with an increasingly narrow focus on our study. We begin by looking at the most important contributions on the theory of portfolio selection. We then focus on the main contributions of life settlement valuation. Finally, in specific relation to our empirical work, we address the literature related to the inclusion of life settlements in the determination of efficient portfolios.

Modern portfolio theory begins with the pioneering work of Markowitz,[9] who introduced the concept of efficient frontiers in portfolios. This theory was then simplified during the 1960s with contributions that would lead to the capital asset pricing

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[4] I.e., the surrender value; Doherty and Singer, (2002).
[5] Doherty and Singer, *ibid.* and Frank (2004).
[6] E.g., Kholi, (2006); Bozanic, (2008).
[7] See Sun Life Assurance Company of Canada v. John R. Paulson, (2008); *Lincoln Life & Annuity Co. of New York v. Jonathan Berck*, (2009); *New York State v. Coventry LLC*, (2009); *Axa v. Settlement Funding*, (2010).
[8] Frank, *op. cit.*
[9] Markowitz (1952).

model.[10] Mossin[11] defends the measurement of systematic risk based on betas, thereby establishing a linear relation between the risk–reward binomial of assets and market portfolio. During the 1970s, the literature provides empirical support for this linear relation[12] with initial criticism of the CAPM appearing at the end of the decade—namely, from Ross and Cox and Roll[13] who applied multifactorial models. Importantly, Fama and French[14] include price–earning ratio, and the relative size of the market entity as other explanatory variables in the determination of the expected asset returns.[15] Throughout the 1990s and 2000s, portfolio theory continued to draw attention from researchers. Some discuss the drawbacks of the CAPM and the statistical models[16] and others, more recently, provide contributions concerning the robustness of the asset allocation models.[17] Because Braun *et al*.[3] find a negative correlation coefficient between the S&P 500 and life settlements fund indexes, we do not use S&P 500 as benchmark for the CAPM model or the three-factor model of Fama and French.[14] Instead, due to the lack of a CAPM benchmark for investment portfolios that includes life settlements in combination with other financial assets, we revert to the Markowitz[9] model.

The studies on stochastic valuation of mortality[18] are of particular interest to our discussion of life settlements from a financial and actuarial point of view. These models combine the valuation of cash flows with specific life expectancy data provided by independent organisations and, in specific cases, incorporate options theory so that a value is assigned to the policies. In this context, Brennan and Schwartz[19] introduce randomness in the payment of the amounts insured. On the other hand, Reitano and Girard[20] use other approaches (options models) to value the liabilities of insurers, and Girard[21] calculates the fair value of policies using cost of capital.

Actuarial valuation determines the value of life settlements based on a comparison of settlement value and cash surrender value and can be calculated by various actuarial mathematical models.[22] The market also estimates the intrinsic economic value of the insurer's payment. A larger difference between the economic intrinsic value and the life settlement value indicates a greater benefit for the insured who is selling the policy. Like life settlement value, intrinsic economic value is calculated by numerous actuarial mathematical formulas.

[10] CAPM; Sharpe, (1964); Lintner, (1965).
[11] Mossin (1966).
[12] Black *et al*. (1972); Blume and Friend, (1973); Fama and MacBeth, (1973).
[13] Ross and Cox (1976) and Roll (1977).
[14] Fama and French (1992).
[15] Fama *et al*. (1993).
[16] E.g., Erb *et al*. (1996); Nawalkha, (1997), among others.
[17] Tütünkü and Köenig, (2004); Ceria and Stubbs, (2006); Scherer, (2007).
[18] Marocco and Pitacco, (1998); Milevsky and Promislow, (2001); Dahl and Møller, (2006); Cairns *et al*., (2008).
[19] Brennan and Schwartz (1976).
[20] Reitano (1997) and Girard (2000).
[21] Girard (2002).
[22] Deloitte Development LLC, (2005).

Although the literature is clearly limited due to the recent appearance of these financial instruments, a number of studies investigate the inclusion of life settlements in the formation of efficient portfolios. For example, Perera and Reeves[23] outline how to transfer the inherent risk of life settlements to investors. In addition, Smith and Washington[24] investigate the process of diversification of risk using life settlements. They find that the inclusion of these instruments improves portfolio performance when active secondary markets are present. Dorr,[1] who offers a theoretical preliminary study of the extension of the efficient frontier model using life settlements, concludes that the inclusion of life settlements reduces the portfolio risk and improves the returns. Rosenfeld[2] finds a correlation matrix with indices of bonds, stocks and mortality (QxX) for a period of 12 months. Sadowsky[25] indicates the possibility of including assets linked to life expectancy in the efficient frontiers of portfolios in the Markowitz[9] model. Recently, Braun *et al.*[3] ran a financial performance analysis and a correlation analysis with life settlements funds indexes and other indexes and concluded that life settlements offer excellent qualities for diversification. Our study builds on this line of research by not only providing empirical evidence of the beneficial effect of life settlements within efficient portfolios but also calculating the optimal weights of life settlements within these portfolios.

Empirical analysis

We hypothesise that the inclusion of life settlements in the mutual funds portfolios mitigates risk and improves portfolio returns. We also investigate the correlation between life settlements funds and other mutual funds to build efficient portfolios to generate efficient frontiers. Our final objective is to calculate the weight of each life settlement fund in the creation of an efficient portfolio.

Data

Given the relatively new introduction of the life settlement financial instrument in portfolio management, not surprisingly, a complete series of settlement values for these funds is not available. However, Bloomberg provides monthly data, given as net asset values, for 11 life settlement funds. From these, we select two funds:[26]

- The EPICL SS GU LS fund, which pays semiannual dividends and offers 42 monthly effective values; and
- The EPICL SC GU LS fund, which does not pay dividends and offers 38 monthly effective values.

