APPLICATIONS OF DERIVATIVES IN LIFE INSURANCE

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Abstract: Life offices can add value through the appropriate use of derivatives in efficient portfolio management, hedging specific liabilities, enhancing returns and solvency management. However, there are many situations in which derivatives may not be appropriate and many offices are still reluctant to use them. This paper aims to encourage actuaries to consider their use more widely by giving examples of how derivatives can be used together with details of specific cases.

1. Introduction

1.1 A recent ABI paper (Hardwick & Adams, 1999) quoted that in 1995 67 UK life insurers out of a population of approximately 270 reported the use of derivative instruments in their DTI returns, with a total notional value of just over £800m. Using a sample of 88 life offices, the paper showed that the use of derivatives is positively related to the size of the office and that mutuals have a greater propensity to use derivatives than proprietary companies.

1.2 However, many life offices are still reluctant to make use of derivatives, despite the best efforts of derivatives salesmen. Anecdotally, this situation is changing rapidly and some of the larger life companies now use derivatives extensively for a variety of purposes. This paper gives an overview of the different ways derivatives can be used by life offices, but also discusses some cases where they might *not* be appropriate. A similar exercise was carried out last year for pension funds (Kemp et al., 1999).

1.3 The remainder of the paper is structured as follows:

- Section 2 discusses the concept of Efficient Portfolio Management (EPM) and the application of derivatives in this area.
- Section 3 describes the use of derivatives for hedging specific liabilities.
- Section 4 explains a number of uses of derivatives to seek to enhance returns within life funds.
- Section 5 covers life office solvency management using derivatives.
- Section 6 summarises the key conclusions.

There are also a number of appendices containing more details in particular areas:

- Appendix A covers the example of guaranteed annuity options.
- Appendix B demonstrates how to value embedded options which may be exercised “irrationally”.
- Appendix C describes RPI swaps in more detail and how they can be used to generate higher returns than investing in index-linked gilts.

2. Efficient Portfolio Management

2.1 In order to qualify as admissible assets, all derivatives owned by life offices must be for the purpose of either efficient portfolio management (EPM) or reduction of investment risk (as well as passing various other tests explained in Prudential Guidance Note 1995/3). In some instances, discussed in this section, these concepts may encapsulate the underlying reason for holding the derivatives. In others, discussed in later sections, the motivation is different.

2.2 EPM refers to derivative transactions which have the same economic effect as alternative transactions involving the underlying assets but which are cheaper to implement. An example is the use of futures to implement tactical asset allocation (TAA) decisions. To effect a (temporary) switch from, say, US to UK equities, an investor could sell S&P futures and buy FTSE futures. This avoids stamp duty as well as incurring lower execution costs than dealing in the underlying shares. It would, however, be necessary to consider the effect of any tracking error between the share portfolio and the index underlying the sold future.

2.3 Reduction of investment risk is relatively self-explanatory - an example here would be currency forwards used to hedge currency risks inherent in TAA investments. (Of course if TAA has itself been implemented using futures rather than underlying stock then there will essentially be no currency risk to hedge.)

2.4 Another use of derivatives which can count as EPM (but which the Inland Revenue is less keen on) is for tax management purposes. An example would be implementing a strategic asset allocation switch by selling equity futures rather than the underlying equities in order to avoid crystallising capital gains and incurring a tax liability. More flexible swaps can be used in a similar way, to transfer the economic effects of asset ownership between counterparties without transferring the underlying ownership, to such an extent that some people are now describing CGT as a voluntary tax! In practice, the timing of capital gains realisations can be heavily driven by accounting factors under US GAAP and IAS (but not UK GAAP), so that derivatives may be helpful here too.

3. Hedging Specific Liabilities

3.1 Another widespread use of derivatives is to hedge specific liabilities. For example, almost all structured products sold by life offices, such as guaranteed equity bonds and high income bonds, are hedged by the life office buying a matching derivative-based asset from an investment bank. This means that derivatives can be used to design products with payouts structured to look attractive to retail customers (see for example Dodhia & Sheldon 1994). This is a large market, with an estimated £30bn of structured products sold in Europe in 1998. To date most of these products have used equity derivatives to structure payouts that depend on the returns on indices or baskets of shares, but there is now a growth in the use of interest rate and credit derivatives to design products that depend on bond returns. Some very careful wording is often required to ensure the hedging assets attract the desired tax treatment.

