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RESEARCH

Hedging and Replicating Non-listed Real Estate Returns: Are Property Derivatives A Pipe Dream?

EXECUTIVE SUMMARY

- After a failed attempt to launch index based property derivatives on the London Fox Futures market in the early 1990s, several property derivative instruments, both over the counter (OTC) and listed, have been developed in the United Kingdom, USA, and Continental Europe over the last 10 years.
- However, success of these promising, albeit fledging, property derivative markets has been limited, in large part because of their failure to capture the full idiosyncrasy of direct property returns.
- As a result, existing property derivatives have resulted in substantial basis risk for hedgers and imperfect proxies for speculators aiming to synthetically replicate non-listed property returns.
- In order to improve hedging effectiveness, better indices of non-listed real estate are important, but one should not overlook the potential for financial innovation.
- Financial innovation could materialize as alternative factor based models of derivatives such as pure factor hedges and combinative hedges (i.e. a combination of index and factors).
- A test of these alternative models on the City of London's office markets shows that investors would benefit from the introduction of macro-factor based instruments in addition to a wider range of property index-based derivatives. A parallel analysis applied to office markets in China's first tier cities yields similar results.

INTRODUCTION

Each field of knowledge has its last frontier. For real estate researchers, one important milestone to be reached is synthetic property. In a nutshell, synthetic property means the ability to replicate non listed real estate returns by going long/short tradable indices and other non property-related instruments. Having the ability to replicate non listed real estate returns would open the door to efficient risk management tools for direct property owners. In *The Role of Investment Real Estate in Portfolio Management* (1970), James Graaskamp, the Wisconsin based pioneer of real estate research and founder of the American Real Estate Society, likened the ability of real estate to withstand a tough economic environment to "*the helicopter which in the absence of power and pilot control has the natural glide angle of a falling brick*". What can be done to allow property to glide through adversity? Synthetic replication might be the key, and exchange traded property derivatives would be an important step.

IN SEARCH OF HEDGING EFFECTIVENESS

How to deal with less than perfect hedges?

The process of hedging supposes a thorough understanding of an asset's risk structure. Non-listed real estate is well known for its overwhelmingly idiosyncratic risk structure stemming from heterogeneous assets traded on illiquid markets with asymmetric information. Beyond the economic jargon, encapsulating these characteristics within a single synthetic instrument or series of instruments is a major hurdle that product designers have found challenging to overcome. While some researchers (e.g. Gordon and Havsy, 1999) argue that designing effective hedges and replication tools for private commercial real estate assets is basically unfeasible because of a lack of reliable and representative underlying indices, others (e.g. Shiller, 1993) claim that markets for cash-settled property derivatives ought to be established based on improved indices.

After a failed attempt to launch index based property derivatives on the erstwhile London Fox Futures market in the early 1990s, several property derivative instruments, both over the counter (OTC) and listed, have been developed in the United Kingdom, USA, and Continental Europe over the last 10 years. Investors have witnessed the emergence of Total Return Swaps (TRS) based on IPD indices and NCREIF Property indices in respectively Europe and the USA. Likewise, in 2009, exchange traded futures and options based on an array of European IPD indices have been introduced on EUREX, a subsidiary of Deutsche Börse AG and one of the world's leading derivatives exchange. Success of these promising, albeit fledging, OTC and standardized markets has been limited. One common shortcoming of these instruments stems from their failure to capture the full idiosyncrasy of direct property returns, thereby resulting in substantial basis risk for hedgers (i.e. low hedging effectiveness[1]) and imperfect proxies for speculators aiming to synthetically replicate non-listed property returns.

Are better indices enough?

Even though they are notoriously cautious with innovation, market authorities are not to blame for this situation. Noticeably, following Case, Shiller and Weiss (1993), researchers' interest with respect to property derivatives has been mostly focused on the choice and design of optimal underlying indices while the basic structure determining the workings of the derivative itself — i.e. the fact that existing or proposed property derivatives are all index-based instruments modelled after financial derivatives (i.e. derivatives using indices on financial assets as underlying) — has been totally overlooked. Although it makes no doubt that the crucial question of indices in real estate has been a catalyst for many breakthroughs in other fields of real estate finance (e.g. smoothing in appraisals, constant liquidity indices), such a one-sided approach seems somewhat limitative. A derivative contract is the combination of both an underlying and a product structure. Hedging effectiveness results from the ability of this combination to deal with the phenomenon at work, not from the underlying alone. Markedly, real estate assets are very different from financial assets whose risk structures can be easily captured by a simple framework such as the Capital Asset Pricing Model (CAPM).