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[23] Perera and Reeves (2006).
[24] Smith and Washington (2006).
[25] Sadowsky (2010).
[26] Both funds are managed by London-based EEA Fund Management Limited (*www.eeafm.com*).

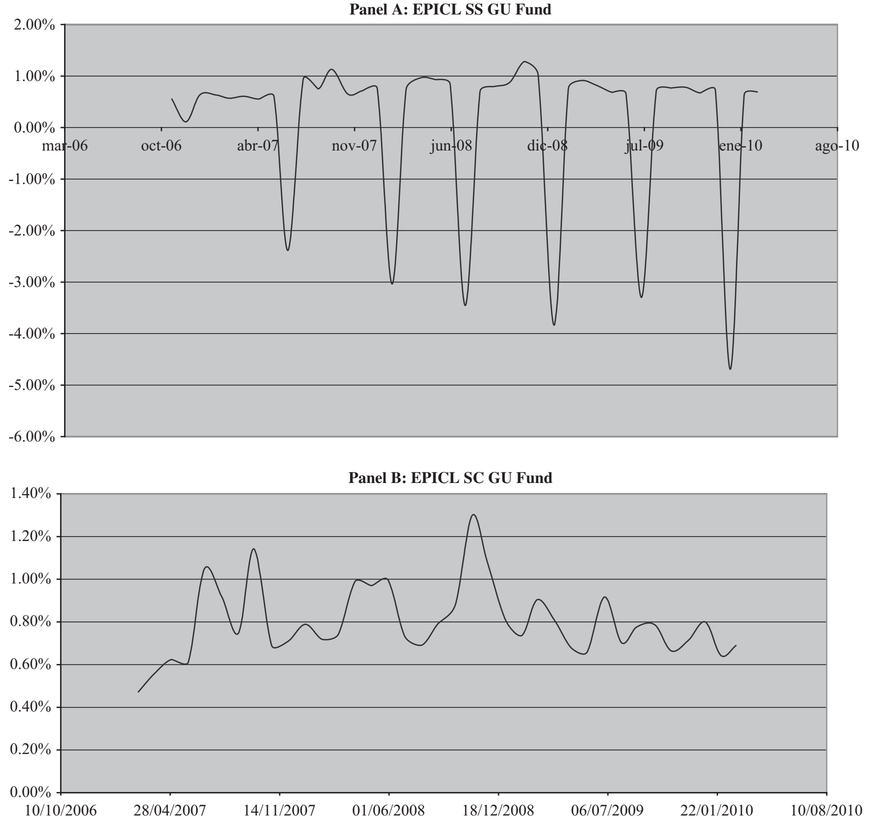

Figure 1. Monthly performance of (a) EPICL SS GU fund; (b) EPICL SC GU fund.

Both life settlement funds seek to achieve medium- to long-term capital growth on a net return of 8 per cent per annum. The funds invest exclusively in EPIC Life Settlement Funds through a wholly owned subsidiary company.

We divide these two life settlement funds between two portfolios. We form Portfolio A (Portfolio B) with the EPICL SS (EPICL SC) fund and five other funds that replicate five indices for which monthly data are available: two fixed income indices and three equity indices from the European and U.S. markets. In other words, Portfolio A (Portfolio B) includes the EPICL SS (EPICL SC) fund and five funds that replicate the following five indices: S&P500, Eurostoxx50, FTSE100, AGG:US iShares Barclays Aggregate Bond Fund and SCHEA1E: LX Schroder International Selection Fund–EURO Corporate Bond. The observation period for Portfolio A starts in September 2006 and ends in February 2010 (42 months). The observation period for Portfolio B runs from January 2007 to February 2010 (38 months).

Figure 1 shows the monthly performance of the EPICLSS GU fund from Portfolio A. The clearly defined stationary component of the performance of this