3.2 Other examples can arise where a life office wishes to hedge its risk arising from options embedded in more traditional with-profits contracts. A topical case arises from guaranteed annuity options in pension contracts, where life offices have effectively written naked interest rate options with a notional value of tens of billions of pounds. More details of this example are given in Appendix A. In cases like this, care is required to ensure any purchased derivatives are admissible assets for the life fund. If necessary, this may be achievable, at some expense, by embedding the derivative in a listed bond. Another problem can be the cost of buying options to hedge these positions – where demand is high, as has been the case with hedging guaranteed annuity options, the market price of the necessary instruments may seem excessive. In these circumstances, offices may seek to replicate the effect of options through dynamic hedging rather than actually purchasing them. However, the company would still be exposed to the risk of sudden market movements which could not be hedged, or so-called "gap risk".

3.3 Some European insurance companies are starting to take a hedging approach to the whole of their business. For example, the Italian company INA has been quoted as saying "we view our life insurance policies as nothing less than a portfolio of embedded options…We use liquid derivatives to replicate the liability portfolio." (*Risk*, November 1999) More details of their approach can be found in Giraldi et al (2000). The UK actuarial profession also seems to be paying more attention than in the past to the connections between policy guarantees and derivatives markets. For example, Hare et al. (1999) examine the cost of seeking to match with-profits guarantees with purchased equity put options (in fact put spreads) and compare this with a putative cost of using capital to back the guarantees.

3.4 One of the problems with seeking to value and hedge some types of options embedded in policies is irrationality of exercise. Unlike financial market participants, policyholders cannot normally be relied upon to exercise any options in the most financially beneficial way. Appendix B shows how this factor might be taken into account.

4. Enhancing Returns

4.1 A further type of use, which is gaining prominence, can be characterised as return enhancement. Derivatives can be thought of as an additional source of alpha i.e. expected outperformance. Alternatively they may enable the generation of what are effectively new asset classes (e.g. market neutral funds) which exhibit low correlation with traditional assets and can therefore improve the overall portfolio risk/return trade-off.

4.2 One such category of use involves creating synthetic assets. For example, there are very few index-linked corporate bonds in the UK, but an equivalent security can be created by purchasing a standard fixed-interest corporate bond and at the same time entering into an "inflation swap" with an investment bank. This should increase returns over the alternative index-linked gilts. A detailed description of this type of derivative is given in Appendix C. Similarly, the limited supply of high-yield sterling bonds can effectively be increased by the use of high-yield dollar or euro bonds combined with cashflow-matched currency swaps. Credit derivatives could also be used to gain controlled exposure to high-yielding bonds.

4.3 An important consideration here concerns the assets available to the swap counterparty to hedge their exposure. Thus if the investment banks need to buy some of the original paper themselves in order to create synthetic versions of it, then the underlying supply and demand situation has not changed. In the case of inflation swaps, the ability of banks to find alternative sources of inflation-linked cashflows, such as some PFI projects rather than just index-linked gilts, is therefore important.

4.4 Derivatives can also be used to enhance returns by exploiting investment views. For example, if it is believed that further equity market upside is limited, then this view can be backed by writing out-of-the-money call options on the index (assuming the underlying stocks are held in the portfolio). Yields are then enhanced by generating premium income, at the expense of limiting potential upside if the view turns out to be wrong. Alternatively yields on a bond portfolio could be enhanced through the purchase of callable bonds. This is equivalent to selling an interest rate option, since the bond issuer has the right to repay the bond if interest rates fall and will therefore be prepared to pay a higher coupon initially for this right.

4.5 Other possible strategies for enhancing returns start to look more like those adopted by hedge funds. For example, if option implied volatilities are high, options can be systematically written at the same time as delta hedging the underlying positions. Alternatively, options can be bought and sold on different markets to exploit apparent anomalies (e.g. between sterling and euro swap rates and volatilities). One potentially important factor here is that life funds do not need to worry quite so much as hedge funds about the mark-to-market value of their assets – they are concerned with the value of assets minus liabilities, which is less volatile due to the long term nature of the liabilities and discretion over bonus levels. However, it is obviously important to consider policyholders' reasonable expectations and whether or not these are likely to be met by undertaking such investment strategies.

