Accepted Manuscript

CFDs, forwards, futures and the cost-of-carry

F. Douglas Foster, Adrian D. Lee, Wai-Man Liu

PII: S0927-538X(17)30507-3
DOI: doi:10.1016/j.pacfin.2018.05.004
Reference: PACFIN 1022

To appear in: *Pacific-Basin Finance Journal*

Received date: 26 October 2017
Revised date: 21 March 2018
Accepted date: 10 May 2018

Please cite this article as: F. Douglas Foster, Adrian D. Lee, Wai-Man Liu , CFDs, forwards, futures and the cost-of-carry. The address for the corresponding author was captured as affiliation for all authors. Please check if appropriate. Pacfin(2017), doi:10.1016/j.pacfin.2018.05.004

CFDs, Forwards, Futures and the Cost-of-Carry

F. Douglas Foster
Discipline of Finance, The University of Sydney Business School
The University of Sydney, N.S.W., 2006 AUSTRALIA.
Email: douglas.foster@sydney.edu.au
Voice: +61 2 9036 9450

Adrian D. Lee
Finance Discipline Group, University of Technology Sydney
Broadway, N.S.W., 2007 AUSTRALIA.
Email: adrian.lee@uts.edu.au
Voice: +61 2 9514 7765

Wai-Man Liu
Research School of Finance, Actuarial Studies and Applied Statistics, The Australian National University
Canberra A.C.T. 0200 AUSTRALIA
Email: waiman.liu@anu.edu.au
Voice: +61 2 6125 3471

Current Draft: March 2018

ABSTRACT

We show that contracts for difference (CFDs) may be viable substitutes for forward contracts and may have some features that are preferable to futures contracts. We develop parity relations between CFDs, forwards, and futures contracts using simple cost-of-carry arguments. We use these parity relations to consider whether exchange listed stock index CFDs might be viable substitutes for exchange listed futures contracts. Using the S&P/ASX 200 stock index we find that listed CFDs (ignoring an open interest charge) generate cash flows similar to listed futures contracts. Our analysis considers stochastic interest rates and uncertain dividend payments by the shares in the index.

JEL classification: G23

Keywords: CFDs, contracts for difference, cost-of-carry, forward contracts, futures contracts

CFDs, Forwards, Futures and the Cost-of-Carry

1. Introduction

The law of one price posits that securities or contracts with identical cash flows should have identical valuations, prices, and risks. Implicit in this claim is that securities or contracts with *nearly* identical cash flows should have *nearly* identical valuations, prices, and risks. Further, one would expect that market regulators would treat identical contracts the same; *nearly* identical contracts should receive similar oversight.

To explore these notions we consider the case of Contracts for Difference (CFDs). The contracts have a structure that is similar to a futures contract, with daily cash flows marked to changes in the underlying asset spot price, and additional adjustments for interest and storage (income) costs (for an investor that is long the contract). This structure seems to mimic the mark-to-market cash flows of futures contracts (which reflect daily changes in both the underlying asset price and remaining costs-of-carry over the life of the contract). The daily cash flows of futures and CFDs are not identical, but over the life of the contract they may have similar aggregate present values.[1] Hence, one might expect that the use, pricing, and regulation of CFDs and futures contracts to be consistent.

However, the development and growth of CFD markets has differed from that of futures contracts. CFDs were first introduced in the early 1990s by hedge funds and institutional managers to manage their exposures to stocks listed on the London Stock Exchange. The CFD structure was initially attractive in this setting as it avoided stamp duty. It is important to note

[1] See for example Brown, Dark and Davis (2010). We demonstrate this in Section 2 of this paper.

that while forward and futures contracts have prices that are distinct from spot prices; CFDs only rely on information taken from prevailing spot prices.

More recently, CFDs have gained popularity among retail investors. Most advertisements and promotional materials stress how CFDs can be used to generate short-term investment gains with little initial capital outlay (see ASIC, 2010; Lee and Choy, 2014), and focus on spot price dynamics. Indeed numerous regulators have expressed concern that CFDs are used primarily by retail investors as speculative instruments focusing on spot markets.[2] In-depth interviews of CFD traders by ASIC (2010) suggest that these traders use CFDs as an investment, rather than risk management vehicle. Interviewees do not appear to consider CFDs as a substitute for forward or futures contracts.

The availability of CFD trading appears to be roughly consistent with the availability of futures contracts.[3] One notable exception to this is the United States of America (US), which has a very vibrant and sophisticated futures markets yet does not allow CFD trading.[4] US regulators are on record for supporting market innovation, subject to ensuring overall market integrity. As an example, in a recent joint Op-Ed (on distributed ledger technology) the Commodity Futures Trading Commission (CFTC) and Securities and Exchange Commission (SEC) Chairs noted:[5]

> *"Our task, as market regulators, is to set and enforce rules that foster innovation while promoting market integrity and confidence."*

---

[2] Examples include in Australia (ASIC, 2011), Canada (OSC, 2009), European Union (ESMA, 2017), Ireland (Central Bank of Ireland, 2017), Singapore (MAS, 2012) and the United Kingdom (FCA, 2016).
[3] We were able to confirm retail CFD trading (all through OTC providers) in 54 of 55 countries with the largest 2017 GDP. Futures trading was also available in all but 7 of these countries (countries with CFD trading and without futures trading were: Algeria, Egypt, Iraq, Nigeria, Peru, Saudi Arabia and Venezuela).
[4] The USA prohibition of CFD trading stems from various state bucket shop laws.
[5] See CFTC Press Release 7680-18, dated 25 January, 2018 at https://www.cftc.gov/PressRoom/PressReleases/pr7680-18.

Hence, it raises the question about whether CFDs are a meaningful innovation (they are often offered in addition to futures trading, suggesting that they may be distinct), and to what extent they might pose a risk to "market integrity and confidence." Highlighting CFDs use for more speculative transactions by retail investors may create concerns among regulators. Another issue is that CFDs have been used for insider trading for which the SEC has prosecuted traders (see SEC (2013)). We believe that any such discussion should start with a detailed consideration of the substitutability of CFDs and futures; which is the focus of this paper.

In Asia, Australia and Europe, retail CFDs are traded over-the-counter. However, for the period 5th November 2007 to 6th June 2014, exchange traded CFDs were available on the Australian Securities Exchange (ASX). A key benefit to exchange traded CFDs is a substantial reduction in counterparty risk as trades and margin were settled through the ASX clearing house, which acted as counterparty to each trade.[6] At this time, the ASX replaced individual share futures with share CFDs; which suggests that the ASX viewed CFDs as similar to, if not as substitutes for, futures contracts. The ASX experience also allows us a unique opportunity to compare CFD contracts and futures contracts in greater detail. Namely, are CFDs are meaningful substitutes for futures (and forward) contracts?

As noted above, while CFDs are often portrayed as investment or speculative vehicles, we are interested in learning the extent to which they are a more fulsome substitute for futures and forward contracts. That is, the possibilities for CFDs to act as forward/futures substitutes may be under-emphasized; indeed, we show that the cash flow performance of CFDs appears to be no worse than its futures counterpart.

[6] See Brown, Dark and Davis (2010) and Lee and Choy (2014) for further details on the history of CFDs and a discussion of institutional details.

Like futures, CFDs are highly levered financial products that allow traders to take positions on the change in value of an underlying asset. A CFD is highly levered because traders are required to commit only a small fraction of the value of the underlying asset to take a position. Similar to futures contracts, CFDs are marked-to-market daily, but to the underlying asset price. Unlike futures, CFD contracts do not have an expiry date.

To show how forwards, futures and CFDs are linked, we first describe the daily cash flows for forwards, futures and CFDs. Under deterministic interest and income rates, we show that the cumulative cash flows of a tailed (weighted) CFD strategy equal that of a tailed futures contract. When the assumptions of deterministic interest and income rate are relaxed, numerical simulation shows that the difference between CFD and futures cash flows is small. Overall, the simulation results suggest that both tailed and untailed CFDs yield cash flows similar to futures contracts.

Ideally we would like to examine daily CFD, futures, and forward prices simultaneously to test the alignment of cash flows described above. We do not have forward price data. However, the ASX simultaneously traded S&P/ASX 200 index CFDs and futures. We use CFD and futures contract data and find that mark-to-market cash flows from CFDs are very similar to those for futures. Further, our results suggest that cumulative CFD cash flows track theoretical forward price payoffs more closely than for cumulative futures cash flows.

If the holding period is shorter than the time to the index future contract expiration, the futures price moves less closely to the spot price, possibly a consequence of uncertainty about future dividends. However, we find that dividend uncertainty contributes little to the variation of the futures basis. CFDs have no basis risk each day because the settlement price of the CFDs must equal the closing price of the underlying asset. However, a CFD does not provide a price that is indicative of a forward price that is "locked–in" when a position is opened. Rather, one must use a model to develop a CFD strategy that delivers cash flows consistent with a theoretical forward price. We find that our simple cost-of-carry model provides CFD cash flows that are comparable to those achieved through traditional futures contract strategies.

CFDs may be preferred to futures for three reasons. First, any holding period can be tailored using CFDs. Second, CFD contracts typically do not have a contract multiplier. Hence, a trader can match exactly a CFD position to their holdings of the underlying asset (ignoring the possible effects of tailing a position). Third, some futures contracts (such as those on equity indices) use a final settlement price on expiry that differs to the actual closing index value on the expiration date. We show that this discrepancy reduces the effectiveness of futures compared to CFDs even when futures contract maturities match the holding period.

