Property Derivatives and Index-Linked Mortgages*

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Abstract

Over the years the academic literature has forcefully attempted to encourage the introduction and the use of property derivatives as a hedge against house price risk (e.g. Shiller and Weiss, 1999). The economic rationale for these financial instruments is manifest, as many households are heavily invested in housing and standard financial instruments offer a poor hedge. In practice however, most of the property derivatives available have been targeted to meet the needs of institutional investors, not those of owner-occupiers. Building on the recent launch of the first Swiss property derivative, we propose index-linked mortgages tailored to retail consumers. The payments of these mortgages depend on the corresponding housing market performance. We discuss the stabilization of homeowner's net wealth, price the instruments and quantify the expected decrease in the mortgage default risk achieved by the asset-liability immunization.

Keywords: House Price Risk; Mortgage Default Risk; Rent or Buy; Hedonic Index.

JEL Classification: D14, G10, G21, R31

1. Introduction

Households are typically heavily exposed to house price risk, since there are no suitable possibilities to unload it. This may lead to suboptimal allocations for the households. Englund, Hwang and Quigley (2002) show that most Swedish homeowners up to an age of 50 hold a strongly unbalanced portfolio. Flavin and Yamashita (1998) report similar findings for the US, where households below 30 years of age invest more than three times their net wealth in owner-occupied housing.

In this paper we propose a new type of mortgages which enables the mortgagee to reduce her house price risk exposure substantially. The basic idea is to link the mortgage to an index of house prices. More precisely, the coupon payments and/or the amortization of the principal are linked to the underlying index movements and not - as it is common - to the evolution of interest rates. From a finance perspective, the mortgage is no longer an interest rate but a house price derivative. If for example house prices deteriorate, either the households have to pay lower coupons on their mortgage or the price decrease is subtracted from the debt face value. Both measures help to smooth the volatility of a household's home equity. Hence, this type of property derivatives reduces the mortgagee's exposure to house price risk while reducing the credit risk exposure of the mortgagor through an asset-liability immunization.

The finding of Iacoviello and Ortalo-Magné (2003) support our approach. These authors investigate the benefits of giving households the possibility to adjust their portfolio holdings through the use of property derivatives. They show that hedging could greatly improve welfare, especially in the case of poorer homeowners who face the highest net wealth volatility and shortfall risk. According to Englund at al (2002) renters would equally benefit from gaining access to housing index investments. Real estate stocks do not represent a reasonable alternative to index instruments.

A second, older stream of research which supports our findings is Baesel and Biger (1980) and Statman (1982). Baesel and Biger (1980) describe a situation where homeowners prefer a mortgage linked to an inflation index over a fixed rate mortgage. Statman (1982) includes the value of the house in the Baesel-Biger model. In his model, the utility of the home-owner depends on the relationship between the rate of change in labor income and the inflation rate on the one hand, and on the relationship of the inflation rate and the changes in the net value of houses on the other hand. Then, linking the mortgage to a house price index instead of inflation provides a much higher correlation to the price of the house under consideration.

Our approach differs from the proposals of Case, Shiller and Weiss (1993), who advanced the introduction of futures contracts contracts tied to regional house price indices. However, in practice it is difficult for poorer households to enter into short positions. But poorer those households typically face the highest leverage, i.e. their investment portfolio is significantly unbalanced. In our approach, households need not enter into short positions since the mortgage is directly linked as property derivative to the an index.

A further key element of our approach - as of many real estate market innovations - is given by the quality, credibility and transparency of the underlying price index. We use a transaction based, hedonic index of the greater Zurich area which passed the credibility and transparency test as, for the first time in Switzerland, real estate derivatives linked to this index were successfully launched in February 2006.

Our paper is organized as follows. We first provide a rationale for property derivatives used in index-linked mortgages. We then consider the design of index-linked mortgages with regard to liquidity constraints and discuss the impact of these mortgages on credit quality. Next, we assess the appropriateness and limits of using property derivatives as a hedge for individual housing. Finally, we price index-linked mortgages and compare their price and sensitivities with standard mortgages. We support our findings with corresponding data, mainly focusing on the Swiss property market.