The property derivatives conundrum

Property derivatives are subject to two parallel requirements: first the necessity to provide efficient risk management tools for hedgers, and second, the need to trade on liquid and cost-effective markets that attract speculators. Because of the idiosyncratic risk profile of real estate assets, hedging effectiveness entails customization whereas liquidity and cost constraints imply standardization. Due to a lack of innovation in terms of product design, existing index-based property derivatives provide an imperfect compromise between standardization and customization, mostly at the expense of hedging effectiveness. As a result, property derivatives fall short of meeting real estate investors' risk management requirements, especially for those investors who manage smaller, less diversified portfolios of properties. As commercial real estate worldwide is caught in between the aftermath of GFC and China's new growth model, exploring more effective templates of property derivatives applicable to both diversified portfolios and individual buildings does not seem unreasonable, especially seen from Asia where property markets have known an historically stellar performances over the last decade.

Alternative models of derivatives

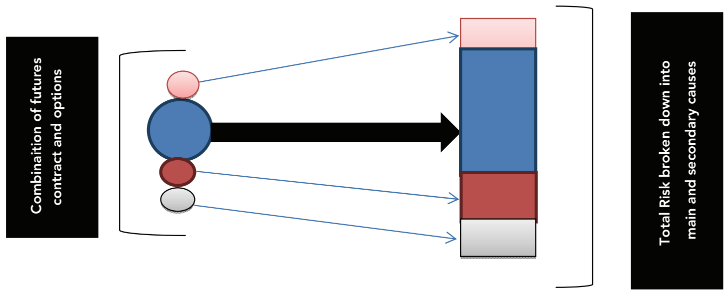
Specifically, Lecomte (2007) argues that current property derivatives are wrongly modelled after financial derivatives and pleads for an increased customization of property derivatives that would accommodate the multifactorial nature of real estate risk. To do so, a new model of property derivatives known as factor hedge is proposed. While index-based derivatives tend to over-simplify the risk structure of real estate assets, factor hedges have the ability to capture real estate risk in all its complexity. Factor hedges could materialize into sophisticated financial instruments where all underlying are standardized risk factors (pure factor hedge), or a combination of non-listed property index and such factors (combinative hedge). These instruments could be used to effectively hedge risks involved in portfolios of properties and individual buildings. Alternative models of property derivatives would represent a major step toward the full customization of property derivatives, akin to risk management's adoption of 'nuclear financial economics' with the Value at Risk concept developed in the 1990s (Sharpe, 1995).

[1] Following traditional hedging theory, hedging effectiveness is simply defined as the fit (aka coefficient de determination R^2) of the regression between a time series of property returns and that of an underlying index/factor returns. Basis risk designates the risk associated with imperfect hedging. A study done by the Bank of England (Holland and Fremault Vila, 1997) points to hedging effectiveness as the main driver of liquidity and success in derivatives contracts.

How combinative hedges would work

The combinative hedge template of property derivatives is modelled after multi-factorial instruments used for hedging duration risk in fixed income portfolios. In its simplest form (as shown on figure 1 below), it would combine a futures contract based on a non-listed property index for the bulk of total risk, and option-like instruments based on factors for secondary risk sources. The optionality embedded into property derivatives would give investors the flexibility of fine-tuning their risk management strategies.

Figure 1: Combinative Hedge Template for Property Derivatives



Castles in the air

Alternative models of property derivatives entail numerous methodological questions which are similar to those raised by multifactor models of stock returns in finance (e.g. Arbitrage Pricing Theory). In particular, issues pertaining to the standardization of underlying factors are central in determining the overall feasibility of the proposed templates of derivatives. Ultimately, the objective is to develop fully customizable hedges for individual properties. Can alternative models of derivatives come to the rescue of property derivatives which, in spite of being a great idea on paper, have been unable to gain ground in practice? The following empirical analysis which focuses on one of the most researched property market in the world (i.e. City of London office properties) provides some interesting clues.

EMPIRICAL ANALYSIS

IPD indices as potential underlying to property derivatives

The Investment Property Databank (IPD) proposes a large series of indices related to the London and City property markets covering 5 levels of granularity (from National/All Property to Local/Office). Among these indices, the following 9 total return indices are selected for the analysis:

- UK Annual All Property (level 1),
- UK Annual All Office (level 2),
- London Office Properties Annual index (level 3),
- City Office Properties – Local Authority Annual Index (level 4)[2],
- City Office Properties – Region Annual Index (level 4),
- EC1 Office Properties Annual index (level 5),
- EC2 Office Properties Annual Index (level 5),
- EC3 Office Properties Annual Index (level 5),
- EC4 Office Properties Annual Index (level 5).