While the existing literature on CFDs is scant our work is closely related to two recent papers by Brown, Dark and Davis (2010) and Lee and Choy (2014). Brown, Dark and Davis (2010) review the design and pricing of ASX exchange traded share CFDs. They note that the cash flow implications of CFDs are similar to futures, although they do not explicitly model cash flows to show explicitly how CFDs may replicate forward/futures contracts. Brown, Dark and Davis (2010) also note that because the ASX includes an Open Interest Charge in the daily mark-to-market cash flow, CFD bid-ask spreads are generally wider than that of the underlying shares. Hence, Brown, Dark and Davis (2010) analyze possible mispricing between the CFD and the underlying asset. They consider the consequences of transaction cost bounds and non-synchronous trading, as well as incorporating trading volume as a measure of liquidity. They demonstrate that CFD prices track the underlying cash prices relatively closely. They note that "after transactions costs, pricing errors are rare except on illiquid contracts."[7] We rely on these crucial results from Brown, Dark and Davis (2010) in our study. Given Brown, Dark and Davis (2010)'s findings of a close relation between CFD prices and the underlying asset price, our goal is to extend their work to show how CFDs may also be used as substitutes to forward/futures. Our paper therefore investigates how CFDs, often perceived as speculative instruments, may be used for hedging

Lee and Choy (2014) study the after cost performance of trading exchange traded share CFDs. They find that market order trades yield positive average excess daily returns in contrast to prior literature where the short-term trading performance of individual investors is generally poor. However, Lee and Choy (2014) find that over longer horizons, the average excess returns are negated through financing costs. In addition, Lee and Choy (2014) show that traders consistently hold large net sell positions, suggesting that CFDs are used as a substitute for stock short sales. Our paper provides a different perspective as we examine CFDs as a substitute for forward or futures contracts.

Other work has focused on the pricing of electricity Contracts for Difference (e.g. Kristiansen, 2004; Marckhoff and Wimschulte, 2009). The strategy employed in this study differs to such papers in using cost-of-carry arguments instead of identifying risk premiums in futures price over the spot price, such as the approach of Breeden (1980). Part of the reason for modeling electricity CFDs using risk premium arguments is that electricity has very high storage costs (e.g. Marckhoff and Wimschulte, 2009). Electricity CFDs also have unique contract specifications compared to the CFDs examined in this paper as they are valued as the price

[7] See Brown, Dark and Davis (2010), page 1141.

difference between energy prices of an area to the system over a period of time rather than between the differences in price of an underlying asset from contract open to contract close. Finally, electricity CFDs do not have explicit financing costs and so perform more closely to forward/futures contracts than the CFDs examined in this study. In short, our study examines the pricing of the more common form of CFDs as adopted by over-the-counter CFDs providers such as CMC Markets and IG Markets.

The paper is organized as follows: Section 2 describes the CFDs, forwards and futures contracts. Section 3 outlines the cost-of-carry relations for forwards, futures, and CFDs. Section 4 provides numerical examples of the cash flow similarities of CFDs, forwards and futures. Section 5 considers uncertainty in dividend flows and consequences for futures and CFD basis risk. Section 6 concludes.

2. The Contracts

In this section we use traditional cost-of-carry arguments to link forward and futures contracts, and to link forward contracts to CFDs.

2.1. Forwards and Futures

The relation between a forward and futures contract is well established in the literature (e.g. Cox, Ingersoll and Ross, 1981; Jarrow and Oldfield, 1981; Figlewski, Landskroner and Silber, 1991; Kawaller, 1997). A forward contract is an agreement to deliver the underlying asset at a given price at a future settlement date. A futures contract is essentially the same agreement except cash flows are marked-to-market daily, dependent on the daily futures settlement price. Hence, the main difference between a forward and future is in the timing of cash flows — a forward contract has one cash flow at expiration whereas the future contract has daily cash flows where the amount depends on futures price changes. Further, on the expiration day there should be no difference between futures, forward and spot prices. At expiration each of these mechanisms provides the same property right and hence ought to have the same price.

A margin account is kept to ensure that adverse daily cash flows can be funded in response to futures price fluctuations. This important difference means that the mark-to-market cash flows of futures must either be funded when the margin account is in deficit or earn interest when it is in surplus. In order for the two contracts' final cash flows to match, and therefore for equivalence of the value of forwards and futures, futures are 'tailed' so that the future value of daily cash flows in the futures matches the final cash flow in the forwards. By doing this, one may use a futures contract to replicate a forward contract.[8]

2.2. CFDs

CFDs are very similar to futures contracts. A margin account is required as the CFDs are marked-to-market every day. However the cash flows are marked-to-market using changes in the asset underlying price. Also, a CFD has no expiration date; once created it continues to be marked-to-market each day. All dividends[9], capitalization adjustments and financing costs are explicit cash inflows and outflows to the CFDs (rather than implied in the derivative price, as is the case for futures contracts). Dividends and capitalization adjustments are cash inflows

[8] The difference between forward and futures prices has been highlighted extensively in the literature. For example, French (1983) shows that significant differences found in these two prices could be attributed to measurement errors caused by tick size and non-synchronous recording of prices in these two markets. Cornell and Reinganum (1981) find that the differences observed between forward and future prices in foreign exchange markets are small compared to the bid-ask spread.

[9] Franking (tax) credits attached to dividends may also be accounted for, and vary between CFD providers for Australian share CFDs. For example, currently at CMC Markets, long positions do not receive franking credits while short positions only pay for the franking credits if CMC Markets borrows shares from a local tax resident to hedge their position. Previously for the ASX, short positions paid the franking credit and long positions would receive a franking credit determined by the designated price maker's net short overnight position. Both the ASX and CMC Markets ignore tax credits on Australian share index CFDs. For generality, our modelling of CFDs does not explicitly account for tax credits and this area is left for future research.

(outflows) to long (short) CFD investors, based on benefits that investors in the underlying asset would receive. Financing costs are explicitly included in mark-to-market cash flows, typically based on the risk-free interest rate plus (minus) a margin for long (or short) CFD positions that are held overnight. This financing cost is 'prepaid'; i.e. it is paid prior to holding a CFD position overnight. As we will show in Section 3, this prepayment of financing costs means CFD cumulative cash flows need not exactly match those from futures positions.

Our strategy in the following section is therefore to formally match the CFDs cash flows to futures as closely as possible, and hence treat CFDs like futures. Through tailing the CFDs, cash flows are matched to the forward contract. We calculate the cash flow discrepancy from matching CFDs to futures and subsequently to forwards.

3. Cost-of-Carry Relations

In this section we derive the cost of carry relations for forwards, futures, and CFDs. We consider two separate cases: contracts where the underlying asset produces continuous income (or storage costs) and cases where any intermediate cash flows are discrete (e.g. dividends paid on a share). For each setting we first review the relations using cost of carry arguments for forwards and futures, and then derive the CFDs strategy that matches the time-adjusted cash flows of the forward (or tailed futures) strategy.

Consider an investor who is long a forward contract that expires at time T (measured in number of days). The one-day interest rate is r and the one-day income rate from the asset is i. This investor can expect to pay (on expiration) a forward price that accounts for interest that would have been paid and income that would have been received had they bought the asset and held it until time T. The difference between the daily interest and income rates becomes the cost-of-carry, which we denote as $b = r - i$. Let t denote the current date, hence $T - t$ gives the number of days until the expiration of the forward contract. We assume interest and income flows are calculated daily and that discrete compounding is used.

The futures (and forward) contract each day is priced by the cost of carry relation. We assume that the spot price of the underlying asset is stochastic, but the interest and income rates are deterministic (and assumed constant for simplicity). This gives the standard cost-of-carry valuation for a forward contract, where f_t is the price of a forward contract on date *t* to be paid for an asset at time *T*:

$$f_t = S_t(1 + b)^{T-t} \tag{1}$$

Expression (1) also gives the price of a futures contract, $F_t = f_t$, with the same terms as the forward contract, but requiring a daily mark-to-market of gains and losses. Specifically, on day *t* the mark-to-market cash flow received from the futures contract is:

$$F_t - F_{t-1} = S_t(1 + b)^{T-t} - S_{t-1}(1 + b)^{T-t+1} \tag{2}$$

This can be written as:

$$F_t - F_{t-1} = (S_t - S_{t-1})(1 + b)^{T-t} - bS_{t-1}(1 + b)^{T-t} \tag{3}$$

Under our assumption of deterministic interest and income rates we know that forward prices and futures prices are equal. Further, using futures to create time-adjusted cash flows equivalent to a forward contract requires tailing the futures position by going long $(1 + r)^{-T+t}$ futures contracts for every forward contract to be replicated on each day, *t*. The future value of daily cash flows from such a strategy over the period $(T - t)$ matches the (unknown at time *t*) net payoff to the forward contract; $\tilde{S}_T - f_t = \tilde{S}_T - F_t = \tilde{S}_T - S_t(1 + b)^{T-t}$.

Now consider the same investor who instead of being long either the futures (or forward) contract is long $(1 + b)^{T-t}$ CFD contracts. The daily cash flow from the CFD position is:

$$(S_t - S_{t-1})(1+b)^{T-t} - bS_t(1+b)^{T-t} \tag{4}$$

On any day, the difference in these futures and CFDs mark-to-market cash flows (expressions (3) and (4)) is:

$$F_t - F_{t-1} - (S_t - S_{t-1})(1+b)^{T-t} + bS_t(1+b)^{T-t} = b(S_t - S_{t-1})(1+b)^{T-t} \tag{5}$$

This difference is small, but not zero, and there are similar differences between these contracts every day until expiration at time *T* (and these future differences depend on unknown future spot prices).

This relation allows us to compare tailed CFDs cash flows to the cash flows from a forward contract. That is, a strategy using CFD contracts can match (in future value) the cash flow of a forward contract.

To see how this works, note that one forward contract has the same (future value of) cash flow consequences of $(1+r)^{-T+t}$ futures contracts. By tailing the CFD position using w_t contracts on day *t*, we are able to obtain the same cash flow consequences as that of taking a long position in the forward contract. In other words:

$$-bS_0(1+r)^T w_0 + \sum_{t=1}^{T-1}(S_t - S_{t-1} - bS_t)(1+r)^{T-t}w_t + (S_T - S_{T-1})w_T = S_T - S_0(1+b)^T \tag{6}$$

To solve for w_t, we set the CFD cash flow on day 0 and on day *T* to be $-S_0(1+b)^T$ and S_T, respectively, and all other CFD cash flows between day 1 and day *T-1* to be 0. This yields the following tailing scheme:

$$w_0 = \frac{1}{b}\left(\frac{1+b}{1+r}\right)^T - \frac{1}{b(1-b)^{T-1}(1+r)^T};\ \ w_t = \left[\frac{1}{(1-b)(1+r)}\right]^{T-t} \text{ for all } t \geq 1 \tag{7}$$

The tailing scheme of expression (7) gives us the same cash flow consequences as a long position in the forward contract, provided that both *b* and *r* are deterministic. If *b* and *r* are stochastic, the tailing scheme is not perfect and like a tailed futures contract, a tailed CFD position faces basis risks.