2. Index-Linked Mortgages

Most homeowners bear a very high amount of property risk. This may be due to a lack of perception, as owner-occupied housing is often regarded as a consumption asset only and is as such excluded from the financial portfolio context. However, even risk-savvy homeowners lack the opportunity of financial instruments enabling them to unload housing risk. Furthermore, as mentioned before, poor households would be likely to benefit most from hedging instruments as they have to bear the lumpiest risk in housing. However, these households typically lack the possibility of accessing over-the-counter hedge contracts. It thus appears reasonable to link the hedging instruments to mortgages, so that all homeowners with leveraged housing risk are automatically confronted with the dimension of housing risk and hedging possibilities. Moreover, the expected loss on the mortgage is reduced thanks to the housing hedge, so the client can benefit directly from a reduced credit spread on the package 'index-linked mortgage.'

2.1. Rent or Buy?

Today's standard decision when it comes to housing is commonly referred to as "rent or buy". In other words, an individual does either bear a large, lumpy property risk (usually leveraged by mortgage financing), or she rents and is thus not exposed to any property risk.[1]

Considering property risk in any reasonable portfolio context, it would a priori make sense for a homeowner to partially unload the property risk, while renters might reasonably take on some property risk.

We consider a homeowner's overall financial situation. A typical homeowner finances his house partly with a mortgage, which has fixed nominal and fixed or LIBOR-linked interest payments. In addition, he may also hold securities such as stocks or bonds in his investment portfolio. Still, the exposure to housing may easily exceed total net wealth, as long as the liability, i.e. the mortgage, is not linked to the price of the property. The result is a poorly diversified overall portfolio for the homeowner. An index-linked mortgage could be used to offset housing exposure and therefore significantly contribute to a more efficient portfolio allocation.

The following example illustrates the risk associated with the current property financing that causes the heavily suboptimal portfolio allocation. A Swiss based homeowner buys a house in the Canton of Zurich in 1994, at a price of CHF 500'000. He takes on a 5 year mortgage

[1] In Switzerland, the market we look at, the (upward) adjustment of rents is heavily regulated and is rarely driven by property performance.

at a rate of 5%, with a notional value of CHF 400’000 and puts down CHF 100’000 in equity. Further, he owns a portfolio consisting of various liquid assets amounting to CHF 80’000. We suppose that within 5 years, house prices in the region reduce by 15%, and so does the value of his house, which is then worth only CHF 425’000. After 5 years, the mortgage is due and the house value is reassessed. The bank offers a renewed 80% mortgage, i.e. is willing to provide CHF 340’000. Since he has to repay CHF 400’000, the difference of CHF 60’000 needs to be paid out of his other funds. For simplicity, let us assume that his consumption, including interest on the mortgage, equals his asset and working income. The adverse development of house prices leaves him with CHF 20’000 in liquid assets and home equity of CHF 85’000, i.e. his net wealth has almost halved. He might feel uncomfortable owning a house and being exposed to further price risk while having only little funds left, and may decide to sell the house.

If he would have financed his house with a mortgage linked to the local house price index, e.g. by purchasing a put option, his net wealth would have been stabilized considerably. Instead of losing 15% on the total house value, he would only incur a loss on the equity part of the house plus the cost of the put option of total 3.5% on the mortgage’s notional. This would leave him with a net wealth position of CHF 171’000 instead of CHF 105’000, whereof 86’000 are in liquid assets.

In effect, he would have reduced his housing exposure from 278% of net wealth to 56% which is a much more reasonable level. But still, the share invested in housing might be too high to achieve optimal diversification. Due to reduced risk, the bank may grant a higher borrowing level, which in turn unloads even more housing risk and makes funds available for investments in other asset classes to further optimize the homeowner’s overall portfolio. Index-linked mortgages would greatly improve the risk profile of many households and thus increase general welfare.

Table 1 shows the impact of a homeowner’s portfolio if the housing asset class is considered. We focus on the first two moments and the correlations of all involved assets. Due to the low correlations of its returns with those of traditional assets, the housing asset class is attractive for diversification.

