Hedging Real Estate Risk

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Real estate assets represent more than one-third of the value of all the underlying physical capital in the U.S. and the world. The relationship between the level of interest rates and housing prices does not always follow one direction and a shock event in one market may trigger deep repercussions in the other. With the spread of the securitization process, the risks rooted in these two fundamental markets can have far-reaching outcomes.

Prices in the residential housing market are determined by direct trade between buyers and sellers who are influenced by emotional involvement and other opaque social factors, such as change of employment or change of school for children. Residential real estate assets are naturally not diversified and are a combination of a consumption asset and a leveraged investment. As Shiller and Weiss [1999] pointed out, this characteristic poses greater risk for the financial stability of individuals due to geographic fluctuations in property prices. Ideally, homeowners could use derivatives on relevant real estate indices to hedge this risk and stabilize prices. Although real estate derivatives should be preferred to insurance-type contracts because of direct settlement, liquidity is very important, and liquidity can be established only after banks decide to participate more actively in the real estate index futures and options markets, as advocated by Case, Shiller, and Weiss [1993]. Housing prices are sticky when they are going down because sellers are reluctant to sell at a price below the price at which the property was initially purchased. Hence, the market is localized, the information is asymmetric, and participants' price expectations are very much influenced by the most recent series of prices.[1] Although it may be difficult for homeowners to directly hedge the price of their homes, banks and building societies with nationally diversified mortgage portfolios should be enticed to hedge their exposure with derivatives written on local indices. The use of index-based futures contracts and options for hedging mortgage risk, default risk, and real estate price risk has long been advocated by Case and Shiller [1996]. Fisher [2005] provided an overview of NCREIF-based swap products and Clayton [2007] examined various indices developed for derivatives trading.

The introduction of derivatives in the real estate market is not easy, because liquidity is difficult to establish when returns are predictable. An extensive discussion highlighting the important psychological barriers that must be overcome to allow the establishment of a real estate derivatives market is provided in Shiller [2008]. Carlton [1984] argued that if changes in market prices are predictable, then changes in prices cannot be perceived as risky. The major obstacle for the introduction of real estate derivatives is that when returns follow trends at certain points in time, then market sentiment moves in only one direction and it is difficult to find counterparties that will trade against the trend. Nevertheless, if a futures contract is already trading for a series of future maturities, then the shape of the futures curve on the real estate index becomes important. Trades may be executed on the curve, say, short futures with a long maturity and long futures with a shorter maturity, which would be impossible to execute otherwise. With futures and options on futures, an entire spectrum of trading strategies becomes available and market participants, such as hedge funds, investment houses, and private equity funds, may provide much needed liquidity.[2]

The exponential growth of the subprime mortgage market from 2002 to 2007 was driven by the exploitation of securitization as a process of ring-fencing the risks of a collateral portfolio on one side and the introduction of the real estate collateralized debt obligation (RE CDO) concept on the other side. The ever-growing demand for credit-risky bonds pushed the boundaries of this new market into new territory—residential mortgage-backed securities (RMBS) backed by home equity loans (i.e., loans to credit-impaired borrowers) and commercial mortgage-backed securities (CMBS). The cash flows of RMBS, CMBS, and RE CDOs depend fundamentally on the performance of a pool of mortgage loans that, in turn, depend on the behavior of individual homeowners and commercial borrowers. These real estate structured products are radically different from a corporate CDO in that its collateral consists of corporate credits whose corporate names can be monitored and whose balance sheets can be scrutinized regularly. Hence, the real estate risk drivers—prepayments and defaults clustering and timing—as well as recovery rates can influence the financial stability of companies and institutions not directly related to the spot real estate market. Hedging the potential disruption of scheduled cash flows is not an easy task; only a few instruments are available in the market.

The advances in futures markets on real estate indices may improve efficiency in spot markets and improve price discovery. Because transaction costs are high and create a barrier for entry into spot markets, futures markets may also help indicate the level of spot prices in the future as well as current market volatility. Real estate derivatives are also a beneficial tool that gives investors access to an important asset class that would be hard to access otherwise. Furthermore, due to the lack of correlation of housing prices with equity prices, expanding diversified portfolios to include real estate could be highly beneficial, particularly for insurance and pension funds.[3] Englund, Hwang, and Quigley [2002] pointed out that there could be large potential gains from instruments that would allow property holders to hedge their lumpy investments in housing.

Obviously, the first step in hedging is the selection of a suitable hedging instrument. A primary factor in deciding which derivative contract will provide the best hedge is the degree of correlation between the factors driving the price of the derivative instrument under consideration as the hedging vehicle and the underlying risk that investors seek to eliminate. Correlation is not, however, the only consideration when the hedging program is of significant size. If, for example, an investor wants to hedge a very large cash position, liquidity becomes an important consideration so that it might be necessary to split the hedge between two or more different derivatives.

Real estate derivatives are useful to several categories of end users. The first category consists of individuals who are property owners and private investors who specialize in real estate. Although this category of users is very large, in practice not many employ property derivatives due to knowledge and transaction costs barriers. The second category consists of portfolio managers who hedge their price risk exposure in both domestic and foreign real estate. An adjacent category contains dealers and portfolio managers in structured products seeking to hedge their positions. Finally, real estate derivatives can be embedded by structurers into newly designed structured products. The risks that users in each of these categories are attempting to hedge with property derivatives may vary. For example, while the members of the first category will hedge price risk, the users in the other categories may also consider property derivatives in connection with interest rate risk and, possibly, with currency risk.