For some assets their income (or storage costs) occurs at discrete points in time. For a stock that pays a dividend of $D_{t'}$ at time t' prior to T the standard carry relation for a forward contract is:

$$f_0 = S_0(1+r)^T - D_{t'}(1+r)^{T-t'} \tag{8}$$

and the net cash flow to the forward contract on the expiration day is:

$$S_T - f_0 = S_T - S_0(1+r)^T + D_{t'}(1+r)^{T-t'} \tag{9}$$

We solve for the CFD tailing scheme by equating the cash flow consequences of the forward and the CFD, which yields:

$$\begin{aligned}
&w_0 = \frac{1}{r} - \frac{1}{r(1+r)} w_1; \quad w_t = \left[\frac{1}{(1-r)(1+r)}\right] w_{t+1} \ \text{ for } 1 \leq t < t';\\
&w_{t'} = \frac{D_{t'}}{S_{t'}(1-r)+D_{t'}} + \frac{S_{t'}}{[S_{t'}(1-r)+D_{t'}](1+r)}\left[\frac{1}{(1-r)(1+r)}\right] w_{t'+1} \ \text{for } t = t';\\
&w_t = \left[\frac{1}{(1-r)(1+r)}\right] w_{t+1} \ \text{ for } t' < t < T;\\
&w_T = 1
\end{aligned} \tag{10}$$

As we did with expression (7), we rewrite (10) through recursive substitution:

$$\begin{aligned}
&w_0 = \frac{1}{r} - \frac{1}{r(1-r)^{T-1}(1+r)^T}\left[\frac{D_{t'}}{S_{t'}(1-r)+D_{t'}} + \frac{S_{t'}}{[S_{t'}(1-r)+D_{t'}](1+r)}\left[\frac{1}{(1-r)(1+r)}\right]^{T-t-1}\right];\\
&w_t = \left[\frac{1}{(1-r)(1+r)}\right]^{T-t}\left[\frac{D_{t'}}{S_{t'}(1-r)+D_{t'}} + \frac{S_{t'}}{[S_{t'}(1-r)+D_{t'}](1+r)}\left[\frac{1}{(1-r)(1+r)}\right]^{T-t-1}\right] \ \text{ for } 1 \leq t < t';\\
&w_{t'} = \frac{D_{t'}}{S_{t'}(1-r)+D_{t'}} + \frac{S_{t'}}{[S_{t'}(1-r)+D_{t'}](1+r)}\left[\frac{1}{(1-r)(1+r)}\right]^{T-t-1} \ \text{ for } t = t';\\
&w_t = \left[\frac{1}{(1-r)(1+r)}\right]^{T-t} \ \text{ for } t' < t < T;\\
&w_T = 1
\end{aligned} \tag{11}$$

In Section 4 we show that the cash flow differences between tailed CFD and forward strategies are modest for typical carry rates and times to expiration.

4. Numerical Examples and Empirical Evidence

4.1.1. Simulation

In this section we use simulated data to test the replication efficiency of futures and CFDs benchmarked against forward contract cash flows. We compare the future value of the cash flow differences between going long one forward contract for a hypothetical asset and going long a CFD or futures contract. For conciseness, we only report results for the continuous income case.

The additive error is the absolute difference in the future value of cash flows for the forward contract and a given strategy:

$$\text{Additive Error } (AE) = \left| S_T - f_0 - \sum_{t=0}^{T} FV(CF_{i,t}) \right| \tag{12}$$

As before, S_T is the asset price at time T while f_0 is the forward price at time 0 based on the cost-of-carry valuation as noted in expression (1). $FV(CF_{i,t})$ is the future value of daily cash flow for replication strategy i, for $i \in$ {tailed/untailed CFDs, tailed/untailed futures}. $S_T - f_0$ is the forward cash flow at expiration and serves as a benchmark for each strategy (e.g. future value of untailed futures cash flows at expiration).

The percentage error, relative to the forward price at $t = 0$ is:

$$\text{Percentage Error } (PE) = \frac{\left| S_T - f_0 - \sum_{t=0}^{T} FV(CF_{i,t}) \right|}{f_0} \tag{13}$$

A high (low) *AE* or *PE* means that the long CFD or futures strategy is further from (closer to) the cash flows of the corresponding long forward strategy. For constant cost-of-carry, tailed futures and tailed CFDs have the same cash flows as forwards and so will have zero *AE* and *PE*, as derived in the previous section.

We test the cash flow equivalence of CFDs and futures to forwards under different holding periods while changing assumptions about the interest rate process. For each scenario, we run 10,000 iterations and report summary statistics of *AE* and *PE* for each strategy. Our first set of scenarios assumes stochastic interest rates only while our second set of results considers both stochastic interest and income rates.

4.1.2. Stochastic Interest Rates Only

For our first set of scenarios we assume that the starting asset price S_0 is \$10, the annual income rate i is fixed at 5 percent per annum, r is stochastic and the price change (ΔS_t) follows the following discrete time stochastic process (where the time increment is a trading day and time is measured in years):

$$\Delta S_t = (\lambda - i_t) S_t \Delta t + \sigma_s S_t \varepsilon \sqrt{\Delta t} \tag{14}$$

We set $\lambda = 0.15$, $\sigma_s = 0.25$, and ε is drawn from a standard normal distribution. For simplicity, we assume that r is also the CFD financing cost. We consider analysis intervals of 63 days (three months) and 250 days (twelve months). For this analysis both the asset price and interest rates are stochastic and vary across scenarios.

With a stochastic r, tailed futures or CFDs will not work as effectively – the strategy uses a tailing hedge ratio based on current values of r; hence such a strategy will over (under) commit to the derivative contract when the interest rate is low (high).

For stochastic r we let Δr_t follow a discrete time Cox-Ingersoll-Ross process (where the time increment is a trading day and time is measured in years):

$$\Delta r_t = k(q - r_t)\Delta t + \sigma_r \varepsilon \sqrt{r_t \Delta t} \quad (15)$$

where k = 2, q = 0.1, and ε is drawn from a standard normal distribution. We use σ_r values of 1, 5 or 10 percent (expressed as annual rates) and use an initial interest rate of 10 percent per annum. We price futures/forwards using the constant cost of carry model updated with today's i and r. By doing so we assume a flat term structure for interest rates (see Hemler and Longstaff, 1991 p.291 for further discussion). While we could price forwards or futures under stochastic interest rates say by using the closed-form solution by Cakici and Chatterjee (1991), for our purposes this is not necessary as we simply want to compare the consequences of mis-weighting using stale interest rates.

4.1.3. Stochastic Interest and Income Rates

We also simulate results using stochastic income rates. It is useful to consider stochastic income rates as it is a non-trivial exercise to derive whether tailed CFDs or futures will perform better as a forward substitute. We use similar parameter assumptions to those detailed in Section 4.1.3 with the exception that stochastic interest rates are assumed to follow a geometric Brownian motion process with a mean of 0.1 and a standard deviation of 0.05 (annualized).

4.1.4. Simulation Results

Table 1 reports summary statistics of the dollar (*AE*) and percentage (*PE*) absolute differences in cash flows between the long forward contract and long CFDs or long futures (both tailed) under the different scenarios and periods. Panel A reports results for a three-month holding period and Panel B gives results for a twelve-month holding period with stochastic interest rates. Both CFDs and futures show increasing variability in the *PE* for increasing σ_r. With σ_r = 1% (which is roughly the volatility of the Federal Reserve fund rates from 1954 to

2011) the average *PE* for both tailed CFDs and tailed futures are small, ranging from a mean *PE* of 0.01 percent for tailed futures with a three-month holding period and 0.1 percent for tailed CFDs with a twelve-month holding period. The standard deviation of *PE* is very small, with at most eight basis points for tailed CFDs with a twelve-month holding period. For both holding periods, futures have the lower mean and standard deviation for *PE*.

[**Insert Table 1 Here**]

For σ_r = 5% and σ_r = 10% futures have lower mean and standard deviation of *PE* for three-month holding periods. However, for twelve-month holding periods CFDs have lower mean and similar or lower standard deviation of *PE*. For example, with σ_r = 10% for a three-month holding period, the mean and standard deviation of *PE* for tailed CFDs is 63 and 46 basis points, respectively, while for tailed futures it is 27 and 15 basis points, respectively. With the same interest rate volatility but with a longer twelve month holding period, the tailed CFDs mean and standard deviation of *PE* are 2.49% and 1.86%, respectively, while for tailed futures it is 16.13% and 2.73%.

When we allow income rates to also be stochastic, as in Table 1 Panel C (three-month holding period) and Panel D (twelve-month holding period), mean and standard deviation of *PE* slightly increase compared with the stochastic interest rate only scenarios. The pattern of mean and standard deviation of *PE* also remains the same with tailed futures having lower mean and standard deviation of *PE* for low interest rate volatility and/or three-month holding period compared to tailed CFDs. Meanwhile, for high interest rate volatility with twelve month holding periods, tailed CFDs have lower mean and similar or lower standard deviation of *PE* than tailed futures.[10]

As a further robustness check we calculate the R-squared for regressions of CFDs or futures cash flows on forward cash flows using the simulation data as detailed in Table 1.[11] We obtain the R-squared from running a regression on the 10,000 simulation runs for the various stochastic interest rate scenarios of varying volatility for the cash flows on expiration of going long a forward contract in comparison to long one CFD or one futures:

$$f_T - f_0 = -b_0 S_0 \times \beta_0 + \sum_{t=1}^{t=T-1} (S_t - S_{t-1} - b_t S_t) \times \beta_t + (S_T - S_{T-1}) \times \beta_T + \varepsilon \quad (16)$$

Where $f_T - f_0$ denotes the cash flow of holding a long forward contract from period 0 to period T, S_t is the asset price at period t and b_t is the interest rate less the income rate. The regression equation for futures is:

$$f_T - f_0 = \sum_{t=1}^{t=T} (f_t - f_{t-1}) \times \beta_t + \varepsilon \quad (17)$$

Where f_t is used as the futures price at time t on the right-had-side of expression (17).