1985 - 2005	Return p.a.	Standard Dev. p.a.	Correlation Matrix			
			Stocks	Bonds	Cash	House Prices
Stocks	11.01	17.79	1.000			
Bonds	5.41	5.53	0.105	1.000		
Cash	3.75	1.35	-0.075	0.140	1.000	
House Prices	6.48	7.56	-0.163	-0.051	0.048	1.000

Table 1
The first two moments and the correlations of all involved assets. We use the MSCI Switzerland for stocks, the 10-year Swiss Government Bond Index for bonds, the J.P.Morgan Switzerland 3-month Cash Index for cash and the Index for owner-occupied housing in the Canton of Zurich ZWEX for house prices. All numbers are based on quarterly observations during the period from Q4 1985 to Q4 2005.

Figure 2.1 shows (on an unlevered basis) the risk/return situation of a buyer's portfolio (100% invested in the house), of a renter's portfolio (100% invested in an optimized portfolio containing stock, bonds and cash) and of a portfolio with a partial exposure to a property, optimized in context with the other investable assets. The usual caveats of the standard mean-variance portfolio approach apply. Also, differences in liquidity between housing and other assets are ignored, as are the considerations involved with the fact that housing is hold not only as an investment but also for the housing service stream it generates.

Clearly, the portfolio risk can be reduced considerably with a combined portfolio. In the context of portfolio theory, any risk-avers individual should invest on the efficient frontier to maximize utility. For a given level of return, the buyer (assuming all wealth is invested in the house and that there is no leverage for now) bears a risk in terms of standard deviations of almost 8% p.a.. The renter on the other hand can invest in an efficient portfolio consisting of tradable assets and reduces his risk to 6% p.a.. However, he has zero percent invested in housing. With a partial investment in both housing and the liquid asset portfolio, the risk reduces to around 4.5%. Financial instruments such as property derivatives even allow an ongoing re-balancing of housing risk exposure.

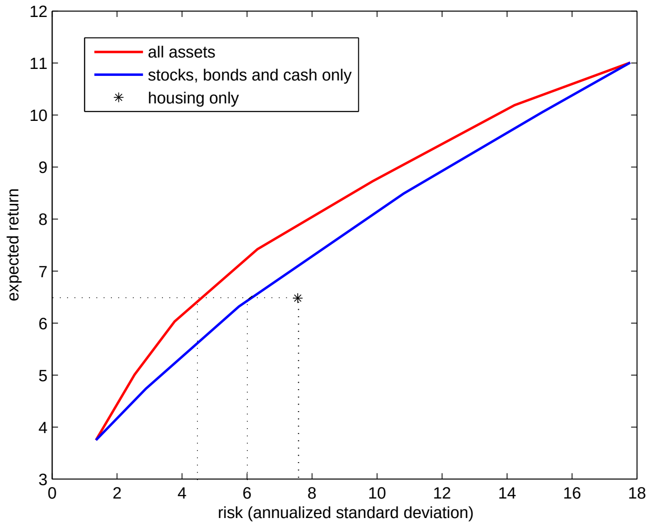

Fig. 1. Combining the house with other assets is superior to renting or buying. Returns, variances and correlations are based on quarterly observations during the period from Q4 1985 to Q4 2005. Again, we use the MSCI Switzerland for stocks, the 10-year Swiss Government Bond Index for bonds, the J.P.Morgan Switzerland 3-month Cash Index for cash and the Index for owner-occupied housing in the Canton of Zurich ZWEX for house prices. The cash and bond indices are calculated as total returns. To obtain the total returns of the stock and the housing index, we include the average income component, i.e. the net dividend respectively net rent yield, over the corresponding 20-year period.

2.2. New Mortgages to Avoid Liquidity Constraints

Homeowners' characteristics are typically very heterogeneous. Their mortgage financing decisions as well as their risk affinity depend upon their net wealth as well as on their income streams and borrowing constraints (Campbell, 2000). As such, the design of the mortgage is crucial when it comes to liquidity constraints and solvency risk of individual homeowners.

We propose two basic designs of index-linked mortgages to address liquidity risk. In the first design, we keep the principal on the mortgage fixed, but link the interest payment to the development of housing prices, i.e. an index-floating mortgage. The interest payment is calculated by adding the periodic performance to a base rate, e.g. 3.5% p.a., within a predefined bandwidth. Should the index fall, the due payment is reduced to a given floor, say 1.5% p.a., i.e. the homeowner is able to save 2% on the mortgage's nominal amount per year. On the other hand, if the index increases, the payment is adjusted upward up to e.g. 5.0% p.a. These levels reflect the pricing practice used at the Cantonal Bank of Zurich. [2] Hence, the maximum a homeowner can save is 2% per year, respectively an accumulated 10% over a 5 year period. Given the low volatility and the historic absence of short term price jumps, this approach absorbs the housing risk well. In contrast to traditional floating mortgages, such index-floating mortgages trigger higher payments only when housing prices actually rise. The cap at 5.0% p.a. avoids a coupon-payment liquidity constraint and the accumulated 10% savings serve as cushion against the refinancing liquidity constraint.

