Pricing Inefficiencies in Private Real Estate Markets Using Total Return Swaps

Colin Lizieri[(1)], Gianluca Marcato[(2)], Paul Ogden[(3)] and Andrew Baum[(4)]

Working Paper

[Current draft: 28 December 2008]

[Please do not quote without the authors' consent]

(1) School of Real Estate & Planning, Henley Business School, University of Reading, Whiteknights, Reading, RG6 6AW, United Kingdom. Email: c.m.lizieri@reading.ac.uk

(2) ** *author for correspondence* ** School of Real Estate & Planning, Henley Business School, University of Reading, Whiteknights, Reading, RG6 6AW, United Kingdom. Email: g.marcato@reading.ac.uk, Tel: +44 118 3788178, Fax: +44 118 3788172.

(3) RPM Investment Management LLP, 84 Aberdeen Park, London, N5 2BE, Email: paul.ogden@rpmim.com

(4) School of Real Estate & Planning Henley Business School, University of Reading, Whiteknights, Reading, RG6 6AW, United Kingdom, Email: a.e.baum@reading.ac.uk

Pricing Inefficiencies in Private Real Estate Market Using Total Return Swaps

1. Introduction

In this paper, we examine the evolving UK market for total return swaps based on the Investment Property Databank index. The total return swaps market is the first actively traded commercial real estate derivatives market and is part of a global trend to create hedging and derivatives vehicles for the real estate market. As at the third quarter of 2008, IPD reported outstanding notional principal of $16billion and over 1500 transactions since the market's initiation in 2004. Total return swaps involve an exchange of returns based on IPD returns and returns based on LIBOR plus or minus a margin or spread.

In contrast to the spreads found in, for example, equity index swaps, the spreads for real estate total return swaps have been large, hundreds of basis points. This paper, building on prior research for the Investment Property Forum (Baum *et al.* 2006), explores the reasons for such spreads. Are they a result of pricing inefficiencies and uncertainties in an immature market, or are they rational, given the nature of the underlying asset market and the problems involved in creating a self-financing arbitrage portfolio? To preview our findings, we will show that transaction costs and heterogeneity results in there being a rational "trading window" around the expected zero spread over LIBOR. Actual trades should occur in that window, with the position of the "consensus" trade depending on the balance between those seeking long and those seeking short positions which, in turn, is linked to asset market sentiment. As the market grows to achieve critical mass and liquidity, one might expect the width of the trading window to shrink.

We begin with a brief introduction to the total returns swap market, looking at the structure of the swap vehicle and at trading volumes. Next, we consider pricing principles in swaps markets and their applicability to the real estate market. We set out some of the reasons why the spread might vary from the expected zero spread and consider whether spreads might be time varying. Section four sets out our pricing model which generates our “rational trading results”. We then present empirical results before drawing some general conclusions.

2. The Total Return Swaps Market

Commercial real estate was arguably, until recently, the only major asset class without a well-developed derivatives market. Early attempts to establish such a market in the United Kingdom were unable to achieve critical mass or trading volume. In particular, in the property forwards markets created on London FOX in 1991, lack of trading led to insider deals and cross-trading to present the illusion of activity. The failure of FOX was damaging for the development of a market for property derivatives, blighting attitudes of investors and regulators alike. Allied to regulatory constraints and unfavourable tax treatment which, in large measure, excluded institutional investors from participating in such markets, this meant that there was little activity during the 1990s, despite the work of energetic advocates from the industry.

In 1994 BZW launched Property Index Certificates (PICs), more recently rebranded as Property Linked Notes. PICS are structured as Eurobonds with coupon payments linked to IPD index income returns each year, and a capital redemption value linked to the IPD All Property capital gain over the life of the certificate. If acquired at par, this instrument effectively replicates IPD returns (less any dealing fees and spreads) for the bond holder, although any exit before maturity may result in a tracking error. They provide a low entry cost means of investing in commercial real estate but are somewhat inflexible as a hedging tool.

The UK property industry continued to seek a derivative vehicle that would facilitate strategic and tactical portfolio management and enable investors to alter their exposure to real estate quickly and without incurring high transaction costs or being exposed to public market price volatility. However, attempts were hamstrung by complications concerning regulatory requirements (in particular whether they were admissible investment assets for institutional investors), by the tax treatment of property derivative cash flows and by concerns about the nature of the underlying property market indices.

Industry groups continued to lobby Government for a relaxation of the constraints on investment in, and trading of, commercial real estate derivatives, making progress at the turn of the century. In 2002, the Financial Services Authority confirmed that life insurance companies could use property derivatives for efficient portfolio management. Taxation issues were largely resolved in 2003, when the Inland Revenue confirmed that property derivatives would fall into the 'standard' derivatives regime, with net cash flows subject to income, not capital gains, tax. This was confirmed in the 2004 Finance Act. Finally, the 2004 FSA collective investment scheme sourcebook allowed authorised retail and non-retail funds to hold property derivatives as investments. By 2005 most of the regulatory restrictions on the development of a property derivatives market had been lifted.

Commercial real estate index total return swaps have been traded in the UK since early 2005, once regulatory issues for institutional investors were resolved. During this period, a degree of standardisation of commercial terms has occurred. It is the standard form of total return swap commonly traded in the inter-bank market which is the focus of analysis in this paper. The UK market grew very rapidly, with outstanding notional principal passing the £1billion mark by the end of 2005, £6billion by the end of 2006 and £9billion by the end of 2007 (see Exhibit 1). By Q2 2008, the notional value of trades had surpassed £10billion, with over 1,400 trades executed. Although trading volume fell as underlying asset market conditions worsened, there were still over 600 trades in the first three quarters of 2008.

Developments in the UK form part of a wider global move towards the creation of property derivatives. In the US market, the development of derivative products in the real estate market is also quite recent, although the first real estate-linked swap was launched in 1991. Fisher (2005) describes a total return swap announced and to be offered by Credit Suisse First Boston (CSFB) in the USA. The credit for each contract would be backed by CSFB which will play a role as counterparty in an exchange of property returns – based on the NCREIF Property Index (NPI), either total return or capital growth – and priced at a spread which could be either positive or negative, depending upon market conditions. NCREIF index swap closing levels are now available on-line but, anecdotally, trading volumes remain thin. In 2006 Real Capital Analytics and MIT announced a set of indices tracking US commercial property prices which were designed to be the basis for derivative trading. CMBS Swaps have existed for some time, based on the Lehman or Bank of America CMBS indices. In 2006, the S&P CME housing futures and options contracts were launched in Chicago, based on the Shiller-Weiss indices.

More recently, it was announced that US real estate index trading would not be subject to the Foreign Investment in Real Property Tax Act, opening up the possibility of more active non-US trading. There is an active Listed Property Trust futures contract on the Australian Stock Exchange, there are exchange traded products based on the EPRA indices, residential property derivatives have been traded in Switzerland and Sweden and commercial real estate total return swaps based on IPD indices have been traded in Australia, Canada France, Germany and Japan.

[INSERT EXHIBIT 1 HERE]

Once established, derivatives markets tend to display similar growths in traded volumes. Good examples of this include credit derivatives and freight derivatives both of which have shown exponential growth over prolonged periods. In these cases the market started with a steady but not too spectacular growth rate during which time participants were being introduced to the product and standardisation of documentation and commercial terms was occurring. Within a few years derivatives cease to be treated as stand alone products and become part of the core activities of players in the underlying market. Once this occurs volumes can rapidly grow to exceed the underlying market size.

The basic structure of the UK is as an over the counter contract for difference where parties swap an annual Investment Property Databank (IPD) property total return index for an interest rate product. In the initial development of the total return swaps market, the standard contract was based on 3 Month LIBOR plus or minus a spread (or margin) expressed in basis points. The IPD leg accrued over a calendar year and settles on the last business day of the March following the year end. The LIBOR leg accrued over a three month period corresponding to calendar quarters settling on the last business day of the quarter (that is, the last business days of March, June, September or December). More recently, there has been a shift towards a simplified annual contract / fixed interest basis but here we analyse the original contract since the spreads reported in the market place reflect that structure[1].

Deviations from these cash flows may occur at the start of a swap. The initial index level used to calculate the first IPD cash flow is, by market convention, the most recently published IPD monthly estimate of the annual total return. These indices are typically published two weeks after the end of each month. This has the effect of giving the swaps a retrospective start date of between two and six weeks. The LIBOR leg starts to accrue on the same date as the IPD leg. To fit with standard quarterly settlements, the first LIBOR payment may be in the form of a one or two month short-stub or, very occasionally when a payment would be due before the trade date, a four month long-stub. In these cases the relevant one, two or four month LIBOR rate is used.

There are a number of significant differences between this structure and most other forms of financial market swap. Most notable is the retro start. This is necessary, as there will always be a delay between the index date and the publication of the index for property whereas in equities or rates the initial index can be set at the moment that the trade is done. The settlement of the IPD leg is also affected by the delay in publication of property indices. Currently the standard settlement for the IPD leg is at the end of March, reflecting the publication of the annual results.

---

[1] The move to a fixed interest rate does not alter the basis of our analysis since investors could easily have swapped out the floating LIBOR payments for fixed in the interest rate swaps market.