The benefits of running the regression are that we do not need to specify a tailing scheme but rather use the data to find the best fit through regression. Additionally, there is no need to

[10] This can be demonstrated analytically. It is possible to write expressions for the expected weights of the CFD and futures strategies (where the stochastic interest rate is represented as its expected value plus an unbiased normally distributed error term). Working with second-order Taylor series expansions of these expressions results in two components where one term depends on the error term variance. From these expressions we can show that the CFD has a higher error in the tailing weights only if *r* (as a daily rate) is unreasonably large. For any reasonable nominal rate with a long-term hedging period, CFD is superior to futures as a hedging instrument.

[11] We thank the referee for this very useful suggestion.

assume a term structure of interest rates and the R-squared may be comparable between CFDs and futures with a higher R-squared, meaning a better hedge to the forward contract.

[**Insert Table 2 Here**]

Table 2 reports relevant R-squared values and finds comparable results to our *PE* results. R-squared values are highest for three month holding periods and for $\sigma_r=1\%$. R-squared values are lower or the same when adding stochastic income rates. Futures have higher R-squared than CFDs with either the three-month holding period or with the lowest volatility for stochastic interest rates. For all other scenarios, CFDs have the higher R-squared. As such we find that CFDs tend to perform better as a forward contract than futures when interest rate volatility is high and over a long holding period.

4.2. Empirical Evidence

4.2.1. S&P/ASX 200 Contracts

A shortcoming of using simulated data is that futures prices do not always equal the forward price values given by cost-of-carry relations. Hence, we use data from the Australian Securities Exchange (ASX) listed S&P/ASX 200 (XJO) CFDs and futures contracts to see whether CFD contracts can be used to replicate the overall cash flows from futures contracts.[12] Since the inception of XJO CFDs in November 2007, both CFDs and futures contracts have been trading concurrently and thus a trader would have been able to use either instrument.

[12] As we are comparing cash flows of CFDs to futures, we are unable to use the R-squared fit, as we do not have a forward contract to compare with.

Another benefit of using actual data is that we are able to test the effect of institutional features of CFDs and futures that may affect their efficacy. For CFDs, traders who are long (short) a CFD will be charged a 1.5 percent open interest charge (OIC) that is added (subtracted) to (from) the financing rate. The net effect is to make CFDs more costly relative to futures contracts. Futures contracts also have a unique feature in which the settlement price on its expiration date differs to the closing price of the underlying asset. Similar to futures on the S&P/500, XJO futures settle on expiration date using a 'special opening quotation' that is the first trading price for all index constituents on the expiry date.[13] This feature results in a price that is difficult to trade on as the first traded price may occur at any time of the day and may differ substantially to the closing cash price on the day.

The scenario we use is to lock in a forward price at t = 0 three months out from each futures contract expiry date. For our *AE* and *PE* measures we now define the benchmark cash flow as either the cash flow of a hypothetical forward contract or an untailed futures position. If untailed futures are used as the benchmark, we use either the special opening quotation index value or the cash market closing index value as the futures settlement price on the expiration date.

As there is no XJO forward market to obtain a forward price, we calculate the price of a hypothetical forward using the standard cost-of-carry relation for discrete income:

$$f_t = S_t(1 + r_t)^{T-t} - FVD_t, \tag{18}$$

where r_t is the zero coupon bond rate of a treasury bill with a three month maturity (on day t = 0) at time t. We use the Reserve Bank of Australia's (RBA's) estimated daily zero-coupon interest

[13] See the ASX Index Futures contract specification site: http://www.asx.com.au/products/index-derivatives/asx-index-futures-contract-specifications.htm for further details.

rates.[14] FVD_t is the future value of dividends paid by shares in the index until expiration at time T. We use two methods to compute FVD_t. The first method computes the perfect foresight forward value. With this method we use actual dividends to compute FVD_t. The second method uses put-call parity to compute the present value of dividends. Put-call parity for European index options observed at time t and expiring at time T is:

$$C_t - P_t = S_t - \frac{K}{(1+r_t)^{T-t}} - PVD_t \tag{19}$$

where C_t and P_t are the price of a call and a put, respectively, at time t, S_t is the asset price at time t, K is the strike price, and PVD_t is the present value of dividends paid by shares in the index prior to expiration at time T. We convert this to the future value of dividends using relevant RBA interest rate:

$$FVD_t = PVD(1 + r_t)^{T-t} \tag{20}$$

We use XJO options that have the same expiry date as the XJO futures. We calculate *PVD* using the minute-by-minute midpoint quotes of XJO put and call options with the same strike price three months from expiration. On each day we compute *PVD* by taking the average of the intraday *PVD*.

We obtain daily and intraday price data from Thomson Reuters Tick History (TRTH) that contains the ASX-listed XJO CFDs (ASX ticker IQ), 17 futures contracts with expiry dates from March 2008 to March 2012 (expiration month: Mar, Jun, Sep and Dec), and intraday put and call options data. The sample period commencement corresponds with the introduction of the XJO CFDs in November 2007. We also obtain the XJO price and accumulation indices from the same data provider to infer the dividend payout.

[14] http://www.rba.gov.au/statistics/tables/index.html#interest_rates

Table 3 reports the average daily volume and average daily open interest for S&P/ASX 200 (XJO) futures contracts with expirations from March 2008 to March 2012 and for three months from expiration date. The daily volume and daily open interest of the respective XJO CFDs are also reported. We further report the tracking error of the futures' contracts as the annualized standard deviation of the difference of daily returns of the last traded futures contracts price and the XJO price level at market close (typically 16:00).

[**Insert Table 3 Here**]

We find that the XJO futures market is far larger than the XJO CFD market both in terms of daily volume (about 1100 times in notional value, with each futures contract $25 times the index value) and open interest (about 950 times in notional value). At the same time, XJO CFDs are more active than share CFDs; Lee and Choy (2014) find that the average daily volume of underlying shares is around 383 times that of share CFDs during November 2007 through June 2010. The futures tracking error (last column of Table 3), is around 4.79 percent p.a. overall, ranging from 2.54 to 11.33 percent depending on the contract. CFD percentage bid-ask spreads are much larger for CFDs, on average more than three times that of the next-to-expire futures contract.

We report summary statistics for the mean and absolute mean *PE* across all contracts in Table 4. The absolute mean is used, where the smaller the absolute deviation of cash flows to the benchmark, the closer the derivative strategy meets the benchmark cash flows (using a model-based forward price). The column 'CFD Long' denotes using CFDs inclusive of a 1.5 percent open interest charge. 'Tfut' and 'Ufut' denote the use of tailed and untailed futures respectively and are settled at the futures 'special opening price' on expiration date. ‘Tfut1’ and ‘Ufut1’ denote the use of tailed and untailed futures respectively, using the closing level of the XJO as the settlement price (i.e. cash settled). There is no tailing required for CFDs to match the forward contract’s cash flow when we assume discrete income (see Section 3).

[Insert Table 4 Here]

Table 4 shows that CFDs consistently outperform futures when benchmarked against the perfect foresight forward contract. The CFD strategy has the smallest mean and absolute mean *PE*, and also the lowest standard deviations. However with the 1.5 percent open interest for the long CFD strategy, this advantage is diminished. Instead, cash settled futures (Tfut1 and Ufut1) have lower mean and *PE* and similar mean absolute *PE* (albeit with higher standard deviations) than the CFDs long strategy. Note that our assumed cash settled futures also have lower absolute mean *PE* and absolute mean *PE* standard deviations compared to actual futures that are settled using the ‘special opening price’ (Tfut and Ufut). This suggests a form of basis risk on the expiration date for index futures.

When benchmarking against the theoretical forward price computed with dividend flows that are inferred put-call parity forward, the replication performance of all strategies worsens, yet the CFD strategy appears to provide the closest match to the model-based forward price. The CFD strategy has the lowest mean, mean standard deviation and absolute mean, while the absolute mean standard deviation is slightly higher than the futures strategies. Again, the cash flow equivalence is reduced with the CFDs long strategy.

When benchmarking against the untailed futures benchmark, by absolute mean *PE* the CFDs strategy performs slightly better than the cash settled futures, with values of 0.74 percent compared with 0.78 and 0.76 percent for cash settled tailed (TFut1) and untailed (UFut1) futures, respectively. The absolute mean *PE* standard deviation is also lower than the two cash settled futures strategies. This suggests that the magnitude of the replication error of CFDs relative to futures is comparable to the difference between futures as currently settled on the expiration day, and futures if they were cash settled on the expiration day. This is the case even when we perfectly match CFD positions to the maturity of the futures contracts. In summary, CFDs without the 1.5 percent open interest charge either do better than, or perform similar to, futures settled at the 'special opening price' on the expiration day across our benchmarks.

4.2.2. CFDs-Futures Relation

Another method to test whether CFDs can be used as substitutes for futures is to study the relation between daily CFD and future cash flows over the life of the futures contract. Theoretically, CFDs mark-to-market cash flows should roughly match those from the tailed futures strategy. We use daily CFD and futures prices to compute the daily mark-to-market cash flows. To see how this is done, consider the simplest case of discrete income. Let D_τ be the dividend paid on day τ, for $\tau > t$.[15] The relation between the futures and the underlying spot is:

$$F_t = S_t(1+r)^{T-t} - \sum_{\tau=t+1}^{T} D_\tau (1+r)^{T-\tau} \tag{21}$$

Taking the first difference (Δ) yields the mark-to-market cash flow from a long position in the futures contract:

$$\Delta F_t = \Delta S_t(1+r)^{T-t} - S_{t-1} r (1+r)^{T-t} + D_t (1+r)^{T-t} \tag{22}$$

[15] For simplicity we assume a constant risk-free rate.