5. Solvency Management

5.1 Risks to the solvency of a life office generally arise from a mismatch between the office's assets and its liabilities. The typical UK office will be exposed to falling equity values relative to bonds. If the company were concerned about falling solvency levels but wanted to maintain its levels of equity investments, it could purchase equity put options to provide protection against a fall in equity values. This possibility was investigated by an Institute/Faculty Research Working Party which reported in June 1997. They concluded that using put options was a viable alternative to reducing equity holdings. Another way to address this problem is to buy relative performance options which provide a payout if equities perform worse than bonds.

5.2 However, such options may be expensive and may affect the relative solvency of the office compared to other companies if the scenario guarded against does not occur. In practice companies may be more worried about this effect on relative solvency and the resulting loss of competitive position than the potential effect on absolute solvency that would affect all companies.

5.3 It should be noted in passing that some proposed uses of derivatives in this area are effectively just smoke and mirrors and are prohibited by actuarial professional guidance notes. This applies to so-called "window-dressing", where solvency protection is only purchased around the time of the office's annual reporting to bolster the apparent position of the fund. Another example is the use of futures to shift the effective asset allocation from bonds to equities whilst continuing to take credit for the higher yield on bonds (which would bolster the reported solvency). In other words it is necessary to look through to the true underlying economic exposures.

5.4 In the US, life companies generally have the bulk of their investments in fixed interest assets. They are therefore exposed to changes in interest rates. Some companies use derivatives to protect solvency in the event of adverse movements in interest rates. For example, Prudential's US subsidiary Jackson National Life was recently quoted as having the largest swaption portfolio amongst US insurance companies, totalling $34.5bn notional value (*Risk*, March 1999). These are generally long-dated deep out-of-the-money swaptions and so are actually relatively inexpensive to purchase.

6. Conclusions

6.1 This paper has reviewed many possible uses of derivatives by life offices for the purposes of:

- efficient portfolio management,
- hedging specific liabilities,
- enhancing returns, and
- solvency management

and commented on their increasing use. The authors believe there is further scope for life offices to add value through the appropriate use of derivatives.

6.2 However, a number of caveats have also been sounded in the paper in terms of ensuring:

- careful wording of contract terms to ensure admissibility and the desired tax treatment,
- market prices of derivatives are not distorted by excessive demand,
- investments are appropriate in the context of PRE, and
- protection reflects the true objectives of the business, e.g. considering relative solvency as well as absolute solvency.

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Appendix A: Guaranteed Annuity Options

A.1 This appendix provides an introduction to the subject of guaranteed annuity options (GAOs), which have been much in the news in recent years (see for example Bolton et al 1997 and Bezooyen et al 1998). We explain what GAOs are, how big the problem is, and what can be done about it.

A.2 During the 1970s and 1980s, UK life offices sold large numbers of pensions policies in which the fund accumulated at retirement could be converted into an annuity at a guaranteed minimum rate. This is equivalent to an interest rate option, since retiring policyholders can choose to use the higher of the guaranteed annuity rate and the currently available market rate (the higher the interest rate used, the larger the level of pension).

A.3 The level of guarantee offered was normally determined by marketing considerations. Some companies only offered low levels of guarantee (e.g. an effective guarantee of 3% interest), but a typical rate would have been £1 of pension for every £9 of accumulated fund. Using the mortality tables then current, this was equivalent to an interest rate of 6.5% with no allowance for expenses.

A.4 At the time these guarantees were issued, the high level of interest rates meant the options had little or no financial value. However, the decline in interest rates over the past 25 years means these annuity guarantees now have significant value. The problem has been aggravated by greater than expected improvements in life expectancy over the period, which have added around 1% to the equivalent guaranteed interest rate.

A.5 There has been considerable confusion in the press about the magnitude of the GAO problem for the UK life industry. The size of the accumulated funds to which a guaranteed annuity rate applies is currently estimated to be of the order of £40bn, with the expected cost of meeting the guarantees estimated at around £10bn.

A.6 No new policies are being sold in the UK with this type of guarantee, although top-ups to existing policies may still obtain a guarantee. In addition, a similar situation can arise as a result of pensions misselling – some life offices have offered policyholders a guarantee that they will be no worse off with a personal pension than they would have been in their company’s defined benefit scheme. This effectively creates a guaranteed annuity which can be mitigated by good investment returns.