Another significant difference is that the cash flows are not settled with the same frequency (see Exhibit 2). There will be a number of LIBOR payments made before the first IPD payment is due. This does, in principle, give rise to both pricing and counterparty credit issues although most trades, while OTC, are backed by investment banks as the “effective” counterparties.

[INSERT EXHIBIT 2 HERE]

The remainder of the paper focuses on the spreads above or below LIBOR. These have fluctuated considerably over the short life of the UK total return swap (see Exhibit 3] and are increasingly treated as a forward indicator of property market returns. This is not the case for equity market index swaps where the spreads over LIBOR are very close to zero. Are the differences observed in real estate markets a function of the particular characteristics of the underlying asset class or do they represent some mispricing of risk and return in the initial development of the market?

[INSERT EXHIBIT 3 HERE]

3. Swap Pricing Principles and the Real Estate Market

The starting point for a consideration of swap pricing comes from the literature on the pricing of interest rate swaps, which developed from the 1980s. Most contemporary pricing models are based on an arbitrage-free efficient market model where the price reflects the ability to create a self-financing arbitrage portfolio. Swaps are thus typically modelled as a portfolio of “swaplets” – typically either as a series of short-term interest forward contracts or FRAs or by the investors going long in a floating bond and short in a fixed rate bond (see reviews in Minton, 1997, Klein, 2004, for example). Two broad interrelated controversies emerge from the literature: one concerning the extent to which swap prices are consistent with interest forward and future prices, the other concerned with counter-party risk.

Since there is limited liquidity in the FRA market, analysis typically draws on price data from interest rate forward and futures markets. These turn out to be incomplete in explaining swap prices. The gaps in explanation have been attributed to differential counterparty default risk (related to the “comparative advantage” explanation of the added value of swap contracts) – for example in Jarrow and Turnbull (1995). The relevance of counterparty risk has been disputed and dismissed (see, for example, Litzenberger, 1992; Collin-Dufresne and Solnik, 2001). The loss on default from a swap is low compared to the underlying asset since no principal is exchanged and treatment of swaps in default is favourable. Further, swaps are generally brokered by a market maker, who stands between the parties and, *de facto,* offers a guarantee. Swap prices are set at market levels and lower credit risk parties do not pay different rates to higher rated parties (although their access to the market may be constrained) ‘*quoted swap rates do not reflect credit rating differences between the counterparties; i.e firms do not pay up to do swaps with highly rated counterparties’* (Litzenberger, *op cit.*).

The difference between swap rates and interest future rates has been explained in terms of differences in cash settlement procedures of the two instruments. Gupta and Subrahmanyam (2000) explain differences in the Eurocurrency futures curve and swap curves as resulting from a ‘convexity bias’ caused by mark to market adjustments in the futures market (causing correlation between overnight interest rates and futures prices). After adjusting for these factors, the appropriate fixed rate for a swap contract eliminates any arbitrage opportunities, producing zero net present values on a risk adjusted basis. It should be noted that the pricing anomalies found by researchers with respect to convexity biases (and, indeed, counterparty default risk, if this is accepted) are very small.

Swaps are brokered, and the market maker will charge a small fee for setting up the deal and matching parties, for warehousing deals, for accepting inventory risk and to cover the (average) risk of counterparty default. The same applies to currency swaps, which, in principal, could be replicated with a series of currency forward agreements or futures. Arbitrage principles this ensure that the spreads are very low.

In considering financial market swaps – for example, parties swapping returns based on an equity market index for LIBOR-based interest rate payments – the same arbitrage principles apply. While the equity market expected return might be higher than forward expectations of interest rates, the existence of an investible underlying asset anchors spreads around LIBOR to very low numbers. The investor receiving LIBOR can use the cash flow to support borrowing that, in turn, can be used to acquire the appropriate index tracking equity portfolio. Given that this is a riskless portfolio, the price of the interest rate leg should be set to ensure that the swap does not generate excess, abnormal returns. There are small transaction costs in acquiring the matching portfolio and small carry costs in managing the portfolio, but, amortised over the life of the swap, these will be marginal.

A common principle here is that a riskless, self-financing portfolio can in practice be created by an investor. In all cases, a perfectly matched long/short position can be acquired with reasonably low transaction costs. As a result, expected cash flows can be discounted at the risk free rate, and differences in risk between the swapped assets become irrelevant. More importantly, *differences in expected returns* also become irrelevant. The only reason for a spread, then, relates to the costs involved in creating the position.

This principle forms the basis of the theoretical models of real estate derivative pricing introduced by Titman and Torous (1989), Buttimer *et al.* (1997), Bjork and Clapham (2002) and Clapham *et al.* (2006). Such models produce low to zero spreads over the matching interest rate return. Other authors have noted that drawing direct analogies with interest rate and equity index swaps is problematic. Park and Switzer (1996) note problems of basis risk (when the assembled portfolio does not track the market index); Okata and Kawaguchi (2003) note problems of swap pricing in incomplete markets where the underlying asset is indivisible, has high transaction costs, limited liquidity and unobservable fundamental prices. Patel & Pereira (2006) reintroduce the idea of counterparty risk: however, as discussed above, the actual operation of the swaps market makes this a minor consideration. Credit risk differences are accommodated in a credit service annex and there is little variation in spread for similarly dated contracts.

Of more direct relevance to this paper is Geltner and Fisher (2007), who consider pricing issues for swap contracts based on real estate indices. They argue that real estate indices differ from conventional financial market indices since they are based on appraisals and because investors cannot hold the underlying portfolio. They suggest that the appraisals have two impacts on the index – introducing noise and lagging effects. Noise comes from random deviation between reported index values and the "true" prices of the underlying market – this is said to add short-run volatility to the index and to induce some negative autocorrelation. Lagging effects are more significant in their model – they present a standard appraisal adjustment model which smoothes market volatility, causes the index to lag behind actual property prices and may result in momentum effects. Given that the underlying index cannot be traded, they argue that these factors must be accounted for in any equilibrium pricing model. Their pricing model starts by examining the pricing of a forward contract. They show that standard pricing results rely on the index reflecting the current equilibrium expected returns in the underlying market and the ability to hold an arbitrage portfolio – conditions that do not hold in real estate markets with appraisal based index number series. They also note that the index risk premium may be lower than the required risk premium in the underlying asset market, due to smoothing effects. Further, momentum effects may mean that the short- to medium-term expected return on the index may differ from its equilibrium required real return.

They then determine a feasible trading range by considering the position of a bullish investor taking a long position and a bearish investor taking a short position. The investor going long may expect higher growth in the index than would be necessary to deliver the equilibrium return: thus the bullish investor will be prepared to pay LIBOR plus the additional growth anticipated plus (or minus) any lag effects from the index construction process. The investor going short may hold a portfolio which she believes could deliver positive alpha – returns greater than those delivered by the index. She too will have a growth expectation which may differ from that of the bullish investor. The two trading conditions define a feasible trading window. If both parties have the same expectations, then the only feasible trading price is a point which is defined by the underlying interest rate and the index lag effect. But if growth expectations differ or if the investor shorting the market feels that her portfolio can deliver alpha, then a range of feasible positions emerge. The paper implicitly suggests that the contract price will be a rate that is a midpoint between the minimum and maximum prices in the trading range, after allowing for a bid-ask spread to pay for brokerage and other dealing costs.

Baum *et al.* (2006) made very similar arguments, concluding that the spread from property index total return swaps should, in principle, be close to zero but that underlying *asset* market efficiencies make trading at non-zero spreads rational. While the margins should not reflect return differentials between LIBOR and expected real estate returns once risk is accounted for, there are rational reasons why margins should exist. Are these asset market differences sufficient to explain the large spreads (and their changes in signs) observed in practice?

The starting point for our conceptual model of swap pricing starts from four basic principles. First, that the equilibrium spread does *not* reflect differences in expected returns. This is consistent with swap pricing in other markets – although the anecdotal evidence in Baum *et al.* (2006) suggests that many market participants based their investment decisions on return differentials and forecasts of property market performance. Second, that arbitrage should ensure that "normal" spreads are zero (or no more than the difference between LIBOR and the borrowing costs of the representative investor). Third, that swap contracts are not negotiated between counterparties, but are arranged by a swap dealer, such that counterparty risk issues are dealt with *outside* the swap contract and, hence, do not affect spreads. Fourth, any non-zero spreads reflect underlying real estate asset market distortions and inefficiencies. The focus, then, is on the nature of the underlying real estate market and its impact on the ability to construct a self-financing arbitrage portfolio.

A first constraint facing any investor seeking to create a self-financing arbitrage portfolio is the existence of high transaction costs in the underlying real asset market. For UK direct real estate acquisitions, round trip costs of around 7.5% can be assumed (with higher entry costs than exit costs due to up front tax costs through stamp duty). Other property investment vehicles may serve to lower the transaction costs – for example buying into a property unit trust (where there still exist bid-ask spreads and dealing costs), buying property within a company wrapper or investing in a private equity fund: however, they bring other problems. In principle, one might invest in a REIT or property company, greatly reducing transaction costs. The return patterns of real estate securities show low correlations with the IPD index used in the swap contract, producing unacceptable basis risk.