IPD indices are customarily used as underlying to existing property derivatives in the UK. As of December 2013, GBP 1.54 billion worth of Total Return Swaps (TRS) traded on UK National Annual indices were outstanding, with the bulk of the TRS linked to the UK All Property index.

Besides, the IPD UK All Property Total Return index is used as underlying to futures contracts traded on EUREX. These annual contracts which were introduced in February 2009 have been met with limited success so far. In July 2011, EUREX introduced three additional contracts based on IPD UK sector indices, i.e. UK Annual All Retail, UK Annual All Office, and UK Annual All Industrial. Hence, the UK Annual All Property index (level 1) and the UK Annual All Office index (level 2) are two important benchmarks that will define the comparative benefits of index based hedges using more granular indices as underlying.

[2] IPD proposes two indices for the City office market with two different definitions of the City's geography: an index based on the *Region* (London)'s definition and one based on the *Local Authority* (City of London Corporation)'s.

IPD database of City office properties

IPD kindly agreed to share historical total returns of 224 City office properties in their database (out of 405 City office overall). The database covers the following information for each building:

- Annual total returns over the holding period (which can be any period from 1981 to 2007)[3],
- Construction date or latest renovation date as defined in IPD ground rules,
- Truncated postal code limited to the EC area and broad indication of neighbourhood,
- Available floor space for each year of the holding period.

Of the 224 buildings, only 37 have a holding period equal to or longer than 15 years. For the sake of statistical significance, the analysis focuses on these 37 buildings.

Factors

Historical data are analyzed in order to identify exogenous (macro) and endogenous (micro) factors impacting returns in the selected sample of London-based office properties. 17 macro-factors and 2 micro-factors are included in the analysis as reported in table 1 below.

TABLE 1: LIST OF 17 MACRO-FACTORS AND 2 MICRO-FACTORS

17 MACRO-FACTORS	INDEPENDENT VARIABLES
New Supply of City office buildings	YoY%
City Employment	YoY%
Inflation Rate	Annual Inflation Rate
Household Consumption	YoY%
Productivity Rate	YoY%
Gross Domestic Product	YoY%
UK Bank Base Rate	Average Monthly Rate over the year
10 Year Gilt	10 Year Gilt
10 Year Spread	Average Annual Spread %
6 month LIBOR	6 month LIBOR
FTSE 100 Index	YoY%
Annual Transaction Volume (LSE)	YoY%
Gold Price (London)	YoY%
S&P 500 Index	YoY%
CBOE VXO Index	CBOE VXO Index
Total Assets owned by London and Scottish Banks	YoY%
British Pension Funds' Real Estate Assets	YoY%
2 MICRO-FACTORS	**INDEPENDENT VARIABLES**
Property Age	Actual Age in years
Construction Type	Category 1 to 5 (Age group)

[3] Due to data availability at the property level, the period covered in the database ends in 2007 before the Global Financial Crisis.

4 different types of hedge are tested:

- Single index based derivative (including EUREX futures contracts) over full holding period (37 individual buildings)
- EUREX futures contracts over full holding period (4 portfolios)
- Pure factor hedges over full holding period (37 individual buildings and 4 portfolios)
- Combinative hedges over full holding period (37 individual buildings and 4 portfolios)

Simulation 1: Single index-based derivatives over full holding periods (individual buildings)

We first identify for each property in the sample the index yielding the best level of hedging effectiveness. There are 9 IPD indices to choose from, embodying 9 potential derivatives including the 2 EUREX contracts. The simulations which are conducted over full holding periods enable us to characterize different risk profiles among the 37 buildings, and to determine the levels of hedging effectiveness that alternative models of property derivatives should achieve in order to add value. Table 2 presents the results.