Suppose the futures contract is tailed every period using $1/(1 + r)^{T-t}$ contracts. The mark-to-market cash flow from a position of long one futures contract is:

$$\frac{1}{(1+r)^{T-t}}\Delta F_t = \Delta S_t - rS_{t-1} + D_t \quad (23)$$

The daily cash flow from a long CFD position (no tailing is necessary for the CFD as this is the case of discrete income) is:

$$CFD_t = \Delta S_t - rS_t + D_t \quad (24)$$

Hence, the difference in daily cash flows between being long a CFD contract and long a tailed-futures contract is:

$$CFD_t - \frac{1}{(1+r)^{T-t}}\Delta F_t = -\Delta S_t r, \quad (25)$$

which implies:

$$CFD_t = \frac{1}{(1+r)^{T-t}}\Delta F_t - \Delta S_t r. \quad (26)$$

Moving $\Delta S_t r$ to the left-hand-side, scaling by $\frac{(1+r)^{T-t}}{\Delta F_t}$, and recognizing that observed values are reported with error gives us the regression model:

$$\frac{CFD_t}{\Delta F_t}(1+r)^{T-t} + \frac{\Delta S_t r}{\Delta F_t}(1+r)^{T-t} = \gamma + e_t, \quad (27)$$

where ΔF_t and CFD_t are the daily mark-to-market cash flows of the XJO futures and the corresponding CFD. If the CFDs are a good substitute for futures, and if r is deterministic, we expect $\gamma = 1$ and e_t to be a standard normal error term. Our reported t-statistics therefore test for the null that $\gamma = 1$. Further, to ensure synchronous trading, F_t and S_t are taken from daily closing prices.

Using the CFDs-futures relation to test for cash flow equivalence is conceptually similar to that of Brown, Dark and Davis (2010)'s CFDs mispricing tests. The main difference is that we are comparing CFDs to futures rather than CFDs to the underlying stock price. We also test at end of day frequency including CFD/futures carry costs (but excluding transaction costs as per Brown, Dark and Davis (2010)) rather than at the trade-by-trade level. Thus our test relates to a hedger choosing whether to hedge with CFDs or futures and holding for more than one day.

Table 5 reports individual and pooled regression coefficient estimates of γ as specified in expression (27), using the three-month from prior to expiration for all 17 XJO futures contracts in our sample. Column two reports coefficient estimates for the full model and finds that the estimated γ is statistically indistinguishable from 1 across all contracts other than the June 2008 expiration. This suggests that CFDs would provide cash flows similar to futures. In column three we remove the $\Delta S_t r$ term, which represents the daily cash flow difference between tailed CFDs and futures under deterministic interest rates. The coefficient remains statistically insignificant suggesting that the $\Delta S_t r$ terms are not economically significant in driving the cash flow difference between tailed CFDs and futures. In column four we remove the tailing term, $(1+r)^{T-t}$, from expressions (26) and (27) to test the importance of futures contract tailing to differences between futures and CFD daily mark-to-market cash flows. The updated γ values remain insignificantly different from 1, suggesting that futures tailing is not a significant factor in differences between CFD and futures contract daily cash flows.

[**Insert Table 5 Here**]

While our point estimates do not reject the null of $\gamma = 1$, this may be a consequence of large standard errors for our estimates. Hence, we plot 95 percent confidence intervals for estimates of γ in Figure 1. The standard errors for our estimated γ are relatively large, and associated confidence intervals across contracts include $\gamma = 1$. Upper and lower confidence values range between -0.5 and 2.76.

[**Insert Figure 1 Here**]

Another way to test the model is to consider the five trading days prior to expiration of the futures contract (i.e. excluding the expiration date). Using a five-day period should reduce the uncertainty of i and r, hence futures prices may better match the cost-of-carry relation and therefore better conform to expression (27). The last column of Table 5 reports γ estimated using a pooled regression from expression (27) with dummy variables serving as intercepts for each contract. We find a statistically insignificant γ coefficient for each individual and across all contracts, with the exception of December 2009.

Our results suggest that, based on daily cash flows, CFDs are noisy but close substitutes for futures contracts.

5. Uncertain Dividends

Our simulation and empirical analysis show that the daily cash flows from a long CFDs contract are, statistically similar to a long tailed futures contract. Next we consider possible sources of basis risk (i.e. how the futures price tracks toward the spot price on expiration). For the CFDs, basis risk (unexpected changes in difference between the contract price and the prevailing asset price) is zero, a consequence of its design. That is, absent of an arbitrage opportunity, the settlement price of the CFDs must equal the closing price of the underlying asset. For futures we know that basis risk is a genuine concern; e.g. futures prices may not converge to spot prices as predicted by a simple cost-of-carry model. The extent of futures basis risk would depend on the setting. For example, even if interest rates are not volatile in the short term, basis risk may be a consequence because of uncertainty in the dividend payout (or asset income more generally) prior to expiry. If risk-averse futures traders are concerned about unanticipated variation in future dividends, futures may be priced at a discount as traders demand compensation for dividend uncertainty. When firms announce the dividend payout, such uncertainty is resolved and hence any premium would dissipate.

XJO index dividend payments are incorporated into the futures price through the cost-of-carry. The CFD incorporates dividends through daily mark-to-market cash flows, hence there is no future dividend information embedded directly in the CFD price. In Figures 1 and 2 we consider implied dividend data for contracts by expiration month: March/September (Panel A) and June/December (Panel B). The dashed lines represent the confidence interval with one standard deviation above and below the mean implied dividend amounts. In addition to the implied dollar dividend line, Figure 2 includes the average number of constituent stocks that have earnings/dividend announcements each day, while Figure 3 includes the average number of constituent stocks that go ex-dividend each day.

[**Insert Figures 2 and 3 Here**]

As can be seen from Figure 2, announcements are concentrated around the two to four weeks prior to the expiration of March and September contracts (Panel A). This is expected in Australia as most semi-annual earnings and dividends announcements occur in February and August (e.g. Ainsworth and Lee, 2014). Further, the width of the confidence interval does not seem to increase with the time-to-expiration or fall after the announcement, which suggests that the market anticipates the dividend and dividend uncertainty is not reflected in the variation of the implied dollar dividend. This result is consistent with Figlewski (1984), who shows that dividend risk contributes little to the risk of the unhedged portfolio.

Figure 3 highlights a clear negative relation between the implied dollar dividend and the number of stocks that go ex-dividend. As the contract approaches its expiry, the number of stocks that go ex-dividend after the announcement increases, and the basis falls (in absolute terms).

Figures 2 and 3 demonstrate that basis risk through uncertain dividend payments is not a concern for future contracts. Hence, from a replication point of view it does not appear that this would provide an advantage to CFDs relative to futures in practice. Because CFD contract settlement prices converge to cash prices each day, it raises the possibility that it is possible to replicate a forward contact for any expiration date. However, unlike its futures counterpart, someone employing this replication strategy will not know the embedded (and uncertain) carrying cost to the CFDs at the outset, because CFDs carrying costs are realized through daily cash flow adjustments to the accounts of CFDs holders. By contrast, the futures price provides an indication of the expected future costs of carrying the underlying asset until the futures expiration date (which may not match the holding period).

6. Conclusion

CFDs are often marketed as an instrument for speculation rather than as substitutes for forwards and futures contracts. In this paper we have shown that CFDs can be used to replicate forward contracts. Under deterministic interest rates, tailed CFDs have almost the same future cash flow differences as forwards and futures. Through simulation we find that this discrepancy is negligible for holding periods for up to a year. With stochastic interest rates, we find CFD strategies have cash flows that are similar to futures contract strategies, while tailing CFDs introduces more noise in its cash flow equivalence.

We explore forward contract replication strategies using ASX-listed S&P/ASX 200 CFD and futures contract data. We find index CFDs perform better than index futures where dividends are known. Cash flow differences between CFD and the futures strategies are similar if we assume futures are settled at the close on expiration date. Further regression results confirm that CFD replication strategies have cash flows comparable to futures strategies. Hence, it appears that CFDs may be a viable substitute for futures contracts.

ACKNOWLEDGEMENTS

We thank Jonathan Dark, Tony He, Boda Kang, Marita Smith, Terry Walter and Li Yang for helpful comments and suggestions. Comments from an anonymous referee improved this paper substantially.

REFERENCES

Ainsworth, A., Lee, A.D., 2014. Waiting costs and limit order book liquidity: Evidence from the ex-dividend deadline in Australia. *Journal of Financial Markets* 20, 101-128.

ASIC, 2010. Report 205: Contracts for difference and retail investors.

ASIC, 2011. Regulatory guide 227: Over-the-counter contracts for difference: Improving disclosure for retail investors.

Breeden, D.T, 1980. Consumption risk in futures markets. *Journal of Finance* 35, 503-520.

Brown, C., Dark, J., Davis, K., 2010. Exchange traded contracts for difference: Design, pricing, and effects. *Journal of Futures Markets* 30, 1108-1149.

Cakici, N., Chatterjee, S., 1991. Pricing stock index futures with stochastic interest rates. *Journal of Futures Markets* 11, 441-452.

Central Bank of Ireland, 2017. Consultation paper 107: Consultation on the protection of retail investors in relation to the distribution of CFDs.

Cornell, B., Reinganum, M.R., 1981. Forward and futures prices: Evidence from the foreign exchange markets. *The Journal of Finance* 36, 1035-1045.

Cox, J.C., Ingersoll, J.E., Ross, S.A., 1981. The relation between forward prices and futures prices. *Journal of Financial Economics* 9, 321-346.

ESMA, 2017. Questions and answers: Relating to the provision of CFDs and other speculative products to retail investors under MiFID.

FCA, 2016. Consultation paper 16/40: Enhancing conduct of business rules for firms providing contract for difference products to retail clients.

Figlewski, S., Landskroner, Y., Silber, W.L., 1991. Tailing the hedge: Why and how. *Journal of Futures Markets* 11, 201-212.

Figlewski, S., 1984. Hedging performance and basis risk in stock index futures. *Journal of Finance* 39, 657-669.

French, K.R., 1983. A comparison of futures and forward prices. *Journal of Financial Economics* 12, 311-342.

Hemler, M.L., Longstaff, F.A., 1991. General equilibrium stock index futures prices: Theory and empirical evidence. *Journal of Financial and Quantitative Analysis* 26, 287-308.