A second constraint faced is execution time. Acquiring (and selling) real estate involves a search process which could easily take six months, and a lengthy time to transact. Investors in private funds face a draw down problem (they may make a commitment to invest, but the fund manager may delay the call for capital); investors in property unit trusts may face delays in redemption, particularly in falling markets or find funds closed to new capital in hot markets. REIT execution times are fast, but the basis risk precludes this as a strategy.

Allied to the execution time issue is the problem of large lot size. This makes it very hard to diversify the investor's exposure to real estate at low cost via direct acquisition of land and buildings (and certainly not at the notional principal of most swap contracts). In turn, given high levels of specific risk in commercial real estate markets, this makes it unlikely that any portfolio will effectively track the IPD index (or equivalent) creating basis risk. There is no guarantee that an assembled portfolio will produce IPD returns. Commercial real estate is also heterogeneous. A property owner whose mimicking strategy involved selling all or some of their portfolio would find it very difficult to reassemble the exact portfolio through reacquisition at the end of the swap contract, even ignoring the transaction costs faced. This is very different from the situation facing a party in an equity index swap.

Finally, we note that an actual arbitrage portfolio would be subject to management obligations and costs which should be, but are not necessarily, reflected in the published IPD returns and that – other than the total returns swaps under consideration – there are no effective ways to short the commercial real estate market. Taken together, these factors mean that, in the absence of a simple to construct, reliable self-financing arbitrage portfolio, the institutional characteristics of the underlying asset market may be significant in determining traded spreads.

These characteristics of the underlying asset market are neither symmetrical nor time invariant. Some appear symmetrical – the tracking error / basis risk problem faces buyer and seller, the portfolio management obligations are a symmetrical cost and saving. Others are quasi-symmetrical. Both parties would face round trip transaction costs, but the acquirer faces higher initial costs than the seller (hence the NPV of the buyer would be less than that of the seller). Heterogeneity creates asymmetry. Sellers cannot recover their original portfolio, a risk not faced by a buyer. Asymmetries in relation to execution time vary over the market cycle. In a rising market, the buyer, unable to get into the market, faces a loss of upside return. In a falling market, the illiquidity facing a seller locks in losses and poor returns.

One other reason for the existence of margins is the belief on the part of investors that their portfolio can generate abnormal returns or alpha. Geltner & Fisher (2007) include this in their formulation of a fair trading range. If the investor does believe that her held portfolio can generate positive risk-adjusted returns despite adverse market conditions, she may choose to short the market while retaining the real estate assets: she will be prepared to pay a premium up to the value of alpha to sell real estate returns. While the market remains wedded to the concept of alpha, empirical evidence of its existence is weak – for example, Bond & Mitchell (2008) found no strong statistical evidence of persistent or significant fund manager out-performance in an analysis of UK professional fund managers.

Finally, a key property of appraisal-based real estate indices is the presence of strong autocorrelation that may result from the valuation smoothing process and from asynchronous valuations and lagging effects. Given the existence of serial correlation, it is possible that investors will be able to detect periods when the delivered index returns will be higher (or lower) than the longer run equilibrium risk-adjusted return appropriate for an index-tracking investment and that this would induce a rational positive or negative spread around LIBOR in swap transactions. This is clearly a significant issue for sub-annual indices and in the US with the stale appraisal problem evident in the NCREIF index, but may be less of an issue in the UK with annual based contracts and an annual sample that is 100% valued each period. How predictable are UK IPD commercial real estate returns: how significant are the lagging effects noted by Geltner & Fisher (2007)? The annual index does exhibit serial correlation – over the 1981-2007 period, the all property index has a first order autocorrelation of 0.357, which is just statistically significantly different from zero and indicates that around 13% of the variation in current returns can be explained by the previous year's returns, but is around half the serial correlation exhibited by NCREIF over the same period[2].. Given that the lagging effect is well known, one might expect that it would reflected in short-run forecasts of property market performance. However, examination of the Investment Property Forum's consensus forecasting service shows that the accuracy of forecasts one and two years out is poor – for 2003-2007, the mean absolute error for the one year out forecast is 10.9%, rising to 11.4% for the two year out forecast (see Exhibit 4).

[INSERT EXHIBIT 4]

The implication of these imperfections in the underlying market (and the absence of an arbitrage portfolio) is that it may be rational at certain points in the market for a party in a real estate total return swap to pay a margin above or below LIBOR. Thus a property owner, wishing to reduce exposure to the real estate market for a period, but also wishing to retain their assembled portfolio might be prepared to pay IPD and receive LIBOR *minus* a margin to avoid both

[2] There is higher serial correlation in monthly and quarterly series, even though the constituents of the sub-period series are valued each period.

transaction costs, delays in execution of sales and the problems of rebuilding the portfolio. An investor wishing to gain short term exposure to UK real estate may be prepared to pay LIBOR *plus* a margin to avoid round trip transaction costs, and that margin might be higher if they are confronted with difficulties in gaining exposure in the underlying market through supply constraints or long execution times.

What this implies is that there is a *rational trading window* around the zero spread equilibrium position. Actual trades should occur within the trading window and, if there is critical mass, liquidity and a balance between buyers and sellers of the IPD leg, one would expect that trades would occur close to the zero spread. However, in a nascent swaps market that is immature, with restricted liquidity and, critically, with an underlying asset that is cyclical in nature, that balance between buyers and sellers (those wishing to go long versus those wishing to short the market) is likely to be disturbed. As a result the shape and position of the trading window will shift over time. It should be emphasised that this is not (primarily) as a result of differences in return expectations, but rather results from changes in the numbers of participants prepared to pay a premium over LIBOR to those prepared to accept a discount to LIBOR. In this restricted sense alone, the spread observed will reflect market sentiment and return forecasts.

In the remaining sections of the paper, we seek to estimate the size of the window using a cash flow-driven model that makes plausible assumptions about the behaviour of the underlying market. In this, we recognise that many of the characteristics of fully efficient markets used in theoretical swap pricing models (that generate closed form solutions) are violated. Underlying cash flows are discrete, not continuous; there are high costs in trading, the underlying asset is not (easily) divisible, it is not possible to perfectly replicate portfolios and it is not easy to short-sell the underlying asset. We next set out the pricing model used (and the assumptions made) before reporting empirical results.

4. The Pricing Model

If we compare the cash flows of an investment in direct property (assuming we can invest obtaining the overall market) with the cash flows of an investment in total return swaps, we can identify and price three main differences: transaction costs, cash flow timing and execution costs.

Our basic model to price total return swaps – with the main assumptions reported in exhibit 5 – refers to a standard contract with a quarterly LIBOR cash flow (negative for the buyer and positive for the seller) and an annual total return cash flow for property (positive for the buyer and negative for the seller). The Net Present Value (NPV henceforth) can then be represented as follows:

$$NPV_{swapB} = \sum_{i=1}^{N} \frac{\left[TR_i - \left(Libor_{i-1,i} + \left(1 + SwapFee + Spread\right)^{\frac{1}{4}} - 1 \right) \right] * NV}{\left(1 + Libor_{0,i}\right)^{i}} \tag{1}$$

where:

- NPV_{swapB} = net present value of a swap contract for a buyer;
- TR_i = annual total return at time *i*;
- $LIBOR_{i-1,i}$ = quarterly LIBOR rate between time *i-1* and *i*;
- *SwapFee* = annual fee for the swap contract (expressed in percentage of the contract value)[3];
- *Spread* = annual spread to be added/subtracted to the LIBOR rate (i.e. price of the swap contract as reported in financial markets);
- *NV* = nominal value of the swap contract.
- *N* = duration of the contract

The above equation – which represents our base case scenario – shows that, at each time *i*, the buyer of a swap contract will receive the net payment of the total return as recorded by the IPD index (i.e. once a year) minus the LIBOR

[3] The swap fee is always equal to zero unless the NPV for the swap contract is computed to assess the impact of transaction costs. In this case, the annual swap fee is assumed to be equal to 0.05%.

rate, a swap fee (normally equal to 0.05% of the nominal value) and a spread, which represents the price agreed between the two parties. The net cash flows are then discounted at the LIBOR rate, which is the rate at which we assumed the investor is able to raise funds in capital markets (i.e. we allow for the possibility of borrowing money at a quasi-risk free rate).

Furthermore, we can represent the NPV of a swap contract from the seller's point of view as follows:

$$NPV_{swapS} = \sum_{i=1}^{N} \frac{\left[\left(Libor_{i-1,i} + (1 - SwapFee + Spread)^{\frac{1}{4}} - 1 \right) - TR_i \right] * NV}{\left(1 + Libor_{0,i}\right)^i} \tag{2}$$

where, differently from before:

- NPV_{swapS} = net present value of a swap contract for a seller;

Our starting point is to equalise the Net Present Values of the swap contract and the returns from an equivalent investment in private real estate. For the purpose of this paper, we make the simplifying assumption that the investor could acquire a real estate portfolio that does track the IPD index – that is, that there is no basis risk. However, when investors buy private real estate, the net cash flow of their investment will differ for some factors we need to price in order to understand the spread a buyer/seller would be willing to pay/receive to bypass these inefficiencies. We will investigate how these affect the 'rational' spreads on swaps.