TABLE 2 – SIMULATION 1: SINGLE INDEX-BASED DERIVATIVES OVER FULL HOLDING PERIODS (INDIVIDUAL BUILDINGS)

					EUREX CONTRACTS R2		SUMMARY: 9 IPD INDICES R2			
Building #	Construction Date	Holding Period	Postal Code	Floor (M2)	UK-All Property	UK-All Office	Max	Min	Average	Best Underlying Index
1	1991	1989-2007	EC2	3,680	0.4664	0.5485	0.7011	0.4664	0.6143	City Office (local)
2	1939	1981-1995	EC2	660	0.3205	0.3289	0.5483	0.2475	0.4174	EC3 Office
3	1933	1981-2007	EC4	1,766	0.1871	0.3265	0.5041	0.1871	0.3881	EC2 Office
4	1966	1981-1999	EC3	790	0.2271	0.2537	0.3415	0.2271	0.2898	EC4 Office
5	1960	1981-1997	EC4	17,206	0.5592	0.5856	0.7845	0.5592	0.6930	City Office (region)
6	1975	1981-1997	EC3	3,540	0.4342	0.4450	0.6937	0.4226	0.5718	EC3 Office
7	1890	1981-1998	EC2	4,222	0.2296	0.2224	0.2650	0.2024	0.2365	EC2 Office
8	1900	1981-2004	EC2	601	0.1977	0.1751	0.2997	0.1751	0.2444	EC2 Office
9	1950	1981-2007	EC4	9,799	0.5337	0.6697	0.7478	0.5337	0.6875	City Office (region)
10	1960	1981-2000	EC3	2,189	0.2823	0.3176	0.5171	0.2823	0.4243	EC2 Office
11	1930	1981-2007	EC2	953	0.5851	0.5351	0.6194	0.4528	0.5682	EC3 Office
12	1958	1993-2007	EC4	2,663	0.0003	0.0258	0.0585	0.0003	0.0305	London Office
13	1995	1981-2000	EC2	8,835	0.2751	0.2918	0.4435	0.2444	0.3394	EC2 Office
14	2004	1986-2007	EC4	10,609	0.2784	0.4168	0.5080	0.2784	0.4152	EC3 Office
15	1930	1981-2002	EC3	9,077	0.2864	0.3516	0.5724	0.2864	0.4287	EC2 Office
16	1976	1981-1997	EC3	13,861	0.4546	0.5148	0.5716	0.4546	0.5093	EC1 Office
17	1975	1981-2007	EC2	28,252	0.2074	0.2699	0.4977	0.2074	0.3917	EC3 Office
18	1992	1988-2007	EC2	NC	0.3140	0.4549	0.5306	0.3140	0.4374	EC1 Office
19	1925	1981-1995	EC1	1,450	0.2381	0.2876	0.3745	0.2381	0.3254	EC3 Office
20	1959	1981-1995	EC2	4,729	0.1844	0.2340	0.3295	0.1823	0.2326	EC1 Office
21	1958	1981-1999	EC3	734	0.5434	0.5779	0.6906	0.4949	0.5883	EC4 Office
22	1992	1991-2007	EC3	71,403	0.5033	0.7225	0.7765	0.5033	0.7166	London Office
23	1920	1981-2002	EC3	15,970	0.3233	0.3869	0.6126	0.3233	0.4965	EC2 Office
24	NC	1981-2007	EC2	16,657	0.1522	0.2941	0.4472	0.1522	0.3562	EC3 Office
25	1939	1981-2003	EC2	697	0.2701	0.3166	0.4726	0.2625	0.3899	City Office (region)
26	1912	1981-2007	EC3	1,504	0.0255	0.0391	0.0391	0.0076	0.0199	UK-All Office
27	1956	1981-2007	EC3	4,161	0.1651	0.2947	0.3259	0.1651	0.2721	London Office
28	1928	1981-2001	EC3	4,756	0.5532	0.5961	0.8378	0.5532	0.7316	City Office (region)
29	1900	1981-2007	EC2	7,941	0.0246	0.0017	0.0246	0.0001	0.0036	UK-All Property
30	1982	1984-1999	EC4	11,993	0.1415	0.1497	0.2919	0.1415	0.2081	EC3 Office
31	1928	1981-2001	EC3	4,041	0.5067	0.6364	0.7004	0.5067	0.6487	EC1 Office
32	1964	1981-1997	EC4	8,036	0.2768	0.2972	0.4196	0.1860	0.3263	EC3 Office
33	1954	1981-2007	EC2	1,049	0.0000	0.0124	0.0140	0.0000	0.0059	London Office
34	1939	1981-2007	E1	2,877	0.1810	0.1603	0.1810	0.1023	0.1322	UK-All Property
35	1936	1981-1997	EC2	167	0.6190	0.6809	0.7243	0.5702	0.6425	London Office
36	1997	1981-2007	EC2	4,157	0.0063	0.0370	0.1302	0.0063	0.0827	EC2 Office
37	1984	1981-1995	EC3	3,647	0.0954	0.0927	0.1192	0.0723	0.0964	EC3 Office
Max	***2004***	***NA***	***NA***	***71,403***	***0.6190***	***0.7225***	***0.8378***	***0.6190***	***0.7316***	***NA***
Min	***1890***	***NA***	***NA***	***167***	***0.0000***	***0.0017***	***0.0017***	***0.0000***	***0.0036***	***NA***
Average	***1953***	***NA***	***NA***	***7,908***	***0.2878***	***0.3392***	***0.4160***	***0.2878***	***0.3774***	***NA***