Jarrow, R.A., Oldfield, G.S., 1981. Forward contracts and futures contracts. *Journal of Financial Economics* 9, 373-382.

Kawaller, I.G., 1997. Tailing futures hedges/tailing spreads. *Journal of Derivatives* 5, 62-70.

Kristiansen, T., 2004. Pricing of contracts for difference in the Nordic market. *Energy Policy* 32, 1075-1085.

Lee, A.D., Choy, S., 2014. Contracts for dummies? The performance of investors in contracts for difference. *Accounting & Finance* 54, 995-997.

Marckhoff, J., Wimschulte, J., 2009. Locational price spreads and the pricing of contracts for difference: Evidence from the Nordic market. *Energy Economics* 31, 257-268.

MAS, 2012. Consultation paper on review of regulatory framework for unlisted margined derivatives offered to retail investors.

OSC, 2009. Staff notice 91-702 – offerings of contracts for difference and foreign exchange contracts to investors in Ontario.

SEC, 2013, SEC charges two traders in Spain with insider trading ahead of BHP acquisition bid, Available from: https://www.sec.gov/news/press-release/2013-138

Table 1
CFDs, Futures and Forward Contract Cash Flows with Stochastic Interest Rates

The table reports statistics for 10,000 simulation runs for various stochastic interest rate scenarios of varying volatility for the cash flows on expiration of going long a forward contract in comparison to long one tailed CFDs or one tailed futures. Forwards/futures are priced using the cost of carry formula assuming a flat term structure for the current period's interest and income rates. Additive Error is the absolute cash flow of going long a forward contract in period 0 less a strategy's cash flow. Percentage Error is Additive Error expressed as a percentage of the forwards/futures contracts starting period price (F_0). The assumptions of the simulations for all panels are S_0=10, i=0.05, r=0, λ=0.15, σ_s=0.25, k=2 and q=0.1. We vary σ_r for 0.01, 0.05, 0.10. For Panels A and B the income rate i is set at 0 while for Panels C and D i follows geometric Brownian motion with a mean of 0.1 and a standard deviation of 0.05. See section IV.A2 for more details. Panels A and C report scenarios using a three month holding period while Panels B and D report scenarios for a twelve month holding period.

Panel A. Three Month Holding period with i=0

			Additive Error ($)		Percentage Error (%)	
σ_r (% p.a.)	Statistic	F_0	Tailed CFDs	Tailed Futures	Tailed CFDs	Tailed Futures
1	Mean	10.25	0.01	0.00	0.06	0.01
	Std Dev	0.01	0.01	0.00	0.05	0.01
	Max	10.28	0.03	0.00	0.25	0.04
	Min	10.23	0.00	0.00	0.00	0.00
5	Mean	10.26	0.03	0.01	0.33	0.08
	Std Dev	0.04	0.03	0.01	0.24	0.06
	Max	10.41	0.15	0.03	1.49	0.33
	Min	10.12	0.00	0.00	0.00	0.00
10	Mean	10.26	0.06	0.03	0.63	0.27
	Std Dev	0.08	0.05	0.02	0.46	0.15
	Max	10.50	0.25	0.09	2.48	0.91
	Min	10.01	0.00	0.00	0.00	0.00

Panel B. Twelve Month Holding period with i=0

			Additive Error ($)		Percentage Error (%)	
σ_r (% p.a.)	Statistic	F_0	Tailed CFDs	Tailed Futures	Tailed CFDs	Tailed Futures
1	Mean	11.05	0.01	0.00	0.10	0.04
	Std Dev	0.01	0.01	0.01	0.08	0.03
	Max	11.09	0.05	0.02	0.44	0.18
	Min	11.01	0.00	0.00	0.00	0.00
5	Mean	11.05	0.14	0.46	1.30	4.12
	Std Dev	0.18	0.11	0.09	0.98	0.83
	Max	11.58	0.61	0.77	5.83	6.95
	Min	10.49	0.00	0.19	0.00	1.68
10	Mean	11.06	0.28	1.78	2.49	16.13
	Std Dev	0.34	0.21	0.30	1.86	2.73
	Max	12.22	1.15	2.87	9.80	25.65
	Min	10.14	0.00	1.03	0.00	9.21

Panel C. Three Month Holding period with stochastic *i*

			Additive Error ($)		Percentage Error (%)	
σ_r (% p.a.)	Statistic	F_0	Tailed CFDs	Tailed Futures	Tailed CFDs	Tailed Futures
1	Mean	10.13	0.01	0.00	0.07	0.01
	Std Dev	0.01	0.01	0.00	0.05	0.01
	Max	10.15	0.03	0.01	0.28	0.05
	Min	10.10	0.00	0.00	0.00	0.00
5	Mean	10.13	0.03	0.01	0.31	0.08
	Std Dev	0.04	0.02	0.01	0.24	0.06
	Max	10.29	0.17	0.03	1.61	0.31
	Min	10.00	0.00	0.00	0.00	0.00
10	Mean	10.13	0.06	0.03	0.63	0.27
	Std Dev	0.08	0.05	0.02	0.47	0.15
	Max	10.36	0.25	0.10	2.53	0.94
	Min	9.87	0.00	0.00	0.00	0.00

Panel D. Twelve Month Holding period with stochastic *i*

			Additive Error ($)		Percentage Error (%)	
σ_r (% p.a.)	Statistic	F_0	Tailed CFDs	Tailed Futures	Tailed CFDs	Tailed Futures
1	Mean	10.51	0.07	0.00	0.69	0.04
	Std Dev	0.01	0.04	0.01	0.35	0.03
	Max	10.56	0.20	0.02	1.86	0.18
	Min	10.46	0.00	0.00	0.00	0.00
5	Mean	10.52	0.15	0.43	1.43	4.06
	Std Dev	0.17	0.11	0.09	1.07	0.88
	Max	11.09	0.61	0.76	5.50	7.13
	Min	10.01	0.00	0.18	0.00	1.74
10	Mean	10.52	0.26	1.73	2.48	16.43
	Std Dev	0.31	0.20	0.27	1.88	2.62
	Max	11.46	1.12	2.99	9.92	28.55
	Min	9.61	0.00	0.89	0.00	8.76

Table 2
R-squared Comparisons

The table reports the R-squared from running the following regression from 10,000 simulation runs for various stochastic interest rate scenarios of varying volatility for the cash flows on expiration of going long a forward contract in comparison to long one CFD or one futures. The regression equation for CFDs is:

$$f_T - f_0 = -b_0 S_0 \times \beta_0 + \sum_{t=1}^{T-1} (S_t - S_{t-1} - b_t S_t) \times \beta_t + (S_T - S_{T-1}) \times \beta_T + \varepsilon$$

Where $f_T - f_0$ denotes the cash flow of holding a long forward contract from period 0 to period *T*, S_t is the asset price at period *t*. b_t is the interest rate less the income rate. The regression equation for futures is:

$$f_T - f_0 = \sum_{t=1}^{T} (f_t - f_{t-1}) \times \beta_t + \varepsilon$$

Where f_t is the futures price at time *t*. Forward/futures are priced using the cost of carry formula assuming a flat term structure for the current period's interest and income rates. The common assumptions of the simulations for all simulation scenarios are S_0=10, i=0.05, r=0, λ=0.15, σ_s=0.25, k=2 and q=0.1. We apply either 3 or 12 month holding periods. We vary σ_r for 0.01, 0.05, 0.10. For *i=0%* the income rate *i* is set at a constant 0 while for 'Stochastic' it follows geometric Brownian motion with a mean of 0.1 and a standard deviation of 0.05.

Holding Period	σ_r	i	R-squared	
(months)	(% p.a.)	0% or Stochastic	CFDs	Futures
3	1	0%	0.9993	1.0000
3	5	0%	0.9933	0.9998
3	10	0%	0.9896	0.9989
12	1	0%	0.9999	1.0000
12	5	0%	0.9998	0.9981
12	10	0%	0.9997	0.9854
3	1	Stochastic	0.9986	1.0000
3	5	Stochastic	0.9852	0.9996
3	10	Stochastic	0.9814	0.9975
12	1	Stochastic	0.9990	1.0000
12	5	Stochastic	0.9988	0.9897
12	10	Stochastic	0.9989	0.9323

Table 3
XJO CFDs and XJO Futures (Three Months from Expiry) Summary Statistics

The table reports the average daily volume and average daily open interest for S&P/ASX 200 (XJO) futures contracts with expirations from March 2008 to March 2012 and for three months out from expiration date. The average daily volume and average daily open interest of the respective XJO CFDs for the same days as each futures contract is also reported. Futures tracking error is the annualized standard deviation difference of daily returns of the lasted traded futures contracts price and the XJO price level at the close of continuous trading hours (typically 16:00).

	Average Daily Volume		Average Daily Open Interest		Average Daily 1 Minute Spreads (%)		
Futures Expiry Date	CFDs	Futures	CFDs	Futures	CFDs	Futures	Futures Tracking Error (% p.a.)
20/03/2008	187	31,174	2,634	277,328	0.18	0.03	5.51
19/06/2008	237	26,322	1,476	253,915	0.12	0.03	4.61
18/09/2008	234	31,080	1,259	258,314	0.12	0.03	5.21
18/12/2008	387	38,667	1,449	314,863	0.22	0.04	11.33
19/03/2009	313	28,507	1,416	309,972	0.09	0.06	6.36
18/06/2009	503	30,347	4,525	296,469	0.08	0.03	4.03
17/09/2009	718	29,876	5,744	229,278	0.09	0.03	3.65
17/12/2009	904	27,891	6,263	216,023	0.09	0.02	2.78
18/03/2010	504	28,194	5,912	195,470	0.11	0.03	3.80
17/06/2010	1,011	33,227	7,710	216,229	0.08	0.02	3.63
16/09/2010	1,349	31,227	19,309	222,401	0.08	0.03	4.13
16/12/2010	835	29,462	18,429	208,054	0.06	0.02	2.89
17/03/2011	1,392	29,868	7,100	193,769	0.08	0.02	2.97
16/06/2011	867	34,191	2,273	190,581	0.08	0.03	2.54
15/09/2011	964	41,888	5,554	224,257	0.12	0.03	3.60
15/12/2011	1,062	35,387	6,440	206,893	0.14	0.03	4.12
15/03/2012	468	28,411	4,741	189,927	0.07	0.03	2.80
All Contracts	710	31,576	6,123	235,328	0.10	0.03	4.79

Table 4
Comparing Cash Flows Using Empirical Data (Three Month Holding period)

We obtain the data from Thomson Reuters Tick History (TRTH) that contains the ASX-listed S&P/ASX 200 CFDs (ASX ticker IQ), 17 S&P/ASX 200 futures contracts with expiry dates from March 2008 to March 2012 (expiration months Mar, Jun, Sep and Dec), and intraday put and call options data. Each benchmark contract (perfect foresight forward, put-call parity forward or untailed futures) is described in Section 4.2.1. The column 'CFDs Long' denotes using CFDs inclusive of a 1.5 percent open interest charge. 'Tfut' and 'Ufut' denote using tailed and untailed futures respectively and are settled at the futures 'special opening price' on expiration date. 'Tfut1' and 'Ufut1' denote using tailed and untailed futures respectively, and the settlement price is the closing level of the XJO on expiration. The table reports summary statistics of the percentage error of a strategy relative to the benchmark contract. Percentage Error is the futures or CFDs cash flow less a benchmark contract strategy's cash flow, expressed as a percentage of the forward contracts starting period price (f_0). *t*-statistics are in parenthesis. ** and * denote statistical significance at the one and five percent levels respectively.