4.1 Transaction Costs

The first factor we consider is the existence of high transaction costs (5.5% acquisition fee at the beginning of the investment and 2.0% selling fee at the end of it) for private real estate investments. Its NPV from a buyer (or seller)'s point of view can then be represented as follows:

$$NPV_{pretcB} = \sum_{i=1}^{N-1} \frac{\left(TR_i - Libor_{i-1,i}\right) * NV}{\left(1 + Libor_{0,i}\right)^i} + \frac{\left[TR_N - Libor_{N-1,N} - SellFee * \left(1 + CG_{0,N}\right)\right] * NV}{\left(1 + Libor_{0,N}\right)}$$

$$- AcqFee * NV \tag{3}$$

$$NPV_{pretcS} = \sum_{i=1}^{N-1} \frac{\left(Libor_{i-1,i} - TR_i\right) * NV}{\left(1 + Libor_{0,i}\right)^i} + \frac{\left[Libor_{N-1,N} - AcqFee * \left(1 + CG_{0,N}\right) - TR_N\right] * NV}{\left(1 + Libor_{0,N}\right)}$$

$$- SellFee * NV \tag{4}$$

where:

- NPV_{pretcB} = net present value of private real estate investment (i.e. *pre*) including transaction costs (i.e. *tc*) for a buyer;
- NPV_{pretcS} = net present value of private real estate investment (i.e. *pre*) including transaction costs (i.e. *tc*) for a seller;
- TR_i = annual total return at time *i*;
- $LIBOR_{i-1,i}$ = quarterly LIBOR rate between time *i-1* and *i*;
- *NV* = nominal value of the investment in direct real estate (assumed to be equal to the nominal value of the swap contract).
- *SellFee* = selling fee when the investor sells the investment (expressed in percentage of the investment value);
- $CG_{0,N}$ = cumulative capital growth for the entire investment period (assuming a compounding effect on the nominal value to compute the selling fee);
- *AcqFee* = acquisition fee when the investor buys the investment (expressed in percentage of the contract value);
- *N* = duration of the contract

The only difference between the buyer and the seller's cash flow (apart from the inverted signs for the LIBOR and total return components) is the timing of the cash flows relating to transaction costs because the acquisition fee (5.5%) occurs respectively at the beginning and the end of the contract, and the selling fee (just 2%) at the end of the buyer's contract and the beginning of the seller's contract

In order to identify the boundaries within which it would be rational for an investor to trade, we simply equate Equations 1 and 3 for the buyer (or 2 and 4 for the seller) and solve for *Spread*.

4.2 Cash Flow Timing

The second factor differentiating the cash flows of a total return swap and the underlying investment in private real estate is their timing. In fact, if investors buy private real estate, they will obtain a quarterly cash flow for the income part (i.e. rents minus costs) and will only cash in the capital gain at the end of the investment period (i.e. when they will sell the property). Correspondingly, if investors sell private real estate (assuming they can do so by taking a short position), they will have to pay a quarterly cash flow for the income part (i.e. rents minus costs) and will only need to contribute the capital gain (which, if positive will represent a loss) at the end of the investment period (i.e. when they seek to buy the property back to close the position).

It is important to remember that in standard UK lease contracts the rent (and we also assume costs) is paid in advance. So the NPV of a buyer (or seller)'s point of view can then be represented as follows:

$$NPV_{precftB} = \sum_{i=1}^{N-1} \frac{\left(IR_{i-1} - Libor_{i-1,i}\right) * NV}{\left(1 + Libor_{0,i}\right)^{i}} + \frac{\left(CG_{0,N} - Libor_{N-1,N}\right) * NV}{\left(1 + Libor_{0,N}\right)} \quad (5)$$

$$NPV_{precftS} = \sum_{i=1}^{N-1} \frac{\left(Libor_{i-1,i} - IR_{i}\right) * NV}{\left(1 + Libor_{0,i}\right)^{i}} + \frac{\left(Libor_{N-1,N} - CG_{0,N}\right) * NV}{\left(1 + Libor_{0,N}\right)} \quad (6)$$

where:

- $NPV_{precftB}$ = net present value of private real estate investment (i.e. *pre*) considering cash flow timing (i.e. *cft*) for a buyer;
- $NPV_{precftS}$ = net present value of private real estate investment (i.e. *pre*) considering cash flow timing (i.e. *cft*) for a seller;
- IR_i = quarterly income return at time i;

- $LIBOR_{i-1,i}$ = quarterly LIBOR rate between time *i-1* and *i*;
- *NV* = nominal value of the investment in direct real estate (assumed to be equal to the nominal value of the swap contract).
- $CG_{0,N}$ = cumulative capital growth for the entire investment period (assuming a compounding effect on the nominal value to compute the selling fee);
- *N* = duration of the contract.

4.3 Execution Time

Investments in private real estate is illiquid and may require a long period of time to be executed. Research from Bond *et al.* (2006) shows that the execution time (for sales) in a normal market is equal to six months to fix the price and a further three months to complete the transaction (i.e. a total of nine months). From a financial point of view, in a growing market, this would result in a loss of return for the buyer (and gain for the seller), and, in a falling market, we should record a loss of return for the seller (and gain for the buyer).

To illustrate this point, we consider the following example. The market is expected to show a total return of 18% during the coming year. For simplicity we assume this performance is evenly spread throughout the year, giving us a total return around ~4.5% each quarter (composed by 1.5% of income return and 3% of capital growth). If, at the beginning of the year, investors decide to buy a property, it will take them around 6 months to fix the price (i.e. during this time investors do not receive either income return or capital growth) and another 3 months to complete the deal. Investors would then have to suffer a loss of possible returns for the first six months (i.e. 9% total return) as well as for the following three months since the price has been fixed (i.e. 1.5% income return). In other words, since they were not able to access the market immediately they would only be able to obtain the capital growth in the third quarter (because the price is fixed by the end of the second quarter) and the total return in the fourth quarter of the contract (because the actual completion happens at the end of the third quarter).

Consequently, since the effect of execution time on the swap contract pricing should be apportioned along the duration of the contract (through the annual spread), this factor will have a bigger impact for shorter contracts. When we account for the time to complete a transaction in private real estate markets, the NPV of a buyer (or seller) will be computed as follows:

$$NPV_{preetB} = \frac{\left[\left(1+TR_{k,k+1}\right)*\left(1+CG_{p,k}\right)-1-Libor_{k,k+1}\right]*NV}{\left(1+Libor_{0,k+1}\right)^{k+1}} + \sum_{i=k+2}^{N}\frac{\left(TR_i - Libor_{i-1,i}\right)*NV}{\left(1+Libor_{0,i}\right)^{i}} \quad (7)$$

$$NPV_{preetS} = \frac{\left[Libor_{k,k+1}-\left(1+TR_{k,k+1}\right)*\left(1+CG_{p,k}\right)+1\right]*NV}{\left(1+Libor_{0,k+1}\right)^{k+1}} + \sum_{i=k+2}^{N}\frac{\left(Libor_{i-1,i} - TR_i\right)*NV}{\left(1+Libor_{0,i}\right)^{i}} \quad (8)$$

where:

- NPV_{preetB} = net present value of private real estate investment (i.e. *pre*) considering execution time (i.e. e*t*) for a buyer;
- NPV_{swapS} = net present value of private real estate investment (i.e. *pre*) considering execution time (i.e. e*t*) for a seller;
- $LIBOR_{i-1,i}$ = quarterly LIBOR rate between time *i-1* and *i*;
- *NV* = nominal value of the swap contract;
- *p* = time necessary to fix the price (expressed in quarters);
- *k* = execution time (expressed in quarters and including both period to fix the price and period to complete).

4.4 Smoothing effects

If real estate markets were efficient and indices constructed using periodically recorded prices (i.e. same properties transacted at each measurement point in time), we may have observed asset prices moving as a random walk. Consequently, we determine the impact of considering a true random walk in the underlying market, as opposed to a smoothed total return (as from the IPD index series).When we account for the smoothing effect – i.e. momentum in Geltner & Fisher (2007) – the NPV of a buyer (or seller) will be computed as follows:

$$NPV_{presmeB} = \sum_{i=1}^{N} \frac{\left[unsmTR_i - \left(Libor_{i-1,i} + (1 + SwapFee + Spread)^{\frac{1}{4}} - 1 \right) \right] * NV}{(1 + Libor_{0,i})^i} \quad (9)$$

$$NPV_{presmeS} = \sum_{i=1}^{N} \frac{\left[\left(Libor_{i-1,i} + (1 - SwapFee + Spread)^{\frac{1}{4}} - 1 \right) - unsmTR_i \right] * NV}{(1 + Libor_{0,i})^i} \quad (10)$$

where:

- $NPV_{presmeB}$ = net present value of private real estate investment (i.e. *pre*) considering the smoothing effect (i.e. *sme*) for a buyer;
- $NPV_{presmeS}$ = net present value of private real estate investment (i.e. *pre*) considering the smoothing effect (i.e. *sme*) for a seller;
- $unsmTR_i$ = unsmoothed quarterly total return at time *i*;
- $LIBOR_{i-1,i}$ = quarterly LIBOR rate between time *i-1* and *i*;
- *NV* = nominal value of the investment in direct real estate (assumed to be equal to the nominal value of the swap contract).
- *N* = duration of the contract.