In the second design, the notional of the mortgage is linked to the index, protecting the homeowner against adverse changes in housing prices. In order to avoid a liquidity constraint in the case of strongly increasing prices (unrealized gains on housing), we propose an asymmetric payoff profile: A put option is incorporated in the mortgage, such that the notional is directly reduced by a potential negative index performance. The put premium can be split and added to the periodic interest instalments. We estimate the put premium to be approximately 0.7% p.a. over a 5 year term.

[2] The Cantonal Bank of Zurich, ZKB, has issued the first property derivatives in Switzerland in February 2006.

2.3. Index-Linkage Improves Credit Quality

Traditional asset and liability management targets an immunization effect that smoothes the equity position and reduces default risk. The same effect applies to the portfolio of homeowners and to home equity. Combining mortgages with property derivatives effectively reduces the collateral's volatility with respect to the mortgage liability. This portfolio optimization has besides the potential risk reducing effect a direct price impact on index-linked mortgages, see Section 4.

Finance theory commonly splits debt instruments into a risk free part and a put option on the collateral. This option is often referred to as credit put, and its premium is charged as a credit spread over the risk free rate. In the case of mortgages, the bank sells an implicit out-of-the money put option on the financed house, with a strike price equal to the mortgage's nominal amount. An index-linked mortgage, which includes an explicit (at-the-money) put option that serves as additional collateral, considerably reduces the probability that the borrower's implicit credit put ends in-the-money. The effectiveness of this credit risk reduction depends on the correlation between the individual house price that underlies the implicit credit put option and the house price index that underlies the explicit index put option. Given this correlation is significantly positive, the banks credit risk is considerably reduced. The result is a lower credit spread charged to homeowners, or, alternatively, a higher loan to value ratio. We describe the accuracy and efficiency of an index hedge in the following chapter.

3. Is an Index-Hedge Appropriate?

The price of housing is subject to considerable fluctuations over time which in turn lead to significant fluctuations in wealth. As pointed out by Sinai and Souleles (2003), the effects of house price risk on consumers' choices are ambiguous. For an household with utility defined over housing consumption, home-ownership acts as a hedge against changes in the cost of consumption, against rent risk. Housing market risk may thus increase homeownership rates. The extent to which hedging considerations affect tenure choice is mitigated by the existence of frictions on the real estate and on the mortgage market. Transaction costs of adjusting the level of housing, coupled with borrowing constraints restrict significantly the number of house trades and the investors' ability to implement first-best strategies (Cocco, 2000). In this context, the existence of a liquid property derivative instruments as the one described would be of great interest for investors. However, the extent to which an investor may take advantage of such a market is limited by the effectiveness of the hedging instrument, i.e. by the size of the idiosyncratic risk of individual properties compared to the market return benchmark.

Results from previous research indicate substantial variability in returns to particular properties relative to the market average. For the Swedish market Englund, Hwang and Quigley (2002) report a standard deviation of the returns of individual properties of 11.3%, compared with 7.6% for the market as whole. Goetzmann (1993) also documents a substantial higher variation for individual properties, with standard deviation 1.5 to 3 times higher for four U.S. metropolitan areas. For New Zealand Bourassa et al. (2005) find standard deviations 1.4 to 2 times higher than the general market. They relate the degree of variation in price changes among houses within a market to their characteristics and to the conditions of the housing market prevailing at the time of the sale. Atypical houses and houses with characteristics in limited supply, for example an ocean view, are generally more risky.