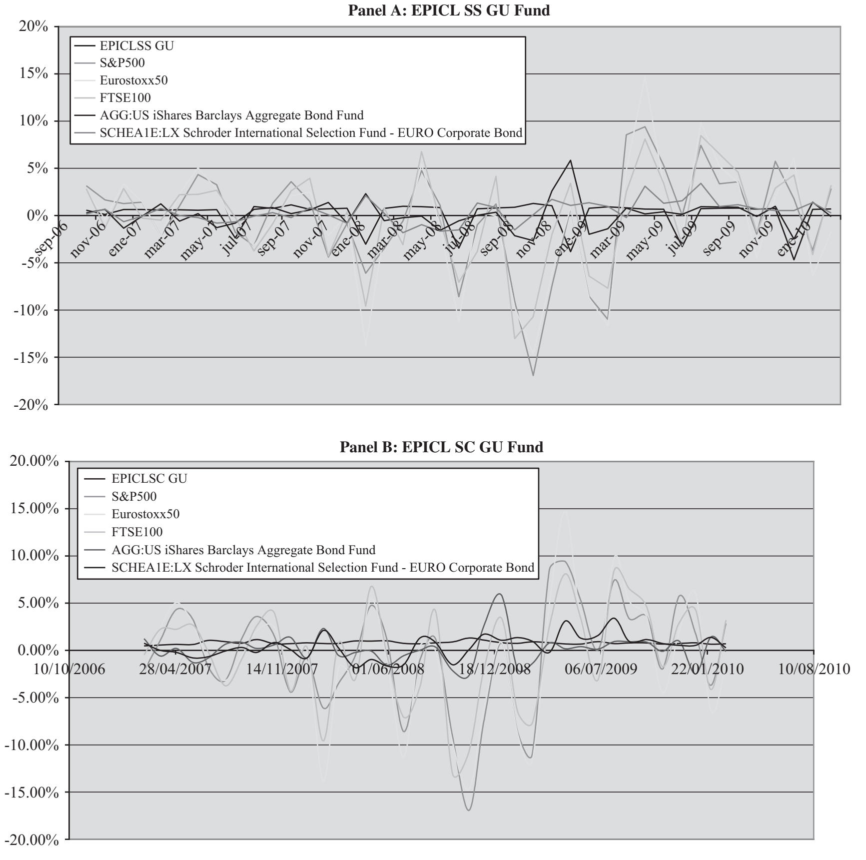

Figure 2. Performance by funds of Portfolio A and B. Panel A: EPICL SS GU fund; Panel B: EPICL SC GU fund.
Note: Sample period is from 42 (38) months in Portfolio A (Portfolio B), September 2006–February 2010 (January 2007–February 2010).

fund is attributed to the payment of semiannual dividends, referred to as *ex dividend* values.[27]

Panel A (Panel B) of Figure 2 shows the monthly performance of all six funds (the EPICL fund and the five funds that replicate the indices) that make up Portfolio A (Portfolio B). Performance is estimated as a variation rate based on the monthly value of the six funds.

Table 1 provides an analytical description of the performance and risk of the funds in Portfolios A and B. The results show that average performance of the funds that replicate the equity fund index is negative and that the fixed income funds and the

[27] The data supplied by Bloomberg are monthly settlement values and cannot differentiate the amount distributed as dividends.

Table 1 Performance and risk by funds in Portfolios A and B

i	$E(R_i)$ (%)	*Var (i)*
Panel A. Portfolio A		
EPICL SS GU	0.13	0.000230960
S&P500	−0.31	0.002921793
Eurostoxx50	−0.68	0.003623199
FTSE100	−0.14	0.002454398
AGG: US Bond F	0.12	0.000218547
SCHEA1€ Bond	0.39	0.000131555
Panel B. Portfolio B		
EPICL SC GU	0.80	0.00000284
S&P500	−0.55	0.00317472
Eurostoxx50	−0.94	0.00392087
FTSE100	−0.26	0.00266686
AGG: US Bond F	0.14	0.00023537
SCHEA 1€ Bond	0.43	0.00014168

Note: In Portfolio A (Portfolio B), performance and variance are estimated as the average over 42 (38) months. Sample period is from 42 (38) months, September 2006–February 2010 (January 2007–February 2010).

EPICL SS fund is positive and very low. It is significant to note that the international financial crisis was in progress during the study period.

Hypothesis

We argue that life settlements add value to mutual fund portfolios because the random variable mortality is not influenced by the price volatility of financial markets. Therefore, we posit that adding life settlement financial instruments to a mutual fund portfolio can help the fund to achieve optimal performance levels. Our hypothesis implies that life settlement funds can improve the performance of a balanced portfolio that integrates other financial assets. Consequently, we also investigate the make-up of the most efficient portfolio by estimating the appropriate weight percentage for each asset class in the portfolio, including life settlement funds. In addition, the performance of the life settlement portfolio itself can be enhanced by optimally weighting life settlement funds of different impairments. In other words, a fund that integrates specific life settlement funds with different illnesses can produce a fund of funds with a distinct performance and level of risk. The fund of funds adds life settlement funds to its portfolio of fixed income funds, equity funds, and so on with the aim of improving overall performance. In addition, we hypothesise that the performance and risk of the life settlements financial instruments are not correlated with the performance of the equities on the stock exchanges.

We formulate our hypothesis that life settlements funds improve the diversification and performance of a portfolio of funds using portfolio selection techniques based on the Markowitz[9] model. Specifically, we follow Goetzmann's[28] five stages for

[28] Goetzmann (1996).

management of financial investments through the process of portfolio allocation: selection of objectives, choice of investment policy, selection of efficient portfolios, review of the portfolios and performance evaluation.

In the first stage, our objective is to specify a performance level that assumes minimum risk. Performance in mutual funds depends on which funds are offered and the risk assumed by the investor. In the second stage, we choose the funds. For the purposes of this study, we invest in two portfolios that are made up of two life settlement funds and five funds that replicate fixed income and equity indices (i.e., Portfolios A and B). The third stage centres on weighing the financial investments. In other words, it is the design or portfolio selection stage, at which point funds are selected and investment weightings are distributed.

We base the decision of how to weigh each fund on Markowitz's[9] portfolio optimisation model. This model determines the efficient frontiers, that is, the investment combinations that optimise the risk–reward relation.

In the fourth, or review, stage, the three previous stages are applied throughout time, including new data, to measure the efficiency of the fund portfolios. Finally, in the fifth stage, the investment performance (i.e., risk–reward) of the chosen portfolio is evaluated by comparison to alternative portfolios.

Method

We investigate the value of portfolios by examining the risk–reward relation, taking note of the potential for risk diversification. Our goal is to determine the optimal portfolio. To do so, we proceed in accordance with the following guidelines:

First, we estimate the return and the risk of each fund in Portfolios A and B. For this purpose, we use the average historical performance, the variance and the standard deviation. Later, we incorporate the return and the risk of each fund to the portfolio risk–reward according to the following steps: We (a) estimate the performance of each fund; (b) estimate the proportion of each fund in the portfolio (Wi); and (c) determine the variance (σi^2), covariance (σij) and the correlation coefficient (ρij) of all pairs of funds. In our empirical analysis, we obtain values for both σij and ρij. Later on, the election of the portfolio is done in accordance with the minimum variance (risk), given a fixed portfolio return.