Since the effect of this inefficiency can only be seen if returns are not assumed to be deterministic, results accounting for smoothing effects are presented in section 6, where the model used to (un)smooth real estate indices can also be found.

5. Empirical Results for Deterministic Values

The modelling exercise adopts a comparative static approach to isolate the impact of the institutional characteristics of the underlying market on the spread that equalises the net present values of the swap contract holder and the holder of the underlying real estate portfolio. We thus start by holding the market performance constant. Real estate capital growth and income return are set to their long run IPD (UK) values and LIBOR is held constant over the contract. We analyse a standard contract of value 1,000 for different maturities, ranging from one year to ten years. Again, to remove noise, we assume that the contracts are made and timed to start at the beginning of a year. Exhibit 5 sets out the main assumptions used in the cashflow models. For each maturity, we solve to equalise the NPVs of the swap holder and the holder (or seller) of the underlying real estate portfolio by changing the spread over (or under) LIBOR.

[INSERT EXHIBIT 5]

Exhibit 6 shows the impact of transaction costs for both buyers and sellers. As can be seen, the impact is strongly related to the maturity of the contract. For a short dated swap, the impact of transaction costs is very pronounced: for a one year swap (that is, for an investor wishing to increase their exposure to real estate for a very short period), the 'rational spread' for a buyer may be as high as 800bp. However, the spread falls sharply as the tenor increases, tending towards the low margins found in financial swap contracts. It should be noted that the spread boundaries are asymmetric, reflecting the higher acquisition costs compared to disposal costs found in UK markets. The key point here is that it is rational to trade within the "trading window" defined by the upper (buyer) and lower (seller) boundaries, with different investors prepared to accept margins between the two limits, the consensus spread reflecting the balance of supply and demand.

[INSERT EXHIBIT 6]

Exhibit 7 shows the impact of cashflow timing. The spread effects are relatively small, and increase with maturity as the receipt or payment of the capital gain in the underlying portfolio is pushed further into the future, by comparison to the payment of total return on an annual basis in the swap contract. The spread increases and goes from negative to positive because the effect of quarterly income returns received in advance (i.e. positive effect for the buyer of private real estate) is for short contract smaller than the effect of capital gains to be received only at the end of the investment period (i.e. negative effect for the buyer because on average the expected capital growth will be lower than the LIBOR rate, i.e. reinvestment rate).

[INSERT EXHIBIT 7]

Exhibit 8 shows the rational spreads that emerge from execution times given normal property market conditions. The spreads are broadly symmetrical and, as expected, fall with maturity as the impact of return differences in the early part of the contract are damped as the length of the investment period increases: the required margin converges on a zero margin. Again, for investors seeking to change their exposure to real estate in the short term (whether seeking to increase or decrease their exposure), it may be rational to accept a spread around LIBOR on a swap contract, when compared to direct real estate market activity.

[INSERT EXHIBIT 8]

The results of combining the three real estate market characteristics of transaction costs, execution time and cashflow timing are shown in Exhibit 9. The resultant window shows very wide plausible margins for short maturities (particularly at the very short end, one or two year contracts), strong asymmetry and a rapid convergence towards low margins as maturity increases. The buyer boundary, however, remains above zero for longer maturities.

[INSERT EXHIBIT 9]

6. Simulation

The models described thus far have been based on fixed real estate market growth and income return. Our final exhibits examine the spreads for swaps with transaction costs with real estate capital growth modelled as a stochastic variable. The validity of our model and its sensitivity to the initial conditions is then tested by assuming that both total return and the LIBOR rate follow a geometric Brownian motion (i.e. GBM), with the following values respectively set for total return and LIBOR:

- initial values: 100 (TR index) and 5.75% (LIBOR);
- average growth rates: 10.3% and 0%;
- standard deviations: 10% and 2%[4].

Since real estate price movements do not show the property of "continuous time" (i.e. market imperfections and inefficiencies), we use a discrete time version of a more general GBM model, which can be represented as follows:

$$S_{t+\Delta t} - S_t = S_t * \left(\mu \, \Delta t + \sigma \, \varepsilon \, \Delta t\right) \qquad (2)$$

where S_t is the value of the asset at time t, Δt represents the discrete measurement period (i.e. quarter in our case), and μ and σ respectively represent the annual expected rate of return for either total return or LIBOR and its annual volatility; and ε represents a single draw from the standard normal distribution taken in every discrete time increment Δt.

Finally, since total return series in real estate markets suffer the existence of a high serial correlation, we assume that the GBM generates an unsmoothed, but in practice unobservable, version of the total return index. Consequently we use a standard first order auto-regressive filter (i.e. FOARF) to smooth the GBM path and compute the smoothed version to be used in the simulation. Quan and

4 We also test for 15% and 20% volatility measures for real estate total returns – results are available from the authors.

Quigley (1987) define the simple model from which Geltner (1991) derives the FOARF model applied empirically by Marcato and Booth (2004) to UK returns using a frequency different from the annual one. We follow this procedure and obtain smoothed total returns as follows:

$$smoothTR_t = (1-\alpha)\,unsmTR_t + \alpha\ smoothTR_{t-1} \qquad (3)$$

where α refers to the autocorrelation coefficient, and $unsmTR_t$ and $smoothTR_t$ respectively represent the unsmoothed and smoothed total return at time t. We assume the quarterly autocorrelation coefficient to be equal to 0.65 and the last recorded returns (necessary to compute the first smoothed return) for stable market conditions[5] as follows:

- last annual total return: 10.3%;
- last quarterly total return: 3.0%.

We then run 1,000 simulations of this model for one to ten year swaps and record the 5th and 95th percentiles and average spread representing the impact of market inefficiencies on the swap pricing.

On average, the direct effects of smoothing dissipate quickly in stable market conditions. Even with a smoothing parameter of 0.65 on a quarterly basis, average buyer required premia for momentum effects alone fall to around 30bp in the fourth year, with seller premia showing a similar sharp fall and never exceed 81bp. However, there is a considerable spread of possible values around those averages. Momentum effects may be most pronounced in cyclical peaks and troughs.

Exhibit 10 shows the combined effects of the various market inefficiencies, including appraisal smoothing allowing for stochastic returns and LIBOR. Panels A and B show the average spreads for, respectively, an investor buying

[5] We have also computed spreads based on a scenario of a steep market crash assuming prior falls of 3% over the previous year and 7.6% in the preceding quarter. The results are somewhat unstable and further testing is required. They suggest that trading of short-term derivatives at the onset of a market downturn is likely to prove problematic, due to the very high negative spreads demanded to deal.

IPD and an investor selling IPD, along with the area bounded by the 5% and 95% quantiles from the simulations. For short contracts, there is considerable disparity in the average values. However, there is equally considerable variation in required spreads for the short-traded contracts, creating sufficient overlap for trading to occur, even allowing for momentum effects. Required spreads, however, do converge quickly as maturity increases.

Panel C shows the average required spreads for both buyer and seller, with a "mid-point" spread shown. The mid-point would reflect the expected trading position *if* the market had frequent trades and a balance between investors seeking to buy and those seeking to sell. In practice, as the market evolves, the *actual* trading position is more likely to reflect imbalances in demand and might occur anywhere in the trading window. Panel C also demonstrates that the spread window is asymmetric: the buyer is prepared to pay a larger premium to avoid transaction costs and tracking error than the seller is prepared to concede to avoid having to sell and repurchase their reference portfolio. Required buyer spreads fall to less than 120bp from the seventh year, while seller spreads reduce to close to zero over the same period. To some extent, such asymmetries will be institutionally determined, with UK commercial property transaction costs falling disproportionately on the buyer.

[INSERT EXHIBIT 10]

6. Conclusions

This paper examines the evolving total property return swaps market, focusing on the pricing of swaps and the margins above and below LIBOR that are observed in the market. These have been both volatile and large. Theoretical analyses of swap spreads and the experience of financial swap contracts (e.g. equity index swaps), by contrast, suggest that the expected margin should be zero or close to zero. Participants in the market have suggested that the high observed margins are a function of expectations about market returns (which thus explains the high negative spreads observed from the third quarter of 2007 and across 2008). However, this should present arbitrage opportunities for investors who can create an arbitrage portfolio in the underlying market (actually or synthetically).

This paper argues that it is institutional characteristics in the underlying market that lead to the possibility of “rational” spreads around LIBOR, particularly for short maturity swaps. We show, using a cashflow approach, that transaction costs, execution times and cashflow patterns in the underlying market mean that it may be rational for an investor seeking to change their exposure to real estate to pay a margin above (below) LIBOR rather than buying (selling) the underlying real estate asset. This result holds without making any assumptions about predictability of returns or tracking error. This creates a “rational trading window with upper and lower bounds, within which individual investors might trade. The width of the window is large for short maturities, but quickly shrinks to the theoretically-expected low margins as maturities increase.