In this article, we will describe the real estate derivatives available worldwide and discuss the issues related to the pricing of these instruments and to the managing of hedging instruments over time.

REVIEW OF INSTRUMENTS USED FOR HEDGING REAL ESTATE RISK

In this section, we describe the worldwide development of real estate–linked derivatives. From the point of view of financial product innovation, the most developed markets are in the U.S. and the U.K., although some activity has been noticed in other developed European countries as well. The instruments can be classified by the type of real estate risk they are hedging: 1) housing price risk, 2) commercial property price risk, or 3) mortgage loan portfolio amortizing risk.

Hedging Housing Price Risk

A major component of the real estate asset class is represented by residential housing. Housing prices are determined by macroeconomic conditions and by the behavior of the individuals buying and selling properties. Housing price risk is mainly associated with the sharp downturn or fall in housing prices. In addition to the owner of the property, this risk is a major concern to banks and other lending institutions and investors in structured products that are backed by residential mortgage loans.

In May 2006, the Chicago Mercantile Exchange (CME) launched futures and options on futures trading on the Standard & Poor's/Case–Shiller® Home Price Index, an index constructed based on repeated sales analysis. As of 2009, futures contracts exist with maturities extending 18 months into the future, listed on the quarterly cycle of February, May, August, and November; futures contracts with maturities extending 19 to 36 months into the future, listed on a biannual schedule of May and November; and futures contracts with maturities extending 37 to 60 months into the future, listed on an annual schedule with a November maturity. The futures contracts trade at $250 times the index with a tick of $50, while the options trade on one futures contract with a tick of $10, for a range of strikes at five-index-point intervals from the previous day' closing price of the futures on the Case–Shiller Index. There are futures for 10 U.S. cities and also an aggregate index.

The RPX is a residential index developed by Radar Logic Incorporated that captures owner-occupied housing in 25 U.S. metropolitan statistical areas (MSAs).[4] The RPX index family comprises a global MSA 25 Composite Index that reflects the top 25 MSAs in addition to indices for the individual MSAs. The index is based on rolling quarterly price fixings measured by price per square foot and is updated daily.[5] Trading on derivatives contingent on the RPX index started in September 2007. The first RPX index-based derivative traded was a total return swap; for this derivative, a fixed payment is periodically exchanged for the growth of the RPX index. RPX forward contracts began trading in May 2008 and have become the most liquid contracts based on the RPX index.

In June 2009, the firm MacroMarkets LLC launched on the New York Stock Exchange securities with an underlying value linked by formula to the S&P/Case–Shiller Composite 10 Home Price Index, an index of home prices in major metropolitan areas. There are two five-year securities with ticker symbols UMM (for Up Major Metro) and DMM (for Down Major Metro). The securities are automatically created or redeemed in pairs by authorized participants and the funds contributed at creation are invested in U.S. Treasury bills. Thus, the securities pair is fully collateralized and represents a balanced book for the issuer that involves no counterparty risk. The elements of the pair trade separately so there is price discovery for real estate five years after issue.

In the U.K., real estate derivatives are written on a house price index, the most common being the Halifax House Price Index (HHPI) series. The HHPI is the longest-running monthly housing price series in the U.K. with data available since January 1983. The index is based on the largest monthly sample of mortgage data, typically covering around 15,000 house purchases per month. It is a hedonic index.

In 2003, Goldman Sachs issued the first series of a range of covered warrants based on the Halifax All-Houses All-Buyers seasonally adjusted index on the London Stock Exchange. More recently, in August 2007, Morgan Stanley agreed to do an exotic swap with an undisclosed counterparty that was based on the HPPI and worth more than £1 million. This was the U.K.'s first residential property derivative trade that included an embedded exotic option, or a *knock-in put* option. The derivative allows the counterparty to gain if the HHPI rises, subject to a maximum payout. The investor's capital is protected unless the HHPI falls below an initially specified value.

Hedging Commercial Property Price Risk

The other major component of the real estate asset class is commercial properties. Price risk for commercial properties is similar to housing price risk, but is not generally influenced by the behavior of residential housing market participants. Commercial property prices are determined by supply and demand and specialized market participants. Although some degree of correlation is expected between commercial price risk and housing price risk, there are sufficient differences to warrant a separate analysis and separate hedging instruments.[6]

A major property index used as an underlying for property derivatives that hedge commercial property price risk in the U.S. is the NCREIF series and, in particular, the National Property Index. The NCREIF Property Index is based on an aggregation of appraised property values. The index is the underlying for two types of swaps that have been traded to date. One is the total return swap that allows an investor to synthetically reproduce the economic gains of the index return. The other is an instrument used to swap different NCREIF property sectors. In June 2008, the NCREIF Property Index Total Return Swaps changed from a quarterly to annually payment schedule with all contracts paying at the end of the fourth quarter. In addition, since June 2008, two new total return swap indices have been traded—the four-year maturity NCREIF National and five-year NCREIF National.