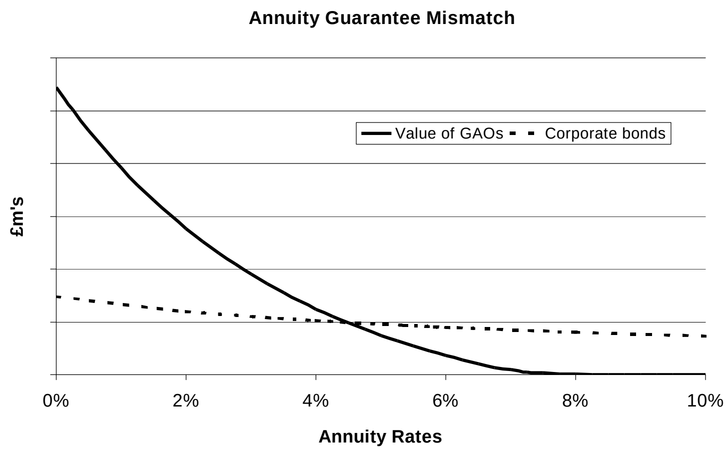
A.7 How life offices have reacted to the GAO issue depends on the type of policies they sold. For unit-linked policies, the benefits payable will depend on investment performance. For with-profits policies, the benefits depend on the bonuses declared, and here there is more scope for actuarial discretion to adjust bonuses to reflect the cost of providing the guarantees. In general it is likely that high equity returns will exacerbate the problem for unit-linked policies (by increasing the size of the funds to which the guarantees apply) but reduce the problem for with-profits policies (by increasing the investment surplus).

A.8 The response of individual life offices also depends on the amount of relevant business written and the financial strength of the office. It has been claimed that some offices are seeking to reduce the cost by using the small print of contracts to devalue the policyholders' guarantees. At the time of writing, the outcome of a High Court appeal by Equitable Life seeking to justify their approach is outstanding. The outcome of this case could have implications for the reputation and financial strength of the whole industry.

A.9 When policies containing GAOs were first issued, there were no appropriate hedging instruments available. Life offices therefore had no choice but to run the option risk within their own funds. Most would have been happy to do this anyway since the options were effectively a long way out-of-the-money (i.e. the guarantees were at a low enough level that the chances of them being exercised were considered negligible).

A.10 Today the situation is different. Many GAOs are already in-the-money (i.e. the guaranteed annuity rates are better than those available in the market) and may become even more valuable if interest rates fall further. In addition, it is now possible to purchase interest rate options (such as "receiver swaptions") to reduce future uncertainty as to the cost of meeting the guarantees

A.11 The problem if options are *not* purchased is to find assets of sufficient duration to match the liability. This is because of the geared nature of the value of the guarantees – a small reduction in interest rates would result in a large increase in value. This is illustrated in the chart below which shows the estimated value of a portfolio of GAOs at different interest rates compared to that of a typical portfolio of corporate bonds.



A.12 The problem if options *are* purchased is that this effectively locks in any losses from the guarantees – the option premium has been spent even if interest rates subsequently rise and the options expire worthless. In addition, the price of the options would reflect the possibility that interest rates could fall further before the policyholders retire (the "time value" of the options) as well as the current value if the options were exercised immediately (the "intrinsic value" of the options). As a result the options may appear expensive. However, this is arguably just a reflection of the true cost of providing the guarantees given.

A.13 There is a further set of issues which life offices need to address before seeking to access options markets to hedge their GAO liability:

(i) *admissibility* - there are questions over the admissibility of certain hedging assets in counting towards the solvency of life funds. Since it would normally be the less solvent offices that would be interested in hedging, these questions would obviously need to be resolved. However, in January 1999 the UK regulators confirmed that they would not seek to interpret guidelines too inflexibly in this area.

(ii) *liability valuation* – the maximum discount rate that can be used to value liabilities depends on the yield on the assets held. Since options have zero yield, there may be a knock-on effect on the liability valuation if bonds are replaced with swaptions. This would depend on the type of product involved and the method of valuation but would clearly need to be considered in assessing the overall impact on published solvency.

(iii) *amount to hedge* – since not all policyholders can be expected to exercise their GAOs even if they are potentially financially valuable, fully hedging the statutory liability will tend to overhedge the realistic current liability. On the other hand, this overhedging could provide an element of hedging of liabilities which are likely to be created by future bonus declarations.

(iv) *type of hedge* – whilst sterling receiver swaptions can be described as the "standard" hedge for the liabilities, a number of alternatives can also be considered. For example, option prices, liquidity and the term structure of interest rates all suggest that hedging in euros may be advantageous. Other possibilities include purchasing puttable bonds, whilst in some cases linking the option payout to equity returns may be appropriate.