Benchmark Contract	Statistic	CFDs	CFDs Long	TFut	UFut	TFut1	UFut1
Perfect Foresight Forward	Mean	0.04*	0.41**	0.09	0.10	-0.09	-0.08
	Std Dev	0.07	0.09	0.88	0.92	0.55	0.58
	t-stat	(2.17)	(18.71)	(0.43)	(0.45)	(-0.65)	(-0.56)
	Abs Mean	0.07**	0.41**	0.69**	0.71**	0.34**	0.35**
	Std Dev	0.04	0.09	0.52	0.56	0.44	0.45
	t-stat	(7.41)	(18.71)	(5.50)	(5.22)	(3.16)	(3.22)
Put-Call Parity Forward	Mean	0.45	0.82	0.50	0.51	0.33	0.34
	Std	2.00	2.01	2.10	2.12	2.19	2.19
	t-stat	(0.93)	(1.69)	(0.98)	(0.99)	(0.62)	(0.63)
	Abs Mean	0.91	1.07*	1.21**	1.22**	1.12*	1.14*
	Std Dev	1.83	1.88	1.77	1.78	1.89	1.88
	t-stat	(2.05)	(2.34)	(2.84)	(2.82)	(2.45)	(2.49)
Untailed Futures	Mean	-0.06	0.31	-0.01	0.00	-0.19	-0.18
	Std Dev	0.96	0.97	0.08	0.00	0.98	0.96
	t-stat	(-0.27)	(1.32)	(-0.50)	-	(-0.78)	(-0.76)
	Abs Mean	0.74**	0.86**	0.05**	0.00	0.78**	0.76**
	Std Dev	0.58	0.52	0.05	0.00	0.60	0.58
	t-stat	(5.27)	(6.85)	(4.21)	-	(5.31)	(5.47)

Table 5
CFD Cash Flows and Futures Price Changes

This table reports individual contract and pooled coefficient estimates of γ_0 from expression (27):

$$\frac{CFD_t}{\Delta F_t}(1+r)^{T-t} + \frac{\Delta S_t r}{\Delta F_t}(1+r)^{T-t} = \gamma + e_t$$

The data is from Thomson Reuters Tick History (TRTH) and contains the ASX-listed XJO CFDs (ASX ticker IQ) price and 17 futures price for contracts with expiry dates from March 2008 to March 2012 (expiration months Mar, Jun, Sep and Dec). Columns two to four test for a three month holding period to expiry with individual regressions for each contract. Column four tests for five days to expiration using a pooled regression of expression 27 with dummy intercepts for each contract. Futures and underlying XJO prices at 16:00 are used to reduce non-synchronous trading. *t*-statistics are in parenthesis for the null hypothesis that $\gamma = 1$. The *F*-test tests for the null hypothesis that the individual contract γ are jointly equal to 1. ** and * denote statistical significance at the one and five percent levels respectively.

	Three Month Holding Period			Five Day Holding Period
Expiry Date	Full Model	No $\Delta S_t r$	No Tail	Full Model
Mar 08	0.71	0.71	0.71	0.50
	(-1.45)	(-1.45)	(-1.49)	(-0.64)
Jun 08	0.32*	0.32*	0.32*	0.63
	(-2.04)	(-2.04)	(-2.07)	(-0.47)
Sep 08	0.90	0.90	0.89	1.08
	(-0.95)	(-0.95)	(-1.04)	(0.10)
Dec 08	1.69	1.69	1.67	0.28
	(1.29)	(1.29)	(1.28)	(-0.91)
Mar 09	0.94	0.94	0.94	1.09
	(-1.18)	(-1.18)	(-1.27)	(0.12)
Jun 09	0.88	0.88	0.87	1.01
	(-0.51)	(-0.51)	(-0.53)	(0.02)
Sep 09	1.13	1.13	1.13	1.26
	(1.21)	(1.21)	(1.18)	(0.33)
Dec 09	1.32	1.32	1.32	3.47**
	(1.80)	(1.80)	(1.78)	(3.13)
Mar 10	0.75	0.75	0.75	1.02
	(-0.76)	(-0.76)	(-0.77)	(0.02)
Jun 10	0.94	0.94	0.94	0.59
	(-0.41)	(-0.41)	(-0.44)	(-0.42)
Sep 10	1.04	1.04	1.03	0.82
	(0.31)	(0.31)	(0.26)	(-0.23)
Dec 10	0.87	0.87	0.86	0.75
	(-1.20)	(-1.20)	(-1.26)	(-0.32)
Mar 11	0.93	0.93	0.92	1.11
	(-0.74)	(-0.75)	(-0.80)	(0.14)
Jun 11	0.99	0.99	0.99	1.08
	(-0.12)	(-0.13)	(-0.22)	(0.09)
Sep 11	0.82	0.82	0.82	1.23
	(-1.50)	(-1.50)	(-1.55)	(0.23)
Dec 11	1.19	1.19	1.19	0.98
	(0.98)	(0.97)	(0.95)	(-0.03)
Mar 12	1.09	1.09	1.08	0.91
	(0.63)	(0.63)	(0.59)	(-0.12)
All contracts	0.98	0.98	0.97	1.05
	(-0.41)	(-0.42)	(-0.52)	(0.28)
F-test	1.30	1.30	1.31	2.63*

Figure 1
CFD Cash Flows and Futures Price Changes
γ_0 Estimates and their 95 Percent Confidence Intervals for Individual Contracts