On average, hedging effectiveness across all properties and all indices amounts to 0.3774. The range is very large: the highest hedging effectiveness tops 0.8378 (building 28/ underlying: City Office Region) while the lowest is close to 0 (building 33/ underlying: EC4 Office). 23 properties achieve their best hedges with the EC Office index series. Interestingly, the best EC Office index is not necessarily the one corresponding to the building's location. For instance, building 15 which is located in EC3 gets its best hedge with EC2 Office index as underlying. The two EUREX contracts only provide best hedge for 3 buildings. Their average hedging effectiveness is equal to 0.2878 and 0.3392 respectively, i.e. basis risk remains superior to 50%.

The best hedges' average effectiveness for all properties is equal to 0.4518. Again, the range is extremely large: from 0.8378 to 0.0140 (for building 28 and 33 respectively). The underlying index yielding the best hedging effectiveness across all properties is EC3 Office with an average effectiveness equal to 0.4160. That leaves basis risk at almost 60%, which is hardly satisfactory for a hedger. Interestingly, some buildings cannot be hedged at all with index-based instruments. Their returns are non-correlated with IPD indices, so much so that basis risk can reach 99%.

TABLE 3: SUMMARIZES SIMULATION 1'S MAIN FINDINGS

IPD Index used as Underlying	CD/Sample	Comments
UK All Property UK All Office	0.2878 (average 37 buildings) 0.3392 (average 37 buildings)	These two indices are used as underlying to EUREX contracts
EC3 Office	0.4160 (average 37 buildings)	Best hedging effectiveness over the sample on average.
City Office-Region	0.8378 (building 28)	Largest hedging effectiveness achieved for a single building (#28).
UK All Property	0 (building 33)	Lowest hedging effectiveness achieved by a single building (#33).

If we limit the range of available derivatives to the two EUREX futures contracts, the UK All Office unsurprisingly dominates the UK All Property contract, coming first for 30 properties out of 37. However, the UK All Office contract's average hedging effectiveness is only 0.3392, which is significantly lower than that of the best underlying indices chosen from the full range of 9 indices (0.4518 on average). Hence, the implied cost of non-availability of a wider range of futures contracts (i.e. underlying basis risk) is significant. In the case of our 37 properties, it amounts to over 10 basis points on average.

Simulation 2: EUREX Futures contracts over full holding periods (4 portfolios)

We now use Simulation1's findings to construct 4 portfolios:

– Portfolio 1 made up of 7 buildings representative of the sample (4, 8, 10, 15, 26, 28, 37).
– Portfolio 2 made up of the full sample (i.e. 37 buildings minus building 18 for which information are not sufficient).
– Portfolio 3 made up of 3 properties (among those selected for Portfolio 1) selected for their lowest hedging – effectiveness as individual property (8, 26, 37).
– Portfolio 4 made up of 3 properties (among those selected in Portfolio 1) selected for their largest hedging effectiveness as individual property (10, 15, 28).

In the absence of information on the properties' annual estimated values, the annual weights of each building in the 4 portfolios are based on the floor areas as reported yearly in the IPD database. Table 4 summarizes our findings.

TABLE 4: SIMULATION 2 – EUREX FUTURES CONTRACTS OVER FULL HOLDING PERIODS (4 PORTFOLIOS)

	Holding Period (*)	Average Annual Return	Standard Deviation	Sharpe Ratio (**)	Optimal EUREX Contracts R2	Underlying Index
Portfolio 1	1981-2007	11.8759	15.8794	0.2024	0.4407	UK All Office
Portfolio 2	1981-2007	11.3395	14.0641	0.2272	0.6830	UK All Office
Portfolio 3	1981-2007	11.5917	15.5385	0.1850	0.2069	UK All Office
Portfolio 4	1981-2002	11.9740	21.4966	0.1390	0.5013	UK All Office

(*) All portfolios are held for 26 years, except portfolio 4 (21 years).
(**) Risk free rate is equal to the 10 year Gilt.