Our arguments are similar to those provided theoretically by Geltner and Fisher (2007). However, they assume a mid-point price in their model and place greatest emphasis on momentum effects from lagging that may be more pronounced for NCREIF-based than for IPD-based swaps. Given the existence of this rational trading window, we argue that the observed spreads can substantially be explained by differences in the numbers of investors seeking to go long versus the numbers of investors wishing to short the market. Imbalances will be a feature of an evolving market where there is restricted liquidity and lack of critical mass. It will also be a feature of a market where there are periods of strong common market sentiment (which might also be linked to serial correlation and persistence in commercial real estate markets, exacerbated by the valuation-basis of the reference index in the market).

This paper, then, helps to reconcile theoretical research that suggests that the spread on a real estate total return swap should be zero or close to zero with the empirical observation that swap spreads are both large and volatile and the persistent market practitioner belief that the margins for different maturities reflect expected return differences and that they thus act as a forecast of property market performance. It is the balance between buyers and sellers within the rational trading window that drives the margin set in the market.

References

Baum, A., Lizieri, C. and Marcato, G. (2006): Pricing Property Derivatives: An Initial Review, London, *Investment Property Forum*.

Bond, S., Crosby, N., Hwang, S., Key, T., Lizieri, C., McAllister, P. and Ward, C. (2006): Liquidity in Commercial Property Markets, London, *Investment Property Forum*.

Bond, S. and Mitchell, P. (2008): Alpha and Persistence in UK Real Estate Fund Performance, *Paper presented to the MIT-Maastricht Property Seminar*, Maastricht, NL, December 2008.

Booth, P. and Marcato, G. (2004): The Dependency Between Returns from Direct Real Estate and Returns from Real Estate Shares, *Journal of Property Investment and Finance*, Vol. 22 No. 2, pp. 147-161.

Bjork, T. and Clapham, E. (2002):A Note on the Pricing of Real Estate Index Linked Swaps, *SSE/EFI Working Paper Series in Economics and Finance*, No. 492.

Buttimer, R.J., Kau, J.B. and Slawson, V.C. (1997): A Model For Pricing Securities Dependent Upon a Real Estate Index, *Journal of Housing Economics,* Vol. 6, pp. 6-30.

Clapham, E., Englund, P., Quigley, J.M. and Redfearn, C.L. (2006): Revisiting the Past and Settling The Score: Index Revision for House Price Derivatives, *Real Estate Economics,* Vol. 34 No. 2, pp 275-302.

Collin-Dufresne, P. and Solnik, P. (2001): On the Term Structure of Default Premia in the Swap and LIBOR Markets, *Journal of Finance,* Vol. 56, pp. 1095-1115.

Geltner, D. (1991): Smoothing in appraisal-based returns, *Journal of Real Estate Finance and Economics*, Vol. 4, pp. 327-345.

Geltner, D. and Fisher, J. (2007): Pricing and Index Considerations in Commercial Real Estate Derivatives, *Journal of Portfolio Management,* special issue, pp. 99-118.

Gupta, A., and Subrahmanyam, M. (2000): An Empirical Examination of the Convexity Bias in the Pricing of Interest Rate Swaps, *Journal of Financial Economics,* Vol. 55, pp. 239-279.

Jarrow, R. and Turnbull, S. (1995): Pricing Derivatives in Financial Securities Subject to Credit Risk, *Journal of Finance,* Vol. 50, pp. 53-85.

Klein, P. (2004): Interest Rate Swaps: Reconciliation of Models, *Journal of Derivatives,* Vol. 12, pp. 46-57.

Litzenberger, R. (1992): Swaps: Plain and Fanciful, *Journal of Finance,* Vol. 47, pp. 831-850.

Minton, B. (1997): An Empirical Examination of Basic Valuation Models for Plain Vanilla US Interest Rate Swaps, *Financial Economics,* Vol. 44, pp. 251.257.

Otaka, M. and Kawaguchi, Y. (2003): Hedging and Pricing of Real Estate Securities Under Market Incompleteness, mimeo, Meikai University Working Papers Series.

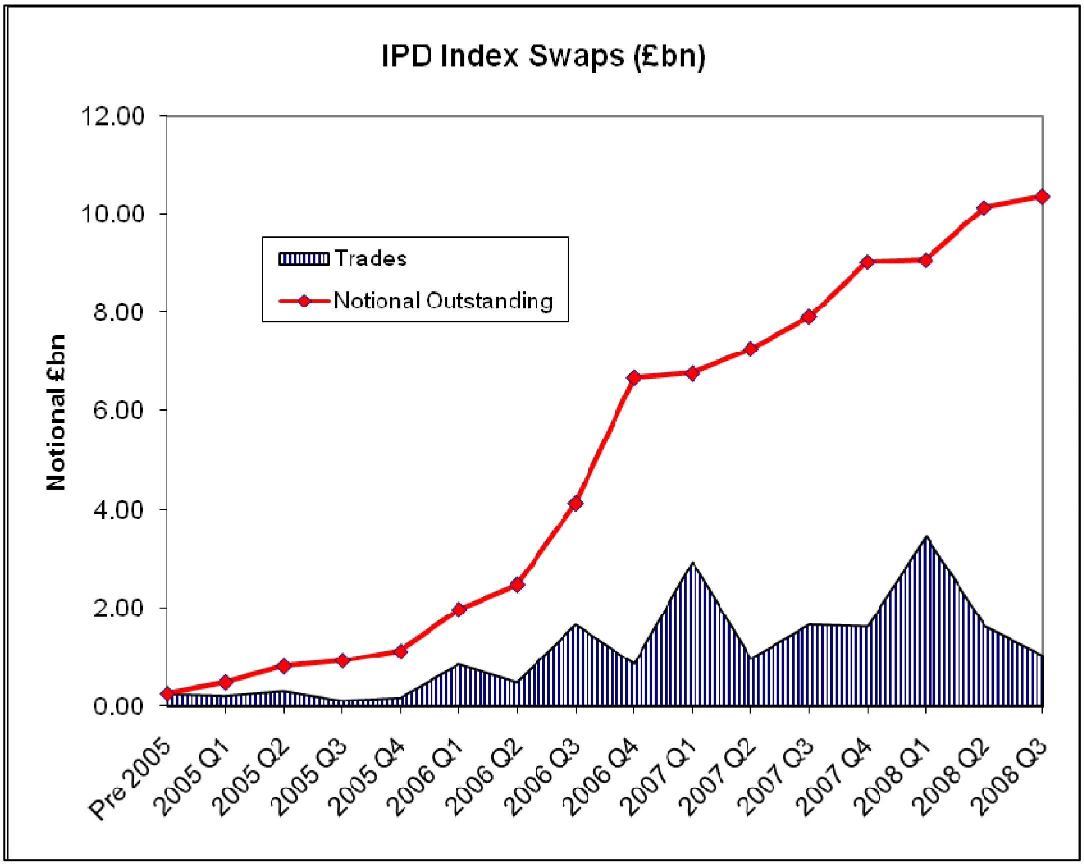
Park, T., and Switzer, L. (1996): An Economic Analysis of Real Estate Swaps, *Canadian Journal of Economics,* Vol. 29, pp. 527-533.

Patel, K. and Pereira, R. (2006): Pricing Property Index Swaps with Counterparty Default Risk, mimeo, *Department of Land Economy, Cambridge University*.

Quan, D. and Quigley, J. (1989): Inferring an investment return series for real estate from observations on sales, *AREUEA Journal*, Vol. 17 No. 2, pp. 218-30.

Exhibits

Exhibit 1: UK Total Return Swaps Trading Volumes.



Source: Adapted from IPD figures.

Exhibit 2: Total Property Swap Structure.