Barclays Capital began issuing Property Index Certificates in 1994 and Property Index Forwards in 1996 with the index comprising U.K. commercial property only. The contracts are currently traded in the over-the-counter (OTC) market and are written on two monthly indices published by the Investment Property Database (IPD)—the IPD Total Return and IPD Capital-Growth indices. These contracts have maturities of three to four years.

The property derivatives market in the U.K. has expanded from £850 million in 2005 to £3.9 billion in 2006 and £7.2 billion in 2007. The volume of IPD Index property derivatives in 2008 was £7.73 billion, not much below the £8.30 billion traded in the record year 2007. In Europe, in 2007, the trading volume on the IPD French All Office Index[7] was £787 million compared to £283 million traded on the German All Property Index.[8] Other markets where property derivatives have been traded include Switzerland, Canada, Japan, Italy, Hong Kong, and Australia. At one time 13 investment banks had a license for the IPD index family. In Europe, property derivatives written on IPD indices traded OTC with a notional over £18.8 billion for trades executed by October 2008.

Eurex began trading property futures on February 9, 2009. These futures contracts are annual contracts based on the total returns of the IPD U.K. Annual All Property Index for individual calendar years.[9] The futures contract aims to eliminate counterparty risk, to improve liquidity in the commercial property sector of the real estate property market, and to attract a complete range of potential participants to the asset class. Further futures contracts are going to be launched by Eurex on IPD property indices, such as U.K. sector indices (Offices, Retail, and Industrial) and other European indices (initially, in France and Germany) on a demand-led basis.

The Australian Stock Exchange introduced its ASX Property Trust futures based on the S&P/ASX200 Listed Property Trust Index in 2002. The index comprises the 200 largest listed property investments by market capitalization and the most liquid securities in Australia. Three years later, the Sydney Futures Exchange listed futures based on the Dow Jones Australia Listed Property Trust index.

Proposals for improved commercial real estate indices and instruments based on them will find their way into the market. For example, Horrigan, Case, Geltner, and Pollakowski [2009] demonstrated how to construct segment-specific indices of property market returns from real estate investment trust (REIT) data, bond data, and property-holding data, and how to use those indices to make pure, targeted investments in the commercial real estate market while retaining the liquidity benefits of the well-developed public market in REITs. It is possible to reconstruct the indices at a daily frequency without significant increases in noise and at various levels of segment granularity. Moreover, it seems that these new indices lead transactions-based direct property market indices during market turns. Thus, the REIT-based commercial property return indices have the potential to be used in the development of hedging strategies in the real estate market and to support derivatives trading.

Mortgage Loan Portfolio Amortizing Risk

At the portfolio level, mortgage loans carry two intrinsic risks that require hedging tools—default risk and prepayment risk. Default risk is the risk of loss of principal and/or interest due to the failure of the borrower to satisfy the terms of the lending agreement. This risk is high for RMBS that are backed by mortgage pools containing subprime mortgages.

A prepayment is the amount of principal repayment that is in excess of the regularly scheduled repayment due. A prepayment can be for the entire amount of the remaining principal balance (i.e., complete payoff of the loan) or for only part of the outstanding mortgage balance (referred to as a curtailment). Prepayment risk is greater for RMBS than CMBS because commercial loans have provisions to mitigate prepayment risk (e.g., lockout periods, prepayment penalties, yield maintenance, and defeasance).

From an investor's perspective, prepayment risk is the risk that borrowers will prepay their loan (in whole or in part) when interest rates decline. This action by borrowers would force investors to reinvest at lower interest rates. Note that if borrowers prepay when interest rates rise, prepayments are beneficial to investors because proceeds received can be reinvested at a higher interest rate. From the perspective of a portfolio manager or risk manager who is seeking to hedge an RMBS position against interest rate risk, prepayment risk exists even if prepayments occur when interest rates rise. This occurs because in establishing a hedge, the amount to be hedged will vary depending on a projected prepayment rate. At the outset of a hedge, an amortization schedule is projected based on the projected prepayment rate. Actual prepayment experience of a hedged asset can cause a deviation between the projected principal outstanding based on the amortization schedule designed at the outset for the hedging instrument and the actual principal. This situation can result in over- or underhedging a position. The stochastic nature of the amortization schedule due to stochastic prepayments faced by hedgers might more aptly be described as amortization risk.

Default and prepayment risks call for special hedging instruments. The rapid growth of the U.S. subprime mortgage market led to the introduction of home equity credit default benchmark indices (ABX.HE indices) that started trading in January 2006.[10] One of the main roles of the ABX.HE indices is to discover the market view on the risk of the underlying subprime loans. The indices are a synthetic instrument that allows investors to identify macro hedges on the subprime sector of the residential housing market. In addition to managing risk, CDO collateral managers use the indices to take advantage of any temporary pricing discrepancies.