A.14 In addition, the capacity of options markets to absorb trades of the size needed to have a significant effect on the overall GAO problem has been a problem. Potential demand has posed a strain on market liquidity and there is therefore a danger that the market impact of any attempted hedging action would be prohibitive. Despite this, recent estimates by dealers put the volume of transactions carried out so far at £10-15bn (*Risk*, December 1999).

Appendix B: Valuing Irrationally Exercised Embedded Options

B.1 As mentioned in section 4, option valuation techniques might help actuaries to value embedded guarantees and actuarial discretion more accurately[1]. A number of attempts have recently been made to bring these techniques closer to the actuarial community. However, there are some additional difficulties with these embedded options, a major one being "irrationality" of exercise[2]. In practice, and in the absence of an accepted objective evaluation methodology, actuaries exercise judgement, with this judgement often being a function of the purpose of the valuation and prudence often being an overriding principle.

B.2 This appendix demonstrates how to evaluate such "irrationality" in general, **using the transaction costs approach**[3]. We borrow this concept from Van Deventer and Imai (1996) who demonstrate how the method can be used for valuing mortgage backed securities and banks' liabilities. We find this concept simultaneously intuitive and technically sound and we believe that it could be extended to valuing embedded guarantees and actuarial discretion in the context of life insurance products as well as defined benefit pension plans.

B.3 The main idea is to quantify the fact that embedded options are not always exercised in accordance with the option writer (e.g. life company) expectations (of option holder rationality). For instance, when a holder of a European style call option is not entirely rational, the option will no longer be exercised when, at the exercise date, the underlying security price reaches the exercise level (K). Rather, to exercise the option, the exercise level will have to be at a level greater than K i.e. K+X(), X()>=0, where X() is termed the transaction costs function and represents all "irrational" factors influencing

[1] In particular, interest rate option techniques could be adapted to value policy guarantees. We need to adopt a suitable stochastic term structure model in order to value interest rate options. In this paper we adopt a Vasicek term structure model and Jamshidian's option valuation formula.

[2] For example, a member of a pension scheme could be better off retiring early simply on financial terms (e.g. the present value of his early retirement benefits is greater than the present value of normal retirement benefits), but he may decide to carry on working for reasons other than size of his early retirement pension and the option to retire early would not be exercised. The question is then, what is the cost (in terms of pension present value) that he would be willing to sacrifice in order to carry on working?

[3] For example, consider fixed-rate mortgages in the US, where many borrowers fail to prepay when current mortgage rates have fallen below the rate on their loan. Apparent irrationality can often be explained by other factors not related to the financing costs (e.g. the opportunity cost of the time spent carrying out the refinancing transaction).

one's decision outside the conventional option valuation framework. We term these factors "irrational" purely from the perspective of the option writer – from the point of view of each option holder the factors may not be irrational at all, but perfectly plausible. In other words, our conventional option valuation models cannot take into account the additional data required to value these factors. Generally, the transaction costs function X() can be modelled using econometric techniques and can be a function of time to expiry, time from inception, opportunity cost, calendar month, etc.