Second, we analyse the effect of the interaction between the funds in each portfolio. According to the Markowitz[9] model, portfolio diversification allows the reduction of systematic and nonsystematic risk while maintaining the same performance level. Nonsystematic risk is reduced because diversification of the funds that make up the portfolios increases, given that the funds have already been diversified. With respect to systematic risk, in our empirical analysis, some variables (such as interest rate yields) affect all markets (i.e. life settlement, fixed income and equity funds), and the influence cannot be mitigated; however, other variables (e.g. life expectancy) only affect some markets (i.e. life settlements) and not others (e.g. fixed income and equities). We hypothesise that the global effect of these changes in the portfolio variables could be lower due to diversification.

Third, we select optimal portfolios based on the application of Markowitz's[9] model, by which we calculate the optimal weight for each fund in the portfolio. We minimise the risk subject to a restriction of return. Markowitz's model separates the efficient portfolios from the nonefficient portfolios and represents the optimal combinations (i.e. efficient frontiers). Following Markowitz, we set a predetermined return to determine the weight of the funds selected for the portfolio. We also set a constraint on returns between zero and the maximum performance.

Once we select our optimal portfolios, we obtain the covariance matrix for the six funds, using the data for net asset values of each fund across 42 months (38 months) for Portfolio A (Portfolio B). Based on these covariance matrices, we apply mathematical optimisation programmes (Excel's Solver)[29] and seek minimum portfolio risk for specific performances. In the optimisation process, based on Fama *et al.*,[15] the objective function minimises the variance of the portfolio performances and a constraint on expected performance is defined:

$$\begin{aligned} \text{Min Var}(r_p) = & \left(\sum_i W_i^2 \sigma^2 ii\right) + \left(\sum_i \sum_j W_i W_j \sigma ij\right) \\ \text{Subject to:} \quad & E(r_p) = \sum_i W_i E(r_i) = \text{r}^* \\ & \sum_i Wi = 1 \\ & Wi > 0, \quad (\text{otherwise, } Wi = 0) \end{aligned} \tag{1}$$

The outputs of the optimisation model are portfolios that minimise volatility with a predetermined yield. We set the expected return that depends on the weights of the different funds within the portfolio (and average historical returns). If we change the return restriction, the weight of the funds in the portfolio would change. The average historical returns (given as monthly net asset values) cover only the period of financial crisis (2007–2010) because no previous market prices for life settlement funds exist.

We set different values of performance r* to obtain combinations of optimal performance–risk, thereby changing funds weights. Using an optimisation tool, we get different efficient portfolios with minimum risk, given a determined performance. We thus obtain the efficient frontier through the union of different risk–reward values of the efficient portfolios. We then show efficient frontiers as the lines that join points of minimum risk at each level of performance. Thus, according to Markowitz's[9] model, we effectively separate the efficient portfolios from the nonefficient portfolios and represent the optimal combinations (i.e. efficient frontiers). We therefore complete the first two steps of our portfolio analysis.

To continue our empirical analysis, we draw on data from the values of the six funds. To analyse the performance of each of the funds (i=1 … 6), we estimate its

[29] We rerun the mathematical optimisation process using different optimatisation tools, including Microsoft Excel and Matlab: All cast the same results.

performance (R_i). The performance of a basket or portfolio with several (n=6) funds would be

$$Rp = \sum_{i=1}^{n} WiRi, \quad (2)$$

where Wi is the weight of each asset (i) within the portfolio.

The Markowitz[9] model allows for election among different assets (in our study, six) from different markets (e.g., life settlements markets, fixed income and equity). This model assumes normal behaviour of the variables. That is, the performance of the portfolio, Rp, is also a random variable associated with a normal probability distribution, where the expected value of the portfolio returns is

$$E(Rp) = \sum_{i=1}^{n} Wi\, E(Ri). \quad (3)$$

However, to analyse the risk of the portfolio, we use the variance of the portfolio, $\sigma_p^2 = E(Rp - E(Rp))^2$, where σ_p is the standard deviation of the returns that measure the risk or volatility (SDp).

Markowitz[9] defines the variance of the portfolio as σ_p^2 and minimises the objective function (subject to a series of constraints such as the portfolio provides a specific return). σ_i^2 is the variance of the performances of fund i, and σ_{ij} is the covariance of fund i's return with respect to j. For instance, $\sigma_{ij} = \sigma_{ji}$ and $\sigma_{ii} = \sigma_i^2$:

$$\begin{aligned} VAR(Rp) = \sigma_p^2 = {} & W_1^2\sigma_1^2 + W_2^2\sigma_2^2 + \cdots + W_n^2\sigma n^2 \\ & + 2W_1W_2\sigma_{12} + 2W_1W_3\sigma_{13} + \cdots + 2W_1W_n\sigma_{1n} \\ & + 2W_2W_3\sigma_{23} + 2W_2W_4\sigma_{24} + \cdots + 2W_2W_n\sigma_{2n} \\ & + 2W_3W_4\sigma_{34} + 2W_3W_5\sigma_{35} + \cdots + 2W_3W_n\sigma_{3n} \\ & + \cdots + 2W_{n-1}W_n\sigma_{n-1,n}. \end{aligned} \quad (4)$$

To form an efficient portfolio made up of six funds (i=1 … 6), we must conduct a risk analysis of this portfolio with the formulas for the variances, and six variances are needed from the asset performances and the covariances among each asset performance. In the Markowitz[9] model, portfolio risk is estimated as a weighted sum of n variances and $[(n*(n-1))/2]$ covariances. Consequently, we calculate these six variances and 15 covariances ((6*5)/2) and show them in matrix form.[30]

In addition, we estimate the correlation based on its coefficient:

$$\rho ij = \sigma ij/(\sigma i\,\sigma j) = \text{covar } ij/(SDi * SDj). \quad (5)$$

Correlation measures the relation between two different financial assets that make up the portfolio to identify the influence that each asset produces on the others. Correlation analysis allows us to reduce the total portfolio risk (VAR (Rp)) by

[30] Harvey (1995).