Unfortunately, the Zurich residential market is quite illiquid, with less than 2% of the housing stock trading each year. Even if our database covers around 20% of all transactions, we are able to identify only 264 repeated sales out a total of 14'000 transactions. In our very limited sample we measure a low correlation (0.19) between individual and market returns over an horizon of 4 years, rising to 0.38 over an interval of 8 years, and to 0.68 over 12 years. Although based on very limited sample, these results are in line with Iacoviello and Ortalo-Magné work for London (2003), who find a weakly positive correlation of 0.13 between the London housing returns and simulated individual returns at a short horizon (1 quarter) but a very strong correlation (0.87) at a 10-year horizon. In order to check for the robustness of our results we implement their methodology, adapted from Englund et al. (2002). The capital returns to single housing unit, r_t^h are defined as

$$r_t^h = (p_t^I + \eta_t) - (p_{t-1}^I + \eta_{t-1}) \tag{1}$$

where p_t^I is the log of the house price index and η is the idiosyncratic noise term with $E(\eta_t) = 0, E(\eta_t^2) = \sigma_\eta^2$. We take advantage of the availability of 11 geographically disaggregated indices for the Zurich area to approximate the returns on individual properties. We thus assume that the idiosyncratic variation of the individual housing returns is captured by the variation of the local index returns around the overall index. Notice that this method is likely to underestimate the true idiosyncratic risk, as the regional segmentation only represents one source of idiosyncratic risks out of many others. On this account, the estimated idiosyncratic volatility of the returns σ_η is equal to 0.082 while the volatility of the yearly index returns σ_I is 0.054. The correlations are indeed very high, ranging from 0.77 at the 4-year interval, to 0.89 at the 8-year intervals and 0.96 for a 12-year period.

Overall these partial and preliminary results confirm the importance of designing hedging instruments with maturities of at least 5 years, as the correlations with the index are higher at longer horizons.

4. Pricing Index-Linked Mortgages

We now price an index-linked mortgage with an embedded put option such that the notional is directly reduced by a potential negative index performance. The pricing of a mortgage with index-linked interest payments is less demanding, since it represents only an replacement of linkage, while payoffs are still periodically realized. In addition to the pricing of the index-linked mortgage we are also interested in comparing the prices of index-linked mortgages with their traditional counterparts.

We represent each loan as a linear combination of financial instruments. More precisely, we decompose the loan into the following securities: an unsecured loan, a credit derivative and, for the index-linked mortgage, a put option. This decomposition follows the logic that an index-linked mortgage equals an unsecured loan plus a credit enhancement through a collateral, i.e. a credit derivative, plus an index put option. From a risk perspective, the risk factor in the unsecured loan is given by the default risk of the borrower, the risk factors of the credit derivative and of the put option are a combination of default risk and house price risk.

We assume that the pricing of the put option in the index-linked mortgages and the rating of the borrowers are given. We present the results below without proofs (for details see Akgün and Vanini (2006)).

We first consider a loan with a maturity of 5 years, fixed coupon payments and a collateral. The linear representation of the present value in terms of financial instruments reads

$$B^{Z_b}(0,T) = U^{Z_u}(0,T) + PD(0,T)\left(1+\frac{r_T}{n}\right)^{-nT}\gamma E\left[min\left(ES, EF\right)\right] \ , \tag{2}$$

with $B^{Z_b,F}(0,T)$ the present value of the secured loan, $U^{Z_u,F}(0,T)$ the unsecured loan, i.e. the price of a loan depending on the borrower's credit worthiness alone. The second term represents the credit derivative. The cumulated customer's probability of default at maturity $T = 5$ is denoted $PD(0,T)$, ES is the effective collateral, EF the effective financing, i.e. the principal net of all amortization, r_T the risk free spot rate and n the frequency of coupon payments per annum, in accordance with the convention of r_T. Coupon payments of the unsecured (secured) bond are denoted $Z_u(Z_b)$.

The implicit credit derivative complies with Swiss jurisdiction as follows: first, for the credit derivative to become effective, the borrower has to default $(PD(0,T))$. After a default, a fraction of the cohort of borrowers is able to recover. This fraction, which empirically ranging from 20% to 30% of all defaulted borrowers is summarized by a fixed probability $1-\gamma$.