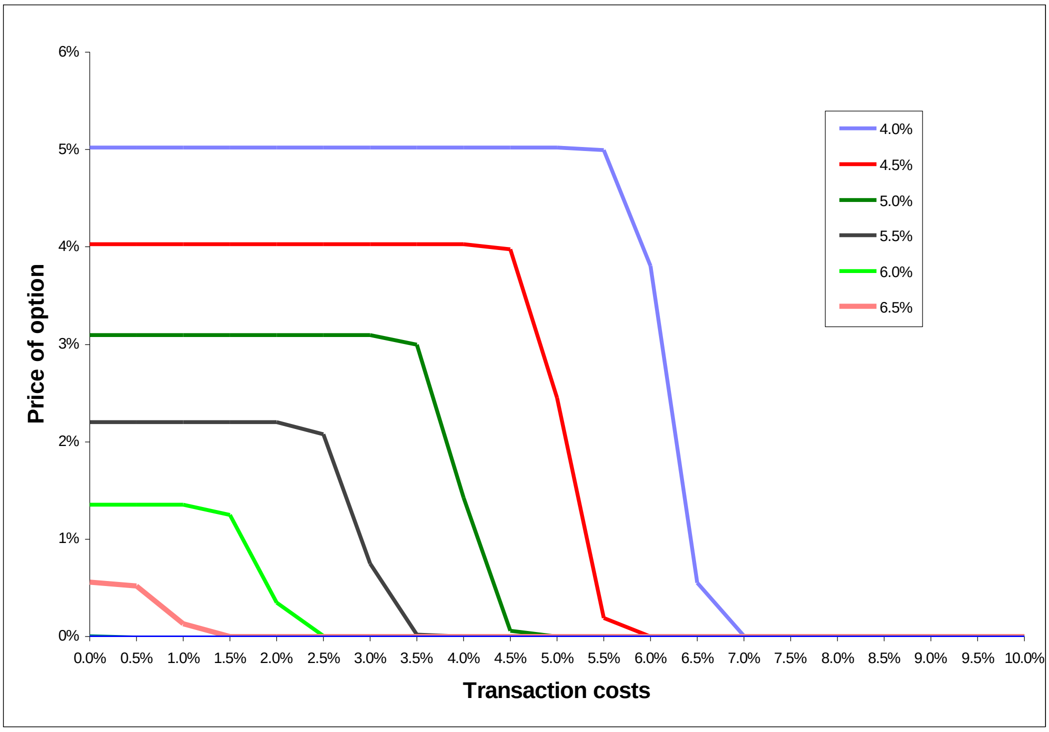
B.4 For a rational investor the transaction costs are equal to zero as such an investor would always exercise the option when the price of the underlying security exceeds K. For a totally irrational investor the value of the underlying against the exercise price would make no difference and X() is equal to infinity for such an investor. The function X() will always be bounded by these two extreme examples for any level of "irrationality".

B.5 In order to demonstrate how to value "irrationality" we need to be able to value (rationally exercised) options in the first place. For this purpose, we assume that interest rates behave in accordance with the Vasicek single factor term structure model with the following parameters:

equilibrium short rate of interest = 5%
speed of mean reversion = 0.08
volatility of short rate = 1.5%
market price of risk = 0.01

B.6 The exhibit below demonstrates the sensitivity, with respect to "irrationality" level (as measured by the transaction cost level) and the short term interest rate, of the European call option on a 10 year zero coupon bond exercisable in 5 years with a strike of 0.75[4].

[4] An analogy could be made with an early or a late retirement case (a single cashflow valuation by zero coupon bond can be readily extended for annuity valuations). For instance let us assume that an individual has reached retirement age of 60 and is thinking about retiring late at 65. If he (or she) were entirely rational, he would compare the present values of his normal and late retirement benefits and decide on his course of action by selecting the greater one. If he were entirely irrational (from the pension scheme's perspective) he would ignore the valuation of the benefits when selecting his course of action. In the example we model the cost of the optionality as a function of irrationality as measured by the level of transaction costs.



B.7 The exhibit shows complex changes in the value of this option as the short-term interest rate varies between 4% and 6.5% and when the transaction costs range between 0% and 10%. The combination of interest rate levels and transaction costs results in the transition from the price of the option with a rationally exercised option to the 0% price of the irrationally exercised option (i.e. no option). It is interesting to note that the price of the option does not linearly decrease with the transaction costs rate. Rather, the transaction costs have no effect on the price up to a certain critical level after which the price quite sharply decreases to zero. As interest rates fall, call options become more expensive and higher levels of transaction costs are needed to make an impact on option prices.

B.8 It is clear that the ability to hedge irrationally exercised options follows directly from the ability to value these options and this in turn depends on the ability to evaluate transaction costs X(). In the case of securities involving irrationally exercised options such as mortgage backed securities, the transaction costs function *can be implied from the market prices* of these securities. However, this method cannot work where prices are not directly observable, such as insurance or pension liabilities.

Appendix C: RPI Swaps

C.1 Traditional inflation-linked assets consist primarily of index-linked (IL) gilts, and their corporate equivalents. However, liquidity in IL gilts is poor, and much worse for corporate IL bonds. Furthermore IL gilts deny the investor the opportunity to earn additional returns by the management of credit risk within the portfolio, and given the paucity of new IL corporate bond issuance, the investor's hands appear to be tied. This drives us to the OTC (Over The Counter) derivatives solution, RPI Swaps.