Table 2 Correlation matrix

	EPICL SS GU	*S&P500*	*Eurostoxx50*	*FTSE100*	*AGG: US Bond F*	*SCHEA 1€ Bond*
Panel A. Portfolio A						
EPICL SS GU	1					
S&P500	0.082429	1				
Eurostoxx50	0.114314	0.917475	1			
FTSE100	0.088320	0.873670	0.912852	1		
AGG: US Bond F	−0.177674	0.256985	0.144015	0.239825	1	
SCHEA 1€ Bond	−0.070504	0.157749	0.198835	0.228282	0.418667	1
Panel B. Portfolio B						
EPICL SC GU	1					
S&P500	−0.3585906	1				
Eurostoxx50	−0.2988820	0.9188264	1			
FTSE100	−0.2715847	0.8785073	0.9139317	1		
AGG: US Bond F	−0.2094489	0.8785073	0.1644523	0.2614590	1	
SCHEA 1€ Bond	−0.2886408	0.2673232	0.2271002	0.2526845	0.4054257	1

appropriating combining assets. Nonetheless, during the calculation of the correlation, an estimation error can occur and, therefore, must be controlled. The correlation effect (or linear relation effect) between two variables evaluates the intensity and direction of their relation. As previously noted, Braun *et al.*[3] find a negative correlation coefficient between the S&P 500 and life settlements fund indexes; therefore, we do not use S&P 500 as benchmark for the CAPM model or the three-factor model of Fama and French.[14] Instead, due to the difficulty in finding a CAPM benchmark for investment portfolios that includes life settlements in combination with other financial assets, we use the Markowitz[9] model. In addition, no market consensus exists on a risk-free return in portfolios composed of life settlements and other funds denominated in different currencies. However, to analyse the possible substitutability between life settlement funds and risk-free assets denominated in the same currency, we examine the correlation between life settlement funds returns and British Sovereign Debt Fund (Invesco Gilt). To do this, we calculate the correlation coefficient from 42 monthly net asset values (September 2006–February 2010) taken from Bloomberg. The correlation coefficient is –0.04992745, indicating an inverse relation between both funds denominated in sterling pounds (untabulated).

Results

Empirical analysis

Table 2 provides the correlation matrix for Portfolios A and B. For Portfolio A (Panel A), the life settlement fund (EPICL SS GU) exhibits a negative sign in relation to the two funds that replicate the fixed income indices. Note that the correlations of the life settlement fund with the equity funds are lower than the correlations between those referenced to fixed income funds and those referenced to equities. For Portfolio B

(Panel B), we find that the effects of negative correlation (and consequently for diversification) are more obvious than in Portfolio A.

We optimise the portfolios by minimising the variance in the portfolio to obtain the optimal weightings or optimal proportions for each financial asset. Specifically, we calculate the optimal weights (W_i) that minimise the portfolio variance (VAR (Rp)). The formula of the statistical variance (VAR (Rp)) is linked to the covariance between funds and its weight. The portfolio return (E (Rp)) is linked to fund returns and its weight. We introduce an initial hypothesis of an equally weighted portfolio (W_i=1/6). The optimisation tool calculates the optimal weights that minimise the risk of the portfolio, given a fixed return.

Table 3 provides the spreadsheet model that generates the optimised portfolios for Portfolios A and B. The results show the advantages of diversification for a portfolio made up of six funds in equal proportions. Specifically, for Portfolio A (Panel A), the diversified fund provides superior performance (although both are negative) to the best fund index (FTSE100; –0.08 per cent vs. –0.14 per cent, respectively), with a lower level of risk (0.000776 vs. 0.002454, respectively).

In terms of performance, Portfolio B, shown in Table 3, Panel B, obtains a better return. Regarding variance, Portfolio B is slightly superior to Portfolio A. Thus, the correlation and covariance matrices from Portfolios B are higher correlation among the fixed income and equity funds compared with Portfolio A, with the exception of the chosen life settlement fund in each portfolio. That is, the EPICL *SC* GU fund in Portfolio B has a negative correlation with all the funds. In addition, the coefficients of the negative correlation of these funds are greater than those from the EPICL *SS* GU fund from Portfolio A.

We then use the Markowitz[9] method to determine the weight of the financial assets that would minimise risk of the portfolio (VAR (Rc)), subject to a specified performance level. Table 4 shows the relevant parameters for Portfolios A (Portfolio B), restricting investments to the EPICL SS GU LS (EPICL SC GU LS) fund and the two equally weighted fixed income funds and rejecting investments in the equity fund indices. The table shows the advantages of diversification as Portfolio A, made up of the life settlement fund and the two fixed income funds, provides a return (0.21 per cent) greater than the fixed income index AGG:US Bond F (0.12 per cent) and with a lower risk (0.000068 vs. 0.000218; see Table 1). Looking at Portfolio B (Panel B), the results show that the EPICL SC GU LS portfolio once again outperforms Portfolio A.