The ABX.HE indices consist of five separate subindices, one for each of the rating categories AAA, AA, A, BBB, and BBB–.[11]Each subindex consists of 20 tranches (of the same rating as the rating category for that particular subindex) from 20 home equity (i.e., subprime) deals, with each deal represented once in each subindex. A new set of ABX.HE indices is launched every six months on January 19 and July 19, referred to as *roll dates*. Closing mid-market prices are published daily for each set of ABX.HE indices. The administrator of the indices, Markit, employs a filtering process similar to that used by the British Banker's Association to calculate LIBOR. The filtering process entails discarding the quotes received that are in the top and bottom quartiles, then calculating an arithmetic mean of the remainder.[12] The key innovation in this product design is the pay-as-you-go (PAUG) credit default swap (CDS), which addresses the unique issues associated with credit events when dealing with CDS backed by residential real estate loans.

Until recently, a synthetic index was available for hedging CMBS.[13] The CMBX is a synthetic family of indices; each index in the family references a basket of 25 of the most recently issued CMBS tranches, sorted by rating class. The CMBS is similar in type to corporate CDS indices, such as the CDX. Hence, the CMBX indices are rolled into a new on-the-run series twice a year with changes in the reference portfolio reflecting the current CMBS market. The payments follow the PAUG template. The CMBX index allows investors to get synthetic risk exposure to a portfolio of CMBS. Five index series have been issued in the market. Each index had seven tranches containing bonds rated AAA, AJ,[14] AA, A, BBB, BBB–, and BB, respectively. To be included in the CMBX index, a reference CMBS had to have a minimum size of $700 million and be secured by at least 50 separate mortgages that are obligations of at least 10 unaffiliated borrowers. The underlying mortgages had to have no more than 40% of the properties in the same state, and no more than 60% of the properties could be of the same property type.

Dealers who have an inventory of whole loans that are not yet securitized or of securitized products and asset managers are exposed to interest rate risk linked to the amortization of mortgage loan portfolio dynamics. The amortization is stochastic and is driven mainly by prepayment and default speeds. As a response to this type of hedging problem, a set of financial instruments that were linked indirectly to real estate risk drivers appeared in the market. These instruments are called structured swaps and are used by building societies in the U.K. and by asset-backed securities (ABS) desks at major investment banks to hedge interest rate exposure on mortgage loan portfolios.

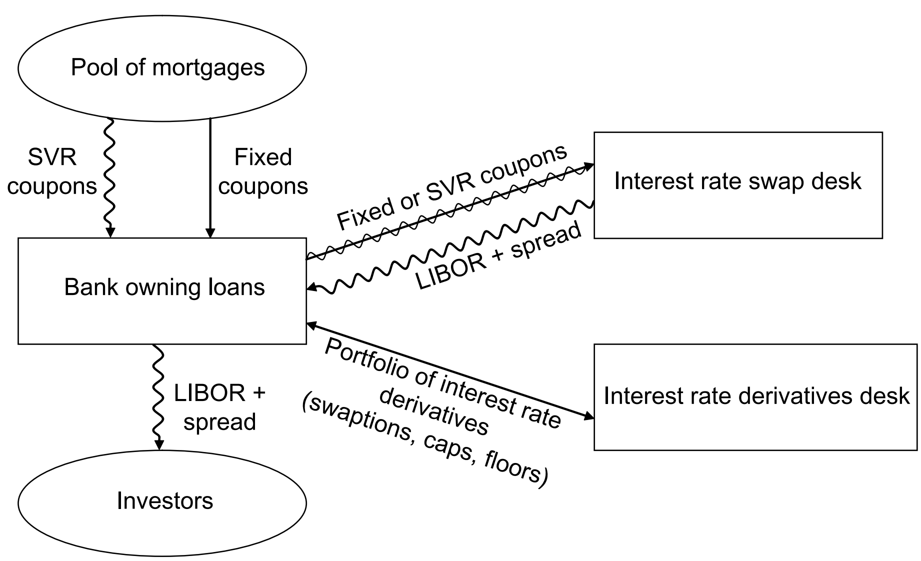
There are three types of structured swaps: 1) a balance guaranteed swap, 2) a cross-currency balance guaranteed swap, and 3) a balance guaranteed LIBOR base rate swap. In a balance guaranteed swap, the collected coupons on a collateral portfolio of mortgage loans are exchanged for a reference LIBOR plus a spread. The notional is the total balance of surviving loans for the period. The swap is complex because the notional is stochastic, being determined by the amount of prepayments, defaults, and arrears in the reference portfolio. The total coupon paid on an exchange date is also stochastic and, even if the notional was known, because of the different possible mixture of loans surviving in the reference portfolio, the coupon could differ for the same notional. The typical structure for a balance guaranteed swap is shown in Exhibit 1.[15] This type of swap became part of the securitization process because its use was mandated by rating agencies to hedge the interest rate risk mismatch between fixed coupons collectable from mortgage loans and floating coupon payments paid post-securitization to investors. Given the large volume of RMBS deals between 2005 and 2007, many institutions are likely holding a number of positions in this type of swap. A balance guaranteed swap is not an instrument to hedge prepayment risk or default risk because it does not guarantee the balance of the reference pool; on the contrary, it is exposed to these two risks. The underwriter of a balance guaranteed swap is exposed to the amortization speed on the reference mortgage loan portfolio.