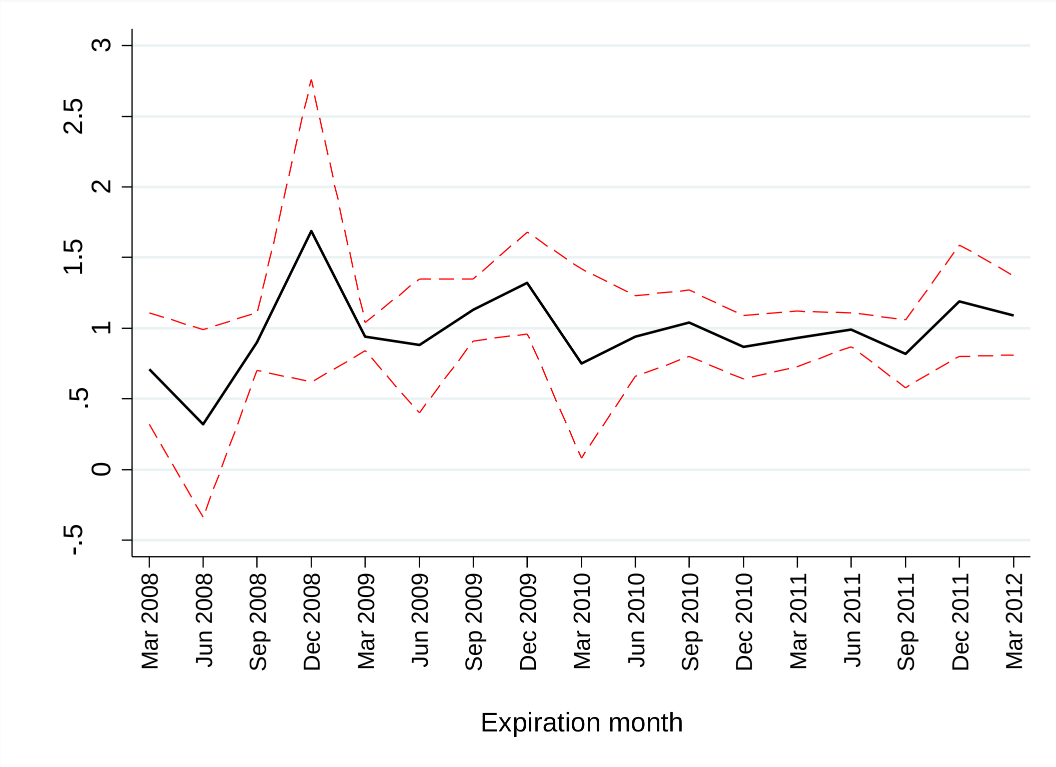
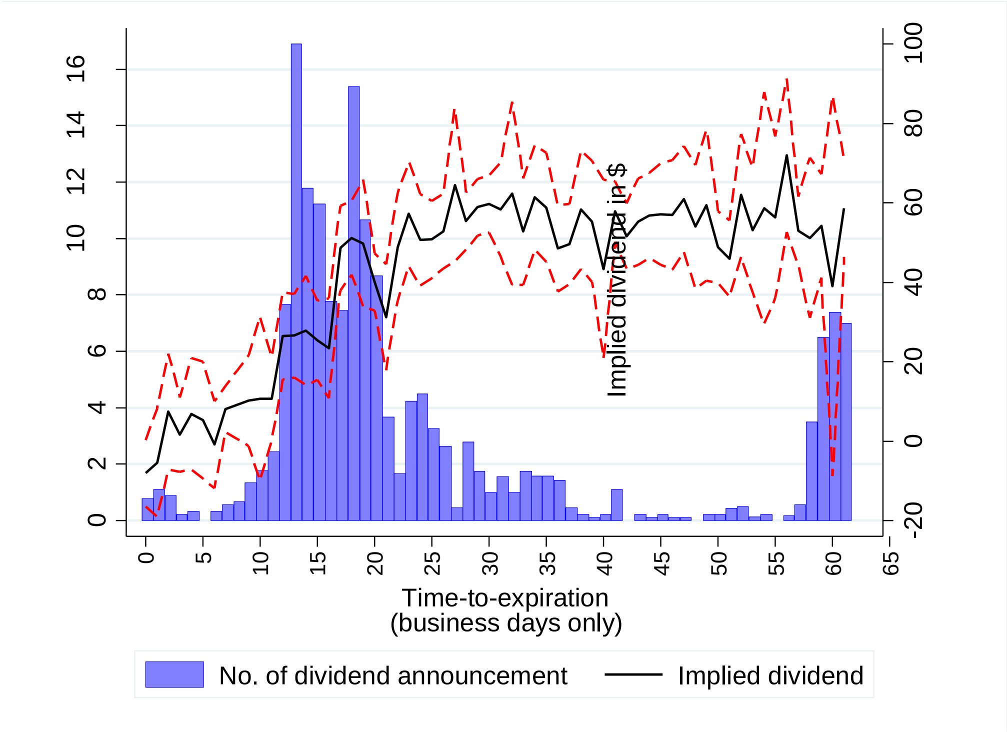
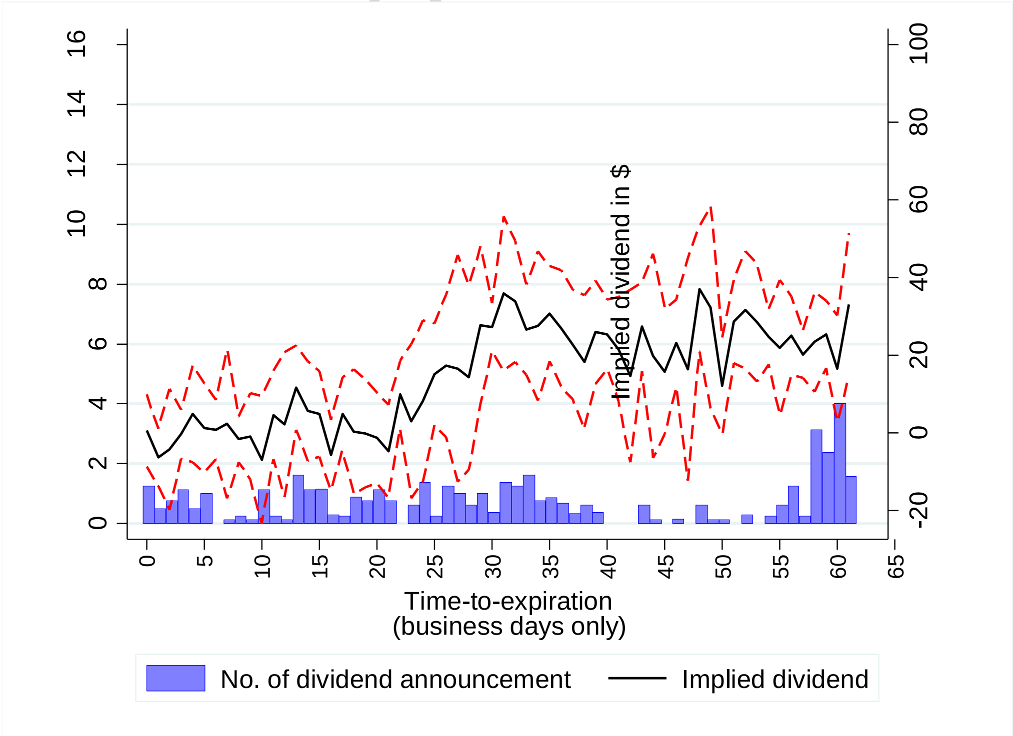


Figure 2

Implied Dividends, Average Number of Earnings/dividend Announcements and Time-to-Expiration of XJO Futures Contracts

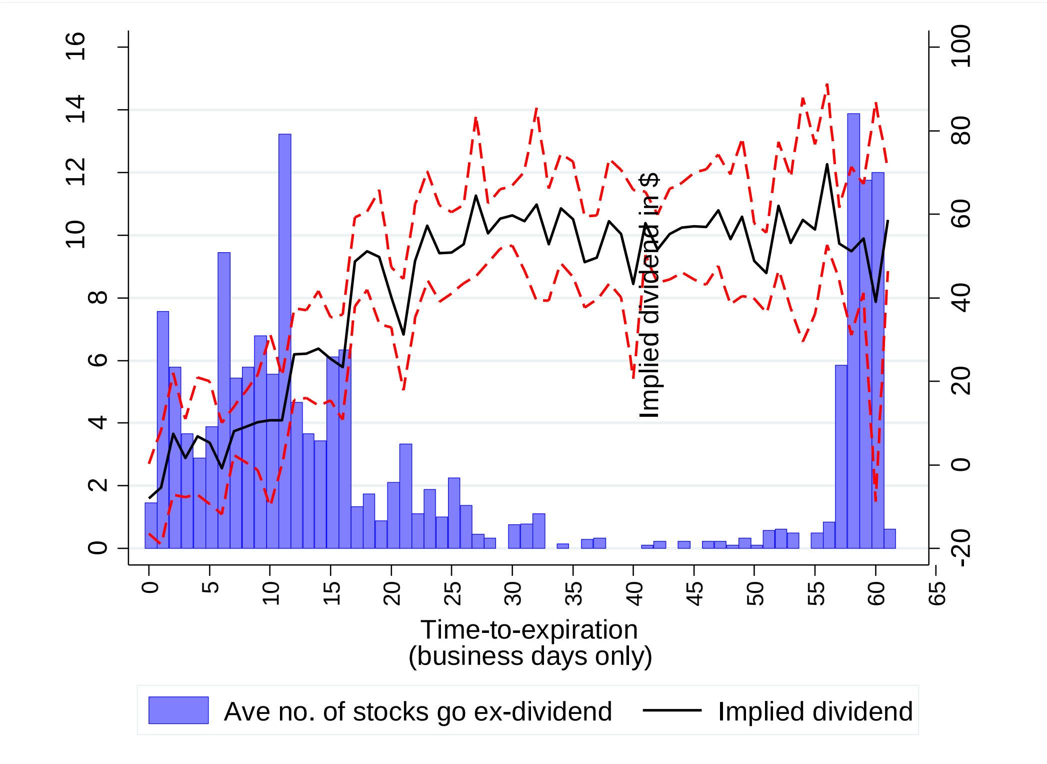


Panel A. March and September Expiration

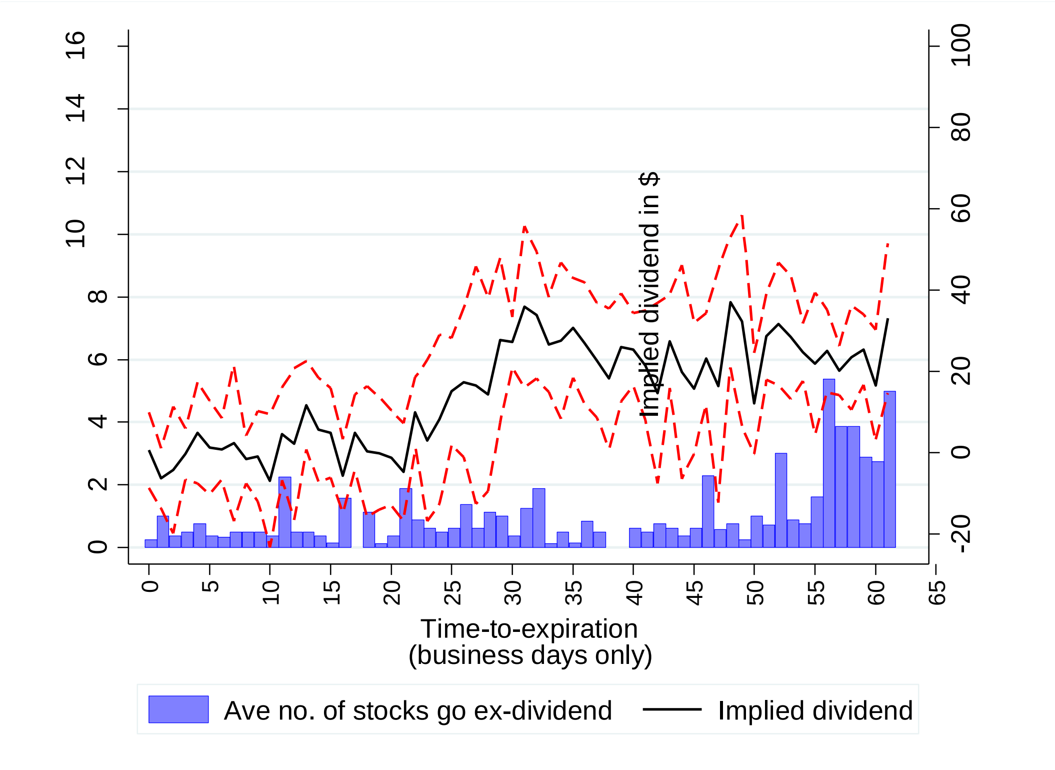


Panel B. June and December Expiration

Figure 3
Implied Dividends, Average Number of Stocks that Go Ex-dividend and Time-to-Expiration of XJO Futures Contracts



Panel A. March and September Expiration



Panel B. June and December Expiration

Highlights

- Contracts for difference (CFDs) are for retail clients but may replace forward/futures.
- CFDs have had a regulatory and market history distinct from future and forward contracts.
- Prior research finds CFDs track the underlying asset well.
- Yet the exact relations to CFDs to forwards/futures has not been explored.
- We establish link the two and find they have similar (yet different) cash flows.