We successfully modified the performance constraint to generate different portfolios, with the indicated investment constraints shown in Table 4 (minimised risk for a specified return). In this way, the possible results are risk–performance combinations that make up the efficient frontier for portfolios that integrate these funds (one life settlement fund and two fixed income funds). Figure 3 shows this efficient frontier for the three funds. The indicated points in the efficient frontiers are the efficient portfolios when the performance constraint is greater than 0.16 per cent (i.e. the lower of the performance values of the two funds that replicate fixed income indices). Table 5 and Figure 4 provide the optimal weighting for the three funds from Portfolios A, used to calculate the efficient frontier.

In Figure 5, we show the efficient frontier for the entire Portfolio A (i.e. including the funds that replicate equity income funds) but with a performance constraint that the

Table 3 Optimisation spreadsheet model

Panel A. Portfolio A

i	W_i	$E(R_i)$ (%)	W_i*$E(R_i)$
EPICL SS GU	0.17	0.13	0.0002
S&P500	0.17	−0.31	−0.0005
Eurostoxx50	0.17	−0.68	−0.0011
FTSE100	0.17	−0.14	−0.0002
AGG: US Bond F	0.17	0.12	0.0002
SCHEA1€ Bond	0.17	0.39	0.0006
Sum W_i	1.00		
$E(Rp)$ (%)	−0.08		
VAR(Rp)	0.000776048		

	EPICL SS GU	*S&P500*	*Eurostoxx50*	*FTSE100*	*AGG: US Bond F*	*SCHEA 1€ Bond*
EPICL SS GU	0.000230960					
S&P500	0.000067713	0.002921793				
Eurostoxx50	0.000104571	0.002985143	0.003623199			
FTSE100	0.0000066497	0.002339617	0.002722193	0.002454398		
AGG: US Bond F	−0.000039918	0.000205355	0.000128152	0.000175647	0.000218547	
SCHEA 1€ Bond	−0.000012289	0.000097801	0.000137275	0.000129717	0.000071159	0.000131555

Panel B. Portfolio B

i	W_i	$E(R_i)$ (%)	W_i*$E(R_i)$
EPICL SS GU	0.17	0.80	0.0013
S&P500	0.17	−0.55	0.0009
Eurostoxx50	0.17	−0.94	−0.0016
FTSE100	0.17	−0.26	−0.0004
AGG: US Bond F	0.17	0.14	0.0002
SCHEA 1€ Bond	0.17	0.43	0.0007
Sum W_i	1.00		
$E(Rp)$ (%)	−0.06		
VAR(Rp)	0.00082420		

	EPICL SS GU	*S&P500*	*Eurostoxx50*	*FTSE100*	*AGG: US Bond F*	*SCHEA 1€ Bond*
EPICL SS GU	0.000002837					
S&P500	−0.000034034	0.003174720				
Eurostoxx50	−0.000031524	0.003241736	0.003920875			
FTSE100	−0.000023624	0.002556218	0.002955324	0.002666856		
AGG: US Bond F	−0.000005413	0.000231079	0.000157980	0.000207145	0.000235365	
SCHEA 1€ Bond	−0.000005787	0.000116685	0.000169261	0.000155320	0.000074034	0.000141676

portfolio return must exceed 0 per cent (the greatest of the three fund performances that replicate equity fund indices). The variations of the weight of the six funds that are used to calculate this efficient frontier are provided in Table 6 and Figure 6.

Discussion

Our findings suggest that life settlements improve overall performance of the fund portfolios. This improvement is possible due to the negative correlation between the

Table 4 Performance and risk: Equally weighted without equity funds

i	W_i	$E(R_i)$ (%)	$W_i{*}E(R_i)$
Panel A: Portfolio A			
EPICL SS GU	0.17	0.13	0.0002
S&P500	0.17	−0.31	−0.0005
Eurostoxx50	0.17	−0.68	−0.0011
FTSE100	0.17	−0.14	−0.0002
AGG: US Bond F	0.17	0.12	0.0002
SCHEA 1€ Bond	0.17	0.39	0.0006
Sum W_i	1.00		
$E(Rp)$ (%)	0.21		
VAR(Rp)	0.000068774		
Panel B: Portfolio B			
EPICL SS GU	0.33	0.80	0.0027
S&P500	0.00	−0.55	0.0000
Eurostoxx50	0.00	−0.94	0.0000
FTSE100	0.00	−0.26	0.0000
AGG: US Bond F	0.33	0.14	0.0005
SCHEA 1€ Bond	0.33	0.43	0.0014
Sum W_i	1.00		
$E(Rp)$ (%)	0.46		
VAR(Rp)	0.00005617		

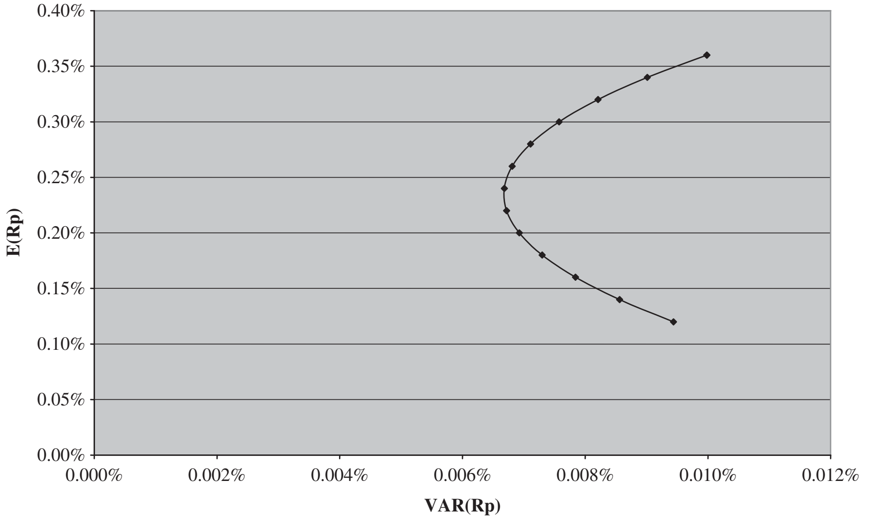

Figure 3. Efficient frontier for three funds from Portfolio A (life settlement fund and two fixed income funds).

