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Forward–futures price differences in the UK commercial property market: Arbitrage and marking-to-model explanations

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ABSTRACT

In this paper the differences between forward and futures prices for the UK commercial property market are analyzed, using both time series and panel data. A first battery of tests establishes that the observed differences are statistically significant over the study period. Further analysis considers the modeling of this difference using mean-reverting models. The proposed models are then estimated with a number of alternative estimation methods and second stage statistical tests are implemented in order to decide which model and estimation method best represent the data.

1. Introduction

The difference between forward and futures prices has been given considerable attention in the finance literature, both from a theoretical as well as from an empirical perspective, and for various underlying assets. On the theoretical side, Cox, Ingersoll, and Ross (1981) (CIR) obtained a relationship between forward and futures prices based solely on no-arbitrage arguments.[1] A series of papers subsequently tested empirically the CIR result(s). Cornell and Reinganum (1981) investigated whether the difference between forward and futures prices in the foreign exchange market is different from zero. For several maturities and currencies, they found that the average forward–futures difference is not statistically different from zero. In addition, they suggested that earlier studies identifying significant forward–futures differences for the Treasury bill markets ought to seek explanations elsewhere than in the CIR framework, since the corresponding covariance terms for this market were even smaller. French (1983) reported significant differences between forward and futures prices for copper and silver. Moreover, he conducted a series of empirical tests of the CIR theoretical framework and concluded that his results are in partial agreement with this theory. Park and Chen (1985) also investigated the forward–futures differences for a number of foreign currencies and commodities and they pointed out to significant differences for most of the commodities that they analyzed, but not for the foreign currencies. Also, their empirical tests confirmed that the majority of the average forward–futures price differences are in accordance with the CIR result.

Kane (1980) tried to explain the differences between futures and forward prices based on market imperfections such as asymmetric taxes and contract performance guarantees. Levy (1989) strongly argued that the difference between forward and futures prices arises from the marked-to-market process of the futures contract. Meulbroek (1992) investigated further the relationship between forward and futures prices on the Eurodollar market and suggested that the marked-to-market effect has a large influence. However, Grinblatt and Jegadeesh (1996) advocated that the difference between the futures and forward Eurodollar rates due to marking-to-market is small. Alles and Peace (2001) concluded that the 90-day Australia futures prices and the implied forwards are not fully supported by the CIR model. Recently, Wimschulte (2010) showed that there is no significant statistical or economical evidence for price differences between electricity futures and forward contracts.

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[1] Other early studies that considered the relationship between forward and futures prices in a perfect market without taxes and transaction costs are Margrabe (1978), Jarrow and Oldfield (1981) and Richard and Sundaresan (1981).

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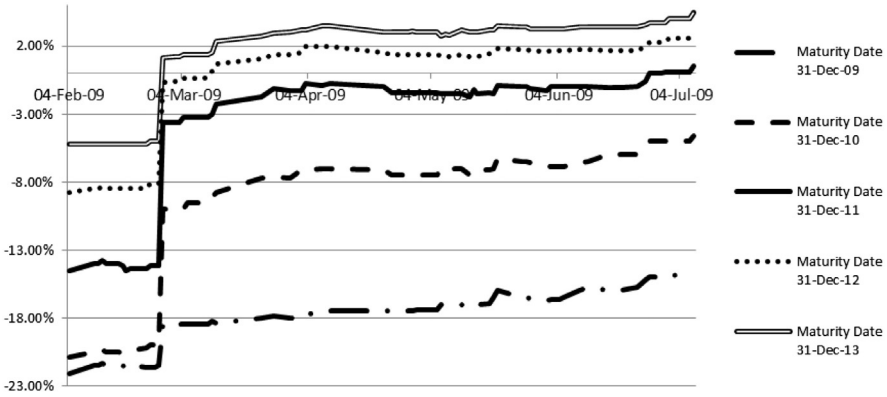

Fig. 1. IPD total return swap rates (mid prices). *Notes*: The plotted data is from 4 February to 7 July 2009 for the five maturity dates fixed in the market calendar, for the period of study. The total return swap rates are given as a fixed rate and not as a spread over LIBOR. A negative total return swap rate implies that the underlying commercial property market will depreciate over the period to the horizon indicated by the maturity of the contract.