A cross-currency balance guaranteed swap is a more complex swap product that deals with cross-currency deals for which the coupons on one leg of the swap and also the notional are determined in a foreign currency. This swap deals with an extra level of risk through its foreign exchange exposure. All characteristics described for a balance guarantee swap apply, but the notional is stochastic and in a different currency. One subtlety of this product is that some macroeconomic risk of the country where the obligors reside is embedded in it. The macro risk may resurface even if there are no changes in the currencies specified in the swap. For example, the ebbs and flows of the political and social environment in the borrower's country may cause job losses or price inflation that may trigger high default rates in the collateral portfolio.

To understand the balance guaranteed LIBOR base rate swap, we need to review the linkages between the official base rate and the standard variable rate charged on mortgage accounts by lending banks. The official base rate is the rate at which the Bank of England lends to other financial institutions. The Bank of England's Monetary Policy Committee meets every month to determine what needs to be done in response to economic conditions. Although the official base rate plays a very important role in these markets, banks have the freedom to use a different rate on their loans, which is the standard variable rate. The standard variable rate is linked directly to the official bank rate, but is usually a little higher, reflecting the following factors: the real rate at which banks borrow from each other, the business costs associated with lending operations, the volume and maturity profile of loans, and the funding arrangements. The standard variable rate is likely to vary from bank to bank and is used to determine the cash flows linked to RMBS. In the U.S., variable rate mortgages lend themselves to hedging in the same way.

EXHIBIT 1

Main Components Affecting a Balance Guaranteed Swap Linked to Mortgage Loan Portfolio



Note: SVR is the standard variable rate that banks charge mortgage borrowers when their mortgage switches from fixed to floating. The SVR is driven by the official base rate, but its exact value is at the discretion of the bank.

While a balance guaranteed swap is useful for converting fixed-rate coupons into LIBOR-based coupons, situations arise when the collateral pool for RMBS and CMBS will contain loans that pay variable coupons determined by the variable rate established by the lender. The level of the variable rate is determined by the lending bank in relation to both the base rate determined by the national, or federal, banks and other funding costs driven by LIBOR swap rates. In general, the basis between the standard variable rate (or its proxy the official base rate) and LIBOR is almost constant and not very large during periods of low interest rate volatility. In turbulent periods, however, such as the subprime mortgage crisis, the basis between the standard variable rate and LIBOR may increase dramatically. Mortgage traders therefore employ the third swap, a balance guaranteed LIBOR base rate swap, to hedge this basis risk. One leg of the swap pays LIBOR plus a spread while the other leg pays the average official base rate during the period. For this type of swap, the LIBOR leg pays the coupon set at the beginning of the period, but the official base rate leg payment can be determined only at the end of the period. For practical market purposes, the notional can be any value within a pre-specified band. The buyer has the right to choose the size of the notional at the beginning of each period. This is a difficult economic decision as only the LIBOR coupon is known.

PRICING AND HEDGING ISSUES RELATED TO REAL ESTATE DERIVATIVES

Derivatives require homogeneity of the underlying to establish liquidity in their trading. The lack of homogeneity in real estate markets was one of the main obstacles to the development of property derivatives. The securitization mechanism, however, has brought wider participation in these markets and an increased demand for hedging tools.

Case and Shiller [1989, 1990] pointed out that the housing market in the U.S. is inefficient due to serial correlation and inertia in housing prices, as well as in the excess returns. A possible explanation has been offered by Case, Quigley, and Shiller [2004] who argued that the price expectation of the majority of market participants is backward looking. The real estate literature suggests that repeat-sales indices have three main characteristics: 1) they are not subject to the noise caused by a change in the mix of sales, 2) they are highly autocorrelated, and 3) they are predictable with a forecast R-squared roughly 50% at a one-year horizon. The hedonic indices are subject to model risk stemming from the multivariate regressions used to build those indices. The factors employed in hedonic regressions are those characteristics of properties that have been historically found to explain housing prices. The methods associated with hedonic indices inherit all the common problems known for regression analysis, namely spurious regression, multicollinearity, and model selection.

When pricing or hedging various instruments, it should be remembered that short sales of real estate properties is impossible and trading may not be feasible for fractional units. These unique characteristics of real estate properties have profound implications regarding valuation principles. Applying the Black–Scholes framework to a market in which the underlying assets have these characteristics would be inappropriate. Moreover, the predictability in housing prices makes it difficult to establish hedging procedures. It may be argued, however, that a well-established futures market may feed information into current prices and that some balance can be achieved with a dual information transmission mechanism.

Given the characteristics of real estate markets, the valuation of property derivatives is not straightforward. Neither is the pricing of credit-type instruments, such as single-name ABS credit default swaps (ABCDS), ABS credit default swap indices (ABX.HE), or ABS CDOs, nor the new cash-flow-driven hedging swaps, such as a balance guaranteed swap or LIBOR base rate swap.