However, the fact that some borrowers do not recover explains the expression γ in (2). Then, the collateral, according to the terms and conditions in the borrower's note, is exchanged with the financing liability. The bank receives the smaller of the two, i.e. $min\,(ES, EF)$. The effective collateral, ES, reads

$$ES = \min\left(S, \max\left((1-\beta)H_T + a_S - v, 0\right)\right)$$

with v the value of any senior debts, H the value of the distrained object, β the average estimated percentage costs in the recovery workout, S the value of the borrowers note and a_S the value of other collateral than property. With

$$\min\left(ES, EF\right) = EF - \max\left(EF - ES, 0\right)\ , \tag{3}$$

the present value of the loan reads

$$\begin{aligned} D^{Z_b}(0,T) &= U^{Z_u}(0,T) \\ &\quad + \gamma PD(0,T)\left[\left(1+\frac{r_T}{n}\right)^{-nT} EF - \text{Put}\left(EF, T, r, \sigma_{ES}, \mu_{ES}\right)\right]\ . \end{aligned} \tag{4}$$

with Put$(\cdot)$ an European put option, σ_{ES} the volatility of the collateral (property) and μ_{ES} the annual growth rate of the collateral. This loan-implicit put option should not be confused with the explicit put option in the index-linked contract discussed below. The prices of loan contracts for 8 different rating categories, with class 8 the defaulted class, are summarized in Table 4 (all amounts are in Tsd. CHF):[3]

The two main conclusions from Table 4 are: first, the lower the creditworthiness of a borrower, the more expensive the terms for the unsecured loan. Second, the lower the creditworthiness of the borrower, the more is the bank (as protection buyer) willing to pay for collateral.

[3]We have chosen the following parameters: β is CHF $20'000$ / CHF $625'000 = 3.2\%$, probability of recovery $1-\gamma$ is 3%, volatility of the collateral σ_{ES} is 6% and the growth rate of the collateral μ_{ES} is 1.5%. For the risk free interest rates we used CHF Swap Rates as 25 October 2005 and internal default statistics to obtain the credit risk dependent discount factors.

Rating	Loan	Estimated Price of Property	Value of Borrower's Note	Terms of Mortgage	Unsecured Loan	Collateral Enhancement
7	500	625	500	**5.67%**	14.21%	8.54%
6	500	625	500	**4.53%**	8.20%	3.68%
5	500	625	500	**4.12%**	5.55%	1.43%
4	500	625	500	**3.96%**	4.43%	0.47%
3	500	625	500	**3.94%**	4.25%	0.32%
2	500	625	500	**3.91%**	4.04%	0.13%
1	500	625	500	**3.90%**	3.95%	0.05%

Table 2
Pricing of interest rate type mortgages. The final price is the difference between the unsecured loan and the price of the collateral for the bank as a protection buyer.

If we consider index-linked mortgages, the standard case described above is modified as follows. First, the automatic amortization of the notional if the put ends in the money, i.e. if the property index declined over the mortgage's life, is equivalent to additional collateral. This results in the replacement of the term $min\,(ES, EF)$ in (2) by P:

$$P = E\left[\chi_{\{I_T>K\}} min\,(ES, EF) + \chi_{\{I_T<K\}} min\left(ES + \frac{(K - I_T)}{K} N, EF\right)\right] \qquad (5)$$

with K the strike price of the put option, I_T the value of the index at maturity, χ the indicator function and N the notional of the mortgage.

Second, the client pays a put premium. For the best two rating categories 1 and 2, the put premium is approximately 0.7% p.a. for a 5 year term.[4] For borrowers with lower creditworthiness, i.e. a higher risk that they will fail to pay the annual put premium for the full contract period, the price of the put premium is higher. The variation of the option premium is shown in Table 4.

Third, one could believe that this put also improves the creditworthiness of the borrowers. But since we consider a 5 years contract with fixed interest payments, the credit risk of the client is only given by the probability that he is not able to pay these periodic instalments before maturity. The put, which becomes effective only at maturity, therefore potentially reduces reinvestment risk of the borrower (thanks to amortization) for the next period, but does not affect credit risk during the actual contract period. Table 4 compares the index-linked mortgage with the traditional one. The parameters are the same as for Table 4 with

[4] The price for the put option is consistent with the pricing practice used at the Zurich Cantonal bank.