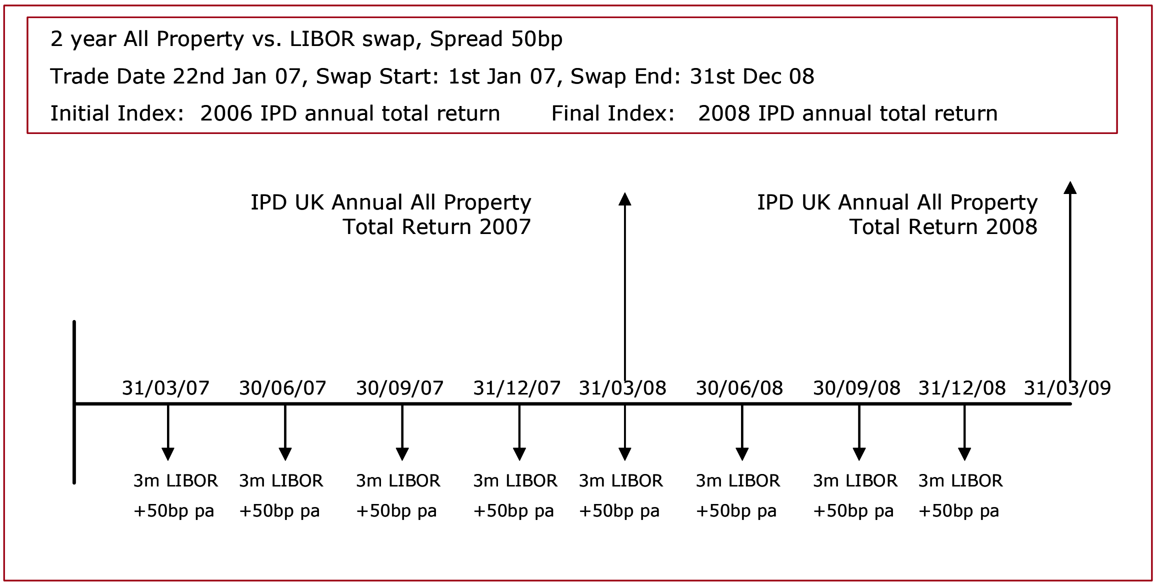
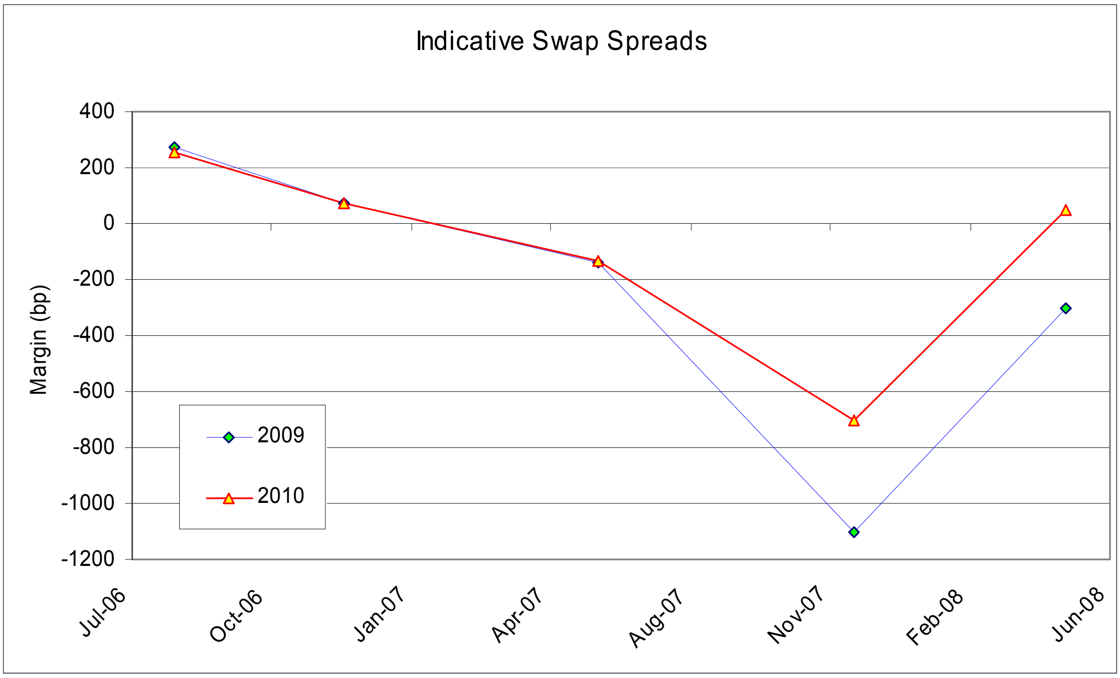


Exhibit 3: Indicative UK IPD Total Return Swap Spreads Over LIBOR



Source: Adapted from TFS "Risk and Manage" Newsletter Indicative Spreads

Exhibit 4: Real Estate Market Forecast Accuracy

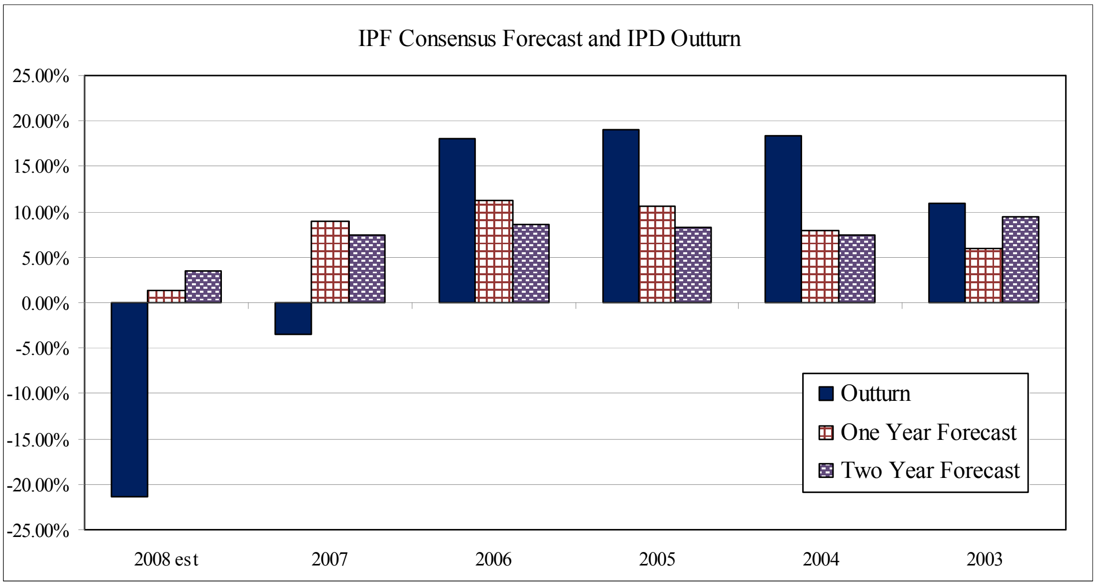
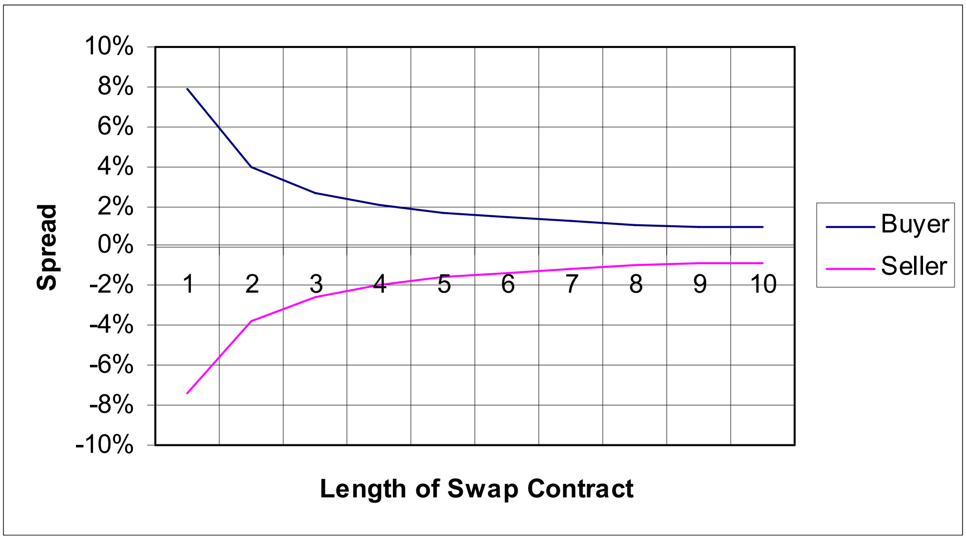


Exhibit 5: Main assumptions used for the modelling exercise.

Nominal Value of Swap Contract	1,000
Acquisition Costs	5.5%
Selling Costs	2.0%
Execution Time (months)	9
Time to Fix Price (months)	6
Swap Contract Fee (p.a)	0.05%
Annual Capital Growth	4.0%
Annual Income Return	6.3%
Flat LIBOR	6.2%

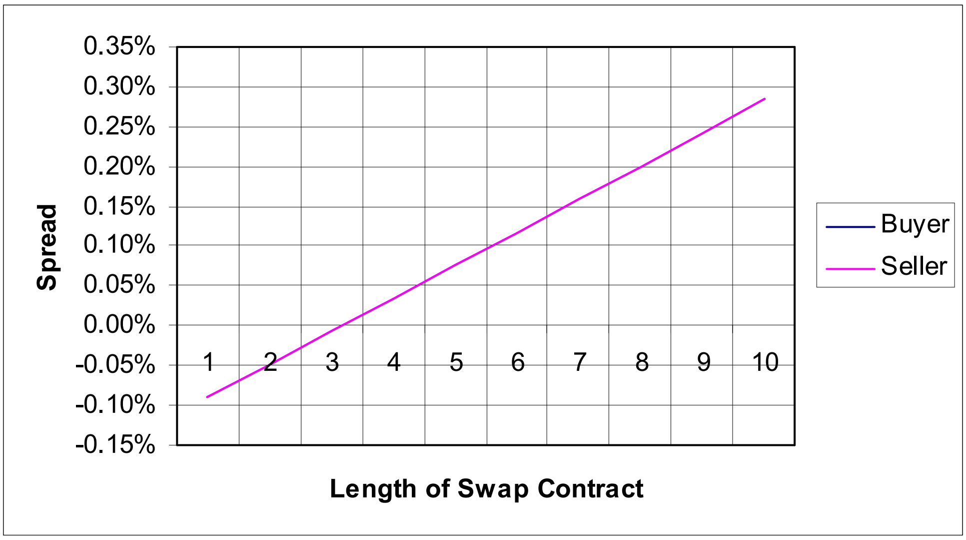
The table reports the main assumptions used for the modelling exercise. Acquisition costs include both stamp duty and other legal and professional fees. The swap contract fee reflects the fee which is normally applied to swap contract (i.e. percentage of the nominal value of the contract). Execution time includes the time which is necessary to negotiate and agree the price, and the time to actually complete the deal. The annual capital growth and income return refer to the long-run average obtained from IPD for the period 1981 - 2006. The LIBOR is maintained flat at 6.2% for the whole period.