The finance literature in this area is quite sparse and the models proposed are dichotomized into no-arbitrage models and equilibrium models.[16] No-arbitrage models focus on the relationship between a real estate variable and an interest rate.[17] They also allow the calculation of counterparty risk, a very important consideration after the subprime mortgage crisis. Under the no-arbitrage framework, it can be demonstrated that the spread over the market interest rate, such as LIBOR, that a total return swap payer must charge is highly dependent on the volatility of the reference index's returns and on counterparty risk; the higher volatility of returns and counterparty risk imply a higher spread over the market interest rate.[18]

The no-arbitrage argument is difficult to apply because of the impossibility of short selling and the non-homogeneity of the property as an asset. Moreover, the underlying index is only an observable variable and not an asset that could be traded freely without any frictions, although real estate portfolios that exactly mimic the index are a possibility for a distinct class of investors. The new generation of products dependent on real estate risks cannot be priced in a risk-neutral framework either. This is due to the relationship between interest rate risk and the term structure of interest rates as well as the risk triggers in RMBS space, such as defaults, prepayments, and arrears. Hence, a real-world-measure approach based on statistical calibration of historical data is required for pricing real estate derivatives. A new method that focuses on the market price of risk as a modeling tool has been proposed by Fabozzi, Shiller, and Tunaru [2009]. These models take into consideration the mean reversion to a nonlinear long-run trend of real estate indices.

Property derivatives markets are incomplete because the primary asset underpinning the market suffers from lack of homogeneity.[19] However, similar properties in close geographical proximity should have similar prices. This high correlation is helpful for cross-hedging spot real estate portfolios with futures on local indices. Nevertheless, the lack of homogeneity implies that hedging with real estate derivatives is always going to be less than perfect.[20]

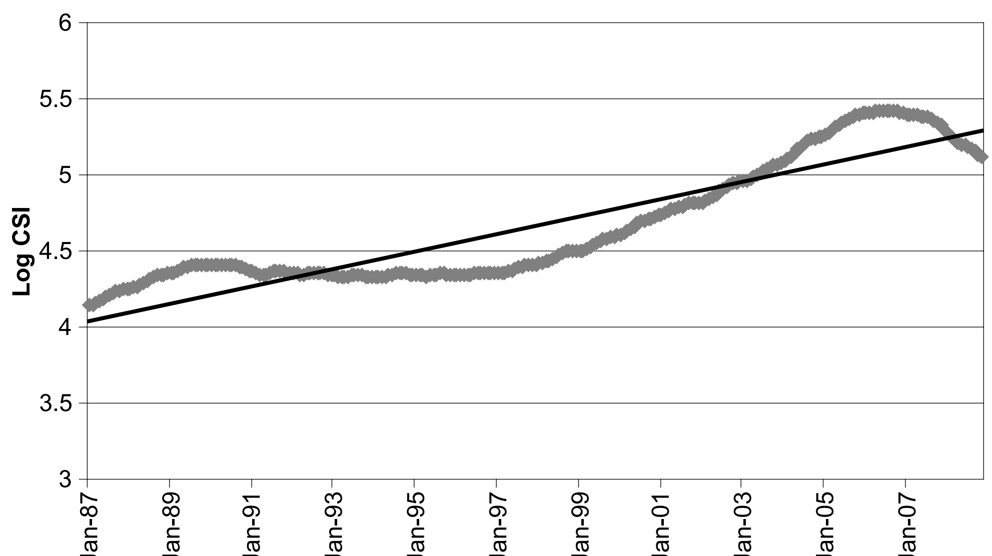
An important characteristic to account for when modeling a real estate underlying index is reversion to a long-run trend. Similar to commodity markets in which the underlying asset is a consumption asset, the supply and demand forces on real estate markets drive real estate prices in a different way than a stock index.

Let $\{X_t\}_{t\geq 0}$ be a stochastic process representing a real estate index. Then consider the process on the log scale $Y_t = \ln(X_t)$. In Exhibit 2, the monthly series of the Case–Shiller Home Price Composite 10 Index is displayed on the log scale. A clear linear time trend exists for this data series. The same can be said of the IPD U.K. Monthly Index since 1986, as illustrated in Exhibit 3 using a log scale,[21] as well as for the Halifax House Price Index in Exhibit 4 based on a quarterly historical series. For all indices, the log index series fluctuates around a positive linear time trend and any model for pricing real estate derivatives on these indices should account for this statistical property.

Therefore, we can assume that $\{Y_t\}_{t\geq 0}$ is a process that is mean reverting towards a deterministic linear trend. In other words, the log index is the sum of a zero-mean stationary autoregressive Gaussian process and a deterministic linear trend. It is also possible to fit nonlinear trends if necessary. It then becomes possible to calculate the solution of this equation in closed form, which can be useful for pricing derivatives. Hence, a real estate index can be modeled with a geometric Ornstein–Uhlenbeck process that always ensures positive levels. Because the real estate market is incomplete, for pricing purposes it is necessary to specify exogenously the market price of risk.