Table 5 Efficient portfolios for three funds from Portfolio A (life settlement fund and two fixed income funds)

E(Rp) (%)	*VAR(Rp)*	*EPICL SS GU*	*AGG: US Bond F*	*SCHEA 1€ Bond*
0.12	0.000094407	0.48	0.53	0.00
0.14	0.000085604	0.46	0.48	0.06
0.16	0.000078421	0.44	0.43	0.13
0.18	0.000072999	0.41	0.38	0.21
0.20	0.000069274	0.39	0.32	0.28
0.22	0.000067207	0.37	0.27	0.36
0.24	0.000066823	0.35	0.22	0.43
0.26	0.000068120	0.32	0.17	0.51
0.28	0.000071100	0.30	0.12	0.58
0.30	0.000075761	0.28	0.07	0.66
0.32	0.000082105	0.25	0.01	0.73
0.34	0.000090130	0.23	0.00	0.81
0.36	0.000099838	0.21	0.00	0.88

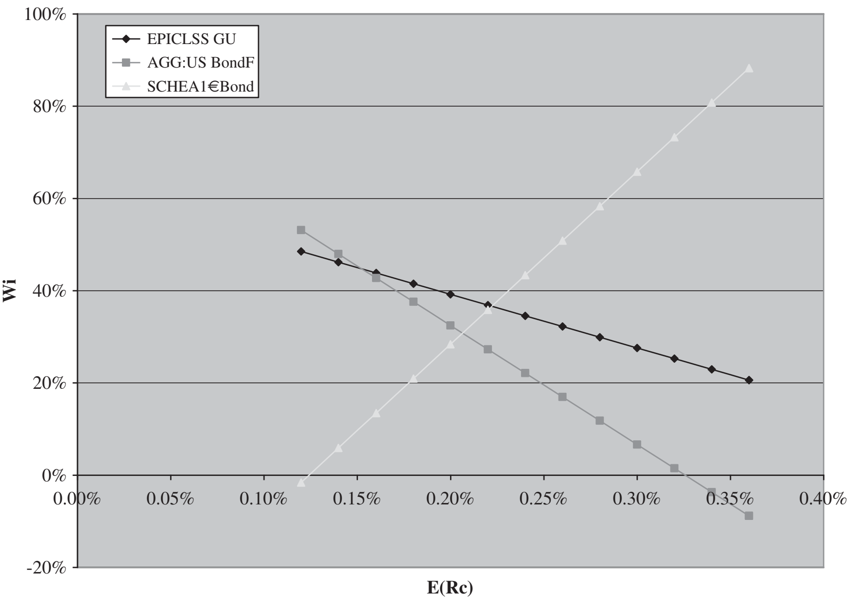

Figure 4. Optimal weights for the three funds from Portfolio A (life settlement fund and two fixed income funds) to form efficient portfolios.

life settlement funds and the two funds that replicate fixed income indices. Similarly, the correlation between the analysed life settlement funds and the three funds that replicate the equity fund indices is lower than the correlation between the fixed income funds and the equity funds.

Our results also provide evidence that investment in life settlement funds allow portfolios to take advantage of improved diversification. In this regard, equally weighted

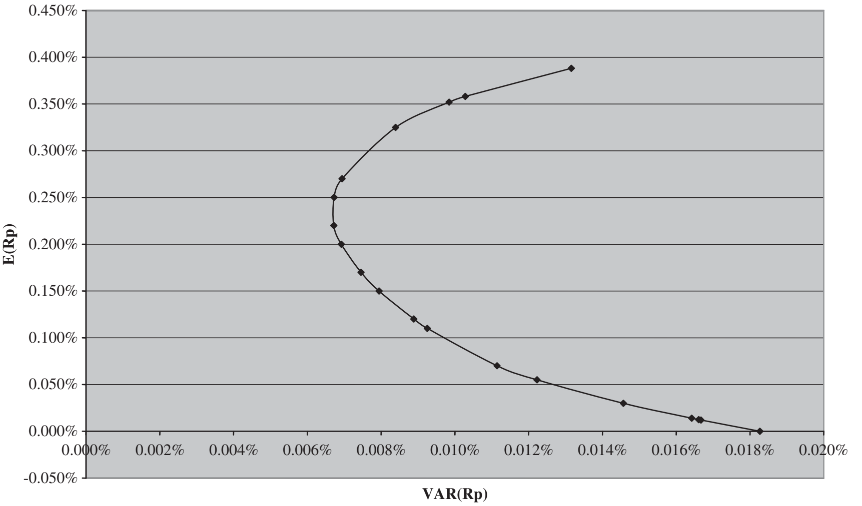

Figure 5. Efficient frontier for Portfolio A with six funds (life settlement fund, two fixed income funds, and three equity funds) and a performance constraint.

