



## 1. General Description of the Research

This is a seminal article on real estate derivative pricing. It seeks to bridge the knowledge gap between real estate investors and derivative traders. The ability to enforce the no arbitrage condition is one of the fundamental requirements of derivative pricing. In theory, this can easily be achieved with the equities and fixed income markets since the underlying assets can be traded in the spot market. For example, all the stocks in the S&P 500 can be traded at virtually any point in time; however it will be impossible to trade all the properties in the NCREIF or IPD indices.

Even if this were possible, the prices at which the assets could be traded at would differ from their appraised values in the NCREIF or IPD series. This is because by nature both these indices contain noise and suffer from a lagged bias. Noise arises as a result of random deviation between the index level and the market price. The consequences of noise are the addition of short-term volatility to the index and negative autocorrelation, thereby increasing basis risk. The lag gives the index inertia, predictability, positive autocorrelation and dampened volatility. The asymmetric nature of the two effects implies that they can be hard to detect empirically. Generally, noise tends to be more visible in a transaction based index while lag is more problematic in the appraisal based index. As far as a suitable index for derivatives is concerned, traders will have a preference for an index with a large sample base and one which does not suffer from the lag bias.

This naturally leads to the construction of transaction based indices for derivative trading. The MIT-NCREIF Transaction Based Index (TBI) is shown to be more responsive to exogenous shocks (such as recessions, the REIT boom) than the NCREIF NPI index. Further, the TBI slightly leads the usual NPI index. However, the fact that the TBI is constructed on the same sample as the NCREIF raises issues regarding the coverage of the index.

## 2. Methodology

The most poignant contribution of the article is that it shows how derivative can be fairly priced even when limits to arbitrage are present. This can be achieved by using the equilibrium price: the price which ensures that each party in the trade receives an expected return which

exactly reflects on the risk each party bears, as measured by their own preferences. Although this will not generally hold for appraisal indices, once lags and smoothing effects have been accounted for it is possible to have a theoretical fair price even on an appraised based index. For example, the fair price of a forward contract will be the expected future index value discounted by the risk premium. If the stochastic process is a martingale difference sequence, as would be expected in any derivative based on the S&P 500 or any transaction based index, then arbitrage would simply require that the price of the forward is related to the current value of the index. On the other hand, if the stochastic process has autocorrelation (e.g. an appraisal index), then arbitrage would require that the current value of the index be adjusted for lags.

It is plausible that a liquid and dense forward or swap market will allow price discovery for real estate investors. This is especially the case if the derivative price is being compared to an appraisal based index. The authors show that once private expectations are taken into account, the creation of such a market is a possibility. Assuming that there is heterogeneity in preferences for the end users, the creation of a liquid derivative market should be possible. The last section of the article shows that in the event of a negative shock, the market price of the asset may fall by a larger amount than the index. Thus, a full hedge will require that the holder of the asset hedges *more* than the notional amount of his building (i.e. the hedge ratio should be more than 1).

### **3. Application to Investor**

This article is very relevant to end users of property derivatives. It addresses many of the issues that are present in derivative pricing and it also shows that a fair price is a possibility. Some of the limitations of property derivatives are also highlighted.

### **4. Caveats**

The inherent heterogeneity in buildings imply that irrespective of how “good” the index is, there will almost always be basis risk when end users consider using property derivatives to hedge their physical assets. In theory, the perfect hedge would be an asset specific hedge where the owner is able to cherry pick which buildings from his or hers portfolio that needs to be hedged. Such an asset specific solution would be the holy grail of property derivatives.