C.2 When considering swaps it is perhaps useful to think first of a "standard" interest rate swap. The swap is in effect the exchange of two sets of cashflow. Each set is called a leg, and the leg we pay is called, unsurprisingly, the "pay leg", and the other the "receive leg". For a standard transaction then, suppose we enter into a swap to pay "fixed" over 10 years. Because this is a standard transaction we know that if one leg is "fixed" then the other is "floating". Floating rates are nearly always stated relative to LIBOR, which is an independent mechanistic determination of what average bank deposit rates are at 11:00am each day, quoted widely in the press, etc. Fixed rates are simply quoted as a percentage, and an indication of whether this is annual, semi-annual, or quarterly. So our swap may be to pay 6% semi-annually and receive 6 month LIBOR + 0.1% every 6 months. In order to determine the magnitude of the payments, the swap must operate on an agreed nominal value (or "notional"). Suppose that our swap was on £10m notional, and that we are 6 months into the life of the swap. Suppose also that at the outset of the agreement 6 month LIBOR was 5%, and now it is 5.5%. The payments that must be made therefore are:

We pay 6% * ½ (year) * £10m (notional) = £300,000
We receive 5.1% (5% + 0.1%) * ½ (year) * £10m (notional) = £255,000

Also note that in a further 6 months we must pay 6% * ½ * £10m = £300,000
to receive 5.6% (the re-fixed floating leg) * ½ * £10m = £280,000

and 6 months further we pay 6% * ½ * £10m = £300,000
to receive L+0.1% * ½ * £10m = £Unknown (Where L is the LIBOR fix 6 months prior to the payment date)

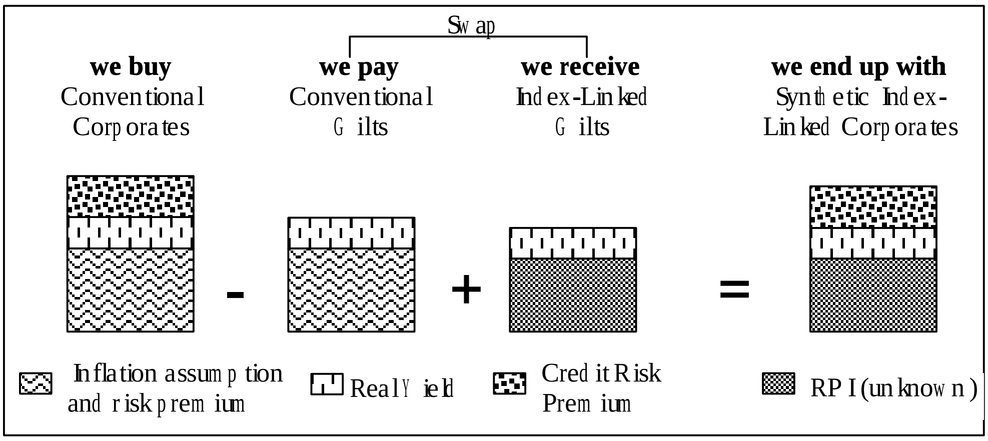
C.3 This example highlights two things. Firstly, given that we pay nothing to enter into the swap at the outset, and given that it is composed of two legs, for the swap to be fair value the present value of everything in the pay leg should equal the present value of everything in the receive leg. It is therefore necessary to have some form of assessment of what LIBOR will turn out to be, in order that a best guess of the "£Unknown" amounts can be made. Interestingly, swaps traders do not take a view on LIBOR based on their own hunches, rather they work out what "the market" anticipates LIBOR to be from other assets such as deposits, bonds and FRAs i.e. Floating Rate Agreements (as well as other people's swaps prices). Given a best guess at LIBOR implied by these instruments (and assuming that they are unable to do an equal and offsetting swap with someone else at the time of the trade), a swap trader can use those other instruments to hedge out their exposure to movements in LIBOR. So given the assessment of LIBOR as above, the swaps trader can either adjust the fixed rate we must pay, or the margin relative to LIBOR we receive, in order that both legs balance. An easy way of thinking about this is that the 6% fixed rate is today's assessment of the "average" rate that LIBOR will be over the life of the swap. At the outset, since both legs balance, the net market value of the swap is zero. Suppose that a little way down the road the market expectations of LIBOR have moved up significantly. A new swap may have a fixed pay leg of , say, 7% to receive LIBOR, and our swap (into which we must pay a meagre 6%) looks attractive. This manifests itself by the Swap having a positive mark to market value (because the pay leg on our swap now has a lower present value than the receive leg).