Over the 4 portfolios, the largest levels of hedging effectiveness are achieved with the UK All Office contract. In the case of Portfolio 2 (i.e. a well-diversified portfolio), basis risk falls to slightly over 30%. Unsurprisingly, the larger the portfolios, the more EUREX contracts are able to capture systematic risk. For portfolios which are not well diversified (e.g. Portfolio 3), hedges based on EUREX futures contracts are still substantially more effective than those achieved when hedging individual properties with the same contracts. Hence, although EUREX futures contracts are not well suited to hedge individual properties' returns, they are effective in case of portfolios, even under-diversified ones.

Simulation 3: Pure Factor hedges over full holding periods (37 individual buildings and 4 portfolios)

We now construct hedges by optimally combining the 19 factors listed in table 1 above. The nature and number of factors selected in the optimal hedges are determined by applying a stepwise regression methodology in order to limit multi-collinearity among factors. Our results for individual properties are reported in table 5 panel A.

TABLE 5: SIMULATION 3 – PURE FACTOR HEDGES OVER FULL HOLDING PERIODS
(37 INDIVIDUAL BUILDINGS AND 4 PORTFOLIOS)

Panel A Buildings	Best Underlying Index (Simulation 1) R2	Optimal Pure Factor Hedge R2	Optimal Pure Factor Hedge # of Factors	% diff/IPD Index
1	0.7011	0.8060	4	14.96%
2	0.5483	0.7900	3	44.08%
3	0.5041	0.7530	5	49.38%
4	0.3415	0.4170	1	22.11%
5	0.7845	0.8480	4	8.09%
6	0.6937	0.8410	5	21.23%
7	0.2650	0.5660	2	113.58%
8	0.2997	0.3460	3	15.45%
9	0.7478	0.7810	6	4.44%
10	0.5171	0.7840	5	51.61%
11	0.6194	0.4540	3	-26.70%
12	0.0585	0.3860	2	559.83%
13	0.4435	0.6830	4	54.00%
14	0.5080	0.7340	5	44.49%
15	0.5724	0.5900	4	3.07%
16	0.5716	0.5380	3	-5.88%
17	0.4977	0.6900	7	38.64%
18	0.5306	0.8620	5	62.46%
19	0.3745	0.2460	1	-34.31%
20	0.3295	0.6860	3	108.19%
21	0.6906	0.6880	3	-0.38%
22	0.7765	0.8680	4	11.78%
23	0.6126	0.6690	4	9.21%
24	0.4472	0.6650	5	48.70%
25	0.4726	0.8160	5	72.66%
26	0.0391	0.1920	1	391.05%
27	0.3259	0.5330	4	63.55%
28	0.8378	0.7560	4	-9.76%
29	0.0246	0.0950	1	286.18%
30	0.2919	0.8420	4	188.45%
31	0.7004	0.6860	3	-2.06%
32	0.4196	0.7720	3	83.98%
33	0.0140	0.1620	2	1056.69%
34	0.1810	0.5330	5	194.48%
35	0.7243	0.8270	3	14.18%
36	0.1302	0.4280	3	228.73%
37	0.1192	0.4080	2	242.28%
Average	***0.4518***	***0.6146***	***3.54***	***36.04%***

Panel B Portfolios	Best Underlying Index (Simulation 1) R2	Optimal Pure Factor Hedge R2	Optimal Pure Factor Hedge # of Factors	% diff/IPD Index
Portfolio 1	0.6708	0.6380	4	-4.9%
Portfolio 2	0.9111	0.8800	5	-3.4%
Portfolio 3	0.2240	0.4410	4	96.9%
Portfolio 4	0.7776	0.7180	4	-7.7%

Over the 37 properties, hedging effectiveness improves by 36% (compared to the best index-based hedges determined in Simulation 1), reaching 0.6146. Optimal hedges contain 3.54 factors on average, with the maximum number of factors in a single hedge being equal to 7. In terms of absolute gains, properties which register weak to average hedging effectiveness with single IPD indices as underlying do benefit the most from the use of factors. Conversely, properties whose returns are strongly hedged by using index-based instruments benefit very little from the use of factors, and in some cases suffer from it. Optimal factor hedges are dominated by three factors: new supply of City office properties, FTSE 100 transaction volume, and household consumption.