Exhibit 6: Spread boundaries with transaction costs in private real estate.



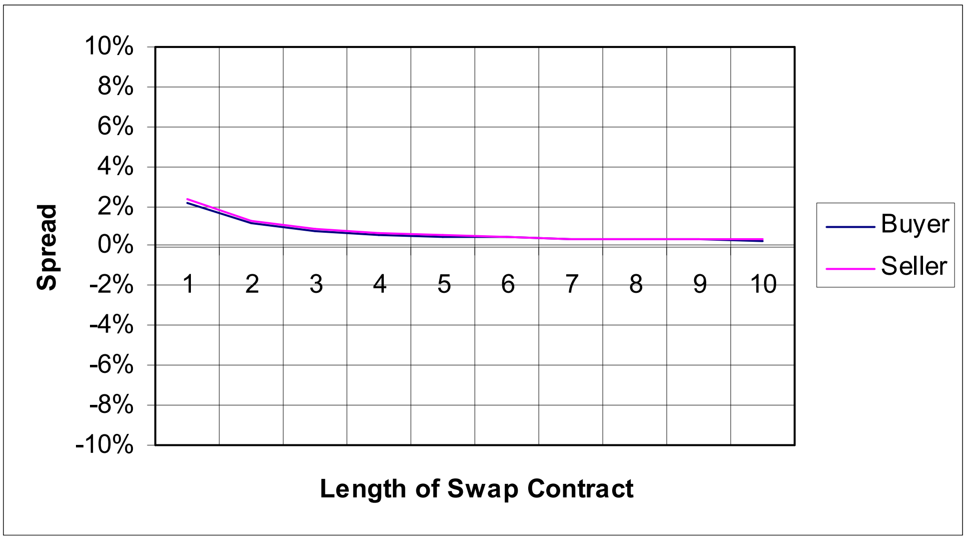
The graph shows the maximum spread a buyer and a seller are willing to pay to enter a total return swap contract in order to avoid transaction costs: 5.5% acquisition costs and 2.0% selling costs. The spread is represented in percentage: 1% spread refers to 100 basis points. The boundaries are given for one to ten years long swap contracts.

Exhibit 7: Spread boundaries with cash flow timing in private real estate.



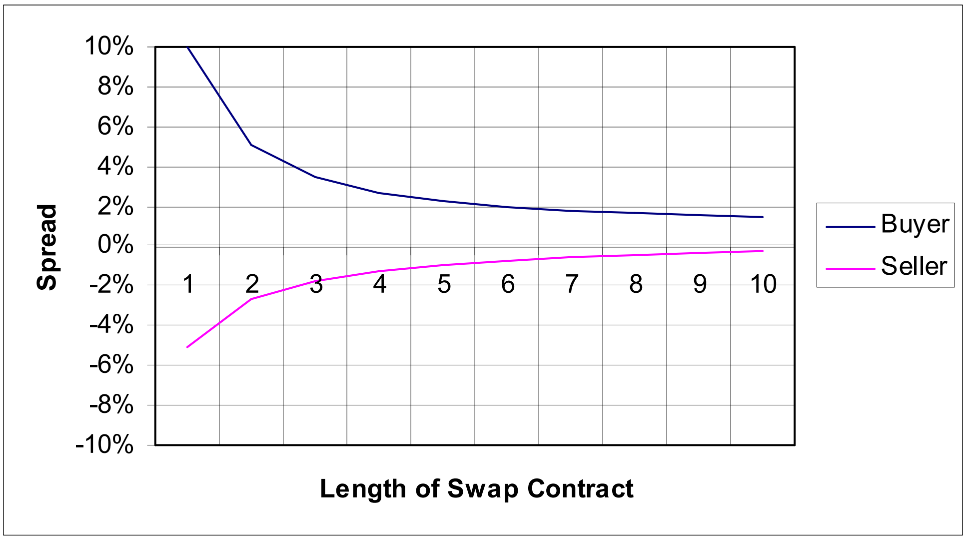
The graph shows the maximum spread a buyer and a seller are willing to accept to enter a total return swap contract in order to adjust for differences in cash flow timing: quarterly income return and one-off capital appreciation. The spread is represented in percentage: 1% spread refers to 100 basis points. The boundaries are given for one to ten years long swap contracts.

Exhibit 8: Spread boundaries with execution time in private real estate.



The graph shows the maximum spread a buyer and a seller are willing to accept to enter a total return swap contract in order to execute the transaction immediately (instead of waiting the time needed to negotiate the price and to actually complete the deal). The spread is represented in percentage: 1% spread refers to 100 basis points. The boundaries are given for one to ten years long swap contracts.

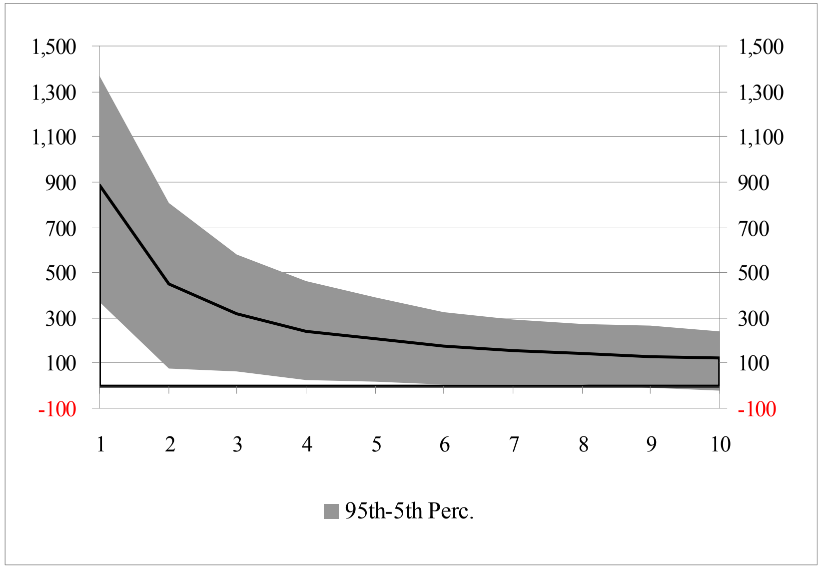
Exhibit 9: Spread boundaries with combined effects in private real estate.



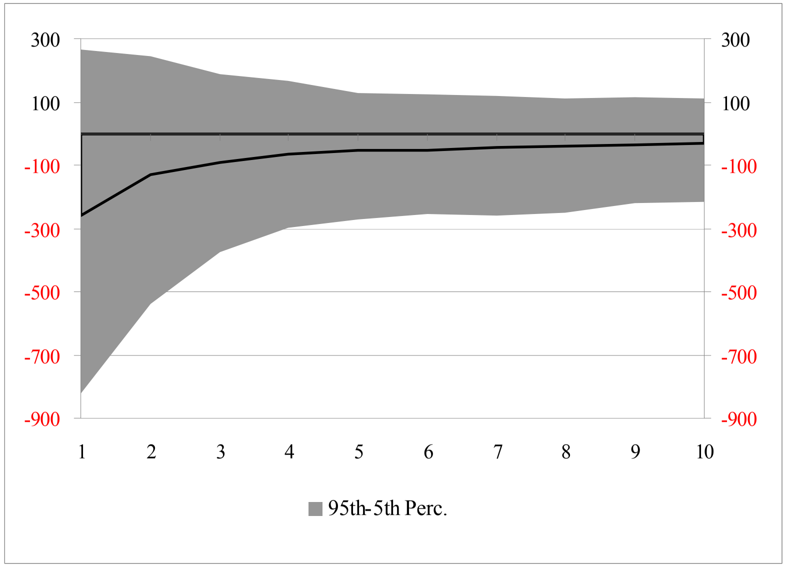
The graph shows the maximum spread that a buyer and a seller are willing to accept to enter a total return swap contract in order to avoid transaction costs (round trip 7.5%), to adjust for differences in cash flow timing, and to complete the transaction immediately. The spread is represented in percentage: 1% spread refers to 100 basis points. The boundaries are given for one to ten years long swap contracts.

Exhibit 10: Stochastic Returns: Simulation Results. Combined Market Factor Effects

Panel A
Buyer: Average Spread and 5% - 95% quantiles



Panel B
Seller: Average Spread and 5% - 95% quantiles



Panel C Buyer – Seller Average Spreads and Mid-Point