The relationship between forward and futures prices as developed under the CIR framework makes the tacit assumption that futures are infinitely divisible. Levy (1989) starts with the same set of assumptions underpinning the CIR model except one. When considering interest rates, he advocates that, if only the next day's interest rate were deterministic, a perfect hedge ratio using fractional futures positions can be constructed to replicate the forward. Thus, for Levy (1989) it is only the interest rate for the next day that is important and not the entire time path of the stochastic rates. Consequently, for Levy (1989), the forward prices *should be equal* to futures prices and any empirical findings regarding actual price differentials are non-systematic and they can have only *statistical* explanations. On the other hand, Morgan (1981) studied the forward–futures differential assuming that capital markets are efficient and concluded that forward and futures prices must be different. His conclusion is mainly based on the fact that current futures price depends on the joint future evolution of stochastic interest rates and futures prices. Polakoff and Diz (1992) argued that due to the indivisibility of the futures contracts,[2] the forward prices *should be different* from futures prices even when interest rates and futures prices exhibit zero local covariances. Moreover, they show that the autocorrelation in the time series of the forward–futures price differences should be expected. Hence, testing must take into consideration the presence of autocorrelation. Polakoff and Diz (1992) offered a theoretical explanation that unifies the contradictory theoretical views originated in how interest rates are negotiated in the model. Their main conclusion is that it is unnecessary for futures prices and interest rates to be correlated in order to imply that forward prices should be different from futures prices.

From the review discussed above it appears that the empirical evidence is mixed and asset class specific. Property derivatives are an emerging asset class of considerable importance for financial systems. Case and Shiller (1989, 1990) found evidence of positive serial correlation as well as inertia in house prices and excess returns, implying that the U.S. market for single-family homes is inefficient. The use of derivatives for risk management in real estate markets has been discussed by Case, Shiller, and Weiss (1993), Case and Shiller (1996) and Shiller and Weiss (1999) with respect to futures and options. Fisher (2005) discussed NCREIF-based swap products, while Shiller (2008) described the role played by the derivatives markets in general for home prices.

For real-estate there has been a perennial lack of developments of derivatives products that could have been used for hedging price risk. The only property derivatives traded more liquidly in the U.S. and the U.K. are the total return swaps (TRSs), forwards and futures. In the U.K. commercial property sector for example, all three types of contract have the Investment Property Databank (IPD) index as the underlying. Since February 2009 the European Exchange (Eurex) has listed the UK property index futures. The most liquid derivatives markets on the IPD UK index are the TRS, which is an over-the-counter market, and the futures, both with at least five yearly market calendar December maturities. Any portfolio of TRS contracts can be decomposed into an equivalent portfolio of forward contracts. Hence, having data on TRS prices and futures prices opens the opportunity to compare, after some financial engineering, forward curves with futures curves on the IPD index. As remarked by Polakoff and Diz (1992) it is difficult to compare forward and futures prices on a daily basis when forwards are traded on a non-synchronous basis. By contrast, when forwards are derived on an implied basis from other instruments then matching the term-to-delivery is easy.

In this paper the forward–futures price differences are investigated for the UK commercial property market for all five December market maturities. To our knowledge, this is the first study that considers the forward–futures price differences for this important asset class. The analysis of the difference is particularly important for two main reasons. Firstly, previous literature addressing the issue for different asset classes found that the empirical evidence was mixed and asset specific. Therefore, addressing the question for a new asset class is not an exercise of confirming previous results, but rather a new and important question in itself, especially since unexplained forward–futures differences can signal arbitrage opportunities. Secondly, intrinsic characteristics of real estate as an asset class make the contribution of this paper particularly relevant, since the underlying (a commercial real estate index in our case) is likely to be correlated with interest rates. According to the CIR result, this in turn should drive significant differences between forward and futures prices, but does this fully explain observed differences or can these occur, at least partially, due to arbitrage also? This is essentially what our paper aims to address. Furthermore, all previous studies relied exclusively on time series analysis, whereas in this paper we also conduct statistical tests for panel data as well as time series tests. To the authors' knowledge, this is the first study that considers panel data modeling in this context. Employing panel data has a series of advantages over basing findings on time series alone.[3] For example, it increases statistical accuracy by increasing the number of degrees of freedom, which is particularly important for this application which benefits from having access to a unique OTC data set, with a relatively limited sample period, but with data available for a number of cross sections. To sum up the contribution of the paper, we analyze the forward–

[2] Although the vast majority of literature on futures is based on the assumption of infinite divisibility, Polakoff (1991) discusses the important role played by the indivisibility of futures contracts.

[3] See, for example Hsiao (2003) for a discussion of the advantages of using panel data.