C.4 The second thing this example shows is that the value of the swap is determined by some very technical, but highly methodical and, once understood, transparent factors. There is no black magic here, but a precise understanding of the details of the swap needs to be agreed. For example, what if one of the six monthly dates fell on a weekend when LIBOR is not published? What value do you use (Friday or Monday)? Detail such as this is gone into at length with each potential counterparty before any deals are done, and agreed in the form of an "ISDA Master Document". This is an overseeing agreement between the two counterparties constructed according to the guidelines of the International Swaps and Derivatives Association (ISDA). This agreement is between the fund and the counterparty, and not between the fund manager and the counterparty, and contains important clauses concerning what happens if ownership is transferred, parental guarantees etc. Because of the bespoke and often unusual aspects of swaps trades an important problem with them is illiquidity. Though it will always be possible to cancel or nullify the effects of a swap at some point in the future, this will not necessarily be easy and will almost always incur costs for the fund: trading swaps is not like trading bonds, futures or other liquid instruments.

C.5 Swaps trades can be very diverse, with payments linked to interest rates, equity indices, currencies, property values, etc, etc. However, they all share the same basic structure: a legal agreement between two counterparties in which one party pays the other a set of cashflows either fixed or linked to an underlying instrument/index according to some pre-defined rules, in exchange for receiving other cashflows determined by a different set of rules. Swaps have an initial market value of zero, and will rise or fall in value depending on how markets move relative to the rules put in place at the outset. An important point is that if the rules are constructed to meet the requirements of the fund, and the transaction is not terminated before maturity, then this mark-to-market fluctuation is an accounting phenomenon and does not undermine the validity of the swap. This is analogous to a bond investment: a bond that is successfully held to maturity will have paid coupon and interest payments as expected notwithstanding any fluctuations in price over its life.

C.6 RPI swaps are no exception to the generic swap type. A typical use of them, for example within an Annuity fund, would involve a fixed pay leg and a floating receive leg. However, the floating receive rate is linked to the RPI index and not interest rates as before. The way the trade is structured is based upon a series of nominal cashflows, say £10m per annum for the next 10 years. The swap will pay to us the inflation adjusted value of these cashflows over time, so if the RPI index rises by 3% in year 1 and 3.5% in year two, we will receive £10.3m (=10m x 1.03) in year one, and approx. £10.66m in year two (=10m x 1.03 x 1.035) etc. We pay into this swap the £10m per annum adjusted for a fixed compound rate. As before, this fixed compound rate can be thought of as the market neutral assessment of "average" inflation over the next 10 years. Suppose this rate is 3.8%, then we must pay into the swap £10.38m (10m x 1.038) in year one and £10.77m (10m x 1.038 x 1.038) in year two and so on. Given we know what payments we have to make into the swap in advance, we can buy a portfolio of conventional bonds that deliver the appropriate flows (from their known coupon and redemption flows). The greater the credit risk we take on within the fixed interest or "conventional" bond portfolio, the higher the yield and the lower the market value of the securities we need to buy (or put another way for a given market value of investment, higher yield implies we will be able to pay greater amounts into the swap, and therefore receive greater amounts out of the swap).

C.7 As before, the swaps trader will look at other assets (in this case index-linked and conventional gilts) to determine the market pricing for future inflation, and can use these bonds as hedging assets. Effectively the swap is akin to selling conventional gilts (the fixed pay leg) and purchasing index-linked gilts. So by buying conventional corporate bonds and entering into the swap, we effectively have corporates - conventional gilts + IL gilts as in the diagram.



C.8 As you can see, by implementing a trade in the way shown, we have effectively created synthetic corporate bonds, that is an asset that pays us an RPI linked return, but with an additional credit risk premium. Naturally, this is a more complex transaction than simply purchasing an index-linked corporate bond, and so the cost of gaining exposure in this way is a little higher than would be the case if one were to directly purchase IL corporate bonds. However, given the scarcity of these IL corporate bonds, the more liquid alternative would be to simply purchase IL gilts, and thus forgo the significant credit risk premium.

C.9 Example transactions to date have involved an investment in AA or A long dated bonds, in conjunction with a swap, and have locked into real returns of around 3.5%. This compares to the returns available in IL gilts of 1.7% at the time, and comparing this to the credit spread on the underlying corporate bonds shows the cost of the transaction to be around 0.1% to 0.15%.