EXHIBIT 2

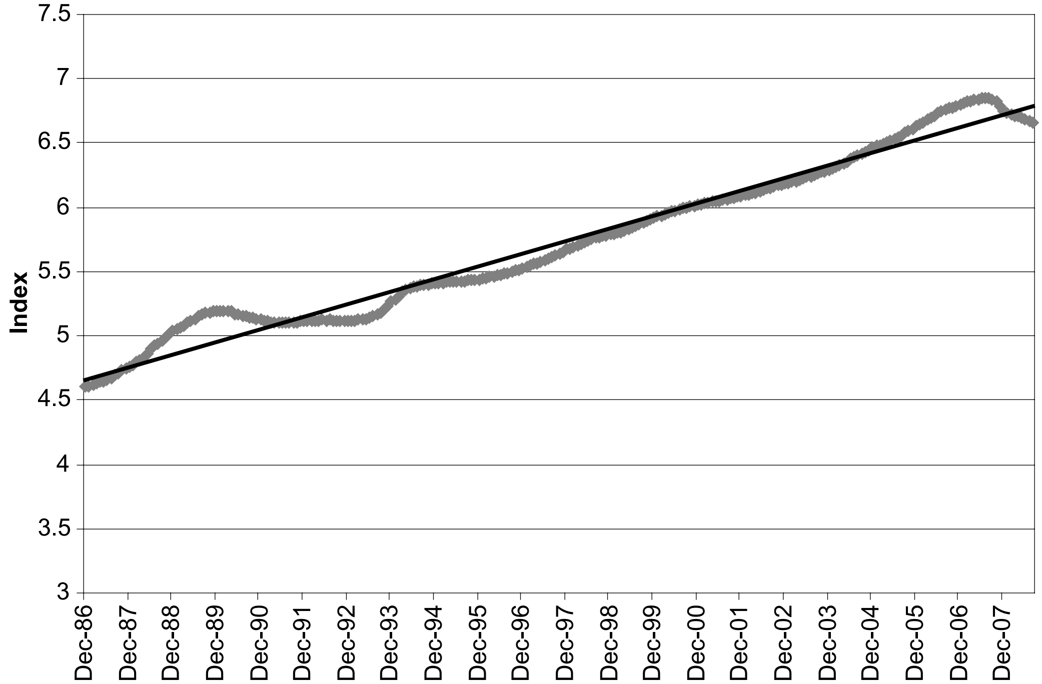
Case-Shiller Home Price Composite 10 Index, Historical Monthly Data, Log Scale



Note: The series displays a linear time trend.

EXHIBIT 3

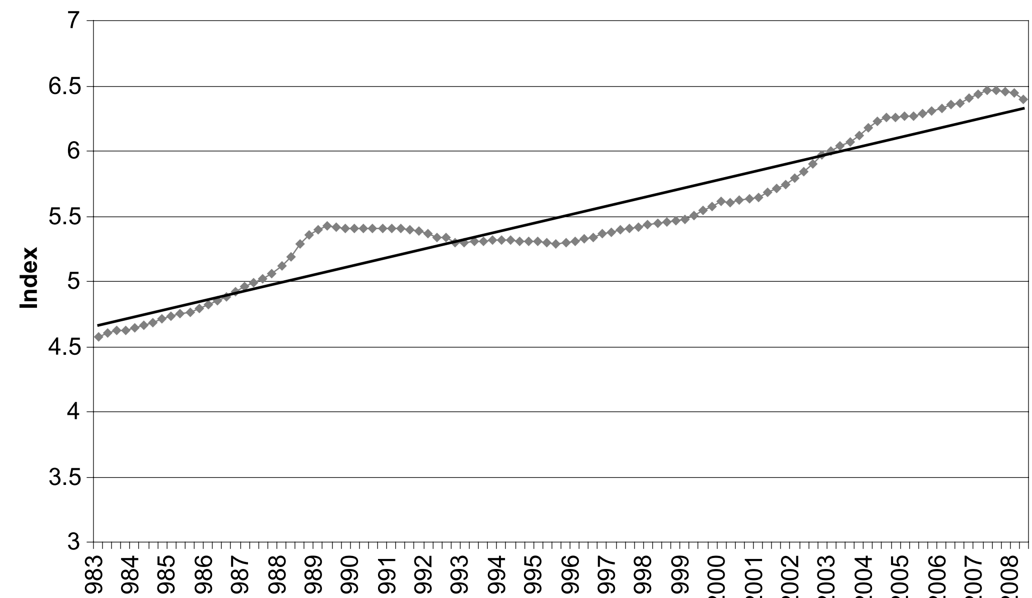
IPD U.K. Monthly Index, Historical Monthly Data, Log Scale



Note: The series displays a linear time trend.

EXHIBIT 4

Halifax House Price Index, Historical Quarterly Data, Log Scale



For example, an equilibrium model could be used to determine the forward price of an index, and then the market price of risk inferred from that point can be used to price other derivatives contingent on the same index.

The same methodology can be applied using a two-factor model where the de-trended log index and a representative interest rate $(Y_t - \alpha - \beta t, r_t)$ are jointly normally distributed. The marginal distribution of $Y_t - \alpha - \beta t$ is, therefore, Gaussian and the distribution of real estate index X_t is log normal as a consequence. The bivariate process $(Y_t - \alpha - \beta t, r_t)$ has three econometric characteristics that make it suitable for modeling a real estate index: 1) it is trend stationary (i.e., the log index may vary around a time trend), 2) the variance of index returns does not grow indefinitely with time, and 3) the model implies autocorrelations that can be positive or negative.[22]

It is critical to be able to model real estate indices as closely as possible to reality, because many mortgage-related securities are marked to model in the absence of a liquid market. A large bias in forecasting future levels of a real estate index is likely to be reflected in marking the profit and loss on a real estate position, and this could be extremely detrimental to banks holding positions in these securities.