The same methodology is then applied to the 4 portfolios. Results are reported in table 5 panel B. For Portfolios 1, 2 and 4 whose risk is properly hedged by an index-based instrument, the use of factor hedge does not add any value. Conversely, for Portfolio 3 whose risk is not effectively hedged with an index based instrument, the factor hedge almost doubles hedging effectiveness. This finding is consistent with results at the individual property level, i.e. factor hedges only add value in case of properties/portfolios whose risk is not effectively hedged with a single index instrument. For other properties/portfolios, the use of factors adds no value, and in some cases, turns out to be detrimental to the hedge's effectiveness.

Simulation 4: Combinative hedges over full holding periods (37 individual buildings and 4 portfolios)

Finally, a simulation is run to test the combinative template of property derivatives (i.e. a combination of index and factors). Stepwise regressions are applied in a similar way to those used to determine optimal factor hedges in Simulation 3. The only difference is that the best underlying IPD index for each property/portfolio over full holding period determined in Simulation 1 is added to the pool of macro/micro factors. Hence, optimal models are selected from 20 variables instead of 19 previously. Table 6 summarizes our results for the 37 properties (panel A) and 4 portfolios (panel B).

TABLE 6: SIMULATION 4 – COMBINATIVE HEDGES OVER FULL HOLDING PERIODS (37 INDIVIDUAL BUILDINGS AND 4 PORTFOLIOS)

Panel A Buildings	Combinative Hedge R2	Index rank	# of Factors	% diff/IPD index	% diff/factor hedge	Best hedge over full holding period
1	0.9100	1	4	29.80%	12.90%	IPD index + Factors
2	0.8680	1	3	58.31%	9.87%	IPD index + Factors
3	0.8000	1	5	58.70%	-0.25%	Factors
4	0.4170	none	1	22.11%	0.00%	Factors
5	0.8700	1	2	10.90%	2.59%	IPD index + Factors
6	0.7930	1	2	14.31%	-5.71%	Factors
7	0.5660	none	2	113.58%	0.00%	Factors
8	0.4530	1	2	51.15%	30.92%	IPD index + Factors
9	0.8000	1	2	6.98%	2.43%	IPD index + Factors
10	0.6510	1	3	25.89%	-16.96%	Factors
11	0.6190	1	none	-0.06%	36.34%	IPD index
12	0.3860	none	2	559.83%	0.00%	Factors
13	0.6980	1	3	57.38%	2.20%	IPD index + Factors
14	0.6500	1	3	27.95%	-11.44%	Factors
15	0.6730	1	2	17.58%	14.07%	IPD index + Factors
16	0.6810	1	1	19.14%	26.58%	IPD index + Factors
17	0.8250	1	3	65.76%	19.57%	IPD index + Factors
18	0.8670	1	3	63.40%	0.58%	IPD index + Factors
19	0.5850	1	1	56.21%	137.80%	IPD index + Factors
20	0.6860	none	3	108.19%	0.00%	Factors
21	0.7640	1	1	10.63%	11.05%	IPD index + Factors
22	0.9620	1	3	23.89%	10.83%	IPD index + Factors
23	0.7930	1	3	29.45%	18.54%	IPD index + Factors
24	0.5180	1	1	15.83%	-22.11%	Factors
25	0.8250	1	3	74.57%	1.10%	IPD index + Factors
26	0.1920	none	1	391.05%	0.00%	Factors
27	0.4100	1	1	25.81%	-23.08%	Factors
28	0.9200	1	3	9.81%	14.29%	IPD index + Factors
29	0.0950	none	1	286.18%	0.00%	Factors
30	0.5360	1	1	83.62%	-36.34%	Factors
31	0.7970	1	2	13.79%	16.18%	IPD index + Factors
32	0.8510	1	4	102.81%	10.23%	IPD index + Factors
33	0.2240	3	2	1499.38%	38.27%	IPD index + Factors
34	0.6060	1	4	234.81%	13.70%	IPD index + Factors
35	0.7243	1	none	0.00%	-12.42%	Factors
36	0.6040	4	5	363.90%	41.12%	IPD index + Factors
37	0.4080	none	2	242.28%	0.00%	Factors
Average	***0.6494***		***2.40***	***43.73%***	***5.66%***	

Panel B Portfolios	Combinative Hedge R2	Index rank	# of Factors	% diff/IPD index	% diff/factor hedge	Best hedge over full holding period
Portfolio 1	0.765	1	2	14.04%	19.91%	IPD index + Factors
Portfolio 2	0.933	1	2	2.40%	6.02%	IPD index + Factors
Portfolio 3	0.556	1	3	148.21%	26.08%	IPD index + Factors
Portfolio 4	0.798	1	1	2.63%	11.14%	IPD index + Factors