Standard Mortgage				Index-Linked Mortgage		
Rating Class	Unsecured Loan	Collateral Enhancement	Terms of Mortgage	Index Put	Credit Enhancement	Index-Linked Mortgage
7	14.21%	8.54%	**5.67%**	1.09%	0.15%	**6.61%**
6	8.20%	3.68%	**4.53%**	0.95%	0.07%	**5.41%**
5	5.55%	1.43%	**4.12%**	0.88%	0.03%	**4.97%**
4	4.43%	0.47%	**3.96%**	0.81%	0.01%	**4.76%**
3	4.25%	0.32%	**3.94%**	0.72%	0.01%	**4.66%**
2	4.04%	0.13%	**3.91%**	0.71%	0.00%	**4.62%**
1	3.95%	0.05%	**3.90%**	0.71%	0.00%	**4.61%**

Table 3
Pricing of interest rate type mortgages and the index-linked mortgages. The index-linked mortgage is always more expensive than the interest rate one. But the lower a homeowner's creditworthiness, the less are the relative additional costs for the put option compared to the interest rate case.

the following additional data for the put: correlation between the index and the collateral is estimated 75% and the strike of the index put is set equal to the initial value of the index, i.e. at 100%.

Table 4 shows that uniform in the borrower's creditworthiness the terms of the index-linked mortgage are more expensive than for the classical one. But one observes that the bank is willing to pay slightly more as protection buyer to lower rated borrowers for the index-put than to borrowers with a high creditworthiness: the difference in the final terms between the two mortgages for the rating class 7 is 0.95% whereas the put premium is 1.09%. The above result is due to the following ideal assumptions: The loans make 80% of the estimated house price and the borrower's notes equal the nominal values. In summary, if the loan policy is tight, index-linked mortgages reduces reinvestment risk essentially - which is *not* considered above - and reduce interest coupon risk only gradually.

If we put the ideal assumption aside, index-linked mortgages not only reduce reinvestment risk but also turn out to be more profitable for clients with a low creditworthiness. Table 4 considers the pricing if the borrower's note is reduced from a nominal value of CHF $500'000$ to CHF $200'000$.

It follows that the lower the creditworthiness of the borrower, the more valuable the index put option as additional collateral.

Standard Mortgage				Index-Linked Mortgage		
Rating Class	**Unsecured Loan**	**Collateral Enhancement**	**Terms of Mortgage**	**Index Put**	**Credit Enhancement**	**Index-Linked Mortgage**
7	14.21%	3.53%	**10.68%**	1.09%	1.56%	**10.78%**
6	8.20%	1.52%	**6.68%**	0.95%	0.67%	**6.96%**
5	5.55%	0.59%	**4.96%**	0.88%	0.26%	**5.58%**
4	4.43%	0.19%	**4.24%**	0.81%	0.09%	**4.96%**
3	4.25%	0.13%	**4.12%**	0.72%	0.06%	**4.79%**
2	4.04%	0.06%	**3.99%**	0.71%	0.03%	**4.67%**
1	3.95%	0.02%	**3.93%**	0.71%	0.01%	**4.63%**

Table 4
Pricing of interest rate type mortgages and the index-linked mortgages. If collateral is a scarce resource, the bank is willing to sell index-linked mortgages with an explicit put option to a similar price than interest rate mortgages to homeowner's with a low creditworthiness.

5. Conclusion

Today, individual homeowners are often largely overexposed to the asset class of real estate. An index-linked mortgage provides the possibility to improve the balance of individual portfolios and reduce the systematic risk of real estate in these portfolios. Institutional investors on the other hand can optimize their portfolios by getting exposure to real estate without actually owning the objects. Mortgage providers, e.g. banks, could therefore pass on parts of the risk of index-linked mortgages to institutional investors. We can assume that demand as well as supply for index linked mortgages would exist. The discussion of real estate risk will facilitate the creation of a universe of suitable indices. Yet, it can be said that it is only a question of time until real estate indices, which are widely accepted by markets and in which investors are comfortable to invest, are established. However, it is unclear, whether the amount of transactions would be big enough to create the demanded regional focus of indexes, addressing idiosyncratic aspects appropriately. Valuations based on the model of the hedonic real estate pricing is increasingly used and widely accepted, and provide an appropriate basis for real estate indices. On the product side, providers will have to offer a menu of options to cater for the individual needs of real estate owners and investors. Reasonable structures of index linked mortgages include the linkage of the face value while keeping interest payments fixed or fixing the face value while linking interest payments. Financial engineering will allow the creation of any combination of these structures.

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