SUMMARY

In this article, we reviewed the role of property derivatives and discussed the instruments available. Mortgage-backed securities require specialized interest hedging tools capable of handling embedded prepayment and default risk. Given the special characteristics associated with the real estate asset class, we emphasized the main points that should be taken into account when pricing property derivatives, which is a typical situation found in incomplete markets.

ENDNOTES

[1]Reasons for sticky prices are discussed in more detail in Case, Quigley, and Shiller [2003].

[2]For example, Alpha Beta Fund Management announced in July 2007 that it targeted pension funds and other investors who may benefit from access to British housing by dealing in an over-the-counter property derivatives market that tracked the Halifax House Price Index (HHPI).

[3]This benefit is more extensively discussed in Webb, Curcio, and Rubens [1988] and Seiler, Webb, and Myer [1999].

[4]More details and price fixings are available at www.radarlogic.com.

[5]This index can also be used to account for values paid in arm's length residential real estate transactions on a price per square foot basis.

[6]One of the first commercial property derivatives was based on the S&P/GRA Commercial Real Estate Index (SPCREX) that was developed by Standard & Poor's and Global Real Analytics/Charles Schwab Investment Management. This index was discontinued in early 2009. This family of indices comprised 10 commercial real estate indices: a national composite, five major U. S. regions (Northeast, Mid-Atlantic South, Midwest, Desert Mountain, and Pacific West), and four property sectors (apartments, office, retail, and warehouse). The indices were calculated monthly using a three-month moving average and published with a three-month lag.

[7]The first French property swap on the IPD France Offices Annual Index was traded in December 2006 by Merrill Lynch and AXA Real Estate Investment Managers.

[8]The first option on an IPD index outside the U.K. was referenced to the German IPD/DIX Index and was traded in January 2007 with Goldman Sachs acting as broker.

[9]At the end of 2007, the IPD index covered 12,234 properties with a total value of £184 billion, equivalent to 49% of the U.K. investment market. The IPD U.K. Annual Property Index measures unleveraged total returns to direct U.K. property investments and is calculated using a time-weighted methodology with returns computed monthly and, thereafter, compounded for the purposes of the annual index construction.

[10]Trading is offered by CDSIndexCo, a consortium of credit derivative desks. The members contribute to the ABX.HE indices, which are managed by Markit Group.

[11]The names of the five subindices are ABX.HE.AAA, ABX.HE.AA, ABX.HE.A, ABX.HE.BBB, and ABX.HE.BBB–.

[12]To calculate the official fixing value for a particular subindex, the administrator must receive closing mid-market prices from the greater of 1) 50% of ABX.HE contributors or 2) five ABX.HE contributors. If, on any date, the administrator receives fewer closing prices for a subindex than the minimum fixing number, no fixing number is published for that date.

[13]The Series 6 of CMBX, originally planned for October 2008, has been postponed due to lack of issuance of CMBS loans.

[14]The AJ tranche is the most subordinate of the AAA rated tranches and has been added to CMBX in order to help institutional investors seeking exposure to an additional credit class.

[15]Many problems are related to the design of the balance guaranteed swap. One problem is that the collateral coupon leg is paid in arrears because mortgage payments are collected every day in the period. The tenor may also differ from deal to deal with the monthly tenor being more common because the frequency of mortgage payments, and consequently the calculation of defaults and prepayments, is monthly. A quarterly tenor is also used in the market on occasion. Because the

usual reference floating rate is three-month LIBOR, there is a basis between three-month LIBOR collected monthly from the swap and three-month LIBOR paid quarterly to the investors. When the reference rate is one-month LIBOR, there is also a basis.

[16]Geltner and Fisher [2007] described the major ideas related to equilibrium modeling in real estate.

[17]Titman and Torous [1989], Buttimer, Kau, and Slawson [1997], Bjork and Clapham [2002], and Ciurlia and Gheno [2008] provided models using the no-arbitrage framework with complete markets models. Otaka and Kawaguchi [2002] took a step further and developed a model for incomplete markets that consists of a security market in which stocks, bonds, currencies, and derivative securities are traded without friction, a space market with the rents of buildings, and a property market in which the prices of real properties are determined.

[18]See Patel and Pereira [2006] for a more detailed discussion.

[19]Black [1986] emphasized that, for the smooth functionality of derivatives, a homogeneous underlying asset is helpful.

[20]Real estate traders who manage portfolios that hold individual high-value assets have extra exposure to idiosyncratic risk that cannot be hedged away easily with property derivatives (Baum [1991]).

[21]The IPD Monthly Index is based on an open market appraised valuation of real buildings. In September 2006, it covered 3,700 properties valued at approximately £47 billion. The index includes commercial and other investment properties representing more than 90% of the combined value of the property assets held in U.K. unit trusts and other unit-linked property investment funds.

[22]Detailed calculations of autocorrelations are provided in Lo and Wang [1995]. The capability of a model to reproduce a wide range of autocorrelations is important because it is then possible to match the empirical findings in Fama and French [1988a, 1988b] and Lo and Mackinlay [1988]. Their findings were that equity portfolios are positively autocorrelated at shorter horizons and negatively correlated at longer horizons.

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