For individual properties, combinative hedges improve hedging effectiveness by 43.74% on average over single index based hedges (Simulation 1) and 5.66% over pure factor hedges (Simulation 3). Hedging effectiveness reaches 0.6494, effectively reducing basis risk to less than 30%. Of the 37 properties, 21 achieve their most effective hedges with a combination of IPD index and factors whereas only 15 are best hedged with factors alone. Only one property (#11) registers its best hedge when using a single IPD index as underlying. For the 21 properties for which combinative hedges dominate, hedging effectiveness increases by 133% on average over single index hedges and by 123% over factor hedges. Notwithstanding some outliers (buildings 33 and 34), such significant improvements embody the potential benefits combinative hedges can represent for investors. Interestingly, a similar analysis applied to Chinese Office properties in 3 first-tier cities (Beijing, Shanghai, and Guangzhou) identifies the dominance of combinative hedges (encompassing macro-factors) over single and combined hedges made up of cross-hedging underlyings (Lecomte, 2013)[4].

On average, combinative hedges contain 2.4 factors. Among the factors most frequently selected in the optimal models are City employment, inflation rate, and productivity. Noticeably, these factors differ from those listed in optimal factor models, e.g. new supply which is prevalent in factor hedges only plays a minor role in combinative hedges. It might already be encapsulated in IPD indices. As before, property age is marginal in the optimal models. Seven properties in the sample are not amenable to the combinative framework (4, 7, 12, 20, 26, 29, 37), with combinative hedges resulting in factor hedges without any IPD indices selected in the optimal models.

With respect to the 4 portfolios, the improvement is very significant for Portfolio 3 (+148% over Simulation1, +26% over Simulation 3). It is less marked for portfolios whose returns are effectively hedged with IPD index based instruments, e.g. Portfolio 2.

CONCLUSION

Notwithstanding its theoretical relevance, the concept of property derivatives has failed to gain ground in practice. Investors' apparent lack of interest stems from existing derivatives' inability to properly hedge and replicate non-listed property returns. One might argue that an original flaw of property derivatives lies in their design modelled after index-based financial derivatives, even though non-listed real estate and financial assets have very different risk structures. Lecomte (2007, 2014) argues that alternative templates of property derivatives based on factors, or combination of index and factors would be more consistent with non-listed real estate's idiosyncratic risk profile.

An empirical study of City office properties over the period 1981-2007 shows that existing property derivatives, i.e. EUREX futures contracts and IPD index based over the counter derivatives (swaps), do not address the hedging needs of individual property owners. Alternative models are significantly more effective than index-based derivatives overall.

Although it seems that a carefully selected set of macro/micro-factors does provide effective hedges for individual buildings, factors cannot replace indices. They complement them but don't substitute for them as exemplified by the outperformance of combinative hedges. Making selected indices and macro-factors simultaneously available to investors while keeping in sight the danger of artificially inflating the number of possible underlyings would enhance hedging effectiveness across the board.

Despite their potential contribution to risk management strategies in many markets across the world including Asia, the two alternative templates of property derivatives are unlikely to be implemented by derivatives markets any time soon. Whereas macro-factors might be traded on an auction market comparable to the one formally used for economic derivatives, it is very unlikely that micro-factors will be traded on any kind of standardized market in the near future. Nevertheless, in the medium term, one step in the direction of more effective property derivatives might entail a futures market where a wider range of index-based contracts can be combined with other derivatives (e.g. options) based on macro-factors selected by property type and economic basis. That would open the door to the process of *customized standardization* advocated by Lecomte and McIntosh (2006).

Finally, beyond the realm of hedging for which they were initially designed, alternative models of property derivatives might find practical relevance as blueprints for financial instruments synthetically replicating commercial real estate returns and risks at the property level. This would indeed help turn around the future of synthetic property.

[4]Lecomte (2013) uses a series of cross hedges (e.g., China ETFs, Red Chips, commodity companies) and combines them with macro-factors to design combinative hedges for China's office markets proxied by CBRE indices. Interestingly, Beijing's and Shanghai's markets are influenced by very different macro-factors. While Beijing's office properties are best hedged with combinative hedges containing national macro-factors (i.e. long term rate, private consumption, money supply), Shanghai's office market is linked to macro-factors at the MSA level: GDP growth and local employment. Due to the unavailability of reliable Chinese commercial real estate indices, Total Return Swaps linked to Chinese non listed properties are still difficult to implement and price.

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