Table 6 Efficient portfolios with six funds and a performance constraint for Portfolio A

E(Rp) (%)	*EPICL SS GU*	*S&P500*	*Eurostoxx50*	*FTSE100*	*AGG: U.S. Bond F*	*SCHEA 1€ Bond*
0.00	0.39	0.00	0.15	0.00	0.46	0.00
0.01	0.40	0.00	0.14	0.00	0.46	0.00
0.01	0.40	0.00	0.14	0.00	0.46	0.00
0.01	0.41	0.00	0.14	0.00	0.46	0.00
0.03	0.42	0.00	0.12	0.00	0.47	0.00
0.06	0.44	0.00	0.09	0.00	0.48	0.00
0.07	0.45	0.00	0.07	0.00	0.49	0.00
0.11	0.45	0.00	0.04	0.00	0.46	0.05
0.12	0.44	0.00	0.03	0.00	0.45	0.08
0.15	0.42	0.00	0.02	0.00	0.40	0.16
0.17	0.41	0.00	0.01	0.00	0.37	0.21
0.20	0.39	0.00	0.00	0.00	0.32	0.29
0.22	0.37	0.00	0.00	0.00	0.27	0.36
0.25	0.33	0.00	0.00	0.00	0.20	0.47
0.27	0.31	0.00	0.00	0.00	0.14	0.55
0.32	0.25	0.00	0.00	0.00	0.00	0.75
0.35	0.14	0.00	0.00	0.00	0.00	0.86
0.36	0.12	0.00	0.00	0.00	0.00	0.88
0.39	0.00	0.00	0.00	0.00	0.00	1.00

portfolios (e.g. Portfolios A and B) have reduced risk and greater performance than the fund that replicates the FTSE100 index, which had the best performance results in equities. On the other hand, constrained portfolios (made up of three funds—one life settlement fund and two fixed income fund—achieved greater returns than the fund that replicated the fixed income fund, AGG:U.S. Bond F).

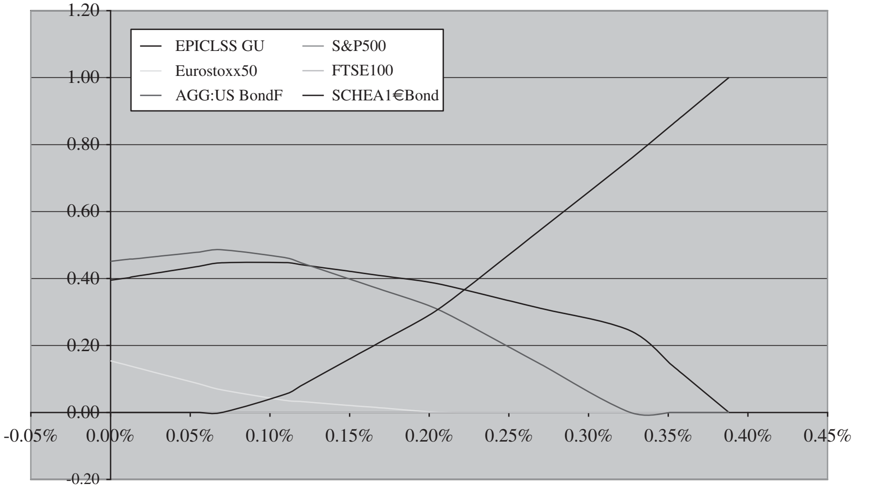

Figure 6. Optimal weightings for the six funds from Portfolio A for the formation of efficient portfolios, with a performance constraint.

In the efficient frontier of Portfolio A (see Figure 3) made up of three funds (one life settlement fund and two funds that replicate fixed income indices), the life settlement fund forms part of the highest yielding efficient portfolio that minimises risk. In addition, as shown in Figure 5, in the efficient frontier of Portfolio A that is formed by six funds (one life settlement fund, two fixed income funds, and three equity funds), the life settlement fund forms part of the best-performing efficient portfolios that also minimises risk.

The results also show that life settlements funds have a lower correlated performance with the fixed income funds and the variable funds and also when compared with each other. This result has the effect of reducing the risk of efficient portfolios, as we show in the formula VAR (*Rp*), introduced in the optimisation tool.

Conclusions

We find that life settlement funds extend the possibilities for portfolio diversification. Our empirical analysis shows that the introduction of life settlement funds in investment strategies by investors produces greater value due to their low correlation with the other financial asset classes—which are even lower than the correlations between fixed income and equity indexes. Thus, we introduce a new type of asset into Markowitz's[9] efficient frontier by combining life settlement funds with traditional investment funds. This funds combination provides greater advantages in portfolio diversification, a key aspect for consideration today, given the greater volatilities in the financial markets.

We obtain these results with 42 EPICL SS GU fund (Portfolio A) and 38 EPICL SC GU fund (Portfolio B) monthly prices. It would be interesting to divide the sample between the pre- and post-crisis period.[31] However, the monthly net asset values

[31] Reddemann *et al*. (2009).

during the pre-crisis period are insufficient (Portfolio A, fund EPICL SS GU) or nonexistent (Portfolio B, fund EPICL SC GU).

We develop the first two stages of Markowitz's[9] portfolio analysis (i.e. the acquisition of efficient portfolios and efficient frontiers). In future research, we expect to introduce the investor utility functions in the assignment decisions. This process requires an analysis of utilisation combinations based on the indifference curves to determine the efficient portfolio that maximises investor utility, namely, the tangent between the indifference curves and the calculated efficient frontier from this study.

One of the limitations of Markowitz's[9] model is that the selection criterion for performance and risk analysis is limited to historic data. In the future, we will apply other models (e.g. Black–Litterman) that calculate the performance as expected returns for longer time periods. Here, however, we cannot apply models based on expected returns due to insufficient data and inability to obtain a reference benchmark for funds with a mix of financial products and assets based on life expectancy. This limitation precludes the use of other models to estimate expected returns.[32]

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[32] Sharpe, *op. cit.*; Black and Litterman, (1991).

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